General Envelope Recommendations

DESIGN GUIDELINES FOR ENERGY EFFICIENT BUILDING ENVELOPES

In many ways, a building is defined by its envelope, or the interface between the interior of the building and the outdoor environment. This includes the walls, roof, foundation, doors, windows and insulation. The envelope plays an enormous role in determining the amount of energy necessary to maintain a comfortable indoor environment. This document presents a number of best practices and general recommendations for improving the building envelope in new construction buildings. These trusted recommendations are based on those of the International Energy Conservation Code (IECC) 2015.

Through your electric utility's energy efficiency programs, CLEAResult helps building owners, architects and engineers evaluate the benefits of energy efficiency. Building owners are encouraged to assess and address their energy use through a variety of program-related services, ranging from energy performance benchmarking and energy master planning, to technical assistance and public relations support. These third-party recommendations are provided at no cost through your electric utility and are not intended to substitute for the services of paid professionals.

Roofing

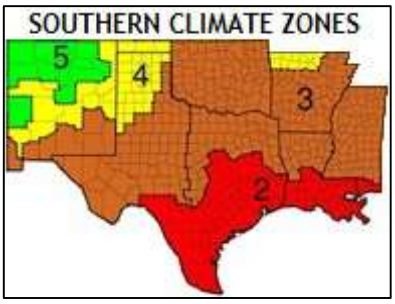
Roof design and materials can reduce the amount of air conditioning required in hot climates by increasing the amount of solar heat that is reflected, rather than absorbed, by the roof. ENERGY STAR® qualifies a number of "cool roof" products that are estimated to reduce the demand for peak cooling by 10 to 15 percent over a typical roof. We recommend installing ENERGY STAR® qualified cool roof products, which most utility incentive programs require in order to receive an incentive. Please visit http://www.energystar.gov/index.cfm?c=roof_prods.pr_crit_roof_products for more information on ENERGY STAR roofs.

Insulation

The design and construction material of the building influence the amount of energy lost or retained through the walls. While the air barrier impedes air flow, insulation provides resistance to heat flow, reducing the amount of energy needed to keep a building warm in the winter and cool in the summer. Insulation is frequently discussed in terms of its ability to resist heat flow, or its R-value. The table to the right lists R-values for various typical building materials and insulation types.

Building Material	R-Value per Inch
Cellulose	3.70
Fiberboard	2.78
Fiberglass	3.20
Perlite	2.78
Polystyrene	4.00
Polyurethane	6.25
Polyisocyanurate	7.00
Rock Wool	3.10
Wood frame	0.10
Concrete 4"	0.20
Brick 4"	0.20

Source: ASHRAE Fundamentals



Local building codes around the country require insulation in roofs, walls, and floors. The following minimum insulation requirements are those championed by the International Energy Conservation Code (IECC) 2015, one of the most progressive codes available. These guidelines should be checked against local building codes because some aggressive local codes may exceed these values. We recommend the following insulation requirements whenever exceeding local building code. These recommendations are based on climate zone location (see map for climate zones).

MINIMUM INSULATION RECOMMENDATIONS				
Climate Zone (see map):	2	3	4	5
Roofing				
Insulation Entirely Above Deck	R-25 ci*	R-25 ci	R-30 ci	R-30 ci
Metal Buildings	R-19 + R-11 ci	R-19 + R-11 ci	R-19 + R-11 ci	R-19 + R-11 ci
Attic and Other	R-38	R-38	R-38	R-38

* CI - Continuous Installation

Source: IECC 2015

MINIMUM INSULATION RECOMMENDATIONS (CONTINUED)				
Climate Zone (see map):	2	3	4	5
Walls				
Mass, Exterior Insulation	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal Building	R-13 + R-6.5 ci	R-13 + R-6.5 ci	R-13 + R-13 ci	R-13 + R-13 ci
Steel Framed	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci
Wood Framed and Other	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20
Floors				
Mass	R-8.3 ci	R-10 ci	R-10.4 ci	R-12.5 ci
Steel Joist	R-30	R-30	R-30	R-30
Wood-Framed and Other	R-30	R-30	R-38	R-49
Heated Slab-on-Grade	R-7.5 for 12in. Below	R-10 for 24in. Below	R-15 for 24in. Below	R-15 for 36in. Below

* CI - Continuous Installation Source: IECC 2015

BELOW-GRADE EXTERIOR INSULATION

According to IECC 2015, slab-on-grade floors and below-grade floors and walls should be isolated from ground temperatures with a minimum R-7.5 layer of rigid insulation on the exterior side of the construction, particularly in hot/humid climate zones. Decoupling the temperature of slab-on-grade or below-grade masonry from the temperature of the ground reduces the potential for condensation on those surfaces.

AIR BARRIER PERFORMANCE

The building envelope should be designed with a continuous air barrier system to control air leakage into and out of the conditioned space. Also, air barrier systems should be provided for interior separations when the temperature and/or humidity differential is more than 50 percent between the conditioned space and design ambient conditions.

