



White Paper

Dissecting Lighting Control Requirements for ANSI/ASHRAE/IES Standard 90.1- 2010 and 2013

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This white paper will highlight key changes in Standard 90.1 for 2013 and will also describe the 2010 revision.

Standard 90.1 2013

The lighting section of Standard 90.1 has become increasingly sophisticated over the past 14 years, particularly in regard to lighting controls. The 2013 standard described below attempts to go even further while simplifying understanding and application.

- Energy consumption for certain lighting systems must be measured separately using a device that communicates remotely with a data acquisition system. The system must be able to store data and provide user reports.
- Certain hotel and motel guest rooms must install lighting controls that automatically turn off power to lighting and switched outlets after a period of vacancy.
- Lighting in commercial and industrial storage stack areas must be controlled by an occupancy sensor that reduces lighting power by at least 50 percent.
- Sign lighting power must be automatically reduced at certain times. The reduction level depends on the lamp type and whether it operates during daylight hours.
- Lighting for exterior uncovered parking areas must be controlled by a photo sensor and astronomical time switch. Certain lighting must be reduced using an occupancy sensor.
- Depending on the controls selected, some occupancy sensors must be set to turn the lights off within 20 minutes after a space is vacated.
- The criteria for applying automatic daylight control for side lighting and top lighting has been changed to a controlled lighting power basis and provides characteristics for the required photo controls.
- Automatic independent control is now required in secondary side lighted daylight zones (covering additional luminaires farther from the windows).
- Daylight harvesting step-dimming control now requires two control points between off and full-on—one dim level between 50–70 percent of design power and one between 20–40 percent—to provide greater flexibility.
- A second automatic lighting shutoff option is required for certain occupancy sensor installations—partial-off to 50 percent of design power within 20 minutes of the space being vacated—spaces where the lights are periodically not needed but must remain on.
- More specific requirements for the functional testing of lighting controls have been added, specifically occupancy sensors, automatic time switches and daylight controls.

Mandatory Lighting Control

Here are some of the key mandatory lighting control requirements in the new 90.1-2013 standard:

Local Control

Each interior space must have at least one lighting control device (such as a manual switch or a dimmer) to control the lighting in that space.

Each control device shall be readily accessible and located so the occupants can see the controlled lighting and can only override the scheduled lighting shut-off by a maximum of two hours.

Automatic Shut-Off Or Scheduled Shut-Off

Lighting in the spaces that include classrooms, lecture halls, conference rooms, break rooms, storage and supply rooms, office space and restrooms must be automatically shut-off (typically using vacancy sensors) within 20 minutes of vacancy. Lighting in all other spaces must have either an automatic lighting shut-off control (e.g. an occupancy sensor) that turns off the lights within 20 minutes of vacancy, or scheduled lighting shut-off during periods when the space is scheduled to be unoccupied (e.g. a time clock).

Manual-On Or Partial Automatic-On

Lighting in most spaces must have either a manual-on lighting control or an automatic-on lighting control configured to turn the lighting on to not more than a 50% light level. This effectively requires manual-on/automatic-off controls, or up to 50% auto-on capability for automatic controls.

Bi-Level Lighting Control

Most areas in commercial buildings must provide at least one light level between 30% and 70% of full lighting power in addition to off. This can be done by continuous or stepped dimming, or stepped/dual switching of luminaires or lamps, while maintaining a reasonably uniform level of illumination throughout the area.

Automatic Daylight Responsive Control For Sidelighting And Toplighting

An automatic reduction in lighting power in areas where the daylight can help illuminate the space will be required in most areas that are sidelighted (with windows) or toplighted (with skylights). General lighting in daylight areas using more than 150 W of power shall be controlled using continuous dimming or with at least one control point of 50% to 70% of design lighting power, a second control point between 20% and 40% of design lighting power, and a third control point that turns off all the controlled lighting.

Automatic Partial-Off

Lighting in stairwells and corridors shall be reduced by at least 50% after 20 minutes of all occupants leaving the space.

