This classroom on the south-facing side of Richardsville Elementary School (Warren County School District, Ky.) is part of the nation's first net-zero-energy school, where clerestory windows and a light shelf provide sidelighting. Courtesy: CMTA, used with permission from Rachel Paul Photography

Focus on: Lighting controls and codes

Engineers and lighting designers should know the new lighting and lighting control requirements for ASHRAE 90.1-2010.

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According to the U.S. Dept. of Energy (DOE), 40% of primary energy consumed in the United States can be attributed to the building sector. Of that 40%, commercial buildings accounted for 46% while homes totaled 54%. In order to reign in the increasing energy consumption of commercial buildings, the DOE and ASHRAE signed a Memorandum of Understanding establishing a goal of 30% energy savings for 90.1-2010 compared to 90.1-2004.

The new ASHRAE 90.1-2010 has been updated targeting the 30% energy savings goal. For lighting, which typically accounts for 30% to 40% of a building's energy use, changes include: automatic daylighting controls, parking garage controls, and adjusted lighting power densities (LPD). Daylighting controls are one of the most significant

modifications to ASHRAE 90.1 concerning lighting. These new daylighting standards recognize that many new daylit buildings miss easy opportunities to save energy because designers did not incorporate appropriate lighting controls. The following is a brief overview of changes to 90.1-2010.

Changes for 90.1-2010

ASHRAE 90.1-2010 changed the language from fixture replacements to alterations of fixtures such as ballast and lamp replacements. Alterations affecting 10% or more of the lighting in a space must conform to the LPD and the automatic shutoff requirements of 90.1-2010, 9.4.1.1. The previous version pertained to fixture replacements of 50% or more and did not require automatic lighting controls.

Lighting zone columns were added for building exterior lighting power allowances. Lighting zones are designated zero through four. These zones allow for additional wattage for major metropolitan areas (Zone 4) and less wattage for a developed area of a National Park (Zone 1). In lieu of a 5% unrestricted allowance, a unique base site allowance is provided for each lighting zone.

Space-by-space method LPD went both up and down in many categories and a significant digit was added. For example, an enclosed office was 1.1 W/sq ft for ASHRAE 90.1-2010. Open plan offices went down to 0.12 W/sq ft. An additional change includes an added room cavity ratio (RCR) threshold column to the space-by-space method. If the RCR is greater than the scheduled value, a 20% increase to the LPD is provided. This was added to account for unusual room shapes including spaces with tall ceilings. For corridor and transition spaces a 20% increase is provided when the corridor/transition space is less than 8 ft wide.

RCR = 2.5 × room cavity height × room perimeter length / room area

room cavity height = luminaire mounting height – workplane

The whole-building method lighting power densities also added a significant digit, and building LPD went down with the exception of hotels, which stayed the same, and hospitals, which increased by 0.01 W/sq ft. The RCR increase is only available for use with the space-by-space method.

Changes to controls included automatic control devices required in sections 9.4.1.1, 9.4.1.2, and 9.4.1.4 that must be manual on or that automatically turn on lighting to no more than 50% of connected load. Full automatic on is allowed in public corridors, stairways, restrooms, primary building entrance areas, lobbies, and where manual on would be a safety or security concern. Standard 90.1-2010 allows for only a maximum 2-hour manual override for automatic time-of-day shutoff controls; 90.1-2004 allowed a maximum 4-hour override.

Adding a requirement for one control step at 30% to 70% of the full connect power between full on and off is another controls change in 90.1-2010. The exceptions to this requirement include lighting in corridors, electrical/mechanical rooms, public lobbies, restrooms, stairways, and storage rooms. Spaces with only one luminaire with rated input that is less than 100 W or spaces with a power allowance of less than 0.6 W/sq ft are also exempt from stepped lighting controls.

Occupancy sensors were already required in conference rooms, meeting rooms, employee lunchrooms and break rooms, and classrooms per 90.1-2007. The following spaces requiring occupancy sensors were added in 90.1-2010: training rooms, lecture halls, storage rooms, and supply rooms of 50 to 1,000 sq ft; rooms used for document copying and printing; office spaces up to 250 sq ft; restrooms; and dressing, locker, and fitting rooms.

Certain spaces are exempt from the occupancy sensor requirement. Spaces with multi-scene lighting control systems, shop and laboratory classrooms, spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s), and spaces where lighting is required for 24-hour operation are exempt from occupancy sensor requirements.

