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NONRESIDENTIAL BUILDING ENERGY EFFICIENCY STANDARDS

CONTRACTOR'S REPORT

VOLUME 1 - MEASURE ANALYSIS

November 2000
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Contractor Report

2001 Update – AB 970 Draft Nonresidential Building Standards

Energy Commission Publication No. P 400-00-025/V1
Measure Analysis

This Contractor Report, prepared by Eley Associates, contains the supporting analysis of the proposed measures for the Nonresidential Building Energy Efficiency Standards. This report is intended for discussion at an Efficiency Standards Committee hearing on November 28, 2000. The hearing purpose is to obtain public comment on this report and revisions to the Title 24 Building Energy Efficiency Standards (California Code of Regulations, Title 24, Part 6).

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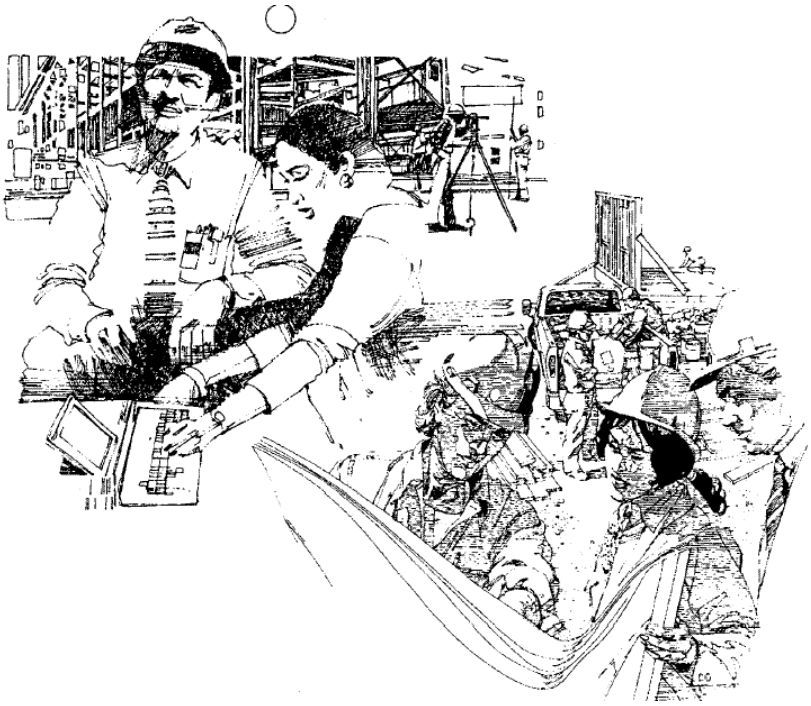
November 17, 2000



Volume I – Measure Analysis

Assembly Bill 970 Emergency Rulemaking – 2001 Update of California Nonresidential Energy Standards

November 17, 2000

California Energy Commission
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Contract Number 400-00-005
Task 2 – Measure Analysis

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Introduction

This document identifies potential upgrades and improvements to the *1998 Energy Efficiency Standards for Residential and Nonresidential Buildings* (California 1998). It is the subject of a public hearing to be held at the California Energy Commission (CEC) on November 28, 2000. The measures that are analyzed in this document were discussed at public workshops held at the Energy Commission on September 8 and 25, 2000. The potential upgrades are mostly based on the national standard, ASHRAE/IESNA Standard 90.1-1999 (ASHRAE 1999), which was recently adopted and approved as an ANSI national consensus standard. These changes are being implemented through an emergency rulemaking, which is mandated by Assembly Bill 970, signed into California law in September 2000.

This document is organized in four volumes. This is Volume I and contains the supporting analysis for the measures. Volume II is the Draft Standard and contains underlines and strikethroughs for the regulation. Volume III is the Draft ACM Manual, which has the rules for making whole building performance calculations for code compliance. Volume IV is an Impact Analysis that estimates state-wide gas and electricity savings that will result from the proposed changes.

The following measures and modifications are being considered.

- **Fenestration**
  - *Update the criteria for U-factor and SHGC to be more consistent with ASHRAE 1999.* The California nonresidential fenestration requirements were last updated in 1992. At that time, the Energy Commission only considered clear and tinted glazing constructions in developing the criteria because of aesthetic issues related to reflective glass as well as cost and availability uncertainties related to low-e coatings. Fenestration technologies have improved in the last 10 years, the markets are more stable. By contrast, ASHRAE 1999 considered a wide variety of glazing constructions in determining the criteria, and as result, the criteria are more stringent and appropriate for modern technologies, especially with regard to reflective glass and low-e coatings.
  - *Require NFRC testing and labeling for site-built fenestration in nonresidential buildings larger than 100,000 ft².*
- **Cool Roofs**. *Provide a credit for cool roofs that can be used with both the building envelope trade-off option and the whole building performance method.* Cool roofs have both a high reflectance and a high emittance. The high reflectance keeps much of the sun's energy from being absorbed and becoming a component of heat transfer. The high emittance assures that when the roof does warm up, its heat can escape through radiation to the sky. Cool roofs are not considered in California 1998 as either a credit or the basis of the standard. However ASHRAE 1999 has credits for cool roofs that allow you to make trade-offs against roof insulation or other measures.
- **Lighting**
  - *Require that exterior lighting have a minimum efficacy of 30 lumens/watt.* This will prohibit mercury vapor and incandescent lighting for lamps larger than 100 W.
  - *Update the area category lighting power density allowances for to be consistent with ASHRAE/IESNA Standard 90.1-1999.*
  - *Modify the exceptions for bi-level illumination.* This will cause the requirement to apply to more cases and increase the ability of building owners to respond to power emergencies.
  - *Close the loophole for task lighting in office applications.*
  - *Eliminate the power credit for lumen maintenance since this technology is no longer used.*
  - The are several instances within California 1998 where the allowable lighting power densities (LPD) for buildings or spaces are higher than that for corresponding constructions in ASHRAE 1999. In addition, a number of metrics and exceptions used to define applicable spaces in California 1998 are not consistent with economic trends or advances in lighting technology.

- **HVAC**
  - *Update the HVAC Equipment Efficiency requirements to be consistent with ASHRAE/IESNA Standard 90.1-1999.* ASHRAE 1999 has more stringent equipment efficiency requirements than California 1998 for non-NAECA HVAC equipment. The ASHRAE efficiency requirements were justified through life cycle cost analysis, using cost data provided by the manufacturers through their trade organizations, the Air-conditioning and Refrigeration Institute (ARI)[1] and the Gas Appliance Manufacturers Association (GAMA).
  - *Adopt the ASHRAE 1999 measures to mitigate standby losses for gas- and oil-fired forced air furnaces.* Requirements include power venting, vent dampers or flue dampers when the equipment is in conditioned space; intermittent ignition or interrupted devices (IID) regardless of location; and limits on jacket losses for furnaces located in unconditioned spaces.
  - *Adopt the tradeoff method for centrifugal chillers designed to operate at non-ARI standard test conditions.*
  - *Provide a prescriptive trade-off table for airside economizers that allow higher equipment efficiencies in lieu of an economizer for unitary air-conditioners and heat pumps.* This requirement is a modification of a trade-off developed for ASHRAE Standard 90.1-1999, but adapted for the 16 California climate zones.
  - *Add requirements for the type of high-limit switch, which can be used for air-side economizers.* This requirement is based on ASHRAE 1999, but adapted for California climates.
  - *Add language to the standard to protect pipe and duct insulation that is exposed to outdoor conditions.* Also protect pipe insulation in unconditioned space.
  - *Add requirements for demand-controlled ventilation in high occupancy spaces.* This requirement is similar to a mandatory measure in ASHRAE 1999 and is supported by a life cycle cost study.
  - *Require fan speed speed controls for cooling towers and air-cooled or evaporatively cooled condensers.*
- **Ducts.** *Modify the Nonresidential ACM to include the impact of duct leakage and insulation levels on heating equipment efficiency and cooling equipment efficiency for individual packaged equipment serving 5000 ft²*. The procedure applies only to duct work located in spaces above insulated ceilings and beneath the roof.

[1] ARI is the national trade association representing manufacturers of more than 90 percent of U.S. produced central air-conditioning and commercial refrigeration equipment.

Economic Analysis

Summary

The Energy Commission is required by law to develop and maintain energy efficiency standards that are ". . *cost effective, when taken in their entirety, and when amortized over the economic life of the structure when compared with historic practice*".[2] The economic assumptions used in previous life cycle cost analysis are documented in "*Summary of Cost Effectiveness Methodology and Assumptions*", Building and Appliances Efficiency Office, California Energy Commission, March 29, 1990. This general approach is used in this measure analysis report. The key points are as follows:

- If a measure reduces overall life cycle cost, then it is considered to be cost effective.
- The change in life cycle cost between two measures is calculated as follows:

Change in Life cycle Cost	=	Change in Initial Cost	–	Present Value of Electricity Cost Savings	–	Present Value of Gas Cost Savings

- The present value of electricity and gas cost savings is calculated as follows:

Present Value of Energy Cost Savings	=	Energy Saved Per Year	X	Present value of the cost of energy over the measure

Determining the value of future energy savings is both a technical task and a policy exercise. The following bullets summarize the basis of the estimate.

- Future energy savings are discounted to present value at the rate of 3%. The discount rate is used to devalue energy savings in the future. The 3% rate is a real rate, with no consideration of inflation and is unchanged from previous Energy Commission life cycle cost analysis.
- For lighting and HVAC measures, energy savings are considered over a period of 15 years. This too is consistent with assumptions used in previous analyses. However, for building envelope measures, energy savings are considered over a period of 30 years (the same as low-rise residential buildings). A shorter 15-life is assumed for HVAC and lighting measures in nonresidential buildings because of high tenant turn over (churn rate) and the typical life of nonresidential HVAC equipment.

Estimating the cost of energy in the future is most difficult. The cost depends on the size of the building, its peak demand and many other factors. In addition, different approaches can be taken in estimating future energy costs. The Energy Commission forcasting group has made estimates of the average cost of electricity and gas for different classes of nonresidential customers. These estimates are over a period of 20 years. Another approach, however, is to evaluate the cost of electricity for different times of the day and for seasons of the year. This is how utility companies currently charge many nonresidential customers. Both of these approaches are used in this analysis, but the statewide averages are used as the basis of the life cycle cost analysis, since they result in lower net present values and provide a conservative approach. The price projections for each of these scenarios are contained in Appendix A.

Based on the statewide averages, the present value of a kWh of electricity saved over the 15-year life of a nonresidential building is $1.02. The present value of a therm of natural gas saved over the life of a nonresidential building is $7.04. For fenestration and building envelope requirements a 30-year time horizon is used and the present value of energy saved is $1.68/kWh-y saved and $11.43/therm-y saved.

[2] Warren Alquist Act, Section 25402.

Statewide Average Net Present Value of Electricity and Gas

Table 1 summarizes the 15-year and 30-year net present value of gas and electricity for various nonresidential customer types. The electricity values were determined based on statewide average price projections provided by the Energy Commission for the years 2000 to 2019. Price projections for the years 2020 to 2030 were calculated through a linear extrapolation of the change in price over the preceding ten years. The projected trends in electricity and gas prices are illustrated in Figures 1 and 2. The data can be found in Appendix A. The same extrapolation method was also used for gas prices between the years 2020 to 2030. Gas prices for the years 2000 to 2019 are weighted by demand and are based on information from Appendices C and H of the *Natural Gas Market Outlook 2000-2020*.

Table 1 –Net Present Value of Gas and Electricity for various sectors

	Electricity ($/kWh-y)			Natural Gas ($/therms-y)		
Class	Low-Rise Residential	Small Commercial (< 20 kW)	Medium Commercial (>20 kW)	Low-Rise Residential	Commercial Core	Commercial Noncore
30 Years	2.07	2.15	1.68	13.27	11.43	7.49
15 Years	1.27	1.31	1.02	8.20	7.04	4.49

Notes: NPV calculations based on statewide average price projections provided by the Energy Commission. The small commercial figure applies to buildings will a demand less than 20 kW while the medium commercial rate applies to buildings with a greater demand.

The residential gas and electric NPVs apply to low-rise residential buildings and are not applicable for nonresidential buildngs. The medium commercial rates (as opposed to small) are used in this analysis since these are lower and if life cycle cost is justified at this lower rate, measures will be automatically cost effective with the higher rate. These electric rates apply to high-rise residential as well as commercial buildings. For gas, the Commercial Core rates apply to nonresidential buildings.

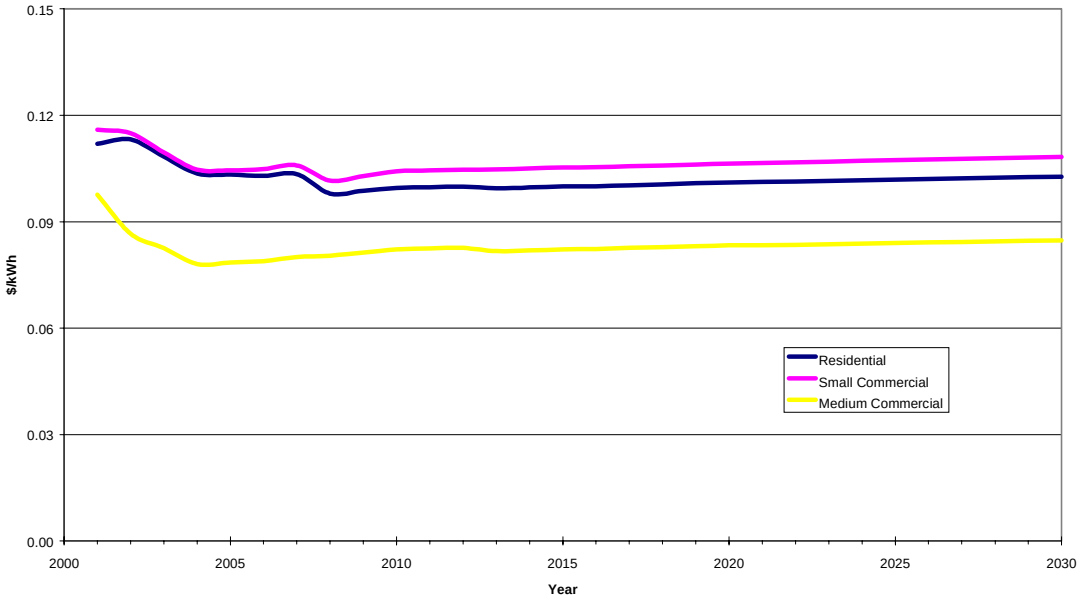

Figure 1 – Projected Statewide Average Electricity Prices

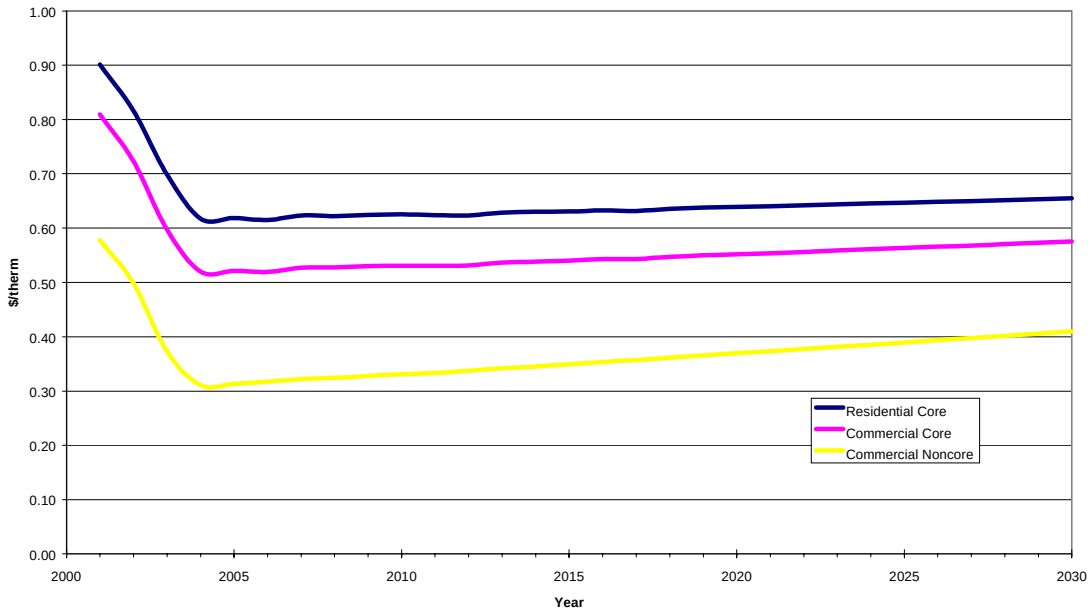

Figure 2 – Projected Statewide Average Gas Prices

Time Block Weighted Net Present Value of Electricity

An alternative to using the statewide average value is to use a time weighted present value. This method is based upon projected electricity prices that vary with season and time of use. The projected prices are estimated for five different time blocks; three for summer and two for winter. Table 2 defines each of the time charge periods.

Table 2 – Definition of Time Blocks.

	On-Peak	Mid-Peak	Off-Peak
Summer (May 1 - October 31)	Noon to 6 pm during all non-holiday weekdays	9 AM to 6 PM during all non-holiday weekdays	9 PM to 9 AM during all non-holiday weekdays and 24 hours/day during weekends and holidays
Winter (November 1 - April 30)	Not Applicable	9 AM to 9 PM during all non-holiday weekdays	

Note: Winter on-peak was not considered here as it is rarely used by California utilities in their tariffs.

Table 3 displays the net present value of electricity in each time block based on a 3% discount rate. Energy Commission staff calculated these data. Two values are given. The first set is based on projections by the California Energy Commission forcasting group. The second set, labeled “ALJ”, are based on estimates of the California Public Utility Commission (CPUC) as described in a ruling by the CPUC’s administrative law judge (ALJ). Both CEC and ALJ price projection data are contained in Appendix A.

Table 3 – CEC and ALJ Adjusted Statewide Average Net Present Value of Electricity for Various Time Blocks and Building Sectors.

	Building Sector	NPV	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter Mid-Peak	Winter Off-Peak	Weighted Average
Weights	Small Commercial		13%	14%	14%	41%	18%	N.A.
	Medium Commercial		19%	16%	17%	32%	16%	N.A.
CEC	Residential	30 Years	2.59	2.10	1.79	2.15	1.94	N.A.
	Small Commercial	30 Years	2.64	2.15	1.84	2.20	2.03	2.17
		15 Years	1.63	1.33	1.15	1.37	1.25	1.35
	Medium Commercial	30 Years	2.10	1.62	1.31	1.66	1.54	1.66
		15 Years	1.30	1.00	0.81	1.03	0.95	1.03
ALJ	Residential	30 Years	5.31	2.44	2.13	2.40	2.12	N.A.
	Small Commercial	30 Years	5.36	2.49	2.18	2.44	2.18	2.74
		15 Years	3.70	1.61	1.43	1.55	1.36	1.79
	Medium Commercial	30 Years	4.80	1.96	1.65	1.91	1.71	2.39
		15 Years	3.35	1.28	1.10	1.22	1.07	1.59

Notes:

1 Weights for each time block are calculated from the NRNC database.

2 Medium commercial is most of the nonresidential new construction, representing more than 99%.

3 NPV calculations based on price projections provided by the CEC

In order to translate the data in Table 3 in to figures that can be compared to those in Table 1, it is necessary to apply weightings for the savings that are expected to occur during each time charge period. The weightings that are used are shown in the first two rows of Table 3 and are calculated according to energy savings associated with the changes between the 1998 standard and the proposed 2001 standard. More details of the analysis are described in *Volume IV – Impact Analysis*.

ASHRAE

Most of the requirements in ASHRAE 1999 were justified with life cycle cost analysis. The ASHRAE approach to life cycle cost is simple. This is based on the concept of a scalar ratio. The scalar ratio accounts for the discount rate, study period (building life), and other factors. The following equation shows how life cycle cost was calculated by ASHRAE.

$$\text{Change in Life cycle Cost} = \text{Change in Initial Cost} - \text{Scalar Ratio} \left(\text{Annual Electricity Cost Savings} + \text{Annual Gas Cost Savings} \right)$$

The scalar ratio combines the effects of equipment life, discount rate, fuel escalation rates, federal and state tax rates, down payment, and financing costs. The scalar ratio is applied to the annual energy costs for each measure in a fashion similar to a series present worth factor. Annual energy costs are determined using the estimated annual energy use for a measure and national average fuel prices of $0.08/kWh for electricity and $0.56/therm for natural gas. Because the analysis considered incremental changes in measure efficiency, maintenance costs for each incremental change were assumed to be zero.

ASHRAE used a scalar ratio of 8 for the development of all criteria. Using the ASHRAE scalar ratio and national average energy prices, the effective present worth of a kWh of electricity saved over the life of the building is approximately $0.64/kWh-y, while the effective present worth of a therm of gas saved over the life of the building is $4.48/therm-y.

Comparison of Economic Scenarios

Table 4 compares the present value of electricity and gas savings for ASHRAE 1999 with that of California 1992, and various California 2001 scenarios. The approach in this analysis is to use the statewide average values for a medium commercial building. These are the lowest of all the various Callifornia pricing scenarios and thus, the most conservative, e.g. if a measure is cost effective with these assumptions, it will be even more cost effective under any of the other scenarios.

Table 4 – Comparison of ASHRAE 1999 and California Standards for Economic Performance

	Present Value of a kWh of Electricity Saved Over the Building Life		Present Value of a Therm of Gas Saved Over the Building Life	
	15-year	30-year	15-year	30-year
California 1992	$1.04	N.A.	$6.47	N.A.
California 2001 – Statewide Averages – Medium	**$1.02**	**$1.68**	**$7.04**	**$11.43**
California 2001 – Statewide Averages – Small	$1.31	$2.15		
California 2001 – Time Block Weighted (CEC) – Medium	$1.03	$1.66		
California 2001 – Time Block Weighted (CEC) – Small	$1.35	$2.17		
California 2001 – Time Block Weighted (ALJ) – Medium	$1.59	$2.39		
California 2001 – Time Block Weighted (ALJ) – Small	$1.79	$2.74		
ASHRAE 1999	$0.64	N.A.	$4.48	N.A.

Since many of the measures that are being considered are taken from ASHRAE/IESNA Standard 90.1-1999, it is important to compare the assumptions used in these analyses to those used in the ASHRAE life cycle cost analysis. As shown in Table 4, all of the California scenarios value energy savings significantly higher than did ASHRAE. If everything else in the analysis is equal, e.g. measure cost, savings models, etc., then it is possible to justify a greater investment in energy efficiency and more stringent criteria using the California economic performance criteria. In addition, the ASHRAE requirements were subjected to three extensive public reviews and were developed using ANSI standards for consensus documents. For these reasons, no California specific life cycle cost analysis was performed for many HVAC measures taken directly from ASHRAE 1999.

Fenestration

Recommendations

Summary

For both windows and skylights, update the U-factor and solar heat gain coefficient (SHGC) criteria for nonresidential and high-rise residential occupancies to account for advances in glazing technologies such as thermal break frames, advanced spacers, low-e and reflective coatings. The following bullets describe the details of the updated criteria.

- Make the window and skylight SHGC criteria more stringent with larger areas, e.g. higher window-wall ratio (WWR) for windows and higher skylight-roof ratio (SSR) for roofs. Also, calculate separate criteria for north and non-north orientations.
- Develop the criteria using a methodology similar to that used to develop ASHRAE/IESNA Standard 90.1-1999, but adapt the methodology for California climates and conditions. Replace the heating degree energy model used for Standard 90.1-1999 with a model that is specific to California climates and update the cost models for fenestration products for California conditions.
- Since fenestration and insulation typically lasts for the life of the building, base the life cycle cost analysis on a 30-year time horizon, rather than the 15-year time horizon used for lighting and HVAC measures. A 15-year life cycle cost analysis was used to develop the current nonresidential fenestration criteria.
- Present one set of U-factor criteria for windows, but base these on operable windows. Fixed windows tend to have a lower U-factor, when all other factors are equal, so they would comply with the criteria for operable windows.
- Present the skylight U-factor and SHGC criteria separately for glass and plastic skylights. For glass skylights present the criteria separately for skylights to be mounted on a curb and those that are not[3]. Plastic skylights include acrylic, fiberglass and other petrol-chemical based products. Drop the distinction between translucent and transparent in the current standard and replace it with the glass/plastic classifications.
- Map the U-factor criteria to generic products represented in the ASHRAE Fundamentals 1997 U-factor table (also included as Table A-17 in Standard 90.1-1999).

Adjust the climate groupings in Tables 1-H and 1-I of the standard so that climate zones 2 and 10 are grouped with the central valley climates (11, 12, and 13). Currently, climate zones 2 and 10 are grouped with the north coast and south coast climate regions, respectively. Cost effective fenestration performance requirements for climates 2 and 10 are closer to the central valley climates than they are to the coastal climates. This change also affects wall and roof insulatfion requirements for climates 2 and 10.

Require NFRC certification of site-built windows and overhead glazing in buildings larger than 100,000 ft². Currently site-built glazing systems are exempt from NFRC testing and labeling requirements. This change would be require testing and label certificates for glazed wall systems and overhead glazing in large buildings, which are estimated to represent 12% of new construction nonresidential building permits and 50% of the floor space[4]. Manufactured skylights (sloped fenestration) in buildings larger than 100,000 ft² is also exempt from NFRC testing and labeling requirements. No change is proposed for manufactured skylights.

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[3] NFRC ratings for skylights include heat loss through the curb. In order to use NFRC ratings the criteria must be expressed in a way that includes the curb.

[4] These estimates are based on the Nonresidential New Construction Baseline Study, RLW Analytics, July 8, 1999, California State-Level Market Assessment and Evaluation Study, Project Manager: Marian Brown, Southern California Edison.

Title 24 Changes

Changes are needed in three sections of the Energy Standards:

- §143 contains the prescriptive requirements and Tables 1-H and 10-I of this section will be modified to include the revised criteria. A minor change is also proposed for the exception for perimeter glazing to allow either the north facing RSHG criteria to be used or glazing with a SHGC of 0.56 or lower. An SHGC of 0.56 can be achieved with clear double glass and a standard sputter low-e coating.
- §10-111 has NFRC labeling requirements and this sections is modified so that the NFRC labeling and testing requirements apply to site built glazed wall systems and overhead glazing in buildings larger than 100,000 ft². The modifications also make it clear that NFRC's "Label Certificate (for site built products)" complys with the labeling requirements.
- §116 has procedures for determining U-factors and SHGC for fenestration systems and products. This section is modified to allow the use of ASHRAE default tables for skylights and site-built fenestration systems in buildings smaller than 100,000 ft². The existing default tables (1-D and 1-E) will continue to be used for other fenestration products and systems.

See *Volume II – Draft Standard* for the specific proposed changes to the regulations.

§143 Prescriptive Requirements For Building Envelopes

Modify Tables 1-H and 1-I to incorporate the updated fenestration criteria. The proposed criteria in Tables 5, 6, 7 and 8 contain the recommendations for fenestration. These criteria were developed through life cycle cost analysis described later in this chapter and included in the appendix. These changes are also shown in Volume II of this report as underlines and strikethroughs to the standard.

It is recommended that climate zones 2 and 10 be grouped with climate zones 11, 12, and 13 for purposes of expressing the prescriptive requirements in Tables 1-H and 1-I. Climates 2 (the Santa Rosa area) and 10 (the San Fernando valley) are more similar to the central valley climates. This regrouping not only changes the fenestration requirements, but also the requirements for roof, wall and floor insulation as well. This analysis demonstrates that the central valley insulation levels are cost effective for Climates 2 and 10. These Climates now require R-11 wall insulation and with the new groupings, they would be required to install R-13. For climate zone 10, the roof insulation requirement would also change. It is now R-11 and it would become R-19.

The proposed fenestration criteria for windows (vertical fenestration) are shown in Tables 5 and 6 below. These contain the criteria for nonresidential and high-rise residential, respectively. The U-factor criteria apply for all window-wall ratio (WWR) ranges. However, the SHGC criteria vary with WWR, in four ranges up to a maximum of 40%. Buildings that have a WWR greater than 40% must use either the whole building Performance Approach (§141) or the Overall Envelope Approach (§143(b))

Note that the criteria is presented as relative solar heat gain (RSHG).

Table 5 – Proposed RSHG Criteria for Vertical Fenestration – Nonresidential

Climate Zones	South Coast (6-9)		North Coast (3-5)		Valley (2, 10-13)		Desert (14,15)		Mountains (1,16)	
Max. U-factor	0.81		0.81		0.49		0.49		0.49	
Max. SHGC	Non-North	North	Non-North	North	Non-North	North	Non-North	North	Non-North	North
0-10% WWR	0.61	0.61	0.61	0.61	0.47	0.61	0.46	0.61	0.49	0.72
11-20% WWR	0.55	0.61	0.61	0.61	0.36	0.51	0.36	0.51	0.43	0.49
21-30% WWR	0.41	0.61	0.39	0.61	0.36	0.47	0.36	0.47	0.43	0.47
31-40% WWR	0.41	0.61	0.34	0.61	0.31	0.47	0.31	0.40	0.43	0.47

Note: In climate zone 1, the criteria for north oriented fenestration shall be used for all orientations.

Table 6 – Proposed RSHG Criteria for Vertical Fenestration – High-Rise Residential

Note: The SHGC values in this table are those determined for nonresidential occupancies, even though greater stringency can be justified with the residential occupancy. See Appendix E for details.

Climate Zones	South Coast (6-9)		North Coast (3-5)		Valley (2, 10-13)		Desert (14,15)		Mountains (1,16)	
Max. U-factor	0.49		0.49		0.49		0.49		0.49	
Max. SHGC	Non-North	North	Non-North	North	Non-North	North	Non-North	North	Non-North	North
0-10% WWR	0.41	0.61	0.47	0.61	0.36	0.49	0.36	0.47	0.46	0.68
11-20% WWR	0.40	0.61	0.40	0.61	0.36	0.49	0.31	0.43	0.46	0.68
21-30% WWR	0.31	0.61	0.36	0.61	0.31	0.40	0.26	0.43	0.36	0.47
31-40% WWR	0.26	0.55	0.31	0.61	0.26	0.40	0.26	0.31	0.30	0.47

Note: In climate zone 1, the criteria for north oriented fenestration shall be used for all orientations.

The proposed fenestration criteria for skylights (horizontal fenestration) are shown in Tables 7 and 8 below. These contain the criteria for nonresidential and high-rise residential, respectively. The U-factor criteria apply for all skylight-roof ratio (SRR) ranges, but depend on the class of skylight: glass with curb, glass without curb and plastic. A curb is assumed for all plastic skylights. The SHGC criteria vary with SRR, in two ranges up to a maximum of 5%. Buildings that have a SRR greater than 5% must use either the whole building Performance Approach (§141) or the Overall Envelope Approach (§143(b))

Table 7 – Proposed Criteria for Skylights – Nonresidential

		South Coast (6-9)	North Coast (3-5)	Valley (2, 10-13)	Desert (14,15)	Mountains (1,16)
U-factor	Glass w/Curb	1.18	1.18	0.99	0.99	0.99
	Glass wo/Curb	0.68	0.68	0.57	0.57	0.57
	Plastic w/Curb	1.30	1.30	1.10	1.10	0.87
SHGC, Glass	0-2%	0.79	0.79	0.46	0.46	0.68
	2.1-5%	0.40	0.40	0.36	0.36	0.46
SHGC, Plastic	0-2%	0.79	0.77	0.77	0.71	0.77
	2.1-5%	0.65	0.62	0.62	0.58	0.58

Table 8 – Proposed Criteria for Skylights – High-Rise Residential

		South Coast (6-9)	North Coast (3-5)	Valley (2, 10-13)	Desert (14,15)	Mountains (1,16)
U-factor	Glass w/Curb	1.18	1.18	0.99	0.99	0.99
	Glass wo/Curb	0.68	0.68	0.57	0.57	0.57
	Plastic w/Curb	1.30	1.30	1.10	0.87	0.87
SHGC, Glass	0-2%	0.58	0.61	0.46	0.46	0.46
	2.1-5%	0.32	0.40	0.32	0.31	0.36
SHGC, Plastic	0-2%	0.65	0.65	0.65	0.65	0.71
	2.1-5%	0.39	0.65	0.34	0.27	0.55

Criteria Selection. Appendices E and F have the life cycle cost analysis for windows and skylights respectively. These appendices have a list of constructions ranked by life cycle cost for a variety of conditions: climate zones, window wall ratios, and orientation. For glass, the life cycle cost rankings are performed separatedly using the ASHRAE cost model and the CADMAC high volume and low volume cost models (see discussion of fenestration cost models). All of the data in Appendices E and F are based on a net present value for electricity of $1.68/kWh-y and a net present value for electricity of $11.43/therm-y (see the Economics chapter). These values are based on a 30-year life cycle cost analysis, which is appropriate for fenestration. The Economics chapter has many other scenarios on the future cost of electricity and gas that result in significantly higher net present values, making the analysis conservative.

Professional judgement was used in selecting criteria from the data in Appendices E and F, e.g. the low-life cycle cost choice was not always selected. However, the selected criteria is always cost effective. The method of selection is based on a few principles described below.

- Vinyl window frames are not permitted as the basis of the standard, since such frames are not acceptable for all building types covered by the nonresidential standards.
- Reflective coatings are not permitted as the basis of the SHGC criteria for high-rise residential, but the coatings are considered acceptable for nonresidential.
- Constructions are selected which are always cost effective using the ASHRAE cost model. In almost all instances, the recommended criteria is also cost effective with the CADMAC high and low cost models.

§10-111 Certification and Labeling of Fenestration Product U-Factors, Solar Heat Gain Coefficient, and Air Leakage

Modify §10-111 to require an NFRC label certificate for site-built glazed wall systems and overhead glazing in buildings larger than 100,000 ft², which represent about 12% of construction projects and 50% of floor space. These larger buildings must perform testing and simulations of proposed glazed wall systems to demonstrate that the proposed systems meet the requirements of the Energy Standards. More disussion is provided below on how this will be achieved. Site-built fenestration in buildings smaller than 100,000 ft² may use CEC specified default tables and/or procedures. The proposed changes in this section are based on recommendations by PG&E in its report, *Code Enhancement Initiative, Commercial Fenestration Ratings*, October 30, 2000.

§116 Mandatory Requirements for Fenestration Products and Exterior Doors

§116 has procedures for determining U-factors and SHGC for fenestration systems and products. This section is modified to allow the use of ASHRAE default tables for skylights and site-built fenestration systems in buildings smaller than 100,000 ft². The existing default tables (1-D and 1-E) will continue to be used for other fenestration products and systems. The ASHRAE default table is the same as that used in ASHRAE/IESNA Standard 90.1-1999 (Table A-17). The proposed changes in this section are based on recommendations by PG&E in its report, *Code Enhancement Initiative, Commercial Fenestration Ratings*, October 30, 2000.

ACM Changes

Update Section 2.2.2.14 of the nonresidential ACM manual to be consistent with the requirement for NFRC testing of site-built fenestration in building larger than 100,000 ft². These changes are shown in *Volume III – Draft ACM Manual*. The ASHRAE default table for site-built fenestration and skylights is added to the ACM approval manual in abbreviated form to make it more clear which values are to be used for compliance purposes. The default table is also included as Appendix C of this document.

The changes to the ACM Approval Manual also include the addition of the a procedure for calculating SHGC. This is not really a change, since the Energy Commission approved the method in July 2000. The procedure, called *Alternative Calculation Method for Nonresidential Solar Heat Gain Coefficient (P400-00-011)*, allows the use of manufacturers SHGC data for compliance purposes through a procedure that accounts for the frame and edge effects.

Discussion

Solar heat gain through windows and skylights is a major contributor to cooling loads and peak electric demand and there are significant opportunities to update and improve the standard and help achieve the legislature's goals as embodied in Assembly Bill 970. The California fenestration criteria were last updated in 1992, and at the time only very basic glazing technologies were considered in developing the criteria. At the time, low-e coatings and other advanced glazing technologies were relatively new and still fairly costly.

A life cycle cost analysis was performed to determine the most cost effective fenestration constructions when taking these newer glazings into account. The result is criteria that are more stringent and appropriate for modern technologies, especially with regard to reflective glass and low-e coatings. The details of the life cycle cost analysis are presented later in this chapter. The technologies needed to comply with the recommended requirements are not new. They are quite common in nonresidential buildings and available from numerous suppliers. The statewide impact of this change in criteria is evaluated in a separate document, *Impact Analysis, AB 970 Emergency Rulemaking to Update the California Nonresidential Building Energy Standards*, November 2000.

The life cycle cost analysis for fenestration is very conservative. For instance, the value assigned to future energy savings is on the low side of the various price scenarios presented in the Economics chapter. The process for selecting the criteria is also conservative, making the choice cost effective with any of the alternative cost models. Maybe the biggest conservatism in the analysis is the decision to not consider the cost savings related to heating, ventilating and air-conditioning (HVAC) equipment downsizing. High performance windows cost a little more, but they reduce peak loads and the prudent mechanical engineer will select smaller heating and cooling equipment in response. Not only can primary heating and cooling systems be reduced in size, but air distrubution and hydronic distribution systems can also be made smaller in many cases. Previous studies have shown that when the cost benefit of downsizing HVAC systems is accounted for, these savings can sometimes exceed the cost premium associated with better glass[5].

Impact on Manufacturers

These proposed changes would affect the glazing industry in California by increasing demand for high performance glazing products, including thermal-break frames and low-emmissivity coatings. Energy Commission staff has consulted with primary glazing manufacturers, coaters and fabricators and the industry believes that it has the manufacturing capacity to respond to the additional demand. The docket for this rulemaking has letters from at least two manufacturers verifying that the industry has adequate capacity to meet the increased demand.

Extending NFRC 100 to Site-Built Glazed Wall Systems and Overhead Glazing

Another impact of the standard is to require NFRC testing and label certificates for site-built fenestration in buildings larger than 100,000 ft². It is estimated that this could affect 12% of buildings and 50% of the floor area. The application of NFRC testing and rating procedures to site-built glazing systems is recent and most codes including California and ASHRAE/IESNA. In Standard 90.1-1999, site-built glazing systems are exempt from the NFRC testing and labeling procedures. The only known jurisdiction that has implemented NFRC for site built glazing systems is the State of Washington. The recommendations for California are based on the experience gained in Washington State and in particular the City of Seattle.

For manufactured fenestration products that arrive at the construction site as a unit, the manufacturer assumes the burden of doing the testing and labeling. However, with site-built glazing systems, there are multiple entities responsible for the glazing system. Architects and/or engineers design the basic glazing system by specifying the components, the geometry of the components, and sometimes, their method of assembly. An extrusion manufacturer provides the mullions and frames that support the glazing and is responsible for thermal breaks, etc. A glazing manufacturer provides the glazing units, cut to size and fabricated as insulated glass (IG) units. The glazing manufacturer is responsible for tempering or heat strengthening, the tint of the glass, any special coatings, the spacers and sealants. A glazing contractor (usually a subcontractor to the general contractor) puts

[5] Eley Associates, Phase III Research Report, Proposed Addendum to ASHRAE Standard 90.1, November 1, 1990, prepared for the Primary Glass Manufacturers Council (PGMC) and the American Architectural Manufacturers Association (AAMA).

the system together at the construction site and is responsible for many quality aspects. Glazed wall systems are custom designed for many buildings making it difficult or impossible to predetermine the performance of the system as a whole.

In order for a glazed wall system to be tested, simulated and labeled, one of the parties identified above must take responsibility for testing and labeling. The responsible party must obtain an NFRC license and establish relationships with a NFRC certified simulation laboratory, an NFRC certified testing laboratory and an NFRC certified independent agent (IA). Once these relationships are established and the proper licenses are obtained, then the following steps are carried out:

1. Identify the number of product lines that are contained in the building project.
2. Arrange for an NFRC certified simulation laboratory to evaluate each product line.
3. Make an arrangement with an NFRC certified testing laboratory to test each product line.
4. Arrange for the glazing manufacturer and the extrusion manufacturer to mockup samples for testing and to send them to the testing laboratory.
5. The NFRC certified independent agent (IA) then issues a label certificate that is kept on file in the general contractor's on-site construction office. The label certificate provides the same function as the temporary label that is required with manufactured fenestration products.

The city of Seattle reports that the glazing contractor typically takes responsibility for NFRC labeling and certification. It is common for the design team to include language in the construction specification that makes the general contractor responsible; the general contractor, of course, assigns this responsibility to the glazing contractor. Seattle reports that once the glazing contractor has established a relationship with an IA, a simulation laboratory and a testing laboratory, that things seem to go fairly smoothly.

Seattle reports that if the process works well, it does not delay either the design or construction process. At the time the compliance documentation is prepared, testing or labeling is needed. However, the plan checkers verify that the levels of fenestration performance shown in the contract documents (plans and specifications) and used in the compliance calculations are "reasonable" and achievable. This requires some judgment and knowledge on the part of the plan checker that will require training. If assumptions are made that are beyond the "reasonable" range, then the plan checker may require that the design team consult with a NFRC certified simulation laboratory to determine what technologies might be required to achieve the specified level of performance.

After the construction contract is awarded, the glazing contractor then takes responsibility for getting the simulations and tests made and for obtaining the label certificate. The IA issues a separate label certificate for each "product line". Each label certificate has the same information as the NFRC temporary label, but includes other information specific to the project such as the name of the glazing manufacturer, the extrusion contractor, the places in the building where the product line is used and other details. The label certificate remains on file in the construction office for the building inspector to view. Afterwards, the label certificate should be filed in the building office with the as-built drawings and other operations and maintenance data. This will give building managers the information needed for repairs or replacements.

The cost for testing and labeling site-built glazing systems varies with the size of the project. Many of the costs are fixed, so the cost per square foot is lower in larger projects. This is the primary rationale for requiring NFRC testing and labeling only in larger buildings. Table 9 shows the cost for five typical scenarios. In these cases, the cost ranges from a low of \$0.16/ft² of glazing to a high of \$0.94/ft². The various components of the cost are shown in the table.

Table 9 – NFRC Evaluation of Projected Costs for Testing and Labeling of Glazed Wall Systems
Source: James Benny, Director of Education, NFRC

		Scenerio				
Project		A	B	C	D	E
Number of Product Lines		10	4	4	2	2
Stories		50	20	10	6	4
Fenestration Area		110000	50000	25000	9000	6000
Floor Area		N.A.	200000	100000	84000	40000
Simulation Costs		$4,500	$2,000	$2,000	$1,000	$800
Testing Costs		$10,000	$4,000	$4,000	$2,000	$2,000
Total		$14,500	$6,000	$6,000	$3,000	$2,800
IA Certification Costs (annual)		$1,800	$1,800	$1,800	$1,800	$1,800
NFRC Project Costs	Member	$1,000	$500	$500	$500	$500
	Non-Member	$1,500	$750	$750	$750	$750
Participation Fees	Member	$500	$500	$500	$200	$200
	Non-Member	$750	$750	$750	$300	$300
Total Costs	Member	$17,800	$8,800	$8,800	$5,500	$5,300
	Non-Member	$18,550	$9,300	$9,300	$5,850	$5,650
Costs/Fenestration Area	Member	0.16	0.18	0.35	0.61	0.88
	Non-Member	0.17	0.19	0.37	0.65	0.94
Costs/Floor Area	Member	N.A.	0.04	0.09	0.07	0.13
	Non-Member	N.A.	0.05	0.09	0.07	0.14

Assumptions: Simulation costs are assumed to range between $300 and $400 per product line with an additional $10 to $20 per glazing option. Testing costs are assumed to be $1000 per product line. The IA certification costs is assumed to be $1800.

Non-Monetary Benefits of High Performance Fenestration

The California statue requires that energy efficiency measures in the code be shown to be cost effective on a life cycle cost basis. Life cycle cost accounts for the monetary value of energy savings, however, many of the benefits of high performance glazing are not accounted for in life cycle cost analysis. These include:

- Condensation is reduced or eliminated. This is especially important in cold climates or hot humid climates. In cold climates, the surface temperature of single glazing can be below the due point temperature and water can condense on the inside surface creating maintenance problems. In hot humid climates, moisture can condense on the outer surface of single glass when the interior is air-conditioned.
- Double glass provides greater acoustic attenuation and can be a great benefit in hotel guest rooms and other spaces where quiet is important.
- Fenestration is a major contributor to the mean radiant temperature of spaces and can have a significant impact on human comfort.
- HVAC systems and equipment can be smaller. This benefits is not included in the life cycle cost analysis performed as part of this study.

Life cycle Cost

General Approach

The basic approach in developing the fenestration criteria is to identify all the reasonable fenestration products or systems that are applicable for windows and skylights, and for each condition, find the one that is most cost effective. The conditions for determining cost effectiveness are climate zone, building type (nonresidential or

residential), window/skylight orientation, and fenestration area. The following steps describe the general approach in more detail.

1. Identify the candidate fenestration products that may be used in vertical and horizontal applications. The library includes metal, thermal break and wood/vinyl frames. It includes clear, tinted and high performance tinted glass. It includes a variety of low-e and reflective coatings. And, it includes both standard and insulating spacers for insulating glass (IG) units. The candidate constructions used in this analysis are the same as those used to develop the fenestration criteria for ASHRAE/IESNA Standard 90.1-1999. See Appendix B for a complete listing.
    a. Calculate the performance characteristics of each fenestration product in a consistent manner. The Window 4.1 program from NFRC/LBNL was used for this purpose. Window 4.1 is the "official" program used by NFRC. Generic metal, thermal break and wood/vinyl frames were used in the calculations.
    b. Collect cost data on each of the various fenestration products. A cost model was developed that assigns a cost premium to various glazing technologies and provides a method to calculate the cost for each fenestration product. See discussion below on the cost models used in this analysis.
2. Develop an energy model that gives the relative energy performance of the candidate fenestration products and accounts for differences in:
    a. U-factor, SHGC, and visible light transmission. The later is accounted for through the addition of a daylighting term in the energy savings models.
    b. Nonresidential and high-rise residential space categories.
    c. Fenestration area and orientation. For skylights only one orientation (horizontal) is considered.
3. Develop a subset of the records in the library of fenestration products that represent technologies intended primarily for reducing U-factor. These are clear products with low-e and other coatings intended to reduce thermal transmittance, as opposed to reducing SHGC.
4. Calculate the life cycle cost of each of the U-factor subset of fenestration products for a window-wall ratio (WWR) of 0.25 for vertical fenestration and a skylight-roof ratio (SRR) of 0.02. The fenestration product with the lowest LCC is used to set the U-factor criteria for all fenestration area ranges. This process is repeated for each climate zone and for each building type (residential and nonresidential).
5. For each SHGC condition, calculate the life cycle cost of each fenestration product. The fenestration product with the lowest LCC is used to set the SHGC criteria. The SHGC conditions include two orientations for vertical fenestration (north and all), and four window-wall ratio ranges (0-10%, 11-20%, 21-30%, and 31-40%). For skylights, two fenestration area ranges were considered: 0-2% and >2-5%. The criteria are calculated for the upper end of each fenestration area range.
6. Review the criteria that resulted from the above steps and apply professional judgment. This step results in criteria that are more consistent between climates and fenestration ratios. See discussion above on the method of selecting fenestration products.

Life cycle Cost Model

The follow equations show how life cycle cost was calculated.

$$LCC_i = Cost_i + (kWh_i + kWh_{Lights}) \cdot NPV_E + Therms_i \cdot NPV_G$$

where

LCC_i The life cycle cost of the ith fenestration product considered in the analysis.

$Cost_i$ The initial cost of the ith fenestration product.

KWh_i The annual heating and cooling electric energy associated with the ith fenestration product. This is calculated on the basis of a square foot of exterior wall for vertical fenestration or a square foot of roof for skylights. See the discussion of the energy model for how this is calculated.

KWh_{Lights} The annual lighting energy associated with the ith fenestration product.

$Therms_i$ The annual gas use associated with the ith fenestration product. This is calculated on the basis of a square foot of exterior surface (including opaque). See the discussion of the energy model for how this is calculated.

NPV_E The present value per kWh of electricity. See the Economics chapter.

NPV_G The present value per therm of natural gas. See the Economics chapter.

Note that there is no credit for downsizing HVAC equipment. This makes the procedure conservative in cases where it is possible to downsize the equipment.

Value of Future Energy Savings

A study period or building life of 30 years is used for evaluating fenestration products. This is contrasted with the 15-year life assumed for lighting and HVAC. The rationale for using 30 years is that the building shell typically lasts much longer than building systems. A 30-year time horizon has always been used for analysis of low-rise residential buildings.

Database of Fenestration Products

A wide variety of fenestration products are available for nonresidential and high-rise residential buildings. The variation of product available is due the choice of glazing material(s), coatings applied to one or more surfaces of glazing, the construction of the frame and the type of spacer used to separate insulating glass units.

Glass may be tinted with the addition of rouge to the molten glass when it is manufactured. Standard tints include green, blue, bronze and gray. These all have roughly the same SHGC, but green and blue have a higher visible light transmission and perform better if all else is equal. Special high performance tints are also available from some manufacturers, including Azurlite and Evergreen. These tints have a lower SHGC than standard tints; yet maintain a relatively high light transmission. In this study only three types of tinted glass are considered: clear, green and HPT (high performance tint). Other standard tinted products cost roughly the same as green, but do not perform as well since they have a lower light transmission. For simplicity, these products are all assumed to have a thickness of 6 mm (1/4 inch). While this is the most common thickness for glazing products, other thicknesses are available from most manufacturers. A 12 mm (1/2 in.) air gap is assumed for all double glazed assemblies.

Many different types of frame constructions are available. In this study, three are considered. The first is a standard metal frame, which is typically constructed of aluminum. The second option is to provide a thermal break in the metal frame. The thermal break is achieved by separating the metal extrusion in two or more parts and connecting them with a non-metallic bond, typically some type of urethane. The third option is to construct the frame with non-metalic materials such as fiberglass, wood or vinyl. While the wood/vinyl option was considered in the life cycle cost analysis, these technologies were screened by professional judgment since they are not applicable for all nonresidential building applications.

Insulating glass units consist of multiple lites of glazing separated by spacers. Two types of spacers are considered in this analysis. The standard spacer used for most IG units consists of a hollow aluminum extrusion that is perforated on the side facing the air gap. The hollow spacer is typically filled with a desiccant to absorb any moisture that might be trapped in the air gap. Insulated spacers use either a non-metallic material or are constructed of thin stainless steel. Their advantage is that less heat is conducted around the edges of the insulating glass unit. Insulating spacers reduce both U-factor and SHGC.

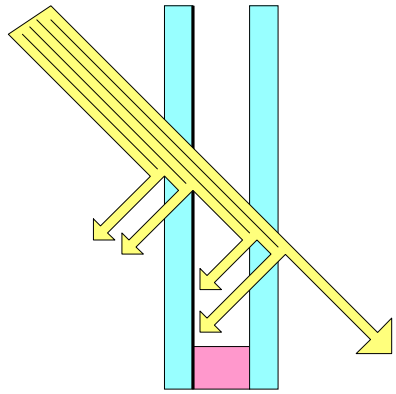


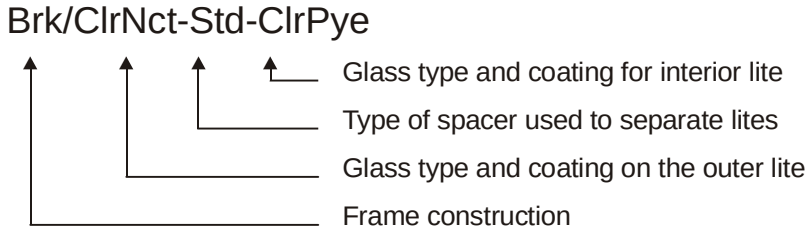
Figure 1 – Heat Transfer Through Glazing

The most exciting advance in glazing technologies is the development of special coatings that can be applied to one or more of the surfaces of single, double or triple insulating glass units. An industry of "coaters" has emerged that specializes in applying coatings to glass manufactured by others. Many of the primary glass manufacturers also apply coatings to their products. Coatings can be applied in one of two ways. Pyrolytic coatings are applied while the glass is being manufactured and while it is still in a molten or semi-molten state. Pyrolytic coatings are hard and durable enough to be used in exposed applications. Most can be used in single glazing applications. The second way to apply a coating is through a sputter process where molecules of various types of metal are deposited onto the surface of the glass. Often sputtered coatings are layered to provide special properties such as being able to filter light from certain wavelengths (spectrally selective coatings). Sputter coatings are soft and are generally applied to the second or third surface of IG units where they are protected from abrasion[6].

The catalogs from glass manufacturers and coaters have literally hundreds of options. The number of coatings that are possible is almost as endless as colors in the rainbow. Only the most important generic coatings are considered in this analysis. Highly reflective coatings, especially those applied to the first surface are deliberately excluded, since these are not applicable in all cases. The coatings that are considered include clear low-e coatings of several varieties: a pyrolytic, a standard sputter coating, a "low-e squared" coating, and a sun-belt low-e coating designed to reduce solar heat gain. Only one reflective coating is considered which is fairly low in reflectance and has medium performance. The reflective coating is only considered in setting the criteria for nonresidential buildings.

The database of constructions is included as Appendix B to this document. The database was developed with input from members of the ASHRAE committee, which included engineers from glass manufacturers and coaters. Performance data for each of the fenestration products was calculated using the Window 4.1 computer program, available from NFRC/LBNL.

Each glazing construction is named using codes so that it is possible to determine from the name the exact combination of technologies used in the construction. The following example represents a double glazed insulating glass unit with a standard spacer and a pyrolytic low-e coating on the inner glass. The assembly is housed in a metal frame with a thermal break. The codes used in the nomenclature are listed in Table 12 along with a brief description and the cost premium associated with them.



[6] The sufaces of double and triple glazed IG units are numbered starting on with the exterior surface and moving to the indoor surface. A double glazed unit has four surfaces.

Skylight Performance Data

NFRC ratings and simulation data are not generally available for plastic skylights, which is the reason that the ASHRAE default tables are permited for compliance purposes. The Window 4.1 simulation program does not work with fenestration products that have a variable air gap, such as typical domed or pyramidal plastic skylights. While skylight U-factors can be tested in NFRC certified testing laboratories, simulation programs cannot be used to extend the test results to other models in the same product line, as is done with vertical fenestration. This Window 4.1 inadequacy increases the cost of labeling and certifying plastic skylights.

The NFRC method of determining SHGC is to use the Window 4.1 computer program in with specular data files for specific glazing products. Specular data files are not available for plastic products, particularly products with prismatic or other embossed patterns in the surface of the glazing. For plastic skylights, SHGC data was determined by a survey of manufacturer's data and that is the basis of the performance data in Appendix B. The skylight was then reviewed by the ASHRAE committee, which reached consensus on values to use. Data used in the analysis is shown in Tables 10 and 11. These are the data used in the optimization, but the values published as criteria are selected from the default table in order to provide consistency with the method of compliance.

For plastic skylights, three types of frames were considered in the analysis: a standard metal frame, a thermal break metal frame, and a vinyl/wood non-metallic frame. Single, double, triple and quadruple acrylic glazings were considered. Four types of tints or pigmentation were considered: bronze, high white, medium white, and low white. The codes, cost premiums and descriptions are shown in Table 13.

Table 10 – Solar Optic Properties – Plastic Skylights

	Single			Double			Triple			Quadruple		
Tint	SC	SHGC	VLT	SC	SHGC	VLT	SC	SHGC	VLT	SC	SHGC	VLT
Brz	0.53	0.46	0.27	0.43	0.37	0.25	0.35	0.30	0.23	0.31	0.27	0.25
Clr	0.97	0.83	0.92	0.89	0.77	0.89	0.82	0.71	0.85	0.76	0.65	0.81
HW	0.76	0.65	0.82	0.72	0.62	0.75	0.68	0.58	0.69	0.64	0.55	0.63
LW	0.45	0.39	0.32	0.40	0.34	0.29	0.36	0.31	0.27	0.53	0.46	0.41
MW	0.68	0.58	0.53	0.63	0.54	0.49	0.58	0.50	0.45	0.30	0.26	0.21

Table 11 – Thermal Transmission (U-factors) – Plastic Skylights

	Single			Double			Triple			Quadruple		
Frame	Mtl	Brk	Vnl	Mtl	Brk	Vnl	Mtl	Brk	Vnl	Mtl	Brk	Vnl
Ufactor	1.92	1.92	N. A.	1.29	1.12	0.84	1.10	0.91	0.65	0.93	0.74	0.48

Cost Model

The life cycle cost approach requires that each fenestration construction be assigned a cost. These costs are listed in Appendix B for each construction and are developed using a relatively simple cost model. The basecase construction (single, clear glass in a metal frame) is assumed to have a cost of zero. Other products have a cost premium relative to the basecase, which depends on the technologies added to the basecase. The cost premiums used in the cost model are listed in Table 12 for each of the technologies. These premiums are summed to get the total cost premium and then 30% is added to account for contractors' overhead and profit. For example the cost for green tinted double glass in a thermal break frame would be $6.38 as calculated in the equation below. The cost premium for tinted glass is $0.39/ft², the cost premium for the thermal break frame is $1.50/ft² and the cost premium for double glass is $3.02/ft². These premiums are summed and 30% is added for the contractors' overhead and profit, as well as other markups.

$$\text{Cost} = 1.3 \cdot (0.39 + 1.50 + 3.02) = 6.38$$

The ASHRAE cost premiums were developed from surveys conducted by Eley Associates in the early 1990's. However, the data were reviewed by the ASHRAE project committee and updated several times. The most

recent update by ASHRAE was in 1998. As part of this project, Nehemiah Stone of the Heschong-Mahone Group contacted six manufacturers and coaters to make a spot check on the ASHRAE cost data. Those that responsed verified the reasonableness of the ASHRAE cost data. For instance, manufacturers reported that the cost for low-e coatings is in the range of $1.01/ft² to $1.80/ft². These data are a little lower than the costs used in the ASHRAE model (1.88/ft²), making the analysis a little conservative.

In addition to the ASHRAE cost model, data was also collected specifically for California as part of the CADMAC project[7]. These data are available for glass fenestration products, but not for acrylic or fiberglass skylights. The CADMAC data includes price quotes for low-volume and high-volume purchases. Table 12 has the ASHRAE price as well as the high-volume and low-volume prices from the CADMAC data set. As a sensitivity study, life cycle cost was calculated using all three prices (see Appendices E and F).

Table 12 – Glass Technologies, Codes and Cost Premiums

Item	Code	ASHRAE	CADMAC High Vol.	CADMAC Low Vol.	Description
Glass Products	Clr	Basecase			Standard 6 mm thick **CL**ea**R** lite
	Clr	3.02	3.01	3.50	Premium for an additional lite of 6 mm clear glass. This premium includes a standard spacer (see below).
	Grn	0.39	0.37	0.43	Standard **GR**ee**N** 6 mm thick tinted glass available from all primary glass manufacturers. The premium is the difference between clear glass and the green tint. Bronze and gray tinted glass were not considered since they have a lower visible light transmission, but equal or near equal SHGC.
	Hpt	1.10	1.35	1.57	**H**igh **P**erformance **T**inted 6 mm thick glass such as Azurlite or Evergreen
Frame Types	Mtl	Basecase			Standard **M**e**T**a**L** frame without a thermal break
	Brk	1.50	0.64	0.75	Metal frame with a thermal **Br**ea**K**
	Vnl	4.00	1.36	1.59	**V**i**N**y**L** or wood frame
Spacers	Std	Basecase			**ST**andar**D** spacer
	Ins	0.80	N.A.	N.A.	**INS**ulating spacer. The cost premium is the difference between the standard spacer and the insulting spacer.
Coatings	Nct	Basecase	Basecase	Basecase	No coating.
	Mpr	1.68	2.01 Brz 2.38 Clr	2.34 Brz 2.76 Clr	A generic **M**edium **P**erformance **R**eflective coatingThis is a durable coating that can be used on single glazing, but is less reflective than LOF Eclipse or PPG Solarcool.
	Pye	1.00	1.46	1.71	**PY**rolytic low-**E** coating similar to LOF Energy Advantage. This is a hard low-e coating that has an emissivity on the order of 0.20.
	Spe	1.88	2.81	3.27	Standard **SP**utter low-**E** coating. This coating is offered by many manufacturers and has an emissivity on the order of 0.10.
	Sbe	1.88	2.81	3.27	**S**un**B**elt low-**E** coating. This has similar emissivity as the Spe product, but a lower SHGC. An example is Guardian's NU-40 coatings.
	Sue	1.88	2.81	3.27	**SU**per low-**E** coating. This is an advanced coating that has an emissivity below 0.04. It also has a lower SHGC.
Suspended Film	HtMr22	6.35	9.05 + Dbl	10.51 + Dbl	These are Heat Mirror suspended films with varying transmission. The 22 in the code to the right is the light transmission of the film and includes other values: 33, 44, 55, 66, 77 and 88. The cost premium is the same for all transmissions and includes spacers and other sealants.

Notes:

The CADMAD cost data base has values for residential and commercial products. The values presented in this table are for commercial products, with the exception of the pyrolytic low-e coating. For this product, only a residential price was presented in the CADMAC data.

[7] 1996 Measure Cost Study, Final Report, Xenergy, Inc., prepared for the California Demand-Side Management Measurement Advisory Committee (CADMAC), December 1996.

Table 13 - Plastic Technologies, Codes and Cost Premiums

Item	Code	ASHRAE	CADMAC High Vol.	CADMAC Low Vol.	Description
Frame	Mtl	Basecase	N.A.	N.A.	Standard **M**e**T**a**L** frame
	Brk	0.70	N.A.	N.A.	Thermal **BR**ea**K** frame
	Vnl	4.00	N.A.	N.A.	**V**i**N**y**L** or wood frame
Tinting	Clr	Basecase	N.A.	N.A.	**CL**ea**R** acrylic
	Brz	0.50	N.A.	N.A.	**BR**on**Z**e tint
	HW	0.50	N.A.	N.A.	**H**igh **W**hite pigment
	MW	0.50	N.A.	N.A.	**M**edium **W**hite pigment
	LW	0.50	N.A.	N.A.	**L**ow **W**hite pigment
Number Panes	Sgl	Basecase	N.A.	N.A.	**S**in**GL**e acrylic glazing
	Dbl	2.00	N.A.	N.A.	**D**ou**BL**e acrylic glazing
	Trp	4.00	N.A.	N.A.	**TR**i**P**le acrylic glazing
	Qud	6.00	N.A.	N.A.	**QU**a**D**ruple acrylic glazing

Table 14 – Description of Fields in Appendix B

Field	*Description*
ID	Unique identifier
DOE-2Code	Reference to Window 4.1 file in DOE-2
Material	Either glass or plastic. Plastic is only used for skylights.
NameIP	Name using above nomenclature
UfactorSet	Yes if in the U-factor set of constructions
UVertW41	U-factor calculated with Window 4.1 and used in optimization for vertical fenestration
USkyCurbW41	U-factor calculated with Window 4.1 and used in optimization for skylights on a curb
USkyNoCurbW41	U-factor calculated with Window 4.1 and used in optimization for skylights without a curb
SC	Shading coefficient calculated with Window 4.1 to account for frame.
SHGC	Solar heat gain coefficient
VLT	Visible light transmission
VLT/SHGC	Glazing efficacy or the ratio of light transmission over SHGC
CostASHRAE	Total cost per ft² of construction including markup based on the ASHRAE cost model
CostCMLow	Total cost per ft² of construction including markup based on the CADMAC low volume cost model
CostCMHigh	Total cost per ft² of construction including markup based on the CADMAC high volume cost model
UVertOperMap	A value from Table A-17 of Standard 90.1-1999 that corresponds to this construction for a vertical, operable window
UVertFixedMap	A value from Table A-17 of Standard 90.1-1999 that corresponds to this construction for a vertical, fixed window
USkyCurbMap	A value from Table A-17 of Standard 90.1-1999 that corresponds to this construction for a skylight on a curb
USkyNoCurbMap	A value from Table A-17 of Standard 90.1-1999 that corresponds to this construction for a skylight not on a curb

U-factor Subset of Fenestration Products

When searching for the low-life cycle cost fenestration product to use as the basis of the U-factor criteria only a subset of the glazing constructions are used in the analysis. This subset includes features, products and technologies that are intended to reduce U-factor as opposed to reducing SHGC. The U-factor subset includes all frame types and spacers since the primary impact of these technologies is to reduce the U-factor. Only clear glazing products are considered in the U-factor set, however. Green and high performance tints (HPT) products are excluded. Also, only the pyrolytic (Pye) and sputter low-e coatings (Spe) are considered in the analysis: The sunbelt low-e product (Sbe), super low-e (Sue) product, and the medium performance reflective coating (Mpr) are excluded from the U-factor set, since they are primarily intended to reduce SHGC. Constructions included in the U-factor set are listed in Table 15. Using the U-factor set to determine the U-factor criteria is consistent with the method used to develop the criteria for ASHRAE/IESNA Standard 90.1-1999.

Table 15 – Glass Fenestration Products in the U-factor Set

Mtl/Clr	Brk/Clr	Brk/Clr-Std-Clr	Vnl/Clr	Vnl/Clr-Std-Clr
Mtl/Clr-Std-Clr	Brk/Clr-Ins-Clr	Brk/Clr-Std-ClrPye	Vnl/Clr-Ins-Clr	Vnl/Clr-Std-ClrPye
Mtl/Clr-Std-ClrPye	Brk/Clr-Ins-Clr-Ins-Clr	Brk/Clr-Std-ClrSpe	Vnl/Clr-Ins-Clr-Ins-Clr	Vnl/Clr-Std-ClrSpe
Mtl/Clr-Std-ClrSpe	Brk/Clr-Ins-ClrPye	Brk/Clr-Ins-V88-Ins-Clr	Vnl/Clr-Ins-ClrPye	Vnl/Clr-Ins-V88-Ins-Clr
	Brk/Clr-Ins-ClrSpe		Vnl/Clr-Ins-ClrSpe	

The U-factor Criterion and NFRC Certification

In the past, there has been a great deal of confusion about fenestration U-factors. Glazing manufacturers sometimes publish values that represent just the center of the glass, yet these do not accurately represent the heat transfer through windows. The NFRC (National Fenestration Rating Council) publishes U-factors for manufactured fenestration products that include the entire assembly, including heat loss through the edge of insulating glass units, the frame and other factors. NFRC U-factors are calculated with a combination of laboratory tests and calculations and follow procedures laid out in the standard, NFRC 100, Procedure for Determining Fenestration Product U-factors (1997). The NFRC U-factor procedure considers the entire fenestration product including the frame, edge effects as well as the center of glass. For skylights that are intended to be mounted on a curb, the NFRC U-factor includes not only the entire skylight assembly, but also the curb that the skylight is mounted on. For skylights that do not have an integral curb provided as part of the product, a standard curb is used in the calculations.

Each of the fenestration products listed in Appendix B and used in this analysis have several U-factors associated with them. Three U-factors were calculated with the Window 4.1 program: UVertW41, USkyCurbW41, and USkyNoCurbW41. These values are used in calculating the criteria, since they reflect subtle differences between various technologies and are calculated in a consistent manner. However, the values actually published as criteria are the corresponding values from Table A-17 of Standard 90.1-1999. These are more consistent with NFRC rating procedures, which will be used to show compliance with the criteria. Table 14 lists all the relevant data fields in the library of fenestration products and describes how they are used in the analysis.

Table A-17 of ASHRAE/IESNA Standard 90.1-1999[8] includes U-factors for a variety of fenestration products that are consistent with NFRC procedures. This table is included in this report as Appendix C. This table is also referenced in §116 of the Energy Standards as a default table for skylights and site-built glazed wall systems in buildings less than 100,000 ft². It is recommended the entry points into the default table be documented with data from manufacturers. These include the type of frame that is used, the type of glazing, and any special coating. This documentation would be provided both at the time compliance and during construction.

Energy Model

A simplified energy model is used to calculate the energy use of each fenestration product. The model is based on DOE-2 simulations and is discussed in greater detail below. The energy models include a term for heating, one for cooling and a third term for a daylighting benefit. The daylighting term is needed to provide a credit for fenestration products that have a high visible light transmission. Visible light transmission is critical since it provides daylighting to spaces, views to the exterior and other benefits. Standard drapes/blinds were assumed in the models and, therefore, in the life cycle cost analysis; no credit is offered in the compliance process.

Heating and Cooling Energy

Regression equations were developed using DOE-2 simulation data from each climate zone. The equations are structurally similar to those used in ASHRAE 90.1, but are tailored to the specific conditions of California. The ASHRAE 90.1 equations account for climate differences through heating and cooling degree-day values, while the coefficients for the equations in this analysis are developed specifically for California's 16 climate zones. Producing regression coefficients for each climate zone allows the energy equations to account for other climate variables such as humidity and its associated wet-bulb temperature, radiation, and wind speed. An U-factor term was added to the cooling energy equation and to the SHGC parameter of the heating energy

[8] This data is also published in the ASHRAE Fundamentals 1997.

equation for vertical fenestrations. These additions produced a better fit between the simple models and the DOE-2 data. The following shows the structure of the equations. The coefficients are $h_{1,j}$ and $h_{2,j}$ for heating and $c_{1,j}$ and $c_{2,j}$ for cooling. The "j" subscript is a reference to a climate zone. The "i" subscript is a reference to a particular fenestration product. The coefficients are also calculated separately for residential and nonresidential occupancies. Values for the coefficients are contained in Appendix D.

$$Therms_i = h_{1,J} \times (FR \times U_i) + h_{2,J} \times (FR \times SHGC_i / U_i) \quad \text{(windows)}$$

$$Therms_i = h_{1,J} \times (FR \times U_i) + h_{2,J} \times (FR \times SHGC_i) \quad \text{(skylights)}$$

$$kWhCool_i = c_{1,J} \times (FR \times U_i) + c_{2,J} \times (FR \times SHGC_i) + kWh_{Lights}$$

where

$Therms_i$	Gas use per square foot of exterior wall or roof
$h_{1,J}$, $h_{2,J}$	Heating coefficients where the "J" subscript refers to one of the 16 climates
FR	Fenestration ratio. For walls this is window-wall ratio (WWR) and for roofs it is skylight to roof ratio (SSR).
$SHGC_i$	Solar heat gain coefficient for the Ith fenestration construction
U_i	U-factor for the Ith fenestration construction
$kWhCool_i$	Electricity use in kWh/year per square foot of exterior wall or roof
$c_{1,J}$, $c_{2,J}$	Heating coefficients where the "J" subscript refers to one of the 16 climates
kWh_{Lights}	Electricity use associated with the lighting. This too is expressed per square foot of wall or roof (see below for more information on this term)

Daylighting

The energy equations include a credit for fenestration products that have a high visible light transmission (VLT), relative to other fenestration products. Without this credit, the methodology would not distinguish between fenestration products with different VLTs. Even though daylighting controls may not be installed or used, there is a benefit to having windows with a high light transmission, all else being equal. This benefit is accounted for in the daylighting term.

The daylighting credit for windows is documented in *Thermal Performance of the Exterior Envelopes of Buildings V*, ASHRAE/DOE/BTECC Conference, Clearwater, Florida, December 1992. The credit is summarized in the following equation. The savings depend on the VLT, the fenestration area, the design illuminance for the lighting system, and for skylights, the configuration and reflectance of the skylight well. The equation for lighting energy is given below:

$$kWh_{Lights} = LPD \cdot Hours \cdot (1 - K_d)$$

where

kWh_{Lights} The electric energy use associated with a square foot of wall or roof. This is based on assumptions on floor-to-floor height

LPD Lighting power density in W/ft^2

Hours Full time equivalent lighting hours

K_d Daylighting savings fraction (see below)

The daylight savings fraction is calculated using the following equation.

$$K_d = [\phi_1 + \phi_2 (C / T_{vis_i})][1 - e^{(\phi_3 + \phi_4 \bullet C) FR \bullet VLT_i \bullet WF}]$$

where

K_d = daylight savings fraction (unitless).

VLT = visible light transmission of the fenestration (unitless),

FR = fenestration ratio (unitless). For skylights, this is the ratio of the skylight area to the area of the roof. For windows, this is the window-wall ratio.

WF = well factor (unitless). Assumed to be 0.6 in LCC analysis for plastic skylights and 0.8 for glass skylights. This is assumed to be 1.0 for windows.

C = design Illumination (footcandles),

ϕ_n = coefficients developed through regression analysis. The coefficients vary between windows and skylights.

DOE-2 Model

DOE-2.1 was used to create a database of heating and cooling energy for a wide variety of inputs. A total of 1120 building energy simulation runs were performed. For all cases, a simple five-zone model was used. The interior zone is 100 ft x 100 ft, and each perimeter zone is 15 ft x 100 ft. The arrangement for thermal zoning is intentionally designed so that perimeter zones are connected only to the interior zone and not to other perimeter zones. This tends to isolate solar effects on the building. Skylights were modeled only in the interior zone. Windows were modeled only on each perimeter zone.

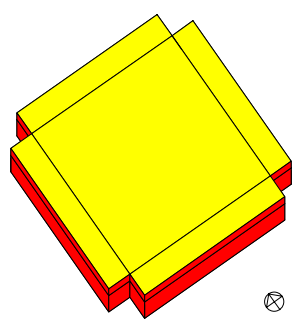


Figure 3 – Five Zone DOE-2 Model

The model was simulated with both nonresidential and high-rise residential schedules of operation. Occupancy schedules for each building type were taken from the 1998 nonresidential ACM approval manual. A lighting power density (LPD) of 1.25 w/ft^2 and an equipment power density (EPD) of 0.75 W/ft^2 were used in both building types. The opaque construction elements were set to be in minimum compliance with the Title 24 prescriptive envelope criteria.

Five different glazing constructions were modeled to represent a wide range of possible fenestration U-factor and SHGC combinations. The window-wall ratio was varied from 0 to 45% in four steps (0%, 15%, 30%, and 45%). The skylight area was varied from 0 to 10% in three steps (0%, 5%, 10%). All exterior zones were set

with double bronze vertical glazing at a 15% WWR during the skylight performance runs. No skylights were placed in the model during window performance runs.

Table 2. Glass types modeled

Glazing Code	Description	U-value	SHGC
1000	Single Clear	0.91	0.86
1403	Single Bronze, High Reflective	0.89	0.22
2204	Double Bronze, 12mm Air	0.45	0.49
2642	Double Clear, Low-E, Argon	0.25	0.65
3692	Triple Tinted Heat Mirror 33	0.21	0.15

Wall and Roof Life Cycle Cost

The proposed changes move climate zones 2 and 10 from the south coast and north coast regions, respectively, to the central valley region. This grouping works better for expressing the fenestration criteria, but also affects the insulation requirements for walls and roofs.

With the 1998 Energy Standards, climates 2 and 10 require R-11 wall insulation and with the new groupings, they would be required to install R-13. For climate zone 10, the roof insulation requirement would also change. It is R-11 with the 1998 Energy Standards and would become R-19 with the proposed change.

