

Lighting Controls Handbook for Commercial Buildings

Includes requirements for
ASHRAE 90.1-2013 & IECC-2015

How to Use the Handbook

This guide is intended to help explain the lighting controls portion of the energy code and does not necessarily include all aspects and details. This guide attempts to compile all relevant information and key practices related to each component. Each entry emphasizes the requirements of ASHRAE 90.1-2013 and (where appropriate) includes references to the 2015 IECC Commercial Provisions. Graphics and illustrations are provided as examples only.

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energycodes@southface.org

404-604-3598

Credits

Principal authors:

Mike Barcik, Southface Senior Technical Principal

Bourke Reeve, Project Manager, Three Points Planning

Graphic design and illustration:

Greg Brough, Southface Senior Technical Principal

Editor: Mike L. Ford, Southface Project Manager

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Contents

Interior Lighting Controls6
A. Local Control7
B. Restricted Manual ON8
C. Restricted Partial Manual ON9
D. Bi-Level Lighting Control 10
E-F. Automatic Daylight Responsive Controls for
 Sidelighting and Toplighting 11
G-H. Automatic OFF: Partial OFF and Full OFF 12
I. Scheduled Shutoff 13
Hotel Guestroom Controls 14
Special Purpose Lighting Controls 15
Ballasts 16
Exterior Lighting Controls 17
Functional Testing 18
2015 IECC Lighting Summary 19
2015 IECC Exterior Lighting Summary 20
2015 IECC Interior Lighting Summary 21

Introduction

The *Commercial Lighting Controls Inspection Handbook* is intended for use by code officials when inspecting commercial construction projects in Georgia for compliance with ASHRAE-2013 or IECC-2105. Specifically, this handbook includes detailed explanations of various lighting control requirements for interior and exterior spaces. This guide can also be helpful to subcontractors and building operators for reducing callbacks and understanding recommended best practices for programming and maintaining lighting control systems.

For more information or training on Commercial Energy Code provisions in Georgia or elsewhere in the Southeast, please visit [www.https://www.southface.org/resources/georgia-energy-code-resources/](http://www.southface.org/resources/georgia-energy-code-resources/) or email energycodes@southface.org.

Interior Lighting Controls

Inspection Requirements

Verify that the lighting controls installed in the building meet the requirements for each space and function as required.

Details

ASHRAE has made significant updates to the lighting control requirements for commercial buildings. ASHRAE 90.1-2013 requires that each space in a building have certain types of lighting controls in place. These control functions are listed by space type in Table 9.6.1.

Control types required for each space are indicated with the symbol "REQ." All controls listed as REQ are mandatory. The symbol "ADD1" indicates additional lighting control functions must be implemented for the space. The symbol "ADD2" indicates that at least one more additional control function must be installed for the space.

These lighting control functions include the following: local control; restricted to manual ON; restricted partial automatic ON; bilevel lighting control; automatic daylight responsive controls for sidelighting; automatic daylight responsive controls for toplighting; automatic partial OFF (full OFF complies); automatic full OFF; and scheduled shutoff. Table 9.6.1 indicates which controls are required for a space using the REQ, ADD1, and ADD2 symbols.

ASHRAE 90.1 rewards certain lighting designs with more advanced controls by offering between 5-30% increased wattage for enhanced controls. For example, retail sales areas with advanced dimming can receive 10% more wattage for fixtures operated by these better-than-minimum controls. See Section 9.6.3 for more details.

The 2015 IECC has added new requirements to Section C405, which covers power and lighting systems in commercial buildings. While the IECC incorporates similar concepts to ASHRAE (including the use of occupant sensors, automatic OFF controls, and day-lighted zones), the IECC lighting control requirements are structured differently.

NOTE: The IECC Lighting summary page at the end of the lighting section highlights some of the key differences between the ASHRAE and IECC lighting requirements.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1

A. Local Control

Inspection Requirements

Verify that independent manual or occupancy-sensing controls have been installed within each space. Use of a clearly labeled, remotely located switch with an “on/off” indicator is allowed when necessary for safety, remotely located, or security reasons.

Details

Each space enclosed by ceiling height partitions shall have at least one control device to independently control all lighting within the space.

The number of control devices required is determined by the size of the space. Each control device must control an area of no more than 2,500 sq. ft. in small spaces (i.e., less than 10,000 sq. ft.). For larger spaces, each control device cannot operate more than 10,000 sq. ft.

Each manual control device shall be readily accessible and located so the occupants can see the controlled lighting. (Remote switch with indicator allowed for safety or security, e.g., big-box retail stores.)

ASHRAE 90.1-2013 requires local control devices in nearly every space type. Only spaces designed specifically for visually impaired persons are exempt from this requirement.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1



B. Restricted Manual ON

Inspection Requirements

Verify that restricted manual ON controls have been installed in each space where they are required.