Standards new to 2010

Power allowances, daylighting controls, functional testing, and submittals are all new standards for 2010. The power allowances take into consideration advancements in fixture technology. For example, when using the space-by-space method, additional interior lighting power allowances are available. Table 9.6.2 was added for additional LPD for open offices, private offices, conference rooms, meeting rooms, retail sales area, lobby, atrium, dining area, corridors, stairways, gym/pool, mall concourse, and parking garages when advanced control strategies are used. There are 12 control strategies above and beyond the mandatory requirements for each of these spaces. There are significant reductions in all four of the retail LPD allowances, which were due in part to the advancements in ceramic metal halide lamps and LED fixtures.

New daylighting standards recognize that many new daylit buildings miss easy opportunities to save energy due to a lack of appropriate lighting controls.

New standards for automatic controls are designed to sustain the 30% energy reduction goal in ASHARE 90.1-2010. New controls standards for automatic daylighting affect both sidelighting and toplighting.

Under 90.1-2010, Section 9.4.1.4, combined sidelighted areas exceeding 250 sq ft are classified as primary sidelighted areas. The artificial lighting within the primary sidelighted areas is required to be controlled by a minimum of one multilevel photocontrolled lighting control device. Multilevel control can be either continuous dimming or

New standards for automatic controls are designed to sustain the 30% energy reduction goal in ASHARE 90.1-2010.

stepped dimming. The stepped dimming must have at least one control step for the artificial lighting of 50% to 70% and one additional step less than 35%, which includes off, of the full connected load. Calibration of the controls must be readily accessible and must be remote from the light sensor.

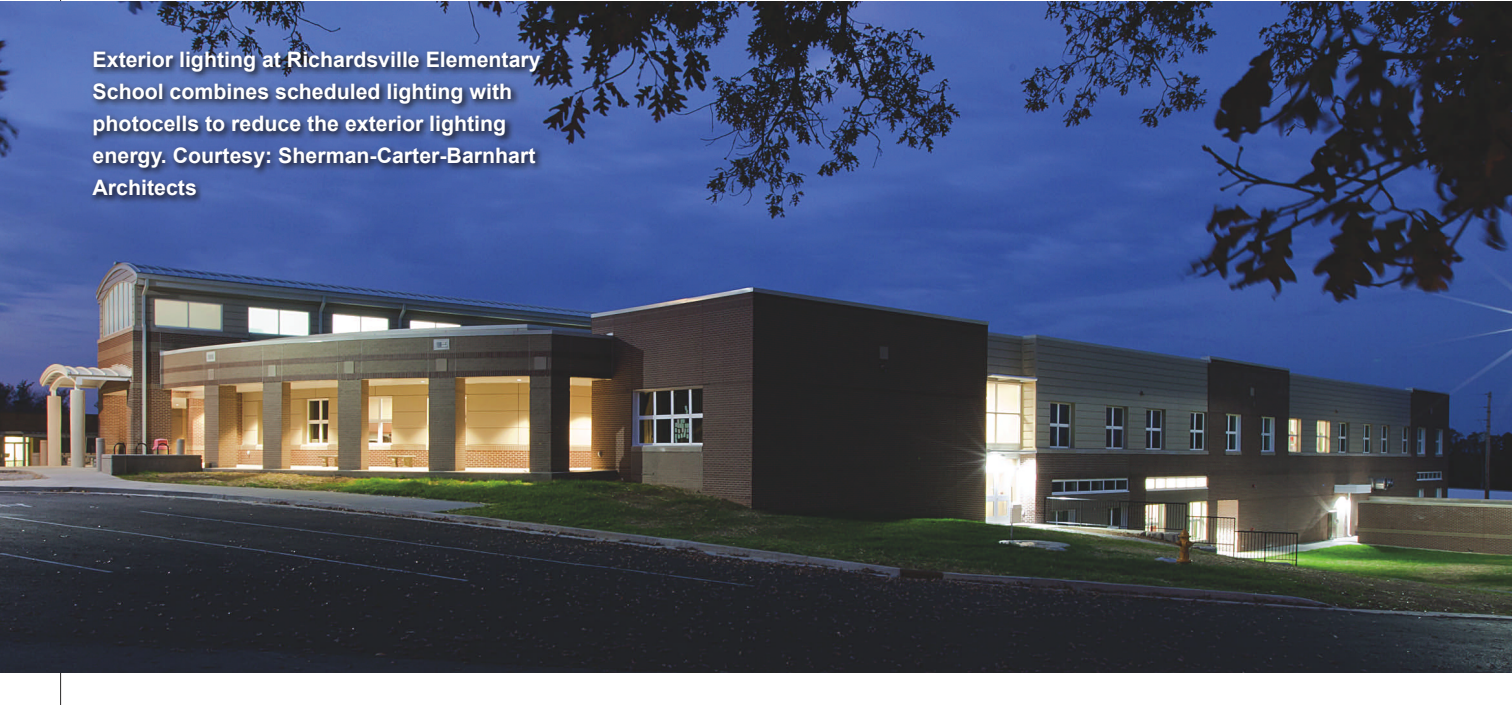
Automatic daylighting controls for toplighting address combined daylight areas under skylights and rooftop monitors in an enclosed space exceeding 900 sq ft. These spaces are required to be controlled by a minimum of one multilevel photocontrolled lighting control device. Like the above, multilevel control can be either continuous dimming or stepped dimming. The stepped dimming must have at least one control step for the artificial lighting of 50% to 70% and one additional step less than 35%, which includes off, of the full connected load. Calibration of the controls must be readily accessible and must be remote from the light sensor.