Appendix G has a life cycle cost analysis for four classes of walls: wood framed walls, metal framed walls, mass walls and metal building walls. The analysis considers three classes of roof construction: roofs that use rigid insulation above the structural deck, metal building roofs, and wood framed and attic roofs. Table 16 shows the low-life cycle cost constructions (from Appendix G) for each class of construction, each occupancy type (residential and nonresidential) and for both climate zones 2 and 10. In all cases, the low-life cycle choices have lower U-factors or have a higher R-value than the criteria.

Table 16 – Cost Effective Wall and Roof Constructions for Climates 2 and 10

	Climate Zone 2		Climate Zone 10	
	Nonresidential	High-Rise Residential	Nonresidential	High-Rise Residential
Walls – Metal Framed	R-13 Cavity/R-7.5 Rigid	R-13 Cavity/R-7.5 Rigid	R-13 Cavity/R-3.8 Rigid	R-13 Cavity/R-7.5 Rigid
Walls – Wood Framed	R-13 Cavity	R-13 Cavity/R-7.5 Rigid	R-13 Cavity	R-13 Cavity/R-7.5 Rigid
Walls – Metal Building	R-13	R-13 + R-13	R-13	R-13 + R-13
Walls – Mass[3]	R-9.5 (U-0.10)	R-13.3 (U-0.08)	R-9.5 (U-0.10)	R-13.3 (U-0.08)
Roofs – Rigid Insulation[2]	N.A.	N.A.	R-20 (U-0.05)	R-25 (U-0.04)
Roofs – Metal Building	N.A.	N.A.	R-13 + R-19	R-16 + R-19
Roofs – Attics/Wood	N.A.	N.A.	R-38[1]	R-60[1]

Notes:

[1] The attic low-life cycle choices are based on having free space in the attic for the insulation. The value would be smaller for framing assemblies where the thickness of the cavity is limited.

[2] The U-factor criteria for roofs is 0.057 so all the low-life cycle cost constructions easily meet the criteria.

[3] The U-factor criteria for mass walls is 0.43 and 0.65 for light mass and heavy mass walls (HC≥15) so all of the low-life cycle cost constructions have a U-factor considerably below the criteria.

[4] These are based on a 30 year life cycle cost analysis, statewide average gas and electricity prices and a 3% discount rate. The net present value of electricity is $1.68/kWh-y and the net present value of gas is $11.43/therm-y.

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Cool Roofs

Recommendations

Summary

A cool roof credit is recommended to allow an equal energy trade-off through both the envelope trade-off procedure and whole building compliance method. The proposed envelope trade-off adjustment creates an opportunity to trade roof performance with fenestration area and SHGC. The whole building method allows trade-offs between the roof performance and all other building systems. The credit creates greater design options while providing an incentive for cool roof implementation. Introducing cool roofs into the energy code increases exposure to this beneficial technology and establishes a trend towards greater stringency in roof absorptivity for future Title-24 revisions.

Title 24 changes

Adjust equations 1-E and1-F in §143 of the 1998 Title-24 Standards to account for solar roof heat gain by adding an absorptance parameter in the heat gain (HG) equations for roofs (see below). The current Title 24 standard includes both heat gain and heat loss in the overall envelope approach. Heat loss uses a UA approach to determine the instantaneous performance of the building envelope in a heating mode. Heat gain uses a mass corrected UA approach with a temperature factor to normalize opaque element heat gain with respect to solar gains from fenestration. The approach requires the overall heat loss of the proposed building to be no greater than the heat loss of a standard building and the overall heat gain of the proposed building to be no greater than the heat gain of the standard building. The absorptance parameter would only be applied to the overall heat gain equation rather than both the overall heat gain and heat loss equations. This focuses tradeoffs against other cooling measures while eliminating tradeoffs that could increase gas consumption.

Figure 4- Current Title 24 Standards Equation (1-E)—Standard Building Heat Gain Equation

$$\begin{aligned} HG_{std} = & \sum_{i=1}^{nW}\left(A_{Wi} \times U_{Wi_{std}} \times TF_i\right) + \sum_{i=1}^{nF}\left(A_{Fi} \times U_{Fi_{std}} \times TF_i\right) + \sum_{i=1}^{nR}\left(A_{Ri} \times U_{Ri_{std}} \times TF_i\right) \\ & + \sum_{i=1}^{nG}\left(A_{Gi} \times U_{Gi_{std}} \times TF_i\right) + \sum_{i=1}^{nS}\left(A_{Si} \times U_{Si_{std}} \times TF_i\right) + \sum_{i=1}^{nG}\left(WF_{Gi} \times A_{Gi} \times RSHG_{Gi_{std}}\right) \times SF \\ & + \sum_{i=1}^{nS}\left(WF_{Si} \times A_{Si} \times SHGC_{Si_{std}}\right) \times SF \end{aligned}$$

Figure 5 – Additional Term to Title 24 Standards Equation (1-E)

$$\sum_{i=1}^{nR} \left(WF_{Ri} \times A_{Ri} \times U_{Ri} \times \alpha_{Ri}\right) \times SF$$

where

i = Each roof type for the standard building

A_{Ri} = Exterior roof area for the standard building

U_{Ri} = Prescriptive roof U-value for the standard building

α_{Ri} = Roof absorptivity of 0.70 for the standard building

SF = Solar factor from Table 1-J

WF_R = Roof Weighting Factor, which depends on climate zone. These factors are added Table 1-K of the Energy Standards. Regression coefficients obtained from DOE-2 simulation data were used to calculate the WF_R for each climate zone. The following discussion section describes this process.

Figure 6-Current Title 24 Standards Equation (1-F)—Proposed Building Heat Gain Equation

$$HG_{prop} = \sum_{j=1}^{nW}\left(A_{Wj} \times U_{Wj_{prop}} \times TF_j\right) + \sum_{j=1}^{nF}\left(A_{Fj} \times U_{Fj_{prop}} \times TF_j\right) + \sum_{j=1}^{nR}\left(A_{Rj} \times U_{Rj_{prop}} \times TF_j\right)$$
$$+ \sum_{j=1}^{nG}\left(A_{Gj} \times U_{Gj_{prop}} \times TF_j\right) + \sum_{j=1}^{nS}\left(A_{Sj} \times U_{Sj_{prop}} \times TF_j\right) + \sum_{j=1}^{nG}\left(WF_{Gj} \times A_{Gj} \times SHGC_{Gj_{prop}} \times OHF_j\right) \times SF$$
$$+ \sum_{j=1}^{nS}\left(WF_{Sj} \times A_{Sj} \times SHGC_{Sj_{prop}}\right) \times SF$$

Figure 7- Additional Term to Title 24 Standards Equation 1-F

$$\sum_{j=1}^{nR} (WF_{Rj} \times A_{Rj} \times U_{Rj} \times \alpha_{Rj}) \times SF$$

j = Each cool roof type for the proposed building

A_{Rj} = Exterior roof area for the proposed building

U_{Rj} = Proposed roof U-value

α_{Rj} = Applicable roof absorptivity value. Use an absorptivity of 0.45 for eligible cool roofs and an absorptivity of 0.70 for non-cool roofs. Cool roof eligibility requirements are listed in the following discussion.

SF = Solar factor from Table 1-J

WF_R = Roof weighting factor

ACM changes

Section 2.2.1.4 of the Nonresidential ACM Approval Manual will include criteria for cool roof eligibility and allow a possible change in roof absorptivity between the reference and proposed design models. The recommended approach is to assume the current default absorptivity of 0.7 (reflectivity of 0.3) for the reference building and an absorptivity of 0.45 for the proposed building if a qualifying cool roof is specified. Emmissivity would be set at 0.9 (the current default value) for both the reference and proposed buildings.

Discussion

Cool roofs, also known as reflective or high albedo roofs, are coated with a material of high reflectance and emittance. These coatings greatly reduce the roof absorption of solar energy. Cool roofs are typically white and have a smooth texture. Commercial roofing products that qualify as cool roofs fall in two categories: single ply and liquid applied. Examples of single ply products include:

- White EPDM (Ethylene-Propylene-Diene-terpolymer Membrane)
- White PVC (polyvinyl chloride)

- White CPE (chlorinated polyethylene)
- White CPSE (chlorosulfonated polyethylene, e.g. Hypalon)
- White TPO (thermoplastic polyolefin)

Liquid applied products may be used to coat a variety of substrates. Products include:

- White elastomeric coatings
- White cementitious coatings
- White acrylic coatings

Cool roof benefits include lower cooling energy, lower peak cooling demand, and potentially longer roof life due to lower surface temperature. In addition to the benefits within the building, a cool roof can reduce temperatures in the local urban environment.

An additional class of cool roof being proposed for credit is concrete and clay tiles. While their reflectance is usually lower than white single ply membranes or white liquid applied coatings, they have been shown to be roughly equally effective when reflectance exceeds 0.40.[9]

Method

DOE-2.1 energy simulations were performed to account for the change in building heat gain caused by the lower absorptivity associated with a cool roof. The model varied roof absorptivity and roof U-factor to determine their combined effect on annual cooling loads. See Appendix H for DOE-2 modeling assumptions. The modeling results were then used to derive regression equations that allow for the calculation of energy use or savings related to roof absorptivity and U-factor. The form of the equation is:

$$KWh = c_o + c_1 a + c_2 U + c_3 Ua$$

where

kWh	Annual electricity use
a	Roof absorptivity,
U	Roof U-factor,
c_0, c_1, c_2, c_3	Regression coefficients.

This regression calculation process and above energy equation follows the method used to develop cool roof credits for ASHRAE 90.1.[10] Figure 5 shows a comparison of energy savings when roof absorptivity is reduced from 0.70 to 0.45, using both the ASHRAE and the proposed cool roof coefficients for the Energy Standards. Savings are lower with the Title 24 coefficients. ASHRAE coefficients are not used for this analysis because they were developed for only a few California locations. In both cases the models are similar, but some assumptions differ. The most significant is probably economizer control. The California model used a more efficient integrated economizer. The ASHRAE model assumed a non-integrated economizer that switches to minimum outside air when temperature exceeds 60 degrees Fahrenheit. Operation schedules are also slightly different because the Title 24 model uses the schedules specified in the Nonresidential ACM Approval Manual.

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[9] "Comparative Summer Attic Thermal Performance of Six Roof Constructions" by Parker et al. FSEC-PF-337-98 on line at www.fsec.ucf.edu/~bdac/pubs.

[10] Derivation of cool roof regression coefficients for Standard 90.1 described in: Akbari, H., S. Konopacki, C. Eley, et al. 1998. Calculations for Reflective Roofs in Support of Standard 90.1, *ASHRAE*, Vol. 104, Part 1

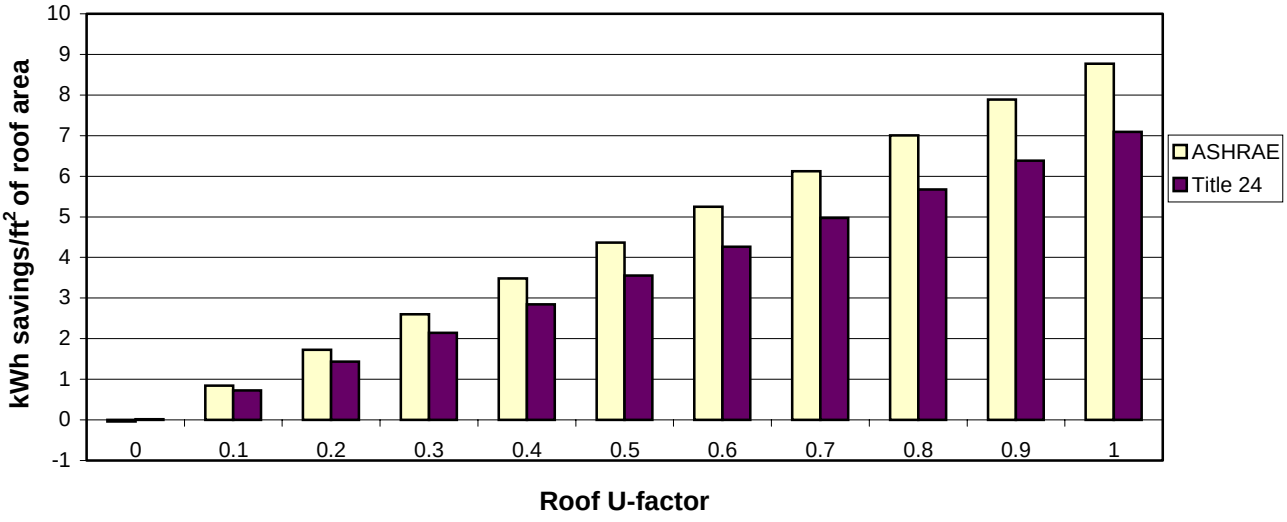

Figure 8 –Annual Electrical Savings (per ft^2 of roof) for .25 reduction in roof absorptivity (from α=0.70 to α=0.45) in San Bernardino, comparing results using ASHRAE 90.1 coefficients and coefficients derived for Title 24

Separate regression coefficients were determined for each California climate zone and for both non-residential and high-rise residential buildings. See Appendix I for the complete list of the cool roof coefficients.

Weighting Factors for the heat gain equation are listed in the table below and were calculated using the cool roof coefficients. These coefficients were developed for roof, window and skylights based on the same DOE-2.1 model. The fenestration weighting factors for each climate zone are set so the average value is one, but the relative value for each orientation is based on the corresponding window regression coefficients (see Appendix D). Then the roof and skylight weighting factors are calculated relative to the window weighting factors based on the relative magnitude of the regression coefficients. Deriving weighting factors from the regression coefficients allows for consistency between roof and glazing heat gain effects and creates an accurate tradeoff.

Table 17- Calculated Roof and Fenestration Weighting Factors for all California Climate Zones

Climate Zone	WF_{north}	WF_{south}	WF_{west}	WF_{east}	WF_{sky}	WF_{roof}
NON-RESIDENTIAL						
1	0.56	1.25	1.16	1.03	1.48	0.93
2	0.56	1.30	1.18	0.96	2.34	1.12
3	0.51	1.28	1.24	0.97	2.42	0.84
4	0.55	1.20	1.24	1.01	2.53	0.96
5	0.58	1.25	1.18	0.98	2.48	0.80
6	0.56	1.23	1.21	1.00	2.40	0.84
7	0.57	1.30	1.17	0.97	2.36	0.87
8	0.60	1.26	1.14	1.00	2.47	0.98
9	0.56	1.36	1.11	0.97	2.29	0.97
10	0.60	1.38	1.07	0.95	2.19	1.02
11	0.55	1.19	1.17	1.10	2.37	0.89
12	0.55	1.17	1.21	1.07	2.40	0.92
13	0.58	1.15	1.17	1.10	2.39	1.04
14	0.57	1.17	1.20	1.07	2.46	1.13
15	0.61	1.27	1.05	1.07	2.29	0.92
16	0.51	1.27	1.15	1.07	2.20	1.03
HIGH-RISE RESIDENTIAL						
1	0.50	1.24	1.23	1.03	1.36	0.82
2	0.55	1.29	1.23	0.94	2.30	1.08
3	0.47	1.28	1.29	0.96	2.42	0.80
4	0.54	1.17	1.33	0.96	2.53	0.96
5	0.49	1.28	1.25	0.97	2.48	0.77
6	0.55	1.20	1.26	0.99	2.37	0.79
7	0.55	1.28	1.21	0.96	2.37	0.88
8	0.57	1.26	1.20	0.97	2.44	0.96
9	0.53	1.39	1.14	0.94	2.24	0.93
10	0.59	1.34	1.12	0.94	1.92	1.00
11	0.53	1.14	1.27	1.06	2.23	0.88
12	0.55	1.14	1.29	1.03	2.31	0.91
13	0.57	1.12	1.27	1.05	2.27	1.02
14	0.57	1.13	1.28	1.02	2.38	1.08
15	0.59	1.26	1.12	1.03	2.26	0.90
16	0.49	1.24	1.25	1.01	2.02	0.95

Tradeoff Example

A cool roof provides an energy credit that can be used to increase the fenestraton area or SHGC. Table 18 shows the increase in WWR or SRR available when a cool roof is added to a 200 ft by 200 ft, two-story non-residential building with a WWR and SRR of 25% and 2%, respectively. The building assumes a roof U-factor for each climate zone at minimum compliance with the 1998 Title 24 prescriptive envelope criteria (0.078 for climate zones 6-10 and 0.057 for all other climate zones). The building contains tinted single glazing, with an SHGC of 0.61, and has an overhang factor of 1.0 (i.e. no overhang). The table shows that for this case window wall ratio could be increased from 25% to roughly 30% when changing from a standard roof to a cool roof.

Table 18 – Example of Possible Trade-offs Between Fenestration Area and Cool Roofs

Vertical Fenestration			Skylights		
Climate Zone	WWR	WWR with cool roof credit	Climate Zone	SRR	SRR with cool roof credit
1	25%	29.0%	1	2%	3.5%
2	25%	29.9%	2	2%	3.1%
3	25%	28.6%	3	2%	2.8%
4	25%	29.2%	4	2%	2.9%
5	25%	28.5%	5	2%	2.8%
6	25%	30.0%	6	2%	3.1%
7	25%	30.1%	7	2%	3.2%
8	25%	30.8%	8	2%	3.3%
9	25%	30.8%	9	2%	3.4%
10	25%	31.0%	10	2%	3.5%
11	25%	28.9%	11	2%	2.9%
12	25%	29.0%	12	2%	2.9%
13	25%	29.5%	13	2%	3.0%
14	25%	29.9%	14	2%	3.1%
15	25%	29.0%	15	2%	2.9%
16	25%	29.4%	16	2%	3.1%

Cool Roof Eligibility Criteria

An eligible cool roof can be defined by either one of the following two criteria.

1. Concrete tile or clay tile roofs with a minimum total solar reflectance of 0.40 when tested in accordance with ASTM E903 or E1918, and a minimum thermal emittance of 0.75 when tested in accordance with ASTM E408
2. Other roofs with a minimum total solar reflectance of 0.70 when tested in accordance with ASTM E903 or E1918 and a minimum thermal emittance of 0.75 when tested in accordance with ASTM E408

Test Procedures

ASTM E408 – Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques. Developed by ASTM Committee E21 on Space Simulation and Applications of Space Technology.

ASTM E903 – Standard Test Method for Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres. Developed by ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources

ASTM E1918 – Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field. ASTM E1918 was developed at LBNL under ASTM Subcommittee: E06.21on Performance of Buildings. This test method covers the measurement of solar reflectance of various horizontal and low-sloped surfaces and materials in the field, using a pyranometer. The test method is intended for use when the sun angle to the normal from a surface is less than 45 degrees.

Lighting

Recommendations

Summary

There are several instances within California 1998 where the applied code language is not consistent with ASHRAE 1999. This includes several values for allowable lighting power density (LPD) and the omission of a section regarding exterior lighting. In addition, a number of metrics and exceptions used to define applicable spaces in California 1998 are either ambiguous or inconsistent with economic trends or advances in lighting technology. The proposed changes to the lighting standard address these issues and are as follows,

- Specify the minimum efficacy of exterior lighting through an addition to Section 130. This will prohibit mercury vapor and incandescent lighting for lamps larger than 100 W.
- Close loophole regarding luminaire wattage through an addition to Section 130.
- Remove blanket exceptions to the mandatory bi-level control requirement and extend requirements for automatic shut-off controls to all buildings and to spaces with lower lighting power levels. (Section 131 (b)&(d))
- Close loophole in Section 146 (a) that allows portable lighting to be ignored in the calculation of actual lighting power density in office spaces.
- Modify allowable lighting power densities in Section 146 and ACM 2.3.1.2 in order to be consistent with ASHRAE/IESNA Standard 90.1-1999.
- Eliminate unused and outdated credits for lumen maintenance in Section 146.

Title 24 Changes

The complete sections with strikethroughs and underlines can be found in *Volume II – Draft Standard*. These changes are summarized in Table 19, below.

Table 19 – Proposed Lighting Changes

Section	*Proposed Changes*
§130 (c)	Addition of the following: (c) Exterior Building Lighting. All permanently installed exterior luminaires attached to, or powered by the electrical service of conditioned or semi-conditioned buildings, and employing lamps rated over 100 watts shall either: 1. Have a source efficacy, determined by dividing the rated initial lamp lumens by the rated lamp watts, of at least 60 lumens per watt; or 2. Be controlled by a motion sensor or programmable time controller that limits lamp use to no more than 60 minutes per start **EXCEPTION 1 to Section 130 (c):** Lighting required by a health or life safety statute, ordinance, or regulation, including, but not limited to emergency lighting. **EXCEPTION 2 to Section 130 (c):** Lighting that is integral to advertising signage. **EXCEPTION 3 to Section 130 (c):** Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electric Code **EXCEPTION 4 to Section 130 (c):** Searchlights and lighting for use in theme parks. **EXCEPTION 5 to Section 130 (c):** Outdoor theatrical equipment, provided it is for temporary or periodic use and is not for continuous use.

§130 (d) Addition of the following:

(d) Luminaire wattage incorporated into the installed interior lighting power shall be determined in accordance with the following criteria:

1. the wattage of incandescent or tungsten-halogen luminaires with medium screw base sockets and not containing permanently installed ballasts shall be the maximum labeled wattage of the luminaire.

2. the wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the specified lamp/ballast combination based on values from manufacturers catalogs or values from independent testing lab reports.

3. the wattage of line-voltage lighting track and plug-in busway that allow the addition and/or relocation of luminaires without altering the wiring of the system shall be the specified wattage of the luminaires included in the system with a minimum of 30 W/lin ft (98 W/lin m).

4. the wattage of low-voltage lighting track, cable conductor, rail conductor, and other flexible lighting systems that allow the addition and/or relocation of luminaires without altering the wiring of the system shall be the specified wattage of the transformer supplying the system.

5. the wattage of all other miscellaneous lighting equipment shall be the specified wattage of the lighting equipment.

§131 (b) (b) **Controls to Reduce Lighting**. The general lighting of any enclosed space 100 square feet or larger in which the connected lighting load exceeds ~~1.00~~.8 watts per square foot for the space as a whole, and that has more than one light source (luminaire), shall be controlled so that the load for the lights may be reduced by at least one half while maintaining a reasonably uniform level of illuminance throughout the area. A reasonably uniform reduction of illuminance shall be achieved by:

~~**EXCEPTION 1 to Section 131 (b):** Lights in areas that are controlled by an occupant-sensing device that meets the requirements of Section 119 (d).~~

EXCEPTION ~~2~~ to Section 131 (b): Lights in corridors.

~~**EXCEPTION 3 to Section 131 (b):** Lights in areas that are controlled by an automatic time switch control device that has a timed manual override available at each switch location required by Section 131 (a) and that controls only the lights in the area enclosed by ceiling-height partitions.~~

(d) **Shut-off Controls**.

1. For every floor, all interior lighting systems shall be equipped with a separate automatic control to shut off the lighting. This automatic control shall meet the requirements of Section 119 and may be an occupancy sensor, automatic time switch, or other device capable of automatically shutting off the lighting.

~~**EXCEPTION 1 to Section 131 (d) 1:** Buildings or separately metered spaces of less than 5,000 square feet of conditioned space.~~

§146 (a) (a) **Calculation of Actual Lighting Power Density**. The actual lighting power ~~density~~ of the proposed building area is the total watts of all planned permanent and portable lighting systems (including, but not limited to, track and flexible lighting systems, lighting that is integral with modular furniture, workstation task lights, portable freestanding lights, lights attached to workstation panels, movable displays and cabinets, and internally illuminated case work for task or display purposes), subject to the following specific requirements and ~~minus any~~ adjustments ~~allowed~~ under Subsections 1 through ~~4~~6.

1. In office areas, if the actual watts of portable lighting are not known at the time of permitting, the actual lighting power for portable and integral lighting shall be determined using either (A.) or (B.) following. However, upon installation of the portable lighting systems the building official may require resubmittal of compliance documentation using exact installed lighting and equipment data.

A. In office areas greater than 250 square feet with permanently installed lighting systems a portable light power of 0.2 watts per square foot shall be included in calculation of actual lighting power density; or

B. In office areas of less than 250 square feet, no additional task lighting power will be required in the calculation of actual power.

2. In office areas greater than 250 square feet with permanently installed lighting systems,

if sufficient supporting evidence is submitted and accepted by the building official, the actual power for portable lighting shall be included in the calculation of actual power. The individual signing the lighting plans, pursuant to Division three of the California Business and Professions Code, must clearly indicate on the plans the actual power for the portable lighting systems in the area.

§146 (b) 1.
Table 1-M

TYPE OF USE	ALLOWED LIGHTING POWER
Religious facilities~~,~~ and auditorium ~~and convention centers~~	1.8
Convention Centers	1.4

§146 (b) 2.
Table 1-N

PRIMARY FUNCTION	ALLOWED LIGHTING POWER
Convention, conference, multipurpose and meeting centers	~~1.6~~1.5*
Lobbies:	
Hotel lobby	~~2.2~~1.7*
Locker/dressing room	~~0.9~~0.8

§146 (a) 2.
Table 1-L

TYPE OF CONTROL	TYPE OF SPACE	FACTOR
~~**Lumen maintenance controls**~~	~~Any space~~	~~0.25~~
Combined controls		
~~Occupant sensor with a separate sensor for each space used in conjunction with lumen maintenance controls~~	~~Any space ≤ 250 square feet and enclosed by opaque floor-to-ceiling partitions~~	~~0.25~~

ACM Changes

Tables 2.1 and 2.2 in the ACM manual are also modified to be consistent with the changes to the Energy Standard. The complete tables are in *Volume III – Draft ACM Manual*, but are summarized in Table 20.

Table 20 – Proposed Lighting Changes in ACM Manual

Section	*Proposed Changes*							
§2.3.1.2 Table 2.1	Occupancy Type	#people 1000SF(1)	Sensible person(2)	Latent person(2)	Recept. W/SF(3)	Water Btuh person	Lighting W/SF(4)	CFM SF(5)
	Religious Worship, Auditorium~~,~~ ~~Convention~~	136	245	112	0.96	57	1.8	1.03
	Convention	136	245	112	0.96	57	1.4	1.03
§2.3.1.2 Table 2.2	Sub-Occupancy Type (1)	#people 1000 SF(2)	Sensible person(3)	Latent person(3)	Recept. W/SF(4)	Water Btuh person	Lighting W/SF(5)	CFM SF(6)
	Convention, Conference and Meeting Center	67	245	155	1.0	60	~~1.6~~1.5	0.50
	Lobby – Hotel	10	250	250	0.5	120	~~2.2~~1.7	0.15
	Locker and Dressing Room	20	255	475	0.5	385	~~0.9~~0.8	0.15

Discussion

Section 130 (c) Exterior Lighting

Description

The current standards do not specify a minimum source efficacy for exterior lighting. The proposed addition would set a minimum efficacy value of 60 lumens/Watt and provide consistency with ASHRAE 1999. A minimum source efficacy of 60 Lumens/Watt would minimize the use of mercury vapor high intensity discharge (HID) lamps and tungsten-halogen lamps for exterior applications. It promotes the use of other HID lamps such as metal halide and high-pressure sodium (HPS).

Cost Effectiveness

The following cost effectiveness analysis follows the California procedure outlined in the economics section. The analysis is normalized with respect to the most efficacious lamp, in this case the HPS unit. In other words, the energy used by a single HPS lamp is compared to that of the corresponding number of tungsten-halogen, mercury vapor, or metal halide lamps needed to provide an equivalent lumen output. Lamp/ballast costs are based on data provided by Robert Kruger and the Grainger online catalog. Lamp performance data come from industry catalogs and *Advanced Lighting Guidelines* (EPRI 1993). The lamps are assumed to be in use for 12 hours per day, or 4380 hours per year. The change in life cycle cost uses mercury vapor as the base case and takes into account the net present value of the total number of lamps used over a 15 year period assuming a 3% discount rate. The summer off-peak, medium commercial value of $0.81 per saved kWh is used to determine the present value of electricity cost savings. This value was used because exterior lighting is not generally operated during on-peak periods and choosing the lowest present value provides a conservative analysis. The results show that Metal Halide and HPS lamps are the most cost effective over a 15 year period and are the only lamps to exceed an efficacy of 60 lumens/Watt. Tables 21 and 22 summarize the results.

Table 21 – Exterior Lighting Cost Effectiveness Comparison 175-W Lamps

Lamp	Initial Output (Lumens)	Cost ($/Lamp-Ballast)	Source Efficacy (Lumens/Watt)	Number of Lamps	Number of Lamps Used Over 15 year period	Change in Life cycle Cost (US$)
Tungsten	3200	20	18	5.9	195.0	$5186
Mercury	7700	30	44	2.5	6.8	$0
Metal Halide	12500	35	71	1.5	10.0	-$468
HPS	19000	38	109	1.0	2.7	-$992

Note: Sample calculations can be found in Appendix J.

Table 22 – Exterior Lighting Cost Effectiveness Comparison 400-W Lamps

Lamp	Initial Output (Lumens)	Cost ($/Lamp-Ballast)	Source Efficacy (Lumens/Watt)	Number of Lamps	Number of Lamps Used Over 15 year period	Change in Life cycle Cost (US$)
Tungsten	7500	30	19	6.3	208.1	$10,608
Mercury	20500	40	51	2.3	6.3	$0
Metal Halide	34500	45	86	1.4	4.5	-$1,375
HPS	47500	50	119	1.0	2.7	-$1,965

Section 130 (d) Luminaire Wattage

Description

The current standard contains a loophole regarding the calculation of luminaire wattage. As the language exists, the calculation can be based on the wattage of the lamps installed in the luminaire. This allows a designer to specify a high wattage luminaire and still comply with code as long as lower wattage lamps are used. With the high wattage luminaire installed, the user has the option to install higher wattage lamps in the

future, thereby eliminating any energy savings. The proposed addition closes this loophole by specifying what is to be used when calculating luminaire wattage.

Cost Effectiveness

The addition of Section 130 (d) to the standard is for clarification purposes and does not require a cost effectiveness analysis.

Section 131 (b)&(d) Bi-Level and Automatic Shut-off Controls

Description

Bi-level control provides a simple and inexpensive method for reducing lighting loads by 50% or more. These controls not only save significant amounts of energy in spaces that do not always require full light, but are also an extremely useful mechanism for decreasing peak demand during energy emergencies. Unfortunately, the current standard includes several exceptions that cause bi-level control not to be used in otherwise applicable situations. The purpose of the proposed changes to Section 131 (b) and (d) is to remove these unnecessary exceptions to bi-level control and to expand coverage of the automatic shut-off control requirement. This is accomplished through an adjustment and several deletions in the code language. The following is a brief explanation of these changes.[11]

California 1992 does not require bi-level switching in spaces having a LPD of less than 1.0 W/ft^2. This value was chosen because the implementation of bi-level controls becomes more difficult and expensive at lower LPD levels. However, advances in lighting technology have allowed many modern spaces to go below 1.0 W/ft^2. The proposed changes would reduce the minimum LPD to 0.8 W/ft^2 in order to account for advances in technology and keep more buildings and spaces under the requirement.

Exceptions 1 and 3 to Section 131 (b) exempt buildings with installed occupancy sensors or automatic time switches with manual override from the bi-level control requirement. Due to this exception, many buildings that are required to have automatic shut-off controls are exempt from bi-level control, as occupancy sensors and time switches are often employed to fulfill this requirement. The proposed changes would eliminate these exceptions. Combining these deletions with the reduction in the minimum LPD would make bi-level control required in all spaces with a lighting load greater than 0.8 W/ft^2 that are larger than 100 ft^2.

Exception 1 to Section 131 (d) exempts buildings and separately metered spaces with less than 5000 ft^2 of conditioned space from the automatic shut-off control requirement. The exemption was originally put in place when automatic shut-off controls were akin to elaborate energy management systems and were only cost-effective in large spaces. Currently the same benefits can be realized with simple, inexpensive occupancy sensors that can save energy cost-effectively even in small spaces. Because this requirement can easily be met with inexpensive occupancy sensors, the proposed changes would remove this exception.

Cost Effectiveness

The following cost effectiveness analysis estimates the costs for bi-level switching and occupancy sensors, the simplest forms of bi-level and automatic shut-off controls.[12] The standard CEC method using an electricity price of $0.115/kWh, a 15-year time period, and a 3% discount rate is then used to examine the costs. This results in an estimate of the number of hours per year the control must turn the lights off, or half off in the case of bi-level switching, in order for the measure to be cost effective.

Tables 23 shows the installed costs for bi-level switching range from $0.173/ft^2 to $0.037/ft^2. The results indicate that half the lights would need to be turned off 187 hours/year (less than 4 hours/week) in order for bi-level switching to be cost effective in small office space, the worst-case scenario. Only 26 hours/year (0.5 hours/week) are required for retail space.

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[11] A more detailed discussion can be found in the Code Enhancement Initiative Report, *Bi-Level and Automatic Shut-off Controls*, prepared for PG&E by the Heschong Mahone Group.

[12] Price data come from the 2000 RS Means Electrical Cost Data.

Table 23 – Bi-Level Switching Cost Effectiveness
Source: "Bi-Level and Automatic Shut-off Controls" PG&E/HMG.

Space type	LPD	Area/Switch	Switch	Wiring	Total incl. O&P	Total/ft^2	Cost-effective Annual h/yr half off
Small office	1.3	150	$ 15.95	$ 1.32	$ 25.90	$ 0.173	187
Large office	1.3	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	40
Large storage	0.6	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	87
Conference	1.3	400	$ 15.95	$ 3.51	$ 29.19	$ 0.073	79
Retail	2	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	26
Grocery	1.6	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	33
Classroom	1.6	900	$ 15.95	$ 7.89	$ 35.76	$ 0.040	35

Note: See Appendix K for sample calculations.

The costs for occupancy sensors range from $0.745/ft^2 to $0.106/ft^2. The results shown in Table 24 suggest the sensors must turn the lights off for 874 hours/year (17 hours/week) for the worst-case situation and 109 hours/year (2 hours/week) for the best-case scenario. It should be noted that the worst-case scenario is a somewhat atypical example involving a small restroom with a low LPD and an expensive occupancy sensor. Because lights are often left on after occupants leave this type of space, extinguishing the lights a few times a day, or preventing them from being left on overnight, could easily make the measure cost effective. Most spaces, however, can use less expensive sensors and are cost effective when sensors turn the lights off for only 2-6 hours/week.

Table 24 – Occupancy Sensor Cost Effectiveness
Source: "Bi-Level and Automatic Shut-off Controls", PG&E/HMG.

Space type	Osensor Type	LPD	Osensor	Wiring	Commisionir	Total	Total/ft^2	Cost-effective Annual h/yr off
Warehouse	PIR ceiling	0.6	$ 180.00	$ 76.20	$ 10.00	$ 266.20	$ 0.106	125
Small office	PIR wallbox	1.3	$ 70.50		$ 10.00	$ 80.50	$ 0.537	291
Large office	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.224	121
Large office	IR ceiling	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.373	202
Conference	PIR wallbox	1.3	$ 70.50		$ 10.00	$ 80.50	$ 0.268	145
Conference	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.559	303
Breakroom	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.224	121
Restroom	wall box ultrasor	0.6	$ 85.50		$ 10.00	$ 95.50	$ 0.318	374
Restroom	ceiling ultrasonic	0.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.745	874
Classroom	Dual tech	1.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.248	109
Classroom	IR or US ceiling	1.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.248	109

Automatic shut-off can be accomplished using other methods besides occupancy sensors. Other mechanisms range from simple twist timers to elaborate building energy management systems. Market forces and individual designers will determine the appropriate technology for each particular situation. Nevertheless, the preceding cost analysis represents practical and achievable solutions to the proposed requirements.

The proposed changes require both bi-level and automatic shut-off controls for most spaces. In these cases the cost effectiveness analysis would be additive. For example, in large office spaces bi-level switching must operate for one hour per week and occupancy sensors for between two and four hours per week, depending on the sensor used, in order for the measure to be cost effective.

Section 146 (a) Portable Lighting

Description

The current California standard contains a loophole regarding portable lighting in office space. The proposed changes clarify that portable lighting is to be included in the calculation of actual lighting power density. The changes specify that actual product data be used in the calculation unless it is unknown at the time of permitting. If the data is unknown and the space is larger than 250 ft^2 a default value of 0.2 W/ft^2 is used in the calculation. However, upon installation of the portable lighting systems, the building official may require resubmittal of compliance documentation using exact installed lighting and equipment data.

Cost Effectiveness

The addition of part (a) in Section 146 is a clarification of the standard. It merely closes a loophole and does not require a cost effectiveness analysis.

Section 146 (b) Lumen Maintenance

Description

Lumen maintenance controls work by initially supplying less power to the lamp and then gradually increasing the power so as to provide a steady lumen output throughout the life of the lamp, while saving energy in the process. Due to economic reasons, advancement in technology, and the reduction in workplace smoking, the lumen depreciation curve is has flattened considerably. This has resulted in an abandonment of lumen maintenance technology. For these reasons, the lumen maintenance credits are considered obsolete and it is suggested they are removed from the standards.

Cost Effectiveness

The proposed change eliminates credits in the standard that are outdated and not used. A cost effectiveness analysis is unnecessary.

Section 146 (b) and 2.3.1.2 Lighting Power Allowances

Description

Several of the lighting power density (LPD) allowances in California 1998 are higher than those specified for the same spaces in ASHRAE 1999. The proposed changes would alter these LPD allowances in order to make them consistent with ASHRAE standards. The ASHRAE standards were developed in conjunction with the Illuminating Engineering Society of North America (IESNA). Together they developed a procedure for calculating lighting power allowances based on assumptions from a panel of lighting design professionals and currently available data for efficient lamps, ballasts, and fixtures. The intention was to take into account both energy-efficient design and the occupants needs. IESNA has compiled a listing of the model spaces that determined the LPD allowances in ASHRAE 1999 on their website. These models illustrate how the LPD allowances can be met with available efficient lighting products and still maintain lighting quality. Data for the specific spaces considered in this update can be found in Appendix L.[13]

Cost Effectiveness

As outlined in the economics chapter, the cost effectiveness for these changes is based on analysis done in ASHRAE 1999. Since the ASHRAE methodology values energy savings less than the California Energy Commission, it follows that all of the requirements in ASHRAE 1999 should be cost effective with California assumptions.

[13] Example space data can also be found on the IESNA website. WWW.IESNA.org

Heating, Ventilating and Air-Conditioning (HVAC)

HVAC is an important component of energy use in nonresidential buildings and there are many opportunities for savings. There are a number of proposals for upgrading and improving the Energy Standard in terms of HVAC. These are all based on the recently adopted ASHRAE/IESNA Standard 90.1-1999. The following is a summary. The subsections of this chapter, which follow, contain more details and discussion.

- *Update the HVAC Equipment Efficiency requirements to be consistent with ASHRAE/IESNA Standard 90.1-1999.* ASHRAE 1999 has more stringent equipment efficiency requirements than California 1998 for non-NAECA HVAC equipment. The ASHRAE efficiency requirements were justified through life cycle cost analysis, using cost data provided by the manufacturers through their trade organizations, the Air-conditioning and Refrigeration Institute (ARI)[14] and the Gas Appliance Manufacturers Association (GAMA).
- *Adopt the ASHRAE 1999 measures to mitigate standby losses for gas- and oil-fired forced air furnaces.* Requirements include power venting, vent dampers or flue dampers when the equipment is in conditioned space; intermittent ignition or interrupted devices (IID) regardless of location; and limits on jacket losses for furnaces located in unconditioned spaces.
- *Adopt the tradeoff method for centrifugal chillers designed to operate at non-ARI standard test conditions.*
- *Provide a prescriptive trade-off table for airside economizers that allow higher equipment efficiencies in lieu of an economizer for unitary air-conditioners and heat pumps.* This requirement is a modification of a trade-off developed for ASHRAE Standard 90.1-1999, but adapted for the 16 California climate zones.
- *Add requirements for the type of high-limit switch, which can be used for air-side economizers.* This requirement is based on ASHRAE 1999, but adapted for California climates.
- *Add language to the standard to protect pipe and duct insulation that is exposed to outdoor conditions.* Also protect pipe insulation in unconditioned space.
- *Add requirements for demand-controlled ventilation in high occupancy spaces.* This requirement is similar to a mandatory measure in ASHRAE 1999 and is supported by a life cycle cost study.
- *Require fan speed speed controls for cooling towers and air-cooled or evaporatively cooled condensers.*

[14] ARI is the national trade association representing manufacturers of more than 90 percent of U.S. produced central air-conditioning and commercial refrigeration equipment.

HVAC Equipment Efficiency Tables

Recommendation

Premanufacturered and packaged HVAC equipment is a very large share of the market, probably more than 80%. Major equipment manufacturers, through ASHRAE/IESNA Standard 90.1-1999 have agreed to new efficiency numbers to become effective October 29, 2001. These are adopted in the national consensus standard and the proposal is to adopt these same equipment efficiency values for the California standard. These efficiency values cover the following classes of equipment:

- Electrically-Operated Unitary Air Conditioners and Condensing Units (Table 6.2.1A of ASHRAE 1999)
- Electrically-Operated Unitary and Applied Heat Pumps (Table 6.2.1B of ASHRAE 1999)
- Water Chilling Packages (Table 6.2.1C of ASHRAE 1999)
- Electrically-Operated Terminal Air Conditioners and Heat Pumps (Table 6.2.1D of ASHRAE 1999)
- Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters (Table 6.2.1E of ASHRAE 1999)
- Gas- and Oil-Fired Boilers (Table 6.2.1F of ASHRAE 1999)
- Heat-Rejection Equipment (Table 6.2.1G of ASHRAE 1999)
- Gas- and Oil-Fired Water Heating Equipment (Table 7.2.2 of ASHRAE 1999)

The proposed efficiencies are presented in the Tables 1-C1 through 1-C7 of §112 of the Energy Standard and Table 1-C11 of §113). See *Volume II – Draft Standard* for the specific proposed changes to the regulations. In the tables, the columns marked “Efficiency up to 10/29/01” contain data from Title 24 1998. The columns marked "Efficiency as of 10/29/2001" contain the values from the new ASHRAE/IESNA Standard 90.1-1999. Equipment manufactured after this date must comply with these levels[15]. This delayed implementation provided a two-year period for manufacturers to gear up for production of new product lines. The columns marked “Efficiency up to 10/29/2001” contain the current Title 24 efficiency levels. Equipment manufactured prior to 10/29/2001 may be installed after 10/29/2001 if they meet or exceed the current Title 24 efficiency requirements.

Discussion

For the development of the ASHRAE 1999, the manufactures and their trade organizations (ARI and GAMA) participated in a detailed life cycle cost study including development of cost curves for mechanical heating and cooling equipment. The cost curves represent the incremental increase in first cost as a function of incremental improvements in full- and part-load equipment efficiencies. These cost curves were used together with hourly simulation models (using the BLAST program) of office and retail buildings in 11 climates across the country to develop life cycle cost equations for cost-effective efficiency levels. The results from the simulation models were weighted by construction activity in each of the 11 climatic regions. Equipment full-load equivalent operating hours (FLEOH) were generated from the climate weighted results. Refer to Appendix M for details of these simulations models. It is important to note that these proposed efficiency levels achieved consensus through the ASHRAE/ANSI process. In general these efficiency levels exceed the requirements of California’s 1998 Standard.

[15] This was clarified in the Standard 90.1 interpretation IC 90.1-1999-2 (available from the ASHRAE website http://www.ashrae.org).

Life Cycle Cost

The equipment tables in the 1999 ASHRAE Standard were developed though a rigorous life cycle cost analysis and subjected to three full rounds of public review and comment. The life cycle cost criteria applied were less stringent than that applied to California's 1998 standard, but the resulting requirements are more stringent due to access to more accurate cost data. This analysis is documented in Appendix M and in the Standard 90.1 committee "blue book." A copy of the ASHRAE "blue book" is available on the website, http://www.taylor-engineering.com/Title24 through February 1 of 2001.

Standby Loss Measures for Gas- and Oil-Fired Forced Air Furnaces

Recommendation

Adopt the ASHRAE 1999 measures to mitigate standby losses for gas- and oil-fired forced air furnaces (§6.2.1 of ASHRAE 1999). This proposed measure is shown as new §112(c) of the Energy Standards. in *Volume II – Draft Standard*.

Discussion

These measures reduce fuel energy by reducing stand-by losses through three mechanisms:

1. The requirement for power venting, vent dampers or flue dampers reduces the off-cycle heat losses from a space where combustion air is drawn from the space (typical for a unit heater or furnace).
2. The requirement for an intermittent ignition device (IID) or interrupted device reduces off-cycle fuel losses for furnaces regardless of location.
3. The limit on jacket losses is appropriate to furnaces located in mechanical rooms or other unconditioned spaces.

These measures are included in response to a comment from Joe Mattingly of GAMA. The fact that GAMA submitted this comment is an indication of the industry support for these requirements.

Life Cycle Cost

This measure was developed through a consensus of committee members including representation from manufacturers and trade organizations (ARI and GAMA). The group agreed that these measures would be cost effective using the ASHRAE 90.1 criteria but did not develop a separate LCC study.

Centrifugal Chiller Trade-Off Method

Recommendation

Adopt the ASHRAE 1999 tradeoff method for centrifugal chillers designed to operate at non-ARI standard test conditions (Tables 6.2.1 I, J and K of ASHRAE 1999). These proposed tradeoffs are presented as an exception to §112(a) and new Tables 1-C8, 1-C9 and 1-C10 in Volume II – Draft Standard.

Discussion

Centrifugal chillers that are designed to operate in the relatively cool California climates often cannot operate stably at the ARI standard test conditions[16]. Each chiller is designed for a specific "lift" the difference in pressure (and temperature) between the evaporator and condenser sides of the machine. Chiller's designed for California's cool climates are often sized for small lifts to improve their efficiency. Centrifugal chillers designed for low lift will not operate at the higher lifts required by ARI test standards due to a physical phenomenon called surge.

Although ostensibly these centrifugal chillers were covered under the current Title 24 standard, manufacturers were demonstrating compliance by extrapolating the chiller's performance beyond the certified operation of these machines. This proposed measure consistent with ASHRAE Standard 90.1 provides a uniform basis for that necessary adjustment. The Standard 90.1 committee developed an equal energy mapping for centrifugal chillers precisely to address these concerns. It is important to note that this uniform equal energy trade-off method was developed by a working group with representation from the four major manufacturer's of centrifugal chillers and their trade organization, ARI.

Life Cycle Cost

The chiller trade-off tables represent an equal energy trade-off; no life cycle cost analysis was performed in support of these tables.

[16] ARI Standards 550 and 590 use rating conditions of 44°F chilled water supply (with 2.4 gpm/ton) and 85°F condenser water supply (with 3.0 gpm/ton).

Air-Side Economizer Trade-Off Method

Recommendation

We recommend the adoption of a prescriptive equal-energy trade-off method to increase HVAC unit efficiency in exchange for the airside economizer requirement for packaged (unitary) air-conditioners and heat pumps. This recommendation is presented as exception 5 to §144(e)1 and Tables 1-X1 and 1-X2 in *Volume II – Draft Standard*. These tables present tradeoff efficiencies based on climate zone and unit size (base unit efficiency).

Discussion

This requirement is a modification of a trade-off developed for ASHRAE Standard 90.1-1999 (Table 6.1.3). As discussed below, a DOE-2 model was run in the 16 California climate zones to develop an equal-energy trade-off between airside economizers and improved equipment efficiency. The model used in this trade-off should be conservative as it assumed perfect economizer operation (utility and commissioning studies indicate that a high percentage of economizers fail to operate properly in the field). Although ostensibly an equal-energy tradeoff, it is believed that this measure should provide greater persistence in energy savings: unit efficiency does not appear to degrade as rapidly as economizer performance. A further benefit of the proposed measure is demand reduction in key areas: the application of high efficiency units in hot climates will help to reduce peak energy when economizers typically do not function.

For the most moderate climates (01, 03 and 05 for example) there is no trade-off available. This is due to the fact that economizers in these climates are so effective that no available unit efficiency can offset their energy benefit. In hot climates (climate zone 15 for example) a relatively small improvement in efficiency trades off against the performance of the airside economizer.

Life Cycle Cost

As previously stated, this measure is an equal energy trade-off. The tables 1-X1 and 1-X2 were developed using non-residential 5-zone models with and without operable airside economizers. The models utilized are described in Appendix H and are consistent with the modeling assumptions for the proposed envelope measures. For this measure, four models were developed for each size category of unitary air-conditioners and heat pumps in each of the 16 climate zones:

- A base-case run with the minimum required efficiency and an operable economizer
- The same base-case efficiency with no economizer
- An EER of 11 and no economizer
- An EER of 12.5 and no economizer

For each run, a first-order linear regression equation was developed for the runs without economizer. The break point efficiency was determined by locating the EER such that the annual kWh/yr of cooling without economizer just equaled the kWh/yr of cooling with the base-case EER and an operable economizer.

Air-Side Economizer High-Limit Switch Controls

Recommendation

We recommend the adoption of the proposed air-side economizer high-limit switch control language as shown in §144(e)3 and Table 1-X3 in Volume II – Draft Standard.

Discussion

Integrated airside economizers operate to provide free cooling whenever the outdoor air is cooler (or has less enthalpy) than the return air from the space. During economizer operation a typical economizer control sequence will modulate the amount of outdoor air between a minimum required for ventilation and 100% outdoor air to maintain a fixed supply air setpoint. As the outdoor air gets hotter (and/or increases in humidity) there comes a point where bringing in outdoor air in excess of the ventilation minimum is an energy penalty. The high-limit switch is a device that determines when that point is reached. In brief there are three sensing technologies that are used in economizer high-limit switches:

- Temperature sensors that measure the dry-bulb of the outdoors and return air streams
- Enthalpy sensors that measure the heat content of the air (a mixture of temperature and humidity)
- Electronic enthalpy sensors that act like a temperature sensor at low humidities and an enthalpy sensor at high humidities

For systems utilizing either temperature or enthalpy sensors controls either have differential controls (two sensors one each in the outdoor air and return air streams) or fixed-setpoint controls (one sensor in the outdoor air and a fixed reference setpoint representing the return air). The right control depends on the climate. This measure regulates the application of high-limit switches by type and setpoint (in the case of fixed setpoint controls).

This requirement is based on a requirement in Standard 90.1-1999 (§6.3.1.1.3 and Tables 6.3.1.1.3A and 6.3.1.1.3B). It presents a climate based mapping of different classes of high-limit switches with the most effective setpoints by climate. The table is largely advisory in nature; the only limit proposed in this table is prohibition of fixed setpoint enthalpy controls in mild climates (01, 02, 03, 05, 11, 13, 14, 15 & 16). The fixed enthalpy control in these climates utilizes more energy than the less expensive fixed dry-bulb control with a high setpoint.

Life Cycle Cost

This requirement was based on analysis performed at Battelle Pacific Northwest National Laboratories on behalf of the ASHRAE Standard 90.1 committee. Each of the 22 BLAST runs detailed in Appendix K below were run with unitary air-conditioning equipment with operable economizers. Each form of high limit control and control setpoints were simulated on the individual runs, and cost premiums were developed using fixed setpoint temperature economizers as the base. Regressions were run to seek correlation of results to climatic variables.

For the proposed Title 24 version of these requirements, the 16 California Climate zones were mapped to the ASHRAE climatological criteria. This mapping is presented in Appendix N.

Protection of Duct and Pipe Insulation

Recommendation

We recommend the adoption of the proposed language in §123 and §124 to protect pipe and duct insulation that is exposed to the outdoors, and pipes located in unconditioned space. See *Volume II – Draft Standard* for the specific proposed changes to the regulations.

Discussion

This proposed language was developed for the ASHRAE Standard 90.1-1999. It represents common sense measures to prevent the degradation of insulation from water, UV and abrasion. These measures are required to insure that the insulation retains its performance for the life of the system (assumed as 15 years in the original life cycle cost study that was used to set the insulation values).

Life Cycle Cost

No life cycle cost study was performed in support of this measure. This measure is considered a clarification of the existing insulation criteria that was developed through life cycle cost analysis. This measure is necessary to provide persistence in the LCC justified levels of insulation.

During the development of ASHRAE Standard 90.1-1999 there was a consensus of opinion amongst the committee members that these measures would be cost effective using the ASHRAE criteria, which values future energy savings considerably less than does California.

Demand Controlled Ventilation

Recommendation

We propose the adoption of a new mandatory measure for demand-controlled ventilation in high usage occupancies as detailed in the proposed §121(c) 3. See *Volume II – Draft Standard* for the specific proposed changes to the regulations.

Discussion

In high occupancy spaces with variable times of occupancy, employing demand ventilation controls can save a significant amount of energy. These controls use sensors located either in the space or return air that reset the amount of outdoor air to maintain the indoor air quality. The most common systems utilize CO2 sensors as a proxy for occupant borne contaminants. Spaces that qualify for this requirement include ballrooms, auditoriums and convention centers.

This requirement was developed following a mandatory Measure in ASHRAE Standard 90.1-1999 (§6.2.3.9). It creates a new mandatory requirement using equipment that meets the current Title 24 Exception 1 to §121 (c) 1. ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality[17] also supports the use of demand controlled ventilation.

This proposed measure is supported by a life cycle cost study. It is also supported by development and availability of new equipment and packaged controls that could be used to satisfy the proposed requirement.

Life Cycle Cost

The model used as the basis for the analysis was the DOE-2 office model as described in Appendix I below. For the purpose of this study, the model was modified to represent an interior space with an assembly type of occupancy, consistent with a theater or auditorium use. An occupant density of 10ft2/person is used to be consistent with the ASHRAE Standard 90.1-1999 requirement on which this was based (§6.2.3.9 of ASHRAE 1999).

Model parameters included:

- 2000 ft2 interior zone
- Occupant peak density of 10 ft2/person (200 people in this 2000 ft2 zone), varied each hour and day of the week using Title 24 1998 Alternate Calculation Manual (ACM) non-residential occupancy schedule. The value 10 ft2/person is taken from ASHRAE Standard 90.1-1999 section 6.2.3.9.
- Lighting peak power of 2 Watts/ft2, varied each hour and day of the week using the ACM non-residential lighting schedule
- Equipment peak power of 0.25 Watts/ft2, varied each hour and day of the week using the ACM non-residential equipment schedule
- Zone heating setpoint of 70°F with a 55°F setback, scheduled per the ACM non-residential heating schedule
- Zone cooling setpoint of 74°F with a 95°F setback, scheduled per the ACM non-residential cooling schedule
- System operation from 6am to 8pm weekdays, 6am to 3pm Saturdays, and off on Sundays, per the ACM non-residential fan schedule

[17] Reference Interpretation IC 62-1989-27. This can be found on the ASHRAE website http://www.ashrae.org under the links for Standards and Interpretations.

The zone is served by a packaged single zone (DOE-2 type PSZ) unit with a 55°F minimum supply air temperature, constant-volume draw-through fan, integrated outdoor air economizer, and a fan power rating of 0.000365 kW/cfm. The unit operates with a cooling EIR of 0.401 and furnace HIR of 1.25.

The analysis holds the above input parameters constant for every run. For each climate zone, two runs are performed with differing minimum outdoor air minimum amounts. The higher outdoor air minimum is determined by the Title 24 (§121) requirement of 15 cfm/person. This gives 3000 cfm minimum outdoor air for our test case of 200 people. The lower outdoor air minimum is determined by using the Title 24 (§121) demand-controlled ventilation floor of 0.15cfm/ft2, which for this test case gives 300 cfm.

For each climate zone, the equipment is sized based on the 2.5% cooling design data as calculated from the Title 24 California climate zone weather files. The cooling capacity is calculated based on the larger outdoor air minimum and then adjusted upward to a nominal tonnage for a commercially available unit. The airflow is then determined by using 300 cfm/ton minimum, which provides coil and fan performance characteristic of commercial single-zone package equipment. When the second run is performed with the smaller outdoor air minimum value, the supply fan capacity and cooling capacity are held constant from the larger outdoor air case.

Economic Analysis

The annual heating and cooling energy amounts for each run are converted to a net present value using the ACM standard amounts listed below.

- $1.02 as the present value of a kilowatt-hour saved over a 15 year life
- $7.04 as the present value of a therm saved over a 15 year life

With these values, the energy cost for the larger and smaller outdoor air minimum cases is calculated. The difference between the cases represents the dollars that would have been saved if the system ran for an entire year at the minimum position. Taking the ratio of the additional first cost of the demand-controlled ventilation equipment and dividing it by the dollar difference between the two cases yields the payback breakpoint.

This breakpoint can be interpreted as the percent of hours where the system is in operation where the outdoor air minimum is set to the low threshold. During the remaining hours, the outdoor air minimum position can be assumed to be at the higher setpoint.

To determine the threshold level below which the measure makes sense for a climate zone, the ACM non-residential occupancy schedule is converted to equivalent full occupancy hours for a year. The unoccupied percentage of the system operating hours is then calculated and compared to the threshold unoccupied percentage for each climate zone. Where the climate zone percentage is below the threshold percentage, the measure makes sense for a zone.

Given a first cost for the demand-controlled ventilation equipment of $1,500, the measure makes sense for all climate zones. CO2 sensors with a 5-year warranty on self-calibration from Telaire corporation are being packaged with unit economizer controls by both CANFAB and MicroMetal. These units on a typical 10 ton air-conditioner represent approximately $925 (owner's cost) premium. Zone based CO2 sensor (also using the Telaire technology) are incorporated into thermostats by Carrier Corporation. These represent an owner's cost premium of approximately $650 per zone. Using the ACM non-residential schedule, this measure as written is cost effective up to a value of $3,000 per zone.

Table 25 – Demand Controlled Ventilation Simulation Results

	3000 cfm Case			300 cfm Case			Cost	% Unoccupied	T24 non-res	Auditorium
	Cooling	Heating	Cost	Cooling	Heating	Cost	Difference	LCC break point	threshold	threshold
	[Mbtu]	[Mbtu]	[$]	[Mbtu]	[Mbtu]	[$]	[$]			
CZ-01	2.2	143.8	$17,780	2.2	0	$7,657	$10,124	30%	pass	pass
CZ-02	23.7	113.9	$90,500	19.9	0.1	$69,264	$21,236	14%	pass	pass
CZ-03	12.5	87.7	$49,677	12.5	0	$43,503	$6,174	49%	pass	pass
CZ-04	31.2	76.7	$113,983	24.6	0	$85,614	$28,369	11%	pass	pass
CZ-05	14.9	70.1	$56,791	14.9	0.1	$51,863	$4,928	61%	pass	pass
CZ-06	21.3	38.1	$76,811	20.8	0	$72,389	$4,422	68%	pass	pass
CZ-07	27.9	29.9	$99,204	24.5	0	$85,266	$13,938	22%	pass	pass
CZ-08	37.3	35.8	$132,333	30.3	0	$105,451	$26,882	11%	pass	pass
CZ-09	46.5	37.3	$164,457	34.4	0	$119,720	$44,737	7%	pass	pass
CZ-10	48.5	45.4	$171,988	35.4	0	$123,200	$48,787	6%	pass	pass
CZ-11	37.8	101.4	$138,692	26.6	0.1	$92,581	$46,110	7%	pass	pass
CZ-12	36.1	102.5	$132,853	25.8	0.1	$89,797	$43,055	7%	pass	pass
CZ-13	56.7	80	$202,962	36	0.1	$125,296	$77,666	4%	pass	pass
CZ-14	42.1	101.4	$153,657	29.2	0.2	$101,637	$52,020	6%	pass	pass
CZ-15	107.2	18.8	$374,405	47.3	0	$164,615	$209,790	1%	pass	pass
CZ-16	15.4	202.8	$67,873	13.3	0.4	$46,315	$21,557	14%	pass	pass

Heat Rejection Control

Recommendation

We recommend the adoption of the proposed requirement §144(h) below for fan speed controls for cooling towers and air-cooled or evaporatively cooled condensers. See *Volume II – Draft Standard* for the specific proposed changes to the regulations.

Discussion

A joint working group consisting of members from ASHRAE TC 8.6, "Cooling Towers and Evaporative Condensers," and the committee responsible for ASHRAE Standard 90.1 developed this measure for ASHRAE Standard 90.1-1999. This group employed the same national energy model that was used for the equipment efficiency requirements (see Appendix M) and developed a computer model of a central chilled water plant. The results from the study-supported development of a new requirement for fan speed control on all fans over 5 hp, however the requirement was set to 7.5 hp to be conservative. The SSPC90.1 subsequently expanded the model to evaluate the impacts of controls on multiple cell towers and condensers with multiple fans.

Life cycle Cost

The life cycle cost analysis had three major sections: a simulation model to determine the energy usage and relative energy costs, estimation of the installed cost premium for alternative fan-speed controls, and a life cycle cost model to evaluate the results. Each of these elements is described in detail below.

Hourly Simulation Model

The working group employed an hourly simulation model as the basis of the energy calculations. The group performed this work in two phases, one for thermal cooling loads and a second for the central cooling plant. The thermal cooling load model had been previously developed by the staff of a national laboratory to support the analysis of heating and cooling equipment efficiencies (See Appendix M). The central plant model was custom built by the working group for this study.

Central Plant Model Overview

The working group converted the results of the BLAST runs into text files for use as input to the central plant. Having obtained a model for the thermal cooling loads, the working group's next task was to define the attributes of the central plant model. This was a process based on the collective experience of the working group members, and decisions were achieved through discussion and consensus. The final plant model included a single centrifugal chiller with inlet-vanes, a single one-cell cooling tower, and three forms of cooling-tower fan control:

- Single-speed fan (on-off);
- Two-speed fan or pony motor sized for 2/3 capacity (100%-67%-off); and
- Two-speed fan or pony motor sized for 1/2 capacity (100%-50%-off)

These cooling tower controls were selected as being representative of the bulk of commercial applications. Variable-speed controls were not explicitly modeled; however, they would be accepted as meeting or exceeding any requirement based on two-speed controls.

The group developed the plant model in the macro language of a spreadsheet application. The assumptions used in this model were as follows:

- Size the chiller to just meet the peak cooling load.

- Base the chiller part-load performance on a centrifugal machine with inlet vanes.[18]
- Set the chilled water supply temperature to 44°F (6.7°C).
- Set the chiller full load efficiency to 6.1 COP at ARI Standard 55-92 (ARI 1992).[19]
- Size the cooling tower to provide a 10°F (5.6°C) approach at the full heat rejection load, a 10°F (5.6°C) range, and the maximum wet-bulb temperature.
- Control the cooling tower to provide condenser water supply equal to the maximum wet-bulb temperature.[20]
- Base the cooling tower available capacity on the default DOE-2 (ver2.1E) curves.
- Set the cooling tower efficiency to 20 gpm/hp (1.7 L/s-kW) at CTI Standard 210-96 conditions (CTI 1996).[21]
- Set the 2/3 speed fan operation to 67% of the design capacity at 30% of the design power.[22]
- Set the 1/2 speed fan operation to 50% of the design capacity at 13% of the design power.
- Set the no fan (induced draft) operation to 15% of design capacity with 0% of the design power.

Cooling Tower Component Model

The cooling tower model used in this study was based on the DOE-2 (ver2.1e) simulation program. At the time, the group selected this model because it was readily understood and available.

The DOE-2 (ver2.1E) cooling tower model has two curves that together represent the variation of available cooling tower capacity (condenser water flow) as a function of desired approach, range and wet-bulb temperatures. This model is shown in Equations 1 to 6 below. The two regression curves, FRA and FRB, combine to create a capacity function as a function of the three variables.

$$t_R = t_{cwr} - t_{cws} \quad \textbf{(1)}$$

$$t_A = t_{cws} - t_{owb} \quad \textbf{(2)}$$

$$t_A = a + b \times t_R + c \times t_R^{\ 2} + d \times FRA + e \times FRA^2 + f \times t_R \times FRA \quad \textbf{(3)}$$

$$FRA = \frac{-d - f \times t_R + \sqrt{(d + f \times t_R)^2 - 4 \times e \times \left(a + b \times t_R + c \times t_R^{\ 2} - t_A\right)}}{2 \times e} \quad \textbf{(4)}$$

$$FWB = g + h \times FRA + i \times FRA^2 + j \times t_{owb} + k \times t_{owb}^{\ 2} + l \times FRA \times t_{owb} \quad \textbf{(5)}$$

$$q_{available} = q_{rated} \times FWB \times \left(\frac{t_R}{10}\right) \quad \textbf{(6)}$$

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18 The curves coefficients were developed by the SSPC90.1 Mechanical Sub-Committee and published as default curve coefficients for centrifugal chillers in Appendix J of the first public review draft of Standard 90.1-1989R (ASHRAE 1996).

19 This efficiency rating was the requirement for the ≥300 ton (1055 kW) category of centrifugal chillers in the first public review draft of Standard 90.1-1989R (ASHRAE 1996).

20 Actually it is equal to the maximum wet-bulb temperature with a minimum of 10°F (5.6°C) approach.

21 This efficiency rating was the requirement for centrifugal fan cooling towers in the first public review draft of Standard 90.1-1989R (ASHRAE 1996).

22 The low speed power for both the 2/3 and 1/2 speed controls is based on the ideal fan law with power proportional to the cube of the speed.

Where:

t_R	=	Range
t_{cwr}	=	Condenser water return temperature
t_{cws}	=	Condenser water supply temperature
t_A	=	Approach
t_{owb}	=	Outside wet-bulb temperature
FRA	=	Regression function for tower capacity as a function of range and approach
FWB	=	Regression function for tower capacity as a function of FRA and wet-bulb temperature
a to l	=	Regression coefficients (see DOE 2 documentation for values)
$q_{availble}$	=	Available heat rejection capacity from tower
q_{rated}	=	Heat rejection capacity from tower at rated conditions

At a given hour, if the available heat rejection capacity exceeds the condenser heat, the model modulates the fans. Figure 9 depicts the percentage power versus percentage heat rejection capacity of single-speed, two-speed 100%/50% and two-speed 100%/67% fan controls. In addition, Figure 9 shows a curve for variable-speed fan control. It is important to note that the two-speed and variable-speed fan models cluster closely together in their part-load performance. The one-speed fan uses significantly more energy as the load decreases. Table 26 summarizes the results at 100%, 75%, 50% and 25% capacities. At 75% capacity, a single-speed fan uses 20%-40% more power than the two-speed or variable-speed fans. At 25% capacity, a single-speed fan uses 50%-85% more power than the two-speed or variable-speed fans. The actual savings will depend on dynamics of the cooling load and coincident wet-bulb temperature as it affects the hours spent at full- and part-load conditions.

It should be noted that the group developed the low-speed operation of these fan curves using the perfect fan laws, and did not account for the degradation of motor efficiency at low speed. The variable-speed curve depicted in Figure 9 assumed a 5% degradation in motor and drive efficiency at all speeds.

Table 26: Cooling Tower Fan Model at Part Load: Percent Power as a Function of Percent Load

Percent Full Capacity	1-Speed Fan	Single Fan with VSD	2-Speed Fan (100%/50%)	2-Speed Fan (100%/67%)
100.0%	100.0%	105.0%	100.0%	100.0%
75.0%	70.6%	44.3%	56.3%	47.2%
50.0%	41.2%	13.1%	12.5%	20.1%
25.0%	11.8%	1.6%	3.6%	5.7%

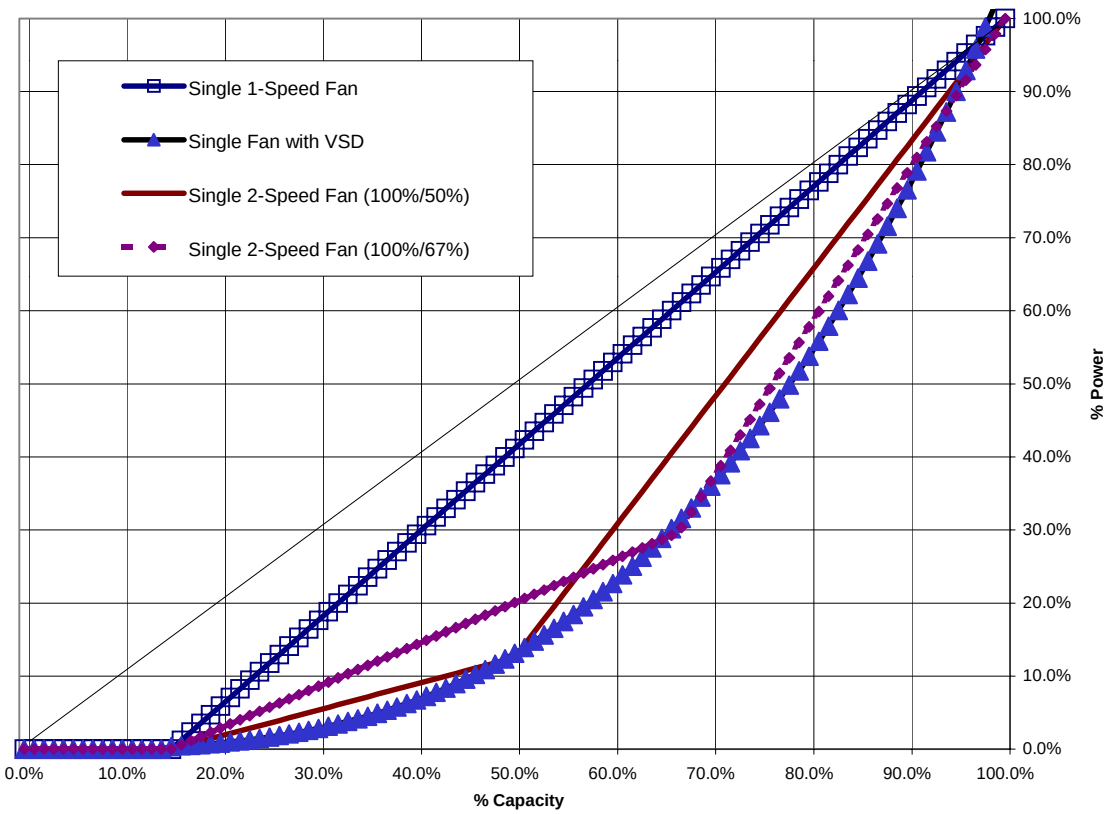

Figure 9: Cooling Tower Fan Model

Electric Chiller Component Model

The electric chiller component model is also based on DOE-2 (ver 2.1E). Like the cooling tower model, the group selected this model because it was readily available and easy to use. In addition, the SSPC90.1 Mechanical Sub-Committee had already developed performance curves in this model format to represent all the major compressor and condenser classes of electric chillers. Subsequent studies have tested these curve formats using both manufacturers' and field-monitored data and found the curve format to be quite accurate (3%-5% CVRMSE).

The DOE-2 (ver 2.1E) chiller model uses three regression curves to represent chiller part-load and off-design performance:

- CAPFT: A curve that represents the variation in capacity with evaporator and condenser temperatures.
- EIRFT: A curve that represents the variation in efficiency with evaporator and condenser temperatures.
- EIRFPLR: A curve that represents the variation in efficiency with part-load conditions. This curve uses an intermediate variable for Part-Load Ratio (PLR)

These curves are represented in Equations 7 through 11.

$$CAPFT = a_{CAPFT} + b_{CAPFT} \times t_{CHWS} + c_{CAPFT} \times (t_{CHWS})^2 + d_{CAPFT} \times t_{CWS} + e_{CAPFT} \times (t_{CWS})^2 + f_{CAPFT} \times t_{CHWS} \times t_{CWS} \quad \textbf{(7)}$$

$$EIRFT = a_{EIRFT} + b_{EIRFT} \times t_{CHWS} + c_{EIRFT} \times (t_{CHWS})^2 + d_{EIRFT} \times t_{CWS} + e_{EIRFT} \times (t_{CWS})^2 + f_{EIRFT} \times t_{CHWS} \times t_{CWS} \quad \textbf{(8)}$$

$$PLR = \frac{q}{q_{rated} \times CAPFT} \quad \textbf{(9)}$$

$$EIRFPLR = a_{EIRFPLR} + b_{EIRFPLR} \times PLR + c_{EIRFPLR} \times (PLR)^2 \quad \textbf{(10)}$$

$$P = P_{rated} \times CAPFT \times EIRFT \times EIRFPLR \quad \textbf{(11)}$$

Where:

CAPFT	=	Regression function for chiller capacity
EIRFT	=	Regression function for chiller efficiency
EIRFPLR	=	Regression function for chiller efficiency
PLR	=	Ratio of load to available capacity for chiller
t_{CHWS}	=	Chilled water supply temperature
t_{CWS}	=	Condenser water supply temperature
a to f	=	Regression coefficients (see DOE 2 documentation for the values)
q	=	Present capacity of chiller
q_{rated}	=	Capacity of chiller at rated conditions
P	=	Present power draw from chiller
P_{rated}	=	Full load power draw from chiller at rated conditions

Central Plant Computer Model Flow Diagram

The central plant computer model calculation flow diagram is represented in Figure 10. This model is comprised of a main routine (MakeRunHr()) and three subroutines (ChillerNorm(), Chiller() and Tower()). The main routine has two loops: one to cycle through each of the 22 climate and occupancy models and another to cycle through each hour of the year. For each of the 22 climate and occupancy files the subroutine ChillerNorm() is called to size the chiller for the peak load at a condenser water temperature corresponding to the approach and the peak wet-bulb temperature (non-coincident). In the hourly loop, the subroutines Chiller() and Tower() are called to estimate the hourly heat rejection and cooling tower fan power usage.

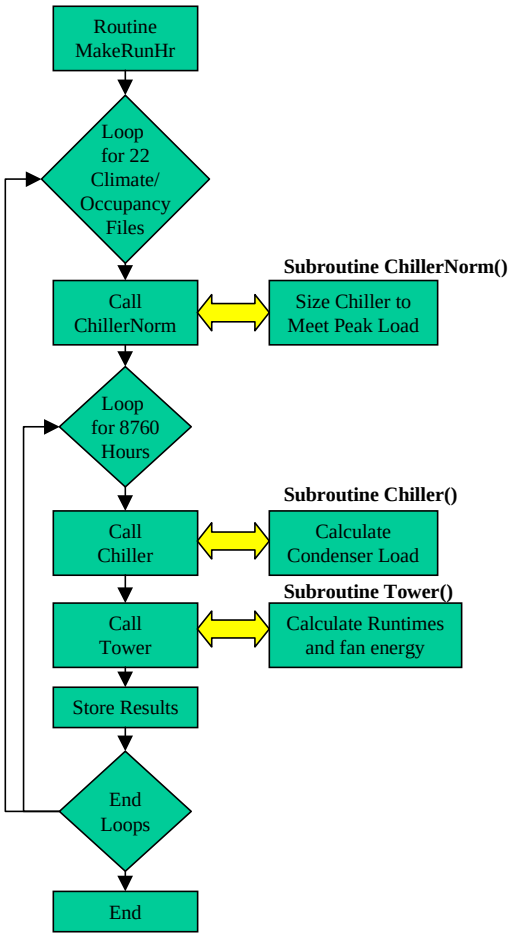

Figure 10 – Simulation Program Flow Diagram

Cost Estimate

A member of TC 8.6 developed the cost premiums for fan speed controls. These costs included the premium for a two-speed motor, the starter, wiring, installation and controls. A 25% factor was added to account for contractor markup and safety. These numbers are presented in Table 28 below.