Exterior Lighting Control

Permanently installed outdoor lighting must be controlled by a photocontrol or astronomical time switch (time clock) that automatically turns off the lighting during daylight hours. The 2013 standard also requires that façade and landscape lighting be turned off between midnight and 6 a.m., or in conjunction with business opening and closing times. Other outdoor lighting, such as advertising signage, must operate at 70% power (or lower) between midnight and 6 a.m., or in conjunction with business closing and opening times, or when no activity has been detected for 15 minutes.

Other Requirements

Other energy efficiency requirements for the electrical and lighting systems include automatic receptacle shut-off (to control task lighting and other plug loads), parking garage lighting control (automatically reduced lighting power when daylight is present and/or during periods of vacancy), energy monitoring (to monitor whole-building energy usage and breakout lighting, HVAC, and plug loads separately), and functional testing requirements to ensure that the lighting controls operate as intended.

Standard 90.1 2010

On October 19, 2011, the U.S. Department of Energy (DOE) issued a ruling that required all states to certify that they had updated the provisions of their commercial building code regarding energy efficiency to meet or exceed Standard 90.1-2010 by Oct. 18, 2013. Thus, it's expected that these lighting control requirements will be in place for most states for all new construction and major renovations of commercial buildings.

The 2010 version can achieve more than 30 percent energy savings compared to the 2004 standard. Part II of the 2010 standard draws heavily on new demands for lighting controls and the role they will play in facilities.

Standard 90.1-2010 Requires:

- Automatic shutoff of indoor and outdoor lighting when not in use
- Automatic lighting shutoff is required in buildings <5,000 sq.ft. unless specifically exempted
- Automatic lighting shutoff requirements of code is required for lamp plus ballast retrofits impacting 10+% of the connected lighting load
- Occupancy sensors are required for a broader range of applications
- Manual-ON or auto-ON to 50% operation is required for automatic controls

- Multilevel lighting is required in spaces using manual space controls
- Automatic multilevel lighting in certain stairwell, parking garage and other spaces
- Automatic daylight harvesting control
- Power credits providing additional lighting power allowances as an incentive for using advanced control strategies
- Functional testing of controls
- Documentation requirements including a control narrative and maintenance schedule

Automatic Shutoff

Standard 90.1-2010 requires that all lighting systems be turned OFF when not in use, with some exceptions.

Indoor: As with previous versions of the standard, for indoor lighting systems, this could be satisfied through use of a schedule-based control device, occupancy sensor or signal from another control or alarm system indicating the area is unoccupied.

Previous versions of the standard limited its automatic shutoff requirements to buildings larger than 5,000 sq.ft. The 2010 standard requires these controls in all buildings, with exemptions limited to lighting required for 24-hour operation, where patient care is provided, and where they might endanger safety or security.

Occupancy Sensors: In previous versions of Standard 90.1, occupancy sensors began to be required in certain applications. The 2010 version expands this list: Occupancy sensors (or timer switches, per approval by the authority having jurisdiction) that turn the lights OFF within 30 minutes of the space becoming unoccupied are required in:

- Classrooms and lecture halls
- Conference, meeting and training rooms
- Employee lunch and break rooms
- Storage and supply rooms between 50 and 1,000 sq.ft. in size
- Rooms used for document copying and printing;
- Office spaces up to 250 sq.ft.
- Restrooms

Exceptions include shop and laboratory classrooms, spaces with multi-scene (e.g., dimming) control systems, lighting required for 24-hour operation and spaces where automatic shutoff would endanger safety or security of people or property.

Occupancy sensing is also required in guestroom bathrooms in hotels, motels, boarding houses and similar buildings. The sensor must turn OFF the lighting, with the exception for night lighting not exceeding 5W, within 60 minutes of the occupant leaving the space. In addition, bathroom lighting is now exempt from the requirement that all lighting in the guestroom must be controlled by a master control at the entry door.

Outdoor: The previous version of 90.1 requires outdoor lighting to be controlled by a photosensor (daylight) or astronomical time switch (scheduling) for dusk-to-dawn lighting and either a time switch or combination photosensor/time switch. It also required that building grounds lighting fixtures >100W either use lamps with an efficacy of 60+ lumens/W or be controlled by a motion sensor, with a long list of exceptions.

