

Daylighting Gains Recognition in Codes

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Daylight harvesting is a relatively new term that encompasses a systematic approach to daylighting in which optimization of sunlight is combined with a sensor-based electric lighting control strategy (automated if possible) to maintain a desired task light level and minimize ongoing energy costs. As a result of its strong energy savings potential, codes and standards have begun to address daylight harvesting—especially the latest editions of national model energy conservation and green building codes.

While these codes and standards are different, they similarly define daylight availability as zones around side-lighting (e.g., windows) and top-lighting (e.g., skylights and tubular daylighting devices [TDDs]) and require separate controls for general lighting in these daylight zones. Most of these target the commercial sector, but recent developments also address residential construction. And, for the first time, there is noticeable effort to make the various codes complementary rather than conflicting, complete with a number of mutual cross-references.

The 2012 I-codes

Last October, the model International Energy Conservation Code (IECC) was revised for 2012 to theoretically achieve energy savings of 30 percent relative to the 2006 version. The changes include all aspects of residential (IECC Chapter 4) construction, laying a strong foundation for residential efficiency gains. The energy chapter of the International Residential Code (IRC Chapter 11) was essentially eliminated and now references the IECC as a single nationwide uniform energy code referenced by both the International Residential Code (IRC) and International Building Code (IBC), rather than each having energy requirements of their own.

Several modifications have been made to make the IECC more consistent with ASHRAE 90.1. Therefore, the 2012 IECC will contain two distinct and comprehensive sections of energy provisions for commercial buildings and low-rise residential buildings.

Two key provisions codify daylighting:

- Skylights are limited to three percent of roof area, five percent when automatic lighting controls are included. Skylight U-factors range from 0.75 in Zone 1 to 0.50 in Zone 8, while SHGC varies from 0.35 to 0.40 south to north, but with no maximum specified for Zones 7 and 8. The SHGC for Zones 1-6 can be increased up to 0.60 if Visible Transmittance(VT) is not less than 0.60 and automatic daylighting controls are installed.
- Top-lighting is mandatory for at least 50 percent of the floor area for big-box and warehouse-type stores, lobbies, atria, transportation centers, manufacturing facilities, warehouse and distribution centers, gymnasiums and exercise centers

and automotive service facilities – if the ceiling is more than 15 feet and the area is more than 10,000 square feet with daylighting controls included.

IgCC

Pending a Final Action Hearing in November, the first edition of the new International Green Construction Code (IgCC), developed by the International Code Council (ICC), the American Institute of Architects (AIA) and the USGBC, will be available for early 2012.

Similar to the 2012 IECC, Section 808 of the new code requires not less than 50 percent of the total floor area in regularly occupied commercial spaces to be located within a daylit area. As another example of the cross-referencing among the new group of codes and standards, it refers to ICC-700 for residential construction and ASHRAE 189.1 as an alternative compliance path for commercial projects.

It incorporates static and dynamic daylighting calculation methods and metrics such as Daylight Factor and Single Point in Time, which are used to give a general sense of the daylight quantity in a given space. Less familiar metrics, which include Daylight Saturation Percentage and various Daylight Autonomy hybrids, tend to be more robust, but require more extensive calculations.

The IGCC requires daylight analysis demonstrating that all points in a daylit area have a daylight saturation of not less than 60 percent. A climate-based daylight simulation analysis must also be performed, considering hourly data for a typical meteorological year, excluding the first hour after sunrise every day and the last hour before sunset every day. Calculations must be based on an array of daylit points no more than four feet apart.

IgCC provides two compliance paths for daylit areas – prescriptive and performance-based. Buildings with more than 25,000 square feet of daylit area must use the performance-based path.

ICC-700

Focusing on the residential sector, ICC 700, National Green Building Standard, covers new single- and multi-family homes, home remodeling and additions, hotels and motels, and the site upon which the green homes are located. The green practices in the standard include lot design, preparation and development; resource, energy and water efficiency; indoor environmental quality (IEQ); and operation, maintenance and building owner education. As a part of the IEQ section, it emphasizes natural daylighting.