Life cycle Cost Model

The life cycle costs were based on the criteria developed by SSPC90.1 and consistent with the other requirements of that standard. These include:

- 0.08$/kWh for electricity (flat rate)
- 20 year project life[23]
- 12.1% real discount rate (7.4 present value factor)

The calculation of life cycle cost effectiveness is shown in Equation 12. A positive number represents a cost-effective investment (or positive net present worth) based on the discount rate and project life. In this equation ΔFLEOH represents the reduction full-load equivalent operating hours of a form of fan control, HP is the horsepower of the motor, and PW is the present worth.

[23] Table 3 in Section 33 of the 1995 ASHRAE Application Handbook lists the service lives of wood and galvanized cooling towers as 20years, electric motors as 18 years and motor starters as 17 years (ASHRAE 1995).

$$PW = \Delta FLEOH \times HP \times 0.7457 \times ElectricRate \times PWF - \Delta InstalledCost \quad \textbf{(12)}$$

Results

The detailed results of the simulation model are presented in Table 27. This table presents the full-load equivalent operating hours (FLEOH) of the 2-speed 100%/50%, 2-speed 100%/67% and 1-speed cooling tower fan controls. Identified in the left column are the file codes representing the city and occupancy. The construction activity weighted averages are presented in the final row. These averages were used in the final life cycle cost analysis (Table 4 below). Note that there was very little difference between the run hours of the 2-speed 100%/50% and 2-speed 100%/67% controls (1689 and 1702 hrs/yr respectively). Both of the 2-speed controls saved significant amounts of energy compared to the 1-speed model (2,322 hrs/yr). As previously noted, these efficiency differences are reflected in Figure 9 above.

Table 27: Hourly Simulation Results by Climate and Occupancy

File	Weight	Cooling Tower (2 speed 100%/50%)			Cooling Tower (2 speed 100%/67%)			CT 1speed
Occupancy and Climate Code		FLEOH (hrs/yr)	Runtime (full speed hrs/yr)	Runtime (Half speed hrs/yr)	FLEOH (hrs/yr)	Runtime (full speed hrs/yr)	Runtime (2/3 speed hrs/yr)	Runtime (full speed hrs/yr)
Office DEN	0.89%	1,027	767	2,082	1,061	525	1,808	1,624
Office DET	9.55%	981	730	2,011	1,006	482	1,771	1,558
Office FRS	1.31%	1,644	1,273	2,962	1,689	925	2,580	2,493
Office KNX	10.15%	1,813	1,556	2,060	1,802	1,229	1,934	2,404
Office LAX	6.23%	1,993	1,560	3,466	2,036	1,131	3,053	2,987
Office MNP	0.91%	867	651	1,727	897	454	1,495	1,362
Office ORL	3.14%	3,163	2,793	2,955	3,127	2,288	2,833	4,010
Office PHX	0.71%	2,377	1,920	3,654	2,434	1,492	3,180	3,425
Office PRV	5.30%	911	684	1,812	945	483	1,558	1,430
Office SEA	2.21%	763	562	1,612	796	388	1,377	1,225
Office SHR	5.18%	2,420	2,129	2,326	2,404	1,754	2,192	3,087
Retail DEN	1.82%	1,145	928	1,735	1,159	699	1,551	1,642
Retail DET	10.39%	1,074	852	1,777	1,086	612	1,600	1,584
Retail FRS	2.09%	1,655	1,348	2,452	1,682	1,040	2,169	2,358
Retail KNX	9.03%	1,852	1,622	1,836	1,854	1,356	1,682	2,378
Retail LAX	7.25%	2,001	1,614	3,095	2,046	1,245	2,705	2,889
Retail MNP	1.47%	898	697	1,609	925	512	1,394	1,359
Retail ORL	5.27%	3,209	2,902	2,457	3,175	2,472	2,372	3,914
Retail PHX	1.74%	2,294	1,931	2,905	2,328	1,567	2,566	3,127
Retail PRV	6.77%	954	739	1,725	983	541	1,494	1,449
Retail SEA	1.74%	798	607	1,530	829	442	1,308	1,237
Retail SHR	6.84%	2,367	2,111	2,041	2,365	1,806	1,884	2,952
Weighted Average =>		**1,689**	**1,413**	**2,205**	**1,702**	**1,113**	**1,988**	**2,322**

Note the Full Load Equivalent Operating Hours (FLEOH) and weighted averages were calculated as shown in Equations 13 to 15.

$$FLEOH_{100/50} = RT_{100} + \left(\frac{1}{2}\right)^3 \times RT_{50} \quad \textbf{(13)}$$

$$FLEOH_{100/67} = RT_{100} + \left(\frac{2}{3}\right)^3 \times RT_{67} \quad \textbf{(14)}$$

$$RT_{weighted_avg} = \frac{\sum_i \left(RT_i \times Weight_i\right)}{22} \quad \textbf{(15)}$$

The results of the life cycle cost analysis are presented in Table 28. Note that this study indicates a positive present worth (benefits outweighing costs) for 5 hp (3.7 kW) motors. By consensus of both the working group

and subsequently the SSPC90.1, the requirement was set at 7.5 hp (5.6 kW) to provide a margin for safety. The group considered a conservative approach prudent as this requirement regulates products that previously were not covered by any energy code.

It should be noted that no credit was taken for the increased motor and drive life that a multiple speed arrangement will have due to the reduced fan cycling.

Table 28: Life cycle Cost Results

Motor Size	Run Hours Single Speed	Run Hours Two Speed	Cost Premium	Markup	Installed Cost Premium	Operating Cost Savings	Life Cycle Cost Savings
hp	hrs/yr	hrs/yr	$Premium	%	$	PW$	PW$
3	2,322	1,689	$ 745	125%	$ 931	$ 840	$ (91)
5	2,322	1,689	$ 882	125%	$ 1,103	$ 1,401	$ 298
7.5	2,322	1,689	$ 993	125%	$ 1,241	$ 2,101	$ 860
10	2,322	1,689	$ 1,348	125%	$ 1,685	$ 2,801	$ 1,116

HVAC Duct Sealing

Recommendation

We recommend that the Non-Residential ACM be modified as detailed below to include the impact of duct leakage and insulation levels on heating equipment efficiency and cooling equipment efficiency for individual single-zone unitary (packaged) equipment serving 5000 ft^2 or less via ductwork located in the space between an insulated ceiling and the roof. We recommend that the impacts of duct leakage and duct insulation on HVAC system efficiency be calculated using the algorithms in Appendix G detailed below (a modified version of Appendix F of the 1998 Residential ACM), and that the duct efficiencies impact the standard building as well as the proposed building. The standard building shall be assumed to have a nominal leakage of 22% of fan flow, split equally between supply and return ducts (same as residences). If the proposed building is verified by a HERS rater to have tight ducts (less than 6% of fan flow for supply and return ducts combined) then the duct efficiency of the proposed building can be calculated using 8% total duct leakage split equally between supply and return ducts. Similarly, if the proposed building is verified by a HERS rater to have duct insulation levels above the standard R-4.2 level, then the duct efficiency of the proposed building shall be calculated using the documented insulation level.

Discussion

Research on duct leakage in light commercial buildings over the past five years in California and Florida has indicated even higher leakage levels in light commercial buildings than has been documented for residences (Delp et al. 1998, Delp et al. 1998a, Cummings et al. 1998). The California data, taken by Lawrence Berkeley National Laboratory, indicates 26% leakage in the supply ducts alone. Moreover, those same studies also showed that these ducts were located outside the conditioned space more than 50% of the time. The recommended changes only apply to buildings where the ductwork is outside the conditioned space.

The recommended ACM changes parallel the 1998 Residential ACM Manual, and as such are rather conservative considering the relative leakage levels in these two sectors. To analyze the impact of the recommended changes on heating and cooling budgets, the proposed ASHRAE Standard 152P (which formed the basis of the 1998 Residential ACM Manual) was used to calculate the savings and equipment sizing impacts. These impacts, calculated using several different assumptions for pre-sealing leakage levels and ceiling-roof space[24] configurations in all climate zones, are summarized in Figures 11 and 12. The six pre-seal configurations analyzed were: 1) 11% supply/11%return with vented ceiling plenum, 2) 11% supply/11%return with unvented ceiling plenum, 3) 26%supply/10%return with vented ceiling plenum, 4) 26%supply/10%return with unvented ceiling plenum, 5) 18%supply/4%return with vented ceiling plenum, and 6) 18%supply/4%return with unvented ceiling plenum. In all cases, the post-seal conditions were 4% supply/4%return with venting to match the post-seal condition being analyzed.

[24] For convenience of discussion, this space will be referred to as a ceiling plenum for the remainder of this discussion.

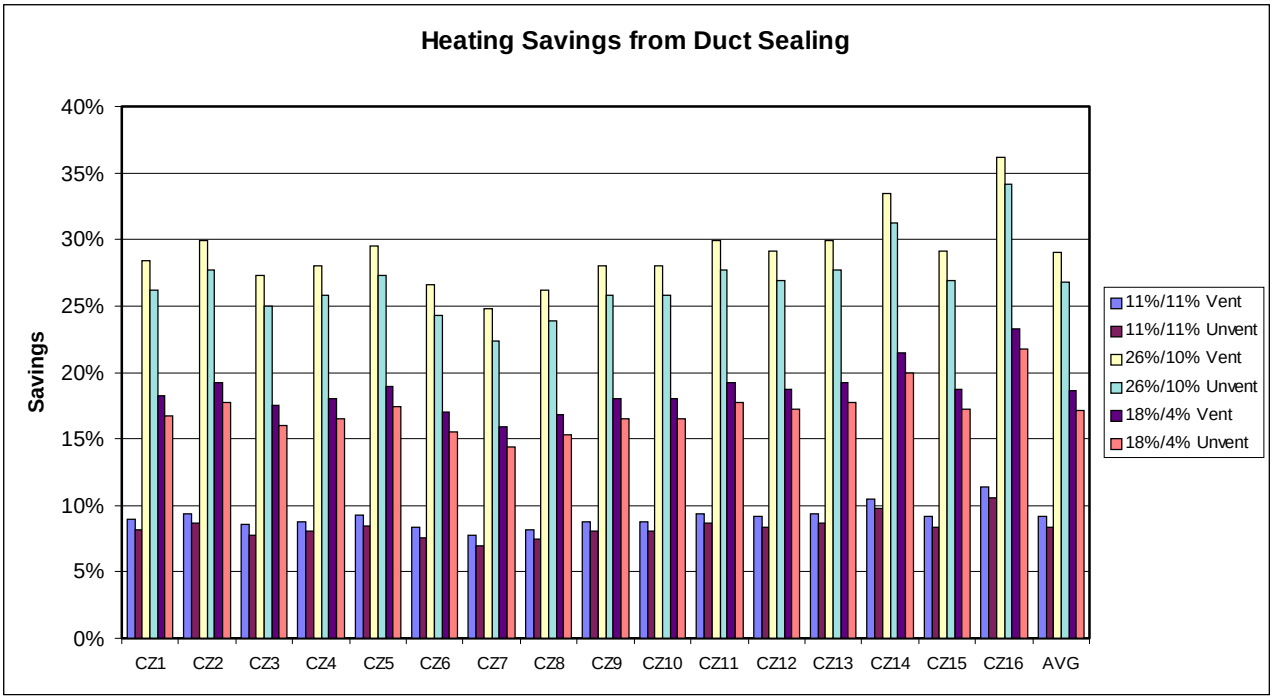

Figure 11 – Duct Heating Energy Savings

Heating energy savings estimates from sealing duct leaks in a single-story 3000 ft^2 commercial building, based upon ASHRAE Standard 152P. All savings relative to 4%/4% supply/return duct leakage.

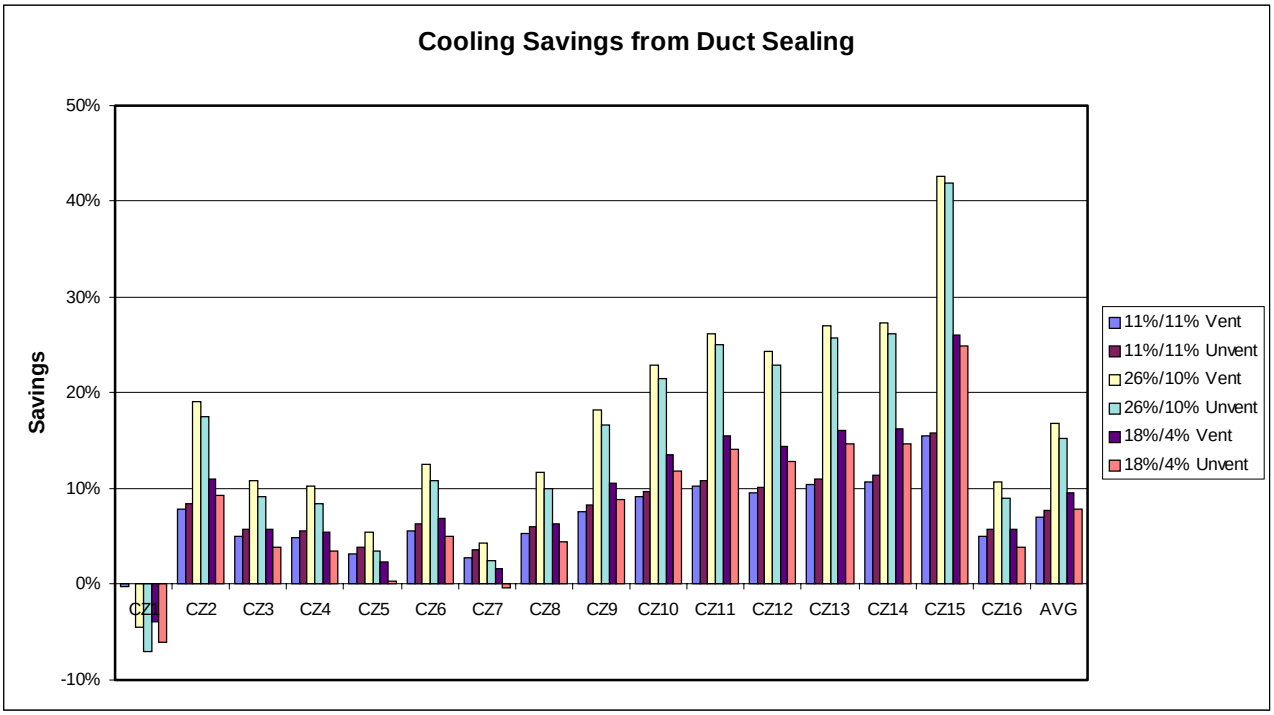

Figure 12 – Duct Cooling Energy Savings

Cooling energy savings estimates from sealing duct leaks in a single-story 3000 ft^2 commercial building, based upon ASHRAE Standard 152P. All savings relative to 4%/4% supply/return duct leakage

Overall, the results in Figures 11 and 12 indicate that the recommended changes yield average cooling energy savings of 7 to 8%, and average heating energy savings of 8 to 9%, relatively independent of whether or not there is ceiling-plenum venting. These recommended values are clearly conservative compared to the assumptions that are more in line with field-test results, either using the full 26%/10% leakage values, or splitting the nominal 22% leakage 18%/4% in favor of the supply ducts. For the 26%/10% leakage values, the average savings are 16% for cooling and 28% for heating, and for the 18%/4% leakage split the average savings are 9% for cooling and 18% for heating. It also must be noted that, in line with the 1998 Residential Standard, the savings are calculated based upon 8% final leakage levels, despite the fact that the verified leakage needs to be less than 6% of fan flow. Yet another reason why these analyses are conservative is that they are based upon an algorithm for seasonal weather calculations that has been shown to underestimate the impacts of leakage and conduction losses on cooling-season duct performance in many California climates. That algorithm has since been replaced in the current version of ASHRAE 152P by on-time weighted weather conditions. A comparison of the two algorithms for overlapping California cities is shown in Figure 13.

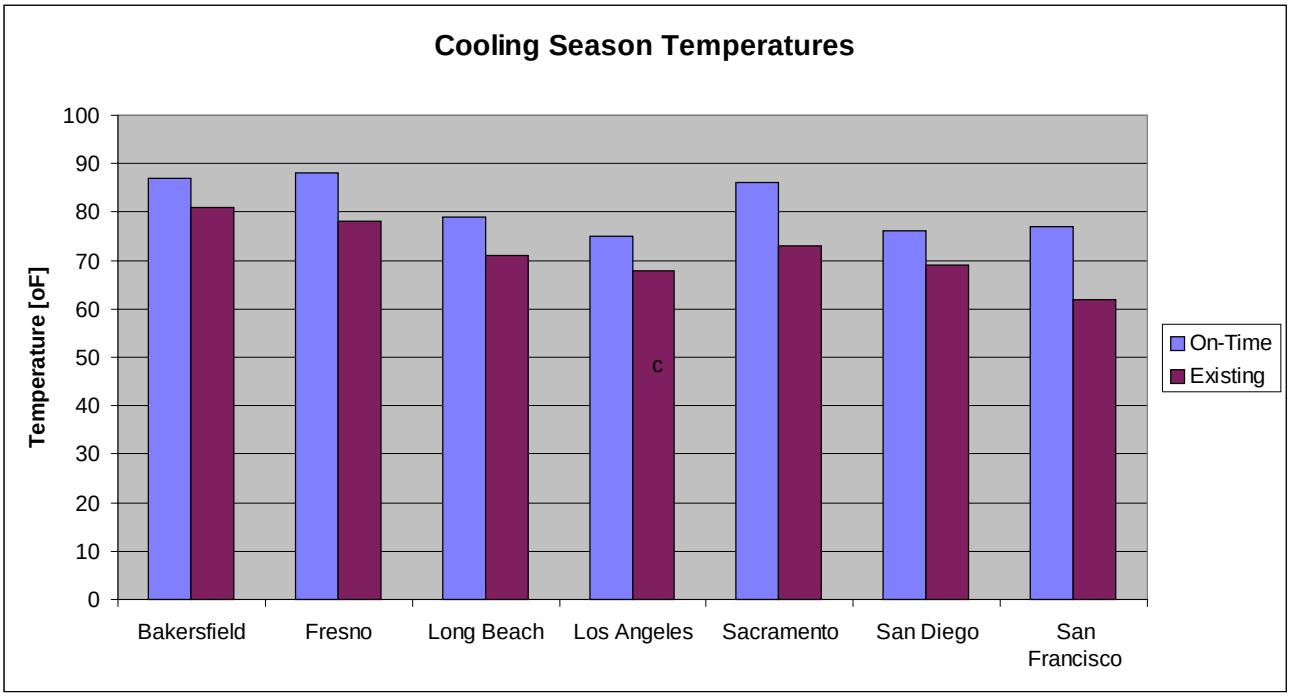

Figure 13 – Cooling Season Ambient Temperatures

Cooling season ambient temperatures based upon on-time weighting versus the simple subtraction from design weather (Current ASHRAE 152P versus version used for 1998 Residential Standard.

The fact that the expected energy savings from duct sealing is considerably larger than the credit being recommended, means that there are considerable net energy benefits associated with this change. In addition, there are considerable peak demand benefits associated with this measure, stemming from the fact that duct sealing and insulation have larger percentage impacts on energy use under design conditions as compared to the seasonal conditions used for energy savings calculations. Figures 11 and 12 show the impact of duct sealing on required HVAC equipment size under design weather conditions, which also corresponds to the expected reduction in electricity demand under design conditions, assuming that the HVAC system is meeting the cooling or heating load under those conditions.

Life Cycle Cost

No life cycle cost analysis is needed since this is an equal energy trade-off. On the other hand, should such an analysis be performed, the recommended change would be expected to prove easily cost-effective. The basis for this comment is that residential duct sealing was found to be cost effective, and the commercial-building savings estimates are clearly more conservative.

Appendix A – Electricity and Gas Price Projections and Net Present Value

Table 29 – Statewide Average Electricity and Gas Price Projections

Electricity ($/kWh)						Natural Gas ($/therms)		
Year	Residential	Small Commercial	Medium Commercial	Industrial	Agricultural	Residential Core	Commercial Core	Commercial Noncore
2000	0.11	0.12	0.10	0.08	0.12	0.90	0.81	0.58
2001	0.11	0.11	0.09	0.07	0.09	0.82	0.72	0.50
2002	0.11	0.11	0.08	0.07	0.09	0.70	0.60	0.37
2003	0.10	0.10	0.08	0.06	0.09	0.62	0.52	0.31
2004	0.10	0.10	0.08	0.06	0.09	0.62	0.52	0.31
2005	0.10	0.10	0.08	0.06	0.09	0.61	0.52	0.32
2006	0.10	0.11	0.08	0.07	0.09	0.62	0.53	0.32
2007	0.10	0.10	0.08	0.07	0.09	0.62	0.53	0.32
2008	0.10	0.10	0.08	0.07	0.09	0.62	0.53	0.33
2009	0.10	0.10	0.08	0.07	0.09	0.63	0.53	0.33
2010	0.10	0.10	0.08	0.07	0.09	0.62	0.53	0.33
2011	0.10	0.10	0.08	0.07	0.09	0.62	0.53	0.34
2012	0.10	0.10	0.08	0.07	0.09	0.63	0.54	0.34
2013	0.10	0.10	0.08	0.07	0.09	0.63	0.54	0.34
2014	0.10	0.11	0.08	0.07	0.09	0.63	0.54	0.35
2015	0.10	0.11	0.08	0.07	0.09	0.63	0.54	0.35
2016	0.10	0.11	0.08	0.07	0.09	0.63	0.54	0.36
2017	0.10	0.11	0.08	0.07	0.09	0.64	0.55	0.36
2018	0.10	0.11	0.08	0.07	0.09	0.64	0.55	0.37
2019	0.10	0.11	0.08	0.07	0.09	0.64	0.55	0.37
2020	0.10	0.11	0.08	0.07	0.09	0.64	0.55	0.37
2021	0.10	0.11	0.08	0.07	0.09	0.64	0.56	0.38
2022	0.10	0.11	0.08	0.07	0.09	0.64	0.56	0.38
2023	0.10	0.11	0.08	0.07	0.09	0.65	0.56	0.39
2024	0.10	0.11	0.08	0.07	0.09	0.65	0.56	0.39
2025	0.10	0.11	0.08	0.07	0.09	0.65	0.57	0.39
2026	0.10	0.11	0.08	0.07	0.09	0.65	0.57	0.40
2027	0.10	0.11	0.08	0.07	0.09	0.65	0.57	0.40
2028	0.10	0.11	0.08	0.07	0.09	0.65	0.57	0.41
2029	0.10	0.11	0.08	0.07	0.09	0.65	0.58	0.41
2030	0.11	0.12	0.10	0.08	0.12	0.90	0.81	0.58

Note: The electricity data for 2000 to 2020 was provided by the Energy Commission. Projections for the years 2020 to 2030 were found through a linear extrapolation of the change in price over the preceding ten years. This method was also used for gas prices between the years 2019 and 2030. Gas prices for the years 2000 to 2019 are weighted by demand and based on information from Appendices C and H of the *Natural Gas Market Outlook 2000-2020 (???Energy Commission document???).*

Table 30 –Statewide Average Net Present Value of Gas and Electricity

Electricity ($/kWh)					Natural Gas ($/therms)			
NPV	Residential	Small Commercial	Medium Commercial	Industrial	Agricultural	Residential Core	Commercial Core	Commercial Noncore
30 Years	2.07	2.15	1.68	1.39	1.82	13.27	11.43	7.49
15 Years	1.27	1.31	1.02	0.83	1.11	8.20	7.04	4.49

Note: Net Present value is calculated using the following,

$$NPV = P_o + \sum_{1}^{N} \frac{P_j}{(1+d)^j}$$

where

$NPV = Net\ Present\ Value$

$Po = Initial\ Price$

$Pj = Price\ \ j\ \ years\ later$

$d = Discount\ Rate$

*Table 31 –*Energy Commission *Small Commercial Price Projections for various time blocks.*

Electricity ($/kWh)						
Year	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter On-Peak•	Winter Mid-Peak	Winter Off-Peak
2001	0.146	0.122	0.102	0.136	0.128	0.111
2002	0.151	0.120	0.103	0.132	0.126	0.110
2003	0.141	0.117	0.100	0.126	0.120	0.104
2004	0.134	0.107	0.097	0.120	0.114	0.100
2005	0.133	0.110	0.096	0.119	0.113	0.100
2006	0.132	0.110	0.095	0.117	0.111	0.100
2007	0.132	0.109	0.095	0.117	0.111	0.101
2008	0.125	0.102	0.087	0.110	0.103	0.096
2009	0.125	0.102	0.087	0.110	0.103	0.098
2010	0.126	0.102	0.087	0.110	0.104	0.099
2011	0.126	0.103	0.087	0.111	0.104	0.099
2012	0.127	0.103	0.088	0.111	0.104	0.099
2013	0.127	0.103	0.088	0.111	0.105	0.099
2014	0.128	0.103	0.088	0.112	0.105	0.100
2015	0.128	0.104	0.088	0.112	0.105	0.100
2016	0.129	0.104	0.088	0.112	0.106	0.100
2017	0.129	0.104	0.088	0.113	0.106	0.100
2018	0.130	0.105	0.089	0.113	0.106	0.100
2019	0.130	0.105	0.089	0.114	0.107	0.100
2020	0.131	0.105	0.089	0.114	0.107	0.101
2021	0.130	0.105	0.089	0.113	0.106	0.100
2022	0.128	0.104	0.088	0.112	0.105	0.100
2023	0.127	0.103	0.088	0.111	0.105	0.099
2024	0.126	0.102	0.087	0.111	0.104	0.099
2025	0.125	0.102	0.087	0.110	0.103	0.098
2026	0.124	0.101	0.086	0.109	0.103	0.098
2027	0.124	0.101	0.086	0.109	0.103	0.098
2028	0.123	0.101	0.086	0.109	0.102	0.098
2029	0.123	0.100	0.086	0.108	0.102	0.098
2030	0.122	0.100	0.085	0.108	0.101	0.098

• Most electricity providers in the state of California do not use a winter on-peak value.

Table 32 –Energy Commission *Medium Commercial Price Projections for various time blocks.*

Electricity ($/kWh)						
Year	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter On-Peak•	Winter Mid-Peak	Winter Off-Peak
2001	0.126	0.100	0.079	0.116	0.107	0.091
2002	0.116	0.086	0.069	0.098	0.092	0.081
2003	0.108	0.083	0.067	0.093	0.087	0.077
2004	0.101	0.074	0.064	0.087	0.082	0.073
2005	0.101	0.079	0.064	0.087	0.082	0.073
2006	0.101	0.079	0.064	0.086	0.080	0.073
2007	0.102	0.079	0.065	0.087	0.081	0.074
2008	0.101	0.079	0.064	0.086	0.080	0.075
2009	0.102	0.079	0.064	0.087	0.080	0.076
2010	0.102	0.079	0.064	0.087	0.080	0.076
2011	0.103	0.079	0.065	0.087	0.081	0.077
2012	0.103	0.080	0.065	0.088	0.081	0.077
2013	0.102	0.079	0.063	0.087	0.080	0.076
2014	0.103	0.079	0.064	0.087	0.080	0.076
2015	0.103	0.079	0.064	0.087	0.081	0.076
2016	0.104	0.079	0.064	0.088	0.081	0.076
2017	0.104	0.080	0.064	0.088	0.081	0.077
2018	0.105	0.080	0.064	0.089	0.082	0.077
2019	0.105	0.080	0.064	0.089	0.082	0.077
2020	0.106	0.081	0.065	0.089	0.082	0.077
2021	0.105	0.080	0.064	0.088	0.081	0.077
2022	0.103	0.079	0.064	0.087	0.081	0.076
2023	0.102	0.078	0.063	0.087	0.080	0.076
2024	0.101	0.078	0.062	0.086	0.079	0.075
2025	0.099	0.077	0.062	0.085	0.078	0.075
2026	0.099	0.076	0.062	0.084	0.078	0.074
2027	0.098	0.076	0.061	0.084	0.078	0.074
2028	0.098	0.076	0.061	0.084	0.077	0.074
2029	0.097	0.075	0.061	0.083	0.077	0.074
2030	0.096	0.075	0.061	0.082	0.076	0.073

• Most electricity providers in the state of California do not use a winter on-peak value.

Table 33 –ALJ Small Commercial Price Projections for various time blocks.

Electricity ($/kWh)						
Year	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter On-Peak•	Winter Mid-Peak	Winter Off-Peak
2001	0.327	0.172	0.167	0.146	0.130	0.110
2002	0.364	0.190	0.184	0.160	0.142	0.117
2003	0.346	0.137	0.117	0.148	0.141	0.118
2004	0.330	0.125	0.113	0.141	0.135	0.113
2005	0.326	0.130	0.112	0.139	0.133	0.112
2006	0.298	0.129	0.112	0.137	0.131	0.112
2007	0.299	0.128	0.111	0.137	0.130	0.113
2008	0.291	0.121	0.103	0.129	0.122	0.109
2009	0.290	0.121	0.103	0.129	0.123	0.110
2010	0.288	0.121	0.103	0.129	0.123	0.111
2011	0.259	0.112	0.097	0.119	0.113	0.106
2012	0.259	0.112	0.097	0.119	0.113	0.106
2013	0.259	0.112	0.096	0.119	0.113	0.106
2014	0.258	0.112	0.096	0.119	0.113	0.106
2015	0.255	0.112	0.096	0.119	0.114	0.106
2016	0.252	0.112	0.096	0.119	0.113	0.106
2017	0.247	0.112	0.096	0.120	0.114	0.106
2018	0.241	0.112	0.096	0.120	0.114	0.106
2019	0.235	0.112	0.096	0.120	0.114	0.106
2020	0.228	0.112	0.096	0.120	0.114	0.106
2021	0.220	0.112	0.095	0.120	0.113	0.105
2022	0.213	0.111	0.095	0.119	0.113	0.105
2023	0.206	0.111	0.095	0.119	0.113	0.104
2024	0.200	0.111	0.095	0.119	0.113	0.104
2025	0.193	0.111	0.094	0.119	0.112	0.103
2026	0.187	0.110	0.094	0.118	0.112	0.103
2027	0.181	0.110	0.094	0.118	0.112	0.103
2028	0.174	0.110	0.094	0.118	0.112	0.102
2029	0.167	0.110	0.093	0.118	0.112	0.102
2030	0.161	0.110	0.093	0.118	0.112	0.102

• Most electricity providers in the state of California do not use a winter on-peak value.

Table 34 –ALJ Medium Commercial Price Projections for various time blocks.

Electricity ($/kWh)						
Year	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter On-Peak•	Winter Mid-Peak	Winter Off-Peak
2001	0.320	0.154	0.149	0.126	0.109	0.091
2002	0.326	0.154	0.149	0.125	0.107	0.089
2003	0.310	0.104	0.084	0.114	0.108	0.092
2004	0.295	0.093	0.081	0.108	0.102	0.087
2005	0.292	0.098	0.081	0.108	0.102	0.087
2006	0.265	0.098	0.081	0.106	0.100	0.087
2007	0.266	0.098	0.081	0.106	0.100	0.088
2008	0.266	0.097	0.080	0.106	0.099	0.088
2009	0.265	0.097	0.080	0.106	0.099	0.089
2010	0.263	0.097	0.080	0.106	0.099	0.090
2011	0.234	0.089	0.074	0.096	0.090	0.084
2012	0.234	0.088	0.073	0.096	0.090	0.084
2013	0.233	0.087	0.072	0.094	0.089	0.083
2014	0.231	0.087	0.072	0.095	0.089	0.083
2015	0.229	0.087	0.072	0.095	0.089	0.083
2016	0.225	0.087	0.071	0.095	0.089	0.083
2017	0.220	0.087	0.071	0.095	0.089	0.083
2018	0.215	0.087	0.071	0.095	0.089	0.083
2019	0.208	0.087	0.071	0.095	0.089	0.083
2020	0.202	0.087	0.071	0.095	0.089	0.083
2021	0.194	0.087	0.071	0.095	0.089	0.082
2022	0.186	0.086	0.070	0.094	0.088	0.082
2023	0.179	0.086	0.070	0.094	0.088	0.081
2024	0.173	0.086	0.070	0.094	0.088	0.080
2025	0.166	0.086	0.069	0.093	0.087	0.080
2026	0.160	0.085	0.069	0.093	0.087	0.080
2027	0.154	0.085	0.069	0.093	0.087	0.079
2028	0.147	0.085	0.069	0.093	0.087	0.079
2029	0.140	0.085	0.069	0.093	0.087	0.078
2030	0.133	0.085	0.068	0.093	0.086	0.078

• Most electricity providers in the state of California do not use a winter on-peak value.

*Table 35 –*Energy Commission *and ALJ Adjusted Statewide Average Net Present Value of Electricity for various time blocks and building sectors.*

	Building Sector	NPV	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak	Winter On-Peak•	Winter Mid-Peak	Winter Off-Peak
CEC	**Residential**	**30 Years**	2.59	2.10	1.79	2.28	2.15	1.94
	Small Commercial	**30 Years**	2.64	2.15	1.84	2.33	2.19	2.03
		15 Years	1.63	1.33	1.15	1.45	1.37	1.25
	Medium Commercial	**30 Years**	2.10	1.62	1.31	1.80	1.66	1.54
		15 Years	1.30	1.00	0.81	1.11	1.03	0.95
ALJ	**Residential**	**30 Years**	5.31	2.44	2.13	2.55	2.40	2.12
	Small Commercial	**30 Years**	5.36	2.49	2.18	2.59	2.44	2.18
		15 Years	3.70	1.61	1.43	1.65	1.55	1.36
	Medium Commercial	**30 Years**	4.80	1.96	1.65	2.06	1.91	1.71
		15 Years	3.35	1.28	1.10	1.31	1.22	1.07

• Most electricity providers in the state of California do not use a winter on-peak value.

Appendix B – Database of Fenestration Constructions

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	VLT	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Brk/ClrMpr	Glass	No	1.15	1.53	1.25	0.64	0.55	0.47	1.08	1.11	1.89	1.25	4.02	3.45	4.13
Brk/ClrMpr-Ins-ClrNct	Glass	No	0.59	0.81	0.67	0.55	0.47	0.43	0.57	0.57	1.07	0.66	9.61	8.40	9.10
Brk/ClrMpr-Ins-ClrPye	Glass	No	0.45	0.7	0.56	0.51	0.44	0.4	0.48	0.46	0.97	0.56	11.51	10.30	10.40
Brk/ClrMpr-Ins-ClrSpe	Glass	No	0.44	0.69	0.55	0.44	0.38	0.39	0.46	0.43	0.96	0.54	13.86	12.05	11.54
Brk/ClrMpr-Ins-ClrSue	Glass	No	0.42	0.68	0.54	0.36	0.31	0.37	0.44	0.42	0.95	0.53	13.86	12.05	11.54
Brk/ClrMpr-Std-ClrNct	Glass	No	0.62	0.84	0.7	0.55	0.47	0.43	0.6	0.6	1.1	0.69	8.57	7.36	8.06
Brk/ClrMpr-Std-ClrPye	Glass	No	0.49	0.74	0.59	0.51	0.44	0.4	0.51	0.49	1	0.59	10.47	9.26	9.36
Brk/ClrMpr-Std-ClrSpe	Glass	No	0.48	0.73	0.58	0.45	0.39	0.39	0.49	0.46	0.99	0.57	12.82	11.01	10.50
Brk/ClrMpr-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.36	0.31	0.37	0.47	0.45	0.98	0.56	12.82	11.01	10.50
Brk/ClrNct	Glass	Yes	1.15	1.53	1.26	0.92	0.79	0.8	1.08	1.11	1.89	1.25	0.98	0.83	1.95
Brk/ClrNct-Ins-ClrNct	Glass	Yes	0.59	0.81	0.67	0.79	0.68	0.71	0.57	0.57	1.07	0.66	6.57	5.79	6.92
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	Glass	Yes	0.42	0.58	0.47	0.69	0.59	0.64	0.43	0.42	0.84	0.46	12.16	10.74	10.84
Brk/ClrNct-Ins-ClrPye	Glass	Yes	0.45	0.7	0.56	0.74	0.64	0.66	0.48	0.46	0.97	0.56	8.46	7.68	8.22
Brk/ClrNct-Ins-ClrSpe	Glass	Yes	0.44	0.69	0.55	0.65	0.56	0.66	0.46	0.43	0.96	0.54	10.82	9.44	9.36
Brk/ClrNct-Ins-ClrSue	Glass	No	0.42	0.67	0.54	0.53	0.46	0.62	0.44	0.42	0.95	0.53	10.82	9.44	9.36
Brk/ClrNct-Ins-HtMr22-Ins-ClrNct	Glass	No	0.33	0.51	0.4	0.19	0.16	0.17	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr33-Ins-ClrNct	Glass	No	0.33	0.51	0.4	0.24	0.21	0.25	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr44-Ins-ClrNct	Glass	No	0.34	0.51	0.4	0.3	0.26	0.34	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr55-Ins-ClrNct	Glass	No	0.34	0.51	0.4	0.35	0.30	0.41	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr66-Ins-ClrNct	Glass	No	0.34	0.51	0.4	0.41	0.35	0.48	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr77-Ins-ClrNct	Glass	No	0.35	0.52	0.41	0.5	0.43	0.57	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Ins-HtMr88-Ins-ClrNct	Glass	Yes	0.35	0.52	0.41	0.62	0.53	0.63	0.33	0.3	0.73	0.36	17.29	16.51	15.17
Brk/ClrNct-Std-ClrNct	Glass	Yes	0.62	0.85	0.7	0.79	0.68	0.71	0.6	0.6	1.1	0.69	5.53	4.75	5.88
Brk/ClrNct-Std-ClrPye	Glass	Yes	0.49	0.74	0.59	0.74	0.64	0.66	0.51	0.49	1	0.59	7.42	6.64	7.18
Brk/ClrNct-Std-ClrSpe	Glass	Yes	0.48	0.73	0.58	0.65	0.56	0.66	0.49	0.46	0.99	0.57	9.78	8.40	8.32
Brk/ClrNct-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.53	0.46	0.62	0.47	0.45	0.98	0.56	9.78	8.40	8.32
Brk/ClrPye-Ins-ClrPye	Glass	No	0.43	0.68	0.55	0.67	0.58	0.62					10.36	9.58	9.52
Brk/ClrPye-Std-ClrPye	Glass	No	0.47	0.72	0.58	0.67	0.58	0.62					9.32	8.54	8.48
Brk/ClrSbe-Ins-ClrNct	Glass	No	0.44	0.69	0.55	0.47	0.40	0.45	0.46	0.43	0.96	0.54	10.82	9.44	9.36
Brk/ClrSbe-Std-ClrNct	Glass	No	0.48	0.73	0.58	0.47	0.40	0.45	0.49	0.46	0.99	0.57	9.78	8.40	8.32
Brk/ClrSpe-Ins-ClrSpe	Glass	No	0.42	0.68	0.54	0.55	0.47	0.61					15.07	13.09	11.80
Brk/ClrSpe-Std-ClrSpe	Glass	No	0.46	0.72	0.57	0.56	0.48	0.61					14.03	12.05	10.76
Brk/ClrSue-Ins-ClrSue	Glass	No	0.41	0.67	0.53	0.42	0.36	0.55					15.07	13.09	11.31
Brk/ClrSue-Std-ClrSue	Glass	No	0.46	0.71	0.56	0.43	0.37	0.55					14.03	12.05	10.27

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	*VLT*	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Brk/GrnMpr	Glass	No	1.15	1.53	1.25	0.48	0.41	0.39	1.08	1.11	1.89	1.25	4.58	3.93	4.64
Brk/GrnMpr-Ins-ClrNct	Glass	No	0.59	0.81	0.67	0.37	0.32	0.35	0.57	0.57	1.07	0.66	10.17	8.88	9.61
Brk/GrnMpr-Ins-ClrPye	Glass	No	0.45	0.7	0.56	0.34	0.29	0.33	0.48	0.46	0.97	0.56	12.06	10.78	10.91
Brk/GrnMpr-Ins-ClrSpe	Glass	No	0.44	0.69	0.55	0.3	0.26	0.32	0.46	0.43	0.96	0.54	14.42	12.53	12.05
Brk/GrnMpr-Ins-ClrSue	Glass	No	0.42	0.68	0.54	0.26	0.22	0.31	0.44	0.42	0.95	0.53	14.42	12.53	12.05
Brk/GrnMpr-Std-ClrNct	Glass	No	0.62	0.84	0.7	0.38	0.33	0.35	0.6	0.6	1.1	0.69	9.13	7.84	8.57
Brk/GrnMpr-Std-ClrPye	Glass	No	0.49	0.74	0.59	0.35	0.30	0.33	0.51	0.49	1	0.59	11.02	9.74	9.87
Brk/GrnMpr-Std-ClrSpe	Glass	No	0.48	0.73	0.58	0.3	0.26	0.32	0.49	0.46	0.99	0.57	13.38	11.49	11.01
Brk/GrnMpr-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.26	0.22	0.31	0.47	0.45	0.98	0.56	13.38	11.49	11.01
Brk/GrnNct	Glass	No	1.15	1.53	1.25	0.67	0.58	0.67	1.08	1.11	1.89	1.25	1.53	1.31	2.46
Brk/GrnNct-Ins-ClrNct	Glass	No	0.59	0.81	0.67	0.55	0.47	0.6	0.57	0.57	1.07	0.66	7.12	6.27	7.42
Brk/GrnNct-Ins-ClrPye	Glass	No	0.45	0.7	0.56	0.49	0.42	0.55	0.48	0.46	0.97	0.56	9.02	8.16	8.72
Brk/GrnNct-Ins-ClrSpe	Glass	No	0.44	0.69	0.55	0.47	0.40	0.55	0.46	0.43	0.96	0.54	11.38	9.92	9.87
Brk/GrnNct-Ins-ClrSue	Glass	No	0.42	0.67	0.54	0.42	0.36	0.52	0.44	0.42	0.95	0.53	11.38	9.92	9.86
Brk/GrnNct-Std-ClrNct	Glass	No	0.62	0.84	0.69	0.55	0.47	0.6	0.6	0.6	1.1	0.69	6.08	5.23	6.38
Brk/GrnNct-Std-ClrPye	Glass	No	0.49	0.74	0.59	0.5	0.43	0.55	0.51	0.49	1	0.59	7.98	7.12	7.68
Brk/GrnNct-Std-ClrSpe	Glass	No	0.48	0.73	0.58	0.47	0.40	0.55	0.49	0.46	0.99	0.57	10.34	8.88	8.83
Brk/GrnNct-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.42	0.36	0.52	0.47	0.45	0.98	0.56	10.34	8.88	8.82
Brk/GrnSbe-Ins-ClrNct	Glass	No	0.44	0.69	0.55	0.35	0.30	0.39	0.46	0.43	0.96	0.54	11.38	9.92	9.87
Brk/GrnSbe-Std-ClrNct	Glass	No	0.48	0.73	0.58	0.36	0.31	0.39	0.49	0.46	0.99	0.57	10.34	8.88	8.83
Brk/HptMpr	Glass	No	1.15	1.53	1.25	0.43	0.37	0.38	1.08	1.11	1.89	1.25	6.06	5.20	5.56
Brk/HptMpr-Ins-ClrNct	Glass	No	0.59	0.81	0.67	0.33	0.28	0.34	0.57	0.57	1.07	0.66	11.65	10.15	10.53
Brk/HptMpr-Ins-ClrPye	Glass	No	0.45	0.7	0.56	0.29	0.25	0.32	0.48	0.46	0.97	0.56	13.55	12.05	11.83
Brk/HptMpr-Ins-ClrSpe	Glass	No	0.44	0.69	0.55	0.26	0.22	0.32	0.46	0.43	0.96	0.54	15.90	13.81	12.97
Brk/HptMpr-Ins-ClrSue	Glass	No	0.42	0.68	0.54	0.22	0.19	0.3	0.44	0.42	0.95	0.53	15.90	13.81	12.97
Brk/HptMpr-Std-ClrNct	Glass	No	0.62	0.84	0.7	0.33	0.28	0.34	0.6	0.6	1.1	0.69	10.61	9.11	9.49
Brk/HptMpr-Std-ClrPye	Glass	No	0.49	0.74	0.59	0.29	0.25	0.32	0.51	0.49	1	0.59	12.51	11.01	10.79
Brk/HptMpr-Std-ClrSpe	Glass	No	0.48	0.73	0.58	0.27	0.23	0.32	0.49	0.46	0.99	0.57	14.86	12.77	11.93
Brk/HptMpr-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.22	0.19	0.3	0.47	0.45	0.98	0.56	14.86	12.77	11.93
Brk/HptNct	Glass	No	1.15	1.53	1.26	0.59	0.51	0.6	1.08	1.11	1.89	1.25	3.02	2.59	3.38
Brk/HptNct-Ins-ClrNct	Glass	No	0.59	0.81	0.67	0.47	0.40	0.54	0.57	0.57	1.07	0.66	8.61	7.54	8.35
Brk/HptNct-Ins-ClrPye	Glass	No	0.45	0.7	0.56	0.41	0.35	0.5	0.48	0.46	0.97	0.56	10.50	9.44	9.65
Brk/HptNct-Ins-ClrSpe	Glass	No	0.44	0.69	0.55	0.4	0.34	0.49	0.46	0.43	0.96	0.54	12.86	11.19	10.79
Brk/HptNct-Ins-ClrSue	Glass	No	0.42	0.68	0.54	0.36	0.31	0.47	0.44	0.42	0.95	0.53	12.86	11.19	10.79
Brk/HptNct-Std-ClrNct	Glass	No	0.62	0.85	0.7	0.47	0.40	0.54	0.6	0.6	1.1	0.69	7.57	6.50	7.31
Brk/HptNct-Std-ClrPye	Glass	No	0.49	0.74	0.59	0.42	0.36	0.5	0.51	0.49	1	0.59	9.46	8.40	8.61
Brk/HptNct-Std-ClrSpe	Glass	No	0.48	0.73	0.58	0.4	0.34	0.49	0.49	0.46	0.99	0.57	11.82	10.15	9.75

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	*VLT*	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Brk/HptNct-Std-ClrSue	Glass	No	0.46	0.71	0.57	0.37	0.32	0.47	0.47	0.45	0.98	0.56	11.82	10.15	9.75
Brk/HptSbe-Ins-ClrNct	Glass	No	0.44	0.69	0.55	0.3	0.26	0.34	0.46	0.43	0.96	0.54	12.86	11.19	10.79
Brk/HptSbe-Std-ClrNct	Glass	No	0.48	0.73	0.58	0.3	0.26	0.34	0.49	0.46	0.99	0.57	11.82	10.15	9.75
Mtl/ClrMpr	Glass	No	1.26	1.58	1.36	0.67	0.58	0.47	1.27	1.22	1.98	1.36	3.04	2.61	2.18
Mtl/ClrMpr-Std-ClrNct	Glass	No	0.73	0.96	0.81	0.58	0.50	0.43	0.81	0.72	1.31	0.8	7.59	6.53	6.11
Mtl/ClrMpr-Std-ClrPye	Glass	No	0.6	0.85	0.7	0.56	0.48	0.4	0.71	0.6	1.2	0.7	9.49	8.42	7.41
Mtl/ClrMpr-Std-ClrSpe	Glass	No	0.59	0.84	0.69	0.49	0.42	0.39	0.69	0.57	1.18	0.68	11.84	10.18	8.55
Mtl/ClrMpr-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.41	0.35	0.37	0.67	0.56	1.17	0.68	11.84	10.18	8.55
Mtl/ClrNct	Glass	Yes	1.26	1.58	1.37	0.95	0.82	0.8	1.27	1.22	1.98	1.36	0.00	0.00	0.00
Mtl/ClrNct-Std-ClrNct	Glass	Yes	0.73	0.96	0.81	0.84	0.72	0.71	0.81	0.72	1.31	0.8	4.55	3.91	3.93
Mtl/ClrNct-Std-ClrPye	Glass	Yes	0.6	0.85	0.7	0.79	0.68	0.66	0.71	0.6	1.2	0.7	6.45	5.81	5.23
Mtl/ClrNct-Std-ClrSpe	Glass	Yes	0.59	0.84	0.69	0.7	0.60	0.66	0.69	0.57	1.18	0.68	8.80	7.57	6.37
Mtl/ClrNct-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.57	0.49	0.62	0.67	0.56	1.17	0.68	8.80	7.57	6.37
Mtl/ClrPye-Std-ClrPye	Glass	No	0.58	0.84	0.69	0.71	0.61	0.62					8.35	7.71	6.53
Mtl/ClrSbe-Std-ClrNct	Glass	No	0.59	0.84	0.69	0.51	0.44	0.45	0.69	0.57	1.18	0.68	8.80	7.57	6.37
Mtl/ClrSpe-Std-ClrSpe	Glass	No	0.57	0.83	0.68	0.59	0.51	0.61					13.05	11.22	8.81
Mtl/ClrSue-Std-ClrSue	Glass	No	0.57	0.82	0.68	0.47	0.40	0.55					13.05	11.22	8.32
Mtl/GrnMpr	Glass	No	1.26	1.58	1.36	0.51	0.44	0.39	1.27	1.22	1.98	1.36	3.60	3.09	2.69
Mtl/GrnMpr-Std-ClrNct	Glass	No	0.73	0.96	0.81	0.42	0.36	0.35	0.81	0.72	1.31	0.8	8.15	7.01	6.62
Mtl/GrnMpr-Std-ClrPye	Glass	No	0.6	0.85	0.7	0.38	0.33	0.33	0.71	0.6	1.2	0.7	10.05	8.91	7.92
Mtl/GrnMpr-Std-ClrSpe	Glass	No	0.59	0.84	0.69	0.35	0.30	0.32	0.69	0.57	1.18	0.68	12.40	10.66	9.06
Mtl/GrnMpr-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.29	0.25	0.31	0.67	0.56	1.17	0.68	12.40	10.66	9.06
Mtl/GrnNct	Glass	No	1.26	1.58	1.36	0.71	0.61	0.67	1.27	1.22	1.98	1.36	0.56	0.48	0.51
Mtl/GrnNct-Std-ClrNct	Glass	No	0.73	0.96	0.81	0.59	0.51	0.6	0.81	0.72	1.31	0.8	5.11	4.39	4.43
Mtl/GrnNct-Std-ClrPye	Glass	No	0.6	0.85	0.7	0.53	0.46	0.55	0.71	0.6	1.2	0.7	7.01	6.29	5.73
Mtl/GrnNct-Std-ClrSpe	Glass	No	0.59	0.84	0.69	0.5	0.43	0.55	0.69	0.57	1.18	0.68	9.36	8.05	6.88
Mtl/GrnNct-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.45	0.39	0.52	0.67	0.56	1.17	0.68	9.36	8.05	6.87
Mtl/GrnSbe-Std-ClrNct	Glass	No	0.59	0.84	0.69	0.4	0.34	0.39	0.69	0.57	1.18	0.68	9.36	8.05	6.88
Mtl/HptMpr	Glass	No	1.26	1.58	1.36	0.47	0.40	0.38	1.27	1.22	1.98	1.36	5.08	4.37	3.61
Mtl/HptMpr-Std-ClrNct	Glass	No	0.73	0.96	0.81	0.37	0.32	0.34	0.81	0.72	1.31	0.8	9.63	8.28	7.54
Mtl/HptMpr-Std-ClrPye	Glass	No	0.6	0.85	0.7	0.34	0.29	0.32	0.71	0.6	1.2	0.7	11.53	10.18	8.84
Mtl/HptMpr-Std-ClrSpe	Glass	No	0.59	0.84	0.69	0.3	0.26	0.32	0.69	0.57	1.18	0.68	13.88	11.93	9.98
Mtl/HptMpr-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.27	0.23	0.3	0.67	0.56	1.17	0.68	13.88	11.93	9.98
Mtl/HptNct	Glass	No	1.27	1.58	1.37	0.64	0.55	0.6	1.27	1.22	1.98	1.36	2.04	1.75	1.43
Mtl/HptNct-Std-ClrNct	Glass	No	0.73	0.96	0.81	0.51	0.44	0.54	0.81	0.72	1.31	0.8	6.59	5.67	5.36
Mtl/HptNct-Std-ClrPye	Glass	No	0.6	0.85	0.7	0.45	0.39	0.5	0.71	0.6	1.2	0.7	8.49	7.57	6.66
Mtl/HptNct-Std-ClrSpe	Glass	No	0.59	0.84	0.69	0.44	0.38	0.49	0.69	0.57	1.18	0.68	10.84	9.32	7.80

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	*VLT*	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Mtl/HptNct-Std-ClrSue	Glass	No	0.57	0.83	0.68	0.41	0.35	0.47	0.67	0.56	1.17	0.68	10.84	9.32	7.80
Mtl/HptSbe-Std-ClrNct	Glass	No	0.59	0.84	0.69	0.35	0.30	0.34	0.69	0.57	1.18	0.68	10.84	9.32	7.80
Vnl/ClrMpr	Glass	No	1.02	1.47	1.12	0.58	0.50	0.45	0.9	0.98	1.75		8.24	7.81	7.38
Vnl/ClrMpr-Ins-ClrNct	Glass	No	0.48	0.82	0.56	0.49	0.42	0.41	0.5	0.47	1.01		13.83	12.77	12.35
Vnl/ClrMpr-Ins-ClrPye	Glass	No	0.35	0.71	0.45	0.47	0.40	0.39	0.41	0.37	0.91		15.73	14.66	13.65
Vnl/ClrMpr-Ins-ClrSpe	Glass	No	0.34	0.7	0.44	0.4	0.34	0.38	0.39	0.34	0.89		18.08	16.42	14.79
Vnl/ClrMpr-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.31	0.27	0.36	0.38	0.33	0.88		18.08	16.42	14.79
Vnl/ClrMpr-Std-ClrNct	Glass	No	0.51	0.82	0.58	0.49	0.42	0.41	0.53	0.5	1.04		12.79	11.73	11.31
Vnl/ClrMpr-Std-ClrPye	Glass	No	0.39	0.72	0.48	0.47	0.40	0.39	0.44	0.4	0.94		14.69	13.62	12.61
Vnl/ClrMpr-Std-ClrSpe	Glass	No	0.37	0.7	0.47	0.41	0.35	0.38	0.42	0.37	0.92		17.04	15.38	13.75
Vnl/ClrMpr-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.31	0.27	0.36	0.41	0.36	0.91		17.04	15.38	13.75
Vnl/ClrNct	Glass	Yes	1.02	1.47	1.12	0.85	0.73	0.77	0.9	0.98	1.75		5.20	5.20	5.20
Vnl/ClrNct-Ins-ClrNct	Glass	Yes	0.48	0.82	0.56	0.73	0.63	0.68	0.5	0.47	1.01		10.79	10.15	10.17
Vnl/ClrNct-Ins-ClrNct-Ins-ClrNct	Glass	Yes	0.33	0.61	0.37	0.64	0.55	0.61	0.37	0.33	0.78		16.38	15.11	14.09
Vnl/ClrNct-Ins-ClrPye	Glass	Yes	0.35	0.71	0.45	0.69	0.59	0.63	0.41	0.37	0.91		12.69	12.05	11.47
Vnl/ClrNct-Ins-ClrSpe	Glass	Yes	0.33	0.7	0.44	0.59	0.51	0.63	0.39	0.34	0.89		15.04	13.81	12.61
Vnl/ClrNct-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.48	0.41	0.6	0.38	0.33	0.88		15.04	13.81	12.61
Vnl/ClrNct-Ins-HtMr22-Ins-ClrNct	Glass	No	0.24	0.54	0.3	0.15	0.13	0.17	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr33-Ins-ClrNct	Glass	No	0.24	0.54	0.3	0.21	0.18	0.24	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr44-Ins-ClrNct	Glass	No	0.24	0.54	0.31	0.26	0.22	0.32	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr55-Ins-ClrNct	Glass	No	0.24	0.54	0.31	0.31	0.27	0.39	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr66-Ins-ClrNct	Glass	No	0.24	0.54	0.31	0.36	0.31	0.46	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr77-Ins-ClrNct	Glass	No	0.25	0.55	0.31	0.45	0.39	0.55	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Ins-HtMr88-Ins-ClrNct	Glass	Yes	0.26	0.55	0.32	0.56	0.48	0.61	0.28	0.22	0.68		21.51	20.88	18.42
Vnl/ClrNct-Std-ClrNct	Glass	Yes	0.51	0.82	0.58	0.73	0.63	0.68	0.53	0.5	1.04		9.75	9.11	9.13
Vnl/ClrNct-Std-ClrPye	Glass	Yes	0.39	0.72	0.48	0.69	0.59	0.63	0.44	0.4	0.94		11.65	11.01	10.43
Vnl/ClrNct-Std-ClrSpe	Glass	Yes	0.37	0.7	0.47	0.59	0.51	0.63	0.42	0.37	0.92		14.00	12.77	11.57
Vnl/ClrNct-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.48	0.41	0.6	0.41	0.36	0.91		14.00	12.77	11.57
Vnl/ClrPye-Ins-ClrPye	Glass	No	0.33	0.69	0.44	0.62	0.53	0.59					14.59	13.95	12.77
Vnl/ClrPye-Std-ClrPye	Glass	No	0.37	0.7	0.47	0.62	0.53	0.59					13.55	12.91	11.73
Vnl/ClrSbe-Ins-ClrNct	Glass	No	0.34	0.7	0.44	0.42	0.36	0.43	0.39	0.34	0.89		15.04	13.81	12.61
Vnl/ClrSbe-Std-ClrNct	Glass	No	0.37	0.71	0.47	0.42	0.36	0.43	0.42	0.37	0.92		14.00	12.77	11.57
Vnl/ClrSpe-Ins-ClrSpe	Glass	No	0.32	0.69	0.43	0.5	0.43	0.58					19.29	17.46	15.05
Vnl/ClrSpe-Std-ClrSpe	Glass	No	0.36	0.69	0.46	0.5	0.43	0.58					18.25	16.42	14.01
Vnl/ClrSue-Ins-ClrSue	Glass	No	0.31	0.68	0.43	0.37	0.32	0.52					19.29	17.46	14.56
Vnl/ClrSue-Std-ClrSue	Glass	No	0.35	0.69	0.46	0.38	0.33	0.52					18.25	16.42	13.52
Vnl/GrnMpr	Glass	No	1.02	1.47	1.12	0.43	0.37	0.37	0.9	0.98	1.75		8.80	8.29	7.89

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	*VLT*	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Vnl/GrnMpr-Ins-ClrNct	Glass	No	0.48	0.82	0.56	0.34	0.29	0.34	0.5	0.47	1.01		14.39	13.25	12.86
Vnl/GrnMpr-Ins-ClrPye	Glass	No	0.35	0.71	0.45	0.3	0.26	0.32	0.41	0.37	0.91		16.29	15.15	14.16
Vnl/GrnMpr-Ins-ClrSpe	Glass	No	0.34	0.7	0.44	0.26	0.22	0.31	0.39	0.34	0.89		18.64	16.90	15.30
Vnl/GrnMpr-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.21	0.18	0.3	0.38	0.33	0.88		18.64	16.90	15.30
Vnl/GrnMpr-Std-ClrNct	Glass	No	0.51	0.82	0.58	0.34	0.29	0.34	0.53	0.5	1.04		13.35	12.21	11.82
Vnl/GrnMpr-Std-ClrPye	Glass	No	0.39	0.72	0.48	0.3	0.26	0.32	0.44	0.4	0.94		15.25	14.11	13.12
Vnl/GrnMpr-Std-ClrSpe	Glass	No	0.37	0.7	0.47	0.27	0.23	0.31	0.42	0.37	0.92		17.60	15.86	14.26
Vnl/GrnMpr-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.22	0.19	0.3	0.41	0.36	0.91		17.60	15.86	14.26
Vnl/GrnNct	Glass	No	1.02	1.47	1.12	0.62	0.53	0.64	0.9	0.98	1.75		5.76	5.68	5.71
Vnl/GrnNct-Ins-ClrNct	Glass	No	0.48	0.82	0.56	0.5	0.43	0.47	0.5	0.47	1.01		11.35	10.63	10.67
Vnl/GrnNct-Ins-ClrPye	Glass	No	0.35	0.71	0.45	0.44	0.38	0.53	0.41	0.37	0.91		13.25	12.53	11.97
Vnl/GrnNct-Ins-ClrSpe	Glass	No	0.33	0.7	0.44	0.41	0.35	0.53	0.39	0.34	0.89		15.60	14.29	13.12
Vnl/GrnNct-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.37	0.32	0.5	0.38	0.33	0.88		15.60	14.29	13.11
Vnl/GrnNct-Std-ClrNct	Glass	No	0.51	0.82	0.58	0.5	0.43	0.47	0.53	0.5	1.04		10.31	9.59	9.63
Vnl/GrnNct-Std-ClrPye	Glass	No	0.39	0.72	0.48	0.44	0.38	0.53	0.44	0.4	0.94		12.21	11.49	10.93
Vnl/GrnNct-Std-ClrSpe	Glass	No	0.37	0.7	0.47	0.42	0.36	0.53	0.42	0.37	0.92		14.56	13.25	12.08
Vnl/GrnNct-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.37	0.32	0.5	0.41	0.36	0.91		14.56	13.25	12.07
Vnl/GrnSbe-Ins-ClrNct	Glass	No	0.34	0.7	0.44	0.31	0.27	0.37	0.39	0.34	0.89		15.60	14.29	13.12
Vnl/GrnSbe-Std-ClrNct	Glass	No	0.37	0.71	0.47	0.31	0.27	0.37	0.42	0.37	0.92		14.56	13.25	12.08
Vnl/HptMpr	Glass	No	1.02	1.47	1.12	0.38	0.33	0.37	0.9	0.98	1.75		10.28	9.57	8.81
Vnl/HptMpr-Ins-ClrNct	Glass	No	0.48	0.82	0.56	0.28	0.24	0.33	0.5	0.47	1.01		15.87	14.52	13.78
Vnl/HptMpr-Ins-ClrPye	Glass	No	0.35	0.71	0.45	0.24	0.21	0.31	0.41	0.37	0.91		17.77	16.42	15.08
Vnl/HptMpr-Ins-ClrSpe	Glass	No	0.34	0.7	0.44	0.22	0.19	0.3	0.39	0.34	0.89		20.12	18.17	16.22
Vnl/HptMpr-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.19	0.16	0.29	0.38	0.33	0.88		20.12	18.17	16.22
Vnl/HptMpr-Std-ClrNct	Glass	No	0.51	0.82	0.58	0.29	0.25	0.33	0.53	0.5	1.04		14.83	13.48	12.74
Vnl/HptMpr-Std-ClrPye	Glass	No	0.39	0.72	0.48	0.26	0.22	0.31	0.44	0.4	0.94		16.73	15.38	14.04
Vnl/HptMpr-Std-ClrSpe	Glass	No	0.37	0.7	0.47	0.22	0.19	0.3	0.42	0.37	0.92		19.08	17.13	15.18
Vnl/HptMpr-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.19	0.16	0.29	0.41	0.36	0.91		19.08	17.13	15.18
Vnl/HptNct	Glass	No	1.02	1.47	1.12	0.55	0.47	0.58	0.9	0.98	1.75		7.24	6.95	6.63
Vnl/HptNct-Ins-ClrNct	Glass	No	0.48	0.82	0.56	0.42	0.36	0.51	0.5	0.47	1.01		12.83	11.91	11.60
Vnl/HptNct-Ins-ClrPye	Glass	No	0.35	0.71	0.45	0.36	0.31	0.48	0.41	0.37	0.91		14.73	13.81	12.90
Vnl/HptNct-Ins-ClrSpe	Glass	No	0.34	0.7	0.44	0.35	0.30	0.47	0.39	0.34	0.89		17.08	15.56	14.04
Vnl/HptNct-Ins-ClrSue	Glass	No	0.32	0.68	0.43	0.31	0.27	0.45	0.38	0.33	0.88		17.08	15.56	14.04
Vnl/HptNct-Std-ClrNct	Glass	No	0.51	0.82	0.58	0.42	0.36	0.51	0.53	0.5	1.04		11.79	10.87	10.56
Vnl/HptNct-Std-ClrPye	Glass	No	0.39	0.72	0.48	0.37	0.32	0.48	0.44	0.4	0.94		13.69	12.77	11.86
Vnl/HptNct-Std-ClrSpe	Glass	No	0.37	0.7	0.47	0.35	0.30	0.47	0.42	0.37	0.92		16.04	14.52	13.00
Vnl/HptNct-Std-ClrSue	Glass	No	0.36	0.69	0.46	0.33	0.28	0.45	0.41	0.36	0.91		16.04	14.52	13.00

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	VLT	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Vnl/HptSbe-Ins-ClrNct	Glass	No	0.34	0.7	0.44	0.26	0.22	0.32	0.39	0.34	0.89		17.08	15.56	14.04
Vnl/HptSbe-Std-ClrNct	Glass	No	0.37	0.71	0.47	0.27	0.23	0.32	0.42	0.37	0.92		16.04	14.52	13.00
Brk/AcrDblBrz	Plastic	No	0	1.12	0	0.43	0.37	0.25	0	0	1.1		0.00	0.00	4.16
Brk/AcrDblClr	Plastic	Yes		1.12		0.89	0.77	0.89			1.1		0.00	0.00	3.51
Brk/AcrDblHW	Plastic	No		1.12		0.72	0.62	0.75			1.1		0.00	0.00	4.16
Brk/AcrDblLW	Plastic	No		1.12		0.4	0.34	0.29			1.1		0.00	0.00	4.16
Brk/AcrDblMW	Plastic	No		1.12		0.63	0.54	0.49			1.1		0.00	0.00	4.16
Brk/AcrQudBrz	Plastic	No		0.74		0.31	0.27	0.25			0.71		0.00	0.00	9.36
Brk/AcrQudClr	Plastic	Yes		0.74		0.76	0.65	0.81			0.71		0.00	0.00	8.71
Brk/AcrQudHW	Plastic	No		0.74		0.64	0.55	0.63			0.71		0.00	0.00	9.36
Brk/AcrQudLW	Plastic	No		0.74		0.53	0.46	0.41			0.71		0.00	0.00	9.36
Brk/AcrQudMW	Plastic	No		0.74		0.3	0.26	0.21			0.71		0.00	0.00	9.36
Brk/AcrSglBrz	Plastic	No		1.93		0.53	0.46	0.27			1.81		0.00	0.00	1.56
Brk/AcrSglClr	Plastic	Yes		1.93		0.97	0.83	0.92			1.81		0.00	0.00	0.91
Brk/AcrSglHW	Plastic	No		1.93		0.76	0.65	0.82			1.81		0.00	0.00	1.56
Brk/AcrSglLW	Plastic	No		1.93		0.45	0.39	0.32			1.81		0.00	0.00	1.56
Brk/AcrSglMW	Plastic	No		1.93		0.68	0.58	0.53			1.81		0.00	0.00	1.56
Brk/AcrTrpBrz	Plastic	No		0.91		0.35	0.30	0.23			0.87		0.00	0.00	6.76
Brk/AcrTrpClr	Plastic	Yes		0.91		0.82	0.71	0.85			0.87		0.00	0.00	6.11
Brk/AcrTrpHW	Plastic	No		0.91		0.68	0.58	0.69			0.87		0.00	0.00	6.76
Brk/AcrTrpLW	Plastic	No		0.91		0.36	0.31	0.27			0.87		0.00	0.00	6.76
Brk/AcrTrpMW	Plastic	No		0.91		0.58	0.50	0.45			0.87		0.00	0.00	6.76
Mtl/AcrDblBrz	Plastic	No		1.29		0.43	0.37	0.25			1.3		0.00	0.00	3.25
Mtl/AcrDblClr	Plastic	Yes		1.29		0.89	0.77	0.89			1.3		0.00	0.00	2.60
Mtl/AcrDblHW	Plastic	No		1.29		0.72	0.62	0.75			1.3		0.00	0.00	3.25
Mtl/AcrDblLW	Plastic	No		1.29		0.4	0.34	0.29			1.3		0.00	0.00	3.25
Mtl/AcrDblMW	Plastic	No		1.29		0.63	0.54	0.49			1.3		0.00	0.00	3.25
Mtl/AcrQudBrz	Plastic	No		0.93		0.31	0.27	0.25			0.94		0.00	0.00	8.45
Mtl/AcrQudClr	Plastic	Yes		0.93		0.76	0.65	0.81			0.94		0.00	0.00	7.80
Mtl/AcrQudHW	Plastic	No		0.93		0.64	0.55	0.63			0.94		0.00	0.00	8.45
Mtl/AcrQudLW	Plastic	No		0.93		0.53	0.46	0.41			0.94		0.00	0.00	8.45
Mtl/AcrQudMW	Plastic	No		0.93		0.3	0.26	0.21			0.94		0.00	0.00	8.45
Mtl/AcrSglBrz	Plastic	No		1.92		0.53	0.46	0.27			1.9		0.00	0.00	0.65
Mtl/AcrSglClr	Plastic	Yes		1.92		0.97	0.83	0.92			1.9		0.00	0.00	0.00
Mtl/AcrSglHW	Plastic	No		1.92		0.76	0.65	0.82			1.9		0.00	0.00	0.65
Mtl/AcrSglLW	Plastic	No		1.92		0.45	0.39	0.32			1.9		0.00	0.00	0.65
Mtl/AcrSglMW	Plastic	No		1.92		0.68	0.58	0.53			1.9		0.00	0.00	0.65

NameIP	Material	UfactorSet	UVertW41	USkyCurbW41	USkyNoCurbW41	SC	SHGC_	VLT	UVertOperMap	UVertFixedMap	USkyCurbMap	USkyNoCurbMap	CostCMLow	CostCMHigh	CostASHRAE
Mtl/AcrTrpBrz	Plastic	No		1.1		0.35	0.30	0.23			1.1		0.00	0.00	5.85
Mtl/AcrTrpClr	Plastic	Yes		1.1		0.82	0.71	0.85			1.1		0.00	0.00	5.20
Mtl/AcrTrpHW	Plastic	No		1.1		0.68	0.58	0.69			1.1		0.00	0.00	5.85
Mtl/AcrTrpLW	Plastic	No		1.1		0.36	0.31	0.27			1.1		0.00	0.00	5.85
Mtl/AcrTrpMW	Plastic	No		1.1		0.58	0.50	0.45			1.1		0.00	0.00	5.85
Vnl/AcrDblBrz	Plastic	No		0.84		0.43	0.37	0.25			0.84		0.00	0.00	8.45
Vnl/AcrDblClr	Plastic	Yes		0.84		0.89	0.77	0.89			0.84		0.00	0.00	7.80
Vnl/AcrDblHW	Plastic	No		0.84		0.72	0.62	0.75			0.84		0.00	0.00	8.45
Vnl/AcrDblLW	Plastic	No		0.84		0.4	0.34	0.29			0.84		0.00	0.00	8.45
Vnl/AcrDblMW	Plastic	No		0.84		0.63	0.54	0.49			0.84		0.00	0.00	8.45
Vnl/AcrQudBrz	Plastic	No		0.48		0.31	0.27	0.25			0.46		0.00	0.00	13.65
Vnl/AcrQudClr	Plastic	Yes		0.48		0.76	0.65	0.81			0.46		0.00	0.00	13.00
Vnl/AcrQudHW	Plastic	No		0.48		0.64	0.55	0.63			0.46		0.00	0.00	13.65
Vnl/AcrQudLW	Plastic	No		0.48		0.53	0.46	0.41			0.46		0.00	0.00	13.65
Vnl/AcrQudMW	Plastic	No		0.48		0.3	0.26	0.21			0.46		0.00	0.00	13.65
Vnl/AcrTrpBrz	Plastic	No		0.65		0.35	0.30	0.23			0.61		0.00	0.00	11.05
Vnl/AcrTrpClr	Plastic	Yes		0.65		0.82	0.71	0.85			0.61		0.00	0.00	10.40
Vnl/AcrTrpH	Plastic	No		0.65		0.68	0.58	0.69			0.61		0.00	0.00	11.05
Vnl/AcrTrpLW	Plastic	No		0.65		0.36	0.31	0.27			0.61		0.00	0.00	11.05
Vnl/AcrTrpMW	Plastic	No		0.65		0.58	0.50	0.45			0.61		0.00	0.00	11.05

Appendix C – Assembly U-Factors for Unlabeled Glazed Wall Systems (Site-Built Windows) and Unlabeled Skylights

Product Type		Vertical Installation				Sloped Installation						
		Unlabeled Glazed Wall Systems (Site Built Windows) (include site assembled fixed windows only, does not include operable windows)				**Unlabeled Skylight with Curb** (includes glass/plastic, flat/domed, fixed/operable)				**Unlabeled Skylight without Curb** (includes glass/plastic, flat/domed, fixed/operable)		
Frame Type		Aluminum without Thermal Break	Aluminum with Thermal Break	Wood/Vinyl	Structural Glazing	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing
ID	**Glazing Type**											
	Single Glazing											
1	1/8" glass	1.22	1.11	0.98	1.11	1.98	1.89	1.75	1.47	1.36	1.25	1.25
2	1/4" acrylic/polycarb	1.08	0.96	0.84	0.96	1.82	1.73	1.60	1.31	1.21	1.10	1.10
3	1/8" acrylic/polycarb	1.15	1.04	0.91	1.04	1.90	1.81	1.68	1.39	1.29	1.18	1.18
	Double Glazing											
4	1/4" airspace	0.79	0.68	0.56	0.63	1.31	1.11	1.05	0.84	0.82	0.70	0.66
5	1/2" airspace	0.73	0.62	0.50	0.57	1.30	1.10	1.04	0.84	0.81	0.69	0.65
6	1/4" argon space	0.75	0.64	0.52	0.60	1.27	1.07	1.00	0.80	0.77	0.66	0.62
7	1/2" argon space	0.70	0.59	0.48	0.55	1.27	1.07	1.00	0.80	0.77	0.66	0.62
	Double Glazing, *e*=0.60 on surface 2 or 3											
8	1/4" airspace	0.76	0.65	0.53	0.61	1.27	1.08	1.01	0.81	0.78	0.67	0.63
9	1/2" airspace	0.69	0.58	0.47	0.54	1.27	1.07	1.00	0.80	0.77	0.66	0.62
10	1/4" argon space	0.72	0.61	0.49	0.56	1.23	1.03	0.97	0.76	0.74	0.63	0.58
11	1/2" argon space	0.67	0.56	0.44	0.51	1.23	1.03	0.97	0.76	0.74	0.63	0.58
	Double Glazing, *e*=0.40 on surface 2 or 3											
12	1/4" airspace	0.74	0.63	0.51	0.58	1.25	1.05	0.99	0.78	0.76	0.64	0.60
13	1/2" airspace	0.66	0.55	0.44	0.51	1.24	1.04	0.98	0.77	0.75	0.64	0.59
14	1/4" argon space	0.69	0.57	0.46	0.53	1.18	0.99	0.92	0.72	0.70	0.58	0.54
15	1/2" argon space	0.63	0.51	0.40	0.47	1.20	1.00	0.94	0.74	0.71	0.60	0.56
	Double Glazing, *e*=0.20 on surface 2 or 3											
16	1/4" airspace	0.70	0.59	0.48	0.55	1.20	1.00	0.94	0.74	0.71	0.60	0.56
17	1/2" airspace	0.62	0.51	0.39	0.46	1.20	1.00	0.94	0.74	0.71	0.60	0.56
18	1/4" argon space	0.64	0.53	0.42	0.49	1.14	0.94	0.88	0.68	0.65	0.54	0.50
19	1/2" argon space	0.57	0.46	0.35	0.42	1.15	0.95	0.89	0.68	0.66	0.55	0.51
	Double Glazing, *e*=0.10 on surface 2 or 3											
20	1/4" airspace	0.68	0.57	0.45	0.52	1.18	0.99	0.92	0.72	0.70	0.58	0.54
21	1/2" airspace	0.59	0.48	0.37	0.44	1.18	0.99	0.92	0.72	0.70	0.58	0.54
22	1/4" argon space	0.62	0.51	0.39	0.46	1.11	0.91	0.85	0.65	0.63	0.52	0.47
23	1/2" argon space	0.55	0.44	0.33	0.39	1.13	0.93	0.87	0.67	0.65	0.53	0.49