The 2010 standard simplifies these requirements. First, all outdoor lighting must be controlled by a photosensor. Second, building façade or landscape lighting must also be controlled by an astronomical time switch that turns the lights OFF between midnight or business closing (whichever comes first) and 6AM or business opening (whichever comes first) or at times designated by the authority having jurisdiction.

Retrofits As Trigger: Standard 90.1-2010 now explicitly covers “maintenance-like” lamp plus ballast (lamp/ballast) retrofits in both indoor and outdoor applications, which have traditionally been ignored for the most part by code officials. Specifically, if a building owner replaces lamp/ballast systems representing 10% or more of the connected lighting load in an indoor space or outdoor area, the owner must comply with the standard’s lighting power density limits expressed in watts per square foot and also its automatic shutoff requirements.

Note that in this situation the standard requires automatic shutoff but not space controls. If a panelboard upgrade is undertaken to provide automatic lighting shutoff in an existing building, the designer should take care to ensure that some form of override is provided to users so they are not left in the dark, even though this is not explicitly required in the standard.

Multilevel Lighting

Previous versions of Standard 90.1 did not require multilevel lighting; the current version embraces it broadly for indoor and outdoor automatic shutoff and space controls, with special requirements for specific applications.

Manual-ON or Auto-ON to 50%: Previous versions of the standard allowed automatic control devices to activate the lighting system as well as turn it OFF. In Standard 90.1-2010, this is no longer the case. Automatic shutoff controls must be manual-ON or automatically turn the lighting ON to not more than 50% power. Exceptions include public corridors and stairwells, restrooms, primary building entrance areas and lobbies, and areas where manual-ON would endanger safety or security.

Manual-ON and auto-ON to 50% occupancy sensors, for example, have been demonstrated to save energy compared to auto-ON to full occupancy sensors, while eliminating nuisance false-ON triggering. Allowing auto-ON to 50% also increases flexibility in choice of light levels for users.

Space Controls: The lights in each enclosed space in the building must be independently controlled by a conveniently located manual control device or automatic occupancy sensor with manual-ON or auto-ON to 50% operation. Certain enclosed spaces, such as public corridors and stairwells, restrooms, primary building entrance areas and lobbies, require occupancy sensors (or timer switches if approved), while designers have a choice of manual control or occupancy sensors in all other spaces. Regardless if using manual controls or occupancy sensors, the lighting must be configured for multiple levels enabling users to select at a minimum OFF, a step between 30% and 70% (inclusive) of full lighting power, and 100% of full lighting power. Exceptions include corridor, electrical/mechanical room, public lobby, restroom, stairway and storage room lighting.

Stairwell Lighting: Stairwell lighting must be controlled so that lighting power can be reduced by at least 50% within 30 minutes of the stairwell space becoming unoccupied.

Parking Garages: Parking garages must comply with the standard’s automatic shutoff requirements but also be controlled so that lighting power can be reduced by at least 30% when there is no activity detected for no longer than 30 minutes, with some exceptions. To satisfy this requirement, the lighting must be grouped in zones no larger than 3,600 sq.ft.

Daylight Harvesting: Daylight harvesting is an important area of the standard and is covered in detail below.

Outdoor Lighting: Standard 90.1-2010 requires a reduction of lighting power during times of night when the lighting is required to be ON but is unlikely to be used, or will be used only intermittently. If the lighting is not building façade or landscape lighting, it must be controlled by a device that reduces lighting power by at least 30% for at least one of these conditions: from midnight or within 1 hour of the end of business operations (whichever is later) until 6 AM 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.

The standard specifically states that this requirement also applies to advertising signage; exceptions include the same as those that apply to automatic shutoff. This requirement would entail using either a time switch or motion sensing.

Daylight Harvesting

Versions of Standard 90.1 prior to 2010 do not address daylight harvesting control, an advanced control strategy that has matured due to strong demand in projects requiring high levels of sustainable design, such as LEED projects. The 2010 standard introduced the most aggressive and complex daylight harvesting control requirements of all the codes at the time.