Other control standards look to reduce energy use in areas that can be unoccupied for extended times during the day. These areas include bathroom lighting in hotels, stairwells, and parking garages. There is a new standard for exterior lighting control and outlets (receptacles) in offices and classrooms. Bathroom lighting in a guest room of a hotel, motel, boarding house, or similar building must turn off after 60 minutes of the occupant leaving the space. A night light not exceeding 5 W is exempt from occupancy controls. Lighting installed in enclosed stairwells must be capable of reducing the connected load by 50% after 30 minutes of inactivity. Lighting within a parking garage must reduce by 30% after 30 minutes of inactivity. Lighting zones are to be no larger than 3,600 sq ft and luminaries within 20 ft of a perimeter wall.

Although outlets (receptacles) are typically not lighting loads, there is a standard for outlet control in 90.1-2010 focusing on time-of-day scheduling. Half of all 125 V-, 15- and 20-amp receptacles in private offices, open offices, and computer classrooms require automatic controls using time-of-day scheduling or occupancy-based controls. Exceptions to this standard include outlets used 24/7 or if safety or security is a concern.

Exterior lighting controls were addressed in 90.1-2010, Section 9.4.1.7. At the very basic level, exterior lighting must turn off when sufficient daylighting is available, unless exempted in Section 9.1. Where there is building façade or landscape lighting, it must automatically shut off between midnight or business closing, whichever is later, and shall not turn on any earlier than 6 a.m. or business opening, whichever comes first, or between times established by the authority having jurisdiction unless excepted in Section 9.1. Other exterior lighting addressed in this standard includes advertising signage, which must be automatically reduced by at least 30% between midnight or within one hour of end of business operation, whichever is later, until 6 a.m. or business opening, whichever is earlier, or during any period when no activity has been detected for a time of no longer than 15 minutes. Covered vehicle entrances and exits from buildings and parking structures where safety, security, and eye adaptation are concerns are also exempt.

In order to ensure the standards are applied in the final construction, functional testing is required within 90 days of occupancy. Functional testing



Exterior lighting at Richardsville Elementary School combines scheduled lighting with photocells to reduce the exterior lighting energy. Courtesy: Sherman-Carter-Barnhart Architects

Classrooms on the north-facing side of Richardsville Elementary School have four tubular daylighting devices that provide top-lighting. Courtesy: CMTA, used with permission from Rachel Paul Photography

is used to confirm that lighting control hardware and software are calibrated and working in accordance with the construction documents. This includes confirming occupancy sensors' time-out and sensitivity perform correctly, time switches turn lights off, and photosensor controls reduce electric light levels. The construction documents must state the party that will conduct the functional testing. The party responsible for the functional test cannot directly be involved in design or construction of the project. Documentation must be provided by the party performing the functional testing to verify conformance with the construction documents. Construction documents must state that within 90 days of system acceptance, record drawings are to be provided to the owner. Record drawings must include locations and identifier of each luminaire, circuiting, and controls. Also within 90 days, manuals are to be provided with submittal data, operation, and maintenance of all lighting equipment

Lighting consumes a significant amount of energy, but it can also contribute to the HVAC load of the building, adding energy use.

Lighting serves many functions in a building. It can be used to illuminate work areas or accent building features. Lighting or absence of light can directly affect the safety and security of an area. Not only does lighting itself consume a significant amount of energy, but it can contribute to the HVAC load of the building, adding energy use. The new ASHARE 90.1-2010 standards encourage the use of available systems such as lighting controls and occupancy sensors to decrease lighting energy use. The standards also challenge lighting designers to incorporate improving technologies such as LED light fixtures and active daylighting into lighting design that will further reduce the energy consumption of a building. csel

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