Product Type		Vertical Installation				Sloped Installation						
		Unlabeled Glazed Wall Systems (Site Built Windows) (include site assembled fixed windows only, does not include operable windows)				**Unlabeled Skylight with Curb** (includes glass/plastic, flat/domed, fixed/operable)				**Unlabeled Skylight without Curb** (includes glass/plastic, flat/domed, fixed/operable)		
Frame Type		Aluminum without Thermal Break	Aluminum with Thermal Break	Wood/Vinyl	Structural Glazing	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing
ID	**Glazing Type**											
	Double Glazing, *e*=0.05 on surface 2 or 3											
24	1/4" airspace	0.67	0.56	0.44	0.51	1.17	0.97	0.91	0.70	0.68	0.57	0.52
25	1/2" airspace	0.57	0.46	0.35	0.42	1.17	0.98	0.91	0.71	0.69	0.58	0.53
26	1/4" argon space	0.60	0.49	0.38	0.44	1.09	0.89	0.83	0.63	0.61	0.50	0.45
27	1/2" argon space	0.53	0.42	0.31	0.38	1.11	0.91	0.85	0.65	0.63	0.52	0.47
	Triple Glazing											
28	1/4" airspaces	0.63	0.52	0.41	0.47	1.12	0.89	0.84	0.64	0.64	0.53	0.48
29	1/2" airspaces	0.57	0.46	0.35	0.41	1.10	0.87	0.81	0.61	0.62	0.51	0.45
30	1/4" argon spaces	0.60	0.49	0.38	0.43	1.09	0.86	0.80	0.60	0.61	0.50	0.44
31	1/2" argon spaces	0.55	0.45	0.34	0.39	1.07	0.84	0.79	0.59	0.59	0.48	0.42
	Triple Glazing, *e*=0.20 on surface 2,3,4, or 5											
32	1/4" airspaces	0.59	0.48	0.37	0.42	1.08	0.85	0.79	0.59	0.60	0.49	0.43
33	1/2" airspaces	0.52	0.41	0.30	0.35	1.05	0.82	0.77	0.57	0.57	0.46	0.41
34	1/4" argon spaces	0.54	0.44	0.33	0.38	1.02	0.79	0.74	0.54	0.55	0.44	0.38
35	1/2" argon spaces	0.49	0.38	0.28	0.33	1.01	0.78	0.73	0.53	0.54	0.43	0.37
	Triple Glazing, *e*=0.20 on surfaces 2 or 3 and 4 or 5											
36	1/4" airspaces	0.55	0.45	0.34	0.39	1.03	0.80	0.75	0.55	0.56	0.45	0.39
37	1/2" airspaces	0.48	0.37	0.26	0.31	1.01	0.78	0.73	0.53	0.54	0.43	0.37
38	1/4" argon spaces	0.50	0.39	0.29	0.34	0.99	0.75	0.70	0.50	0.51	0.40	0.35
39	1/2" argon spaces	0.45	0.34	0.24	0.29	0.97	0.74	0.69	0.49	0.50	0.39	0.33
	Triple Glazing, *e*=0.10 on surfaces 2 or 3 and 4 or 5											
40	1/4" airspaces	0.54	0.43	0.32	0.37	1.01	0.78	0.73	0.53	0.54	0.43	0.37
41	1/2" airspaces	0.46	0.35	0.25	0.29	0.99	0.76	0.71	0.51	0.52	0.41	0.36
42	1/4" argon spaces	0.48	0.38	0.27	0.32	0.96	0.73	0.68	0.48	0.49	0.38	0.32
43	1/2" argon spaces	0.42	0.32	0.21	0.26	0.95	0.72	0.67	0.47	0.48	0.37	0.31
	Quadruple Glazing, *e*=0.10 on surfaces 2 or 3 and 4 or 5											
44	1/4" airspaces	0.49	0.38	0.28	0.33	0.97	0.74	0.69	0.49	0.50	0.39	0.33
45	1/2" airspaces	0.43	0.32	0.22	0.27	0.94	0.71	0.66	0.46	0.47	0.36	0.30
46	1/4" argon spaces	0.45	0.34	0.24	0.29	0.93	0.70	0.65	0.45	0.46	0.35	0.30
47	1/2" argon spaces	0.41	0.30	0.20	0.24	0.91	0.68	0.63	0.43	0.44	0.33	0.28
48	1/4" krypton spaces	0.41	0.30	0.20	0.24	0.88	0.65	0.60	0.40	0.42	0.31	0.25

Appendix D – Coefficients used in Fenestration Energy Models

Table 1 – Climate Zone 1 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	4.499	-0.566	0.926	0.983	0.000	-0.038	0.413	0.155	0.984
Non-North	9.217	1.356	1.170	0.958	0.000	-0.060	0.308	0.149	0.979
All sides	8.038	0.875	1.109	0.961	0.000	-0.055	0.334	0.151	0.981
South	10.039	1.753	1.259	0.952	0.000	-0.059	0.301	0.148	0.978
West	9.339	1.428	1.237	0.954	0.000	-0.069	0.332	0.150	0.975
East	8.274	0.887	1.015	0.965	0.000	-0.053	0.291	0.151	0.982
Skylight	8.352	0.003	0.445	0.990	-0.186	0.000	0.363	0.047	0.972

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	6.298	-0.428	0.922	0.988	0.000	-0.085	0.547	0.098	0.985
Non-North	14.703	3.380	1.305	0.950	0.000	-0.096	0.251	0.088	0.936
All sides	12.602	2.428	1.209	0.956	0.000	-0.093	0.325	0.090	0.961
South	15.677	4.062	1.364	0.943	0.000	-0.083	0.199	0.074	0.915
West	15.508	3.126	1.506	0.950	0.000	-0.095	0.276	0.084	0.938
East	12.925	2.953	1.045	0.955	0.000	-0.110	0.279	0.106	0.942
Skylight	12.003	-0.001	0.445	0.989	-0.268	0.000	0.271	0.020	0.975

Table 2 – Climate Zone2 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	7.386	0.556	2.134	0.998	0.000	-0.029	0.365	0.170	0.977
Non-North	15.274	3.865	2.660	0.962	0.000	-0.054	0.259	0.160	0.979
All sides	13.302	3.037	2.528	0.969	0.000	-0.048	0.285	0.162	0.979
South	17.308	4.306	2.838	0.952	0.000	-0.057	0.257	0.158	0.979
West	15.759	3.913	2.668	0.968	0.000	-0.061	0.280	0.162	0.968
East	12.754	3.375	2.474	0.966	0.000	-0.045	0.240	0.161	0.975
Skylight	21.832	2.576	1.613	0.984	-0.241	0.000	0.531	0.086	0.969

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	10.930	1.212	2.485	0.999	0.000	-0.063	0.446	0.123	0.989
Non-North	23.046	6.224	3.225	0.960	0.000	-0.085	0.195	0.110	0.974
All sides	20.017	4.971	3.040	0.968	0.000	-0.079	0.258	0.113	0.984
South	25.899	6.788	3.412	0.950	0.000	-0.082	0.151	0.096	0.957
West	24.521	6.453	3.414	0.966	0.000	-0.082	0.207	0.107	0.969
East	18.717	5.431	2.848	0.964	0.000	-0.091	0.226	0.126	0.982
Skylight	32.206	3.103	1.750	0.989	-0.388	0.000	0.380	0.050	0.932

Table 3 – Climate Zone 3 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	6.590	-0.722	1.414	0.996	0.000	-0.036	0.346	0.145	0.983
Non-North	14.903	0.613	1.760	0.981	0.000	-0.062	0.257	0.138	0.982
All sides	12.825	0.279	1.673	0.984	0.000	-0.055	0.279	0.140	0.983
South	16.443	0.627	1.846	0.983	0.000	-0.060	0.258	0.137	0.980
West	15.878	0.242	1.795	0.982	0.000	-0.074	0.287	0.140	0.973
East	12.388	0.970	1.639	0.979	0.000	-0.051	0.226	0.138	0.982
Skylight	21.769	-0.649	1.148	0.994	-0.297	0.000	0.524	0.070	0.966

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	8.398	-0.561	1.247	0.996	0.000	-0.068	0.412	0.096	0.990
Non-North	21.249	1.423	1.723	0.981	0.000	-0.084	0.188	0.085	0.917
All sides	18.036	0.927	1.604	0.983	0.000	-0.080	0.244	0.088	0.950
South	23.168	1.527	1.809	0.984	0.000	-0.075	0.158	0.073	0.896
West	23.325	0.710	1.782	0.981	0.000	-0.087	0.223	0.086	0.917
East	17.253	2.033	1.579	0.975	0.000	-0.091	0.181	0.097	0.924
Skylight	30.514	-1.369	0.973	0.995	-0.358	0.000	0.349	0.030	0.963

Table 4 – Climate Zone 4 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	8.299	-0.009	2.206	0.997	0.000	-0.027	0.330	0.144	0.978
Non-North	17.328	2.080	2.629	0.978	0.000	-0.051	0.242	0.136	0.978
All sides	15.071	1.558	2.524	0.982	0.000	-0.045	0.264	0.138	0.979
South	18.093	2.369	2.793	0.976	0.000	-0.050	0.244	0.134	0.976
West	18.657	1.372	2.572	0.983	0.000	-0.059	0.273	0.139	0.965
East	15.235	2.499	2.523	0.973	0.000	-0.044	0.210	0.135	0.973
Skylight	26.657	0.057	1.728	0.993	-0.248	0.000	0.505	0.072	0.978

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	11.806	-0.018	2.272	0.997	0.000	-0.056	0.380	0.096	0.989
Non-North	25.430	3.150	2.855	0.979	0.000	-0.072	0.169	0.084	0.949
All sides	22.024	2.358	2.709	0.983	0.000	-0.068	0.221	0.087	0.968
South	25.825	3.572	3.036	0.978	0.000	-0.062	0.143	0.071	0.941
West	29.293	2.066	2.888	0.986	0.000	-0.075	0.202	0.087	0.930
East	21.171	3.812	2.641	0.969	0.000	-0.078	0.160	0.095	0.948
Skylight	39.043	-0.430	1.660	0.994	-0.340	0.000	0.339	0.035	0.951

Table 5 – Climate Zone5 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	8.236	-1.043	1.439	0.996	0.000	-0.027	0.314	0.144	0.971
Non-North	16.218	1.357	1.887	0.976	0.000	-0.055	0.236	0.137	0.975
All sides	14.222	0.757	1.775	0.980	0.000	-0.048	0.255	0.139	0.974
South	17.839	1.937	2.074	0.975	0.000	-0.054	0.233	0.136	0.972
West	16.848	0.122	1.808	0.981	0.000	-0.065	0.265	0.139	0.962
East	13.966	2.012	1.779	0.971	0.000	-0.046	0.208	0.137	0.970
Skylight	24.715	-1.300	1.195	0.994	-0.270	0.000	0.498	0.071	0.972

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.284	-0.171	1.302	0.993	0.000	-0.050	0.364	0.074	0.992
Non-North	22.210	2.603	1.805	0.973	0.000	-0.064	0.157	0.067	0.945
All sides	18.978	1.909	1.679	0.976	0.000	-0.061	0.209	0.069	0.969
South	24.377	3.450	1.997	0.971	0.000	-0.056	0.128	0.056	0.928
West	23.804	0.523	1.653	0.980	0.000	-0.067	0.200	0.069	0.927
East	18.448	3.836	1.764	0.965	0.000	-0.068	0.144	0.075	0.947
Skylight	32.970	-1.406	0.924	0.995	-0.260	0.000	0.287	0.024	0.969

Table 6 – Climate Zone 6 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	8.664	-1.136	1.955	0.992	0.000	-0.022	0.218	0.108	0.972
Non-North	17.927	0.896	2.336	0.980	0.000	-0.046	0.147	0.103	0.976
All sides	15.611	0.388	2.241	0.982	0.000	-0.040	0.164	0.104	0.976
South	19.277	1.892	2.547	0.971	0.000	-0.048	0.141	0.102	0.978
West	18.841	-0.053	2.276	0.986	0.000	-0.048	0.173	0.104	0.952
East	15.662	0.848	2.185	0.982	0.000	-0.040	0.126	0.102	0.974
Skylight	26.273	-1.404	1.609	0.994	-0.214	0.000	0.348	0.056	0.966

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	11.585	-1.531	1.454	0.992	0.000	-0.028	0.191	0.033	0.992
Non-North	24.195	1.776	2.014	0.978	0.000	-0.031	0.072	0.028	0.924
All sides	21.042	0.949	1.874	0.981	0.000	-0.030	0.102	0.029	0.961
South	25.176	3.680	2.262	0.965	0.000	-0.025	0.051	0.022	0.900
West	26.563	-0.142	1.960	0.987	0.000	-0.034	0.107	0.029	0.922
East	20.845	1.790	1.820	0.978	0.000	-0.033	0.057	0.033	0.897
Skylight	34.954	-2.527	1.218	0.996	-0.115	0.000	0.150	0.008	0.982

Table 7 – Climate Zone 7 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.369	-0.931	2.293	0.997	0.000	-0.019	0.199	0.095	0.975
Non-North	18.906	0.626	2.662	0.984	0.000	-0.040	0.132	0.090	0.976
All sides	16.522	0.236	2.570	0.987	0.000	-0.035	0.149	0.091	0.977
South	21.489	0.465	2.742	0.985	0.000	-0.043	0.132	0.089	0.974
West	19.264	0.627	2.729	0.983	0.000	-0.041	0.154	0.091	0.964
East	15.965	0.784	2.515	0.984	0.000	-0.035	0.109	0.089	0.977
Skylight	27.287	-0.956	1.889	0.994	-0.186	0.000	0.297	0.049	0.959

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	12.196	-0.891	1.834	0.997	0.000	-0.020	0.159	0.027	0.993
Non-North	25.766	1.443	2.394	0.982	0.000	-0.024	0.063	0.023	0.928
All sides	22.374	0.860	2.254	0.985	0.000	-0.023	0.087	0.024	0.963
South	28.647	1.335	2.469	0.982	0.000	-0.022	0.053	0.019	0.917
West	27.112	1.208	2.492	0.983	0.000	-0.026	0.088	0.024	0.941
East	21.539	1.786	2.222	0.980	0.000	-0.025	0.047	0.026	0.885
Skylight	37.194	-1.003	1.475	0.994	-0.082	0.000	0.118	0.007	0.981

Table 8 – Climate Zone 8 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.902	-0.108	2.682	0.996	0.000	-0.018	0.201	0.102	0.972
Non-North	18.717	2.642	3.219	0.975	0.000	-0.038	0.131	0.096	0.978
All sides	16.513	1.954	3.085	0.979	0.000	-0.033	0.149	0.097	0.977
South	20.805	2.869	3.387	0.975	0.000	-0.040	0.132	0.095	0.976
West	18.880	2.890	3.252	0.974	0.000	-0.039	0.149	0.098	0.970
East	16.467	2.166	3.017	0.974	0.000	-0.034	0.112	0.095	0.971
Skylight	28.573	-0.247	2.124	0.994	-0.172	0.000	0.309	0.054	0.961

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	13.143	0.199	2.504	0.998	0.000	-0.024	0.189	0.034	0.995
Non-North	26.228	4.214	3.165	0.975	0.000	-0.028	0.074	0.029	0.961
All sides	22.957	3.210	3.000	0.980	0.000	-0.027	0.103	0.030	0.981
South	28.906	4.424	3.310	0.975	0.000	-0.024	0.061	0.024	0.950
West	27.525	4.551	3.239	0.977	0.000	-0.028	0.092	0.030	0.972
East	22.254	3.666	2.945	0.974	0.000	-0.030	0.069	0.033	0.937
Skylight	39.254	-0.315	1.823	0.995	-0.115	0.000	0.146	0.010	0.973

Table 9 – Climate Zone 9 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.663	0.742	3.039	0.995	0.000	-0.021	0.232	0.109	0.974
Non-North	19.738	3.750	3.556	0.975	0.000	-0.041	0.147	0.102	0.980
All sides	17.219	2.998	3.427	0.978	0.000	-0.036	0.168	0.104	0.979
South	23.395	4.049	3.775	0.972	0.000	-0.046	0.140	0.101	0.981
West	19.139	4.126	3.583	0.971	0.000	-0.042	0.176	0.105	0.973
East	16.679	3.075	3.311	0.981	0.000	-0.036	0.126	0.101	0.969
Skylight	27.557	0.388	2.339	0.994	-0.194	0.000	0.347	0.057	0.966

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	13.390	1.188	2.965	0.996	0.000	-0.023	0.191	0.034	0.996
Non-North	29.056	5.693	3.683	0.974	0.000	-0.029	0.067	0.029	0.957
All sides	25.139	4.567	3.504	0.978	0.000	-0.028	0.098	0.030	0.982
South	34.861	5.919	3.925	0.974	0.000	-0.026	0.044	0.024	0.913
West	28.653	6.123	3.779	0.973	0.000	-0.030	0.099	0.030	0.981
East	23.654	5.037	3.347	0.974	0.000	-0.031	0.057	0.033	0.933
Skylight	39.405	0.791	2.082	0.994	-0.112	0.000	0.157	0.010	0.978

Table 10 – Climate Zone 10 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	10.373	1.392	3.314	0.996	0.000	-0.018	0.220	0.119	0.974
Non-North	19.628	5.104	3.887	0.964	0.000	-0.040	0.141	0.111	0.981
All sides	17.314	4.176	3.743	0.971	0.000	-0.035	0.161	0.113	0.979
South	23.814	5.986	4.126	0.961	0.000	-0.047	0.130	0.109	0.983
West	18.536	4.990	3.807	0.966	0.000	-0.039	0.173	0.115	0.971
East	16.534	4.336	3.727	0.965	0.000	-0.035	0.119	0.109	0.963
Skylight	26.583	2.284	2.496	0.988	-0.170	0.000	0.336	0.064	0.953

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	16.859	2.252	3.569	0.981	0.000	-0.030	0.207	0.047	0.956
Non-North	32.193	8.518	4.272	0.984	0.000	-0.037	0.065	0.040	0.836
All sides	28.360	6.952	4.096	0.987	0.000	-0.035	0.101	0.042	0.887
South	38.091	9.895	4.557	0.980	0.000	-0.034	0.033	0.034	0.764
West	31.759	8.031	4.250	0.989	0.000	-0.036	0.096	0.043	0.852
East	26.731	7.627	4.009	0.979	0.000	-0.040	0.066	0.045	0.858
Skylight	38.095	3.633	2.405	0.990	-0.141	0.000	0.183	0.017	0.942

Table 11 – Climate Zone 11 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.121	1.137	2.580	0.999	0.000	-0.033	0.399	0.152	0.988
Non-North	19.246	3.762	3.035	0.980	0.000	-0.053	0.289	0.146	0.988
All sides	16.714	3.106	2.921	0.985	0.000	-0.048	0.317	0.148	0.988
South	19.882	3.716	3.128	0.977	0.000	-0.053	0.288	0.144	0.987
West	19.485	4.521	3.161	0.978	0.000	-0.057	0.311	0.148	0.986
East	18.369	3.049	2.815	0.986	0.000	-0.050	0.268	0.148	0.988
Skylight	27.686	0.745	1.932	0.993	-0.241	0.000	0.531	0.080	0.973

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	13.569	1.849	3.313	0.998	0.000	-0.073	0.558	0.137	0.995
Non-North	29.725	5.968	3.783	0.982	0.000	-0.105	0.318	0.131	0.983
All sides	25.686	4.938	3.665	0.986	0.000	-0.097	0.378	0.133	0.990
South	29.286	5.942	3.756	0.977	0.000	-0.098	0.293	0.119	0.983
West	32.702	6.975	4.222	0.982	0.000	-0.106	0.328	0.126	0.978
East	27.188	4.987	3.370	0.986	0.000	-0.111	0.333	0.148	0.984
Skylight	40.161	0.597	2.169	0.995	-0.485	0.000	0.565	0.053	0.977

Table 12 – Climate Zone 12 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	8.970	0.940	2.510	0.997	0.000	-0.037	0.389	0.152	0.986
Non-North	18.757	3.647	2.921	0.978	0.000	-0.057	0.271	0.144	0.987
All sides	16.310	2.970	2.818	0.981	0.000	-0.052	0.301	0.146	0.987
South	19.064	3.744	3.013	0.973	0.000	-0.056	0.278	0.141	0.985
West	19.736	3.972	3.001	0.979	0.000	-0.063	0.297	0.146	0.979
East	17.471	3.226	2.749	0.980	0.000	-0.051	0.239	0.144	0.984
Skylight	27.412	0.949	1.880	0.993	-0.261	0.000	0.530	0.078	0.978

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	13.301	1.246	2.787	0.998	0.000	-0.076	0.504	0.124	0.993
Non-North	28.083	5.820	3.352	0.977	0.000	-0.101	0.238	0.114	0.957
All sides	24.387	4.677	3.211	0.981	0.000	-0.095	0.304	0.116	0.976
South	27.698	6.029	3.382	0.973	0.000	-0.091	0.203	0.099	0.942
West	31.495	5.938	3.633	0.982	0.000	-0.102	0.264	0.112	0.946
East	25.055	5.493	3.041	0.974	0.000	-0.110	0.246	0.129	0.968
Skylight	39.395	0.687	1.901	0.995	-0.483	0.000	0.480	0.047	0.972

Table 13 – Climate Zone 13 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	10.468	1.418	3.307	0.996	0.000	-0.025	0.291	0.121	0.983
Non-North	20.719	5.081	3.839	0.975	0.000	-0.041	0.193	0.114	0.983
All sides	18.156	4.166	3.706	0.979	0.000	-0.037	0.217	0.116	0.984
South	20.947	5.108	3.925	0.970	0.000	-0.041	0.190	0.112	0.981
West	21.285	5.918	3.964	0.975	0.000	-0.043	0.218	0.116	0.981
East	19.924	4.218	3.628	0.981	0.000	-0.038	0.170	0.114	0.980
Skylight	30.398	2.056	2.474	0.990	-0.180	0.000	0.392	0.064	0.967

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	15.609	2.500	4.023	0.999	0.000	-0.056	0.368	0.088	0.990
Non-North	31.571	7.977	4.730	0.977	0.000	-0.071	0.163	0.079	0.964
All sides	27.580	6.608	4.553	0.982	0.000	-0.067	0.214	0.081	0.978
South	30.765	7.919	4.815	0.972	0.000	-0.063	0.140	0.069	0.956
West	35.059	9.249	4.994	0.980	0.000	-0.071	0.172	0.077	0.958
East	28.888	6.762	4.380	0.978	0.000	-0.079	0.178	0.092	0.970
Skylight	43.814	3.594	2.725	0.993	-0.333	0.000	0.331	0.033	0.959

Table 14 – Climate Zone 14 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.302	1.420	3.037	0.997	0.000	-0.026	0.346	0.159	0.981
Non-North	18.608	5.188	3.564	0.969	0.000	-0.047	0.225	0.146	0.981
All sides	16.282	4.246	3.432	0.974	0.000	-0.042	0.255	0.149	0.983
South	18.989	4.042	3.576	0.966	0.000	-0.048	0.230	0.142	0.980
West	19.490	6.382	3.686	0.968	0.000	-0.050	0.280	0.154	0.983
East	17.346	5.138	3.431	0.972	0.000	-0.044	0.165	0.142	0.941
Skylight	28.050	2.956	2.262	0.987	-0.191	0.000	0.469	0.085	0.954

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	14.323	2.763	3.769	0.998	0.000	-0.065	0.514	0.124	0.993
Non-North	28.830	8.431	4.396	0.971	0.000	-0.085	0.240	0.105	0.968
All sides	25.203	7.014	4.239	0.977	0.000	-0.080	0.308	0.110	0.985
South	28.517	6.747	4.319	0.964	0.000	-0.078	0.233	0.091	0.956
West	32.342	10.226	4.722	0.978	0.000	-0.085	0.265	0.108	0.978
East	25.631	8.319	4.146	0.968	0.000	-0.091	0.221	0.116	0.947
Skylight	41.949	4.012	2.508	0.991	-0.399	0.000	0.434	0.050	0.919

Table 15 – Climate Zone 15 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	14.571	3.768	4.970	0.998	0.000	-0.010	0.163	0.066	0.970
Non-North	27.114	7.483	5.538	0.980	0.000	-0.025	0.102	0.060	0.978
All sides	23.978	6.554	5.396	0.984	0.000	-0.021	0.118	0.062	0.976
South	30.533	7.336	5.709	0.974	0.000	-0.029	0.094	0.059	0.981
West	25.220	7.890	5.538	0.983	0.000	-0.022	0.134	0.064	0.971
East	25.588	7.222	5.367	0.982	0.000	-0.023	0.079	0.059	0.957
Skylight	38.354	2.747	3.653	0.992	-0.099	0.000	0.253	0.033	0.976

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	20.874	6.419	6.350	0.998	0.000	-0.014	0.131	0.020	0.994
Non-North	39.918	11.342	6.988	0.981	0.000	-0.018	0.051	0.018	0.972
All sides	35.157	10.111	6.829	0.986	0.000	-0.017	0.071	0.018	0.988
South	44.288	11.110	7.180	0.973	0.000	-0.016	0.036	0.015	0.942
West	39.244	11.751	7.083	0.987	0.000	-0.018	0.077	0.019	0.984
East	36.221	11.164	6.703	0.981	0.000	-0.020	0.039	0.020	0.934
Skylight	55.579	3.556	4.136	0.995	-0.069	0.000	0.113	0.006	0.984

Table 16 – Climate Zone 16 Fenestration Coefficients

NON-RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	5.971	0.105	1.712	0.996	0.000	-0.067	0.722	0.253	0.988
Non-North	13.604	2.281	2.070	0.974	0.000	-0.095	0.522	0.239	0.990
All sides	11.696	1.737	1.981	0.978	0.000	-0.088	0.572	0.243	0.990
South	14.893	1.502	2.082	0.981	0.000	-0.091	0.505	0.233	0.990
West	13.460	3.217	2.184	0.966	0.000	-0.098	0.589	0.244	0.989
East	12.459	2.122	1.945	0.973	0.000	-0.097	0.471	0.240	0.990
Skylight	18.016	2.186	1.239	0.987	-0.427	0.000	0.903	0.127	0.971

RESIDENTIAL

	c_2	c_1	c_0	r^2	h_3	h_2	h_1	h_0	r^2
North	9.370	0.564	1.976	0.996	0.000	-0.123	1.195	0.260	0.993
Non-North	22.139	4.071	2.332	0.972	0.000	-0.199	0.769	0.245	0.989
All sides	18.947	3.194	2.243	0.976	0.000	-0.180	0.876	0.249	0.993
South	23.555	2.960	2.243	0.978	0.000	-0.194	0.697	0.222	0.976
West	23.670	4.940	2.639	0.970	0.000	-0.196	0.815	0.242	0.989
East	19.192	4.312	2.116	0.965	0.000	-0.207	0.796	0.270	0.992
Skylight	26.816	2.732	1.342	0.988	-0.885	0.000	1.121	0.112	0.953

Appendix E – 30 Year Life Cycle Cost Analysis – Windows

This analysis was performed with a NPV of electricity of $1.68/kWh-y and a NPV for gas of $11.43/therm-y. The U-factor set was used in determining the U-factor criteria. The “All” coefficients are used for non-north orientations and the “North” coefficients for north facing. The SHGC criteria were calculated with no constraint on U-factor, e.g. “Use Max. U-factor” was not checked. The criteria were calculated with the Title 24 Fenestration Optimizer software developed as part of this project.

U-factor Criteria – Nonresidential

South Coast

Table 1 – Vertical Fenestration U-factor Criteria – Nonresidential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrSpe	14.17	1.10	0.63	5.49	1.30	6.37	0.60	0.59	0.103	12.57	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrSpe	14.26	1.18	0.63	5.29	1.30	8.32	0.56	0.48	0.097	12.18	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrSpe	14.48	1.18	0.63	5.29	1.30	9.36	0.56	0.44	0.094	12.14	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrPye	14.52	0.97	0.63	5.87	1.30	5.23	0.68	0.60	0.102	13.21	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrNct	**14.52**	**0.99**	**0.64**	**6.07**	**1.25**	**3.93**	**0.72**	**0.73**	**0.108**	**13.54**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/ClrNct-Std-ClrPye	14.61	1.03	0.63	5.67	1.30	7.18	0.64	0.49	0.096	12.81	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	14.61	1.04	0.64	5.87	1.25	5.88	0.68	0.62	0.103	13.14	0.60	0.60	1.10	0.69
Vnl/ClrNct-Std-ClrSpe	14.64	1.24	0.62	5.04	1.33	11.57	0.51	0.37	0.091	11.75	0.42	0.37	0.92	0.00
Brk/ClrNct	14.72	1.01	0.66	6.43	1.18	1.95	0.79	1.15	0.127	14.24	1.08	1.11	1.89	1.25
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	14.48	1.01	0.66	6.43	1.18	0.98	0.79	1.15	0.127	14.24	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	14.52	1.04	0.64	5.87	1.25	5.53	0.68	0.62	0.103	13.14	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSpe	14.62	1.18	0.63	5.29	1.30	9.78	0.56	0.48	0.097	12.18	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrPye	14.67	1.03	0.63	5.67	1.30	7.42	0.64	0.49	0.096	12.81	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrNct	**14.67**	**0.99**	**0.64**	**6.07**	**1.25**	**4.55**	**0.72**	**0.73**	**0.108**	**13.54**	**0.81**	**0.72**	**1.31**	**0.80**
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	14.28	1.18	0.63	5.29	1.30	8.40	0.56	0.48	0.097	12.18	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrNct	14.33	1.04	0.64	5.87	1.25	4.75	0.68	0.62	0.103	13.14	0.60	0.60	1.10	0.69
Brk/ClrNct	14.45	1.01	0.66	6.43	1.18	0.83	0.79	1.15	0.127	14.24	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrSpe	14.47	1.10	0.63	5.49	1.30	7.57	0.60	0.59	0.103	12.57	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	14.47	1.03	0.63	5.67	1.30	6.64	0.64	0.49	0.096	12.81	0.51	0.49	1.00	0.59

North Coast

Table 2 – Vertical Fenestration U-factor Criteria – Nonresidential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrSpe	12.30	1.10	0.63	3.95	1.30	6.37	0.60	0.59	0.165	10.71	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrSpe	12.41	1.18	0.63	3.79	1.30	8.32	0.56	0.48	0.155	10.33	0.49	0.46	0.99	0.57
Mtl/ClrNct-Std-ClrNct	**12.49**	**0.99**	**0.64**	**4.41**	**1.25**	**3.93**	**0.72**	**0.73**	**0.175**	**11.51**	**0.81**	**0.72**	**1.31**	**0.80**
Mtl/ClrNct-Std-ClrPye	12.50	0.97	0.63	4.25	1.30	5.23	0.68	0.60	0.164	11.20	0.71	0.60	1.20	0.70
Brk/ClrNct-Std-ClrNct	12.61	1.04	0.64	4.25	1.25	5.88	0.68	0.62	0.166	11.14	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrPye	12.61	1.03	0.63	4.09	1.30	7.18	0.64	0.49	0.153	10.81	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrSpe	12.61	1.18	0.63	3.79	1.30	9.36	0.56	0.44	0.150	10.27	0.46	0.43	0.96	0.54
Brk/ClrNct	12.75	1.01	0.66	4.70	1.18	1.95	0.79	1.15	0.209	12.27	1.08	1.11	1.89	1.25
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	12.51	1.01	0.66	4.70	1.18	0.98	0.79	1.15	0.209	12.27	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	12.52	1.04	0.64	4.25	1.25	5.53	0.68	0.62	0.166	11.14	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrNct	**12.65**	**0.99**	**0.64**	**4.41**	**1.25**	**4.55**	**0.72**	**0.73**	**0.175**	**11.51**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/ClrNct-Std-ClrPye	12.67	1.03	0.63	4.09	1.30	7.42	0.64	0.49	0.153	10.81	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrNct	12.74	1.04	0.64	4.25	1.25	6.57	0.68	0.59	0.163	11.10	0.57	0.57	1.07	0.66
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrNct	12.32	1.04	0.64	4.25	1.25	4.75	0.68	0.62	0.166	11.14	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSpe	12.43	1.18	0.63	3.79	1.30	8.40	0.56	0.48	0.155	10.33	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrPye	12.47	1.03	0.63	4.09	1.30	6.64	0.64	0.49	0.153	10.81	0.51	0.49	1.00	0.59
Brk/ClrNct	12.47	1.01	0.66	4.70	1.18	0.83	0.79	1.15	0.209	12.27	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrNct	**12.49**	**0.99**	**0.64**	**4.41**	**1.25**	**3.91**	**0.72**	**0.73**	**0.175**	**11.51**	**0.81**	**0.72**	**1.31**	**0.80**

Central Valley

Table 3 – Vertical Fenestration U-factor Criteria – Nonresidential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**15.94**	**1.18**	**0.63**	**5.83**	**1.30**	**8.32**	**0.56**	**0.48**	**0.164**	**13.86**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	16.03	1.10	0.63	6.10	1.30	6.37	0.60	0.59	0.175	14.43	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	16.09	1.18	0.63	5.80	1.30	9.36	0.56	0.44	0.160	13.75	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	16.14	1.24	0.62	5.51	1.33	11.57	0.51	0.37	0.153	13.25	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	16.29	1.24	0.62	5.48	1.33	12.61	0.51	0.33	0.147	13.13	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	16.29	1.03	0.63	6.22	1.30	7.18	0.64	0.49	0.163	14.49	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrPye	16.38	0.97	0.63	6.49	1.30	5.23	0.68	0.60	0.174	15.07	0.71	0.60	1.20	0.70
Brk/ClrNct-Ins-ClrPye	16.44	1.03	0.63	6.19	1.30	8.22	0.64	0.45	0.158	14.39	0.48	0.46	0.97	0.56
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**16.30**	**1.18**	**0.63**	**5.83**	**1.30**	**9.78**	**0.56**	**0.48**	**0.164**	**13.86**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Std-ClrPye	16.35	1.03	0.63	6.22	1.30	7.42	0.64	0.49	0.163	14.49	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	16.42	1.04	0.64	6.50	1.25	5.53	0.68	0.62	0.176	15.04	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSpe	16.46	1.18	0.63	5.80	1.30	10.82	0.56	0.44	0.160	13.75	0.46	0.43	0.96	0.54
Brk/ClrNct-Ins-ClrPye	16.50	1.03	0.63	6.19	1.30	8.46	0.64	0.45	0.158	14.39	0.48	0.46	0.97	0.56
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**15.96**	**1.18**	**0.63**	**5.83**	**1.30**	**8.40**	**0.56**	**0.48**	**0.164**	**13.86**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	16.11	1.18	0.63	5.80	1.30	9.44	0.56	0.44	0.160	13.75	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	16.15	1.03	0.63	6.22	1.30	6.64	0.64	0.49	0.163	14.49	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	16.22	1.04	0.64	6.50	1.25	4.75	0.68	0.62	0.176	15.04	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	16.31	1.03	0.63	6.19	1.30	7.68	0.64	0.45	0.158	14.39	0.48	0.46	0.97	0.56

Desert

Table 4 – Vertical Fenestration U-factor Criteria – Nonresidential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**17.23**	**1.18**	**0.63**	**6.59**	**1.30**	**8.32**	**0.56**	**0.48**	**0.165**	**15.15**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	17.36	1.10	0.63	6.90	1.30	6.37	0.60	0.59	0.174	15.76	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	17.37	1.18	0.63	6.55	1.30	9.36	0.56	0.44	0.162	15.03	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	17.39	1.24	0.62	6.24	1.33	11.57	0.51	0.37	0.156	14.50	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	17.53	1.24	0.62	6.20	1.33	12.61	0.51	0.33	0.151	14.38	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	17.59	1.03	0.63	6.98	1.30	7.18	0.64	0.49	0.164	15.79	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrPye	17.72	0.97	0.63	7.29	1.30	5.23	0.68	0.60	0.173	16.41	0.71	0.60	1.20	0.70
Brk/ClrNct-Ins-ClrPye	17.73	1.03	0.63	6.94	1.30	8.22	0.64	0.45	0.160	15.67	0.48	0.46	0.97	0.56
Vnl/ClrNct-Std-ClrPye	17.78	1.07	0.62	6.64	1.33	10.43	0.59	0.39	0.155	15.17	0.44	0.40	0.94	0.00
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**17.59**	**1.18**	**0.63**	**6.59**	**1.30**	**9.78**	**0.56**	**0.48**	**0.165**	**15.15**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Std-ClrPye	17.65	1.03	0.63	6.98	1.30	7.42	0.64	0.49	0.164	15.79	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrSpe	17.74	1.18	0.63	6.55	1.30	10.82	0.56	0.44	0.162	15.03	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrNct	17.76	1.04	0.64	7.31	1.25	5.53	0.68	0.62	0.175	16.38	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	17.79	1.03	0.63	6.94	1.30	8.46	0.64	0.45	0.160	15.67	0.48	0.46	0.97	0.56
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**17.25**	**1.18**	**0.63**	**6.59**	**1.30**	**8.40**	**0.56**	**0.48**	**0.165**	**15.15**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	17.39	1.18	0.63	6.55	1.30	9.44	0.56	0.44	0.162	15.03	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	17.45	1.03	0.63	6.98	1.30	6.64	0.64	0.49	0.164	15.79	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	17.57	1.04	0.64	7.31	1.25	4.75	0.68	0.62	0.175	16.38	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	17.59	1.03	0.63	6.94	1.30	7.68	0.64	0.45	0.160	15.67	0.48	0.46	0.97	0.56

Cold Region

Table 5 – Vertical Fenestration U-factor Criteria – Nonresidential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**14.36**	**1.18**	**0.63**	**4.09**	**1.30**	**8.32**	**0.56**	**0.48**	**0.282**	**12.28**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	14.41	1.10	0.63	4.28	1.30	6.37	0.60	0.59	0.301	12.81	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	14.50	1.18	0.63	4.08	1.30	9.36	0.56	0.44	0.273	12.16	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	14.52	1.03	0.63	4.37	1.30	7.18	0.64	0.49	0.280	12.72	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrPye	14.57	0.97	0.63	4.55	1.30	5.23	0.68	0.60	0.300	13.26	0.71	0.60	1.20	0.70
Vnl/ClrNct-Std-ClrSpe	14.62	1.24	0.62	3.88	1.33	11.57	0.51	0.37	0.261	11.73	0.42	0.37	0.92	0.00
Brk/ClrNct-Ins-ClrPye	14.65	1.03	0.63	4.35	1.30	8.22	0.64	0.45	0.271	12.59	0.48	0.46	0.97	0.56
Brk/ClrNct-Std-ClrNct	14.71	1.04	0.64	4.56	1.25	5.88	0.68	0.62	0.304	13.24	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrNct	14.74	0.99	0.64	4.75	1.25	3.93	0.72	0.73	0.322	13.76	0.81	0.72	1.31	0.80
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrPye	14.58	1.03	0.63	4.37	1.30	7.42	0.64	0.49	0.280	12.72	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	14.62	1.04	0.64	4.56	1.25	5.53	0.68	0.62	0.304	13.24	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	14.71	1.03	0.63	4.35	1.30	8.46	0.64	0.45	0.271	12.59	0.48	0.46	0.97	0.56
Brk/ClrNct-Std-ClrSpe	**14.73**	**1.18**	**0.63**	**4.09**	**1.30**	**9.78**	**0.56**	**0.48**	**0.282**	**12.28**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrNct	14.79	1.04	0.64	4.55	1.25	6.57	0.68	0.59	0.298	13.15	0.57	0.57	1.07	0.66
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**14.38**	**1.18**	**0.63**	**4.09**	**1.30**	**8.40**	**0.56**	**0.48**	**0.282**	**12.28**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Std-ClrPye	14.38	1.03	0.63	4.37	1.30	6.64	0.64	0.49	0.280	12.72	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	14.42	1.04	0.64	4.56	1.25	4.75	0.68	0.62	0.304	13.24	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	14.51	1.03	0.63	4.35	1.30	7.68	0.64	0.45	0.271	12.59	0.48	0.46	0.97	0.56
Brk/ClrNct-Ins-ClrSpe	14.52	1.18	0.63	4.08	1.30	9.44	0.56	0.44	0.273	12.16	0.46	0.43	0.96	0.54

U-factor Criteria – Residential

South Coast

Table 6 – Vertical Fenestration U-factor Criteria – Residential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**14.65**	**1.18**	**0.63**	**6.00**	**1.30**	**8.32**	**0.56**	**0.48**	**0.027**	**12.57**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	14.68	1.10	0.63	6.28	1.30	6.37	0.60	0.59	0.030	13.08	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	14.87	1.18	0.63	5.99	1.30	9.36	0.56	0.44	0.025	12.53	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	14.89	1.24	0.62	5.65	1.33	11.57	0.51	0.37	0.023	11.99	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	15.11	1.24	0.62	5.64	1.33	12.61	0.51	0.33	0.021	11.96	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	15.23	1.03	0.63	6.52	1.30	7.18	0.64	0.49	0.026	13.44	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrPye	15.26	0.97	0.63	6.81	1.30	5.23	0.68	0.60	0.029	13.95	0.71	0.60	1.20	0.70
Brk/ClrNct-Std-ClrNct	15.36	1.04	0.64	6.81	1.25	5.88	0.68	0.62	0.030	13.89	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrNct	15.38	0.99	0.64	7.09	1.25	3.93	0.72	0.73	0.033	14.40	0.81	0.72	1.31	0.80
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**15.01**	**1.18**	**0.63**	**6.00**	**1.30**	**9.78**	**0.56**	**0.48**	**0.027**	**12.57**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	15.24	1.18	0.63	5.99	1.30	10.82	0.56	0.44	0.025	12.53	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrNct	15.27	1.04	0.64	6.81	1.25	5.53	0.68	0.62	0.030	13.89	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrSpe	15.28	1.10	0.63	6.28	1.30	8.80	0.60	0.59	0.030	13.08	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	15.29	1.03	0.63	6.52	1.30	7.42	0.64	0.49	0.026	13.44	0.51	0.49	1.00	0.59
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**14.67**	**1.18**	**0.63**	**6.00**	**1.30**	**8.40**	**0.56**	**0.48**	**0.027**	**12.57**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	14.89	1.18	0.63	5.99	1.30	9.44	0.56	0.44	0.025	12.53	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	14.97	1.10	0.63	6.28	1.30	7.57	0.60	0.59	0.030	13.08	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrNct	15.07	1.04	0.64	6.81	1.25	4.75	0.68	0.62	0.030	13.89	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrPye	15.10	1.03	0.63	6.52	1.30	6.64	0.64	0.49	0.026	13.44	0.51	0.49	1.00	0.59

North Coast

Table 7 – Vertical Fenestration U-factor Criteria – Residential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**13.11**	**1.18**	**0.63**	**4.65**	**1.30**	**8.32**	**0.56**	**0.48**	**0.090**	**11.03**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	13.13	1.10	0.63	4.89	1.30	6.37	0.60	0.59	0.100	11.54	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	13.30	1.18	0.63	4.64	1.30	9.36	0.56	0.44	0.085	10.96	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	13.36	1.24	0.62	4.36	1.33	11.57	0.51	0.37	0.079	10.47	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrPye	13.50	1.03	0.63	5.07	1.30	7.18	0.64	0.49	0.088	11.71	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrPye	13.53	0.97	0.63	5.31	1.30	5.23	0.68	0.60	0.098	12.22	0.71	0.60	1.20	0.70
Vnl/ClrNct-Ins-ClrSpe	13.53	1.24	0.62	4.35	1.33	12.61	0.51	0.33	0.072	10.38	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrNct	13.64	1.04	0.64	5.31	1.25	5.88	0.68	0.62	0.100	12.17	0.60	0.60	1.10	0.69
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**13.47**	**1.18**	**0.63**	**4.65**	**1.30**	**9.78**	**0.56**	**0.48**	**0.090**	**11.03**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Std-ClrNct	13.55	1.04	0.64	5.31	1.25	5.53	0.68	0.62	0.100	12.17	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrPye	13.56	1.03	0.63	5.07	1.30	7.42	0.64	0.49	0.088	11.71	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrSpe	13.66	1.18	0.63	4.64	1.30	10.82	0.56	0.44	0.085	10.96	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	13.74	1.10	0.63	4.89	1.30	8.80	0.60	0.59	0.100	11.54	0.69	0.57	1.18	0.68
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**13.13**	**1.18**	**0.63**	**4.65**	**1.30**	**8.40**	**0.56**	**0.48**	**0.090**	**11.03**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	13.32	1.18	0.63	4.64	1.30	9.44	0.56	0.44	0.085	10.96	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrNct	13.36	1.04	0.64	5.31	1.25	4.75	0.68	0.62	0.100	12.17	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrPye	13.37	1.03	0.63	5.07	1.30	6.64	0.64	0.49	0.088	11.71	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrSpe	13.43	1.10	0.63	4.89	1.30	7.57	0.60	0.59	0.100	11.54	0.69	0.57	1.18	0.68

Central Valley

Table 8 – Vertical Fenestration U-factor Criteria – Residential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Vnl/ClrNct-Std-ClrSpe	18.54	1.24	0.62	7.26	1.33	11.57	0.51	0.37	0.106	15.65	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	18.63	1.24	0.62	7.21	1.33	12.61	0.51	0.33	0.098	15.48	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrSpe	**18.65**	**1.18**	**0.63**	**7.74**	**1.30**	**8.32**	**0.56**	**0.48**	**0.120**	**16.57**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	18.76	1.18	0.63	7.70	1.30	9.36	0.56	0.44	0.114	16.42	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	18.99	1.10	0.63	8.15	1.30	6.37	0.60	0.59	0.133	17.40	0.69	0.57	1.18	0.68
Vnl/ClrNct-Std-ClrPye	19.22	1.07	0.62	7.85	1.33	10.43	0.59	0.39	0.104	16.61	0.44	0.40	0.94	0.00
Brk/ClrNct-Std-ClrPye	19.30	1.03	0.63	8.32	1.30	7.18	0.64	0.49	0.117	17.50	0.51	0.49	1.00	0.59
Vnl/ClrNct-Ins-ClrPye	19.31	1.07	0.62	7.80	1.33	11.47	0.59	0.35	0.096	16.45	0.41	0.37	0.91	0.00
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**19.01**	**1.18**	**0.63**	**7.74**	**1.30**	**9.78**	**0.56**	**0.48**	**0.120**	**16.57**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	19.12	1.18	0.63	7.70	1.30	10.82	0.56	0.44	0.114	16.42	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	19.15	1.24	0.62	7.26	1.33	14.00	0.51	0.37	0.106	15.65	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	19.24	1.24	0.62	7.21	1.33	15.04	0.51	0.33	0.098	15.48	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	19.36	1.03	0.63	8.32	1.30	7.42	0.64	0.49	0.117	17.50	0.51	0.49	1.00	0.59
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**18.66**	**1.18**	**0.63**	**7.74**	**1.30**	**8.40**	**0.56**	**0.48**	**0.120**	**16.57**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	18.78	1.18	0.63	7.70	1.30	9.44	0.56	0.44	0.114	16.42	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	18.84	1.24	0.62	7.26	1.33	12.77	0.51	0.37	0.106	15.65	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	18.93	1.24	0.62	7.21	1.33	13.81	0.51	0.33	0.098	15.48	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	19.16	1.03	0.63	8.32	1.30	6.64	0.64	0.49	0.117	17.50	0.51	0.49	1.00	0.59

Desert

Table 9 – Vertical Fenestration U-factor Criteria – Residential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Vnl/ClrNct-Std-ClrSpe	20.84	1.24	0.62	8.62	1.33	11.57	0.51	0.37	0.106	17.95	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	20.90	1.24	0.62	8.55	1.33	12.61	0.51	0.33	0.099	17.75	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrSpe	**21.06**	**1.18**	**0.63**	**9.18**	**1.30**	**8.32**	**0.56**	**0.48**	**0.120**	**18.98**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	21.14	1.18	0.63	9.11	1.30	9.36	0.56	0.44	0.114	18.80	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	21.53	1.10	0.63	9.67	1.30	6.37	0.60	0.59	0.132	19.93	0.69	0.57	1.18	0.68
Vnl/ClrNct-Std-ClrPye	21.58	1.07	0.62	9.25	1.33	10.43	0.59	0.39	0.105	18.97	0.44	0.40	0.94	0.00
Vnl/ClrNct-Ins-ClrPye	21.64	1.07	0.62	9.18	1.33	11.47	0.59	0.35	0.098	18.77	0.41	0.37	0.91	0.00
Vnl/ClrNct-Ins-HtMr88-Ins-ClrNct	21.68	1.27	0.61	8.21	1.36	18.42	0.48	0.26	0.087	17.07	0.28	0.22	0.68	0.00
Brk/ClrNct-Std-ClrPye	21.76	1.03	0.63	9.79	1.30	7.18	0.64	0.49	0.117	19.97	0.51	0.49	1.00	0.59
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**21.43**	**1.18**	**0.63**	**9.18**	**1.30**	**9.78**	**0.56**	**0.48**	**0.120**	**18.98**	**0.49**	**0.46**	**0.99**	**0.57**
Vnl/ClrNct-Std-ClrSpe	21.45	1.24	0.62	8.62	1.33	14.00	0.51	0.37	0.106	17.95	0.42	0.37	0.92	0.00
Brk/ClrNct-Ins-ClrSpe	21.50	1.18	0.63	9.11	1.30	10.82	0.56	0.44	0.114	18.80	0.46	0.43	0.96	0.54
Vnl/ClrNct-Ins-ClrSpe	21.51	1.24	0.62	8.55	1.33	15.04	0.51	0.33	0.099	17.75	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	21.82	1.03	0.63	9.79	1.30	7.42	0.64	0.49	0.117	19.97	0.51	0.49	1.00	0.59
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**21.08**	**1.18**	**0.63**	**9.18**	**1.30**	**8.40**	**0.56**	**0.48**	**0.120**	**18.98**	**0.49**	**0.46**	**0.99**	**0.57**
Vnl/ClrNct-Std-ClrSpe	21.14	1.24	0.62	8.62	1.33	12.77	0.51	0.37	0.106	17.95	0.42	0.37	0.92	0.00
Brk/ClrNct-Ins-ClrSpe	21.16	1.18	0.63	9.11	1.30	9.44	0.56	0.44	0.114	18.80	0.46	0.43	0.96	0.54
Vnl/ClrNct-Ins-ClrSpe	21.20	1.24	0.62	8.55	1.33	13.81	0.51	0.33	0.099	17.75	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	21.63	1.03	0.63	9.79	1.30	6.64	0.64	0.49	0.117	19.97	0.51	0.49	1.00	0.59

Cold Region

Table 10 – Vertical Fenestration U-factor Criteria – Residential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Vnl/ClrNct-Std-ClrSpe	17.06	1.24	0.62	5.35	1.33	11.57	0.51	0.37	0.258	14.17	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	17.07	1.24	0.62	5.32	1.33	12.61	0.51	0.33	0.240	13.92	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrSpe	**17.21**	**1.18**	**0.63**	**5.71**	**1.30**	**8.32**	**0.56**	**0.48**	**0.293**	**15.13**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	17.25	1.18	0.63	5.68	1.30	9.36	0.56	0.44	0.279	14.91	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrPye	17.52	1.07	0.62	5.80	1.33	10.43	0.59	0.39	0.255	14.91	0.44	0.40	0.94	0.00
Vnl/ClrNct-Ins-ClrPye	17.52	1.07	0.62	5.77	1.33	11.47	0.59	0.35	0.237	14.65	0.41	0.37	0.91	0.00
Mtl/ClrNct-Std-ClrSpe	17.60	1.10	0.63	6.02	1.30	6.37	0.60	0.59	0.325	16.01	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	17.62	1.03	0.63	6.16	1.30	7.18	0.64	0.49	0.288	15.82	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrPye	17.65	1.03	0.63	6.13	1.30	8.22	0.64	0.45	0.273	15.60	0.48	0.46	0.97	0.56
U-factor Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**17.57**	**1.18**	**0.63**	**5.71**	**1.30**	**9.78**	**0.56**	**0.48**	**0.293**	**15.13**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	17.61	1.18	0.63	5.68	1.30	10.82	0.56	0.44	0.279	14.91	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	17.67	1.24	0.62	5.35	1.33	14.00	0.51	0.37	0.258	14.17	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	17.68	1.24	0.62	5.32	1.33	15.04	0.51	0.33	0.240	13.92	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	17.68	1.03	0.63	6.16	1.30	7.42	0.64	0.49	0.288	15.82	0.51	0.49	1.00	0.59
U-factor Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**17.23**	**1.18**	**0.63**	**5.71**	**1.30**	**8.40**	**0.56**	**0.48**	**0.293**	**15.13**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	17.27	1.18	0.63	5.68	1.30	9.44	0.56	0.44	0.279	14.91	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	17.36	1.24	0.62	5.35	1.33	12.77	0.51	0.37	0.258	14.17	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	17.37	1.24	0.62	5.32	1.33	13.81	0.51	0.33	0.240	13.92	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	17.48	1.03	0.63	6.16	1.30	6.64	0.64	0.49	0.288	15.82	0.51	0.49	1.00	0.59

SHGC Criteria – Nonresidential

South Coast

Table 11 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**11.07**	**1.10**	**0.41**	**3.77**	**2.05**	**0.51**	**0.61**	**1.26**	**0.108**	**11.02**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	11.14	1.16	0.41	3.71	2.05	2.46	0.58	1.15	0.106	10.90	1.08	1.11	1.89	1.25
Mtl/HptNct	11.15	1.09	0.39	3.66	2.16	1.43	0.55	1.27	0.108	11.01	1.27	1.22	1.98	1.36
Brk/HptNct	11.19	1.18	0.39	3.58	2.16	3.38	0.51	1.15	0.106	10.85	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	11.19	1.18	0.39	3.57	2.16	4.43	0.51	0.73	0.099	10.75	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrNct	11.23	1.23	0.36	3.43	2.26	5.36	0.44	0.73	0.099	10.69	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	11.05	1.16	0.41	3.71	2.05	1.53	0.58	1.15	0.106	10.90	1.08	1.11	1.89	1.25
Mtl/GrnNct	**11.07**	**1.10**	**0.41**	**3.77**	**2.05**	**0.56**	**0.61**	**1.26**	**0.108**	**11.02**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/HptNct	11.15	1.18	0.39	3.58	2.16	3.02	0.51	1.15	0.106	10.85	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	11.20	1.28	0.39	3.49	2.16	6.08	0.47	0.62	0.097	10.60	0.60	0.60	1.10	0.69
Mtl/HptNct	11.21	1.09	0.39	3.66	2.16	2.04	0.55	1.27	0.108	11.01	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	11.03	1.16	0.41	3.71	2.05	1.31	0.58	1.15	0.106	10.90	1.08	1.11	1.89	1.25
Mtl/GrnNct	**11.07**	**1.10**	**0.41**	**3.77**	**2.05**	**0.48**	**0.61**	**1.26**	**0.108**	**11.02**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/HptNct	11.11	1.18	0.39	3.58	2.16	2.59	0.51	1.15	0.106	10.85	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	11.12	1.28	0.39	3.49	2.16	5.23	0.47	0.62	0.097	10.60	0.60	0.60	1.10	0.69
Mtl/HptNct	11.18	1.09	0.39	3.66	2.16	1.76	0.55	1.27	0.108	11.01	1.27	1.22	1.98	1.36

Table 12 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	12.23	1.33	0.52	4.10	1.67	6.87	0.39	0.57	0.102	10.86	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrNct	12.27	1.23	0.53	4.30	1.64	5.36	0.44	0.73	0.108	11.20	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrPye	12.27	1.28	0.51	4.10	1.71	6.66	0.39	0.60	0.104	10.94	0.71	0.60	1.20	0.70
Mtl/HptNct	**12.27**	**1.09**	**0.56**	**4.74**	**1.54**	**1.43**	**0.55**	**1.27**	**0.125**	**11.99**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnNct	12.31	1.10	0.59	4.97	1.44	0.51	0.61	1.26	0.125	12.21	1.27	1.22	1.98	1.36
Mtl/HptNct-Std-ClrSue	12.33	1.34	0.50	3.94	1.77	7.80	0.35	0.57	0.103	10.77	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	12.27	1.16	0.59	4.85	1.44	1.53	0.58	1.15	0.121	11.96	1.08	1.11	1.89	1.25
Brk/HptNct	12.28	1.18	0.56	4.58	1.54	3.02	0.51	1.15	0.122	11.68	1.08	1.11	1.89	1.25
Mtl/GrnNct	12.32	1.10	0.59	4.97	1.44	0.56	0.61	1.26	0.125	12.21	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrNct	12.38	1.28	0.56	4.41	1.54	6.08	0.47	0.62	0.103	11.17	0.60	0.60	1.10	0.69
Mtl/HptNct	**12.40**	**1.09**	**0.56**	**4.74**	**1.54**	**2.04**	**0.55**	**1.27**	**0.125**	**11.99**	**1.27**	**1.22**	**1.98**	**1.36**
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	12.19	1.35	0.53	4.14	1.64	6.50	0.40	0.62	0.104	10.89	0.60	0.60	1.10	0.69
Brk/HptNct	12.19	1.18	0.56	4.58	1.54	2.59	0.51	1.15	0.122	11.68	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.21	1.28	0.56	4.41	1.54	5.23	0.47	0.62	0.103	11.17	0.60	0.60	1.10	0.69
Brk/GrnNct	12.23	1.16	0.59	4.85	1.44	1.31	0.58	1.15	0.121	11.96	1.08	1.11	1.89	1.25
Mtl/GrnNct	12.30	1.10	0.59	4.97	1.44	0.48	0.61	1.26	0.125	12.21	1.27	1.22	1.98	1.36

Table 13 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	13.69	1.15	0.54	4.57	1.60	6.88	0.34	0.59	0.110	11.63	0.69	0.57	1.18	0.68
Mtl/GrnNct-Std-ClrSue	13.74	1.33	0.61	4.86	1.36	6.87	0.39	0.57	0.108	11.68	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	13.75	1.28	0.61	4.86	1.39	6.66	0.39	0.60	0.110	11.75	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrSue	13.77	1.34	0.59	4.63	1.44	7.80	0.35	0.57	0.109	11.43	0.67	0.56	1.17	0.68
Mtl/HptMpr	13.79	0.95	0.54	4.96	1.62	3.61	0.40	1.26	0.143	12.71	1.27	1.22	1.98	1.36
Mtl/HptSbe-Std-ClrNct	13.81	1.13	0.51	4.34	1.73	7.80	0.30	0.59	0.111	11.47	0.69	0.57	1.18	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct	13.97	1.18	0.64	5.59	1.26	3.02	0.51	1.15	0.137	13.07	1.08	1.11	1.89	1.25
Brk/HptNct-Std-ClrNct	14.03	1.35	0.62	4.92	1.33	7.57	0.40	0.62	0.111	11.76	0.60	0.60	1.10	0.69
Brk/GrnMpr	**14.06**	**0.95**	**0.54**	**5.01**	**1.60**	**4.58**	**0.41**	**1.15**	**0.138**	**12.69**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct	14.09	1.16	0.66	5.99	1.19	1.53	0.58	1.15	0.136	13.63	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	14.13	1.28	0.64	5.32	1.26	6.08	0.47	0.62	0.109	12.30	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	13.71	1.35	0.62	4.92	1.33	6.50	0.40	0.62	0.111	11.76	0.60	0.60	1.10	0.69
Brk/HptNct	13.84	1.18	0.64	5.59	1.26	2.59	0.51	1.15	0.137	13.07	1.08	1.11	1.89	1.25
Brk/GrnMpr	**13.87**	**0.95**	**0.54**	**5.01**	**1.60**	**3.93**	**0.41**	**1.15**	**0.138**	**12.69**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct-Std-ClrNct	13.87	1.28	0.64	5.32	1.26	5.23	0.47	0.62	0.109	12.30	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	13.90	1.39	0.61	4.68	1.39	8.40	0.36	0.49	0.104	11.38	0.51	0.49	1.00	0.59

Table 14 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	15.22	1.15	0.60	5.24	1.39	6.88	0.34	0.59	0.117	12.47	0.69	0.57	1.18	0.68
Mtl/GrnMpr-Std-ClrSue	15.26	1.24	0.55	4.54	1.58	9.06	0.25	0.57	0.118	11.64	0.67	0.56	1.17	0.68
Mtl/HptSbe-Std-ClrNct	15.27	1.13	0.57	4.93	1.50	7.80	0.30	0.59	0.118	12.15	0.69	0.57	1.18	0.68
Mtl/HptMpr	15.33	0.95	0.60	5.76	1.41	3.61	0.40	1.26	0.161	13.89	1.27	1.22	1.98	1.36
Mtl/HptMpr-Std-ClrSue	15.43	1.30	0.54	4.39	1.61	9.98	0.23	0.57	0.118	11.44	0.67	0.56	1.17	0.68
Brk/HptSbe-Std-ClrNct	15.44	1.31	0.57	4.61	1.50	9.75	0.26	0.48	0.111	11.54	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnMpr	**15.71**	**0.95**	**0.60**	**5.83**	**1.39**	**4.58**	**0.41**	**1.15**	**0.154**	**13.88**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnMpr	15.80	0.89	0.60	6.07	1.39	3.60	0.44	1.26	0.160	14.36	1.27	1.22	1.98	1.36
Brk/HptMpr	15.83	1.03	0.60	5.52	1.41	6.06	0.37	1.15	0.154	13.40	1.08	1.11	1.89	1.25
Mtl/HptMpr	15.92	0.95	0.60	5.76	1.41	5.08	0.40	1.26	0.161	13.89	1.27	1.22	1.98	1.36
Brk/HptNct	15.92	1.18	0.68	6.60	1.13	3.02	0.51	1.15	0.152	14.72	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnMpr	**15.45**	**0.95**	**0.60**	**5.83**	**1.39**	**3.93**	**0.41**	**1.15**	**0.154**	**13.88**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/HptMpr	15.48	1.03	0.60	5.52	1.41	5.20	0.37	1.15	0.154	13.40	1.08	1.11	1.89	1.25
Brk/HptNct-Std-ClrNct	15.50	1.35	0.67	5.70	1.18	6.50	0.40	0.62	0.117	12.90	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	15.52	1.26	0.60	5.00	1.39	8.88	0.31	0.48	0.109	11.97	0.49	0.46	0.99	0.57
Brk/HptMpr-Std-ClrNct	15.57	1.21	0.57	4.78	1.50	9.11	0.28	0.62	0.121	11.93	0.60	0.60	1.10	0.69

Table 15 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**9.63**	**1.10**	**0.41**	**2.84**	**2.05**	**0.51**	**0.61**	**1.26**	**0.119**	**9.58**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.76	1.16	0.41	2.82	2.05	2.46	0.58	1.15	0.117	9.52	1.08	1.11	1.89	1.25
Mtl/HptNct	9.79	1.09	0.39	2.77	2.16	1.43	0.55	1.27	0.119	9.65	1.27	1.22	1.98	1.36

Brk/ClrNct	9.80	1.01	0.46	3.05	1.88	1.95	0.79	1.15	0.116	9.61	1.08	1.11	1.89	1.25
Brk/HptNct	9.91	1.18	0.39	2.74	2.16	3.38	0.51	1.15	0.117	9.57	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.98	1.18	0.39	2.78	2.16	4.43	0.51	0.73	0.108	9.53	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**9.64**	**1.10**	**0.41**	**2.84**	**2.05**	**0.56**	**0.61**	**1.26**	**0.119**	**9.58**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.67	1.16	0.41	2.82	2.05	1.53	0.58	1.15	0.117	9.52	1.08	1.11	1.89	1.25
Brk/ClrNct	9.71	1.01	0.46	3.05	1.88	0.98	0.79	1.15	0.116	9.61	1.08	1.11	1.89	1.25
Mtl/HptNct	9.85	1.09	0.39	2.77	2.16	2.04	0.55	1.27	0.119	9.65	1.27	1.22	1.98	1.36
Brk/HptNct	9.87	1.18	0.39	2.74	2.16	3.02	0.51	1.15	0.117	9.57	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**9.63**	**1.10**	**0.41**	**2.84**	**2.05**	**0.48**	**0.61**	**1.26**	**0.119**	**9.58**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.65	1.16	0.41	2.82	2.05	1.31	0.58	1.15	0.117	9.52	1.08	1.11	1.89	1.25
Brk/ClrNct	9.69	1.01	0.46	3.05	1.88	0.83	0.79	1.15	0.116	9.61	1.08	1.11	1.89	1.25
Mtl/HptNct	9.83	1.09	0.39	2.77	2.16	1.76	0.55	1.27	0.119	9.65	1.27	1.22	1.98	1.36
Brk/HptNct	9.83	1.18	0.39	2.74	2.16	2.59	0.51	1.15	0.117	9.57	1.08	1.11	1.89	1.25

Table 16 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**9.85**	**1.10**	**0.59**	**3.39**	**1.44**	**0.51**	**0.61**	**1.26**	**0.143**	**9.75**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	9.98	1.09	0.56	3.25	1.54	1.43	0.55	1.27	0.144	9.70	1.27	1.22	1.98	1.36
Brk/GrnNct	10.12	1.16	0.59	3.34	1.44	2.46	0.58	1.15	0.139	9.63	1.08	1.11	1.89	1.25
Brk/HptNct	10.21	1.18	0.56	3.19	1.54	3.38	0.51	1.15	0.139	9.53	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	10.35	1.18	0.56	3.27	1.54	4.43	0.51	0.73	0.121	9.46	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**9.86**	**1.10**	**0.59**	**3.39**	**1.44**	**0.56**	**0.61**	**1.26**	**0.143**	**9.75**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.93	1.16	0.59	3.34	1.44	1.53	0.58	1.15	0.139	9.63	1.08	1.11	1.89	1.25
Mtl/HptNct	10.10	1.09	0.56	3.25	1.54	2.04	0.55	1.27	0.144	9.70	1.27	1.22	1.98	1.36
Brk/HptNct	10.14	1.18	0.56	3.19	1.54	3.02	0.51	1.15	0.139	9.53	1.08	1.11	1.89	1.25
Brk/ClrNct	10.35	1.01	0.63	3.80	1.31	0.98	0.79	1.15	0.138	10.15	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**9.85**	**1.10**	**0.59**	**3.39**	**1.44**	**0.48**	**0.61**	**1.26**	**0.143**	**9.75**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.89	1.16	0.59	3.34	1.44	1.31	0.58	1.15	0.139	9.63	1.08	1.11	1.89	1.25
Mtl/HptNct	10.05	1.09	0.56	3.25	1.54	1.76	0.55	1.27	0.144	9.70	1.27	1.22	1.98	1.36
Brk/HptNct	10.05	1.18	0.56	3.19	1.54	2.59	0.51	1.15	0.139	9.53	1.08	1.11	1.89	1.25
Brk/ClrNct	10.32	1.01	0.63	3.80	1.31	0.83	0.79	1.15	0.138	10.15	1.08	1.11	1.89	1.25

Table 17 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**10.67**	**1.10**	**0.66**	**3.93**	**1.19**	**0.51**	**0.61**	**1.26**	**0.167**	**10.52**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	10.73	1.09	0.64	3.74	1.26	1.43	0.55	1.27	0.168	10.31	1.27	1.22	1.98	1.36
Brk/GrnNct	11.07	1.16	0.66	3.87	1.19	2.46	0.58	1.15	0.160	10.33	1.08	1.11	1.89	1.25
Brk/HptNct	11.07	1.18	0.64	3.64	1.26	3.38	0.51	1.15	0.161	10.06	1.08	1.11	1.89	1.25
Mtl/GrnMpr	11.09	0.89	0.54	3.38	1.60	2.69	0.44	1.26	0.168	10.28	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**10.69**	**1.10**	**0.66**	**3.93**	**1.19**	**0.56**	**0.61**	**1.26**	**0.167**	**10.52**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.79	1.16	0.66	3.87	1.19	1.53	0.58	1.15	0.160	10.33	1.08	1.11	1.89	1.25
Mtl/HptNct	10.92	1.09	0.64	3.74	1.26	2.04	0.55	1.27	0.168	10.31	1.27	1.22	1.98	1.36
Brk/HptNct	10.96	1.18	0.64	3.64	1.26	3.02	0.51	1.15	0.161	10.06	1.08	1.11	1.89	1.25
Mtl/GrnMpr	11.36	0.89	0.54	3.38	1.60	3.60	0.44	1.26	0.168	10.28	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**10.66**	**1.10**	**0.66**	**3.93**	**1.19**	**0.48**	**0.61**	**1.26**	**0.167**	**10.52**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.72	1.16	0.66	3.87	1.19	1.31	0.58	1.15	0.160	10.33	1.08	1.11	1.89	1.25
Mtl/HptNct	10.83	1.09	0.64	3.74	1.26	1.76	0.55	1.27	0.168	10.31	1.27	1.22	1.98	1.36
Brk/HptNct	10.84	1.18	0.64	3.64	1.26	2.59	0.51	1.15	0.161	10.06	1.08	1.11	1.89	1.25
Mtl/GrnMpr	11.21	0.89	0.54	3.38	1.60	3.09	0.44	1.26	0.168	10.28	1.27	1.22	1.98	1.36

Table 18 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**11.74**	**1.10**	**0.69**	**4.48**	**1.08**	**0.51**	**0.61**	**1.26**	**0.191**	**11.53**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	11.74	1.09	0.68	4.22	1.13	1.43	0.55	1.27	0.192	11.17	1.27	1.22	1.98	1.36
Mtl/GrnMpr	11.89	0.89	0.60	3.74	1.39	2.69	0.44	1.26	0.192	10.81	1.27	1.22	1.98	1.36
Mtl/HptMpr	12.00	0.95	0.60	3.57	1.41	3.61	0.40	1.26	0.192	10.56	1.27	1.22	1.98	1.36
Brk/HptNct	12.20	1.18	0.68	4.09	1.13	3.38	0.51	1.15	0.183	10.84	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**11.76**	**1.10**	**0.69**	**4.48**	**1.08**	**0.56**	**0.61**	**1.26**	**0.191**	**11.53**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	11.89	1.16	0.69	4.39	1.08	1.53	0.58	1.15	0.182	11.28	1.08	1.11	1.89	1.25
Mtl/HptNct	11.99	1.09	0.68	4.22	1.13	2.04	0.55	1.27	0.192	11.17	1.27	1.22	1.98	1.36
Brk/HptNct	12.05	1.18	0.68	4.09	1.13	3.02	0.51	1.15	0.183	10.84	1.08	1.11	1.89	1.25
Mtl/GrnMpr	12.25	0.89	0.60	3.74	1.39	3.60	0.44	1.26	0.192	10.81	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**11.72**	**1.10**	**0.69**	**4.48**	**1.08**	**0.48**	**0.61**	**1.26**	**0.191**	**11.53**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	11.80	1.16	0.69	4.39	1.08	1.31	0.58	1.15	0.182	11.28	1.08	1.11	1.89	1.25
Mtl/HptNct	11.87	1.09	0.68	4.22	1.13	1.76	0.55	1.27	0.192	11.17	1.27	1.22	1.98	1.36
Brk/HptNct	11.88	1.18	0.68	4.09	1.13	2.59	0.51	1.15	0.183	10.84	1.08	1.11	1.89	1.25

North Coast

Table 19 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**9.87**	**1.10**	**0.41**	**2.62**	**2.05**	**0.51**	**0.61**	**1.26**	**0.172**	**9.81**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.94	1.16	0.41	2.57	2.05	2.46	0.58	1.15	0.169	9.70	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.97	1.18	0.39	2.45	2.16	4.43	0.51	0.73	0.156	9.53	0.81	0.72	1.31	0.80
Mtl/HptNct	9.99	1.09	0.39	2.53	2.16	1.43	0.55	1.27	0.173	9.85	1.27	1.22	1.98	1.36
Mtl/ClrNct-Std-ClrSue	10.00	1.27	0.39	2.42	2.13	6.37	0.49	0.57	0.150	9.36	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	9.85	1.16	0.41	2.57	2.05	1.53	0.58	1.15	0.169	9.70	1.08	1.11	1.89	1.25
Mtl/GrnNct	**9.87**	**1.10**	**0.41**	**2.62**	**2.05**	**0.56**	**0.61**	**1.26**	**0.172**	**9.81**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	9.99	1.28	0.39	2.39	2.16	6.08	0.47	0.62	0.152	9.39	0.60	0.60	1.10	0.69
Brk/HptNct	10.00	1.18	0.39	2.47	2.16	3.02	0.51	1.15	0.169	9.70	1.08	1.11	1.89	1.25
Brk/ClrNct	10.02	1.01	0.46	2.88	1.88	0.98	0.79	1.15	0.168	9.92	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	9.83	1.16	0.41	2.57	2.05	1.31	0.58	1.15	0.169	9.70	1.08	1.11	1.89	1.25
Mtl/GrnNct	**9.86**	**1.10**	**0.41**	**2.62**	**2.05**	**0.48**	**0.61**	**1.26**	**0.172**	**9.81**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	9.91	1.28	0.39	2.39	2.16	5.23	0.47	0.62	0.152	9.39	0.60	0.60	1.10	0.69
Brk/HptNct	9.96	1.18	0.39	2.47	2.16	2.59	0.51	1.15	0.169	9.70	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.97	1.18	0.39	2.45	2.16	4.39	0.51	0.73	0.156	9.53	0.81	0.72	1.31	0.80