ICC 700 offers a rating system analogous to that of LEED, featuring four threshold levels – Bronze, Silver, Gold and Emerald – that provides builders with a means to achieve basic, entry-level green building, or, on the other end of the spectrum, achieve the highest level of sustainable green building that incorporates energy savings of 60 percent or higher.

Two points are awarded for the use of TDDs or low-E insulating glass skylights in rooms without windows (Section 704.2.4). Section 701.4.4 requires windows, exterior doors, skylights and TDDs to have NFRC-certified U-factors and SHGCs in accordance with ENERGY STAR® or equivalent.

The prescriptive path outlined in the standard also includes two levels of “enhanced fenestration specifications” that can earn builders additional points. The skylight and TDD portions of those specifications and the points available for achieving the indicated performance levels are listed in the following table:

ICC-700 Enhanced Specifications			
IECC			
Climate	U Factor	SHGC	Points
Zones			Available
Level One			
1 and 2	0.55	0.35	8
3	0.55	0.4	8
4 and 5	0.6	Any	5
6 through 8	0.6	Any	6
Level Two			
1 and 2	0.5	0.35	10
3	0.5	0.35	10
4 and 5	0.5	Any	10
6 through 8	0.5	Any	12

ASHRAE Standards 90.1 and 189.1

ASHRAE 189.1

ASHRAE 189.1-2009, Standard for the Design of High-Performance Green Buildings, developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers in cooperation with USGBC and the Illuminating Engineering Society, covers all buildings except low-rise residential buildings and includes renovations and additions to existing buildings. Like ICC 700, ASHRAE 189.1 is not a design guide or rating system; rather, it is written in code mandatory language intended for adoption and enforcement and provides both simple compliance paths and more flexible performance options in requirements for similar sustainability elements.

This standard is meant to reach beyond minimum requirements to mandate significant reductions in energy use, with major emphasis on the use of renewable energy systems, stringent water conservation provisions and extensive building owner and operator education to ensure future efficiencies are realized.

The IEQ Section 8 of Standard 189.1 addresses four major categories: indoor air quality (IAQ), thermal comfort, acoustical control and daylighting. Each of these four areas has been identified as a critical component in balancing “environmental responsibility, resource efficiency, occupant comfort and well-being and community sensitivity” in the design of high-performance, green buildings.

For daylighting, ASHRAE 189.1 includes measures intended to provide a minimum quality and quantity of daylighting. For large open spaces (more than 20,000 sq.ft.) under a roof, skylights are required to daylight at least half of the space, much like the 2012 IECC. For offices and classrooms, side-lit daylighting is required. Additionally, measures requiring window shading limit the amount of direct sun in these spaces, minimizing the potential for problematic daylighting conditions. The IEQ daylighting requirements are complemented by lighting control requirements in Section 7, Energy Efficiency.

There are both mandatory and optional pathways for compliance.

For daylighting by top-lighting, in spaces where either the lighting power allowance or the LPD is greater than 0.5W/sq.ft., 50 percent of the floor area under roof must be in a daylight zone. Areas that are daylighted must have a minimum ratio of top-lighting area to daylight zone area per the following table:

Minimum Top-lighting-to-Daylight Zone Area Ratio	
The Greater of (a) the LPD or (b) the Lighting Power Allowance in Daylight Zone (w/Square Foot)	Minimum Top-lighting-to-Daylight Zone Area Ratio
> 1.4	3.60%
> 1.0 and < 1.4	3.30%
> 0.5 and < 1.0	3.00%

Areas subject to this requirement are enclosed spaces greater than 20,000 sq.ft. that are directly under a roof with a finished ceiling height greater than 15 feet and that have a lighting power allowance not less than 0.5 W/sq.ft.