The code first distinguishes between primary sidelighted areas directly adjacent to daylight apertures and secondary areas in proximity but not directly adjacent to daylight apertures. These areas are strictly defined by the standard using helpful diagrams and are intended to define zones in which consistent, unblocked, high levels of daylight availability is typically expected.

If the primary sidelighted area (defined in the standard and based on space geometry and window effective aperture characteristics) in an enclosed space is 250 sq.ft. or larger, the general lighting in that area must be separately controlled using either a stepped switching or continuous dimming controller, with some exceptions. More aggressive daylight harvesting in primary and secondary sidelighted areas is rewarded with power adjustment credits described later in this white paper.

In toplighted spaces, if the total daylight area under skylights plus the total daylight area under rooftop monitors is larger than 900 sq.ft., the general lighting must be separately controlled using either a stepped switching or continuous dimming controller, with some exceptions. As with sidelighted spaces, more aggressive daylight harvesting control (i.e., automatic continuous dimming) is rewarded with power adjustment credits.

Additionally, perimeter lighting in parking garages is required to be automatically reduced in response to daylight, with some exceptions.

While Standard 90.1-2010 endeavors to simplify the process, its approach to daylight harvesting control increases the complexity involved in compliance.

Power Adjustment Credits

When using the Space by Space Method of compliance with the standard's prescriptive lighting power allowance requirements, Standard 90.1-2010 offers lighting power adjustment credits based on use of advanced lighting control strategies in certain offices, meeting spaces, education spaces, retail sales areas and public spaces. Qualifying technologies range from manual dimming control to automatic continuous daylight harvesting dimming, with power adjustment factors, which are applied to the controlled lighting load, of 5-30%.

For example, in an open office, if workstation-specific fixtures are installed with occupancy sensor-based dim-to-OFF control of the downlight component and occupant manual continuous dimming control of the downlight component, the designer can claim 30% of the wattage of these fixtures as an additional interior lighting power allowance anywhere inside the building.

Functional Testing For Lighting Controls

Standard 90.1-2010 requires functional testing of lighting controls and systems, a service typically provided by the installing electrical contractor in a new construction project, and sometimes supervised by the designer or a commissioning agent. The standard requires that the construction documents identify who will conduct and certify the testing.

Specifically, all specified lighting controls and associated software must be calibrated, adjusted, programmed and assured to operate in accordance with construction documents and manufacturer installation instructions. Specific requirements are identified for occupancy sensors, programmable schedule controls and photosensors.

For example, at a minimum, the party conducting the testing must confirm that the placement, sensitivity and time-out settings for any installed occupancy sensors provide acceptable performance—e.g., the lights must turn OFF only after the space is vacated, and must turn ON only when the space is occupied. Time switches and programmable schedule controls must be programmed to turn the lights OFF. And photocontrol systems must reduce light levels produced by the electric lighting based on the amount of usable daylight in the space as specified.

Documentation To Include Control Narrative

Standard 90.1-2010 requires that certain documents be turned over to the owner within 90 days of system acceptance, including, for example, as-built drawings of the lighting and control system, operating and maintenance manuals for all lighting equipment, recommended relamping program, schedule for inspecting and recalibrating lighting controls, and a complete narrative of how each lighting control system is supposed to operate, including its recommended settings.

A Stronger Code Standard

The Standard 90.1-2010 standard is far more comprehensive, stringent and complicated than its predecessors. To obtain a copy of the standard, visit the ASHRAE bookstore at www.ashrae.org or the IES bookstore at www.ies.org.

About Daintree Networks

Daintree Networks® leads the market in smart building control, sensing, and Enterprise Internet of Things™ (E-IoT™) applications. ControlScope®, the company's open networked wireless solution for lighting and building control, monitoring, and optimization, reduces energy and operating costs, improves the occupant experience, increases business productivity and scales to manage a large portfolio of buildings. Leveraging an open system architecture and an expanding ecosystem of certified lighting, building, and software partners, ControlScope also serves as a platform for best-of-breed applications such as facility and asset management, space planning, and more. Daintree is headquartered in Silicon Valley, California. More information is available at daintree.net.

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