Table 20 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**10.85**	**1.10**	**0.59**	**3.56**	**1.44**	**0.51**	**0.61**	**1.26**	**0.204**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnNct-Std-ClrSue	10.86	1.33	0.52	2.87	1.67	6.87	0.39	0.57	0.163	9.49	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrNct	10.87	1.18	0.56	3.23	1.54	4.43	0.51	0.73	0.172	9.98	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrNct	10.88	1.23	0.53	3.03	1.64	5.36	0.44	0.73	0.173	9.81	0.81	0.72	1.31	0.80
Mtl/HptNct	10.90	1.09	0.56	3.38	1.54	1.43	0.55	1.27	0.205	10.62	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	10.82	1.16	0.59	3.47	1.44	1.53	0.58	1.15	0.198	10.51	1.08	1.11	1.89	1.25
Mtl/GrnNct	**10.86**	**1.10**	**0.59**	**3.56**	**1.44**	**0.56**	**0.61**	**1.26**	**0.204**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	10.91	1.28	0.56	3.11	1.54	6.08	0.47	0.62	0.165	9.69	0.60	0.60	1.10	0.69
Brk/HptNct	10.93	1.18	0.56	3.26	1.54	3.02	0.51	1.15	0.198	10.33	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	11.01	1.18	0.56	3.23	1.54	5.11	0.51	0.73	0.172	9.98	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	10.74	1.28	0.56	3.11	1.54	5.23	0.47	0.62	0.165	9.69	0.60	0.60	1.10	0.69
Brk/GrnNct	10.77	1.16	0.59	3.47	1.44	1.31	0.58	1.15	0.198	10.51	1.08	1.11	1.89	1.25
Brk/HptNct-Std-ClrNct	10.82	1.35	0.53	2.90	1.64	6.50	0.40	0.62	0.166	9.52	0.60	0.60	1.10	0.69
Mtl/GrnNct	**10.84**	**1.10**	**0.59**	**3.56**	**1.44**	**0.48**	**0.61**	**1.26**	**0.204**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/HptNct	10.85	1.18	0.56	3.26	1.54	2.59	0.51	1.15	0.198	10.33	1.08	1.11	1.89	1.25

Table 21 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	**12.16**	**1.33**	**0.61**	**3.47**	**1.36**	**6.87**	**0.39**	**0.57**	**0.175**	**10.10**	**0.67**	**0.56**	**1.17**	**0.68**
Mtl/HptNct-Std-ClrPye	12.18	1.28	0.61	3.47	1.39	6.66	0.39	0.60	0.178	10.19	0.71	0.60	1.20	0.70

Mtl/HptNct-Std-ClrNct	12.23	1.23	0.62	3.70	1.33	5.36	0.44	0.73	0.190	10.62	0.81	0.72	1.31	0.80
Mtl/GrnSbe-Std-ClrNct	12.24	1.15	0.54	3.24	1.60	6.88	0.34	0.59	0.178	10.17	0.69	0.57	1.18	0.68
Mtl/HptNct-Std-ClrSue	12.28	1.34	0.59	3.29	1.44	7.80	0.35	0.57	0.176	9.94	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	12.38	1.16	0.66	4.36	1.19	1.53	0.58	1.15	0.227	11.92	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.39	1.28	0.64	3.83	1.26	6.08	0.47	0.62	0.177	10.57	0.60	0.60	1.10	0.69
Brk/HptNct	12.42	1.18	0.64	4.05	1.26	3.02	0.51	1.15	0.228	11.52	1.08	1.11	1.89	1.25
Mtl/GrnNct	12.44	1.10	0.66	4.51	1.19	0.56	0.61	1.26	0.236	12.27	1.27	1.22	1.98	1.36
Brk/HptNct-Std-ClrNct	12.46	1.35	0.62	3.51	1.33	7.57	0.40	0.62	0.180	10.19	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	12.13	1.28	0.64	3.83	1.26	5.23	0.47	0.62	0.177	10.57	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	12.14	1.35	0.62	3.51	1.33	6.50	0.40	0.62	0.180	10.19	0.60	0.60	1.10	0.69
Brk/HptNct	12.29	1.18	0.64	4.05	1.26	2.59	0.51	1.15	0.228	11.52	1.08	1.11	1.89	1.25
Brk/GrnNct	12.31	1.16	0.66	4.36	1.19	1.31	0.58	1.15	0.227	11.92	1.08	1.11	1.89	1.25
Mtl/HptNct-Std-ClrNct	12.32	1.23	0.62	3.70	1.33	5.67	0.44	0.73	0.190	10.62	0.81	0.72	1.31	0.80

Table 22 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	**13.59**	**1.15**	**0.60**	**3.77**	**1.39**	**6.88**	**0.34**	**0.59**	**0.191**	**10.84**	**0.69**	**0.57**	**1.18**	**0.68**
Mtl/GrnNct-Std-ClrSue	13.71	1.33	0.66	4.06	1.20	6.87	0.39	0.57	0.186	10.96	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	13.72	1.28	0.65	4.07	1.22	6.66	0.39	0.60	0.190	11.05	0.71	0.60	1.20	0.70
Mtl/HptSbe-Std-ClrNct	13.77	1.13	0.57	3.53	1.50	7.80	0.30	0.59	0.193	10.65	0.69	0.57	1.18	0.68
Mtl/HptNct-Std-ClrSue	13.80	1.34	0.64	3.82	1.26	7.80	0.35	0.57	0.188	10.68	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	14.13	1.28	0.68	4.55	1.13	6.08	0.47	0.62	0.190	11.70	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	14.14	1.35	0.67	4.13	1.18	7.57	0.40	0.62	0.193	11.11	0.60	0.60	1.10	0.69
Brk/HptNct	14.17	1.18	0.68	4.84	1.13	3.02	0.51	1.15	0.257	12.97	1.08	1.11	1.89	1.25
Brk/GrnNct	14.19	1.16	0.69	5.26	1.08	1.53	0.58	1.15	0.255	13.58	1.08	1.11	1.89	1.25
Brk/GrnMpr	14.26	0.95	0.60	4.25	1.39	4.58	0.41	1.15	0.259	12.43	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	13.71	1.35	0.67	4.13	1.18	6.50	0.40	0.62	0.193	11.11	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	13.79	1.28	0.68	4.55	1.13	5.23	0.47	0.62	0.190	11.70	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	13.91	1.26	0.60	3.58	1.39	8.88	0.31	0.48	0.177	10.36	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrPye	13.93	1.39	0.65	3.88	1.22	8.40	0.36	0.49	0.176	10.57	0.51	0.49	1.00	0.59
Mtl/HptNct-Std-ClrNct	13.95	1.23	0.67	4.38	1.18	5.67	0.44	0.73	0.206	11.69	0.81	0.72	1.31	0.80

Table 23 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.64**	**1.10**	**0.41**	**1.79**	**2.05**	**0.51**	**0.61**	**1.26**	**0.187**	**8.59**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct	8.69	1.01	0.46	1.94	1.88	1.95	0.79	1.15	0.182	8.49	1.08	1.11	1.89	1.25
Brk/GrnNct	8.77	1.16	0.41	1.78	2.05	2.46	0.58	1.15	0.183	8.52	1.08	1.11	1.89	1.25
Mtl/HptNct	8.84	1.09	0.39	1.74	2.16	1.43	0.55	1.27	0.187	8.69	1.27	1.22	1.98	1.36
Mtl/ClrNct-Std-ClrNct	8.86	0.99	0.43	1.91	2.00	3.93	0.72	0.73	0.166	8.47	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	8.59	1.01	0.46	1.94	1.88	0.98	0.79	1.15	0.182	8.49	1.08	1.11	1.89	1.25
Mtl/GrnNct	**8.65**	**1.10**	**0.41**	**1.79**	**2.05**	**0.56**	**0.61**	**1.26**	**0.187**	**8.59**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.67	1.16	0.41	1.78	2.05	1.53	0.58	1.15	0.183	8.52	1.08	1.11	1.89	1.25
Mtl/HptNct	8.90	1.09	0.39	1.74	2.16	2.04	0.55	1.27	0.187	8.69	1.27	1.22	1.98	1.36

Brk/HptNct	8.91	1.18	0.39	1.72	2.16	3.02	0.51	1.15	0.183	8.61	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	8.58	1.01	0.46	1.94	1.88	0.83	0.79	1.15	0.182	8.49	1.08	1.11	1.89	1.25
Mtl/GrnNct	**8.64**	**1.10**	**0.41**	**1.79**	**2.05**	**0.48**	**0.61**	**1.26**	**0.187**	**8.59**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.65	1.16	0.41	1.78	2.05	1.31	0.58	1.15	0.183	8.52	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	8.86	1.04	0.43	1.89	2.00	4.75	0.68	0.62	0.162	8.38	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrNct	8.86	0.99	0.43	1.91	2.00	3.91	0.72	0.73	0.166	8.47	0.81	0.72	1.31	0.80

Table 24 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.78**	**1.10**	**0.59**	**2.17**	**1.44**	**0.51**	**0.61**	**1.26**	**0.228**	**8.67**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	8.98	1.09	0.56	2.07	1.54	1.43	0.55	1.27	0.229	8.69	1.27	1.22	1.98	1.36
Brk/GrnNct	9.03	1.16	0.59	2.14	1.44	2.46	0.58	1.15	0.220	8.53	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.15	1.18	0.56	2.09	1.54	4.43	0.51	0.73	0.190	8.27	0.81	0.72	1.31	0.80
Brk/HptNct	9.20	1.18	0.56	2.03	1.54	3.38	0.51	1.15	0.221	8.52	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**8.79**	**1.10**	**0.59**	**2.17**	**1.44**	**0.56**	**0.61**	**1.26**	**0.228**	**8.67**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.84	1.16	0.59	2.14	1.44	1.53	0.58	1.15	0.220	8.53	1.08	1.11	1.89	1.25
Brk/ClrNct	9.02	1.01	0.63	2.46	1.31	0.98	0.79	1.15	0.219	8.83	1.08	1.11	1.89	1.25
Mtl/HptNct	9.10	1.09	0.56	2.07	1.54	2.04	0.55	1.27	0.229	8.69	1.27	1.22	1.98	1.36
Brk/HptNct	9.12	1.18	0.56	2.03	1.54	3.02	0.51	1.15	0.221	8.52	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**8.77**	**1.10**	**0.59**	**2.17**	**1.44**	**0.48**	**0.61**	**1.26**	**0.228**	**8.67**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.80	1.16	0.59	2.14	1.44	1.31	0.58	1.15	0.220	8.53	1.08	1.11	1.89	1.25
Brk/ClrNct	8.99	1.01	0.63	2.46	1.31	0.83	0.79	1.15	0.219	8.83	1.08	1.11	1.89	1.25
Brk/HptNct	9.04	1.18	0.56	2.03	1.54	2.59	0.51	1.15	0.221	8.52	1.08	1.11	1.89	1.25
Mtl/HptNct	9.04	1.09	0.56	2.07	1.54	1.76	0.55	1.27	0.229	8.69	1.27	1.22	1.98	1.36

Table 25 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**9.51**	**1.10**	**0.66**	**2.54**	**1.19**	**0.51**	**0.61**	**1.26**	**0.270**	**9.35**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	9.68	1.09	0.64	2.40	1.26	1.43	0.55	1.27	0.271	9.25	1.27	1.22	1.98	1.36
Brk/GrnNct	9.88	1.16	0.66	2.50	1.19	2.46	0.58	1.15	0.258	9.14	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.94	1.18	0.64	2.43	1.26	4.43	0.51	0.73	0.212	8.61	0.81	0.72	1.31	0.80
Brk/HptNct	10.01	1.18	0.64	2.34	1.26	3.38	0.51	1.15	0.259	8.99	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**9.52**	**1.10**	**0.66**	**2.54**	**1.19**	**0.56**	**0.61**	**1.26**	**0.270**	**9.35**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.60	1.16	0.66	2.50	1.19	1.53	0.58	1.15	0.258	9.14	1.08	1.11	1.89	1.25
Mtl/HptNct	9.86	1.09	0.64	2.40	1.26	2.04	0.55	1.27	0.271	9.25	1.27	1.22	1.98	1.36
Brk/HptNct	9.90	1.18	0.64	2.34	1.26	3.02	0.51	1.15	0.259	8.99	1.08	1.11	1.89	1.25
Brk/ClrNct	10.08	1.01	0.69	2.98	1.10	0.98	0.79	1.15	0.256	9.79	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**9.50**	**1.10**	**0.66**	**2.54**	**1.19**	**0.48**	**0.61**	**1.26**	**0.270**	**9.35**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.54	1.16	0.66	2.50	1.19	1.31	0.58	1.15	0.258	9.14	1.08	1.11	1.89	1.25
Brk/HptNct	9.77	1.18	0.64	2.34	1.26	2.59	0.51	1.15	0.259	8.99	1.08	1.11	1.89	1.25
Mtl/HptNct	9.78	1.09	0.64	2.40	1.26	1.76	0.55	1.27	0.271	9.25	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrNct	9.93	1.28	0.64	2.36	1.26	5.23	0.47	0.62	0.200	8.36	0.60	0.60	1.10	0.69

Table 26 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**10.49**	**1.10**	**0.69**	**2.92**	**1.08**	**0.51**	**0.61**	**1.26**	**0.311**	**10.28**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	10.64	1.09	0.68	2.73	1.13	1.43	0.55	1.27	0.314	10.07	1.27	1.22	1.98	1.36
Brk/GrnNct	10.99	1.16	0.69	2.86	1.08	2.46	0.58	1.15	0.296	10.00	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	10.99	1.18	0.68	2.77	1.13	4.43	0.51	0.73	0.234	9.22	0.81	0.72	1.31	0.80
Mtl/GrnMpr	11.02	0.89	0.60	2.40	1.39	2.69	0.44	1.26	0.314	9.94	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**10.51**	**1.10**	**0.69**	**2.92**	**1.08**	**0.56**	**0.61**	**1.26**	**0.311**	**10.28**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.62	1.16	0.69	2.86	1.08	1.53	0.58	1.15	0.296	10.00	1.08	1.11	1.89	1.25
Mtl/HptNct	10.88	1.09	0.68	2.73	1.13	2.04	0.55	1.27	0.314	10.07	1.27	1.22	1.98	1.36
Brk/HptNct	10.93	1.18	0.68	2.65	1.13	3.02	0.51	1.15	0.297	9.73	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	11.26	1.18	0.68	2.77	1.13	5.11	0.51	0.73	0.234	9.22	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**10.47**	**1.10**	**0.69**	**2.92**	**1.08**	**0.48**	**0.61**	**1.26**	**0.311**	**10.28**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.53	1.16	0.69	2.86	1.08	1.31	0.58	1.15	0.296	10.00	1.08	1.11	1.89	1.25
Brk/HptNct	10.76	1.18	0.68	2.65	1.13	2.59	0.51	1.15	0.297	9.73	1.08	1.11	1.89	1.25
Mtl/HptNct	10.77	1.09	0.68	2.73	1.13	1.76	0.55	1.27	0.314	10.07	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrNct	10.97	1.28	0.68	2.68	1.13	5.23	0.47	0.62	0.218	8.88	0.60	0.60	1.10	0.69

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Table 27 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	12.59	1.35	0.39	3.83	2.13	8.32	0.46	0.46	0.154	11.76	0.47	0.45	0.98	0.56
Mtl/ClrNct-Std-ClrSue	12.60	1.27	0.39	3.92	2.13	6.37	0.49	0.57	0.158	11.96	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	12.61	1.44	0.35	3.64	2.29	8.82	0.36	0.46	0.155	11.73	0.47	0.45	0.98	0.56
Mtl/GrnNct-Std-ClrSue	12.61	1.33	0.35	3.73	2.29	6.87	0.39	0.57	0.159	11.93	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrNct	**12.64**	**1.28**	**0.39**	**3.89**	**2.16**	**6.38**	**0.47**	**0.62**	**0.160**	**12.00**	**0.60**	**0.60**	**1.10**	**0.69**
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**12.61**	**1.28**	**0.39**	**3.89**	**2.16**	**6.08**	**0.47**	**0.62**	**0.160**	**12.00**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Ins-ClrNct	12.68	1.28	0.39	3.88	2.16	7.12	0.47	0.59	0.159	11.97	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrPye	12.69	1.28	0.36	3.78	2.24	7.98	0.43	0.49	0.155	11.89	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	12.70	1.35	0.36	3.76	2.26	7.57	0.40	0.62	0.161	11.95	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrPye	12.72	1.31	0.36	3.75	2.24	9.02	0.42	0.45	0.154	11.82	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**12.52**	**1.28**	**0.39**	**3.89**	**2.16**	**5.23**	**0.47**	**0.62**	**0.160**	**12.00**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Ins-ClrNct	12.60	1.28	0.39	3.88	2.16	6.27	0.47	0.59	0.159	11.97	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrNct	12.60	1.35	0.36	3.76	2.26	6.50	0.40	0.62	0.161	11.95	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	12.60	1.28	0.36	3.78	2.24	7.12	0.43	0.49	0.155	11.89	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrSue	12.60	1.35	0.39	3.83	2.13	8.40	0.46	0.46	0.154	11.76	0.47	0.45	0.98	0.56

Table 28 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**13.94**	**1.44**	**0.52**	**4.46**	**1.67**	**8.82**	**0.36**	**0.46**	**0.164**	**12.17**	**0.47**	**0.45**	**0.98**	**0.56**
Mtl/GrnNct-Std-ClrSue	13.94	1.33	0.52	4.64	1.67	6.87	0.39	0.57	0.172	12.56	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	14.01	1.28	0.51	4.65	1.71	6.66	0.39	0.60	0.174	12.68	0.71	0.60	1.20	0.70
Brk/HptNct-Std-ClrPye	14.01	1.39	0.51	4.47	1.71	8.61	0.36	0.49	0.167	12.29	0.51	0.49	1.00	0.59
Mtl/HptNct-Std-ClrSue	14.04	1.34	0.50	4.48	1.77	7.80	0.35	0.57	0.173	12.48	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	14.14	1.28	0.56	4.97	1.54	6.08	0.47	0.62	0.174	12.92	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	14.16	1.28	0.54	4.74	1.62	7.98	0.43	0.49	0.165	12.57	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	14.17	1.35	0.53	4.70	1.64	7.57	0.40	0.62	0.176	12.66	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	**14.18**	**1.39**	**0.51**	**4.47**	**1.71**	**9.46**	**0.36**	**0.49**	**0.167**	**12.29**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Ins-ClrPye	14.23	1.31	0.54	4.68	1.62	9.02	0.42	0.45	0.162	12.43	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**13.95**	**1.44**	**0.52**	**4.46**	**1.67**	**8.88**	**0.36**	**0.46**	**0.164**	**12.17**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrNct	13.96	1.35	0.53	4.70	1.64	6.50	0.40	0.62	0.176	12.66	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	13.97	1.28	0.56	4.97	1.54	5.23	0.47	0.62	0.174	12.92	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	13.97	1.39	0.51	4.47	1.71	8.40	0.36	0.49	0.167	12.29	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	13.99	1.28	0.54	4.74	1.62	7.12	0.43	0.49	0.165	12.57	0.51	0.49	1.00	0.59

Table 29 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**15.77**	**1.44**	**0.61**	**5.28**	**1.36**	**8.82**	**0.36**	**0.46**	**0.173**	**13.12**	**0.47**	**0.45**	**0.98**	**0.56**
Mtl/GrnNct-Std-ClrSue	15.77	1.33	0.61	5.54	1.36	6.87	0.39	0.57	0.185	13.71	0.67	0.56	1.17	0.68
Mtl/GrnSbe-Std-ClrNct	15.78	1.15	0.54	5.28	1.60	6.88	0.34	0.59	0.189	13.71	0.69	0.57	1.18	0.68
Brk/GrnSbe-Std-ClrNct	15.78	1.26	0.54	5.01	1.60	8.83	0.31	0.48	0.178	13.13	0.49	0.46	0.99	0.57
Mtl/HptNct-Std-ClrSue	15.81	1.34	0.59	5.32	1.44	7.80	0.35	0.57	0.186	13.47	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrPye	**16.10**	**1.39**	**0.61**	**5.30**	**1.39**	**9.46**	**0.36**	**0.49**	**0.177**	**13.26**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Std-ClrNct	16.16	1.35	0.62	5.65	1.33	7.57	0.40	0.62	0.190	13.89	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	16.17	1.28	0.63	5.70	1.31	7.98	0.43	0.49	0.174	13.78	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	16.21	1.43	0.61	5.21	1.39	10.50	0.35	0.45	0.173	13.05	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	16.22	1.44	0.61	5.28	1.36	10.34	0.36	0.46	0.173	13.12	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrPye	**15.78**	**1.39**	**0.61**	**5.30**	**1.39**	**8.40**	**0.36**	**0.49**	**0.177**	**13.26**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrSue	15.79	1.44	0.61	5.28	1.36	8.88	0.36	0.46	0.173	13.12	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	15.80	1.26	0.54	5.01	1.60	8.88	0.31	0.48	0.178	13.13	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrNct	15.84	1.35	0.62	5.65	1.33	6.50	0.40	0.62	0.190	13.89	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrPye	15.89	1.43	0.61	5.21	1.39	9.44	0.35	0.45	0.173	13.05	0.48	0.46	0.97	0.56

Table 30 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptSbe-Std-ClrNct	17.61	1.31	0.57	5.36	1.50	9.75	0.26	0.48	0.191	13.71	0.49	0.46	0.99	0.57
Mtl/GrnSbe-Std-ClrNct	17.65	1.15	0.60	6.10	1.39	6.88	0.34	0.59	0.203	14.90	0.69	0.57	1.18	0.68
Brk/GrnSbe-Std-ClrNct	**17.66**	**1.26**	**0.60**	**5.74**	**1.39**	**8.83**	**0.31**	**0.48**	**0.188**	**14.12**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/GrnMpr-Std-ClrSue	17.67	1.24	0.55	5.39	1.58	9.06	0.25	0.57	0.204	14.05	0.67	0.56	1.17	0.68
Brk/GrnMpr-Std-ClrSue	17.69	1.41	0.55	5.03	1.58	11.01	0.22	0.46	0.190	13.28	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**18.26**	**1.26**	**0.60**	**5.74**	**1.39**	**10.34**	**0.31**	**0.48**	**0.188**	**14.12**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptNct-Std-ClrPye	18.27	1.39	0.65	6.13	1.22	9.46	0.36	0.49	0.187	14.49	0.51	0.49	1.00	0.59
Brk/GrnSbe-Ins-ClrNct	18.40	1.30	0.60	5.62	1.39	11.38	0.30	0.44	0.182	13.85	0.46	0.43	0.96	0.54
Brk/HptNct-Ins-ClrPye	18.41	1.43	0.65	6.01	1.22	10.50	0.35	0.45	0.181	14.21	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrNct	18.41	1.35	0.67	6.59	1.18	7.57	0.40	0.62	0.205	15.39	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**17.68**	**1.26**	**0.60**	**5.74**	**1.39**	**8.88**	**0.31**	**0.48**	**0.188**	**14.12**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptSbe-Std-ClrNct	17.77	1.31	0.57	5.36	1.50	10.15	0.26	0.48	0.191	13.71	0.49	0.46	0.99	0.57
Brk/GrnSbe-Ins-ClrNct	17.82	1.30	0.60	5.62	1.39	9.92	0.30	0.44	0.182	13.85	0.46	0.43	0.96	0.54
Brk/HptNct-Std-ClrPye	17.85	1.39	0.65	6.13	1.22	8.40	0.36	0.49	0.187	14.49	0.51	0.49	1.00	0.59
Brk/GrnMpr-Std-ClrSue	17.88	1.41	0.55	5.03	1.58	11.49	0.22	0.46	0.190	13.28	0.47	0.45	0.98	0.56

Table 31 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**11.26**	**1.10**	**0.41**	**3.26**	**2.05**	**0.51**	**0.61**	**1.26**	**0.199**	**11.21**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnNct-Std-ClrNct	11.32	1.18	0.39	3.11	2.16	4.43	0.51	0.73	0.177	10.88	0.81	0.72	1.31	0.80
Mtl/ClrNct-Std-ClrSue	11.33	1.27	0.39	3.07	2.13	6.37	0.49	0.57	0.170	10.69	0.67	0.56	1.17	0.68
Brk/GrnNct	11.33	1.16	0.41	3.22	2.05	2.46	0.58	1.15	0.195	11.09	1.08	1.11	1.89	1.25
Brk/ClrNct	11.35	1.01	0.46	3.44	1.88	1.95	0.79	1.15	0.194	11.16	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	11.24	1.16	0.41	3.22	2.05	1.53	0.58	1.15	0.195	11.09	1.08	1.11	1.89	1.25
Brk/ClrNct	11.26	1.01	0.46	3.44	1.88	0.98	0.79	1.15	0.194	11.16	1.08	1.11	1.89	1.25
Mtl/GrnNct	**11.26**	**1.10**	**0.41**	**3.26**	**2.05**	**0.56**	**0.61**	**1.26**	**0.199**	**11.21**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	11.35	1.28	0.39	3.06	2.16	6.08	0.47	0.62	0.173	10.74	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	11.37	1.04	0.43	3.28	2.00	5.53	0.68	0.62	0.171	10.82	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	11.22	1.16	0.41	3.22	2.05	1.31	0.58	1.15	0.195	11.09	1.08	1.11	1.89	1.25
Brk/ClrNct	11.24	1.01	0.46	3.44	1.88	0.83	0.79	1.15	0.194	11.16	1.08	1.11	1.89	1.25
Mtl/GrnNct	**11.26**	**1.10**	**0.41**	**3.26**	**2.05**	**0.48**	**0.61**	**1.26**	**0.199**	**11.21**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	11.26	1.28	0.39	3.06	2.16	5.23	0.47	0.62	0.173	10.74	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	11.30	1.04	0.43	3.28	2.00	4.75	0.68	0.62	0.171	10.82	0.60	0.60	1.10	0.69

Table 32 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrNct	**12.02**	**1.18**	**0.56**	**3.71**	**1.54**	**4.43**	**0.51**	**0.73**	**0.203**	**11.14**	**0.81**	**0.72**	**1.31**	**0.80**
Mtl/GrnNct-Std-ClrPye	12.08	1.20	0.54	3.58	1.62	5.73	0.46	0.60	0.192	10.93	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrSue	12.09	1.27	0.57	3.64	1.51	6.37	0.49	0.57	0.189	10.81	0.67	0.56	1.17	0.68
Mtl/GrnNct	12.09	1.10	0.59	4.02	1.44	0.51	0.61	1.26	0.246	11.99	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrSue	12.12	1.33	0.52	3.43	1.67	6.87	0.39	0.57	0.190	10.75	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	12.06	1.16	0.59	3.94	1.44	1.53	0.58	1.15	0.237	11.75	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.08	1.28	0.56	3.61	1.54	6.08	0.47	0.62	0.194	10.86	0.60	0.60	1.10	0.69
Mtl/GrnNct	12.10	1.10	0.59	4.02	1.44	0.56	0.61	1.26	0.246	11.99	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrNct	**12.16**	**1.18**	**0.56**	**3.71**	**1.54**	**5.11**	**0.51**	**0.73**	**0.203**	**11.14**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/GrnNct-Ins-ClrNct	12.24	1.28	0.56	3.60	1.54	7.12	0.47	0.59	0.191	10.82	0.57	0.57	1.07	0.66
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.91	1.28	0.56	3.61	1.54	5.23	0.47	0.62	0.194	10.86	0.60	0.60	1.10	0.69
Brk/GrnNct	12.01	1.16	0.59	3.94	1.44	1.31	0.58	1.15	0.237	11.75	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	**12.02**	**1.18**	**0.56**	**3.71**	**1.54**	**4.39**	**0.51**	**0.73**	**0.203**	**11.14**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/GrnNct-Ins-ClrNct	12.07	1.28	0.56	3.60	1.54	6.27	0.47	0.59	0.191	10.82	0.57	0.57	1.07	0.66
Mtl/GrnNct	12.09	1.10	0.59	4.02	1.44	0.48	0.61	1.26	0.246	11.99	1.27	1.22	1.98	1.36

Table 33 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrPye	13.27	1.20	0.63	4.12	1.31	5.73	0.46	0.60	0.212	11.55	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrSue	13.27	1.33	0.61	3.89	1.36	6.87	0.39	0.57	0.210	11.21	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrNct	13.29	1.18	0.64	4.31	1.26	4.43	0.51	0.73	0.228	11.96	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrPye	13.32	1.28	0.61	3.90	1.39	6.66	0.39	0.60	0.214	11.32	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrNct	13.34	1.23	0.62	4.09	1.33	5.36	0.44	0.73	0.229	11.73	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**13.37**	**1.28**	**0.64**	**4.16**	**1.26**	**6.08**	**0.47**	**0.62**	**0.215**	**11.54**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct	13.47	1.16	0.66	4.65	1.19	1.53	0.58	1.15	0.280	13.01	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	13.49	1.18	0.64	4.31	1.26	5.11	0.51	0.73	0.228	11.96	0.81	0.72	1.31	0.80
Mtl/GrnNct	13.53	1.10	0.66	4.77	1.19	0.56	0.61	1.26	0.293	13.37	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrPye	13.57	1.28	0.63	3.99	1.31	7.98	0.43	0.49	0.198	11.18	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**13.11**	**1.28**	**0.64**	**4.16**	**1.26**	**5.23**	**0.47**	**0.62**	**0.215**	**11.54**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrNct	13.26	1.35	0.62	3.94	1.33	6.50	0.40	0.62	0.216	11.31	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	13.28	1.18	0.64	4.31	1.26	4.39	0.51	0.73	0.228	11.96	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	13.32	1.28	0.63	3.99	1.31	7.12	0.43	0.49	0.198	11.18	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	13.36	1.28	0.64	4.15	1.26	6.27	0.47	0.59	0.211	11.48	0.57	0.57	1.07	0.66

Table 34 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	14.68	1.33	0.66	4.35	1.20	6.87	0.39	0.57	0.229	11.94	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	14.72	1.28	0.65	4.36	1.22	6.66	0.39	0.60	0.234	12.05	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrPye	14.73	1.20	0.67	4.65	1.17	5.73	0.46	0.60	0.232	12.43	0.71	0.60	1.20	0.70
Mtl/GrnSbe-Std-ClrNct	14.73	1.15	0.60	4.15	1.39	6.88	0.34	0.59	0.234	11.98	0.69	0.57	1.18	0.68
Mtl/HptNct-Std-ClrNct	14.80	1.23	0.67	4.62	1.18	5.36	0.44	0.73	0.255	12.65	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**14.92**	**1.28**	**0.68**	**4.70**	**1.13**	**6.08**	**0.47**	**0.62**	**0.235**	**12.48**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/GrnNct-Std-ClrNct	15.09	1.18	0.68	4.91	1.13	5.11	0.51	0.73	0.254	13.04	0.81	0.72	1.31	0.80
Brk/GrnNct	15.12	1.16	0.69	5.36	1.08	1.53	0.58	1.15	0.322	14.51	1.08	1.11	1.89	1.25
Brk/HptNct-Std-ClrNct	15.13	1.35	0.67	4.41	1.18	7.57	0.40	0.62	0.237	12.10	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	15.13	1.28	0.67	4.49	1.17	7.98	0.43	0.49	0.213	11.94	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**14.58**	**1.28**	**0.68**	**4.70**	**1.13**	**5.23**	**0.47**	**0.62**	**0.235**	**12.48**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrNct	14.70	1.35	0.67	4.41	1.18	6.50	0.40	0.62	0.237	12.10	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	14.79	1.28	0.67	4.49	1.17	7.12	0.43	0.49	0.213	11.94	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	14.80	1.18	0.68	4.91	1.13	4.39	0.51	0.73	0.254	13.04	0.81	0.72	1.31	0.80
Brk/GrnNct-Ins-ClrNct	14.91	1.28	0.68	4.69	1.13	6.27	0.47	0.59	0.230	12.40	0.57	0.57	1.07	0.66

Desert

Table 35 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**13.74**	**1.35**	**0.39**	**4.50**	**2.13**	**8.32**	**0.46**	**0.46**	**0.156**	**12.91**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	13.76	1.44	0.35	4.31	2.29	8.82	0.36	0.46	0.157	12.88	0.47	0.45	0.98	0.56
Mtl/ClrNct-Std-ClrSue	13.76	1.27	0.39	4.60	2.13	6.37	0.49	0.57	0.159	13.13	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrSue	13.78	1.33	0.35	4.41	2.29	6.87	0.39	0.57	0.160	13.09	0.67	0.56	1.17	0.68
Brk/ClrNct-Ins-ClrSue	13.80	1.35	0.39	4.48	2.13	9.36	0.46	0.42	0.154	12.87	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	13.78	1.28	0.39	4.59	2.16	6.08	0.47	0.62	0.161	13.17	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	13.84	1.28	0.36	4.45	2.24	7.98	0.43	0.49	0.157	13.04	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	13.85	1.28	0.39	4.57	2.16	7.12	0.47	0.59	0.160	13.14	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	13.87	1.31	0.36	4.42	2.24	9.02	0.42	0.45	0.156	12.97	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrNct	13.88	1.35	0.36	4.45	2.26	7.57	0.40	0.62	0.162	13.12	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	13.69	1.28	0.39	4.59	2.16	5.23	0.47	0.62	0.161	13.17	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	**13.75**	**1.35**	**0.39**	**4.50**	**2.13**	**8.40**	**0.46**	**0.46**	**0.156**	**12.91**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrPye	13.75	1.28	0.36	4.45	2.24	7.12	0.43	0.49	0.157	13.04	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	13.76	1.28	0.39	4.57	2.16	6.27	0.47	0.59	0.160	13.14	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrSue	13.77	1.44	0.35	4.31	2.29	8.88	0.36	0.46	0.157	12.88	0.47	0.45	0.98	0.56

Table 36 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**15.17**	**1.44**	**0.52**	**5.19**	**1.67**	**8.82**	**0.36**	**0.46**	**0.165**	**13.40**	**0.47**	**0.45**	**0.98**	**0.56**
Mtl/GrnNct-Std-ClrSue	15.20	1.33	0.52	5.39	1.67	6.87	0.39	0.57	0.171	13.83	0.67	0.56	1.17	0.68
Brk/HptNct-Std-ClrPye	15.25	1.39	0.51	5.21	1.71	8.61	0.36	0.49	0.167	13.53	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrSue	15.27	1.47	0.50	5.03	1.77	9.75	0.32	0.46	0.166	13.32	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrPye	15.29	1.28	0.51	5.42	1.71	6.66	0.39	0.60	0.173	13.95	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	15.41	1.28	0.54	5.48	1.62	7.98	0.43	0.49	0.165	13.81	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	15.42	1.28	0.56	5.74	1.54	6.08	0.47	0.62	0.173	14.21	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	**15.42**	**1.39**	**0.51**	**5.21**	**1.71**	**9.46**	**0.36**	**0.49**	**0.167**	**13.53**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Std-ClrNct	15.45	1.35	0.53	5.47	1.64	7.57	0.40	0.62	0.174	13.94	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrPye	15.46	1.31	0.54	5.40	1.62	9.02	0.42	0.45	0.163	13.66	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**15.18**	**1.44**	**0.52**	**5.19**	**1.67**	**8.88**	**0.36**	**0.46**	**0.165**	**13.40**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	15.21	1.39	0.51	5.21	1.71	8.40	0.36	0.49	0.167	13.53	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	15.23	1.28	0.54	5.48	1.62	7.12	0.43	0.49	0.165	13.81	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	15.24	1.35	0.53	5.47	1.64	6.50	0.40	0.62	0.174	13.94	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	15.25	1.28	0.56	5.74	1.54	5.23	0.47	0.62	0.173	14.21	0.60	0.60	1.10	0.69

Table 37 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**17.08**	**1.44**	**0.61**	**6.06**	**1.36**	**8.82**	**0.36**	**0.46**	**0.173**	**14.44**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnSbe-Std-ClrNct	17.10	1.26	0.54	5.80	1.60	8.83	0.31	0.48	0.176	14.45	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrSue	17.13	1.47	0.59	5.84	1.44	9.75	0.32	0.46	0.174	14.20	0.47	0.45	0.98	0.56
Mtl/GrnNct-Std-ClrSue	17.13	1.33	0.61	6.37	1.36	6.87	0.39	0.57	0.183	15.07	0.67	0.56	1.17	0.68
Brk/HptSbe-Std-ClrNct	17.14	1.31	0.51	5.52	1.73	9.75	0.26	0.48	0.178	14.21	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrPye	**17.43**	**1.39**	**0.61**	**6.10**	**1.39**	**9.46**	**0.36**	**0.49**	**0.176**	**14.59**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrPye	17.51	1.28	0.63	6.50	1.31	7.98	0.43	0.49	0.174	15.11	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	17.51	1.43	0.61	5.99	1.39	10.50	0.35	0.45	0.172	14.36	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	17.54	1.44	0.61	6.06	1.36	10.34	0.36	0.46	0.173	14.44	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrNct	17.55	1.35	0.62	6.49	1.33	7.57	0.40	0.62	0.187	15.28	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**17.10**	**1.44**	**0.61**	**6.06**	**1.36**	**8.88**	**0.36**	**0.46**	**0.173**	**14.44**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	17.11	1.39	0.61	6.10	1.39	8.40	0.36	0.49	0.176	14.59	0.51	0.49	1.00	0.59
Brk/GrnSbe-Std-ClrNct	17.12	1.26	0.54	5.80	1.60	8.88	0.31	0.48	0.176	14.45	0.49	0.46	0.99	0.57
Brk/HptNct-Ins-ClrPye	17.19	1.43	0.61	5.99	1.39	9.44	0.35	0.45	0.172	14.36	0.48	0.46	0.97	0.56
Brk/GrnSbe-Ins-ClrNct	17.21	1.30	0.54	5.70	1.60	9.92	0.30	0.44	0.173	14.23	0.46	0.43	0.96	0.54

Table 38 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptSbe-Std-ClrNct	19.00	1.31	0.57	6.22	1.50	9.75	0.26	0.48	0.187	15.10	0.49	0.46	0.99	0.57
Brk/GrnSbe-Std-ClrNct	**19.06**	**1.26**	**0.60**	**6.59**	**1.39**	**8.83**	**0.31**	**0.48**	**0.185**	**15.53**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnMpr-Std-ClrSue	19.07	1.41	0.55	5.88	1.58	11.01	0.22	0.46	0.187	14.67	0.47	0.45	0.98	0.56
Mtl/GrnSbe-Std-ClrNct	19.12	1.15	0.60	7.01	1.39	6.88	0.34	0.59	0.198	16.37	0.69	0.57	1.18	0.68
Brk/HptMpr-Std-ClrSue	19.12	1.58	0.54	5.65	1.61	11.93	0.19	0.46	0.188	14.35	0.47	0.45	0.98	0.56
Mtl/GrnMpr-Std-ClrSue	19.12	1.24	0.55	6.29	1.58	9.06	0.25	0.57	0.199	15.50	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**19.66**	**1.26**	**0.60**	**6.59**	**1.39**	**10.34**	**0.31**	**0.48**	**0.185**	**15.53**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptNct-Std-ClrPye	19.69	1.39	0.65	6.99	1.22	9.46	0.36	0.49	0.185	15.90	0.51	0.49	1.00	0.59
Brk/GrnSbe-Ins-ClrNct	19.78	1.30	0.60	6.45	1.39	11.38	0.30	0.44	0.181	15.23	0.46	0.43	0.96	0.54
Brk/HptNct-Ins-ClrPye	19.80	1.43	0.65	6.85	1.22	10.50	0.35	0.45	0.180	15.60	0.48	0.46	0.97	0.56
Brk/HptSbe-Std-ClrNct	19.83	1.31	0.57	6.22	1.50	11.82	0.26	0.48	0.187	15.10	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**19.08**	**1.26**	**0.60**	**6.59**	**1.39**	**8.88**	**0.31**	**0.48**	**0.185**	**15.53**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptSbe-Std-ClrNct	19.17	1.31	0.57	6.22	1.50	10.15	0.26	0.48	0.187	15.10	0.49	0.46	0.99	0.57
Brk/GrnSbe-Ins-ClrNct	19.20	1.30	0.60	6.45	1.39	9.92	0.30	0.44	0.181	15.23	0.46	0.43	0.96	0.54
Brk/HptNct-Std-ClrPye	19.26	1.39	0.65	6.99	1.22	8.40	0.36	0.49	0.185	15.90	0.51	0.49	1.00	0.59
Brk/GrnMpr-Std-ClrSue	19.26	1.41	0.55	5.88	1.58	11.49	0.22	0.46	0.187	14.67	0.47	0.45	0.98	0.56

Table 39 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**12.31**	**1.10**	**0.41**	**3.88**	**2.05**	**0.51**	**0.61**	**1.26**	**0.201**	**12.26**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/ClrNct-Std-ClrSue	12.35	1.27	0.39	3.65	2.13	6.37	0.49	0.57	0.176	11.72	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrNct	12.35	1.18	0.39	3.69	2.16	4.43	0.51	0.73	0.182	11.91	0.81	0.72	1.31	0.80
Brk/GrnNct	12.38	1.16	0.41	3.83	2.05	2.46	0.58	1.15	0.197	12.13	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.40	1.28	0.39	3.63	2.16	6.38	0.47	0.62	0.178	11.77	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	12.29	1.16	0.41	3.83	2.05	1.53	0.58	1.15	0.197	12.13	1.08	1.11	1.89	1.25
Mtl/GrnNct	**12.32**	**1.10**	**0.41**	**3.88**	**2.05**	**0.56**	**0.61**	**1.26**	**0.201**	**12.26**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct	12.32	1.01	0.46	4.05	1.88	0.98	0.79	1.15	0.197	12.22	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.38	1.28	0.39	3.63	2.16	6.08	0.47	0.62	0.178	11.77	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	12.42	1.04	0.43	3.86	2.00	5.53	0.68	0.62	0.177	11.87	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	12.27	1.16	0.41	3.83	2.05	1.31	0.58	1.15	0.197	12.13	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	12.29	1.28	0.39	3.63	2.16	5.23	0.47	0.62	0.178	11.77	0.60	0.60	1.10	0.69
Brk/ClrNct	12.30	1.01	0.46	4.05	1.88	0.83	0.79	1.15	0.197	12.22	1.08	1.11	1.89	1.25
Mtl/GrnNct	**12.31**	**1.10**	**0.41**	**3.88**	**2.05**	**0.48**	**0.61**	**1.26**	**0.201**	**12.26**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct-Std-ClrNct	12.34	1.04	0.43	3.86	2.00	4.75	0.68	0.62	0.177	11.87	0.60	0.60	1.10	0.69

Table 40 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrNct	**13.12**	**1.18**	**0.56**	**4.35**	**1.54**	**4.43**	**0.51**	**0.73**	**0.205**	**12.24**	**0.81**	**0.72**	**1.31**	**0.80**
Mtl/GrnNct-Std-ClrPye	13.16	1.20	0.54	4.20	1.62	5.73	0.46	0.60	0.196	12.02	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrSue	13.18	1.27	0.57	4.26	1.51	6.37	0.49	0.57	0.193	11.90	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrSue	13.19	1.33	0.52	4.04	1.67	6.87	0.39	0.57	0.194	11.82	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrNct	13.22	1.23	0.53	4.20	1.64	5.36	0.44	0.73	0.206	12.15	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	13.16	1.28	0.56	4.23	1.54	6.08	0.47	0.62	0.197	11.95	0.60	0.60	1.10	0.69
Brk/GrnNct	13.18	1.16	0.59	4.62	1.44	1.53	0.58	1.15	0.236	12.88	1.08	1.11	1.89	1.25
Mtl/GrnNct	13.24	1.10	0.59	4.71	1.44	0.56	0.61	1.26	0.243	13.13	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrNct	**13.26**	**1.18**	**0.56**	**4.35**	**1.54**	**5.11**	**0.51**	**0.73**	**0.205**	**12.24**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/GrnNct-Ins-ClrNct	13.33	1.28	0.56	4.22	1.54	7.12	0.47	0.59	0.195	11.91	0.57	0.57	1.07	0.66
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	12.99	1.28	0.56	4.23	1.54	5.23	0.47	0.62	0.197	11.95	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	**13.12**	**1.18**	**0.56**	**4.35**	**1.54**	**4.39**	**0.51**	**0.73**	**0.205**	**12.24**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/GrnNct	13.14	1.16	0.59	4.62	1.44	1.31	0.58	1.15	0.236	12.88	1.08	1.11	1.89	1.25
Brk/GrnNct-Ins-ClrNct	13.16	1.28	0.56	4.22	1.54	6.27	0.47	0.59	0.195	11.91	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrNct	13.16	1.35	0.53	4.08	1.64	6.50	0.40	0.62	0.198	11.86	0.60	0.60	1.10	0.69

Table 41 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	14.40	1.33	0.61	4.55	1.36	6.87	0.39	0.57	0.212	12.34	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrPye	14.42	1.20	0.63	4.79	1.31	5.73	0.46	0.60	0.214	12.70	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrPye	14.45	1.28	0.61	4.56	1.39	6.66	0.39	0.60	0.215	12.45	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrNct	14.45	1.18	0.64	5.00	1.26	4.43	0.51	0.73	0.228	13.13	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrNct	14.48	1.23	0.62	4.78	1.33	5.36	0.44	0.73	0.229	12.88	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**14.52**	**1.28**	**0.64**	**4.83**	**1.26**	**6.08**	**0.47**	**0.62**	**0.216**	**12.69**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/GrnNct-Std-ClrNct	14.66	1.18	0.64	5.00	1.26	5.11	0.51	0.73	0.228	13.13	0.81	0.72	1.31	0.80
Brk/GrnNct	14.67	1.16	0.66	5.41	1.19	1.53	0.58	1.15	0.274	14.21	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrPye	14.71	1.28	0.63	4.64	1.31	7.98	0.43	0.49	0.202	12.31	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	14.71	1.35	0.62	4.60	1.33	7.57	0.40	0.62	0.218	12.44	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**14.26**	**1.28**	**0.64**	**4.83**	**1.26**	**5.23**	**0.47**	**0.62**	**0.216**	**12.69**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrNct	14.39	1.35	0.62	4.60	1.33	6.50	0.40	0.62	0.218	12.44	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	14.44	1.18	0.64	5.00	1.26	4.39	0.51	0.73	0.228	13.13	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	14.45	1.28	0.63	4.64	1.31	7.12	0.43	0.49	0.202	12.31	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	14.51	1.28	0.64	4.81	1.26	6.27	0.47	0.59	0.213	12.63	0.57	0.57	1.07	0.66

Table 42 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	15.86	1.33	0.66	5.05	1.20	6.87	0.39	0.57	0.230	13.11	0.67	0.56	1.17	0.68
Mtl/GrnSbe-Std-ClrNct	15.89	1.15	0.60	4.84	1.39	6.88	0.34	0.59	0.234	13.14	0.69	0.57	1.18	0.68
Mtl/HptNct-Std-ClrPye	15.90	1.28	0.65	5.07	1.22	6.66	0.39	0.60	0.234	13.23	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrPye	15.93	1.20	0.67	5.37	1.17	5.73	0.46	0.60	0.233	13.64	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrNct	16.00	1.23	0.67	5.36	1.18	5.36	0.44	0.73	0.253	13.86	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	16.13	1.28	0.68	5.42	1.13	6.08	0.47	0.62	0.236	13.69	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	**16.31**	**1.35**	**0.67**	**5.12**	**1.18**	**7.57**	**0.40**	**0.62**	**0.237**	**13.29**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/GrnNct-Std-ClrNct	16.32	1.18	0.68	5.66	1.13	5.11	0.51	0.73	0.252	14.27	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	16.32	1.28	0.67	5.18	1.17	7.98	0.43	0.49	0.216	13.13	0.51	0.49	1.00	0.59
Brk/GrnNct	16.41	1.16	0.69	6.20	1.08	1.53	0.58	1.15	0.312	15.80	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	15.78	1.28	0.68	5.42	1.13	5.23	0.47	0.62	0.236	13.69	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	**15.89**	**1.35**	**0.67**	**5.12**	**1.18**	**6.50**	**0.40**	**0.62**	**0.237**	**13.29**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrPye	15.98	1.28	0.67	5.18	1.17	7.12	0.43	0.49	0.216	13.13	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	16.03	1.18	0.68	5.66	1.13	4.39	0.51	0.73	0.252	14.27	0.81	0.72	1.31	0.80
Brk/HptNct-Std-ClrPye	16.08	1.39	0.65	4.87	1.22	8.40	0.36	0.49	0.218	12.72	0.51	0.49	1.00	0.59

Cold Regions

Table 43 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrSue	**11.87**	**1.27**	**0.39**	**2.75**	**2.13**	**6.37**	**0.49**	**0.57**	**0.267**	**11.24**	**0.67**	**0.56**	**1.17**	**0.68**
Brk/ClrNct-Std-ClrSue	11.88	1.35	0.39	2.69	2.13	8.32	0.46	0.46	0.259	11.05	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	11.94	1.35	0.39	2.68	2.13	9.36	0.46	0.42	0.256	11.00	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrNct	11.94	1.28	0.39	2.73	2.16	6.38	0.47	0.62	0.271	11.30	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	11.95	1.18	0.39	2.80	2.16	4.43	0.51	0.73	0.278	11.51	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.91	1.28	0.39	2.73	2.16	6.08	0.47	0.62	0.271	11.30	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	11.98	1.28	0.39	2.72	2.16	7.12	0.47	0.59	0.269	11.27	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrPye	12.01	1.28	0.36	2.65	2.24	7.98	0.43	0.49	0.262	11.21	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	12.02	1.18	0.39	2.80	2.16	5.11	0.51	0.73	0.278	11.51	0.81	0.72	1.31	0.80
Brk/ClrNct-Std-ClrNct	12.03	1.04	0.43	3.01	2.00	5.53	0.68	0.62	0.267	11.47	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.83	1.28	0.39	2.73	2.16	5.23	0.47	0.62	0.271	11.30	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	11.89	1.35	0.39	2.69	2.13	8.40	0.46	0.46	0.259	11.05	0.47	0.45	0.98	0.56
Brk/GrnNct-Ins-ClrNct	11.90	1.28	0.39	2.72	2.16	6.27	0.47	0.59	0.269	11.27	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrPye	11.92	1.28	0.36	2.65	2.24	7.12	0.43	0.49	0.262	11.21	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrSue	11.94	1.35	0.39	2.68	2.13	9.44	0.46	0.42	0.256	11.00	0.44	0.42	0.95	0.53

Table 44 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	12.99	1.33	0.52	3.24	1.67	6.87	0.39	0.57	0.294	11.61	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	13.01	1.44	0.52	3.12	1.67	8.82	0.36	0.46	0.280	11.24	0.47	0.45	0.98	0.56
Mtl/GrnNct-Std-ClrPye	13.03	1.20	0.54	3.44	1.62	5.73	0.46	0.60	0.296	11.88	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrSue	13.03	1.27	0.57	3.51	1.51	6.37	0.49	0.57	0.291	11.76	0.67	0.56	1.17	0.68
Brk/ClrNct-Std-ClrSue	13.05	1.35	0.57	3.39	1.51	8.32	0.46	0.46	0.275	11.38	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	13.05	1.28	0.56	3.47	1.54	6.08	0.47	0.62	0.298	11.83	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	**13.11**	**1.28**	**0.54**	**3.32**	**1.62**	**7.98**	**0.43**	**0.49**	**0.281**	**11.51**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Ins-ClrPye	13.18	1.31	0.54	3.28	1.62	9.02	0.42	0.45	0.275	11.38	0.48	0.46	0.97	0.56
Brk/GrnNct-Ins-ClrNct	13.19	1.28	0.56	3.46	1.54	7.12	0.47	0.59	0.294	11.77	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrNct	13.22	1.35	0.53	3.28	1.64	7.57	0.40	0.62	0.301	11.70	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	12.88	1.28	0.56	3.47	1.54	5.23	0.47	0.62	0.298	11.83	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	**12.94**	**1.28**	**0.54**	**3.32**	**1.62**	**7.12**	**0.43**	**0.49**	**0.281**	**11.51**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Std-ClrNct	13.00	1.35	0.53	3.28	1.64	6.50	0.40	0.62	0.301	11.70	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrPye	13.01	1.31	0.54	3.28	1.62	8.16	0.42	0.45	0.275	11.38	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	13.02	1.44	0.52	3.12	1.67	8.88	0.36	0.46	0.280	11.24	0.47	0.45	0.98	0.56

Table 45 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	14.49	1.33	0.61	3.87	1.36	6.87	0.39	0.57	0.320	12.43	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	14.53	1.44	0.61	3.69	1.36	8.82	0.36	0.46	0.298	11.88	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrPye	14.58	1.28	0.61	3.88	1.39	6.66	0.39	0.60	0.326	12.58	0.71	0.60	1.20	0.70
Brk/HptNct-Std-ClrPye	14.62	1.39	0.61	3.71	1.39	8.61	0.36	0.49	0.305	12.03	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrPye	14.62	1.20	0.63	4.17	1.31	5.73	0.46	0.60	0.322	12.90	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**14.74**	**1.28**	**0.63**	**3.99**	**1.31**	**7.98**	**0.43**	**0.49**	**0.300**	**12.34**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrNct	14.75	1.28	0.64	4.22	1.26	6.08	0.47	0.62	0.326	12.93	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrPye	14.85	1.31	0.63	3.93	1.31	9.02	0.42	0.45	0.292	12.14	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	14.87	1.39	0.61	3.71	1.39	9.46	0.36	0.49	0.305	12.03	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	14.88	1.35	0.62	3.94	1.33	7.57	0.40	0.62	0.330	12.61	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**14.48**	**1.28**	**0.63**	**3.99**	**1.31**	**7.12**	**0.43**	**0.49**	**0.300**	**12.34**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrNct	14.50	1.28	0.64	4.22	1.26	5.23	0.47	0.62	0.326	12.93	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrSue	14.55	1.44	0.61	3.69	1.36	8.88	0.36	0.46	0.298	11.88	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	14.55	1.39	0.61	3.71	1.39	8.40	0.36	0.49	0.305	12.03	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	14.56	1.35	0.62	3.94	1.33	6.50	0.40	0.62	0.330	12.61	0.60	0.60	1.10	0.69

Table 46 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	16.26	1.15	0.60	4.24	1.39	6.88	0.34	0.59	0.354	13.50	0.69	0.57	1.18	0.68
Mtl/GrnNct-Std-ClrSue	16.26	1.33	0.66	4.50	1.20	6.87	0.39	0.57	0.345	13.51	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	16.31	1.44	0.66	4.26	1.20	8.82	0.36	0.46	0.316	12.78	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	16.31	1.26	0.60	4.00	1.39	8.83	0.31	0.48	0.326	12.78	0.49	0.46	0.99	0.57
Mtl/HptNct-Std-ClrPye	16.35	1.28	0.65	4.52	1.22	6.66	0.39	0.60	0.354	13.68	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**16.63**	**1.28**	**0.67**	**4.66**	**1.17**	**7.98**	**0.43**	**0.49**	**0.319**	**13.44**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrNct	16.72	1.28	0.68	4.97	1.13	6.08	0.47	0.62	0.354	14.28	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	16.74	1.39	0.65	4.28	1.22	9.46	0.36	0.49	0.325	12.95	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	16.78	1.31	0.67	4.58	1.17	9.02	0.42	0.45	0.308	13.17	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrNct	16.81	1.35	0.67	4.59	1.18	7.57	0.40	0.62	0.358	13.78	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**16.29**	**1.28**	**0.67**	**4.66**	**1.17**	**7.12**	**0.43**	**0.49**	**0.319**	**13.44**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Std-ClrPye	16.31	1.39	0.65	4.28	1.22	8.40	0.36	0.49	0.325	12.95	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	16.33	1.44	0.66	4.26	1.20	8.88	0.36	0.46	0.316	12.78	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	16.33	1.26	0.60	4.00	1.39	8.88	0.31	0.48	0.326	12.78	0.49	0.46	0.99	0.57
Brk/GrnNct-Std-ClrNct	16.37	1.28	0.68	4.97	1.13	5.23	0.47	0.62	0.354	14.28	0.60	0.60	1.10	0.69

Table 47 – Vertical Fenestration SHGC Criteria – Nonresidential – 0-10% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrNct	**10.88**	**0.99**	**0.43**	**2.22**	**2.00**	**3.93**	**0.72**	**0.73**	**0.298**	**10.49**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/ClrNct-Std-ClrNct	10.93	1.04	0.43	2.19	2.00	5.88	0.68	0.62	0.289	10.34	0.60	0.60	1.10	0.69
Brk/ClrNct	10.95	1.01	0.46	2.27	1.88	1.95	0.79	1.15	0.331	10.76	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrSue	10.95	1.27	0.39	2.06	2.13	6.37	0.49	0.57	0.287	10.32	0.67	0.56	1.17	0.68
Mtl/ClrNct-Std-ClrPye	10.96	0.97	0.41	2.19	2.07	5.23	0.68	0.60	0.287	10.44	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	10.86	1.01	0.46	2.27	1.88	0.98	0.79	1.15	0.331	10.76	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	10.89	1.04	0.43	2.19	2.00	5.53	0.68	0.62	0.289	10.34	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrNct	**10.95**	**0.99**	**0.43**	**2.22**	**2.00**	**4.55**	**0.72**	**0.73**	**0.298**	**10.49**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/ClrNct-Ins-ClrNct	10.97	1.04	0.43	2.19	2.00	6.57	0.68	0.59	0.287	10.31	0.57	0.57	1.07	0.66
Brk/GrnNct	10.97	1.16	0.41	2.13	2.05	1.53	0.58	1.15	0.332	10.82	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrNct	10.82	1.04	0.43	2.19	2.00	4.75	0.68	0.62	0.289	10.34	0.60	0.60	1.10	0.69
Brk/ClrNct	10.84	1.01	0.46	2.27	1.88	0.83	0.79	1.15	0.331	10.76	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrNct	**10.88**	**0.99**	**0.43**	**2.22**	**2.00**	**3.91**	**0.72**	**0.73**	**0.298**	**10.49**	**0.81**	**0.72**	**1.31**	**0.80**
Brk/ClrNct-Ins-ClrNct	10.89	1.04	0.43	2.19	2.00	5.79	0.68	0.59	0.287	10.31	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrNct	10.92	1.28	0.39	2.04	2.16	5.23	0.47	0.62	0.292	10.40	0.60	0.60	1.10	0.69

Table 48 – Vertical Fenestration SHGC Criteria – Nonresidential – 11-20% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrSue	**11.53**	**1.27**	**0.57**	**2.40**	**1.51**	**6.37**	**0.49**	**0.57**	**0.322**	**10.26**	**0.67**	**0.56**	**1.17**	**0.68**
Mtl/GrnNct-Std-ClrNct	11.54	1.18	0.56	2.44	1.54	4.43	0.51	0.73	0.348	10.65	0.81	0.72	1.31	0.80
Mtl/GrnNct-Std-ClrPye	11.58	1.20	0.54	2.36	1.62	5.73	0.46	0.60	0.328	10.44	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrNct	11.64	0.99	0.60	2.73	1.40	3.93	0.72	0.73	0.343	10.85	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrNct	11.64	1.28	0.56	2.38	1.54	6.38	0.47	0.62	0.331	10.36	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.58	1.28	0.56	2.38	1.54	6.08	0.47	0.62	0.331	10.36	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	11.66	1.04	0.60	2.67	1.40	5.53	0.68	0.62	0.325	10.55	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	11.67	1.18	0.56	2.44	1.54	5.11	0.51	0.73	0.348	10.65	0.81	0.72	1.31	0.80
Brk/GrnNct	11.70	1.16	0.59	2.54	1.44	1.53	0.58	1.15	0.411	11.40	1.08	1.11	1.89	1.25
Brk/GrnNct-Ins-ClrNct	11.73	1.28	0.56	2.38	1.54	7.12	0.47	0.59	0.326	10.30	0.57	0.57	1.07	0.66
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.41	1.28	0.56	2.38	1.54	5.23	0.47	0.62	0.331	10.36	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	11.50	1.04	0.60	2.67	1.40	4.75	0.68	0.62	0.325	10.55	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	11.53	1.18	0.56	2.44	1.54	4.39	0.51	0.73	0.348	10.65	0.81	0.72	1.31	0.80
Brk/GrnNct-Ins-ClrNct	11.56	1.28	0.56	2.38	1.54	6.27	0.47	0.59	0.326	10.30	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrPye	11.58	1.28	0.54	2.32	1.62	7.12	0.43	0.49	0.310	10.16	0.51	0.49	1.00	0.59

Table 49 – Vertical Fenestration SHGC Criteria – Nonresidential – 21-30% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrPye	12.62	1.20	0.63	2.69	1.31	5.73	0.46	0.60	0.365	10.90	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrNct	12.65	1.18	0.64	2.80	1.26	4.43	0.51	0.73	0.395	11.32	0.81	0.72	1.31	0.80
Mtl/ClrNct-Std-ClrSue	12.68	1.27	0.65	2.75	1.23	6.37	0.49	0.57	0.356	10.77	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrSue	12.73	1.33	0.61	2.54	1.36	6.87	0.39	0.57	0.360	10.67	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrPye	12.79	1.28	0.63	2.62	1.31	7.68	0.43	0.49	0.339	10.49	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**12.71**	**1.28**	**0.64**	**2.71**	**1.26**	**6.08**	**0.47**	**0.62**	**0.370**	**10.89**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/GrnNct-Std-ClrNct	12.85	1.18	0.64	2.80	1.26	5.11	0.51	0.73	0.395	11.32	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	12.88	1.28	0.63	2.62	1.31	7.98	0.43	0.49	0.339	10.49	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	12.94	1.28	0.64	2.71	1.26	7.12	0.47	0.59	0.362	10.80	0.57	0.57	1.07	0.66
Mtl/GrnNct-Std-ClrPye	13.00	1.20	0.63	2.69	1.31	7.01	0.46	0.60	0.365	10.90	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**12.46**	**1.28**	**0.64**	**2.71**	**1.26**	**5.23**	**0.47**	**0.62**	**0.370**	**10.89**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrPye	12.62	1.28	0.63	2.62	1.31	7.12	0.43	0.49	0.339	10.49	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	12.64	1.18	0.64	2.80	1.26	4.39	0.51	0.73	0.395	11.32	0.81	0.72	1.31	0.80
Brk/GrnNct-Ins-ClrNct	12.68	1.28	0.64	2.71	1.26	6.27	0.47	0.59	0.362	10.80	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrNct	12.74	1.35	0.62	2.56	1.33	6.50	0.40	0.62	0.372	10.79	0.60	0.60	1.10	0.69

Table 50 – Vertical Fenestration SHGC Criteria – Nonresidential – 31-40% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrPye	13.92	1.20	0.67	3.01	1.17	5.73	0.46	0.60	0.402	11.62	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrSue	14.02	1.33	0.66	2.82	1.20	6.87	0.39	0.57	0.396	11.27	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrNct	14.02	1.18	0.68	3.16	1.13	4.43	0.51	0.73	0.442	12.25	0.81	0.72	1.31	0.80
Mtl/ClrNct-Std-ClrSue	14.09	1.27	0.68	3.10	1.11	6.37	0.49	0.57	0.391	11.54	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	14.09	1.28	0.65	2.82	1.22	6.66	0.39	0.60	0.406	11.43	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**14.11**	**1.28**	**0.68**	**3.04**	**1.13**	**6.08**	**0.47**	**0.62**	**0.408**	**11.67**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrPye	14.27	1.28	0.67	2.93	1.17	7.98	0.43	0.49	0.367	11.07	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	14.29	1.18	0.68	3.16	1.13	5.11	0.51	0.73	0.442	12.25	0.81	0.72	1.31	0.80
Brk/GrnNct-Ins-ClrNct	14.41	1.28	0.68	3.04	1.13	7.12	0.47	0.59	0.399	11.56	0.57	0.57	1.07	0.66
Mtl/GrnNct-Std-ClrPye	14.43	1.20	0.67	3.01	1.17	7.01	0.46	0.60	0.402	11.62	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**13.76**	**1.28**	**0.68**	**3.04**	**1.13**	**5.23**	**0.47**	**0.62**	**0.408**	**11.67**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrPye	13.92	1.28	0.67	2.93	1.17	7.12	0.43	0.49	0.367	11.07	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	14.01	1.18	0.68	3.16	1.13	4.39	0.51	0.73	0.442	12.25	0.81	0.72	1.31	0.80
Brk/GrnNct-Ins-ClrNct	14.06	1.28	0.68	3.04	1.13	6.27	0.47	0.59	0.399	11.56	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrNct	14.07	1.35	0.67	2.85	1.18	6.50	0.40	0.62	0.412	11.47	0.60	0.60	1.10	0.69

SHGC Criteria – Residential

South Coast

Table 51 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	10.42	1.33	0.35	3.32	2.29	6.87	0.39	0.57	0.027	9.73	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	10.45	1.44	0.35	3.23	2.29	8.82	0.36	0.46	0.026	9.57	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrNct	10.46	1.35	0.36	3.35	2.26	7.31	0.40	0.62	0.028	9.73	0.60	0.60	1.10	0.69
Mtl/HptNct-Std-ClrPye	10.47	1.28	0.34	3.32	2.33	6.66	0.39	0.60	0.027	9.80	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrNct	10.47	1.23	0.36	3.46	2.26	5.36	0.44	0.73	0.029	9.93	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	10.46	1.16	0.41	3.86	2.05	1.53	0.58	1.15	0.033	10.31	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	**10.48**	**1.28**	**0.39**	**3.53**	**2.16**	**6.08**	**0.47**	**0.62**	**0.027**	**9.87**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct	10.48	1.18	0.39	3.68	2.16	3.02	0.51	1.15	0.033	10.18	1.08	1.11	1.89	1.25
Brk/HptNct-Std-ClrNct	10.49	1.35	0.36	3.35	2.26	7.57	0.40	0.62	0.028	9.73	0.60	0.60	1.10	0.69
Mtl/GrnNct	10.53	1.10	0.41	3.95	2.05	0.56	0.61	1.26	0.034	10.47	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	10.38	1.35	0.36	3.35	2.26	6.50	0.40	0.62	0.028	9.73	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	**10.39**	**1.28**	**0.39**	**3.53**	**2.16**	**5.23**	**0.47**	**0.62**	**0.027**	**9.87**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct	10.44	1.18	0.39	3.68	2.16	2.59	0.51	1.15	0.033	10.18	1.08	1.11	1.89	1.25
Brk/GrnNct	10.44	1.16	0.41	3.86	2.05	1.31	0.58	1.15	0.033	10.31	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrSue	10.46	1.44	0.35	3.23	2.29	8.88	0.36	0.46	0.026	9.57	0.47	0.45	0.98	0.56

Table 52 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	11.89	1.33	0.52	4.38	1.67	6.87	0.39	0.57	0.030	10.51	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrSue	11.89	1.34	0.50	4.17	1.77	7.80	0.35	0.57	0.031	10.33	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	11.93	1.28	0.51	4.39	1.71	6.66	0.39	0.60	0.031	10.59	0.71	0.60	1.20	0.70
Mtl/GrnSbe-Std-ClrNct	11.94	1.15	0.44	4.12	1.95	6.88	0.34	0.59	0.031	10.56	0.69	0.57	1.18	0.68
Brk/GrnNct-Std-ClrSue	11.96	1.44	0.52	4.21	1.67	8.82	0.36	0.46	0.028	10.19	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	**12.08**	**1.35**	**0.53**	**4.44**	**1.64**	**7.57**	**0.40**	**0.62**	**0.031**	**10.57**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrPye	12.17	1.39	0.51	4.21	1.71	9.46	0.36	0.49	0.029	10.27	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	12.23	1.28	0.56	4.81	1.54	6.08	0.47	0.62	0.031	11.01	0.60	0.60	1.10	0.69
Brk/HptNct	12.24	1.18	0.56	5.11	1.54	3.02	0.51	1.15	0.042	11.64	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrSue	12.26	1.44	0.52	4.21	1.67	10.34	0.36	0.46	0.028	10.19	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	**11.87**	**1.35**	**0.53**	**4.44**	**1.64**	**6.50**	**0.40**	**0.62**	**0.031**	**10.57**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrPye	11.95	1.39	0.51	4.21	1.71	8.40	0.36	0.49	0.029	10.27	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	11.97	1.44	0.52	4.21	1.67	8.88	0.36	0.46	0.028	10.19	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	12.02	1.26	0.44	3.95	1.95	8.88	0.31	0.48	0.029	10.24	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrSue	12.04	1.47	0.50	4.00	1.77	10.15	0.32	0.46	0.028	10.01	0.47	0.45	0.98	0.56

Table 53 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnMpr-Std-ClrSue	13.49	1.24	0.48	4.35	1.82	9.06	0.25	0.57	0.035	10.77	0.67	0.56	1.17	0.68
Brk/HptMpr-Std-ClrSue	13.54	1.58	0.47	3.86	1.85	11.93	0.19	0.46	0.033	9.96	0.47	0.45	0.98	0.56
Mtl/HptMpr-Std-ClrSue	13.56	1.30	0.47	4.20	1.85	9.98	0.23	0.57	0.036	10.57	0.67	0.56	1.17	0.68
Brk/GrnMpr-Std-ClrSue	13.60	1.41	0.48	4.09	1.82	11.01	0.22	0.46	0.032	10.30	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	13.60	1.31	0.51	4.41	1.73	9.75	0.26	0.48	0.032	10.68	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	14.20	1.35	0.62	5.54	1.33	7.57	0.40	0.62	0.035	11.93	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	**14.21**	**1.26**	**0.54**	**4.80**	**1.60**	**10.34**	**0.31**	**0.48**	**0.031**	**11.10**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptSbe-Std-ClrNct	14.22	1.31	0.51	4.41	1.73	11.82	0.26	0.48	0.032	10.68	0.49	0.46	0.99	0.57
Brk/HptMpr-Std-ClrNct	14.23	1.21	0.51	4.60	1.73	10.61	0.28	0.62	0.037	11.05	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	14.24	1.39	0.61	5.19	1.39	9.46	0.36	0.49	0.031	11.40	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptSbe-Std-ClrNct	13.72	1.31	0.51	4.41	1.73	10.15	0.26	0.48	0.032	10.68	0.49	0.46	0.99	0.57
Brk/GrnMpr-Std-ClrSue	13.74	1.41	0.48	4.09	1.82	11.49	0.22	0.46	0.032	10.30	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	**13.77**	**1.26**	**0.54**	**4.80**	**1.60**	**8.88**	**0.31**	**0.48**	**0.031**	**11.10**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptMpr-Std-ClrNct	13.78	1.21	0.51	4.60	1.73	9.11	0.28	0.62	0.037	11.05	0.60	0.60	1.10	0.69
Brk/HptMpr-Std-ClrSue	13.79	1.58	0.47	3.86	1.85	12.77	0.19	0.46	0.033	9.96	0.47	0.45	0.98	0.56

Table 54 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – All – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnMpr-Std-ClrSue	15.22	1.24	0.55	5.05	1.58	9.06	0.25	0.57	0.039	11.59	0.67	0.56	1.17	0.68
Brk/HptMpr-Std-ClrSue	15.26	1.58	0.54	4.39	1.61	11.93	0.19	0.46	0.036	10.49	0.47	0.45	0.98	0.56
Mtl/HptMpr-Std-ClrSue	15.29	1.30	0.54	4.84	1.61	9.98	0.23	0.57	0.040	11.30	0.67	0.56	1.17	0.68
Brk/GrnMpr-Std-ClrSue	15.36	1.41	0.55	4.70	1.58	11.01	0.22	0.46	0.035	10.96	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**15.43**	**1.31**	**0.57**	**5.12**	**1.50**	**9.75**	**0.26**	**0.48**	**0.035**	**11.53**	**0.49**	**0.46**	**0.99**	**0.57**
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptSbe-Std-ClrNct	**16.26**	**1.31**	**0.57**	**5.12**	**1.50**	**11.82**	**0.26**	**0.48**	**0.035**	**11.53**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptMpr-Std-ClrNct	16.27	1.21	0.57	5.38	1.50	10.61	0.28	0.62	0.041	12.03	0.60	0.60	1.10	0.69
Brk/GrnMpr-Std-ClrSue	16.31	1.41	0.55	4.70	1.58	13.38	0.22	0.46	0.035	10.96	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	16.33	1.26	0.60	5.65	1.39	10.34	0.31	0.48	0.034	12.20	0.49	0.46	0.99	0.57
Brk/HptMpr	16.40	1.03	0.60	6.50	1.41	6.06	0.37	1.15	0.061	13.98	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	15.55	1.41	0.55	4.70	1.58	11.49	0.22	0.46	0.035	10.96	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**15.59**	**1.31**	**0.57**	**5.12**	**1.50**	**10.15**	**0.26**	**0.48**	**0.035**	**11.53**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptMpr-Std-ClrSue	15.60	1.58	0.54	4.39	1.61	12.77	0.19	0.46	0.036	10.49	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrNct	15.67	1.21	0.57	5.38	1.50	9.11	0.28	0.62	0.041	12.03	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	15.75	1.26	0.60	5.65	1.39	8.88	0.31	0.48	0.034	12.20	0.49	0.46	0.99	0.57

Table 55 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.37**	**1.10**	**0.41**	**2.59**	**2.05**	**0.51**	**0.61**	**1.26**	**0.046**	**8.32**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.49	1.16	0.41	2.55	2.05	2.46	0.58	1.15	0.044	8.24	1.08	1.11	1.89	1.25
Mtl/HptNct	8.50	1.09	0.39	2.50	2.16	1.43	0.55	1.27	0.046	8.36	1.27	1.22	1.98	1.36
Brk/HptNct	8.59	1.18	0.39	2.45	2.16	3.38	0.51	1.15	0.044	8.26	1.08	1.11	1.89	1.25
Brk/ClrNct	8.65	1.01	0.46	2.85	1.88	1.95	0.79	1.15	0.044	8.45	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**8.38**	**1.10**	**0.41**	**2.59**	**2.05**	**0.56**	**0.61**	**1.26**	**0.046**	**8.32**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.40	1.16	0.41	2.55	2.05	1.53	0.58	1.15	0.044	8.24	1.08	1.11	1.89	1.25
Brk/ClrNct	8.55	1.01	0.46	2.85	1.88	0.98	0.79	1.15	0.044	8.45	1.08	1.11	1.89	1.25
Brk/HptNct	8.56	1.18	0.39	2.45	2.16	3.02	0.51	1.15	0.044	8.26	1.08	1.11	1.89	1.25
Mtl/HptNct	8.56	1.09	0.39	2.50	2.16	2.04	0.55	1.27	0.046	8.36	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**8.37**	**1.10**	**0.41**	**2.59**	**2.05**	**0.48**	**0.61**	**1.26**	**0.046**	**8.32**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.38	1.16	0.41	2.55	2.05	1.31	0.58	1.15	0.044	8.24	1.08	1.11	1.89	1.25
Brk/HptNct	8.51	1.18	0.39	2.45	2.16	2.59	0.51	1.15	0.044	8.26	1.08	1.11	1.89	1.25
Mtl/HptNct	8.53	1.09	0.39	2.50	2.16	1.76	0.55	1.27	0.046	8.36	1.27	1.22	1.98	1.36
Brk/ClrNct	8.53	1.01	0.46	2.85	1.88	0.83	0.79	1.15	0.044	8.45	1.08	1.11	1.89	1.25