Details

The Restricted Manual ON control function requires that none of the lighting in the space be automatically turned on. Only Manual ON control devices are allowed. Manual ON/Automatic OFF controls (e.g., vacancy sensors), are allowed. Automatic ON (motion sensing) control devices are not permitted in spaces requiring restricted Manual ON control function. ASHRAE 90.1-2013 requires restricted Manual ON in the majority of spaces. Only corridors, mechanical rooms, lobbies, restrooms, stairwells, storage rooms, dorms, fire stations, and certain types of healthcare facilities are exempt from this requirement. (See Table 9.6.1 for full space type and control function list.)

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

C. Restricted Partial Manual ON

Inspection Requirements

Verify that restricted partial manual ON controls have been installed in each space where they are required.

Details

The Restricted Partial Manual ON control function requires that no more than 50% of the general lighting in the space be automatically turned on. None of the remaining lighting may be automatically turned on.

ASHRAE 90.1-2013 requires restricted partial manual ON in the majority of spaces. Only corridors, mechanical rooms, lobbies, restrooms, stairwells, storage rooms, dorm and fire station living quarters, and certain types of healthcare facilities are exempted from this requirement. (See table 9.6.1 for full space type and control function list.)

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

D. Bi-Level Lighting Control

Inspection Requirements

Verify that bi-level lighting controls have been installed in each space where they are required.

Details

The bi-level lighting control function requires space lighting to have at least one light level step in addition to full ON and full OFF. This can be achieved through continuous dimming or a stepped lighting level between 30% and 70% of full power.

ASHRAE 90.1-2013 requires bi-level lighting control in a wide variety of spaces including offices, break rooms, sales areas, stairwells, healthcare facilities, warehouses, and others. (See Table 9.6.1 for full space type and control function list.)

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

E–F. Automatic Daylight Responsive Controls for Sidelighting and Toplighting

Inspection Requirements

Verify that automatic daylight responsive controls have been installed in each space where they are required.

Details

ASHRAE 90.1-2013 now requires many spaces to have automatic controls that are responsive to daylight in the space. These controls automatically reduce or turn OFF the powered lighting when natural daylight is available.

Sidelighting is generally defined as the daylight area adjacent to vertical fenestration (windows). Toplighting is generally defined as the daylight area below skylights and roof top monitors.

Automatic controls are required for areas with “sidelighting” (windows) and “toplighting” (skylights and roof monitors). Some exceptions do exist for these requirements. Specifically, buildings in which the daylight is fully blocked by an existing adjacent structure, very small window areas (less than 20 sq. ft. total), and retail spaces may be exempt from daylight responsive control requirements.

Designers must perform calculations to determine the sidelighted and toplighted areas. Inspectors should check for the presence of photocells in areas directly adjacent to windows and below skylights or roof monitors.

Automatic daylight responsive controls are generally required in sidelighted or toplighted areas, where a photocell device must automatically adjust lighting in these areas in three steps:

- 50% to 70%
- 20% to 40%
- Full OFF

Lighting controls must be accessible to allow calibration of functions. ASHRAE 90.1-2013 requires automatic daylight responsive controls in a wide variety of spaces. The specific sidelighted and toplighted areas must be calculated by the building designer and installed control functions should be verified by inspectors.

See Table 9.6.1 for space type and control function list. See Section 3.2 for definitions and calculations related to sidelighted and toplighted areas. Section 9.4.1.1 for descriptions of required control functions.

Code reference ASHRAE 90.1-2013—Sections 3.2 & 9.4.1.1 & Table 9.6.1

G–H. Automatic OFF: Partial OFF and Full OFF**Inspection Requirements**

Verify that automatic OFF controls have been installed for each space in which they are required.

Details

Controls that automatically provide either Partial OFF or Full OFF are required for many spaces.

Generally, each space enclosed by ceiling height partitions shall have at least one control device capable of automatically turning off lights within 20 minutes of all occupants leaving the space.

Where Partial OFF is acceptable, the automatic lighting control must reduce lighting power by 50% within 20 minutes of all occupants leaving.

For spaces that require automatic Full OFF, all lighting shall be auto shut off within 20 minutes of being unoccupied.

Exceptions: Compliance is not required for spaces that meet all three of the following requirements:

1. The space has an LPD of no more than 0.80 W/ft².
2. The space is lighted by HID.
3. The general lighting power in the space is automatically reduced by at least 30% within 20 minutes of all occupants leaving the space

The maximum area served by each control is 5,000 sq. ft.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1



I. Scheduled Shutoff

Inspection Requirements

Verify that scheduled shutoff lighting controls have been installed, which will automatically turn off lights during unoccupied times.

Details

Scheduled shutoff automatic control devices shall function on:

A scheduled basis using a time-of-day operated control device that turns lighting off at specific programmed times—an independent program schedule shall be provided for areas of no more than 25,000 sq. ft. but not more than one floor.