The air barrier materials in a building should be joined in an airtight and flexible manner, allowing for heat and moisture deflection while keeping air flow restricted between conditioned and non-conditioned spaces. All penetrations of the air barrier system should be made airtight to conserve the energy used to condition indoor air. To maintain the air barrier, all ducts in unconditioned spaces should be insulated and sealed at joints with mastic. The following picture demonstrates the many ways that air can leak into and out of a building.

INDOOR AIR QUALITY

Per building codes, indoor air must be flushed out and replaced by fresh outdoor air to remove contaminants and replenish oxygen. Any outdoor air brought into a space should be brought in by the heating, ventilation, or air conditioning (HVAC) system rather than infiltration.

Fenestration

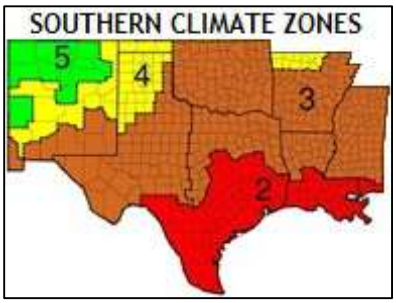
Fenestration refers to windows, skylights, and doors, all of which are rated by the National Fenestration Rating Council (NFRC). Whole window and door assemblies are rated for air leakage and U-Factor, a measure of heat conductance (which is the inverse of R-value). Translucent glazing is also rated for Solar Heat Gain Coefficient (SHGC), the percentage of solar radiation transmitted through the material, and Visible Light Transmittance (VT), a measure of the visible light transmitted through the material. High performance windows and doors have special coatings that let visible wavelengths pass through but keep ultraviolet and infrared wavelengths out of the building. Buildings where above-grade walls are more than

40 percent glazing, or where more than 5 percent of the roof area is skylight, should be assessed with energy modeling software to ensure that the glazing area will not incur significant energy costs. For buildings where walls have less than 40 percent glazing and roofing is less than 5 percent skylight, we recommend that all fenestration meets the requirements presented in the following table.

FENESTRATION RECOMMENDATIONS								
Climate Zone (see map):	2		3		4		5	
Vertical Fenestration U-factor								
Fixed Fenestration	0.50		0.46		0.38		0.38	
Operable Fenestration	0.65		0.60		0.45		0.45	
Entrance Doors	0.83		0.77		0.77		0.77	
Vertical Fenestration SHGC								
Orientation*	SEW	N	SEW	N	SEW	N	SEW	N
Projection Factor (PF) < 0.2	0.25	0.33	0.25	0.33	0.40	0.53	0.40	0.53
0.2 ≤ PF < 0.5	0.30	0.37	0.30	0.37	0.48	0.58	0.48	0.58
PF ≥ 0.5	0.40	0.40	0.40	0.40	0.64	0.64	0.64	0.64
Skylights								
U-factor	0.65		0.55		0.50		0.50	
SHGC	0.35		0.35		0.40		0.40	

*"N" indicates vertical fenestration oriented within 45 degrees of true north. "SEW" indicates orientations other than "N".

Source: International Energy Conservation Code 2015



Source: ASHRAE 90.1

WINDOW TREATMENTS

In air-conditioning-dominated climates, it is beneficial to consider the heat gain sustained from south- and west-facing windows. The installation of window films and solar screens reduce the heat transmitted into the building space, saving energy in air-conditioning. We recommend window films and solar screens for new or existing windows. If installed on single-pane clear glass windows without any other shading, deemed savings are available for south- and west-facing windows receiving window films or solar screens in Texas.

ENTRANCE AND EXIT DOORS

Entrance and exit doors often leave clearance gaps to allow for proper operation. The gaps around the doors allow for the infiltration of unconditioned air into the building, adding to the cooling and heating loads of the HVAC system. Weatherstripping and brush-style door sweeps installed along door jams can prevent this air infiltration. In 2020, Texas offers a deemed savings approach for incentivizing weatherstripping and/or door sweeps on exterior doors with visible gaps of 1/8 to 3/4 inches.

Example Building Envelope Specifications

NEW CONSTRUCTION AND RETROFIT

A. The building construction shall maintain a continuous air barrier between conditioned space and non-conditioned space. Materials used for the air barrier system should have an air permeability not to exceed 0.004 cfm/ft2 under a pressure differential of 0.3 inches of water (1.57 psf).

B. Roof Reflectivity:
    a. Low Slope roofs must have an initial solar reflectance of ≥ 0.65. After 3 years, the solar reflectance must be ≥ 0.50.
    b. Steep Slope roofs must have an initial solar reflectance of ≥ 0.25. After 3 years, the solar reflectance must be ≥ 0.15.

C. Insulation values shall meet or exceed those presented in IECC 2015 for roofing, walls and floors.

D. All fenestration shall comply with IECC 2015.