Table 56 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.88**	**1.10**	**0.59**	**3.34**	**1.44**	**0.51**	**0.61**	**1.26**	**0.065**	**8.78**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	8.94	1.09	0.56	3.17	1.54	1.43	0.55	1.27	0.065	8.65	1.27	1.22	1.98	1.36
Brk/GrnNct	9.12	1.16	0.59	3.27	1.44	2.46	0.58	1.15	0.061	8.63	1.08	1.11	1.89	1.25
Brk/HptNct	9.13	1.18	0.56	3.08	1.54	3.38	0.51	1.15	0.062	8.46	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	9.30	1.18	0.56	3.15	1.54	4.43	0.51	0.73	0.047	8.42	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**8.89**	**1.10**	**0.59**	**3.34**	**1.44**	**0.56**	**0.61**	**1.26**	**0.065**	**8.78**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.93	1.16	0.59	3.27	1.44	1.53	0.58	1.15	0.061	8.63	1.08	1.11	1.89	1.25
Brk/HptNct	9.06	1.18	0.56	3.08	1.54	3.02	0.51	1.15	0.062	8.46	1.08	1.11	1.89	1.25
Mtl/HptNct	9.06	1.09	0.56	3.17	1.54	2.04	0.55	1.27	0.065	8.65	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrNct	9.43	1.28	0.56	3.06	1.54	6.08	0.47	0.62	0.043	8.21	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**8.87**	**1.10**	**0.59**	**3.34**	**1.44**	**0.48**	**0.61**	**1.26**	**0.065**	**8.78**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.89	1.16	0.59	3.27	1.44	1.31	0.58	1.15	0.061	8.63	1.08	1.11	1.89	1.25
Brk/HptNct	8.97	1.18	0.56	3.08	1.54	2.59	0.51	1.15	0.062	8.46	1.08	1.11	1.89	1.25
Mtl/HptNct	9.01	1.09	0.56	3.17	1.54	1.76	0.55	1.27	0.065	8.65	1.27	1.22	1.98	1.36
Brk/GrnNct-Std-ClrNct	9.26	1.28	0.56	3.06	1.54	5.23	0.47	0.62	0.043	8.21	0.60	0.60	1.10	0.69

Table 57 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/HptNct	9.95	1.09	0.64	3.83	1.26	1.43	0.55	1.27	0.085	9.52	1.27	1.22	1.98	1.36
Mtl/GrnNct	**9.98**	**1.10**	**0.66**	**4.09**	**1.19**	**0.51**	**0.61**	**1.26**	**0.084**	**9.83**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnMpr	10.12	0.89	0.54	3.37	1.60	2.69	0.44	1.26	0.085	9.31	1.27	1.22	1.98	1.36
Mtl/HptMpr	10.15	0.95	0.54	3.20	1.62	3.61	0.40	1.26	0.085	9.07	1.27	1.22	1.98	1.36
Brk/HptNct	10.23	1.18	0.64	3.70	1.26	3.38	0.51	1.15	0.079	9.22	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**10.00**	**1.10**	**0.66**	**4.09**	**1.19**	**0.56**	**0.61**	**1.26**	**0.084**	**9.83**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.06	1.16	0.66	3.99	1.19	1.53	0.58	1.15	0.078	9.60	1.08	1.11	1.89	1.25
Brk/HptNct	10.12	1.18	0.64	3.70	1.26	3.02	0.51	1.15	0.079	9.22	1.08	1.11	1.89	1.25
Mtl/HptNct	10.13	1.09	0.64	3.83	1.26	2.04	0.55	1.27	0.085	9.52	1.27	1.22	1.98	1.36
Mtl/GrnMpr	10.39	0.89	0.54	3.37	1.60	3.60	0.44	1.26	0.085	9.31	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnNct	**9.97**	**1.10**	**0.66**	**4.09**	**1.19**	**0.48**	**0.61**	**1.26**	**0.084**	**9.83**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/HptNct	10.00	1.18	0.64	3.70	1.26	2.59	0.51	1.15	0.079	9.22	1.08	1.11	1.89	1.25
Brk/GrnNct	10.00	1.16	0.66	3.99	1.19	1.31	0.58	1.15	0.078	9.60	1.08	1.11	1.89	1.25
Mtl/HptNct	10.04	1.09	0.64	3.83	1.26	1.76	0.55	1.27	0.085	9.52	1.27	1.22	1.98	1.36
Mtl/GrnMpr	10.24	0.89	0.54	3.37	1.60	3.09	0.44	1.26	0.085	9.31	1.27	1.22	1.98	1.36

Table 58 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – North – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnMpr	11.11	0.89	0.60	3.88	1.39	2.69	0.44	1.26	0.104	10.04	1.27	1.22	1.98	1.36
Mtl/HptMpr	11.14	0.95	0.60	3.65	1.41	3.61	0.40	1.26	0.104	9.69	1.27	1.22	1.98	1.36
Mtl/HptNct	**11.21**	**1.09**	**0.68**	**4.50**	**1.13**	**1.43**	**0.55**	**1.27**	**0.104**	**10.64**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnNct	11.34	1.10	0.69	4.85	1.08	0.51	0.61	1.26	0.103	11.13	1.27	1.22	1.98	1.36
Brk/GrnMpr	11.59	0.95	0.60	3.75	1.39	4.64	0.41	1.15	0.097	9.74	1.08	1.11	1.89	1.25
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	11.36	1.10	0.69	4.85	1.08	0.56	0.61	1.26	0.103	11.13	1.27	1.22	1.98	1.36
Brk/GrnNct	11.44	1.16	0.69	4.71	1.08	1.53	0.58	1.15	0.095	10.83	1.08	1.11	1.89	1.25
Brk/HptNct	11.45	1.18	0.68	4.32	1.13	3.02	0.51	1.15	0.096	10.24	1.08	1.11	1.89	1.25
Mtl/HptNct	**11.46**	**1.09**	**0.68**	**4.50**	**1.13**	**2.04**	**0.55**	**1.27**	**0.104**	**10.64**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnMpr	11.48	0.89	0.60	3.88	1.39	3.60	0.44	1.26	0.104	10.04	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Mtl/GrnMpr	11.27	0.89	0.60	3.88	1.39	3.09	0.44	1.26	0.104	10.04	1.27	1.22	1.98	1.36
Brk/HptNct	11.28	1.18	0.68	4.32	1.13	2.59	0.51	1.15	0.096	10.24	1.08	1.11	1.89	1.25
Brk/GrnMpr	11.31	0.95	0.60	3.75	1.39	3.93	0.41	1.15	0.097	9.74	1.08	1.11	1.89	1.25
Mtl/GrnNct	11.32	1.10	0.69	4.85	1.08	0.48	0.61	1.26	0.103	11.13	1.27	1.22	1.98	1.36
Mtl/HptNct	**11.34**	**1.09**	**0.68**	**4.50**	**1.13**	**1.76**	**0.55**	**1.27**	**0.104**	**10.64**	**1.27**	**1.22**	**1.98**	**1.36**

North Coast

Table 59 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														

Mtl/GrnNct-Std-ClrSue	9.79	1.33	0.35	2.47	2.29	6.87	0.39	0.57	0.096	9.10	0.67	0.56	1.17	0.68
Mtl/ClrNct-Std-ClrSue	9.79	1.27	0.39	2.68	2.13	6.37	0.49	0.57	0.094	9.16	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrNct	**9.81**	**1.28**	**0.39**	**2.65**	**2.16**	**6.38**	**0.47**	**0.62**	**0.096**	**9.17**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/GrnNct-Std-ClrNct	9.81	1.18	0.39	2.74	2.16	4.43	0.51	0.73	0.099	9.37	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrSue	9.82	1.44	0.35	2.40	2.29	8.82	0.36	0.46	0.092	8.93	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**9.78**	**1.28**	**0.39**	**2.65**	**2.16**	**6.08**	**0.47**	**0.62**	**0.096**	**9.17**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct	9.79	1.16	0.41	2.93	2.05	1.53	0.58	1.15	0.111	9.64	1.08	1.11	1.89	1.25
Mtl/GrnNct	9.85	1.10	0.41	3.00	2.05	0.56	0.61	1.26	0.114	9.80	1.27	1.22	1.98	1.36
Brk/HptNct-Std-ClrNct	9.86	1.35	0.36	2.50	2.26	7.57	0.40	0.62	0.097	9.10	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	9.87	1.28	0.39	2.64	2.16	7.12	0.47	0.59	0.095	9.15	0.57	0.57	1.07	0.66
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**9.69**	**1.28**	**0.39**	**2.65**	**2.16**	**5.23**	**0.47**	**0.62**	**0.096**	**9.17**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrNct	9.75	1.35	0.36	2.50	2.26	6.50	0.40	0.62	0.097	9.10	0.60	0.60	1.10	0.69
Brk/GrnNct	9.77	1.16	0.41	2.93	2.05	1.31	0.58	1.15	0.111	9.64	1.08	1.11	1.89	1.25
Brk/GrnNct-Ins-ClrNct	9.78	1.28	0.39	2.64	2.16	6.27	0.47	0.59	0.095	9.15	0.57	0.57	1.07	0.66
Mtl/GrnNct-Std-ClrNct	9.81	1.18	0.39	2.74	2.16	4.39	0.51	0.73	0.099	9.37	0.81	0.72	1.31	0.80

Table 60 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	10.98	1.33	0.52	3.35	1.67	6.87	0.39	0.57	0.103	9.61	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrPye	11.03	1.28	0.51	3.35	1.71	6.66	0.39	0.60	0.105	9.70	0.71	0.60	1.20	0.70
Brk/GrnNct-Std-ClrSue	11.04	1.44	0.52	3.20	1.67	8.82	0.36	0.46	0.096	9.28	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrSue	11.06	1.34	0.50	3.18	1.77	7.80	0.35	0.57	0.104	9.50	0.67	0.56	1.17	0.68
Brk/HptNct-Std-ClrPye	11.10	1.39	0.51	3.20	1.71	8.61	0.36	0.49	0.098	9.38	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	**11.18**	**1.35**	**0.53**	**3.40**	**1.64**	**7.57**	**0.40**	**0.62**	**0.106**	**9.67**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	11.19	1.28	0.56	3.69	1.54	6.08	0.47	0.62	0.104	9.98	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	11.27	1.39	0.51	3.20	1.71	9.46	0.36	0.49	0.098	9.38	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	11.29	1.28	0.54	3.50	1.62	7.98	0.43	0.49	0.096	9.69	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	11.35	1.44	0.52	3.20	1.67	10.34	0.36	0.46	0.096	9.28	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	**10.97**	**1.35**	**0.53**	**3.40**	**1.64**	**6.50**	**0.40**	**0.62**	**0.106**	**9.67**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	11.02	1.28	0.56	3.69	1.54	5.23	0.47	0.62	0.104	9.98	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrSue	11.05	1.44	0.52	3.20	1.67	8.88	0.36	0.46	0.096	9.28	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	11.06	1.39	0.51	3.20	1.71	8.40	0.36	0.49	0.098	9.38	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	11.11	1.28	0.54	3.50	1.62	7.12	0.43	0.49	0.096	9.69	0.51	0.49	1.00	0.59

Table 61 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	12.63	1.15	0.54	3.91	1.60	6.88	0.34	0.59	0.115	10.57	0.69	0.57	1.18	0.68
Mtl/GrnNct-Std-ClrSue	12.69	1.33	0.61	4.22	1.36	6.87	0.39	0.57	0.111	10.63	0.67	0.56	1.17	0.68
Mtl/HptNct-Std-ClrSue	12.70	1.34	0.59	3.96	1.44	7.80	0.35	0.57	0.113	10.36	0.67	0.56	1.17	0.68
Mtl/GrnMpr-Std-ClrSue	12.72	1.24	0.48	3.34	1.82	9.06	0.25	0.57	0.117	10.00	0.67	0.56	1.17	0.68
Mtl/HptSbe-Std-ClrNct	12.72	1.13	0.51	3.66	1.73	7.80	0.30	0.59	0.117	10.38	0.69	0.57	1.18	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	13.03	1.35	0.62	4.29	1.33	7.57	0.40	0.62	0.115	10.76	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	**13.08**	**1.39**	**0.61**	**4.01**	**1.39**	**9.46**	**0.36**	**0.49**	**0.103**	**10.24**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrNct	13.17	1.28	0.64	4.73	1.26	6.08	0.47	0.62	0.112	11.34	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	13.18	1.26	0.54	3.69	1.60	10.34	0.31	0.48	0.105	10.08	0.49	0.46	0.99	0.57
Brk/GrnNct-Std-ClrPye	13.21	1.28	0.63	4.45	1.31	7.98	0.43	0.49	0.099	10.81	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	12.71	1.35	0.62	4.29	1.33	6.50	0.40	0.62	0.115	10.76	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	12.75	1.26	0.54	3.69	1.60	8.88	0.31	0.48	0.105	10.08	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrPye	**12.76**	**1.39**	**0.61**	**4.01**	**1.39**	**8.40**	**0.36**	**0.49**	**0.103**	**10.24**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrSue	12.80	1.44	0.61	4.00	1.36	8.88	0.36	0.46	0.100	10.13	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	12.85	1.31	0.51	3.37	1.73	10.15	0.26	0.48	0.108	9.81	0.49	0.46	0.99	0.57

Table 62 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – All – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnMpr-Std-ClrSue	14.31	1.24	0.55	3.91	1.58	9.06	0.25	0.57	0.127	10.69	0.67	0.56	1.17	0.68
Mtl/GrnSbe-Std-ClrNct	14.35	1.15	0.60	4.67	1.39	6.88	0.34	0.59	0.124	11.60	0.69	0.57	1.18	0.68
Mtl/HptSbe-Std-ClrNct	14.38	1.13	0.57	4.34	1.50	7.80	0.30	0.59	0.127	11.26	0.69	0.57	1.18	0.68
Brk/HptSbe-Std-ClrNct	14.39	1.31	0.57	3.96	1.50	9.75	0.26	0.48	0.115	10.49	0.49	0.46	0.99	0.57
Brk/GrnMpr-Std-ClrSue	14.46	1.41	0.55	3.62	1.58	11.01	0.22	0.46	0.115	10.06	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**15.09**	**1.26**	**0.60**	**4.38**	**1.39**	**10.34**	**0.31**	**0.48**	**0.111**	**10.96**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptNct-Std-ClrNct	15.14	1.35	0.67	5.19	1.18	7.57	0.40	0.62	0.125	12.12	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	15.15	1.39	0.65	4.81	1.22	9.46	0.36	0.49	0.108	11.36	0.51	0.49	1.00	0.59
Brk/HptSbe-Std-ClrNct	15.22	1.31	0.57	3.96	1.50	11.82	0.26	0.48	0.115	10.49	0.49	0.46	0.99	0.57
Brk/GrnSbe-Ins-ClrNct	15.28	1.30	0.60	4.28	1.39	11.38	0.30	0.44	0.106	10.73	0.46	0.43	0.96	0.54
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**14.51**	**1.26**	**0.60**	**4.38**	**1.39**	**8.88**	**0.31**	**0.48**	**0.111**	**10.96**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptSbe-Std-ClrNct	14.55	1.31	0.57	3.96	1.50	10.15	0.26	0.48	0.115	10.49	0.49	0.46	0.99	0.57
Brk/GrnMpr-Std-ClrSue	14.65	1.41	0.55	3.62	1.58	11.49	0.22	0.46	0.115	10.06	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrNct	14.70	1.21	0.57	4.18	1.50	9.11	0.28	0.62	0.132	11.05	0.60	0.60	1.10	0.69
Brk/GrnSbe-Ins-ClrNct	14.70	1.30	0.60	4.28	1.39	9.92	0.30	0.44	0.106	10.73	0.46	0.43	0.96	0.54

Table 63 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.12**	**1.10**	**0.41**	**1.77**	**2.05**	**0.51**	**0.61**	**1.26**	**0.144**	**8.07**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct	8.22	1.01	0.46	1.95	1.88	1.95	0.79	1.15	0.138	8.02	1.08	1.11	1.89	1.25
Brk/GrnNct	8.23	1.16	0.41	1.75	2.05	2.46	0.58	1.15	0.139	7.98	1.08	1.11	1.89	1.25
Mtl/HptNct	8.30	1.09	0.39	1.71	2.16	1.43	0.55	1.27	0.145	8.16	1.27	1.22	1.98	1.36

Mtl/ClrNct-Std-ClrNct	8.31	0.99	0.43	1.91	2.00	3.93	0.72	0.73	0.118	7.92	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	8.12	1.01	0.46	1.95	1.88	0.98	0.79	1.15	0.138	8.02	1.08	1.11	1.89	1.25
Mtl/GrnNct	**8.13**	**1.10**	**0.41**	**1.77**	**2.05**	**0.56**	**0.61**	**1.26**	**0.144**	**8.07**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.13	1.16	0.41	1.75	2.05	1.53	0.58	1.15	0.139	7.98	1.08	1.11	1.89	1.25
Brk/HptNct	8.35	1.18	0.39	1.68	2.16	3.02	0.51	1.15	0.140	8.05	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	8.35	1.04	0.43	1.88	2.00	5.53	0.68	0.62	0.113	7.80	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	8.10	1.01	0.46	1.95	1.88	0.83	0.79	1.15	0.138	8.02	1.08	1.11	1.89	1.25
Brk/GrnNct	8.11	1.16	0.41	1.75	2.05	1.31	0.58	1.15	0.139	7.98	1.08	1.11	1.89	1.25
Mtl/GrnNct	**8.12**	**1.10**	**0.41**	**1.77**	**2.05**	**0.48**	**0.61**	**1.26**	**0.144**	**8.07**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct-Std-ClrNct	8.27	1.04	0.43	1.88	2.00	4.75	0.68	0.62	0.113	7.80	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	8.28	1.28	0.39	1.67	2.16	5.23	0.47	0.62	0.116	7.75	0.60	0.60	1.10	0.69

Table 64 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**8.58**	**1.10**	**0.59**	**2.30**	**1.44**	**0.51**	**0.61**	**1.26**	**0.192**	**8.48**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	8.75	1.09	0.56	2.18	1.54	1.43	0.55	1.27	0.194	8.46	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrNct	8.76	1.18	0.56	2.16	1.54	4.43	0.51	0.73	0.145	7.88	0.81	0.72	1.31	0.80
Brk/GrnNct	8.79	1.16	0.59	2.25	1.44	2.46	0.58	1.15	0.183	8.30	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrPye	8.88	1.20	0.54	2.08	1.62	5.73	0.46	0.60	0.133	7.73	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**8.59**	**1.10**	**0.59**	**2.30**	**1.44**	**0.56**	**0.61**	**1.26**	**0.192**	**8.48**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	8.60	1.16	0.59	2.25	1.44	1.53	0.58	1.15	0.183	8.30	1.08	1.11	1.89	1.25
Brk/HptNct	8.84	1.18	0.56	2.11	1.54	3.02	0.51	1.15	0.184	8.24	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	8.87	1.28	0.56	2.10	1.54	6.08	0.47	0.62	0.135	7.65	0.60	0.60	1.10	0.69
Mtl/HptNct	8.87	1.09	0.56	2.18	1.54	2.04	0.55	1.27	0.194	8.46	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	8.56	1.16	0.59	2.25	1.44	1.31	0.58	1.15	0.183	8.30	1.08	1.11	1.89	1.25
Mtl/GrnNct	**8.58**	**1.10**	**0.59**	**2.30**	**1.44**	**0.48**	**0.61**	**1.26**	**0.192**	**8.48**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	8.70	1.28	0.56	2.10	1.54	5.23	0.47	0.62	0.135	7.65	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	8.75	1.18	0.56	2.16	1.54	4.39	0.51	0.73	0.145	7.88	0.81	0.72	1.31	0.80
Brk/HptNct	8.76	1.18	0.56	2.11	1.54	2.59	0.51	1.15	0.184	8.24	1.08	1.11	1.89	1.25

Table 65 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**9.64**	**1.10**	**0.66**	**2.82**	**1.19**	**0.51**	**0.61**	**1.26**	**0.240**	**9.49**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	9.76	1.09	0.64	2.64	1.26	1.43	0.55	1.27	0.243	9.33	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrNct	9.78	1.18	0.64	2.62	1.26	4.43	0.51	0.73	0.170	8.45	0.81	0.72	1.31	0.80
Mtl/GrnNct-Std-ClrPye	9.85	1.20	0.63	2.49	1.31	5.73	0.46	0.60	0.152	8.14	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrNct	9.86	1.23	0.62	2.41	1.33	5.36	0.44	0.73	0.172	8.25	0.81	0.72	1.31	0.80
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**9.65**	**1.10**	**0.66**	**2.82**	**1.19**	**0.56**	**0.61**	**1.26**	**0.240**	**9.49**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	9.67	1.16	0.66	2.75	1.19	1.53	0.58	1.15	0.226	9.21	1.08	1.11	1.89	1.25
Brk/HptNct	9.90	1.18	0.64	2.55	1.26	3.02	0.51	1.15	0.228	8.99	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	9.94	1.28	0.64	2.52	1.26	6.08	0.47	0.62	0.155	8.11	0.60	0.60	1.10	0.69
Mtl/HptNct	9.94	1.09	0.64	2.64	1.26	2.04	0.55	1.27	0.243	9.33	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	9.60	1.16	0.66	2.75	1.19	1.31	0.58	1.15	0.226	9.21	1.08	1.11	1.89	1.25
Mtl/GrnNct	**9.63**	**1.10**	**0.66**	**2.82**	**1.19**	**0.48**	**0.61**	**1.26**	**0.240**	**9.49**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct-Std-ClrNct	9.68	1.28	0.64	2.52	1.26	5.23	0.47	0.62	0.155	8.11	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	9.77	1.18	0.64	2.62	1.26	4.39	0.51	0.73	0.170	8.45	0.81	0.72	1.31	0.80
Brk/HptNct	9.77	1.18	0.64	2.55	1.26	2.59	0.51	1.15	0.228	8.99	1.08	1.11	1.89	1.25

Table 66 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – North – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct	**10.94**	**1.10**	**0.69**	**3.35**	**1.08**	**0.51**	**0.61**	**1.26**	**0.288**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/HptNct	11.02	1.09	0.68	3.11	1.13	1.43	0.55	1.27	0.292	10.45	1.27	1.22	1.98	1.36
Mtl/GrnNct-Std-ClrNct	11.05	1.18	0.68	3.08	1.13	4.43	0.51	0.73	0.194	9.28	0.81	0.72	1.31	0.80
Mtl/HptNct-Std-ClrNct	11.08	1.23	0.67	2.80	1.18	5.36	0.44	0.73	0.197	8.94	0.81	0.72	1.31	0.80
Mtl/GrnNct-Std-ClrPye	11.09	1.20	0.67	2.91	1.17	5.73	0.46	0.60	0.171	8.80	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Mtl/GrnNct	**10.96**	**1.10**	**0.69**	**3.35**	**1.08**	**0.56**	**0.61**	**1.26**	**0.288**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/GrnNct	10.98	1.16	0.69	3.25	1.08	1.53	0.58	1.15	0.270	10.37	1.08	1.11	1.89	1.25
Brk/HptNct	11.21	1.18	0.68	2.98	1.13	3.02	0.51	1.15	0.271	10.00	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	11.26	1.28	0.68	2.94	1.13	6.08	0.47	0.62	0.174	8.83	0.60	0.60	1.10	0.69
Mtl/HptNct	11.27	1.09	0.68	3.11	1.13	2.04	0.55	1.27	0.292	10.45	1.27	1.22	1.98	1.36
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	10.89	1.16	0.69	3.25	1.08	1.31	0.58	1.15	0.270	10.37	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	10.92	1.28	0.68	2.94	1.13	5.23	0.47	0.62	0.174	8.83	0.60	0.60	1.10	0.69
Mtl/GrnNct	**10.93**	**1.10**	**0.69**	**3.35**	**1.08**	**0.48**	**0.61**	**1.26**	**0.288**	**10.74**	**1.27**	**1.22**	**1.98**	**1.36**
Mtl/GrnNct-Std-ClrNct	11.04	1.18	0.68	3.08	1.13	4.39	0.51	0.73	0.194	9.28	0.81	0.72	1.31	0.80
Brk/HptNct	11.04	1.18	0.68	2.98	1.13	2.59	0.51	1.15	0.271	10.00	1.08	1.11	1.89	1.25

Central Valley

Table 67 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														

Brk/GrnNct-Std-ClrSue	**13.59**	**1.44**	**0.35**	**4.45**	**2.29**	**8.82**	**0.36**	**0.46**	**0.121**	**12.71**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	13.64	1.44	0.35	4.43	2.29	9.86	0.36	0.42	0.119	12.65	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrSue	13.65	1.47	0.32	4.33	2.38	9.75	0.32	0.46	0.122	12.68	0.47	0.45	0.98	0.56
Vnl/GrnNct-Std-ClrSue	13.66	1.56	0.34	4.29	2.33	12.07	0.32	0.36	0.117	12.45	0.41	0.36	0.91	0.00
Brk/HptNct-Ins-ClrSue	13.66	1.52	0.32	4.29	2.38	10.79	0.31	0.42	0.121	12.58	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**13.74**	**1.44**	**0.35**	**4.45**	**2.29**	**10.34**	**0.36**	**0.46**	**0.121**	**12.71**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	13.75	1.39	0.34	4.46	2.33	9.46	0.36	0.49	0.123	12.81	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	13.76	1.43	0.34	4.41	2.33	10.50	0.35	0.45	0.121	12.71	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrPye	13.77	1.28	0.36	4.66	2.24	7.98	0.43	0.49	0.121	12.98	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	13.78	1.31	0.36	4.61	2.24	9.02	0.42	0.45	0.119	12.88	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**13.59**	**1.44**	**0.35**	**4.45**	**2.29**	**8.88**	**0.36**	**0.46**	**0.121**	**12.71**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	13.64	1.44	0.35	4.43	2.29	9.92	0.36	0.42	0.119	12.65	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrPye	13.65	1.39	0.34	4.46	2.33	8.40	0.36	0.49	0.123	12.81	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	13.65	1.43	0.34	4.41	2.33	9.44	0.35	0.45	0.121	12.71	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrNct	13.69	1.35	0.36	4.64	2.26	6.50	0.40	0.62	0.128	13.04	0.60	0.60	1.10	0.69

Table 68 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptNct-Std-ClrSue	15.56	1.47	0.50	5.46	1.77	9.75	0.32	0.46	0.129	13.61	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrSue	15.57	1.58	0.37	4.72	2.21	11.93	0.19	0.46	0.135	13.18	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrSue	**15.57**	**1.44**	**0.52**	**5.68**	**1.67**	**8.82**	**0.36**	**0.46**	**0.127**	**13.80**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Ins-ClrSue	15.57	1.52	0.50	5.36	1.77	10.79	0.31	0.42	0.125	13.41	0.44	0.42	0.95	0.53
Brk/GrnMpr-Std-ClrSue	15.60	1.41	0.38	4.89	2.18	11.01	0.22	0.46	0.133	13.40	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrPye	**15.84**	**1.39**	**0.51**	**5.71**	**1.71**	**9.46**	**0.36**	**0.49**	**0.130**	**13.95**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Ins-ClrPye	15.85	1.43	0.51	5.62	1.71	10.50	0.35	0.45	0.126	13.75	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	15.87	1.44	0.52	5.68	1.67	10.34	0.36	0.46	0.127	13.80	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	15.94	1.26	0.44	5.42	1.95	10.34	0.31	0.48	0.131	13.88	0.49	0.46	0.99	0.57
Brk/GrnSbe-Ins-ClrNct	15.96	1.30	0.44	5.32	1.95	11.38	0.30	0.44	0.128	13.68	0.46	0.43	0.96	0.54
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**15.58**	**1.44**	**0.52**	**5.68**	**1.67**	**8.88**	**0.36**	**0.46**	**0.127**	**13.80**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	15.63	1.39	0.51	5.71	1.71	8.40	0.36	0.49	0.130	13.95	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	15.64	1.43	0.51	5.62	1.71	9.44	0.35	0.45	0.126	13.75	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrSue	15.64	1.47	0.50	5.46	1.77	10.15	0.32	0.46	0.129	13.61	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrSue	15.65	1.52	0.50	5.36	1.77	11.19	0.31	0.42	0.125	13.41	0.44	0.42	0.95	0.53

Table 69 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptMpr-Std-ClrSue	17.54	1.58	0.47	5.47	1.85	11.93	0.19	0.46	0.144	13.96	0.47	0.45	0.98	0.56
Brk/GrnMpr-Std-ClrSue	17.61	1.41	0.48	5.73	1.82	11.01	0.22	0.46	0.142	14.31	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	17.69	1.31	0.51	6.10	1.73	9.75	0.26	0.48	0.142	14.77	0.49	0.46	0.99	0.57
Brk/HptMpr-Ins-ClrSue	17.70	1.58	0.47	5.42	1.85	12.97	0.19	0.42	0.139	13.81	0.44	0.42	0.95	0.53
Brk/GrnMpr-Ins-ClrSue	17.77	1.41	0.48	5.67	1.82	12.05	0.22	0.42	0.137	14.15	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptSbe-Std-ClrNct	18.31	1.31	0.51	6.10	1.73	11.82	0.26	0.48	0.142	14.77	0.49	0.46	0.99	0.57
Brk/GrnMpr-Std-ClrSue	18.32	1.41	0.48	5.73	1.82	13.38	0.22	0.46	0.142	14.31	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	**18.33**	**1.26**	**0.54**	**6.52**	**1.60**	**10.34**	**0.31**	**0.48**	**0.138**	**15.22**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnSbe-Ins-ClrNct	18.34	1.30	0.54	6.38	1.60	11.38	0.30	0.44	0.134	14.93	0.46	0.43	0.96	0.54
Brk/HptMpr-Std-ClrSue	18.41	1.58	0.47	5.47	1.85	14.86	0.19	0.46	0.144	13.96	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	17.75	1.41	0.48	5.73	1.82	11.49	0.22	0.46	0.142	14.31	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrSue	17.79	1.58	0.47	5.47	1.85	12.77	0.19	0.46	0.144	13.96	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	17.81	1.31	0.51	6.10	1.73	10.15	0.26	0.48	0.142	14.77	0.49	0.46	0.99	0.57
Brk/GrnSbe-Std-ClrNct	**17.89**	**1.26**	**0.54**	**6.52**	**1.60**	**8.88**	**0.31**	**0.48**	**0.138**	**15.22**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnSbe-Ins-ClrNct	17.91	1.30	0.54	6.38	1.60	9.92	0.30	0.44	0.134	14.93	0.46	0.43	0.96	0.54

Table 70 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – All – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptMpr-Std-ClrSue	19.70	1.58	0.54	6.23	1.61	11.93	0.19	0.46	0.154	14.93	0.47	0.45	0.98	0.56
Brk/GrnMpr-Std-ClrSue	19.82	1.41	0.55	6.57	1.58	11.01	0.22	0.46	0.151	15.41	0.47	0.45	0.98	0.56
Brk/HptMpr-Ins-ClrSue	19.91	1.58	0.54	6.15	1.61	12.97	0.19	0.42	0.147	14.73	0.44	0.42	0.95	0.53
Brk/HptSbe-Std-ClrNct	**20.00**	**1.31**	**0.57**	**7.06**	**1.50**	**9.75**	**0.26**	**0.48**	**0.150**	**16.10**	**0.49**	**0.46**	**0.99**	**0.57**
Vnl/HptMpr-Std-ClrSue	20.01	1.81	0.53	5.70	1.64	15.18	0.16	0.36	0.140	13.94	0.41	0.36	0.91	0.00
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	20.77	1.41	0.55	6.57	1.58	13.38	0.22	0.46	0.151	15.41	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**20.82**	**1.31**	**0.57**	**7.06**	**1.50**	**11.82**	**0.26**	**0.48**	**0.150**	**16.10**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptMpr-Std-ClrSue	20.87	1.58	0.54	6.23	1.61	14.86	0.19	0.46	0.154	14.93	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	20.94	1.26	0.60	7.63	1.39	10.34	0.31	0.48	0.146	16.81	0.49	0.46	0.99	0.57
Brk/GrnSbe-Ins-ClrNct	20.97	1.30	0.60	7.44	1.39	11.38	0.30	0.44	0.139	16.42	0.46	0.43	0.96	0.54
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	20.01	1.41	0.55	6.57	1.58	11.49	0.22	0.46	0.151	15.41	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrSue	20.03	1.58	0.54	6.23	1.61	12.77	0.19	0.46	0.154	14.93	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**20.16**	**1.31**	**0.57**	**7.06**	**1.50**	**10.15**	**0.26**	**0.48**	**0.150**	**16.10**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnMpr-Ins-ClrSue	20.22	1.41	0.55	6.49	1.58	12.53	0.22	0.42	0.144	15.21	0.44	0.42	0.95	0.53
Brk/HptMpr-Ins-ClrSue	20.25	1.58	0.54	6.15	1.61	13.81	0.19	0.42	0.147	14.73	0.44	0.42	0.95	0.53

Table 71 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/ClrNct-Std-ClrSue	**11.94**	**1.27**	**0.39**	**3.62**	**2.13**	**6.37**	**0.49**	**0.57**	**0.145**	**11.31**	**0.67**	**0.56**	**1.17**	**0.68**
Brk/ClrNct-Std-ClrSue	11.96	1.35	0.39	3.56	2.13	8.32	0.46	0.46	0.138	11.13	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrNct	12.00	1.28	0.39	3.59	2.16	6.38	0.47	0.62	0.149	11.36	0.60	0.60	1.10	0.69
Mtl/GrnNct-Std-ClrNct	12.00	1.18	0.39	3.67	2.16	4.43	0.51	0.73	0.155	11.55	0.81	0.72	1.31	0.80
Mtl/GrnNct-Std-ClrPye	12.02	1.20	0.36	3.57	2.24	5.73	0.46	0.60	0.147	11.45	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.97	1.28	0.39	3.59	2.16	6.08	0.47	0.62	0.149	11.36	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	12.04	1.28	0.39	3.59	2.16	7.12	0.47	0.59	0.147	11.33	0.57	0.57	1.07	0.66
Brk/GrnNct	12.06	1.16	0.41	3.83	2.05	1.53	0.58	1.15	0.178	11.91	1.08	1.11	1.89	1.25
Mtl/GrnNct-Std-ClrNct	12.06	1.18	0.39	3.67	2.16	5.11	0.51	0.73	0.155	11.55	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	12.07	1.28	0.36	3.51	2.24	7.98	0.43	0.49	0.141	11.28	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	11.88	1.28	0.39	3.59	2.16	5.23	0.47	0.62	0.149	11.36	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	11.96	1.28	0.39	3.59	2.16	6.27	0.47	0.59	0.147	11.33	0.57	0.57	1.07	0.66
Brk/ClrNct-Std-ClrSue	11.97	1.35	0.39	3.56	2.13	8.40	0.46	0.46	0.138	11.13	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrPye	11.99	1.28	0.36	3.51	2.24	7.12	0.43	0.49	0.141	11.28	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrNct	11.99	1.18	0.39	3.67	2.16	4.39	0.51	0.73	0.155	11.55	0.81	0.72	1.31	0.80

Table 72 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	13.06	1.33	0.52	4.14	1.67	6.87	0.39	0.57	0.169	11.69	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	13.11	1.44	0.52	4.02	1.67	8.82	0.36	0.46	0.157	11.34	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrPye	13.14	1.28	0.51	4.14	1.71	6.66	0.39	0.60	0.173	11.81	0.71	0.60	1.20	0.70
Mtl/GrnNct-Std-ClrPye	13.14	1.20	0.54	4.36	1.62	5.73	0.46	0.60	0.171	12.00	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrSue	**13.18**	**1.27**	**0.57**	**4.44**	**1.51**	**6.37**	**0.49**	**0.57**	**0.166**	**11.91**	**0.67**	**0.56**	**1.17**	**0.68**
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	13.17	1.28	0.56	4.40	1.54	6.08	0.47	0.62	0.173	11.95	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	13.24	1.28	0.54	4.24	1.62	7.98	0.43	0.49	0.158	11.65	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	13.28	1.35	0.53	4.18	1.64	7.57	0.40	0.62	0.175	11.77	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	13.32	1.28	0.56	4.39	1.54	7.12	0.47	0.59	0.169	11.89	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	13.32	1.31	0.54	4.20	1.62	9.02	0.42	0.45	0.153	11.52	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	12.99	1.28	0.56	4.40	1.54	5.23	0.47	0.62	0.173	11.95	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	13.07	1.35	0.53	4.18	1.64	6.50	0.40	0.62	0.175	11.77	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	13.07	1.28	0.54	4.24	1.62	7.12	0.43	0.49	0.158	11.65	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	13.12	1.44	0.52	4.02	1.67	8.88	0.36	0.46	0.157	11.34	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	13.14	1.39	0.51	4.02	1.71	8.40	0.36	0.49	0.160	11.46	0.51	0.49	1.00	0.59

Table 73 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	14.61	1.33	0.61	4.81	1.36	6.87	0.39	0.57	0.192	12.55	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	14.68	1.44	0.61	4.63	1.36	8.82	0.36	0.46	0.173	12.03	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrPye	14.68	1.28	0.61	4.82	1.39	6.66	0.39	0.60	0.197	12.68	0.71	0.60	1.20	0.70
Mtl/GrnSbe-Std-ClrNct	14.72	1.15	0.54	4.59	1.60	6.88	0.34	0.59	0.198	12.65	0.69	0.57	1.18	0.68
Mtl/HptNct-Std-ClrSue	14.74	1.34	0.59	4.62	1.44	7.80	0.35	0.57	0.194	12.40	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	14.93	1.28	0.64	5.20	1.26	6.08	0.47	0.62	0.198	13.10	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	14.94	1.28	0.63	4.97	1.31	7.98	0.43	0.49	0.175	12.55	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	**14.98**	**1.35**	**0.62**	**4.87**	**1.33**	**7.57**	**0.40**	**0.62**	**0.201**	**12.71**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrPye	15.01	1.39	0.61	4.64	1.39	9.46	0.36	0.49	0.179	12.17	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	15.07	1.31	0.63	4.90	1.31	9.02	0.42	0.45	0.167	12.36	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	**14.66**	**1.35**	**0.62**	**4.87**	**1.33**	**6.50**	**0.40**	**0.62**	**0.201**	**12.71**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	14.67	1.28	0.64	5.20	1.26	5.23	0.47	0.62	0.198	13.10	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	14.69	1.39	0.61	4.64	1.39	8.40	0.36	0.49	0.179	12.17	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	14.69	1.28	0.63	4.97	1.31	7.12	0.43	0.49	0.175	12.55	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	14.69	1.44	0.61	4.63	1.36	8.88	0.36	0.46	0.173	12.03	0.47	0.45	0.98	0.56

Table 74 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – North – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Mtl/GrnSbe-Std-ClrNct	16.34	1.15	0.60	5.18	1.39	6.88	0.34	0.59	0.223	13.58	0.69	0.57	1.18	0.68
Mtl/GrnNct-Std-ClrSue	16.42	1.33	0.66	5.48	1.20	6.87	0.39	0.57	0.215	13.68	0.67	0.56	1.17	0.68
Brk/GrnSbe-Std-ClrNct	16.43	1.26	0.60	4.94	1.39	8.83	0.31	0.48	0.198	12.90	0.49	0.46	0.99	0.57
Mtl/HptNct-Std-ClrPye	16.49	1.28	0.65	5.50	1.22	6.66	0.39	0.60	0.222	13.82	0.71	0.60	1.20	0.70
Mtl/HptSbe-Std-ClrNct	16.51	1.13	0.57	4.94	1.50	7.80	0.30	0.59	0.225	13.39	0.69	0.57	1.18	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	16.91	1.28	0.67	5.69	1.17	7.98	0.43	0.49	0.192	13.71	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrPye	16.92	1.39	0.65	5.26	1.22	9.46	0.36	0.49	0.197	13.13	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	**16.95**	**1.35**	**0.67**	**5.57**	**1.18**	**7.57**	**0.40**	**0.62**	**0.226**	**13.92**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	16.95	1.28	0.68	6.00	1.13	6.08	0.47	0.62	0.222	14.52	0.60	0.60	1.10	0.69
Brk/GrnSbe-Std-ClrNct	17.03	1.26	0.60	4.94	1.39	10.34	0.31	0.48	0.198	12.90	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	16.45	1.26	0.60	4.94	1.39	8.88	0.31	0.48	0.198	12.90	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrPye	16.49	1.39	0.65	5.26	1.22	8.40	0.36	0.49	0.197	13.13	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	**16.52**	**1.35**	**0.67**	**5.57**	**1.18**	**6.50**	**0.40**	**0.62**	**0.226**	**13.92**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrSue	16.53	1.44	0.66	5.24	1.20	8.88	0.36	0.46	0.189	12.98	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrPye	16.56	1.28	0.67	5.69	1.17	7.12	0.43	0.49	0.192	13.71	0.51	0.49	1.00	0.59

Desert

Table 75 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**15.50**	**1.44**	**0.35**	**5.62**	**2.29**	**8.82**	**0.36**	**0.46**	**0.117**	**14.62**	**0.47**	**0.45**	**0.98**	**0.56**
Vnl/GrnNct-Std-ClrSue	15.53	1.56	0.34	5.43	2.33	12.07	0.32	0.36	0.113	14.32	0.41	0.36	0.91	0.00
Brk/GrnNct-Ins-ClrSue	15.54	1.44	0.35	5.59	2.29	9.86	0.36	0.42	0.115	14.55	0.44	0.42	0.95	0.53
Brk/HptNct-Ins-ClrSue	15.55	1.52	0.32	5.44	2.38	10.79	0.31	0.42	0.116	14.47	0.44	0.42	0.95	0.53
Vnl/GrnNct-Ins-ClrSue	15.56	1.56	0.34	5.40	2.33	13.11	0.32	0.32	0.111	14.25	0.38	0.33	0.88	0.00
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**15.65**	**1.44**	**0.35**	**5.62**	**2.29**	**10.34**	**0.36**	**0.46**	**0.117**	**14.62**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Ins-ClrPye	15.67	1.43	0.34	5.58	2.33	10.50	0.35	0.45	0.117	14.62	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	15.68	1.39	0.34	5.64	2.33	9.46	0.36	0.49	0.118	14.73	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrSue	15.69	1.44	0.35	5.59	2.29	11.38	0.36	0.42	0.115	14.55	0.44	0.42	0.95	0.53
Brk/GrnNct-Ins-ClrPye	15.70	1.31	0.36	5.79	2.24	9.02	0.42	0.45	0.115	14.80	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**15.51**	**1.44**	**0.35**	**5.62**	**2.29**	**8.88**	**0.36**	**0.46**	**0.117**	**14.62**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	15.54	1.44	0.35	5.59	2.29	9.92	0.36	0.42	0.115	14.55	0.44	0.42	0.95	0.53
Brk/HptNct-Ins-ClrPye	15.56	1.43	0.34	5.58	2.33	9.44	0.35	0.45	0.117	14.62	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	15.57	1.39	0.34	5.64	2.33	8.40	0.36	0.49	0.118	14.73	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrSue	15.59	1.52	0.32	5.44	2.38	11.19	0.31	0.42	0.116	14.47	0.44	0.42	0.95	0.53

Table 76 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptMpr-Std-ClrSue	17.67	1.58	0.37	6.00	2.21	11.93	0.19	0.46	0.131	15.28	0.47	0.45	0.98	0.56
Vnl/HptNct-Ins-ClrSue	17.69	1.67	0.48	6.27	1.81	14.04	0.27	0.32	0.114	14.88	0.38	0.33	0.88	0.00
Brk/HptNct-Ins-ClrSue	**17.69**	**1.52**	**0.50**	**6.65**	**1.77**	**10.79**	**0.31**	**0.42**	**0.122**	**15.53**	**0.44**	**0.42**	**0.95**	**0.53**
Brk/HptNct-Std-ClrSue	17.71	1.47	0.50	6.76	1.77	9.75	0.32	0.46	0.125	15.76	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Ins-ClrPye	18.01	1.43	0.51	6.92	1.71	10.50	0.35	0.45	0.123	15.91	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	18.03	1.39	0.51	7.04	1.71	9.46	0.36	0.49	0.127	16.14	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	18.04	1.44	0.52	6.99	1.67	10.34	0.36	0.46	0.124	15.97	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	18.09	1.30	0.44	6.61	1.95	11.38	0.30	0.44	0.124	15.81	0.46	0.43	0.96	0.54
Brk/HptNct-Ins-ClrSue	**18.10**	**1.52**	**0.50**	**6.65**	**1.77**	**12.86**	**0.31**	**0.42**	**0.122**	**15.53**	**0.44**	**0.42**	**0.95**	**0.53**
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	17.75	1.44	0.52	6.99	1.67	8.88	0.36	0.46	0.124	15.97	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrSue	**17.77**	**1.52**	**0.50**	**6.65**	**1.77**	**11.19**	**0.31**	**0.42**	**0.122**	**15.53**	**0.44**	**0.42**	**0.95**	**0.53**
Brk/HptNct-Std-ClrSue	17.79	1.47	0.50	6.76	1.77	10.15	0.32	0.46	0.125	15.76	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrPye	17.79	1.43	0.51	6.92	1.71	9.44	0.35	0.45	0.123	15.91	0.48	0.46	0.97	0.56
Brk/GrnSbe-Ins-ClrNct	17.80	1.30	0.44	6.61	1.95	9.92	0.30	0.44	0.124	15.81	0.46	0.43	0.96	0.54

Table 77 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptMpr-Std-ClrSue	19.86	1.58	0.47	6.88	1.85	11.93	0.19	0.46	0.141	16.28	0.47	0.45	0.98	0.56
Brk/GrnMpr-Std-ClrSue	19.95	1.41	0.48	7.14	1.82	11.01	0.22	0.46	0.139	16.65	0.47	0.45	0.98	0.56
Brk/HptMpr-Ins-ClrSue	19.97	1.58	0.47	6.79	1.85	12.97	0.19	0.42	0.136	16.08	0.44	0.42	0.95	0.53
Vnl/HptMpr-Std-ClrSue	19.98	1.81	0.46	6.40	1.89	15.18	0.16	0.36	0.131	15.42	0.41	0.36	0.91	0.00
Vnl/GrnMpr-Ins-ClrSue	20.03	1.67	0.47	6.49	1.85	15.30	0.18	0.32	0.124	15.44	0.38	0.33	0.88	0.00
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	20.66	1.41	0.48	7.14	1.82	13.38	0.22	0.46	0.139	16.65	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**20.70**	**1.31**	**0.51**	**7.53**	**1.73**	**11.82**	**0.26**	**0.48**	**0.139**	**17.16**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnSbe-Ins-ClrNct	20.71	1.30	0.54	7.80	1.60	11.38	0.30	0.44	0.132	17.30	0.46	0.43	0.96	0.54
Brk/HptMpr-Std-ClrSue	20.74	1.58	0.47	6.88	1.85	14.86	0.19	0.46	0.141	16.28	0.47	0.45	0.98	0.56
Brk/GrnSbe-Std-ClrNct	20.74	1.26	0.54	7.97	1.60	10.34	0.31	0.48	0.136	17.64	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	20.09	1.41	0.48	7.14	1.82	11.49	0.22	0.46	0.139	16.65	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrSue	20.11	1.58	0.47	6.88	1.85	12.77	0.19	0.46	0.141	16.28	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**20.20**	**1.31**	**0.51**	**7.53**	**1.73**	**10.15**	**0.26**	**0.48**	**0.139**	**17.16**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnMpr-Ins-ClrSue	20.21	1.41	0.48	7.06	1.82	12.53	0.22	0.42	0.134	16.45	0.44	0.42	0.95	0.53
Brk/HptMpr-Ins-ClrSue	20.22	1.58	0.47	6.79	1.85	13.81	0.19	0.42	0.136	16.08	0.44	0.42	0.95	0.53

Table 78 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – All – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/HptMpr-Std-ClrSue	22.24	1.58	0.54	7.76	1.61	11.93	0.19	0.46	0.151	17.47	0.47	0.45	0.98	0.56
Vnl/HptMpr-Std-ClrSue	22.38	1.81	0.53	7.12	1.64	15.18	0.16	0.36	0.138	16.31	0.41	0.36	0.91	0.00
Brk/GrnMpr-Std-ClrSue	22.39	1.41	0.55	8.11	1.58	11.01	0.22	0.46	0.149	17.98	0.47	0.45	0.98	0.56
Brk/HptMpr-Ins-ClrSue	22.40	1.58	0.54	7.64	1.61	12.97	0.19	0.42	0.145	17.21	0.44	0.42	0.95	0.53
Vnl/GrnMpr-Ins-ClrSue	22.47	1.67	0.54	7.25	1.61	15.30	0.18	0.32	0.128	16.35	0.38	0.33	0.88	0.00
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnMpr-Std-ClrSue	23.33	1.41	0.55	8.11	1.58	13.38	0.22	0.46	0.149	17.98	0.47	0.45	0.98	0.56
Brk/HptMpr-Std-ClrSue	23.41	1.58	0.54	7.76	1.61	14.86	0.19	0.46	0.151	17.47	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	**23.45**	**1.31**	**0.57**	**8.63**	**1.50**	**11.82**	**0.26**	**0.48**	**0.149**	**18.73**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/GrnMpr-Ins-ClrSue	23.48	1.41	0.55	8.00	1.58	14.42	0.22	0.42	0.142	17.72	0.44	0.42	0.95	0.53
Brk/HptMpr-Ins-ClrSue	23.57	1.58	0.54	7.64	1.61	15.90	0.19	0.42	0.145	17.21	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC High Volume Cost Model														
Brk/HptMpr-Std-ClrSue	22.58	1.58	0.54	7.76	1.61	12.77	0.19	0.46	0.151	17.47	0.47	0.45	0.98	0.56
Brk/GrnMpr-Std-ClrSue	22.58	1.41	0.55	8.11	1.58	11.49	0.22	0.46	0.149	17.98	0.47	0.45	0.98	0.56
Brk/GrnMpr-Ins-ClrSue	22.73	1.41	0.55	8.00	1.58	12.53	0.22	0.42	0.142	17.72	0.44	0.42	0.95	0.53
Brk/HptMpr-Ins-ClrSue	22.73	1.58	0.54	7.64	1.61	13.81	0.19	0.42	0.145	17.21	0.44	0.42	0.95	0.53
Brk/HptSbe-Std-ClrNct	**22.79**	**1.31**	**0.57**	**8.63**	**1.50**	**10.15**	**0.26**	**0.48**	**0.149**	**18.73**	**0.49**	**0.46**	**0.99**	**0.57**

Table 79 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	13.84	1.35	0.39	4.66	2.13	8.32	0.46	0.46	0.140	13.01	0.47	0.45	0.98	0.56
Mtl/ClrNct-Std-ClrSue	13.86	1.27	0.39	4.74	2.13	6.37	0.49	0.57	0.147	13.22	0.67	0.56	1.17	0.68
Brk/ClrNct-Ins-ClrSue	13.89	1.35	0.39	4.65	2.13	9.36	0.46	0.42	0.137	12.96	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrSue	13.90	1.44	0.35	4.50	2.29	8.82	0.36	0.46	0.142	13.02	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrNct	**13.92**	**1.28**	**0.39**	**4.72**	**2.16**	**6.38**	**0.47**	**0.62**	**0.150**	**13.28**	**0.60**	**0.60**	**1.10**	**0.69**
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**13.89**	**1.28**	**0.39**	**4.72**	**2.16**	**6.08**	**0.47**	**0.62**	**0.150**	**13.28**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrPye	13.95	1.28	0.36	4.62	2.24	7.98	0.43	0.49	0.143	13.15	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	13.95	1.28	0.39	4.71	2.16	7.12	0.47	0.59	0.148	13.24	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	13.98	1.31	0.36	4.59	2.24	9.02	0.42	0.45	0.140	13.08	0.48	0.46	0.97	0.56
Brk/ClrNct-Std-ClrSue	13.99	1.35	0.39	4.66	2.13	9.78	0.46	0.46	0.140	13.01	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	**13.80**	**1.28**	**0.39**	**4.72**	**2.16**	**5.23**	**0.47**	**0.62**	**0.150**	**13.28**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Std-ClrSue	13.85	1.35	0.39	4.66	2.13	8.40	0.46	0.46	0.140	13.01	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrPye	13.87	1.28	0.36	4.62	2.24	7.12	0.43	0.49	0.143	13.15	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	13.87	1.28	0.39	4.71	2.16	6.27	0.47	0.59	0.148	13.24	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	13.90	1.31	0.36	4.59	2.24	8.16	0.42	0.45	0.140	13.08	0.48	0.46	0.97	0.56

Table 80 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	15.17	1.44	0.52	5.22	1.67	8.82	0.36	0.46	0.159	13.40	0.47	0.45	0.98	0.56
Mtl/GrnNct-Std-ClrSue	15.19	1.33	0.52	5.38	1.67	6.87	0.39	0.57	0.172	13.82	0.67	0.56	1.17	0.68
Brk/HptNct-Std-ClrPye	15.26	1.39	0.51	5.24	1.71	8.61	0.36	0.49	0.163	13.54	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrSue	15.28	1.44	0.52	5.20	1.67	9.86	0.36	0.42	0.154	13.31	0.44	0.42	0.95	0.53
Mtl/HptNct-Std-ClrPye	15.28	1.28	0.51	5.40	1.71	6.66	0.39	0.60	0.176	13.95	0.71	0.60	1.20	0.70
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**15.35**	**1.28**	**0.54**	**5.47**	**1.62**	**7.98**	**0.43**	**0.49**	**0.161**	**13.75**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrNct	15.36	1.28	0.56	5.68	1.54	6.08	0.47	0.62	0.176	14.14	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrPye	15.41	1.31	0.54	5.42	1.62	9.02	0.42	0.45	0.156	13.60	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	15.43	1.39	0.51	5.24	1.71	9.46	0.36	0.49	0.163	13.54	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	15.44	1.35	0.53	5.44	1.64	7.57	0.40	0.62	0.178	13.93	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**15.18**	**1.28**	**0.54**	**5.47**	**1.62**	**7.12**	**0.43**	**0.49**	**0.161**	**13.75**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrSue	15.18	1.44	0.52	5.22	1.67	8.88	0.36	0.46	0.159	13.40	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrNct	15.18	1.28	0.56	5.68	1.54	5.23	0.47	0.62	0.176	14.14	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	15.22	1.39	0.51	5.24	1.71	8.40	0.36	0.49	0.163	13.54	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	15.23	1.35	0.53	5.44	1.64	6.50	0.40	0.62	0.178	13.93	0.60	0.60	1.10	0.69

Table 81 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	16.94	1.44	0.61	5.95	1.36	8.82	0.36	0.46	0.177	14.30	0.47	0.45	0.98	0.56
Mtl/GrnNct-Std-ClrSue	16.98	1.33	0.61	6.19	1.36	6.87	0.39	0.57	0.196	14.92	0.67	0.56	1.17	0.68
Brk/GrnSbe-Std-ClrNct	17.03	1.26	0.54	5.72	1.60	8.83	0.31	0.48	0.183	14.39	0.49	0.46	0.99	0.57
Brk/HptNct-Std-ClrPye	17.04	1.39	0.61	5.97	1.39	8.61	0.36	0.49	0.183	14.46	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrSue	17.04	1.47	0.59	5.75	1.44	9.75	0.32	0.46	0.179	14.12	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	**17.28**	**1.28**	**0.63**	**6.32**	**1.31**	**7.98**	**0.43**	**0.49**	**0.180**	**14.89**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/HptNct-Std-ClrPye	17.29	1.39	0.61	5.97	1.39	9.46	0.36	0.49	0.183	14.46	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	17.37	1.31	0.63	6.24	1.31	9.02	0.42	0.45	0.172	14.66	0.48	0.46	0.97	0.56
Brk/HptNct-Ins-ClrPye	17.39	1.43	0.61	5.89	1.39	10.50	0.35	0.45	0.176	14.23	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrNct	17.39	1.28	0.64	6.63	1.26	6.08	0.47	0.62	0.202	15.56	0.60	0.60	1.10	0.69
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	16.96	1.44	0.61	5.95	1.36	8.88	0.36	0.46	0.177	14.30	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	16.97	1.39	0.61	5.97	1.39	8.40	0.36	0.49	0.183	14.46	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	**17.02**	**1.28**	**0.63**	**6.32**	**1.31**	**7.12**	**0.43**	**0.49**	**0.180**	**14.89**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnSbe-Std-ClrNct	17.05	1.26	0.54	5.72	1.60	8.88	0.31	0.48	0.183	14.39	0.49	0.46	0.99	0.57
Brk/HptNct-Ins-ClrPye	17.07	1.43	0.61	5.89	1.39	9.44	0.35	0.45	0.176	14.23	0.48	0.46	0.97	0.56

Table 82 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – North – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnSbe-Std-ClrNct	**18.88**	**1.26**	**0.60**	**6.36**	**1.39**	**8.83**	**0.31**	**0.48**	**0.203**	**15.34**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptSbe-Std-ClrNct	18.91	1.31	0.57	6.03	1.50	9.75	0.26	0.48	0.206	15.01	0.49	0.46	0.99	0.57
Mtl/GrnSbe-Std-ClrNct	18.92	1.15	0.60	6.69	1.39	6.88	0.34	0.59	0.228	16.17	0.69	0.57	1.18	0.68
Brk/GrnNct-Std-ClrSue	18.98	1.44	0.66	6.68	1.20	8.82	0.36	0.46	0.195	15.45	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	19.00	1.30	0.60	6.25	1.39	9.87	0.30	0.44	0.194	15.05	0.46	0.43	0.96	0.54
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrPye	19.42	1.39	0.65	6.71	1.22	9.46	0.36	0.49	0.203	15.63	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	19.47	1.28	0.67	7.18	1.17	7.98	0.43	0.49	0.198	16.28	0.51	0.49	1.00	0.59
Brk/GrnSbe-Std-ClrNct	**19.48**	**1.26**	**0.60**	**6.36**	**1.39**	**10.34**	**0.31**	**0.48**	**0.203**	**15.34**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptNct-Ins-ClrPye	19.54	1.43	0.65	6.60	1.22	10.50	0.35	0.45	0.193	15.34	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	19.59	1.44	0.66	6.68	1.20	10.34	0.36	0.46	0.195	15.45	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Std-ClrNct	**18.90**	**1.26**	**0.60**	**6.36**	**1.39**	**8.88**	**0.31**	**0.48**	**0.203**	**15.34**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/HptNct-Std-ClrPye	18.99	1.39	0.65	6.71	1.22	8.40	0.36	0.49	0.203	15.63	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	19.00	1.44	0.66	6.68	1.20	8.88	0.36	0.46	0.195	15.45	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	19.02	1.30	0.60	6.25	1.39	9.92	0.30	0.44	0.194	15.05	0.46	0.43	0.96	0.54
Brk/HptSbe-Std-ClrNct	19.07	1.31	0.57	6.03	1.50	10.15	0.26	0.48	0.206	15.01	0.49	0.46	0.99	0.57

Cold Regions

Table 83 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**13.19**	**1.35**	**0.39**	**3.40**	**2.13**	**8.32**	**0.46**	**0.46**	**0.268**	**12.36**	**0.47**	**0.45**	**0.98**	**0.56**
Vnl/ClrNct-Std-ClrSue	13.20	1.46	0.39	3.26	2.16	11.57	0.41	0.36	0.257	12.04	0.41	0.36	0.91	0.00
Brk/GrnNct-Std-ClrSue	13.20	1.44	0.35	3.18	2.29	8.82	0.36	0.46	0.273	12.32	0.47	0.45	0.98	0.56
Vnl/ClrNct-Ins-ClrSue	13.20	1.46	0.39	3.25	2.16	12.61	0.41	0.32	0.250	11.94	0.38	0.33	0.88	0.00
Brk/ClrNct-Ins-ClrSue	13.21	1.35	0.39	3.39	2.13	9.36	0.46	0.42	0.263	12.27	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Ins-ClrPye	13.30	1.31	0.36	3.31	2.24	9.02	0.42	0.45	0.269	12.40	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrPye	13.31	1.28	0.36	3.35	2.24	7.98	0.43	0.49	0.274	12.51	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrSue	**13.34**	**1.35**	**0.39**	**3.40**	**2.13**	**9.78**	**0.46**	**0.46**	**0.268**	**12.36**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	13.35	1.44	0.35	3.18	2.29	10.34	0.36	0.46	0.273	12.32	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	13.36	1.35	0.39	3.39	2.13	10.82	0.46	0.42	0.263	12.27	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**13.20**	**1.35**	**0.39**	**3.40**	**2.13**	**8.40**	**0.46**	**0.46**	**0.268**	**12.36**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	13.20	1.44	0.35	3.18	2.29	8.88	0.36	0.46	0.273	12.32	0.47	0.45	0.98	0.56
Brk/GrnNct-Ins-ClrPye	13.22	1.31	0.36	3.31	2.24	8.16	0.42	0.45	0.269	12.40	0.48	0.46	0.97	0.56
Brk/ClrNct-Ins-ClrSue	13.22	1.35	0.39	3.39	2.13	9.44	0.46	0.42	0.263	12.27	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrPye	13.22	1.28	0.36	3.35	2.24	7.12	0.43	0.49	0.274	12.51	0.51	0.49	1.00	0.59

Table 84 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**14.89**	**1.44**	**0.52**	**4.12**	**1.67**	**8.82**	**0.36**	**0.46**	**0.297**	**13.13**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	14.94	1.44	0.52	4.10	1.67	9.86	0.36	0.42	0.287	12.97	0.44	0.42	0.95	0.53
Vnl/GrnNct-Std-ClrSue	14.95	1.56	0.51	3.88	1.71	12.07	0.32	0.36	0.275	12.54	0.41	0.36	0.91	0.00
Brk/HptNct-Ins-ClrSue	14.98	1.52	0.50	3.88	1.77	10.79	0.31	0.42	0.292	12.82	0.44	0.42	0.95	0.53
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Ins-ClrPye	15.18	1.31	0.54	4.38	1.62	9.02	0.42	0.45	0.289	13.38	0.48	0.46	0.97	0.56
Brk/HptNct-Ins-ClrPye	15.19	1.43	0.51	4.07	1.71	10.50	0.35	0.45	0.295	13.09	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	**15.19**	**1.44**	**0.52**	**4.12**	**1.67**	**10.34**	**0.36**	**0.46**	**0.297**	**13.13**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	15.20	1.39	0.51	4.14	1.71	9.46	0.36	0.49	0.304	13.30	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrPye	15.20	1.28	0.54	4.45	1.62	7.98	0.43	0.49	0.298	13.60	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**14.90**	**1.44**	**0.52**	**4.12**	**1.67**	**8.88**	**0.36**	**0.46**	**0.297**	**13.13**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	14.95	1.44	0.52	4.10	1.67	9.92	0.36	0.42	0.287	12.97	0.44	0.42	0.95	0.53
Brk/HptNct-Ins-ClrPye	14.97	1.43	0.51	4.07	1.71	9.44	0.35	0.45	0.295	13.09	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	14.98	1.39	0.51	4.14	1.71	8.40	0.36	0.49	0.304	13.30	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	15.01	1.31	0.54	4.38	1.62	8.16	0.42	0.45	0.289	13.38	0.48	0.46	0.97	0.56

Table 85 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**17.10**	**1.44**	**0.61**	**5.06**	**1.36**	**8.82**	**0.36**	**0.46**	**0.321**	**14.45**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Ins-ClrSue	17.11	1.52	0.59	4.69	1.44	10.79	0.31	0.42	0.313	13.88	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrSue	17.13	1.47	0.59	4.80	1.44	9.75	0.32	0.46	0.326	14.20	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	17.13	1.30	0.54	4.65	1.60	9.87	0.30	0.44	0.322	14.17	0.46	0.43	0.96	0.54
Vnl/GrnNct-Std-ClrSue	17.14	1.56	0.61	4.70	1.39	12.07	0.32	0.36	0.288	13.52	0.41	0.36	0.91	0.00
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Ins-ClrPye	17.50	1.43	0.61	4.99	1.39	10.50	0.35	0.45	0.318	14.35	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	**17.51**	**1.39**	**0.61**	**5.09**	**1.39**	**9.46**	**0.36**	**0.49**	**0.332**	**14.67**	**0.51**	**0.49**	**1.00**	**0.59**
Brk/GrnNct-Std-ClrSue	17.55	1.44	0.61	5.06	1.36	10.34	0.36	0.46	0.321	14.45	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	17.59	1.30	0.54	4.65	1.60	11.38	0.30	0.44	0.322	14.17	0.46	0.43	0.96	0.54
Brk/GrnSbe-Std-ClrNct	17.59	1.26	0.54	4.75	1.60	10.34	0.31	0.48	0.335	14.49	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**17.11**	**1.44**	**0.61**	**5.06**	**1.36**	**8.88**	**0.36**	**0.46**	**0.321**	**14.45**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnSbe-Ins-ClrNct	17.15	1.30	0.54	4.65	1.60	9.92	0.30	0.44	0.322	14.17	0.46	0.43	0.96	0.54
Brk/GrnSbe-Std-ClrNct	17.16	1.26	0.54	4.75	1.60	8.88	0.31	0.48	0.335	14.49	0.49	0.46	0.99	0.57
Brk/HptNct-Ins-ClrPye	17.18	1.43	0.61	4.99	1.39	9.44	0.35	0.45	0.318	14.35	0.48	0.46	0.97	0.56
Brk/GrnNct-Ins-ClrSue	17.19	1.44	0.61	5.02	1.36	9.92	0.36	0.42	0.306	14.21	0.44	0.42	0.95	0.53

Table 86 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – All – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnMpr-Std-ClrSue	19.31	1.41	0.55	4.77	1.58	11.01	0.22	0.46	0.370	14.90	0.47	0.45	0.98	0.56
Brk/HptSbe-Std-ClrNct	19.32	1.31	0.57	5.15	1.50	9.75	0.26	0.48	0.372	15.42	0.49	0.46	0.99	0.57
Brk/HptMpr-Std-ClrSue	19.34	1.58	0.54	4.51	1.61	11.93	0.19	0.46	0.376	14.57	0.47	0.45	0.98	0.56
Brk/GrnSbe-Ins-ClrNct	**19.39**	**1.30**	**0.60**	**5.45**	**1.39**	**9.87**	**0.30**	**0.44**	**0.346**	**15.44**	**0.46**	**0.43**	**0.96**	**0.54**
Brk/GrnSbe-Std-ClrNct	19.40	1.26	0.60	5.59	1.39	8.83	0.31	0.48	0.363	15.87	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnSbe-Ins-ClrNct	**19.99**	**1.30**	**0.60**	**5.45**	**1.39**	**11.38**	**0.30**	**0.44**	**0.346**	**15.44**	**0.46**	**0.43**	**0.96**	**0.54**
Brk/GrnSbe-Std-ClrNct	20.00	1.26	0.60	5.59	1.39	10.34	0.31	0.48	0.363	15.87	0.49	0.46	0.99	0.57
Brk/HptNct-Ins-ClrPye	20.07	1.43	0.65	5.90	1.22	10.50	0.35	0.45	0.342	15.87	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	20.09	1.39	0.65	6.04	1.22	9.46	0.36	0.49	0.359	16.30	0.51	0.49	1.00	0.59
Brk/HptSbe-Std-ClrNct	20.14	1.31	0.57	5.15	1.50	11.82	0.26	0.48	0.372	15.42	0.49	0.46	0.99	0.57
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnSbe-Ins-ClrNct	**19.41**	**1.30**	**0.60**	**5.45**	**1.39**	**9.92**	**0.30**	**0.44**	**0.346**	**15.44**	**0.46**	**0.43**	**0.96**	**0.54**
Brk/GrnSbe-Std-ClrNct	19.42	1.26	0.60	5.59	1.39	8.88	0.31	0.48	0.363	15.87	0.49	0.46	0.99	0.57
Brk/HptSbe-Std-ClrNct	19.48	1.31	0.57	5.15	1.50	10.15	0.26	0.48	0.372	15.42	0.49	0.46	0.99	0.57
Brk/GrnMpr-Std-ClrSue	19.50	1.41	0.55	4.77	1.58	11.49	0.22	0.46	0.370	14.90	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrSue	19.59	1.44	0.66	6.00	1.20	8.88	0.36	0.46	0.345	16.03	0.47	0.45	0.98	0.56

Table 87 – Vertical Fenestration SHGC Criteria – Residential – 0-10% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	12.05	1.35	0.39	2.50	2.13	8.32	0.46	0.46	0.301	11.22	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	12.08	1.35	0.39	2.50	2.13	9.36	0.46	0.42	0.295	11.14	0.44	0.42	0.95	0.53
Mtl/ClrNct-Std-ClrSue	12.09	1.27	0.39	2.54	2.13	6.37	0.49	0.57	0.316	11.45	0.67	0.56	1.17	0.68
Brk/ClrNct-Std-ClrSpe	12.13	1.18	0.41	2.61	2.07	8.32	0.56	0.48	0.301	11.30	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrPye	12.16	1.03	0.41	2.70	2.07	7.18	0.64	0.49	0.300	11.44	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	12.17	1.28	0.39	2.52	2.16	6.08	0.47	0.62	0.323	11.56	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrNct	**12.17**	**1.04**	**0.43**	**2.75**	**2.00**	**5.53**	**0.68**	**0.62**	**0.318**	**11.62**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Std-ClrPye	12.18	1.03	0.41	2.70	2.07	7.42	0.64	0.49	0.300	11.44	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrSue	12.19	1.35	0.39	2.50	2.13	9.78	0.46	0.46	0.301	11.22	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrPye	12.21	1.03	0.41	2.70	2.07	8.46	0.64	0.45	0.293	11.36	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSue	12.06	1.35	0.39	2.50	2.13	8.40	0.46	0.46	0.301	11.22	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrNct	12.08	1.28	0.39	2.52	2.16	5.23	0.47	0.62	0.323	11.56	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSue	12.09	1.35	0.39	2.50	2.13	9.44	0.46	0.42	0.295	11.14	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrNct	**12.09**	**1.04**	**0.43**	**2.75**	**2.00**	**4.75**	**0.68**	**0.62**	**0.318**	**11.62**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Std-ClrPye	12.10	1.03	0.41	2.70	2.07	6.64	0.64	0.49	0.300	11.44	0.51	0.49	1.00	0.59

Table 88 – Vertical Fenestration SHGC Criteria – Residential – 11-20% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	13.19	1.35	0.57	3.03	1.51	8.32	0.46	0.46	0.341	11.53	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	13.25	1.35	0.57	3.03	1.51	9.36	0.46	0.42	0.329	11.38	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrPye	13.27	1.28	0.54	2.97	1.62	7.68	0.43	0.49	0.352	11.73	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	13.27	1.44	0.52	2.81	1.67	8.82	0.36	0.46	0.348	11.50	0.47	0.45	0.98	0.56
Mtl/ClrNct-Std-ClrSue	13.28	1.27	0.57	3.11	1.51	6.37	0.49	0.57	0.372	12.01	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	13.33	1.28	0.54	2.97	1.62	7.98	0.43	0.49	0.352	11.73	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	13.36	1.31	0.54	2.94	1.62	9.02	0.42	0.45	0.341	11.56	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrNct	13.38	1.28	0.56	3.07	1.54	6.08	0.47	0.62	0.386	12.16	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	13.48	1.35	0.57	3.03	1.51	9.78	0.46	0.46	0.341	11.53	0.47	0.45	0.98	0.56
Brk/GrnNct-Ins-ClrNct	13.49	1.28	0.56	3.07	1.54	7.12	0.47	0.59	0.378	12.06	0.57	0.57	1.07	0.66
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	13.15	1.28	0.54	2.97	1.62	7.12	0.43	0.49	0.352	11.73	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	13.19	1.31	0.54	2.94	1.62	8.16	0.42	0.45	0.341	11.56	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrNct	13.21	1.28	0.56	3.07	1.54	5.23	0.47	0.62	0.386	12.16	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	13.21	1.35	0.57	3.03	1.51	8.40	0.46	0.46	0.341	11.53	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	13.27	1.35	0.57	3.03	1.51	9.44	0.46	0.42	0.329	11.38	0.44	0.42	0.95	0.53

Table 89 – Vertical Fenestration SHGC Criteria – Residential – 21-30% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	14.82	1.44	0.61	3.23	1.36	8.82	0.36	0.46	0.391	12.18	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrPye	14.88	1.28	0.63	3.46	1.31	7.68	0.43	0.49	0.398	12.58	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrSue	14.91	1.35	0.65	3.56	1.23	8.32	0.46	0.46	0.382	12.42	0.47	0.45	0.98	0.56
Brk/GrnNct-Ins-ClrSue	14.92	1.44	0.61	3.22	1.36	9.86	0.36	0.42	0.374	11.97	0.44	0.42	0.95	0.53
Mtl/GrnNct-Std-ClrSue	14.93	1.33	0.61	3.35	1.36	6.87	0.39	0.57	0.435	12.87	0.67	0.56	1.17	0.68
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	14.97	1.28	0.63	3.46	1.31	7.98	0.43	0.49	0.398	12.58	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	15.03	1.31	0.63	3.42	1.31	9.02	0.42	0.45	0.381	12.32	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrNct	**15.15**	**1.28**	**0.64**	**3.62**	**1.26**	**6.08**	**0.47**	**0.62**	**0.450**	**13.33**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrPye	15.22	1.39	0.61	3.24	1.39	9.46	0.36	0.49	0.404	12.38	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	15.28	1.44	0.61	3.23	1.36	10.34	0.36	0.46	0.391	12.18	0.47	0.45	0.98	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	14.72	1.28	0.63	3.46	1.31	7.12	0.43	0.49	0.398	12.58	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	14.77	1.31	0.63	3.42	1.31	8.16	0.42	0.45	0.381	12.32	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	14.84	1.44	0.61	3.23	1.36	8.88	0.36	0.46	0.391	12.18	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrNct	**14.89**	**1.28**	**0.64**	**3.62**	**1.26**	**5.23**	**0.47**	**0.62**	**0.450**	**13.33**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Std-ClrPye	14.90	1.39	0.61	3.24	1.39	8.40	0.36	0.49	0.404	12.38	0.51	0.49	1.00	0.59

Table 90 – Vertical Fenestration SHGC Criteria – Residential – 31-40% WWR – North – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
SHGC Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	16.64	1.44	0.66	3.65	1.20	8.82	0.36	0.46	0.435	13.11	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrPye	16.76	1.28	0.67	3.96	1.17	7.68	0.43	0.49	0.444	13.69	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrSue	16.77	1.44	0.66	3.64	1.20	9.86	0.36	0.42	0.412	12.83	0.44	0.42	0.95	0.53
Mtl/GrnNct-Std-ClrSue	16.79	1.33	0.66	3.80	1.20	6.87	0.39	0.57	0.493	14.04	0.67	0.56	1.17	0.68
Brk/HptNct-Std-ClrPye	16.80	1.39	0.65	3.66	1.22	8.61	0.36	0.49	0.452	13.36	0.51	0.49	1.00	0.59
SHGC Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrPye	16.88	1.28	0.67	3.96	1.17	7.98	0.43	0.49	0.444	13.69	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	16.95	1.31	0.67	3.91	1.17	9.02	0.42	0.45	0.422	13.34	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	17.14	1.39	0.65	3.66	1.22	9.46	0.36	0.49	0.452	13.36	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	**17.18**	**1.28**	**0.68**	**4.16**	**1.13**	**6.08**	**0.47**	**0.62**	**0.513**	**14.75**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/HptNct-Ins-ClrPye	17.22	1.43	0.65	3.60	1.22	10.50	0.35	0.45	0.431	13.02	0.48	0.46	0.97	0.56
SHGC Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrPye	16.54	1.28	0.67	3.96	1.17	7.12	0.43	0.49	0.444	13.69	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrPye	16.61	1.31	0.67	3.91	1.17	8.16	0.42	0.45	0.422	13.34	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	16.66	1.44	0.66	3.65	1.20	8.88	0.36	0.46	0.435	13.11	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	16.71	1.39	0.65	3.66	1.22	8.40	0.36	0.49	0.452	13.36	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	16.80	1.43	0.65	3.60	1.22	9.44	0.35	0.45	0.431	13.02	0.48	0.46	0.97	0.56

Appendix F – 30 Year Life Cycle Cost Analysis – Skylights

This analysis was performed with a NPV of electricity of $1.68/kWh-y and a NPV for gas of $11.43/therm-y. The U-factor set was used in determining the U-factor criteria. The SHGC criteria were calculated with no constraint on U-factor, e.g. “Use Max. U-factor” was not checked. The glass criteria were calculated with a curb. The criteria were calculated with the Title 24 Fenestration Optimizer software developed as part of this project.