In addition, skylight glazing materials and diffusers used to comply with the above shall have a measured haze value greater than 90 percent per ASTM D1003 (subject to a few listed exceptions).

Once the mandatory provisions are met, the user may follow either the prescriptive path or a performance-based path for achieving the appropriate level of task lighting. The prescriptive path addresses only windows. The performance-based approach, which can include skylights, utilizes daylighting simulation to demonstrate that daylight provides an illuminance of at least 30 footcandles on a plane three feet above the floor for at least 75 percent of the daylight zones and that direct sunlight does not reach any work surface during more than 20 percent of the occupied hours (during an equinox day).

ASHRAE 90.1

While previous versions of ASHRAE/IES 90.1 do not address daylight harvesting control, strong demand in projects requiring high levels of sustainable design has spurred its inclusion in the 2010 version. The newer standard arguably features the most aggressive and complex daylight harvesting control requirements in current codes. Also of note: daylight harvesting control, particularly zoning, is now treated differently in ASHRAE/IES 90.1-2010, ASHRAE 189.1, IECC 2009 and California's Title 24-2008.

In top-lit spaces, if the total daylight area under skylights and rooftop monitors is larger than 900 sq.ft., the general lighting must be separately controlled using either a stepped switching or continuous dimming controller. More aggressive daylight harvesting control such as using automatic continuous dimming receives additional power adjustment credits.

LEED® 2009 and GreenGlobes™

LEED

The U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system and certification program provides opportunities to earn points for the use of daylight and views.

The use of skylights up to 3-6 percent of the floor area is offered as a potential solution to achieve Daylight and Views credits 8.1 (daylighting introduced in at least 75 percent of the occupied spaces) and 8.2 (direct outdoor views provided for 90 percent of the occupied spaces). Further, the Green Interior Design & Construction version of LEED further awards two points for introducing daylight harvesting controls in all daylighted areas (1 point) and/or on 50 percent of the lighting load (1 point).

Green Globes

The Green Building Initiative (GBI) organization sponsors its Green Globes environmental assessment and rating system for commercial buildings. In late March of 2010, GBI released ANSI/GBI 01-2010: Green Building Assessment Protocol for Commercial Buildings, which was derived from the rating system.

ANSI/GBI-01-2010 specifically recognizes "light wells, light shafts or tubes, skylights, clerestory windows" among recommended daylighting strategies. In Section 8.5, rating points are granted as follows:

- Points are added incrementally up to a maximum of eight points if the combined effective side-lit and top-lit areas range between 10 percent up to more than 50 percent of the net building area
- Three points are granted if skylights are installed over 2 to 3 percent of the roof area
- Up to 6 points are granted if photocontrols are used per Section 8.7.4

This standard is more explicit and provides prescriptive requirements for meeting the standard where the LEED program(s) do not.

NFRC

The National Fenestration Rating Council (NFRC) is actively considering a program to rate fenestration products for daylighting. A task group was formed at the NFRC's April, 2010 meeting charged with beginning this challenging work.

To create fair and credible comparative ratings for the lighting potential of a window, door or skylight, the task group's efforts initially concentrated on providing a simple rating (Phase 1) for residential products based on available data for Visual Transmittance (VT). A more complex rating (Phase 2) that would look at new metrics needed to comply with the emerging code requirements would come after the Phase 1 rating.

NFRC recently formed a Daylighting Subcommittee under the Technical Committee to develop the "Phase 1" scope for near-term ratings, and left the previous Task Group in place to simultaneously address the research-heavy "Phase 2" scope. That task group continues to report to the Optical Properties Subcommittee under the Research and Technology Committee.

Last March, AAMA published a free [daylighting fact sheet](#) that addresses key differences between fenestration products installed primarily vertically (windows, doors, curtain walls and storefronts), and those installed primarily overhead (skylights, roof windows and tubular daylighting devices [TDD]) and their relation to daylighting and energy savings.