U-factor Criteria – Nonresidential

South Coast

Table 1 – Skylight U-factor Criteria – Nonresidential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	8.28	1.18	0.55	2.74	1.57	8.32	0.56	0.73	0.054	7.86	0.49	0.46	0.99	0.57
Mtl/ClrNct-Std-ClrSpe	**8.29**	**1.10**	**0.55**	**2.80**	**1.57**	**6.37**	**0.60**	**0.84**	**0.055**	**7.97**	**0.69**	**0.57**	**1.18**	**0.68**
Brk/ClrNct-Ins-ClrSpe	8.32	1.18	0.55	2.74	1.57	9.36	0.56	0.69	0.053	7.86	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	8.34	1.24	0.55	2.66	1.59	11.57	0.51	0.70	0.054	7.76	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	8.39	1.24	0.55	2.66	1.59	12.61	0.51	0.70	0.054	7.76	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	8.42	1.03	0.55	2.87	1.57	7.18	0.64	0.74	0.053	8.06	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	8.43	1.04	0.56	2.93	1.55	5.88	0.68	0.85	0.054	8.13	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrPye	8.44	0.97	0.55	2.93	1.57	5.23	0.68	0.85	0.054	8.18	0.71	0.60	1.20	0.70
Mtl/ClrNct-Std-ClrNct	8.44	0.99	0.56	2.99	1.55	3.93	0.72	0.96	0.055	8.25	0.81	0.72	1.31	0.80
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrTrpClr	8.40	1.21	0.57	2.96	1.50	5.20	0.71	1.10	0.058	8.14	0.00	0.00	1.10	0.00
Mtl/AcrQudClr	8.41	1.24	0.57	2.88	1.51	7.80	0.65	0.93	0.056	8.02	0.00	0.00	0.94	0.00
Mtl/AcrDblClr	**8.43**	**1.16**	**0.58**	**3.04**	**1.49**	**2.60**	**0.77**	**1.29**	**0.060**	**8.30**	**0.00**	**0.00**	**1.30**	**0.00**
Brk/AcrTrpClr	8.43	1.21	0.57	2.96	1.50	6.11	0.71	0.91	0.055	8.13	0.00	0.00	0.87	0.00
Brk/AcrQudClr	8.43	1.24	0.57	2.89	1.51	8.71	0.65	0.74	0.053	8.00	0.00	0.00	0.71	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	8.35	1.18	0.55	2.74	1.57	9.78	0.56	0.73	0.054	7.86	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrSpe	8.40	1.18	0.55	2.74	1.57	10.82	0.56	0.69	0.053	7.86	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrNct	8.41	1.04	0.56	2.93	1.55	5.53	0.68	0.85	0.054	8.13	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrSpe	**8.41**	**1.10**	**0.55**	**2.80**	**1.57**	**8.80**	**0.60**	**0.84**	**0.055**	**7.97**	**0.69**	**0.57**	**1.18**	**0.68**
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	8.28	1.18	0.55	2.74	1.57	8.40	0.56	0.73	0.054	7.86	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrSpe	8.33	1.18	0.55	2.74	1.57	9.44	0.56	0.69	0.053	7.86	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	**8.35**	**1.10**	**0.55**	**2.80**	**1.57**	**7.57**	**0.60**	**0.84**	**0.055**	**7.97**	**0.69**	**0.57**	**1.18**	**0.68**
Brk/ClrNct-Std-ClrNct	8.37	1.04	0.56	2.93	1.55	4.75	0.68	0.85	0.054	8.13	0.60	0.60	1.10	0.69

North Coast

Table 2 – Skylight U-factor Criteria – Nonresidential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	7.04	1.18	0.55	1.83	1.57	8.32	0.56	0.73	0.079	6.63	0.49	0.46	0.99	0.57
Mtl/ClrNct-Std-ClrSpe	**7.05**	**1.10**	**0.55**	**1.88**	**1.57**	**6.37**	**0.60**	**0.84**	**0.082**	**6.73**	**0.69**	**0.57**	**1.18**	**0.68**
Brk/ClrNct-Ins-ClrSpe	7.08	1.18	0.55	1.83	1.57	9.36	0.56	0.69	0.078	6.62	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	7.13	1.24	0.55	1.77	1.59	11.57	0.51	0.70	0.080	6.55	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrNct	7.14	1.04	0.56	1.98	1.55	5.88	0.68	0.85	0.081	6.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSpe	7.04	1.18	0.55	1.83	1.57	8.32	0.56	0.73	0.079	6.63	0.49	0.46	0.99	0.57
Mtl/ClrNct-Std-ClrSpe	7.05	1.10	0.55	1.88	1.57	6.37	0.60	0.84	0.082	6.73	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	7.08	1.18	0.55	1.83	1.57	9.36	0.56	0.69	0.078	6.62	0.46	0.43	0.96	0.54
Plastic Criteria ASHRAE Cost Model														
Brk/AcrTrpClr	7.14	1.21	0.57	2.01	1.50	6.11	0.71	0.91	0.082	6.83	0.00	0.00	0.87	0.00
Mtl/AcrTrpClr	**7.14**	**1.21**	**0.57**	**2.00**	**1.50**	**5.20**	**0.71**	**1.10**	**0.087**	**6.88**	**0.00**	**0.00**	**1.10**	**0.00**
Brk/AcrQudClr	7.14	1.24	0.57	1.95	1.51	8.71	0.65	0.74	0.078	6.71	0.00	0.00	0.71	0.00
Mtl/AcrQudClr	7.14	1.24	0.57	1.95	1.51	7.80	0.65	0.93	0.083	6.75	0.00	0.00	0.94	0.00
Mtl/AcrDblClr	7.16	1.16	0.58	2.07	1.49	2.60	0.77	1.29	0.091	7.03	0.00	0.00	1.30	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	7.11	1.18	0.55	1.83	1.57	9.78	0.56	0.73	0.079	6.63	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrNct	7.12	1.04	0.56	1.98	1.55	5.53	0.68	0.85	0.081	6.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrPye	7.15	1.03	0.55	1.93	1.57	7.42	0.64	0.74	0.078	6.78	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrSpe	7.16	1.18	0.55	1.83	1.57	10.82	0.56	0.69	0.078	6.62	0.46	0.43	0.96	0.54
Brk/ClrNct-Ins-ClrNct	7.16	1.04	0.56	1.98	1.55	6.57	0.68	0.81	0.079	6.84	0.57	0.57	1.07	0.66
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	7.05	1.18	0.55	1.83	1.57	8.40	0.56	0.73	0.079	6.63	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrNct	7.08	1.04	0.56	1.98	1.55	4.75	0.68	0.85	0.081	6.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSpe	7.09	1.18	0.55	1.83	1.57	9.44	0.56	0.69	0.078	6.62	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	**7.11**	**1.10**	**0.55**	**1.88**	**1.57**	**7.57**	**0.60**	**0.84**	**0.082**	**6.73**	**0.69**	**0.57**	**1.18**	**0.68**
Brk/ClrNct-Std-ClrPye	7.11	1.03	0.55	1.93	1.57	6.64	0.64	0.74	0.078	6.78	0.51	0.49	1.00	0.59

Central Valley

Table 3 – Skylight U-factor Criteria – Nonresidential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.79**	**1.18**	**0.55**	**2.81**	**1.57**	**8.32**	**0.56**	**0.73**	**0.089**	**8.37**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.82	1.18	0.55	2.81	1.57	9.36	0.56	0.69	0.088	8.35	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	8.83	1.10	0.55	2.88	1.57	6.37	0.60	0.84	0.091	8.51	0.69	0.57	1.18	0.68
Vnl/ClrNct-Std-ClrSpe	8.84	1.24	0.55	2.73	1.59	11.57	0.51	0.70	0.089	8.26	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	8.89	1.24	0.55	2.73	1.59	12.61	0.51	0.70	0.089	8.26	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	8.93	1.03	0.55	2.94	1.57	7.18	0.64	0.74	0.088	8.57	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	8.95	1.08	0.55	2.85	1.58	10.84	0.59	0.58	0.084	8.41	0.43	0.42	0.84	0.46
Brk/ClrNct-Std-ClrNct	8.97	1.04	0.56	3.00	1.55	5.88	0.68	0.85	0.090	8.67	0.60	0.60	1.10	0.69
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	8.94	1.24	0.57	2.96	1.51	8.71	0.65	0.74	0.088	8.51	0.00	0.00	0.71	0.00
Mtl/AcrQudClr	8.97	1.24	0.57	2.97	1.51	7.80	0.65	0.93	0.093	8.58	0.00	0.00	0.94	0.00
Brk/AcrTrpClr	8.99	1.21	0.57	3.05	1.50	6.11	0.71	0.91	0.091	8.68	0.00	0.00	0.87	0.00
Mtl/AcrTrpClr	**9.02**	**1.21**	**0.57**	**3.06**	**1.50**	**5.20**	**0.71**	**1.10**	**0.096**	**8.76**	**0.00**	**0.00**	**1.10**	**0.00**
Vnl/AcrQudClr	9.06	1.24	0.57	2.94	1.51	13.00	0.65	0.48	0.081	8.41	0.00	0.00	0.46	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.86**	**1.18**	**0.55**	**2.81**	**1.57**	**9.78**	**0.56**	**0.73**	**0.089**	**8.37**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.89	1.18	0.55	2.81	1.57	10.82	0.56	0.69	0.088	8.35	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	8.94	1.03	0.55	2.94	1.57	7.42	0.64	0.74	0.088	8.57	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	8.95	1.04	0.56	3.00	1.55	5.53	0.68	0.85	0.090	8.67	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrSpe	8.95	1.10	0.55	2.88	1.57	8.80	0.60	0.84	0.091	8.51	0.69	0.57	1.18	0.68
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.79**	**1.18**	**0.55**	**2.81**	**1.57**	**8.40**	**0.56**	**0.73**	**0.089**	**8.37**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.83	1.18	0.55	2.81	1.57	9.44	0.56	0.69	0.088	8.35	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	8.89	1.10	0.55	2.88	1.57	7.57	0.60	0.84	0.091	8.51	0.69	0.57	1.18	0.68
Vnl/ClrNct-Std-ClrSpe	8.90	1.24	0.55	2.73	1.59	12.77	0.51	0.70	0.089	8.26	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrPye	8.91	1.03	0.55	2.94	1.57	6.64	0.64	0.74	0.088	8.57	0.51	0.49	1.00	0.59

Desert

Table 4 – Skylight U-factor Criteria – Nonresidential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.67**	**1.18**	**0.55**	**3.28**	**1.57**	**8.32**	**0.56**	**0.73**	**0.096**	**9.25**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	9.70	1.18	0.55	3.28	1.57	9.36	0.56	0.69	0.095	9.23	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	9.71	1.24	0.55	3.20	1.59	11.57	0.51	0.70	0.096	9.13	0.42	0.37	0.92	0.00
Mtl/ClrNct-Std-ClrSpe	9.73	1.10	0.55	3.36	1.57	6.37	0.60	0.84	0.098	9.41	0.69	0.57	1.18	0.68
Vnl/ClrNct-Ins-ClrSpe	9.76	1.24	0.55	3.20	1.59	12.61	0.51	0.70	0.096	9.13	0.39	0.34	0.89	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	9.81	1.08	0.55	3.31	1.58	10.84	0.59	0.58	0.092	9.27	0.43	0.42	0.84	0.46
Brk/ClrNct-Std-ClrPye	9.82	1.03	0.55	3.42	1.57	7.18	0.64	0.74	0.095	9.46	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-HtMr88-Ins-ClrNct	9.85	1.19	0.55	3.20	1.59	15.17	0.53	0.52	0.091	9.09	0.33	0.30	0.73	0.36
Brk/ClrNct-Ins-ClrPye	9.85	1.03	0.55	3.41	1.57	8.22	0.64	0.70	0.094	9.44	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	9.83	1.24	0.57	3.44	1.51	8.71	0.65	0.74	0.095	9.40	0.00	0.00	0.71	0.00
Mtl/AcrQudClr	9.89	1.24	0.57	3.47	1.51	7.80	0.65	0.93	0.100	9.50	0.00	0.00	0.94	0.00
Brk/AcrTrpClr	9.91	1.21	0.57	3.55	1.50	6.11	0.71	0.91	0.099	9.60	0.00	0.00	0.87	0.00
Vnl/AcrQudClr	9.91	1.24	0.57	3.40	1.51	13.00	0.65	0.48	0.089	9.26	0.00	0.00	0.46	0.00
Mtl/AcrTrpClr	**9.96**	**1.21**	**0.57**	**3.57**	**1.50**	**5.20**	**0.71**	**1.10**	**0.103**	**9.70**	**0.00**	**0.00**	**1.10**	**0.00**
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.74**	**1.18**	**0.55**	**3.28**	**1.57**	**9.78**	**0.56**	**0.73**	**0.096**	**9.25**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	9.77	1.18	0.55	3.28	1.57	10.82	0.56	0.69	0.095	9.23	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	9.83	1.24	0.55	3.20	1.59	14.00	0.51	0.70	0.096	9.13	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrPye	9.83	1.03	0.55	3.42	1.57	7.42	0.64	0.74	0.095	9.46	0.51	0.49	1.00	0.59
Mtl/ClrNct-Std-ClrSpe	9.85	1.10	0.55	3.36	1.57	8.80	0.60	0.84	0.098	9.41	0.69	0.57	1.18	0.68
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.67**	**1.18**	**0.55**	**3.28**	**1.57**	**8.40**	**0.56**	**0.73**	**0.096**	**9.25**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	9.70	1.18	0.55	3.28	1.57	9.44	0.56	0.69	0.095	9.23	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	9.77	1.24	0.55	3.20	1.59	12.77	0.51	0.70	0.096	9.13	0.42	0.37	0.92	0.00
Mtl/ClrNct-Std-ClrSpe	9.79	1.10	0.55	3.36	1.57	7.57	0.60	0.84	0.098	9.41	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	9.80	1.03	0.55	3.42	1.57	6.64	0.64	0.74	0.095	9.46	0.51	0.49	1.00	0.59

Cold Region

Table 5 – Skylight U-factor Criteria – Nonresidential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**7.92**	**1.18**	**0.55**	**1.91**	**1.57**	**8.32**	**0.56**	**0.73**	**0.146**	**7.51**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	7.95	1.18	0.55	1.90	1.57	9.36	0.56	0.69	0.144	7.48	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	7.96	1.10	0.55	1.96	1.57	6.37	0.60	0.84	0.150	7.64	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	7.99	1.03	0.55	1.99	1.57	7.18	0.64	0.74	0.145	7.63	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	8.01	1.08	0.55	1.92	1.58	10.84	0.59	0.58	0.139	7.47	0.43	0.42	0.84	0.46
Brk/ClrNct-Ins-ClrPye	8.02	1.03	0.55	1.99	1.57	8.22	0.64	0.70	0.143	7.61	0.48	0.46	0.97	0.56
Vnl/ClrNct-Std-ClrSpe	8.02	1.24	0.55	1.85	1.59	11.57	0.51	0.70	0.146	7.44	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrNct	8.02	1.04	0.56	2.04	1.55	5.88	0.68	0.85	0.148	7.73	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrPye	8.03	0.97	0.55	2.04	1.57	5.23	0.68	0.85	0.148	7.77	0.71	0.60	1.20	0.70
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	7.99	1.24	0.57	2.00	1.51	8.71	0.65	0.74	0.144	7.55	0.00	0.00	0.71	0.00
Vnl/AcrQudClr	8.02	1.24	0.57	1.98	1.51	13.00	0.65	0.48	0.132	7.37	0.00	0.00	0.46	0.00
Brk/AcrTrpClr	**8.04**	**1.21**	**0.57**	**2.08**	**1.50**	**6.11**	**0.71**	**0.91**	**0.151**	**7.73**	**0.00**	**0.00**	**0.87**	**0.00**
Vnl/AcrTrpClr	8.07	1.16	0.57	2.05	1.50	10.40	0.71	0.65	0.139	7.55	0.00	0.00	0.61	0.00
Mtl/AcrQudClr	8.08	1.24	0.57	2.03	1.51	7.80	0.65	0.93	0.153	7.69	0.00	0.00	0.94	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.00**	**1.18**	**0.55**	**1.91**	**1.57**	**9.78**	**0.56**	**0.73**	**0.146**	**7.51**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Std-ClrPye	8.00	1.03	0.55	1.99	1.57	7.42	0.64	0.74	0.145	7.63	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	8.00	1.04	0.56	2.04	1.55	5.53	0.68	0.85	0.148	7.73	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSpe	8.02	1.18	0.55	1.90	1.57	10.82	0.56	0.69	0.144	7.48	0.46	0.43	0.96	0.54
Brk/ClrNct-Ins-ClrPye	8.03	1.03	0.55	1.99	1.57	8.46	0.64	0.70	0.143	7.61	0.48	0.46	0.97	0.56
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**7.93**	**1.18**	**0.55**	**1.91**	**1.57**	**8.40**	**0.56**	**0.73**	**0.146**	**7.51**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	7.95	1.18	0.55	1.90	1.57	9.44	0.56	0.69	0.144	7.48	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	7.97	1.03	0.55	1.99	1.57	6.64	0.64	0.74	0.145	7.63	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	7.97	1.04	0.56	2.04	1.55	4.75	0.68	0.85	0.148	7.73	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrPye	7.99	1.03	0.55	1.99	1.57	7.68	0.64	0.70	0.143	7.61	0.48	0.46	0.97	0.56

U-factor Criteria – Residential

South Coast

Table 6 – Skylight U-factor Criteria – Residential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	7.60	1.18	0.55	2.65	1.57	8.32	0.56	0.73	0.009	7.19	0.49	0.46	0.99	0.57
Vnl/ClrNct-Std-ClrSpe	7.62	1.24	0.55	2.54	1.59	11.57	0.51	0.70	0.009	7.04	0.42	0.37	0.92	0.00
Mtl/ClrNct-Std-ClrSpe	**7.65**	**1.10**	**0.55**	**2.73**	**1.57**	**6.37**	**0.60**	**0.84**	**0.009**	**7.33**	**0.69**	**0.57**	**1.18**	**0.68**
Brk/ClrNct-Ins-ClrSpe	7.66	1.18	0.55	2.65	1.57	9.36	0.56	0.69	0.008	7.19	0.46	0.43	0.96	0.54
Vnl/ClrNct-Ins-ClrSpe	7.67	1.24	0.55	2.54	1.59	12.61	0.51	0.70	0.009	7.04	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	7.83	1.03	0.55	2.82	1.57	7.18	0.64	0.74	0.008	7.47	0.51	0.49	1.00	0.59
Vnl/ClrNct-Std-ClrPye	7.85	1.07	0.55	2.71	1.59	10.43	0.59	0.72	0.008	7.32	0.44	0.40	0.94	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	7.86	1.08	0.55	2.72	1.58	10.84	0.59	0.58	0.008	7.32	0.43	0.42	0.84	0.46
Brk/ClrNct-Std-ClrNct	7.87	1.04	0.56	2.90	1.55	5.88	0.68	0.85	0.009	7.57	0.60	0.60	1.10	0.69
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrQudClr	7.81	1.24	0.57	2.84	1.51	7.80	0.65	0.93	0.009	7.42	0.00	0.00	0.94	0.00
Mtl/AcrTrpClr	**7.84**	**1.21**	**0.57**	**2.94**	**1.50**	**5.20**	**0.71**	**1.10**	**0.010**	**7.58**	**0.00**	**0.00**	**1.10**	**0.00**
Brk/AcrQudClr	7.86	1.24	0.57	2.85	1.51	8.71	0.65	0.74	0.008	7.42	0.00	0.00	0.71	0.00
Brk/AcrTrpClr	7.89	1.21	0.57	2.95	1.50	6.11	0.71	0.91	0.009	7.59	0.00	0.00	0.87	0.00
Mtl/AcrDblClr	7.91	1.16	0.58	3.07	1.49	2.60	0.77	1.29	0.011	7.78	0.00	0.00	1.30	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	7.68	1.18	0.55	2.65	1.57	9.78	0.56	0.73	0.009	7.19	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrSpe	7.73	1.18	0.55	2.65	1.57	10.82	0.56	0.69	0.008	7.19	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	7.74	1.24	0.55	2.54	1.59	14.00	0.51	0.70	0.009	7.04	0.42	0.37	0.92	0.00
Mtl/ClrNct-Std-ClrSpe	**7.77**	**1.10**	**0.55**	**2.73**	**1.57**	**8.80**	**0.60**	**0.84**	**0.009**	**7.33**	**0.69**	**0.57**	**1.18**	**0.68**
Vnl/ClrNct-Ins-ClrSpe	7.79	1.24	0.55	2.54	1.59	15.04	0.51	0.70	0.009	7.04	0.39	0.34	0.89	0.00
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	7.61	1.18	0.55	2.65	1.57	8.40	0.56	0.73	0.009	7.19	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrSpe	7.66	1.18	0.55	2.65	1.57	9.44	0.56	0.69	0.008	7.19	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	7.68	1.24	0.55	2.54	1.59	12.77	0.51	0.70	0.009	7.04	0.42	0.37	0.92	0.00
Mtl/ClrNct-Std-ClrSpe	**7.71**	**1.10**	**0.55**	**2.73**	**1.57**	**7.57**	**0.60**	**0.84**	**0.009**	**7.33**	**0.69**	**0.57**	**1.18**	**0.68**
Vnl/ClrNct-Ins-ClrSpe	7.73	1.24	0.55	2.54	1.59	13.81	0.51	0.70	0.009	7.04	0.39	0.34	0.89	0.00

North Coast

Table 7 – Skylight U-factor Criteria – Residential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**6.63**	**1.18**	**0.55**	**1.92**	**1.57**	**8.32**	**0.56**	**0.73**	**0.031**	**6.21**	**0.49**	**0.46**	**0.99**	**0.57**
Mtl/ClrNct-Std-ClrSpe	6.65	1.10	0.55	1.98	1.57	6.37	0.60	0.84	0.032	6.33	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-ClrSpe	6.68	1.18	0.55	1.92	1.57	9.36	0.56	0.69	0.030	6.21	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	6.68	1.24	0.55	1.83	1.59	11.57	0.51	0.70	0.032	6.10	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	6.73	1.24	0.55	1.83	1.59	12.61	0.51	0.70	0.032	6.10	0.39	0.34	0.89	0.00
Brk/ClrNct-Std-ClrPye	6.79	1.03	0.55	2.06	1.57	7.18	0.64	0.74	0.030	6.43	0.51	0.49	1.00	0.59
Brk/ClrNct-Std-ClrNct	6.81	1.04	0.56	2.12	1.55	5.88	0.68	0.85	0.031	6.51	0.60	0.60	1.10	0.69
Mtl/ClrNct-Std-ClrPye	6.81	0.97	0.55	2.12	1.57	5.23	0.68	0.85	0.031	6.55	0.71	0.60	1.20	0.70
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrQudClr	6.78	1.24	0.57	2.07	1.51	7.80	0.65	0.93	0.033	6.39	0.00	0.00	0.94	0.00
Mtl/AcrTrpClr	**6.78**	**1.21**	**0.57**	**2.15**	**1.50**	**5.20**	**0.71**	**1.10**	**0.035**	**6.52**	**0.00**	**0.00**	**1.10**	**0.00**
Brk/AcrQudClr	6.81	1.24	0.57	2.08	1.51	8.71	0.65	0.74	0.029	6.37	0.00	0.00	0.71	0.00
Brk/AcrTrpClr	6.81	1.21	0.57	2.16	1.50	6.11	0.71	0.91	0.031	6.51	0.00	0.00	0.87	0.00
Mtl/AcrDblClr	6.82	1.16	0.58	2.24	1.49	2.60	0.77	1.29	0.037	6.69	0.00	0.00	1.30	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**6.70**	**1.18**	**0.55**	**1.92**	**1.57**	**9.78**	**0.56**	**0.73**	**0.031**	**6.21**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	6.75	1.18	0.55	1.92	1.57	10.82	0.56	0.69	0.030	6.21	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	6.77	1.10	0.55	1.98	1.57	8.80	0.60	0.84	0.032	6.33	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrNct	6.79	1.04	0.56	2.12	1.55	5.53	0.68	0.85	0.031	6.51	0.60	0.60	1.10	0.69
Vnl/ClrNct-Std-ClrSpe	6.80	1.24	0.55	1.83	1.59	14.00	0.51	0.70	0.032	6.10	0.42	0.37	0.92	0.00
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**6.63**	**1.18**	**0.55**	**1.92**	**1.57**	**8.40**	**0.56**	**0.73**	**0.031**	**6.21**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	6.68	1.18	0.55	1.92	1.57	9.44	0.56	0.69	0.030	6.21	0.46	0.43	0.96	0.54
Mtl/ClrNct-Std-ClrSpe	6.71	1.10	0.55	1.98	1.57	7.57	0.60	0.84	0.032	6.33	0.69	0.57	1.18	0.68
Vnl/ClrNct-Std-ClrSpe	6.74	1.24	0.55	1.83	1.59	12.77	0.51	0.70	0.032	6.10	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrNct	6.75	1.04	0.56	2.12	1.55	4.75	0.68	0.85	0.031	6.51	0.60	0.60	1.10	0.69

Central Valley

Table 8 – Skylight U-factor Criteria – Residential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.00**	**1.18**	**0.55**	**3.21**	**1.57**	**8.32**	**0.56**	**0.73**	**0.049**	**8.59**	**0.49**	**0.46**	**0.99**	**0.57**
Vnl/ClrNct-Std-ClrSpe	9.01	1.24	0.55	3.09	1.59	11.57	0.51	0.70	0.049	8.43	0.42	0.37	0.92	0.00
Brk/ClrNct-Ins-ClrSpe	9.04	1.18	0.55	3.21	1.57	9.36	0.56	0.69	0.048	8.57	0.46	0.43	0.96	0.54
Vnl/ClrNct-Ins-ClrSpe	9.06	1.24	0.55	3.09	1.59	12.61	0.51	0.70	0.049	8.43	0.39	0.34	0.89	0.00
Mtl/ClrNct-Std-ClrSpe	9.08	1.10	0.55	3.30	1.57	6.37	0.60	0.84	0.050	8.76	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-HtMr88-Ins-ClrNct	9.20	1.19	0.55	3.13	1.59	15.17	0.53	0.52	0.045	8.44	0.33	0.30	0.73	0.36
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	9.20	1.08	0.55	3.27	1.58	10.84	0.59	0.58	0.044	8.66	0.43	0.42	0.84	0.46
Vnl/ClrNct-Ins-HtMr88-Ins-ClrNct	9.22	1.27	0.54	3.02	1.60	18.42	0.48	0.55	0.047	8.29	0.28	0.22	0.68	0.00
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	9.25	1.24	0.57	3.42	1.51	8.71	0.65	0.74	0.046	8.82	0.00	0.00	0.71	0.00
Mtl/AcrQudClr	9.27	1.24	0.57	3.43	1.51	7.80	0.65	0.93	0.051	8.88	0.00	0.00	0.94	0.00
Brk/AcrTrpClr	9.35	1.21	0.57	3.55	1.50	6.11	0.71	0.91	0.049	9.04	0.00	0.00	0.87	0.00
Mtl/AcrTrpClr	**9.36**	**1.21**	**0.57**	**3.55**	**1.50**	**5.20**	**0.71**	**1.10**	**0.054**	**9.10**	**0.00**	**0.00**	**1.10**	**0.00**
Vnl/AcrQudClr	9.38	1.24	0.57	3.41	1.51	13.00	0.65	0.48	0.040	8.73	0.00	0.00	0.46	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.07**	**1.18**	**0.55**	**3.21**	**1.57**	**9.78**	**0.56**	**0.73**	**0.049**	**8.59**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	9.11	1.18	0.55	3.21	1.57	10.82	0.56	0.69	0.048	8.57	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	9.13	1.24	0.55	3.09	1.59	14.00	0.51	0.70	0.049	8.43	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	9.18	1.24	0.55	3.09	1.59	15.04	0.51	0.70	0.049	8.43	0.39	0.34	0.89	0.00
Mtl/ClrNct-Std-ClrSpe	9.20	1.10	0.55	3.30	1.57	8.80	0.60	0.84	0.050	8.76	0.69	0.57	1.18	0.68
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**9.01**	**1.18**	**0.55**	**3.21**	**1.57**	**8.40**	**0.56**	**0.73**	**0.049**	**8.59**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	9.04	1.18	0.55	3.21	1.57	9.44	0.56	0.69	0.048	8.57	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	9.07	1.24	0.55	3.09	1.59	12.77	0.51	0.70	0.049	8.43	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	9.12	1.24	0.55	3.09	1.59	13.81	0.51	0.70	0.049	8.43	0.39	0.34	0.89	0.00
Mtl/ClrNct-Std-ClrSpe	9.14	1.10	0.55	3.30	1.57	7.57	0.60	0.84	0.050	8.76	0.69	0.57	1.18	0.68

Desert

Table 9 – Skylight U-factor Criteria – Residential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Vnl/ClrNct-Std-ClrSpe	10.39	1.24	0.55	3.89	1.59	11.57	0.51	0.70	0.053	9.82	0.42	0.37	0.92	0.00
Brk/ClrNct-Std-ClrSpe	**10.41**	**1.18**	**0.55**	**4.02**	**1.57**	**8.32**	**0.56**	**0.73**	**0.053**	**10.00**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	10.44	1.18	0.55	4.01	1.57	9.36	0.56	0.69	0.052	9.97	0.46	0.43	0.96	0.54
Vnl/ClrNct-Ins-ClrSpe	10.45	1.24	0.55	3.89	1.59	12.61	0.51	0.70	0.053	9.82	0.39	0.34	0.89	0.00
Mtl/ClrNct-Std-ClrSpe	10.53	1.10	0.55	4.14	1.57	6.37	0.60	0.84	0.054	10.21	0.69	0.57	1.18	0.68
Brk/ClrNct-Ins-HtMr88-Ins-ClrNct	10.55	1.19	0.55	3.90	1.59	15.17	0.53	0.52	0.049	9.79	0.33	0.30	0.73	0.36
Vnl/ClrNct-Ins-HtMr88-Ins-ClrNct	10.56	1.27	0.54	3.79	1.60	18.42	0.48	0.55	0.051	9.63	0.28	0.22	0.68	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	10.58	1.08	0.55	4.06	1.58	10.84	0.59	0.58	0.049	10.04	0.43	0.42	0.84	0.46
Vnl/ClrNct-Ins-ClrNct-Ins-ClrNct	10.64	1.11	0.54	3.97	1.60	14.09	0.55	0.61	0.050	9.94	0.37	0.33	0.78	0.00
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	10.70	1.24	0.57	4.25	1.51	8.71	0.65	0.74	0.051	10.26	0.00	0.00	0.71	0.00
Vnl/AcrQudClr	10.76	1.24	0.57	4.20	1.51	13.00	0.65	0.48	0.045	10.11	0.00	0.00	0.46	0.00
Mtl/AcrQudClr	10.76	1.24	0.57	4.29	1.51	7.80	0.65	0.93	0.055	10.37	0.00	0.00	0.94	0.00
Brk/AcrTrpClr	**10.84**	**1.21**	**0.57**	**4.41**	**1.50**	**6.11**	**0.71**	**0.91**	**0.053**	**10.54**	**0.00**	**0.00**	**0.87**	**0.00**
Vnl/AcrTrpClr	10.91	1.16	0.57	4.36	1.50	10.40	0.71	0.65	0.048	10.39	0.00	0.00	0.61	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**10.48**	**1.18**	**0.55**	**4.02**	**1.57**	**9.78**	**0.56**	**0.73**	**0.053**	**10.00**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	10.51	1.18	0.55	4.01	1.57	10.82	0.56	0.69	0.052	9.97	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	10.52	1.24	0.55	3.89	1.59	14.00	0.51	0.70	0.053	9.82	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	10.57	1.24	0.55	3.89	1.59	15.04	0.51	0.70	0.053	9.82	0.39	0.34	0.89	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	10.65	1.08	0.55	4.06	1.58	12.16	0.59	0.58	0.049	10.04	0.43	0.42	0.84	0.46
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**10.42**	**1.18**	**0.55**	**4.02**	**1.57**	**8.40**	**0.56**	**0.73**	**0.053**	**10.00**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	10.44	1.18	0.55	4.01	1.57	9.44	0.56	0.69	0.052	9.97	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	10.45	1.24	0.55	3.89	1.59	12.77	0.51	0.70	0.053	9.82	0.42	0.37	0.92	0.00
Vnl/ClrNct-Ins-ClrSpe	10.51	1.24	0.55	3.89	1.59	13.81	0.51	0.70	0.053	9.82	0.39	0.34	0.89	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	10.58	1.08	0.55	4.06	1.58	10.74	0.59	0.58	0.049	10.04	0.43	0.42	0.84	0.46

Cold Region

Table 10 – Skylight U-factor Criteria – Residential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.36**	**1.18**	**0.55**	**2.31**	**1.57**	**8.32**	**0.56**	**0.73**	**0.124**	**7.95**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.38	1.18	0.55	2.31	1.57	9.36	0.56	0.69	0.122	7.91	0.46	0.43	0.96	0.54
Vnl/ClrNct-Std-ClrSpe	8.42	1.24	0.55	2.23	1.59	11.57	0.51	0.70	0.125	7.85	0.42	0.37	0.92	0.00
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	8.44	1.08	0.55	2.34	1.58	10.84	0.59	0.58	0.114	7.89	0.43	0.42	0.84	0.46
Mtl/ClrNct-Std-ClrSpe	8.44	1.10	0.55	2.39	1.57	6.37	0.60	0.84	0.128	8.12	0.69	0.57	1.18	0.68
Brk/ClrNct-Std-ClrPye	8.48	1.03	0.55	2.44	1.57	7.18	0.64	0.74	0.121	8.12	0.51	0.49	1.00	0.59
Vnl/ClrNct-Ins-ClrSpe	8.48	1.24	0.55	2.23	1.59	12.61	0.51	0.70	0.125	7.85	0.39	0.34	0.89	0.00
Brk/ClrNct-Ins-HtMr88-Ins-ClrNct	8.49	1.19	0.55	2.24	1.59	15.17	0.53	0.52	0.114	7.73	0.33	0.30	0.73	0.36
Brk/ClrNct-Ins-ClrPye	8.49	1.03	0.55	2.44	1.57	8.22	0.64	0.70	0.118	8.08	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Vnl/AcrQudClr	8.47	1.24	0.57	2.43	1.51	13.00	0.65	0.48	0.105	7.82	0.00	0.00	0.46	0.00
Brk/AcrQudClr	8.48	1.24	0.57	2.46	1.51	8.71	0.65	0.74	0.120	8.04	0.00	0.00	0.71	0.00
Vnl/AcrTrpClr	8.57	1.16	0.57	2.53	1.50	10.40	0.71	0.65	0.112	8.05	0.00	0.00	0.61	0.00
Brk/AcrTrpClr	**8.58**	**1.21**	**0.57**	**2.57**	**1.50**	**6.11**	**0.71**	**0.91**	**0.127**	**8.28**	**0.00**	**0.00**	**0.87**	**0.00**
Mtl/AcrQudClr	8.60	1.24	0.57	2.49	1.51	7.80	0.65	0.93	0.130	8.21	0.00	0.00	0.94	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.43**	**1.18**	**0.55**	**2.31**	**1.57**	**9.78**	**0.56**	**0.73**	**0.124**	**7.95**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.45	1.18	0.55	2.31	1.57	10.82	0.56	0.69	0.122	7.91	0.46	0.43	0.96	0.54
Brk/ClrNct-Std-ClrPye	8.49	1.03	0.55	2.44	1.57	7.42	0.64	0.74	0.121	8.12	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	8.50	1.08	0.55	2.34	1.58	12.16	0.59	0.58	0.114	7.89	0.43	0.42	0.84	0.46
Brk/ClrNct-Ins-ClrPye	8.50	1.03	0.55	2.44	1.57	8.46	0.64	0.70	0.118	8.08	0.48	0.46	0.97	0.56
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSpe	**8.36**	**1.18**	**0.55**	**2.31**	**1.57**	**8.40**	**0.56**	**0.73**	**0.124**	**7.95**	**0.49**	**0.46**	**0.99**	**0.57**
Brk/ClrNct-Ins-ClrSpe	8.38	1.18	0.55	2.31	1.57	9.44	0.56	0.69	0.122	7.91	0.46	0.43	0.96	0.54
Brk/ClrNct-Ins-ClrNct-Ins-ClrNct	8.43	1.08	0.55	2.34	1.58	10.74	0.59	0.58	0.114	7.89	0.43	0.42	0.84	0.46
Brk/ClrNct-Std-ClrPye	8.45	1.03	0.55	2.44	1.57	6.64	0.64	0.74	0.121	8.12	0.51	0.49	1.00	0.59
Brk/ClrNct-Ins-ClrPye	8.47	1.03	0.55	2.44	1.57	7.68	0.64	0.70	0.118	8.08	0.48	0.46	0.97	0.56

SHGC Criteria – Nonresidential

South Coast

Table 11 – Skylight SHGC Criteria – 0-2% WWR – Nonresidential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct	**7.95**	**1.01**	**0.44**	**2.36**	**1.98**	**1.95**	**0.79**	**1.53**	**0.055**	**7.91**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	7.96	1.10	0.40	2.25	2.11	0.51	0.61	1.58	0.056	7.95	1.27	1.22	1.98	1.36
Brk/GrnNct	7.97	1.16	0.40	2.23	2.11	2.46	0.58	1.53	0.056	7.92	1.08	1.11	1.89	1.25
Vnl/ClrNct	8.00	1.05	0.43	2.32	2.01	5.20	0.73	1.47	0.055	7.90	0.90	0.98	1.75	0.00
Mtl/ClrNct-Std-ClrSue	8.03	1.27	0.38	2.18	2.17	6.37	0.49	0.83	0.052	7.90	0.67	0.56	1.17	0.68
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	**7.93**	**1.01**	**0.44**	**2.36**	**1.98**	**0.98**	**0.79**	**1.53**	**0.055**	**7.91**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct	7.95	1.16	0.40	2.23	2.11	1.53	0.58	1.53	0.056	7.92	1.08	1.11	1.89	1.25
Mtl/GrnNct	7.97	1.10	0.40	2.25	2.11	0.56	0.61	1.58	0.056	7.95	1.27	1.22	1.98	1.36
Vnl/ClrNct	8.00	1.05	0.43	2.32	2.01	5.20	0.73	1.47	0.055	7.90	0.90	0.98	1.75	0.00
Brk/ClrNct-Std-ClrNct	8.04	1.04	0.41	2.30	2.07	5.53	0.68	0.85	0.051	7.93	0.60	0.60	1.10	0.69
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	**7.93**	**1.01**	**0.44**	**2.36**	**1.98**	**0.83**	**0.79**	**1.53**	**0.055**	**7.91**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct	7.95	1.16	0.40	2.23	2.11	1.31	0.58	1.53	0.056	7.92	1.08	1.11	1.89	1.25
Mtl/GrnNct	7.96	1.10	0.40	2.25	2.11	0.48	0.61	1.58	0.056	7.95	1.27	1.22	1.98	1.36
Vnl/ClrNct	8.00	1.05	0.43	2.32	2.01	5.20	0.73	1.47	0.055	7.90	0.90	0.98	1.75	0.00
Brk/ClrNct-Std-ClrNct	8.02	1.04	0.41	2.30	2.07	4.75	0.68	0.85	0.051	7.93	0.60	0.60	1.10	0.69
Plastic Criteria ASHRAE Cost Model														
Brk/ClrNct	**7.95**	**1.01**	**0.44**	**2.36**	**1.98**	**1.95**	**0.79**	**1.53**	**0.055**	**7.91**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	7.96	1.10	0.40	2.25	2.11	0.51	0.61	1.58	0.056	7.95	1.27	1.22	1.98	1.36
Brk/GrnNct	7.97	1.16	0.40	2.23	2.11	2.46	0.58	1.53	0.056	7.92	1.08	1.11	1.89	1.25
Vnl/ClrNct	8.00	1.05	0.43	2.32	2.01	5.20	0.73	1.47	0.055	7.90	0.90	0.98	1.75	0.00
Mtl/ClrNct-Std-ClrSue	8.03	1.27	0.38	2.18	2.17	6.37	0.49	0.83	0.052	7.90	0.67	0.56	1.17	0.68

Table 12 – Skylight SHGC Criteria – 2.1-5% WWR – Nonresidential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	7.95	1.33	0.52	2.47	1.67	6.87	0.39	0.83	0.057	7.61	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	7.96	1.44	0.52	2.43	1.67	8.82	0.36	0.71	0.056	7.52	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrNct	**7.97**	**1.35**	**0.53**	**2.48**	**1.65**	**7.31**	**0.40**	**0.85**	**0.057**	**7.61**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/HptNct-Std-ClrPye	7.98	1.28	0.52	2.47	1.69	6.66	0.39	0.85	0.057	7.65	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrNct	7.98	1.23	0.53	2.54	1.65	5.36	0.44	0.96	0.058	7.72	0.81	0.72	1.31	0.80
Glass Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	**7.98**	**1.35**	**0.53**	**2.48**	**1.65**	**7.57**	**0.40**	**0.85**	**0.057**	**7.61**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	8.01	1.28	0.54	2.59	1.61	6.08	0.47	0.84	0.056	7.70	0.60	0.60	1.10	0.69
Brk/HptNct	8.02	1.18	0.54	2.62	1.61	3.02	0.51	1.53	0.066	7.87	1.08	1.11	1.89	1.25
Brk/HptNct-Ins-ClrNct	8.03	1.35	0.53	2.48	1.65	8.61	0.40	0.81	0.057	7.60	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrPye	8.03	1.39	0.52	2.42	1.69	9.46	0.36	0.74	0.056	7.56	0.51	0.49	1.00	0.59
Glass Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	**7.93**	**1.35**	**0.53**	**2.48**	**1.65**	**6.50**	**0.40**	**0.85**	**0.057**	**7.61**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	7.96	1.28	0.54	2.59	1.61	5.23	0.47	0.84	0.056	7.70	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrSue	7.97	1.44	0.52	2.43	1.67	8.88	0.36	0.71	0.056	7.52	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrNct	7.98	1.35	0.53	2.48	1.65	7.54	0.40	0.81	0.057	7.60	0.57	0.57	1.07	0.66
Brk/HptNct-Std-ClrPye	7.98	1.39	0.52	2.42	1.69	8.40	0.36	0.74	0.056	7.56	0.51	0.49	1.00	0.59
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglHW	**8.13**	**1.25**	**0.57**	**2.83**	**1.51**	**0.65**	**0.65**	**1.92**	**0.070**	**8.10**	**0.00**	**0.00**	**1.90**	**0.00**
Mtl/AcrDblHW	8.16	1.21	0.56	2.81	1.53	3.25	0.62	1.29	0.061	7.99	0.00	0.00	1.30	0.00
Brk/AcrSglHW	8.18	1.25	0.57	2.83	1.51	1.56	0.65	1.93	0.071	8.10	0.00	0.00	1.81	0.00
Brk/AcrDblHW	8.19	1.21	0.56	2.82	1.53	4.16	0.62	1.12	0.059	7.98	0.00	0.00	1.10	0.00
Mtl/AcrSglMW	8.22	0.91	0.53	2.72	1.66	0.65	0.58	1.92	0.071	8.19	0.00	0.00	1.90	0.00

North Coast

Table 13 – Skylight SHGC Criteria – 0-2% WWR – Nonresidential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct	**6.85**	**1.01**	**0.44**	**1.53**	**1.98**	**1.95**	**0.79**	**1.53**	**0.081**	**6.81**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	6.91	1.10	0.40	1.44	2.11	0.51	0.61	1.58	0.082	6.90	1.27	1.22	1.98	1.36
Vnl/ClrNct	6.91	1.05	0.43	1.50	2.01	5.20	0.73	1.47	0.080	6.81	0.90	0.98	1.75	0.00
Brk/GrnNct	6.92	1.16	0.40	1.42	2.11	2.46	0.58	1.53	0.082	6.87	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	6.93	1.04	0.41	1.48	2.07	5.88	0.68	0.85	0.074	6.81	0.60	0.60	1.10	0.69
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	**6.83**	**1.01**	**0.44**	**1.53**	**1.98**	**0.98**	**0.79**	**1.53**	**0.081**	**6.81**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct	6.90	1.16	0.40	1.42	2.11	1.53	0.58	1.53	0.082	6.87	1.08	1.11	1.89	1.25
Mtl/GrnNct	6.91	1.10	0.40	1.44	2.11	0.56	0.61	1.58	0.082	6.90	1.27	1.22	1.98	1.36
Vnl/ClrNct	6.91	1.05	0.43	1.50	2.01	5.20	0.73	1.47	0.080	6.81	0.90	0.98	1.75	0.00
Brk/ClrNct-Std-ClrNct	6.92	1.04	0.41	1.48	2.07	5.53	0.68	0.85	0.074	6.81	0.60	0.60	1.10	0.69
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	**6.83**	**1.01**	**0.44**	**1.53**	**1.98**	**0.83**	**0.79**	**1.53**	**0.081**	**6.81**	**1.08**	**1.11**	**1.89**	**1.25**
Brk/GrnNct	6.90	1.16	0.40	1.42	2.11	1.31	0.58	1.53	0.082	6.87	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	6.90	1.04	0.41	1.48	2.07	4.75	0.68	0.85	0.074	6.81	0.60	0.60	1.10	0.69
Mtl/GrnNct	6.91	1.10	0.40	1.44	2.11	0.48	0.61	1.58	0.082	6.90	1.27	1.22	1.98	1.36
Vnl/ClrNct	6.91	1.05	0.43	1.50	2.01	5.20	0.73	1.47	0.080	6.81	0.90	0.98	1.75	0.00
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrDblClr	**6.69**	**1.16**	**0.46**	**1.52**	**1.90**	**2.60**	**0.77**	**1.29**	**0.078**	**6.64**	**0.00**	**0.00**	**1.30**	**0.00**
Brk/AcrDblClr	6.70	1.16	0.46	1.52	1.90	3.51	0.77	1.12	0.076	6.63	0.00	0.00	1.10	0.00
Mtl/AcrSglHW	6.73	1.25	0.44	1.45	1.96	0.65	0.65	1.92	0.086	6.71	0.00	0.00	1.90	0.00
Brk/AcrTrpClr	6.73	1.21	0.45	1.49	1.93	6.11	0.71	0.91	0.075	6.61	0.00	0.00	0.87	0.00
Mtl/AcrTrpClr	6.74	1.21	0.45	1.49	1.93	5.20	0.71	1.10	0.077	6.63	0.00	0.00	1.10	0.00

Table 14 – Skylight SHGC Criteria – 2.1-5% WWR – Nonresidential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	6.84	1.33	0.52	1.61	1.67	6.87	0.39	0.83	0.085	6.49	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	6.85	1.44	0.52	1.58	1.67	8.82	0.36	0.71	0.082	6.41	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrNct	**6.85**	**1.35**	**0.53**	**1.63**	**1.65**	**7.31**	**0.40**	**0.85**	**0.085**	**6.49**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	6.86	1.28	0.54	1.72	1.61	6.38	0.47	0.84	0.084	6.54	0.60	0.60	1.10	0.69
Mtl/HptNct-Std-ClrNct	6.86	1.23	0.53	1.67	1.65	5.36	0.44	0.96	0.088	6.59	0.81	0.72	1.31	0.80
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	6.84	1.28	0.54	1.72	1.61	6.08	0.47	0.84	0.084	6.54	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	**6.87**	**1.35**	**0.53**	**1.63**	**1.65**	**7.57**	**0.40**	**0.85**	**0.085**	**6.49**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Ins-ClrNct	6.89	1.28	0.54	1.72	1.61	7.12	0.47	0.81	0.083	6.53	0.57	0.57	1.07	0.66
Mtl/GrnNct-Std-ClrNct	6.90	1.18	0.54	1.76	1.61	5.11	0.51	0.96	0.086	6.65	0.81	0.72	1.31	0.80
Brk/GrnNct-Std-ClrPye	6.90	1.28	0.53	1.67	1.65	7.98	0.43	0.74	0.082	6.50	0.51	0.49	1.00	0.59
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	6.80	1.28	0.54	1.72	1.61	5.23	0.47	0.84	0.084	6.54	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrNct	**6.81**	**1.35**	**0.53**	**1.63**	**1.65**	**6.50**	**0.40**	**0.85**	**0.085**	**6.49**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Ins-ClrNct	6.85	1.28	0.54	1.72	1.61	6.27	0.47	0.81	0.083	6.53	0.57	0.57	1.07	0.66
Brk/GrnNct-Std-ClrSue	6.85	1.44	0.52	1.58	1.67	8.88	0.36	0.71	0.082	6.41	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrNct	6.85	1.35	0.53	1.63	1.65	7.54	0.40	0.81	0.084	6.48	0.57	0.57	1.07	0.66
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrDblHW	**6.97**	**1.21**	**0.56**	**1.89**	**1.53**	**3.25**	**0.62**	**1.29**	**0.093**	**6.81**	**0.00**	**0.00**	**1.30**	**0.00**
Brk/AcrDblHW	6.98	1.21	0.56	1.90	1.53	4.16	0.62	1.12	0.089	6.77	0.00	0.00	1.10	0.00
Mtl/AcrSglHW	7.02	1.25	0.57	1.91	1.51	0.65	0.65	1.92	0.109	6.99	0.00	0.00	1.90	0.00
Brk/AcrTrpHW	7.03	1.18	0.56	1.86	1.55	6.76	0.58	0.91	0.084	6.69	0.00	0.00	0.87	0.00
Mtl/AcrTrpHW	7.03	1.18	0.56	1.85	1.55	5.85	0.58	1.10	0.089	6.74	0.00	0.00	1.10	0.00

Central Valley

Table 15 – Skylight SHGC Criteria – 0-2% WWR – Nonresidential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**8.43**	**1.35**	**0.38**	**2.19**	**2.17**	**8.32**	**0.46**	**0.71**	**0.083**	**8.26**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct	8.44	1.01	0.44	2.41	1.98	1.95	0.79	1.53	0.089	8.40	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrSue	8.44	1.27	0.38	2.21	2.17	6.37	0.49	0.83	0.084	8.31	0.67	0.56	1.17	0.68
Brk/ClrNct-Ins-ClrSue	8.44	1.35	0.38	2.19	2.17	9.36	0.46	0.67	0.082	8.26	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrNct	8.45	1.04	0.41	2.33	2.07	5.88	0.68	0.85	0.083	8.33	0.60	0.60	1.10	0.69
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	8.42	1.01	0.44	2.41	1.98	0.98	0.79	1.53	0.089	8.40	1.08	1.11	1.89	1.25
Brk/GrnNct	8.44	1.16	0.40	2.28	2.11	1.53	0.58	1.53	0.091	8.41	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	8.44	1.04	0.41	2.33	2.07	5.53	0.68	0.85	0.083	8.33	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	8.46	1.28	0.38	2.20	2.19	6.08	0.47	0.84	0.084	8.33	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrNct	8.46	1.04	0.41	2.33	2.07	6.57	0.68	0.81	0.082	8.33	0.57	0.57	1.07	0.66
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	8.42	1.01	0.44	2.41	1.98	0.83	0.79	1.53	0.089	8.40	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrNct	8.43	1.04	0.41	2.33	2.07	4.75	0.68	0.85	0.083	8.33	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	**8.43**	**1.35**	**0.38**	**2.19**	**2.17**	**8.40**	**0.46**	**0.71**	**0.083**	**8.26**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct	8.44	1.16	0.40	2.28	2.11	1.31	0.58	1.53	0.091	8.41	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	8.44	1.28	0.38	2.20	2.19	5.23	0.47	0.84	0.084	8.33	0.60	0.60	1.10	0.69
Plastic Criteria ASHRAE Cost Model														
Brk/AcrDblClr	**8.25**	**1.16**	**0.46**	**2.39**	**1.90**	**3.51**	**0.77**	**1.12**	**0.085**	**8.18**	**0.00**	**0.00**	**1.10**	**0.00**
Mtl/AcrDblClr	8.26	1.16	0.46	2.39	1.90	2.60	0.77	1.29	0.087	8.21	0.00	0.00	1.30	0.00
Brk/AcrTrpClr	8.27	1.21	0.45	2.35	1.93	6.11	0.71	0.91	0.083	8.15	0.00	0.00	0.87	0.00
Mtl/AcrTrpClr	8.28	1.21	0.45	2.35	1.93	5.20	0.71	1.10	0.085	8.18	0.00	0.00	1.10	0.00
Vnl/AcrDblClr	8.30	1.16	0.46	2.38	1.90	7.80	0.77	0.84	0.082	8.14	0.00	0.00	0.84	0.00

Table 16 – Skylight SHGC Criteria – 2.1-5% WWR – Nonresidential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**8.47**	**1.44**	**0.52**	**2.49**	**1.67**	**8.82**	**0.36**	**0.71**	**0.091**	**8.03**	**0.47**	**0.45**	**0.98**	**0.56**
Mtl/GrnNct-Std-ClrSue	8.50	1.33	0.52	2.54	1.67	6.87	0.39	0.83	0.094	8.15	0.67	0.56	1.17	0.68
Brk/HptNct-Std-ClrPye	8.51	1.39	0.52	2.49	1.69	8.61	0.36	0.74	0.092	8.08	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrSue	8.51	1.44	0.52	2.49	1.67	9.86	0.36	0.67	0.090	8.02	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrSue	8.51	1.47	0.51	2.42	1.73	9.75	0.32	0.71	0.092	8.02	0.47	0.45	0.98	0.56
Glass Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	8.53	1.35	0.53	2.56	1.65	7.57	0.40	0.85	0.094	8.16	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrSue	**8.55**	**1.44**	**0.52**	**2.49**	**1.67**	**10.34**	**0.36**	**0.71**	**0.091**	**8.03**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrNct	8.55	1.28	0.54	2.67	1.61	6.08	0.47	0.84	0.093	8.25	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	8.55	1.39	0.52	2.49	1.69	9.46	0.36	0.74	0.092	8.08	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	8.56	1.43	0.52	2.47	1.69	10.50	0.35	0.70	0.091	8.04	0.48	0.46	0.97	0.56
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**8.48**	**1.44**	**0.52**	**2.49**	**1.67**	**8.88**	**0.36**	**0.71**	**0.091**	**8.03**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrNct	8.48	1.35	0.53	2.56	1.65	6.50	0.40	0.85	0.094	8.16	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	8.50	1.39	0.52	2.49	1.69	8.40	0.36	0.74	0.092	8.08	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	8.51	1.28	0.54	2.67	1.61	5.23	0.47	0.84	0.093	8.25	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrPye	8.51	1.43	0.52	2.47	1.69	9.44	0.35	0.70	0.091	8.04	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Brk/AcrDblHW	**8.81**	**1.21**	**0.56**	**2.92**	**1.53**	**4.16**	**0.62**	**1.12**	**0.098**	**8.60**	**0.00**	**0.00**	**1.10**	**0.00**
Brk/AcrTrpHW	8.81	1.18	0.56	2.86	1.55	6.76	0.58	0.91	0.093	8.47	0.00	0.00	0.87	0.00
Mtl/AcrDblHW	8.83	1.21	0.56	2.93	1.53	3.25	0.62	1.29	0.103	8.66	0.00	0.00	1.30	0.00
Mtl/AcrTrpHW	8.84	1.18	0.56	2.86	1.55	5.85	0.58	1.10	0.098	8.55	0.00	0.00	1.10	0.00
Brk/AcrQudHW	8.85	1.14	0.55	2.79	1.59	9.36	0.55	0.74	0.089	8.38	0.00	0.00	0.71	0.00

Desert

Table 17 – Skylight SHGC Criteria – 0-2% WWR – Nonresidential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**9.21**	**1.35**	**0.38**	**2.60**	**2.17**	**8.32**	**0.46**	**0.71**	**0.090**	**9.04**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	9.22	1.35	0.38	2.60	2.17	9.36	0.46	0.67	0.089	9.03	0.44	0.42	0.95	0.53
Mtl/ClrNct-Std-ClrSue	9.23	1.27	0.38	2.63	2.17	6.37	0.49	0.83	0.091	9.10	0.67	0.56	1.17	0.68
Brk/ClrNct-Std-ClrSpe	9.24	1.18	0.40	2.67	2.12	8.32	0.56	0.73	0.089	9.07	0.49	0.46	0.99	0.57
Brk/ClrNct-Std-ClrNct	9.25	1.04	0.41	2.76	2.07	5.88	0.68	0.85	0.090	9.13	0.60	0.60	1.10	0.69
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**9.24**	**1.35**	**0.38**	**2.60**	**2.17**	**9.78**	**0.46**	**0.71**	**0.090**	**9.04**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Std-ClrNct	9.24	1.04	0.41	2.76	2.07	5.53	0.68	0.85	0.090	9.13	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	9.24	1.28	0.38	2.62	2.19	6.08	0.47	0.84	0.091	9.12	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSue	9.25	1.35	0.38	2.60	2.17	10.82	0.46	0.67	0.089	9.03	0.44	0.42	0.95	0.53
Brk/ClrNct-Ins-ClrNct	9.25	1.04	0.41	2.75	2.07	6.57	0.68	0.81	0.090	9.12	0.57	0.57	1.07	0.66
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**9.21**	**1.35**	**0.38**	**2.60**	**2.17**	**8.40**	**0.46**	**0.71**	**0.090**	**9.04**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	9.22	1.35	0.38	2.60	2.17	9.44	0.46	0.67	0.089	9.03	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrNct	9.22	1.04	0.41	2.76	2.07	4.75	0.68	0.85	0.090	9.13	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrNct	9.23	1.28	0.38	2.62	2.19	5.23	0.47	0.84	0.091	9.12	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrNct	9.24	1.04	0.41	2.75	2.07	5.79	0.68	0.81	0.090	9.12	0.57	0.57	1.07	0.66
Plastic Criteria ASHRAE Cost Model														
Brk/AcrTrpClr	**9.07**	**1.21**	**0.45**	**2.78**	**1.93**	**6.11**	**0.71**	**0.91**	**0.090**	**8.95**	**0.00**	**0.00**	**0.87**	**0.00**
Brk/AcrDblClr	9.07	1.16	0.46	2.83	1.90	3.51	0.77	1.12	0.092	9.00	0.00	0.00	1.10	0.00
Mtl/AcrDblClr	9.09	1.16	0.46	2.84	1.90	2.60	0.77	1.29	0.094	9.03	0.00	0.00	1.30	0.00
Brk/AcrQudClr	9.09	1.24	0.44	2.73	1.97	8.71	0.65	0.74	0.089	8.92	0.00	0.00	0.71	0.00
Mtl/AcrTrpClr	9.09	1.21	0.45	2.79	1.93	5.20	0.71	1.10	0.092	8.99	0.00	0.00	1.10	0.00

Table 18 – Skylight SHGC Criteria – 2.1-5% WWR – Nonresidential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**9.33**	**1.44**	**0.52**	**2.95**	**1.67**	**8.82**	**0.36**	**0.71**	**0.098**	**8.89**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	9.36	1.44	0.52	2.95	1.67	9.86	0.36	0.67	0.097	8.87	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrSue	9.36	1.47	0.51	2.89	1.73	9.75	0.32	0.71	0.098	8.88	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	9.37	1.39	0.52	2.96	1.69	8.61	0.36	0.74	0.098	8.94	0.51	0.49	1.00	0.59
Mtl/GrnNct-Std-ClrSue	9.37	1.33	0.52	3.02	1.67	6.87	0.39	0.83	0.100	9.03	0.67	0.56	1.17	0.68
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**9.41**	**1.44**	**0.52**	**2.95**	**1.67**	**10.34**	**0.36**	**0.71**	**0.098**	**8.89**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	9.41	1.39	0.52	2.96	1.69	9.46	0.36	0.74	0.098	8.94	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	9.41	1.35	0.53	3.04	1.65	7.57	0.40	0.85	0.100	9.03	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrPye	9.42	1.43	0.52	2.94	1.69	10.50	0.35	0.70	0.098	8.89	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrNct	9.44	1.28	0.54	3.15	1.61	6.08	0.47	0.84	0.099	9.13	0.60	0.60	1.10	0.69
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**9.33**	**1.44**	**0.52**	**2.95**	**1.67**	**8.88**	**0.36**	**0.71**	**0.098**	**8.89**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	9.36	1.39	0.52	2.96	1.69	8.40	0.36	0.74	0.098	8.94	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrNct	9.36	1.35	0.53	3.04	1.65	6.50	0.40	0.85	0.100	9.03	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrPye	9.36	1.43	0.52	2.94	1.69	9.44	0.35	0.70	0.098	8.89	0.48	0.46	0.97	0.56
Brk/GrnNct-Ins-ClrSue	9.36	1.44	0.52	2.95	1.67	9.92	0.36	0.67	0.097	8.87	0.44	0.42	0.95	0.53
Plastic Criteria ASHRAE Cost Model														
Brk/AcrTrpHW	**9.72**	**1.18**	**0.56**	**3.35**	**1.55**	**6.76**	**0.58**	**0.91**	**0.100**	**9.38**	**0.00**	**0.00**	**0.87**	**0.00**
Brk/AcrQudHW	9.73	1.14	0.55	3.27	1.59	9.36	0.55	0.74	0.096	9.26	0.00	0.00	0.71	0.00
Brk/AcrDblHW	9.75	1.21	0.56	3.44	1.53	4.16	0.62	1.12	0.104	9.54	0.00	0.00	1.10	0.00
Mtl/AcrTrpHW	9.77	1.18	0.56	3.38	1.55	5.85	0.58	1.10	0.104	9.48	0.00	0.00	1.10	0.00
Mtl/AcrQudHW	9.78	1.14	0.55	3.30	1.59	8.45	0.55	0.93	0.101	9.36	0.00	0.00	0.94	0.00

Cold Regions

Table 19 – Skylight SHGC Criteria – 0-2% WWR – Nonresidential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrNct	**7.76**	**1.04**	**0.41**	**1.56**	**2.07**	**5.88**	**0.68**	**0.85**	**0.136**	**7.64**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Ins-ClrNct	7.77	1.04	0.41	1.56	2.07	6.92	0.68	0.81	0.135	7.63	0.57	0.57	1.07	0.66
Mtl/ClrNct-Std-ClrNct	7.78	0.99	0.41	1.58	2.07	3.93	0.72	0.96	0.137	7.70	0.81	0.72	1.31	0.80
Brk/ClrNct	7.79	1.01	0.44	1.64	1.98	1.95	0.79	1.53	0.147	7.75	1.08	1.11	1.89	1.25
Brk/ClrNct-Std-ClrSpe	7.80	1.18	0.40	1.51	2.12	8.32	0.56	0.73	0.135	7.63	0.49	0.46	0.99	0.57
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrNct	**7.75**	**1.04**	**0.41**	**1.56**	**2.07**	**5.53**	**0.68**	**0.85**	**0.136**	**7.64**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Ins-ClrNct	7.76	1.04	0.41	1.56	2.07	6.57	0.68	0.81	0.135	7.63	0.57	0.57	1.07	0.66
Brk/ClrNct	7.77	1.01	0.44	1.64	1.98	0.98	0.79	1.53	0.147	7.75	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrNct	7.79	0.99	0.41	1.58	2.07	4.55	0.72	0.96	0.137	7.70	0.81	0.72	1.31	0.80
Brk/ClrNct-Std-ClrSpe	7.83	1.18	0.40	1.51	2.12	9.78	0.56	0.73	0.135	7.63	0.49	0.46	0.99	0.57
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrNct	**7.74**	**1.04**	**0.41**	**1.56**	**2.07**	**4.75**	**0.68**	**0.85**	**0.136**	**7.64**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/ClrNct-Ins-ClrNct	7.75	1.04	0.41	1.56	2.07	5.79	0.68	0.81	0.135	7.63	0.57	0.57	1.07	0.66
Brk/ClrNct	7.77	1.01	0.44	1.64	1.98	0.83	0.79	1.53	0.147	7.75	1.08	1.11	1.89	1.25
Mtl/ClrNct-Std-ClrNct	7.78	0.99	0.41	1.58	2.07	3.91	0.72	0.96	0.137	7.70	0.81	0.72	1.31	0.80
Brk/ClrNct-Std-ClrSpe	7.80	1.18	0.40	1.51	2.12	8.40	0.56	0.73	0.135	7.63	0.49	0.46	0.99	0.57
Plastic Criteria ASHRAE Cost Model														
Brk/AcrDblClr	**7.57**	**1.16**	**0.46**	**1.61**	**1.90**	**3.51**	**0.77**	**1.12**	**0.140**	**7.50**	**0.00**	**0.00**	**1.10**	**0.00**
Vnl/AcrDblClr	7.57	1.16	0.46	1.60	1.90	7.80	0.77	0.84	0.135	7.42	0.00	0.00	0.84	0.00
Brk/AcrTrpClr	7.58	1.21	0.45	1.57	1.93	6.11	0.71	0.91	0.136	7.45	0.00	0.00	0.87	0.00
Vnl/AcrTrpClr	7.59	1.16	0.45	1.56	1.93	10.40	0.71	0.65	0.132	7.38	0.00	0.00	0.61	0.00
Mtl/AcrDblClr	7.59	1.16	0.46	1.62	1.90	2.60	0.77	1.29	0.143	7.54	0.00	0.00	1.30	0.00

Table 20 – Skylight SHGC Criteria – 2.1-5% WWR – Nonresidential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**7.80**	**1.35**	**0.55**	**1.80**	**1.59**	**8.32**	**0.46**	**0.71**	**0.148**	**7.39**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	7.81	1.44	0.52	1.69	1.67	8.82	0.36	0.71	0.150	7.37	0.47	0.45	0.98	0.56
Brk/ClrNct-Ins-ClrSue	7.83	1.35	0.55	1.79	1.59	9.36	0.46	0.67	0.146	7.36	0.44	0.42	0.95	0.53
Mtl/ClrNct-Std-ClrSue	7.83	1.27	0.55	1.84	1.59	6.37	0.49	0.83	0.152	7.51	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrNct	7.83	1.28	0.54	1.82	1.61	6.38	0.47	0.84	0.153	7.51	0.60	0.60	1.10	0.69
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	7.82	1.28	0.54	1.82	1.61	6.08	0.47	0.84	0.153	7.51	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrPye	7.85	1.28	0.53	1.77	1.65	7.98	0.43	0.74	0.150	7.45	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	7.85	1.28	0.54	1.82	1.61	7.12	0.47	0.81	0.152	7.49	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	7.86	1.31	0.53	1.76	1.65	9.02	0.42	0.70	0.148	7.41	0.48	0.46	0.97	0.56
Brk/ClrNct-Std-ClrSue	**7.87**	**1.35**	**0.55**	**1.80**	**1.59**	**9.78**	**0.46**	**0.71**	**0.148**	**7.39**	**0.47**	**0.45**	**0.98**	**0.56**
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrNct	7.78	1.28	0.54	1.82	1.61	5.23	0.47	0.84	0.153	7.51	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	**7.81**	**1.35**	**0.55**	**1.80**	**1.59**	**8.40**	**0.46**	**0.71**	**0.148**	**7.39**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrPye	7.81	1.28	0.53	1.77	1.65	7.12	0.43	0.74	0.150	7.45	0.51	0.49	1.00	0.59
Brk/GrnNct-Ins-ClrNct	7.81	1.28	0.54	1.82	1.61	6.27	0.47	0.81	0.152	7.49	0.57	0.57	1.07	0.66
Brk/GrnNct-Ins-ClrPye	7.82	1.31	0.53	1.76	1.65	8.16	0.42	0.70	0.148	7.41	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Brk/AcrTrpHW	**7.98**	**1.18**	**0.56**	**1.95**	**1.55**	**6.76**	**0.58**	**0.91**	**0.154**	**7.65**	**0.00**	**0.00**	**0.87**	**0.00**
Brk/AcrQudClr	7.99	1.24	0.57	2.00	1.51	8.71	0.65	0.74	0.144	7.55	0.00	0.00	0.71	0.00
Brk/AcrQudHW	8.00	1.14	0.55	1.90	1.59	9.36	0.55	0.74	0.147	7.53	0.00	0.00	0.71	0.00
Brk/AcrDblHW	8.01	1.21	0.56	2.01	1.53	4.16	0.62	1.12	0.162	7.80	0.00	0.00	1.10	0.00
Vnl/AcrTrpH	8.02	1.21	0.56	1.92	1.55	11.05	0.58	0.65	0.142	7.46	0.00	0.00	0.61	0.00

SHGC Criteria – Residential

South Coast

Table 21 – Skylight SHGC Criteria – 0-2% WWR – Residential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
U-factor Criteria ASHRAE Cost Model														
Brk/GrnNct	**6.97**	**1.16**	**0.40**	**1.95**	**2.11**	**2.46**	**0.58**	**1.53**	**0.010**	**6.92**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	6.98	1.10	0.40	1.97	2.11	0.51	0.61	1.58	0.010	6.96	1.27	1.22	1.98	1.36
Brk/ClrNct-Std-ClrSue	7.02	1.35	0.38	1.86	2.17	8.32	0.46	0.71	0.008	6.85	0.47	0.45	0.98	0.56
Vnl/GrnNct	7.02	1.21	0.39	1.90	2.14	5.71	0.53	1.47	0.009	6.91	0.90	0.98	1.75	0.00
Mtl/ClrNct-Std-ClrSue	7.02	1.27	0.38	1.88	2.17	6.37	0.49	0.83	0.008	6.90	0.67	0.56	1.17	0.68
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct	**6.95**	**1.16**	**0.40**	**1.95**	**2.11**	**1.53**	**0.58**	**1.53**	**0.010**	**6.92**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	6.98	1.10	0.40	1.97	2.11	0.56	0.61	1.58	0.010	6.96	1.27	1.22	1.98	1.36
Brk/ClrNct	7.02	1.01	0.44	2.13	1.98	0.98	0.79	1.53	0.009	7.00	1.08	1.11	1.89	1.25
Brk/HptNct	7.02	1.18	0.38	1.89	2.19	3.02	0.51	1.53	0.010	6.96	1.08	1.11	1.89	1.25
Vnl/GrnNct	7.02	1.21	0.39	1.90	2.14	5.76	0.53	1.47	0.009	6.91	0.90	0.98	1.75	0.00
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct	**6.95**	**1.16**	**0.40**	**1.95**	**2.11**	**1.31**	**0.58**	**1.53**	**0.010**	**6.92**	**1.08**	**1.11**	**1.89**	**1.25**
Mtl/GrnNct	6.97	1.10	0.40	1.97	2.11	0.48	0.61	1.58	0.010	6.96	1.27	1.22	1.98	1.36
Brk/HptNct	7.01	1.18	0.38	1.89	2.19	2.59	0.51	1.53	0.010	6.96	1.08	1.11	1.89	1.25
Brk/GrnNct-Std-ClrNct	7.01	1.28	0.38	1.86	2.19	5.23	0.47	0.84	0.008	6.91	0.60	0.60	1.10	0.69
Brk/ClrNct	7.02	1.01	0.44	2.13	1.98	0.83	0.79	1.53	0.009	7.00	1.08	1.11	1.89	1.25
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglHW	**6.79**	**1.25**	**0.44**	**2.00**	**1.96**	**0.65**	**0.65**	**1.92**	**0.010**	**6.77**	**0.00**	**0.00**	**1.90**	**0.00**
Brk/AcrSglHW	6.81	1.25	0.44	2.00	1.96	1.56	0.65	1.93	0.010	6.77	0.00	0.00	1.81	0.00
Mtl/AcrDblClr	6.89	1.16	0.46	2.11	1.90	2.60	0.77	1.29	0.009	6.84	0.00	0.00	1.30	0.00
Mtl/AcrDblHW	6.90	1.21	0.42	1.98	2.03	3.25	0.62	1.29	0.009	6.84	0.00	0.00	1.30	0.00
Brk/AcrDblClr	6.91	1.16	0.46	2.11	1.90	3.51	0.77	1.12	0.008	6.84	0.00	0.00	1.10	0.00

Table 22 – Skylight SHGC Criteria – 2.1-5% WWR – Residential – Climate Zone 7

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/HptNct-Std-ClrSue	**7.08**	**1.47**	**0.51**	**2.13**	**1.73**	**9.75**	**0.32**	**0.71**	**0.010**	**6.59**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	7.09	1.44	0.52	2.22	1.67	8.82	0.36	0.71	0.009	6.64	0.47	0.45	0.98	0.56
Mtl/HptNct-Std-ClrSue	7.09	1.34	0.51	2.19	1.73	7.80	0.35	0.83	0.010	6.70	0.67	0.56	1.17	0.68
Mtl/GrnNct-Std-ClrSue	7.09	1.33	0.52	2.28	1.67	6.87	0.39	0.83	0.010	6.75	0.67	0.56	1.17	0.68
Brk/HptNct-Ins-ClrSue	7.10	1.52	0.51	2.11	1.73	10.79	0.31	0.68	0.010	6.56	0.44	0.42	0.95	0.53
Glass Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	7.13	1.35	0.53	2.30	1.65	7.57	0.40	0.85	0.010	6.75	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	7.15	1.39	0.52	2.22	1.69	9.46	0.36	0.74	0.010	6.68	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	7.16	1.44	0.52	2.22	1.67	10.34	0.36	0.71	0.009	6.64	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrPye	7.17	1.43	0.52	2.20	1.69	10.50	0.35	0.70	0.009	6.64	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrSue	**7.18**	**1.47**	**0.51**	**2.13**	**1.73**	**11.82**	**0.32**	**0.71**	**0.010**	**6.59**	**0.47**	**0.45**	**0.98**	**0.56**
Glass Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	7.08	1.35	0.53	2.30	1.65	6.50	0.40	0.85	0.010	6.75	0.60	0.60	1.10	0.69
Brk/GrnNct-Std-ClrSue	7.09	1.44	0.52	2.22	1.67	8.88	0.36	0.71	0.009	6.64	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	7.10	1.39	0.52	2.22	1.69	8.40	0.36	0.74	0.010	6.68	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrSue	**7.10**	**1.47**	**0.51**	**2.13**	**1.73**	**10.15**	**0.32**	**0.71**	**0.010**	**6.59**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Ins-ClrPye	7.11	1.43	0.52	2.20	1.69	9.44	0.35	0.70	0.009	6.64	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglLW	**7.27**	**0.83**	**0.44**	**2.22**	**1.98**	**0.65**	**0.39**	**1.92**	**0.016**	**7.23**	**0.00**	**0.00**	**1.90**	**0.00**
Brk/AcrSglLW	7.31	0.83	0.44	2.22	1.98	1.56	0.39	1.93	0.017	7.23	0.00	0.00	1.81	0.00
Mtl/AcrDblLW	7.37	0.84	0.42	2.15	2.05	3.25	0.34	1.29	0.013	7.21	0.00	0.00	1.30	0.00
Brk/AcrDblLW	7.42	0.84	0.42	2.16	2.05	4.16	0.34	1.12	0.012	7.21	0.00	0.00	1.10	0.00
Mtl/AcrSglHW	7.43	1.25	0.57	2.79	1.51	0.65	0.65	1.92	0.015	7.40	0.00	0.00	1.90	0.00

North Coast

Table 23 – Skylight SHGC Criteria – 0-2% WWR – Residential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Mtl/GrnNct	**6.25**	**1.10**	**0.40**	**1.36**	**2.11**	**0.51**	**0.61**	**1.58**	**0.036**	**6.24**	**1.27**	**1.22**	**1.98**	**1.36**
Brk/ClrNct	6.26	1.01	0.44	1.49	1.98	1.95	0.79	1.53	0.034	6.22	1.08	1.11	1.89	1.25
Brk/GrnNct	6.26	1.16	0.40	1.34	2.11	2.46	0.58	1.53	0.036	6.21	1.08	1.11	1.89	1.25
Vnl/ClrNct	6.30	1.05	0.43	1.45	2.01	5.20	0.73	1.47	0.034	6.20	0.90	0.98	1.75	0.00
Mtl/ClrNct-Std-ClrSue	6.31	1.27	0.38	1.30	2.17	6.37	0.49	0.83	0.032	6.19	0.67	0.56	1.17	0.68
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct	6.24	1.01	0.44	1.49	1.98	0.98	0.79	1.53	0.034	6.22	1.08	1.11	1.89	1.25
Brk/GrnNct	6.24	1.16	0.40	1.34	2.11	1.53	0.58	1.53	0.036	6.21	1.08	1.11	1.89	1.25
Mtl/GrnNct	**6.26**	**1.10**	**0.40**	**1.36**	**2.11**	**0.56**	**0.61**	**1.58**	**0.036**	**6.24**	**1.27**	**1.22**	**1.98**	**1.36**
Vnl/ClrNct	6.30	1.05	0.43	1.45	2.01	5.20	0.73	1.47	0.034	6.20	0.90	0.98	1.75	0.00
Vnl/GrnNct	6.33	1.21	0.39	1.31	2.14	5.76	0.53	1.47	0.036	6.21	0.90	0.98	1.75	0.00
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct	6.24	1.01	0.44	1.49	1.98	0.83	0.79	1.53	0.034	6.22	1.08	1.11	1.89	1.25
Brk/GrnNct	6.24	1.16	0.40	1.34	2.11	1.31	0.58	1.53	0.036	6.21	1.08	1.11	1.89	1.25
Mtl/GrnNct	**6.25**	**1.10**	**0.40**	**1.36**	**2.11**	**0.48**	**0.61**	**1.58**	**0.036**	**6.24**	**1.27**	**1.22**	**1.98**	**1.36**
Vnl/ClrNct	6.30	1.05	0.43	1.45	2.01	5.20	0.73	1.47	0.034	6.20	0.90	0.98	1.75	0.00
Brk/GrnNct-Std-ClrNct	6.31	1.28	0.38	1.28	2.19	5.23	0.47	0.84	0.032	6.21	0.60	0.60	1.10	0.69
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglHW	**6.07**	**1.25**	**0.44**	**1.38**	**1.96**	**0.65**	**0.65**	**1.92**	**0.038**	**6.05**	**0.00**	**0.00**	**1.90**	**0.00**
Brk/AcrSglHW	6.08	1.25	0.44	1.38	1.96	1.56	0.65	1.93	0.038	6.05	0.00	0.00	1.81	0.00
Mtl/AcrDblClr	6.11	1.16	0.46	1.48	1.90	2.60	0.77	1.29	0.033	6.06	0.00	0.00	1.30	0.00
Brk/AcrDblClr	6.12	1.16	0.46	1.49	1.90	3.51	0.77	1.12	0.031	6.05	0.00	0.00	1.10	0.00
Brk/AcrSglClr	6.13	1.10	0.46	1.51	1.88	0.91	0.83	1.93	0.037	6.12	0.00	0.00	1.81	0.00

Table 24 – Skylight SHGC Criteria – 2.1-5% WWR – Residential – Climate Zone 3

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Mtl/GrnNct-Std-ClrSue	6.27	1.33	0.52	1.61	1.67	6.87	0.39	0.83	0.036	5.93	0.67	0.56	1.17	0.68
Brk/GrnNct-Std-ClrSue	6.28	1.44	0.52	1.56	1.67	8.82	0.36	0.71	0.035	5.84	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrNct	**6.29**	**1.35**	**0.53**	**1.62**	**1.65**	**7.31**	**0.40**	**0.85**	**0.037**	**5.93**	**0.60**	**0.60**	**1.10**	**0.69**
Mtl/HptNct-Std-ClrPye	6.30	1.28	0.52	1.61	1.69	6.66	0.39	0.85	0.037	5.96	0.71	0.60	1.20	0.70
Mtl/HptNct-Std-ClrSue	6.30	1.34	0.51	1.54	1.73	7.80	0.35	0.83	0.037	5.91	0.67	0.56	1.17	0.68
Glass Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Std-ClrNct	**6.30**	**1.35**	**0.53**	**1.62**	**1.65**	**7.57**	**0.40**	**0.85**	**0.037**	**5.93**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrNct	6.34	1.28	0.54	1.75	1.61	6.08	0.47	0.84	0.035	6.04	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrPye	6.34	1.39	0.52	1.56	1.69	9.46	0.36	0.74	0.035	5.87	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrSue	6.35	1.44	0.52	1.56	1.67	10.34	0.36	0.71	0.035	5.84	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrNct	6.35	1.35	0.53	1.63	1.65	8.61	0.40	0.81	0.036	5.92	0.57	0.57	1.07	0.66
Glass Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Std-ClrNct	**6.25**	**1.35**	**0.53**	**1.62**	**1.65**	**6.50**	**0.40**	**0.85**	**0.037**	**5.93**	**0.60**	**0.60**	**1.10**	**0.69**
Brk/GrnNct-Std-ClrSue	6.28	1.44	0.52	1.56	1.67	8.88	0.36	0.71	0.035	5.84	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	6.29	1.39	0.52	1.56	1.69	8.40	0.36	0.74	0.035	5.87	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	6.30	1.28	0.54	1.75	1.61	5.23	0.47	0.84	0.035	6.04	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrNct	6.30	1.35	0.53	1.63	1.65	7.54	0.40	0.81	0.036	5.92	0.57	0.57	1.07	0.66
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglHW	**6.50**	**1.25**	**0.57**	**2.00**	**1.51**	**0.65**	**0.65**	**1.92**	**0.050**	**6.46**	**0.00**	**0.00**	**1.90**	**0.00**
Mtl/AcrDblHW	6.52	1.21	0.56	1.98	1.53	3.25	0.62	1.29	0.040	6.35	0.00	0.00	1.30	0.00
Brk/AcrSglHW	6.54	1.25	0.57	2.00	1.51	1.56	0.65	1.93	0.050	6.47	0.00	0.00	1.81	0.00
Brk/AcrDblHW	6.55	1.21	0.56	1.99	1.53	4.16	0.62	1.12	0.037	6.34	0.00	0.00	1.10	0.00
Mtl/AcrSglLW	6.56	0.83	0.44	1.53	1.98	0.65	0.39	1.92	0.055	6.52	0.00	0.00	1.90	0.00

Central Valley

Table 25 – Skylight SHGC Criteria – 0-2% WWR – Residential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**8.28**	**1.35**	**0.38**	**2.33**	**2.17**	**8.32**	**0.46**	**0.71**	**0.049**	**8.12**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	8.30	1.35	0.38	2.33	2.17	9.36	0.46	0.67	0.048	8.11	0.44	0.42	0.95	0.53
Mtl/ClrNct-Std-ClrSue	8.30	1.27	0.38	2.36	2.17	6.37	0.49	0.83	0.049	8.18	0.67	0.56	1.17	0.68
Vnl/ClrNct-Std-ClrSue	8.32	1.46	0.38	2.29	2.19	11.57	0.41	0.69	0.049	8.09	0.41	0.36	0.91	0.00
Brk/GrnNct-Std-ClrNct	8.32	1.28	0.38	2.34	2.19	6.38	0.47	0.84	0.050	8.19	0.60	0.60	1.10	0.69
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrNct	8.31	1.28	0.38	2.34	2.19	6.08	0.47	0.84	0.050	8.19	0.60	0.60	1.10	0.69
Brk/ClrNct-Std-ClrSue	**8.31**	**1.35**	**0.38**	**2.33**	**2.17**	**9.78**	**0.46**	**0.71**	**0.049**	**8.12**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct	8.33	1.16	0.40	2.45	2.11	1.53	0.58	1.53	0.055	8.30	1.08	1.11	1.89	1.25
Brk/ClrNct-Ins-ClrSue	8.33	1.35	0.38	2.33	2.17	10.82	0.46	0.67	0.048	8.11	0.44	0.42	0.95	0.53
Brk/GrnNct-Ins-ClrNct	8.33	1.28	0.38	2.34	2.19	7.12	0.47	0.81	0.049	8.19	0.57	0.57	1.07	0.66
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**8.29**	**1.35**	**0.38**	**2.33**	**2.17**	**8.40**	**0.46**	**0.71**	**0.049**	**8.12**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrNct	8.29	1.28	0.38	2.34	2.19	5.23	0.47	0.84	0.050	8.19	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSue	8.30	1.35	0.38	2.33	2.17	9.44	0.46	0.67	0.048	8.11	0.44	0.42	0.95	0.53
Brk/GrnNct-Ins-ClrNct	8.31	1.28	0.38	2.34	2.19	6.27	0.47	0.81	0.049	8.19	0.57	0.57	1.07	0.66
Brk/GrnNct	8.32	1.16	0.40	2.45	2.11	1.31	0.58	1.53	0.055	8.30	1.08	1.11	1.89	1.25
Plastic Criteria ASHRAE Cost Model														
Mtl/AcrSglHW	**8.21**	**1.25**	**0.44**	**2.53**	**1.96**	**0.65**	**0.65**	**1.92**	**0.058**	**8.20**	**0.00**	**0.00**	**1.90**	**0.00**
Brk/AcrTrpClr	8.22	1.21	0.45	2.56	1.93	6.11	0.71	0.91	0.048	8.10	0.00	0.00	0.87	0.00
Brk/AcrDblClr	8.23	1.16	0.46	2.62	1.90	3.51	0.77	1.12	0.049	8.16	0.00	0.00	1.10	0.00
Mtl/AcrTrpClr	8.23	1.21	0.45	2.56	1.93	5.20	0.71	1.10	0.050	8.12	0.00	0.00	1.10	0.00
Mtl/AcrDblClr	8.23	1.16	0.46	2.62	1.90	2.60	0.77	1.29	0.051	8.18	0.00	0.00	1.30	0.00

Table 26 – Skylight SHGC Criteria – 2.1-5% WWR – Residential – Climate Zone 12

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/HptNct-Std-ClrSue	**8.48**	**1.47**	**0.51**	**2.66**	**1.73**	**9.75**	**0.32**	**0.71**	**0.055**	**8.00**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Std-ClrSue	8.49	1.44	0.52	2.75	1.67	8.82	0.36	0.71	0.054	8.05	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrSue	8.49	1.52	0.51	2.63	1.73	10.79	0.31	0.68	0.055	7.95	0.44	0.42	0.95	0.53
Brk/HptNct-Std-ClrPye	8.52	1.39	0.52	2.75	1.69	8.61	0.36	0.74	0.055	8.09	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrSpe	8.52	1.44	0.51	2.70	1.70	9.75	0.34	0.73	0.055	8.03	0.49	0.46	0.99	0.57
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrSue	8.56	1.44	0.52	2.75	1.67	10.34	0.36	0.71	0.054	8.05	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrPye	8.56	1.39	0.52	2.75	1.69	9.46	0.36	0.74	0.055	8.09	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrPye	8.57	1.43	0.52	2.73	1.69	10.50	0.35	0.70	0.054	8.04	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrNct	8.58	1.35	0.53	2.85	1.65	7.57	0.40	0.85	0.056	8.20	0.60	0.60	1.10	0.69
Brk/HptNct-Std-ClrSue	**8.59**	**1.47**	**0.51**	**2.66**	**1.73**	**11.82**	**0.32**	**0.71**	**0.055**	**8.00**	**0.47**	**0.45**	**0.98**	**0.56**
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	8.49	1.44	0.52	2.75	1.67	8.88	0.36	0.71	0.054	8.05	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrSue	**8.50**	**1.47**	**0.51**	**2.66**	**1.73**	**10.15**	**0.32**	**0.71**	**0.055**	**8.00**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/HptNct-Std-ClrPye	8.51	1.39	0.52	2.75	1.69	8.40	0.36	0.74	0.055	8.09	0.51	0.49	1.00	0.59
Brk/HptNct-Ins-ClrSue	8.51	1.52	0.51	2.63	1.73	11.19	0.31	0.68	0.055	7.95	0.44	0.42	0.95	0.53
Brk/HptNct-Ins-ClrPye	8.51	1.43	0.52	2.73	1.69	9.44	0.35	0.70	0.054	8.04	0.48	0.46	0.97	0.56
Plastic Criteria ASHRAE Cost Model														
Brk/AcrDblLW	**8.97**	**0.84**	**0.42**	**2.73**	**2.05**	**4.16**	**0.34**	**1.12**	**0.064**	**8.76**	**0.00**	**0.00**	**1.10**	**0.00**
Mtl/AcrDblLW	8.98	0.84	0.42	2.73	2.05	3.25	0.34	1.29	0.068	8.82	0.00	0.00	1.30	0.00
Brk/AcrTrpLW	9.00	0.87	0.40	2.64	2.10	6.76	0.31	0.91	0.060	8.66	0.00	0.00	0.87	0.00
Mtl/AcrTrpLW	9.02	0.87	0.40	2.65	2.10	5.85	0.31	1.10	0.065	8.72	0.00	0.00	1.10	0.00
Brk/AcrQudBrz	9.02	0.94	0.38	2.54	2.16	9.36	0.27	0.74	0.057	8.55	0.00	0.00	0.71	0.00

Desert

Table 27 – Skylight SHGC Criteria – 0-2% WWR – Residential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**9.47**	**1.35**	**0.38**	**3.01**	**2.17**	**8.32**	**0.46**	**0.71**	**0.052**	**9.30**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	9.48	1.35	0.38	3.01	2.17	9.36	0.46	0.67	0.052	9.29	0.44	0.42	0.95	0.53
Vnl/ClrNct-Std-ClrSue	9.49	1.46	0.38	2.96	2.19	11.57	0.41	0.69	0.052	9.26	0.41	0.36	0.91	0.00
Mtl/ClrNct-Std-ClrSue	9.50	1.27	0.38	3.05	2.17	6.37	0.49	0.83	0.053	9.37	0.67	0.56	1.17	0.68
Vnl/ClrNct-Ins-ClrSue	9.51	1.46	0.38	2.96	2.19	12.61	0.41	0.68	0.052	9.26	0.38	0.33	0.88	0.00
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**9.49**	**1.35**	**0.38**	**3.01**	**2.17**	**9.78**	**0.46**	**0.71**	**0.052**	**9.30**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	9.51	1.35	0.38	3.01	2.17	10.82	0.46	0.67	0.052	9.29	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrNct	9.51	1.28	0.38	3.03	2.19	6.08	0.47	0.84	0.053	9.39	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	9.52	1.28	0.38	3.03	2.19	7.12	0.47	0.81	0.053	9.38	0.57	0.57	1.07	0.66
Vnl/ClrNct-Std-ClrSue	9.54	1.46	0.38	2.96	2.19	14.00	0.41	0.69	0.052	9.26	0.41	0.36	0.91	0.00
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrSue	**9.47**	**1.35**	**0.38**	**3.01**	**2.17**	**8.40**	**0.46**	**0.71**	**0.052**	**9.30**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	9.48	1.35	0.38	3.01	2.17	9.44	0.46	0.67	0.052	9.29	0.44	0.42	0.95	0.53
Brk/GrnNct-Std-ClrNct	9.49	1.28	0.38	3.03	2.19	5.23	0.47	0.84	0.053	9.39	0.60	0.60	1.10	0.69
Brk/GrnNct-Ins-ClrNct	9.51	1.28	0.38	3.03	2.19	6.27	0.47	0.81	0.053	9.38	0.57	0.57	1.07	0.66
Vnl/ClrNct-Std-ClrSue	9.52	1.46	0.38	2.96	2.19	12.77	0.41	0.69	0.052	9.26	0.41	0.36	0.91	0.00
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudClr	**9.44**	**1.24**	**0.44**	**3.21**	**1.97**	**8.71**	**0.65**	**0.74**	**0.050**	**9.27**	**0.00**	**0.00**	**0.71**	**0.00**
Brk/AcrTrpClr	9.45	1.21	0.45	3.27	1.93	6.11	0.71	0.91	0.051	9.33	0.00	0.00	0.87	0.00
Vnl/AcrQudClr	9.47	1.24	0.44	3.18	1.97	13.00	0.65	0.48	0.048	9.21	0.00	0.00	0.46	0.00
Mtl/AcrQudClr	9.47	1.24	0.44	3.22	1.97	7.80	0.65	0.93	0.052	9.31	0.00	0.00	0.94	0.00
Vnl/AcrTrpClr	9.48	1.16	0.45	3.25	1.93	10.40	0.71	0.65	0.049	9.27	0.00	0.00	0.61	0.00

Table 28 – Skylight SHGC Criteria – 2.1-5% WWR – Residential – Climate Zone 14

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/HptNct-Ins-ClrSue	**9.81**	**1.52**	**0.51**	**3.40**	**1.73**	**10.79**	**0.31**	**0.68**	**0.058**	**9.27**	**0.44**	**0.42**	**0.95**	**0.53**
Brk/HptNct-Std-ClrSue	9.82	1.47	0.51	3.43	1.73	9.75	0.32	0.71	0.058	9.33	0.47	0.45	0.98	0.56
Brk/GrnNct-Std-ClrSue	9.83	1.44	0.52	3.53	1.67	8.82	0.36	0.71	0.057	9.39	0.47	0.45	0.98	0.56
Vnl/HptNct-Std-ClrSue	9.85	1.61	0.50	3.33	1.75	13.00	0.28	0.69	0.058	9.20	0.41	0.36	0.91	0.00
Brk/GrnNct-Ins-ClrSue	9.86	1.44	0.52	3.52	1.67	9.86	0.36	0.67	0.056	9.37	0.44	0.42	0.95	0.53
Glass Criteria CADMAC Low Volume Cost Model														
Brk/HptNct-Ins-ClrPye	9.91	1.43	0.52	3.50	1.69	10.50	0.35	0.70	0.057	9.38	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrSue	9.91	1.44	0.52	3.53	1.67	10.34	0.36	0.71	0.057	9.39	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrSue	**9.91**	**1.52**	**0.51**	**3.40**	**1.73**	**12.86**	**0.31**	**0.68**	**0.058**	**9.27**	**0.44**	**0.42**	**0.95**	**0.53**
Brk/HptNct-Std-ClrPye	9.92	1.39	0.52	3.53	1.69	9.46	0.36	0.74	0.058	9.44	0.51	0.49	1.00	0.59
Brk/HptNct-Std-ClrSue	9.92	1.47	0.51	3.43	1.73	11.82	0.32	0.71	0.058	9.33	0.47	0.45	0.98	0.56
Glass Criteria CADMAC High Volume Cost Model														
Brk/HptNct-Ins-ClrSue	**9.83**	**1.52**	**0.51**	**3.40**	**1.73**	**11.19**	**0.31**	**0.68**	**0.058**	**9.27**	**0.44**	**0.42**	**0.95**	**0.53**
Brk/GrnNct-Std-ClrSue	9.83	1.44	0.52	3.53	1.67	8.88	0.36	0.71	0.057	9.39	0.47	0.45	0.98	0.56
Brk/HptNct-Std-ClrSue	9.84	1.47	0.51	3.43	1.73	10.15	0.32	0.71	0.058	9.33	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrPye	9.85	1.43	0.52	3.50	1.69	9.44	0.35	0.70	0.057	9.38	0.48	0.46	0.97	0.56
Brk/HptNct-Std-ClrPye	9.86	1.39	0.52	3.53	1.69	8.40	0.36	0.74	0.058	9.44	0.51	0.49	1.00	0.59
Plastic Criteria ASHRAE Cost Model														
Brk/AcrQudBrz	**10.34**	**0.94**	**0.38**	**3.31**	**2.16**	**9.36**	**0.27**	**0.74**	**0.060**	**9.87**	**0.00**	**0.00**	**0.71**	**0.00**
Brk/AcrTrpLW	10.38	0.87	0.40	3.45	2.10	6.76	0.31	0.91	0.063	10.04	0.00	0.00	0.87	0.00
Vnl/AcrQudBrz	10.40	0.94	0.38	3.25	2.16	13.65	0.27	0.48	0.054	9.72	0.00	0.00	0.46	0.00
Mtl/AcrQudBrz	10.41	0.94	0.38	3.34	2.16	8.45	0.27	0.93	0.064	9.98	0.00	0.00	0.94	0.00
Brk/AcrDblLW	10.41	0.84	0.42	3.57	2.05	4.16	0.34	1.12	0.066	10.20	0.00	0.00	1.10	0.00

Cold Regions

Table 29 – Skylight SHGC Criteria – 0-2% WWR – Residential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/ClrNct-Std-ClrSue	**7.96**	**1.35**	**0.38**	**1.67**	**2.17**	**8.32**	**0.46**	**0.71**	**0.118**	**7.80**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Std-ClrNct	7.97	1.04	0.41	1.81	2.07	5.88	0.68	0.85	0.117	7.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrSue	7.97	1.35	0.38	1.67	2.17	9.36	0.46	0.67	0.118	7.78	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrSpe	7.97	1.18	0.40	1.73	2.12	8.32	0.56	0.73	0.117	7.81	0.49	0.46	0.99	0.57
Brk/ClrNct-Ins-ClrNct	7.98	1.04	0.41	1.81	2.07	6.92	0.68	0.81	0.116	7.84	0.57	0.57	1.07	0.66
Glass Criteria CADMAC Low Volume Cost Model														
Brk/ClrNct-Std-ClrNct	7.96	1.04	0.41	1.81	2.07	5.53	0.68	0.85	0.117	7.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrNct	7.97	1.04	0.41	1.81	2.07	6.57	0.68	0.81	0.116	7.84	0.57	0.57	1.07	0.66
Brk/ClrNct-Std-ClrSue	**7.99**	**1.35**	**0.38**	**1.67**	**2.17**	**9.78**	**0.46**	**0.71**	**0.118**	**7.80**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	8.00	1.35	0.38	1.67	2.17	10.82	0.46	0.67	0.118	7.78	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrSpe	8.00	1.18	0.40	1.73	2.12	9.78	0.56	0.73	0.117	7.81	0.49	0.46	0.99	0.57
Glass Criteria CADMAC High Volume Cost Model														
Brk/ClrNct-Std-ClrNct	7.95	1.04	0.41	1.81	2.07	4.75	0.68	0.85	0.117	7.85	0.60	0.60	1.10	0.69
Brk/ClrNct-Ins-ClrNct	7.96	1.04	0.41	1.81	2.07	5.79	0.68	0.81	0.116	7.84	0.57	0.57	1.07	0.66
Brk/ClrNct-Std-ClrSue	**7.97**	**1.35**	**0.38**	**1.67**	**2.17**	**8.40**	**0.46**	**0.71**	**0.118**	**7.80**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/ClrNct-Ins-ClrSue	7.97	1.35	0.38	1.67	2.17	9.44	0.46	0.67	0.118	7.78	0.44	0.42	0.95	0.53
Brk/ClrNct-Std-ClrSpe	7.98	1.18	0.40	1.73	2.12	8.40	0.56	0.73	0.117	7.81	0.49	0.46	0.99	0.57
Plastic Criteria ASHRAE Cost Model														
Vnl/AcrTrpClr	**7.79**	**1.16**	**0.45**	**1.82**	**1.93**	**10.40**	**0.71**	**0.65**	**0.112**	**7.58**	**0.00**	**0.00**	**0.61**	**0.00**
Brk/AcrTrpClr	7.80	1.21	0.45	1.83	1.93	6.11	0.71	0.91	0.118	7.68	0.00	0.00	0.87	0.00
Vnl/AcrQudClr	7.80	1.24	0.44	1.78	1.97	13.00	0.65	0.48	0.109	7.54	0.00	0.00	0.46	0.00
Vnl/AcrDblClr	7.80	1.16	0.46	1.87	1.90	7.80	0.77	0.84	0.115	7.65	0.00	0.00	0.84	0.00
Brk/AcrQudClr	7.81	1.24	0.44	1.79	1.97	8.71	0.65	0.74	0.115	7.63	0.00	0.00	0.71	0.00

Table 30 – Skylight SHGC Criteria – 2.1-5% WWR – Residential – Climate Zone 16

Fenestration Product	*LCC*	*Eff*	*Kd*	*kWhC*	*kWhL*	*Icost*	*SHGC*	*U41*	*Thrms*	*Ecost*	*Uvo*	*Uvf*	*Usc*	*Usnc*
Glass Criteria ASHRAE Cost Model														
Brk/GrnNct-Std-ClrSue	**8.14**	**1.44**	**0.52**	**2.00**	**1.67**	**8.82**	**0.36**	**0.71**	**0.133**	**7.69**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	8.15	1.44	0.52	1.99	1.67	9.86	0.36	0.67	0.131	7.66	0.44	0.42	0.95	0.53
Brk/ClrSue-Ins-ClrSue	8.18	1.53	0.53	1.99	1.65	11.31	0.36	0.67	0.131	7.61	0.00	0.00	0.00	0.00
Brk/ClrNct-Std-ClrSue	8.18	1.35	0.55	2.16	1.59	8.32	0.46	0.71	0.128	7.76	0.47	0.45	0.98	0.56
Brk/HptNct-Ins-ClrPye	8.18	1.43	0.52	1.98	1.69	9.65	0.35	0.70	0.133	7.70	0.48	0.46	0.97	0.56
Glass Criteria CADMAC Low Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**8.21**	**1.44**	**0.52**	**2.00**	**1.67**	**10.34**	**0.36**	**0.71**	**0.133**	**7.69**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrPye	8.21	1.31	0.53	2.09	1.65	9.02	0.42	0.70	0.130	7.76	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrPye	8.22	1.28	0.53	2.11	1.65	7.98	0.43	0.74	0.131	7.82	0.51	0.49	1.00	0.59
Brk/GrnNct-Std-ClrNct	8.22	1.28	0.54	2.19	1.61	6.08	0.47	0.84	0.135	7.92	0.60	0.60	1.10	0.69
Brk/HptNct-Ins-ClrPye	8.22	1.43	0.52	1.98	1.69	10.50	0.35	0.70	0.133	7.70	0.48	0.46	0.97	0.56
Glass Criteria CADMAC High Volume Cost Model														
Brk/GrnNct-Std-ClrSue	**8.14**	**1.44**	**0.52**	**2.00**	**1.67**	**8.88**	**0.36**	**0.71**	**0.133**	**7.69**	**0.47**	**0.45**	**0.98**	**0.56**
Brk/GrnNct-Ins-ClrSue	8.16	1.44	0.52	1.99	1.67	9.92	0.36	0.67	0.131	7.66	0.44	0.42	0.95	0.53
Brk/GrnNct-Ins-ClrPye	8.17	1.31	0.53	2.09	1.65	8.16	0.42	0.70	0.130	7.76	0.48	0.46	0.97	0.56
Brk/HptNct-Ins-ClrPye	8.17	1.43	0.52	1.98	1.69	9.44	0.35	0.70	0.133	7.70	0.48	0.46	0.97	0.56
Brk/GrnNct-Std-ClrPye	8.17	1.28	0.53	2.11	1.65	7.12	0.43	0.74	0.131	7.82	0.51	0.49	1.00	0.59
Plastic Criteria ASHRAE Cost Model														
Vnl/AcrQudHW	**8.42**	**1.14**	**0.55**	**2.27**	**1.59**	**13.65**	**0.55**	**0.48**	**0.111**	**7.74**	**0.00**	**0.00**	**0.46**	**0.00**
Brk/AcrQudHW	8.43	1.14	0.55	2.30	1.59	9.36	0.55	0.74	0.125	7.96	0.00	0.00	0.71	0.00
Vnl/AcrTrpH	8.45	1.21	0.56	2.34	1.55	11.05	0.58	0.65	0.118	7.90	0.00	0.00	0.61	0.00
Brk/AcrTrpHW	8.46	1.18	0.56	2.38	1.55	6.76	0.58	0.91	0.133	8.13	0.00	0.00	0.87	0.00
Vnl/AcrQudClr	8.47	1.24	0.57	2.43	1.51	13.00	0.65	0.48	0.105	7.82	0.00	0.00	0.46	0.00

Appendix G – 30 Year Life Cycle Cost Analysis – Walls and Roofs

This analysis was performed with a NPV of electricity of $1.68/Electricity (kWh)-y and a NPV for gas of $11.43/therm-y.

Wall Insulation Life Cycle Cost Analysis

Climate Zone 2

Table 1 – Life Cycle Cost – Metal Framed Walls – Nonresidential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-7.5 ci	1.60	0.89	0.06	0.13	0.04
R-13.0 + R-3.8 ci	1.60	0.67	0.08	0.17	0.06
R-13.0	1.70	0.33	0.12	0.26	0.08
R-13.0 + R-10 ci	1.73	1.12	0.06	0.11	0.04
R-13.0 + R-18 ci	1.90	1.40	0.05	0.09	0.03

Table 2 – Life Cycle Cost – Wood Framed Walls – Nonresidential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0	1.23	0.25	0.09	0.18	0.06
R-13.0 + R-3.8 ci	1.30	0.59	0.06	0.13	0.04
R-13.0 + R-7.5 ci	1.37	0.81	0.05	0.11	0.03
R-13.0 + R-10 ci	1.54	1.04	0.05	0.09	0.03
R-13.0 + R-18 ci	1.74	1.32	0.04	0.08	0.03

Table 3 – Life Cycle Cost – Metal Building Walls – Nonresidential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0	1.70	0.46	0.11	0.23	0.07
R-13.0 + R-13.0	1.76	1.13	0.06	0.12	0.04
R-11.0	1.78	0.43	0.12	0.25	0.08
R-13.0 + R-16.0	1.79	1.19	0.05	0.11	0.04
R-10.0	1.88	0.41	0.13	0.28	0.09

Table 4 – Life Cycle Cost – Mass Walls – Nonresidential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-9.5 ci	3.31	2.16	0.10	0.22	0.07
R-11.4 ci	3.31	2.32	0.09	0.19	0.06
R-7.6 ci	3.35	1.99	0.12	0.26	0.08
R-13.3 ci	3.37	2.49	0.08	0.17	0.05
R-15.2 ci	3.43	2.65	0.07	0.15	0.05

Table 5 – Life Cycle Cost – Metal Framed Walls – Residential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-7.5 ci	2.04	0.89	0.06	0.26	0.06
R-13.0 + R-10 ci	2.11	1.12	0.06	0.22	0.05
R-13.0 + R-3.8 ci	2.18	0.67	0.08	0.34	0.08
R-13.0 + R-18 ci	2.21	1.40	0.05	0.18	0.04
R-13.0 + R-21.6 ci	2.29	1.57	0.04	0.16	0.04

Table 6 – Life Cycle Cost – Wood Framed Walls – Residential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-7.5 ci	1.73	0.81	0.05	0.21	0.05
R-13.0 + R-3.8 ci	1.74	0.59	0.06	0.26	0.06
R-13.0	1.84	0.25	0.09	0.36	0.09
R-13.0 + R-10 ci	1.85	1.04	0.05	0.18	0.04
R-13.0 + R-18 ci	2.00	1.32	0.04	0.15	0.04

Table 7 – Life Cycle Cost – Metal Building Walls – Residential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-13.0	2.15	1.13	0.06	0.23	0.06
R-13.0 + R-16.0	2.17	1.19	0.05	0.22	0.05
R-13.0 + R-25.0	2.31	1.38	0.05	0.21	0.05
R-13.0	2.48	0.46	0.11	0.46	0.11
R-11.0	2.63	0.43	0.12	0.50	0.12

Table 8 – Life Cycle Cost – Mass Walls – Residential – Climate Zone 2

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.3 ci	3.92	2.49	0.08	0.32	0.08
R-15.2 ci	3.93	2.65	0.07	0.29	0.07
R-11.4 ci	3.94	2.32	0.09	0.37	0.09
R-9.5 ci	4.03	2.16	0.1	0.42	0.10
R-7.6 ci	4.20	1.99	0.12	0.50	0.12

Climate Zone 10

Table 9 – Life Cycle Cost – Metal Framed Walls – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-3.8 ci	1.55	0.67	0.08	0.28	0.04
R-13.0 + R-7.5 ci	1.56	0.89	0.06	0.21	0.03
R-13.0	1.62	0.33	0.12	0.41	0.05
R-13.0 + R-10 ci	1.70	1.12	0.06	0.18	0.02
R-13.0 + R-18 ci	1.87	1.40	0.05	0.15	0.02

Table 10 – Life Cycle Cost – Wood Framed Walls – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0	1.17	0.25	0.09	0.29	0.04
R-13.0 + R-3.8 ci	1.26	0.59	0.06	0.21	0.03
R-13.0 + R-7.5 ci	1.34	0.81	0.05	0.17	0.02
R-13.0 + R-10 ci	1.51	1.04	0.05	0.15	0.02
R-13.0 + R-18 ci	1.72	1.32	0.04	0.13	0.02

Table 11 – Life Cycle Cost – Metal Building Walls – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0	1.64	0.46	0.11	0.37	0.05
R-11.0	1.71	0.43	0.12	0.40	0.05
R-13.0 + R-13.0	1.72	1.13	0.06	0.19	0.02
R-13.0 + R-16.0	1.76	1.19	0.05	0.18	0.02
R-10.0	1.81	0.41	0.13	0.44	0.06

Table 12 – Life Cycle Cost – Mass Walls – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-9.5 ci	3.25	2.16	0.10	0.34	0.04
R-11.4 ci	3.26	2.32	0.09	0.30	0.04
R-7.6 ci	3.28	1.99	0.12	0.41	0.05
R-13.3 ci	3.32	2.49	0.08	0.26	0.03
R-5.7 ci	3.38	1.81	0.15	0.50	0.06

Table 13 – Life Cycle Cost – Metal Framed Walls – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-7.5 ci	2.05	0.89	0.06	0.41	0.04
R-13.0 + R-10 ci	2.12	1.12	0.06	0.36	0.04
R-13.0 + R-3.8 ci	2.19	0.67	0.08	0.54	0.05
R-13.0 + R-18 ci	2.22	1.40	0.05	0.29	0.03
R-13.0 + R-21.6 ci	2.29	1.57	0.04	0.26	0.03

Table 14 – Life Cycle Cost – Wood Framed Walls – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-7.5 ci	1.73	0.81	0.05	0.33	0.03
R-13.0 + R-3.8 ci	1.75	0.59	0.06	0.41	0.04
R-13.0	1.85	0.25	0.09	0.57	0.06

R-13.0 + R-10 ci	1.85	1.04	0.05	0.29	0.03
R-13.0 + R-18 ci	2.01	1.32	0.04	0.25	0.02

Table 15 – Life Cycle Cost – Metal Building Walls – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-13.0	2.16	1.13	0.06	0.37	0.04
R-13.0 + R-16.0	2.18	1.19	0.05	0.35	0.03
R-13.0 + R-25.0	2.32	1.38	0.05	0.33	0.03
R-13.0	2.50	0.46	0.11	0.73	0.07
R-11.0	2.65	0.43	0.12	0.79	0.08

Table 16 – Life Cycle Cost – Mass Walls – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.3 ci	3.93	2.49	0.08	0.51	0.05
R-15.2 ci	3.93	2.65	0.07	0.46	0.04
R-11.4 ci	3.95	2.32	0.09	0.58	0.06
R-9.5 ci	4.04	2.16	0.10	0.67	0.07
R-7.6 ci	4.21	1.99	0.12	0.79	0.08

Roof Insulation Life Cycle Cost Analysis

Climate Zone 10

Table 17 – Life Cycle Cost – Roof Insulation Above Deck – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-20	2.55	1.36	0.05	0.57	0.02
R-25	2.60	1.64	0.04	0.46	0.02
R-15.0	2.65	1.08	0.06	0.75	0.03
R-30	2.73	1.92	0.03	0.38	0.01
R-10.0	3.10	0.80	0.09	1.10	0.04

Table 18 – Life Cycle Cost – Metal Building Roofs Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-13.0 + R-19.0	2.13	0.92	0.05	0.58	0.02
R-16.0 + R-19.0	2.14	0.98	0.05	0.56	0.02
R-13.0 + R-13.0	2.16	0.80	0.05	0.65	0.02
R-19.0 + R-19.0	2.18	1.04	0.05	0.54	0.02
R-19.0	2.23	0.62	0.06	0.77	0.03

Table 19 – Life Cycle Cost – Roofs, Attic and Other – Nonresidential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-38.0	1.17	0.50	0.03	0.32	0.01
R-49.0	1.18	0.66	0.02	0.25	0.01
R-60.0	1.20	0.77	0.02	0.20	0.01
R-30.0	1.24	0.40	0.03	0.40	0.01
R-71.0	1.26	0.90	0.01	0.17	0.01

Table 20 – Life Cycle Cost – Roof Insulation Above Deck – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-25	3.12	1.64	0.04	0.72	0.02
R-30	3.16	1.92	0.03	0.60	0.02
R-20	3.20	1.36	0.05	0.89	0.03
R-15.0	3.50	1.08	0.06	1.17	0.04
R-39.2	3.58	2.62	0.03	0.46	0.02

Table 21 – Life Cycle Cost – Metal Building Roofs Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-16.0 + R-19.0	2.78	0.98	0.05	0.87	0.03
R-13.0 + R-19.0	2.79	0.92	0.05	0.90	0.03
R-19.0 + R-19.0	2.80	1.04	0.05	0.85	0.03
R-13.0 + R-13.0	2.90	0.80	0.05	1.02	0.03
R-19.0	3.11	0.62	0.06	1.20	0.04

Table 22 – Life Cycle Cost – Roofs, Attic and Other – Residential – Climate Zone 10

Name	LCC	Initial Cost	U-factor	Electricity (kWh)	Gas (therms)
R-60.0	1.43	0.77	0.02	0.32	0.01
R-71.0	1.46	0.90	0.01	0.27	0.01
R-49.0	1.46	0.66	0.02	0.39	0.01
R-82.0	1.51	1.03	0.01	0.23	0.01
R-38.0	1.53	0.50	0.03	0.50	0.02

Appendix H – DOE-2 Model Description

DOE-2.1 was used to create a database of heating and cooling energy for a wide variety of inputs. Simulations were separately created in the analysis of fenestration, cool roofs, and economizers. For all cases, a simple five-zone model was used. The interior zone is 100 ft x 100 ft, and each perimeter zone is 15 ft x 100 ft. The arrangement for thermal zoning was intentionally designed so that perimeter zones are connected only to the interior zone and not to other perimeter zones. This tends to isolate solar effects on the building. Skylights were modeled only in the interior zone. Windows were modeled only on each perimeter zone.

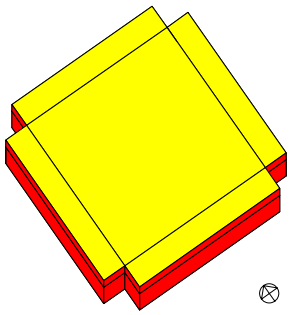

Figure 14 – Five Zone DOE-2 Model

The model was simulated with both nonresidential and high-rise residential schedules of operation. Occupancy schedules for each building type were taken from the 1998 nonresidential ACM approval manual. An LPD of 1.25 w/ft² and an EPD of 0.75 W/ft² were used in both building types. Occupancy density was set at 275 ft^2/person. Opaque construction elements were set to be in minimum compliance with the Title 24 prescriptive envelope criteria. Tables 1 and 2 describe general modeling assumptions. Assumptions specific to each measure follow.

Table 23-General Modeling Assumptions for Non-Residential Buildings

Non-Residential			CLIMATE	REGIONS	
	1,16	2--5	6--10	11--13	14,15
Roof U-value					
(except Cool Roof runs)	0.045	0.045	0.067	0.045	0.045
Wall U-value	0.068	0.075	0.075	0.068	0.068
Floor U-value	0.042	0.062	0.062	0.062	0.062

Table 24-General Modeling Assumptions for High-Rise Residential Buildings

High-Rise Residential			CLIMATE	REGIONS	
	1,16	2--5	6--10	11--13	14,15
Roof U-value					
(except Cool Roof runs)	0.031	0.045	0.045	0.031	0.031
Wall U-value	0.052	0.075	0.075	0.068	0.068
Floor U-value	0.042	0.062	0.062	0.062	0.062

Fenestration Assumptions

Five different glazing constructions were modeled to represent the full spectrum of possible fenestration U-factor and SHGC combinations. The window-wall ratio was varied from 0 to 45% in four steps (0%, 15%, 30%, 45%). The skylight area was varied from 0 to 10% in three steps (0%, 5%, 10%). All exterior zones were

set with double bronze vertical glazing at a 15% WWR during the skylight performance runs. A total of 1120 building energy simulation runs were performed for the fenestration analysis.

Table 25-Glass types modeled

Glazing Code	Description	U-value	SHGC
1000	Single Clear	0.91	0.86
1403	Single Bronze, High Reflective	0.89	0.22
2204	Double Bronze, 12mm Air	0.45	0.49
2642	Double Clear, Low-E, Argon	0.25	0.65
3692	Triple Tinted Heat Mirror 33	0.21	0.15

Cool Roof Assumptions

Nine roof types were produced from three different roof-U factors and three different roof absorptivities. These combinations represent a wide range of possible roof performance. Simulations of each roof type were run in each climate zone for both non-residential and high-rise residential occupancy schedules, producing a total of 288 runs. The model's exterior zones all contain double bronze, 12mm air, glazing with a 25% WWR. No skylights were placed in this version of the model.

Table 26-Roof U-factors and absorptivity modeled

Roof U-factor	Roof Absorptivity
0.02	0.1
0.10	0.5
0.18	0.9

Economizer Assumptions

28 conditions varying EER, economizer use, air-conditioner use, and heat pump use were modeled. These conditions were modeled for each climate zone and for both non-residential and high-rise residential occupancy schedules, producing a total of 896 runs. The model's exterior zones all contained double bronze, 12mm air, glazing with a 25% WWR. No skylights were placed in this version of the model.

Table 27- Heating Systems modeled

Heating system	EER	Economizer	Equipment type
1	10.3	Yes	Air-Conditioner
2	9.7	Yes	Air-Conditioner
3	9.5	Yes	Air-Conditioner
4	9.2	Yes	Air-Conditioner
5	10.1	Yes	Heat Pump
6	9.3	Yes	Heat Pump
7	9.0	Yes	Heat Pump
8	10.3	No	Air-Conditioner
9	9.7	No	Air-Conditioner
10	9.5	No	Air-Conditioner
11	9.2	No	Air-Conditioner
12	10.1	No	Heat Pump
13	9.3	No	Heat Pump
14	9.0	No	Heat Pump
15	11.0	No	Air-Conditioner
16	11.0	No	Air-Conditioner
17	11.0	No	Air-Conditioner
18	11.0	No	Air-Conditioner
19	11.0	No	Heat Pump
20	11.0	No	Heat Pump
21	11.0	No	Heat Pump
22	12.5	No	Air-Conditioner
23	12.5	No	Air-Conditioner
24	12.5	No	Air-Conditioner
25	12.5	No	Air-Conditioner
26	12.5	No	Heat Pump
27	12.5	No	Heat Pump
28	12.5	No	Heat Pump

Appendix I – Coefficients used in Cool Roof Energy Models

Table 1 – Cool Roof Coefficients

	Residential					Nonresidential				
Climate	c_3	c_2	c_1	c_0	r^2	c_3	c_2	c_1	c_0	r^2
1	10.301	-2.169	-0.087	7.929	0.986	7.449	-1.730	0.012	5.823	0.999
2	21.675	-3.342	-0.078	9.234	0.998	14.925	-1.891	0.020	6.930	0.999
3	14.438	-2.739	-0.09xx	8.234	0.996	10.748	-1.960	0.018	6.358	1.000
4	21.049	-3.686	-0.055	9.062	0.999	14.500	-2.044	0.036	7.019	0.999
5	14.620	-2.788	-0.068	8.292	0.992	11.389	-2.525	0.017	6.506	0.999
6	16.565	-4.146	-0.080	8.601	0.996	13.075	-2.867	0.030	6.779	0.999
7	19.656	-3.962	-0.092	8.833	0.999	14.342	-2.602	0.031	7.009	1.000
8	21.965	-3.634	-0.048	9.312	0.999	16.259	-2.412	0.036	7.322	0.999
9	23.358	-3.712	-0.097	9.793	0.999	16.777	-2.146	0.035	7.582	0.999
10	28.289	-1.227	0.074	10.079	0.994	17.669	-1.940	0.041	7.796	0.999
11	22.688	-1.994	-0.136	10.058	0.999	14.959	-0.913	0.008	7.367	1.000
12	22.167	-2.201	-0.089	9.648	0.999	15.111	-1.096	0.027	7.263	0.999
13	28.077	-2.143	-0.151	10.746	1.000	18.964	-1.204	0.017	7.957	0.999
14	27.249	-2.081	-0.143	10.454	0.999	18.371	-1.207	0.038	7.680	0.998
15	31.506	-0.111	-0.201	12.778	0.999	22.078	0.110	0.068	9.396	0.999
16	17.952	-2.493	-0.096	8.841	0.998	12.021	-1.323	0.027	6.463	0.999

Appendix J – Cost Analysis For Exterior Lighting

Table 1 – Cost Analysis for Exterior Lighting

Power (Watts)	Lamp	Life (Hours)	Initial Output (Lumens)	Cost $/vnlamp and ballast	Source Efficacy (Lumens/Watt)	Usage (hours/year)	Number of Lamps	Lamps Used Per Year	Energy Use (kWh/year)	Present Value of Electricity Cost Savings (US$)	Present Value of Lamps used over 15 years (US$)	Change in Life cycle Cost (US$)
175	Tungsten	2000	3200	20	18	4380	5.9	13.0	4551	$0	$3,198	$0
175	Mercury	24000	7700	30	44	4380	2.5	0.5	1891	$3,005	$166	-$6,037
175	Metal Halide	10000	12500	35	71	4380	1.5	0.7	1165	$3,826	$287	-$6,737
175	HPS	24000	19000	38	109	4380	1.0	0.2	767	$4,277	$85	-$7,389
400	Tungsten	2000	7500	30	19	4380	6.3	13.9	11096	$0	$5,116	$0
400	Mercury	24000	20500	40	51	4380	2.3	0.4	4060	$7,951	$208	-$12,860
400	Metal Halide	20000	34500	45	86	4380	1.4	0.3	2412	$9,813	$167	-$14,762
400	HPS	24000	47500	50	119	4380	1.0	0.2	1752	$10,559	$112	-$15,563

- Sample Calculations for 175-W Mercury Lamp

$$Source\ Efficacy = \frac{Initial\ Output}{Power} = \frac{7700}{175} = 44\ {}^{Lumens}\!/_{Watt}$$

$$Number\ of\ Lamps = \frac{Initial\ Output(HPS)}{Initial\ Output(Hgvapor)} = \frac{19000}{7700} = 2.5\ lamps$$

$$Lamps\ Used\ per\ Year = \frac{Usage}{Life} \cdot Number\ of\ Lamps = \frac{4380}{24000} = 0.5\ {}^{lamps}\!/_{year}$$

$$Energy\ Use = Power \cdot Usage \cdot Number\ of\ Lamps = 175 \cdot 4380 \cdot 2.5 = 1891\ {}^{kWh}\!/_{year}$$

$$Lamps\ Used\ per\ Year = \frac{Usage}{Life} \cdot Number\ of\ Lamps = \frac{4380}{24000} = 0.5\ {}^{lamps}\!/_{year}$$

$$Present\ value\ of\ lamps\ used\ over\ 15\ year\ period = \text{Cost} + \sum_{1}^{15} \frac{\text{Cost}}{(1+\text{d})^{j}} = 30 + \sum_{1}^{15} \frac{30}{(1+0.03)^{j}} = \$166$$

$$Present\ value\ of\ electricity\ cost\ saving\ over\ 15\ year\ period = (Base\ Case\ Energy\ Use\ (Tungsten) - Energy\ Use\ (Hg\ Vapor)) \cdot 15 - Year\ Present\ Value\ of\ Electricity = (4551 - 1891) \cdot 1.13 = \$3{,}005$$

$$Change\ in\ Life\ Cycle\ Cost = Present\ Value\ of\ Lamps\ Used\ (Mercury\ Vapor) - Present\ Value\ of\ Lamps\ Used\ (Tungsten) - Present\ Value\ of\ Electricity\ Cost\ Savings = 166 - 3198 - 3005 = \$6{,}037$$

Appendix K – Cost Summary for Bi-Level and Automatic Shut-off Controls

(Source: Bi-Level and Automatic Shut-off Controls, PG&E/HMG)

Table 2 – Bi-Level Switching Cost Effectiveness

Space type	LPD	Area/Switch	Switch	Wiring	Total incl. O&P	Total/ft^2	CEC Scalar 12.3 Cost-effective Annual h/yr half off
Small office	1.3	150	$ 15.95	$ 1.32	$ 25.90	$ 0.173	187
Large office	1.3	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	40
Large storage	0.6	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	87
Conference	1.3	400	$ 15.95	$ 3.51	$ 29.19	$ 0.073	79
Retail	2	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	26
Grocery	1.6	1,000	$ 15.95	$ 8.77	$ 37.08	$ 0.037	33
Classroom	1.6	900	$ 15.95	$ 7.89	$ 35.76	$ 0.040	35

Source: "Bi-Level and Automatic Shut-off Controls" PG&E/HMG.

The cost figures in Table 23 come from the 2000 RS Means Electrical Cost Data. The base light switch costing assumes there is one light switch per 1000 square feet and 420 feet of 12 gauge THHN solid copper wire. The installed bare cost (not including overhead and profit) is $14.95 per switch and $17.54 for the 420 feet of wire. Recognizing that a single switch needs two wires (the power lead and a switch leg) and a double switch needs three wires (the power lead and two switch legs) adding an extra switch requires half as much wire as installing the initial switch. Thus the incremental materials needed for adding bi-level switching of a 1,000 square foot area requires an additional switch and 210 extra feet of wire. We also added in an extra $1.00 per switch for the change from single to double gang plaster rings and cover plates. We also added 50% overhead and profit. Thus for a large office where the base case is one switch per 1,000 square feet the installed costs are:

[$15.95 (switch and cover plate) + $17.54/2 (wiring)] x 1.50 (overhead and profit) = $37.08

For smaller rooms, the wiring cost is reduced as a proportion of room area. Thus the wiring costs for a 150 square foot small office are $17.54/2 x (150/1000) = $1.32

By dividing the costs by the size of the zone controlled by a switch, we were able to describe the cost density of adding a bi-level switch in terms of dollars per square foot. The real value of the 15 year present worth of electricity used to determine the cost-effectiveness of the Standards is $1.42 in 2002 dollars. The economic parameters used in evaluating the cost effectiveness of the non-residential standards are a 3% real discount rate and a 15 year time period. These factors yield a scalar of 12.3 or an annual cost of electricity of $0.115/kWh.

We then calculated how many hours half of the lights would have to be off to pay for the costs of the bi-level switch. Since the first costs are given in $/sf we could evaluate the energy savings in kWh/yr·sf using hours and the LPD (W/sf) and develop energy cost savings in terms of $/yr·sf.

$$Hours\ lights\ half\ off = \frac{Incremental\ Cost\ (\$/SF) \times 1{,}000\ (W/kW)}{0.5(Fraction\ Off) \times \$0.115/kWh \times LPD(W/SF)}$$

As an example let us consider the large office area, which costs $0.037/sf to add bi-level switching, and which contains 1.3 W/sf of electric lighting. Applying these numbers to the above equation results in the following number of hours that half of the lights must be off during the period of analysis.

$$\times \textit{Hours lights half off} = \frac{\textit{Incremental Cost}\ (\$0.037/SF)\times 1{,}000\ (W/kW)}{0.5(\textit{Fraction Off})\times \$0.115/kWh\times 1.3(W/SF)} = 495\ \textit{Hours}$$

If we divide by the scalar used to calculate the cost-effectiveness of the CA Nonresidential Standards, we will obtain the number of hours per year where the energy cost savings of turning half of the lamps off pays for the cost of the extra switch and wiring.

The nonresidential scalar is 12.3, thus the number of hours per year required for cost-effectiveness is 495/12.3 = 40 hours/yr. This amounts to less than one hour per week.

Table 3 – Occupancy Sensor Cost Effectiveness

Space type	Osensor Type	LPD	Osensor	Wiring	Commisioni	Total	Total/ft^2	CEC Scalar 12.3 Cost-effective Annual h/yr off
Warehouse	PIR ceiling	0.6	$ 180.00	$ 76.20	$ 10.00	$ 266.20	$ 0.106	125
Small office	PIR wallbox	1.3	$ 70.50		$ 10.00	$ 80.50	$ 0.537	291
Large office	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.224	121
Large office	IR ceiling	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.373	202
Conference	PIR wallbox	1.3	$ 70.50		$ 10.00	$ 80.50	$ 0.268	145
Conference	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.559	303
Breakroom	Dual tech	1.3	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.224	121
Restroom	wall box ultrasor	0.6	$ 85.50		$ 10.00	$ 95.50	$ 0.318	374
Restroom	ceiling ultrasonic	0.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.745	874
Classroom	Dual tech	1.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.248	109
Classroom	IR or US ceiling	1.6	$ 150.00	$ 63.50	$ 10.00	$ 223.50	$ 0.248	109

Source: "Bi-Level and Automatic Shut-off Controls" PG&E/HMG.

The costing figures in Table 24 also come from the RS Means 2000 Electrical Cost Data. Wiring costs are primarily for power packs - typically a dry contact relay that interrupts the flow of line voltage power to the lighting circuit in response to a low voltage signal from a ceiling mounted or wall mounted remote occupancy sensor. It is assumed t hat most larger areas are controlled with dual technology sensors - these have both passive infrared sensing to prevent false "ons" and active ultrasonic sensing to keep the lights on with minimal movement in a large area. Ultrasonic sensors are used in restrooms since much of the bathroom is not in the "line of sight" needed by a passive infrared sensor.

Appendix L – IESNA Model Spaces For ASHRAE 1999 LPD Allowances

Source: WWW.IESNA.ORG

Table 1 – Sample Space Data for "Conference Meeting/Mulipurpose"

Space Description: Conference Meeting/Multipurpose
Model Number: 31
Building Type: NA (typical all bldgs)
Task Area: 50 % **Recommended Light Level (fc):** 50
General Area: 50 % **Recommended Light Level (fc):** 30
Weighted Avg. Footcandles: 40

Expected RCR Category: B **Calculated Lighting Power Density:** 1.5

Fixtures Used In This Space Model (See tables at end of appendix for fixture type data)

Fixture Type	535	537-1	572
Light Source	FL	FL	TH
Light Distribution	Linear Dir/Indir	Linear WW Open 1 wall	Downlight open
%FC Provided by Type	75	20	5
Total Efficiency Factors for Type (A<2.5, 2.5=<B=7.0,C<7.0)	TEF RCR=A: 49.63 *RCR=B: 30.96* RCR=C: 24.7	TEF RCR=A: 19.33 *RCR=B: 14.92* RCR=C: 13.28	TEF RCR=A: 11.03 *RCR=B: 9.54* RCR=C: 8.86
Coefficients of Utilization for Type (A<2.5, 2.5=<B=7.0,C<7.0)	CU RCR=A: 0.824 *RCR=B: 0.514* RCR=C: 0.41	CU RCR=A: 0.329 *RCR=B: 0.254* RCR=C: 0.226	CU RCR=A: 0.81 *RCR=B: 0.7* RCR=C: 0.65
Horizontal FC provide by Type	30	8	2
Luminous Efficacy	80	80	19
Light Loss Factor	0.75	0.73	0.72
Luminaire Dirt Depreciation	0.89	0.85	0.77
Lamp Lumen Depreciation	0.9	0.9	0.97
Room Surface Dirt Depreciation	0.94	0.96	0.96

Table 2 – Sample Space Data for "Conference Meeting/Mulipurpose"

Space Description: Lobby
Model Number: 79
Building Type: Hotel

Task Area: 25 % **Recommended Light Level (fc):** 50

General Area: 75 % **Recommended Light Level (fc):** 20
Weighted Avg. Footcandles: 28

Expected RCR Category: A

Calculated Lighting Power Density: 1.69

Fixtures Used In This Space Model (See tables at end of appendix for fixture type data)

Fixture Type	535	572	524
Light Source	FL	TH	CF
Light Distribution	Linear Dir/Indir	Downlight open	indirect Wall Sconce
%FC Provided by Type	10	75	15
Total Efficiency Factors for Type (A<2.5, 2.5=<B=7.0,C<7.0)	TEF RCR=A: 49.63 RCR=B: 30.96 RCR=C: 24.7	TEF RCR=A: 11.03 RCR=B: 9.54 RCR=C: 8.86	TEF RCR=A: 19.95 RCR=B: 11.86 RCR=C: 9.6
Coefficients of Utilization for Type (A<2.5, 2.5=<B=7.0,C<7.0)	CU RCR=A: 0.824 RCR=B: 0.514 RCR=C: 0.41	CU RCR=A: 0.81 RCR=B: 0.7 RCR=C: 0.65	CU RCR=A: 0.53 RCR=B: 0.315 RCR=C: 0.255
Horizontal FC provide by Type	2.8	20.6	4.1
Luminous Efficacy	80	19	57
Light Loss Factor	0.75	0.72	0.66
Luminaire Dirt Depreciation	0.89	0.77	0.8
Lamp Lumen Depreciation	0.9	0.97	0.86
Room Surface Dirt Depreciation	0.94	0.96	0.96

Table 3 – Sample Space Data for "Conference Meeting/Mulipurpose"

Space Description: Dressing/Locker/Fitting Room
Model Number: 24.01
Building Type: Exercise Center

Task Area: 100 % **Recommended Light Level (fc):** 20
General Area: 0 % **Recommended Light Level (fc):** 0
Weighted Avg. Footcandles: 20

Expected RCR Category: B

Calculated Lighting Power Density: 0.81

Fixtures Used In This Space Model (See tables at end of appendix for fixture type data)

Fixture Type	530	520
Light Source	FL	CF
Light Distribution	Linear Direct lensed	Downlight - lensed
%FC Provided by Type	90	10
Total Efficiency Factors for Type (A<2.5, 2.5=<B=7.0,C<7.0)	TEF RCR=A: 40.82 *RCR=B: 26.35* RCR=C: 21.47	TEF RCR=A: 15.3 *RCR=B: 10.64* RCR=C: 8.96
Coefficients of Utilization for Type (A<2.5, 2.5=<B=7.0,C<7.0)	CU RCR=A: 0.767 *RCR=B: 0.495* RCR=C: 0.403	CU RCR=A: 0.422 *RCR=B: 0.294* RCR=C: 0.247
Horizontal FC provide by Type	18	2
Luminous Efficacy	80	57
Light Loss Factor	0.67	0.64
Luminaire Dirt Depreciation	0.77	0.77
Lamp Lumen Depreciation	0.9	0.86
Room Surface Dirt Depreciation	0.96	0.96

Table 4 – Sample Space Data for Whole Building Category "Convention Centers"

Building Number	Square Feet	Specific Building LPD	Specific Bldg LPD Contribution %	Specific Bldg LPD Contribution Value	Source of Space Data
Convention Center 96075322	298355	1.49	0.5	0.75	DODGE Film Data
Convention Center 94028053	23658	1.32	0.5	0.66	DODGE Film Data

Note: Detailed information regarding the sample convention center spaces can be found at WWW.IESNA.org.

Table 5 – Fixtures used to calculate average photometric values for fixture type 520

Light Source	Distribution	Lamp(s)	Lens	Size	Reflect.	CU at RCR=A (A<2.5)	CU at RCR=B (2.5<=B=<7.0)	CU at RCR=C (C>7.0)	Cutsheet backup	Special Characteristics	Description
CF	Downlight - lensed	13 W Quad CFL	n/a	n/a	70/50/20	0.42	0.29	0.25	Yes	n/a	COMPACT FLUORESCENT - Surface Mounted Diffuse
CF	Downlight - lensed	1 13 W twin	Round	n/a	70/50/20	0.44	0.34	0.3	Yes	n/a	
CF	Downlight - lensed	1 13 W twin	Sq lens	n/a	70/50/20	0.52	0.35	0.29	Yes	n/a	
CF	Downlight - lensed	1 13 W twin	Sq lens	n/a	70/50/20	0.39	0.26	0.21	Yes	n/a	
CF	Downlight - lensed	2 13 W twin	Sq lens	n/a	70/50/20	0.49	0.34	0.28	Yes	n/a	
CF	Downlight - lensed	2 lamp 13W QU	Rnd Prismatic Lens	n/a	70/50/20	0.37	0.27	0.23	Yes	n/a	COMPACT FLUORESCENT DOWNLIGHTS - Controlled
CF	Downlight - lensed	2 lamp 18W QU	Rnd Prismatic Lens	n/a	70/50/20	0.49	0.37	0.32	Yes	n/a	COMPACT FLUORESCENT DOWNLIGHTS - Controlled
CF	Downlight lensed	(2) 18W quad	lLensed	n/a	80/50/20	0.39	0.27	0.23	Yes	n/a	COMPACT FLUORESCENT PENDANT - Down Light Lensed
CF	Downlight lensed	(2) 26W quad	lLensed	n/a	80/50/20	0.4	0.28	0.23	Yes	n/a	COMPACT FLUORESCENT PENDANT - Down Light Lensed
CF	Downlight - lensed	(2) 9 W twin	n/a	n/a	80/50/20	0.54	0.38	0.32	Yes	n/a	COMPACT FLUORESCENT - Surface Mounted Diffuse
CF	Downlight - lensed	(2) 13 W twin	n/a	n/a	80/50/20	0.48	0.33	0.28	Yes	n/a	COMPACT FLUORESCENT - Surface Mounted Diffuse
CF	Downlight - lensed	15 W Quad CFL	n/a	n/a	80/50/20	0.29	0.18	0.14	Yes	n/a	
CF	Downlight - lensed	14 W Quad CFL	n/a	n/a	80/50/20	0.41	0.27	0.23	Yes	n/a	
CF	Downlight - lensed	13 W Quad CFL	n/a	n/a	80/50/20	0.28	0.18	0.15	Yes	n/a	COMPACT FLUORESCENT - Surface Mounted Diffuse

Table 6 – Fixtures used to calculate average photometric values for fixture type 524

Light Source	Distribution	Lamp(s)	Lens	Size	Reflect.	CU at RCR=A (A<2.5)	CU at RCR=B (2.5<=B=<7.0)	CU at RCR=C (C>7.0)	Cutsheet backup	Special Characteristics	Description
CF	indiredt Wall Scounce	2- 13W twin	n/a	n/a	70/50/20	0.6	0.36	0.29	Yes	n/a	
CF	indirect Wall Sconce	(1) 39BX	n/a	n/a	70/50/20	0.46	0.27	0.22	Yes	- Efficiency=66.2%	COMPACT FLUORESCENT WALL MT - Direct/Indirect

Table 7 – Fixtures used to calculate average photometric values for fixture type 530

Light Source	Distribution	Lamp(s)	Lens	Size	Reflect.	CU at RCR=A (A<2.5)	CU at RCR=B (2.5<=B=<7.0)	CU at RCR=C (C>7.0)	Cutsheet backup	Special Characteristics	Description
FL	Linear Direct lensed	2 lamp T8	n/a	n/a	70/50/20	0.78	0.5	n/a	Yes	n/a	
FL	Linear Direct lensed	4 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.69	0.44	0.36	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	4 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.84	0.54	0.44	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	3 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.69	0.45	0.37	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	3 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.89	0.57	0.46	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	2 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.73	0.47	0.39	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	2 lamp T8	(Acrylic 12 Lens)	2x4	70/50/20	0.89	0.57	0.46	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	2 lamp T8	(Acrylic 12 Lens)	1x4	80/50/20	0.59	0.39	0.32	Yes	KEENE Troffer	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air
FL	Linear Direct lensed	1 lamp	(Acrylic 12 Lens)	1X4	70/59/20	0.79	0.51	0.42	Yes	n/a	
FL	Linear Direct lensed	2 lamp T8	(Acrylic 12 Lens)	1x4	70/50/20	0.78	0.51	0.41	Yes	n/a	FLUORESCENT-Direct/Non-VDT/Wide/Non-Air

Table 8 – Fixtures used to calculate average photometric values for fixture type 535

Light Source	Distribution	Lamp(s)	Lens	Size	Reflect.	CU at RCR=A (A<2.5)	CU at RCR=B (2.5<=B=<7.0)	CU at RCR=C (C>7.0)	Cutsheet backup	Special Characteristics	Description
FL	Linear Dir/Indir	2 lamp T8 louvered	n/a	10"x4'	80/50/20	0.87	0.54	0.43	Yes	Direct control compound	FLUORESCENT-Direct/Indirect-Non-VDT
FL	Linear Dir/Indir	3 lamp T8	n/a	10"x4'	80/50/20	0.87	0.55	0.44	No	High performance 88% Min.	FLUORESCENT-Direct/Indirect-Non-VDT
FL	Linear Dir/Indir	2 lamp T8	para multi-cell louver	10"x4'	80/50/20	0.81	0.5	0.4	No	n/a	FLUORESCENT-Direct/Indirect-Non-VDT
FL	Linear Dir/Indir	2 lamp T8	n/a	10"x4'	80/50/20	0.8	0.49	0.39	Yes	Very high performance	FLUORESCENT-Direct/Indirect-Non-VDT
FL	Linear Dir/Indir	2 lamp T8 louvered	n/a	"10""x4'	70/50/20	0.77	0.49	0.39	Yes	88% Min. Efficiency	FLUORESCENT-Direct/Indirect-Non-VDT

Table 9 – Fixtures used to calculate average photometric values for fixture type 537-1

Light Source	Distribution	Lamp(s)	Lens	Size	Reflect.	CU at RCR=A (A<2.5)	CU at RCR=B (2.5<=B=<7.0)	CU at RCR=C (C>7.0)	Cutsheet backup	Special Characteristics	Description
FL	Linear WW Open 1 wall	n/a	n/a	n/a	70/40/20	n/a	n/a	n/a	Yes		FLUORESCENT-Wallwash Open
FL	Linear WW Open 1 wall	(1) T8	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	
FL	Linear WW Open 1 wall	(1) T8	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	
FL	Linear WW Open 1 wall	(1) T8	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	
FL	Linear WW Open 1 wall	(1) T8 biax	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	
FL	Linear WW Open 1 wall	n/a	n/a	n/a	70/50/20	0.69	0.41	0.33	Yes		FLUORESCENT-Wallwash Open

Table 10 – Fixtures used to calculate average photometric values for fixture type 572

Light Source	**Distribution**	**Lamp(s)**	**Lens**	**Size**	**Reflect.**	**CU at RCR=A** (A<2.5)	**CU at RCR=B** (2.5<=B=<7.0)	**CU at RCR=C** (C>7.0)	**Cutsheet backup**	**Special Characteristics**	**Description**
TH	Downlight open	n/a	n/a	9"	70/50/20	0.78	0.55	0.45	Yes	n/a	
TH	Downlight open	250W	n/a	med beam	70/50/20	0.94	0.7	0.61	Yes	n/a	

Appendix M – ASHRAE Standard 90.1 Thermal Cooling Load Model

A single model of 22 simulations was used for a number of the ASHRAE Standard 90.1-1999 requirements. This includes the studies for air-side economizers, HVAC equipment efficiencies and heat-rejection fan controls. The model was developed by Battelle Pacific Northwest National Laboratories using the BLAST program. These models form a common basis for many of the requirements in Standard 90.1-1989R: prior to their application in this study, the SSPC90.1 used the hourly loads from these simulations to determining life cycle costs for efficiencies of mechanical equipment. The BLAST simulations represent two occupancies, an office building and a retail building, each of which were customized for 11 different climate locations in the United States. The modelers used a common 3 story, 48,000 ft^2 commercial building envelope and geometry for both occupancies, however they modified the operation schedules, base building internal loads, and ventilation requirements as appropriate to represent each occupancy. The modelers designed the building shell, lighting and HVAC elements to just meet the Prescriptive requirements of ASHRAE 90.1-1989 and ASHRAE 62-1989. They employed two mechanical system models: a packaged single zone system and a central VAV system. The working group selected the VAV system model as appropriate for this study.

The modelers selected the 11 cities and 2 occupancies to represent the bulk of construction activity in the United States. They grouped similar climates by applying statistical clustering of available climate data from the National Oceanographic and Atmospheric Administration (NOAA)[25] as follows:

- Select climate parameters, such as heating degree days, base 65°F (18.3°C), that are unique in their influence on energy use in commercial buildings.
- Identify groups of climate stations that are similar in these climate parameters.
- Define the geographic extent of each climate group.

This analysis yielded 16 unique climate regions each represented by a specific climate station. They then considered new construction activity in each of these geographical regions. They used commercial building construction and population data from the U.S. Census[26] and aggregated the data for each climate-based geographical region. Based on this examination, they dropped five climate regions because of low population and/or little expected new construction activity. Construction volume data for these regions were assigned to the next most similar climate region. The final 11 representative climate stations, and the relative construction volume in both the retail and office building categories, are shown in Table 1. A complete description of the clustering process is reported in a paper presented at the CLIMA 2000 conference (Hadley and Jarnagin, 1993-).

[25] They considered the 212 locations in the continental United States for which Typical Meterological Year (TMY) weather data files were available.

[26] The source of this data was not recorded. To the best of our recollection, this was data available from the US Census bureau on construction valuation that was available for commercial buildings up to 1993. It may have been based on building permits.

Table 11: BLAST Simulation Cities and Construction Activity Weighting Factors

City	Office	Retail
Denver CO	0.9%	1.8%
Detroit MI	9.6%	10.4%
Fresno CA	1.3%	2.1%
Knoxville TN	10.2%	9.0%
Los Angeles CA	6.2%	7.3%
Minneapolis MN	0.9%	1.5%
Orlando FL	3.1%	5.3%
Pheonix AZ	0.7%	1.7%
Providence RI	5.3%	6.8%
Seattle WA	2.2%	1.7%
Shreveport MI	5.2%	6.8%
Total	**45.6%**	**54.4%**

Appendix N – Mapping of California Climate Zones to ASHRAE Criteria

To translate the ASHRAE Standard 90.1 requirements for economizer high-limit switches and the climatic exception to the heat-rejection fan control requirement, the authors evaluated the 16 California Climate Zones using the CTZRV2 weather files and an MSAccess database. The results of the mappings are presented in Table ? below.

Table 12: California Climate Zone Data Mapped to ASHRAE Standard 90.1 Criteria

ZONE	#Hours Btwn 8am and 4pm, 55F and 69F	CDD50	Hours WB<69		Hours WB<73		Hours WB<75		Hours DB<100		Designation
CZ01	1,864	1,596	8753	0.1%	8760	0.0%	8760	0.0%	8760	0.0%	DRY
CZ02	1,044	3,091	8741	0.2%	8760	0.0%	8760	0.0%	8760	0.0%	DRY
CZ03	1,682	2,801	8713	0.5%	8759	0.0%	8760	0.0%	8760	0.0%	DRY
CZ04	1,185	3,386	8240	5.9%	8663	1.1%	8728	0.4%	8760	0.0%	HUMID
CZ05	1,620	2,860	8724	0.4%	8755	0.1%	8759	0.0%	8760	0.0%	DRY
CZ06	1,516	4,132	8653	1.2%	8754	0.1%	8760	0.0%	8760	0.0%	INTERMEDIATE
CZ07	1,416	4,516	8446	3.6%	8698	0.7%	8724	0.4%	8760	0.0%	INTERMEDIATE
CZ08	1,103	4,664	8410	4.0%	8710	0.6%	8745	0.2%	8760	0.0%	INTERMEDIATE
CZ09	965	4,941	8398	4.1%	8679	0.9%	8729	0.4%	8745	0.2%	INTERMEDIATE
CZ10	944	5,022	8604	1.8%	8756	0.0%	8760	0.0%	8721	0.4%	INTERMEDIATE
CZ11	810	4,405	8715	0.5%	8760	0.0%	8760	0.0%	8712	0.5%	DRY
CZ12	843	3,811	8636	1.4%	8752	0.1%	8759	0.0%	8727	0.4%	INTERMEDIATE
CZ13	496	5,345	8433	3.7%	8706	0.6%	8746	0.2%	8643	1.3%	HOT/DRY
CZ14	726	4,811	8760	0.0%	8760	0.0%	8760	0.0%	8649	1.3%	DRY
CZ15	500	8,554	8011	8.6%	8481	3.2%	8700	0.7%	8010	8.6%	HOT/DRY
CZ16	666	2,025	8732	0.3%	8759	0.0%	8760	0.0%	8760	0.0%	DRY

Although climate zone 4 was determined to be a "humid" climate using the ASHRAE criteria, it was changed to intermediate to reflect the design day criteria for San Jose the largest city in this climate zone.