OR

An occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space.

OR

A signal from another control or alarm system that indicates the area is unoccupied.

There are exceptions to this requirement for:

- Lighting intended for 24-hour operation
- Lighting in spaces where patient care is rendered
- Lighting in spaces where an automatic shutoff would endanger the safety or security of the room or building occupants

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1



Hotel Guestroom Controls

Inspection Requirements

Verify that an automatically controlled switch has been installed that will automatically turn off lighting in hotel guestrooms and bathrooms.

Details

Hotel and motel guestrooms and guest suites must have an automatic shutoff device that turns off all permanently installed luminaires and switched receptacles within 20 minutes of occupants leaving the room.

“Captive key” systems that control the lighting and switched receptacles meet the intent of this requirement (and are therefore exempt).

Bathrooms in guestrooms must have a separate control device to turn off the lighting within 30 minutes of occupants leaving the room. A vacancy sensor (not occupancy sensor) will meet this requirement.

Bathrooms are permitted a “nightlight” of not more than 5 watts.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.3



By removing the keycard upon occupant departure, lighting power is automatically interrupted for all interior lights.

Special Purpose Lighting Controls

Inspection Requirements

Verify that separate control device has been installed for specialty purpose and task lighting.

Details

ASHRAE 90.1-2013 requires the following types of specialty lighting be separately controlled.

- Display lighting
- Accent lighting
- Display case lighting
- Food warming lighting and other “non-visual” lighting
- Lighting that is for sale, demonstration, or education
- Task lighting
- Under-cabinet lighting

Code reference

ASHRAE 90.1-2013—Section 9.4.1.3



Display/accent lighting must be controlled independently from general space lighting.

Ballasts

Inspection Requirements

Verify that no ballasted light fixtures are single-lamp unless they are tandem-wired to another fixture or have an electronic high-frequency ballast.

Exceptions:

- Fixtures not on same switch
- Recessed fixtures > 10 ft. apart
- Emergency circuits

Details

It is more energy efficient to share conventional electromagnetic ballasts between multiple fixtures than to control the same number of lamps with separate ballasts.

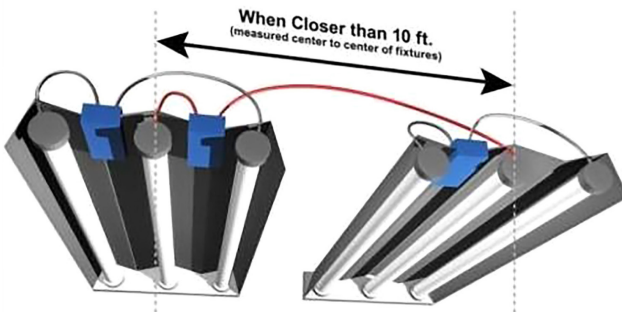
Code reference

ASHRAE 90.1-2013—Section 9.4.2

Electronic ballast



Electromagnetic ballast



Exterior Lighting Controls

Inspection Requirements

Verify that all exterior lighting fixtures are automatically turned OFF during daylight hours. Verify that exterior lighting control system meets after-hour and curfew capabilities.

Details

Exterior lighting must be automatically controlled, and those control systems must be capable of meeting daylight, curfew, and after-hours lighting setbacks and OFF functions.

There are 4 requirements for exterior lighting control systems:

- Automatic OFF during daylight hours (this can be controlled by a photosensor).
- Facade and landscape lighting must automatically turn OFF between midnight and 6 a.m. or close-to-open for the business. (This can be controlled by a time clock.)
- Lighting for signage must automatically reduce power by at least 30% from midnight to 6 a.m. or one hour after close and before open of the business. (This can be controlled by a time clock.)
- Control system must be capable of retaining programming and the time settings for at least ten hours during loss of power.

Exceptions are provided for certain types of lighting:

- Lighting in covered vehicle parking entrance and exit areas that is specifically designed for safety, security, and eye adaptation
- Lighting that is installed by the manufacturer within signage

Code reference

ASHRAE 90.1-2013—Section 9.4.1.4



Functional Testing

Inspection Requirements

Test all lighting control devices and control systems to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

Details

When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures must be performed.

For occupant sensors:

1. Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
2. For projects with up to seven occupancy sensors, all occupancy sensors must be tested.
3. For projects with more than seven occupancy sensors, testing must be done for each unique combination of sensor type and space geometry.
 - a. For each sensor to be tested, verify that:
 1. Status indicator (as applicable) operates correctly
 2. Controlled lights turn off or down to the permitted level within the required time
 3. For auto-on occupant sensors, the lights turn on to the permitted level when someone enters the space
 4. For manual-on sensors, the lights turn on only when manually activated
 5. The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation

For automatic time switches:

1. Confirm that the automatic time-switch control is programmed with appropriate weekday, weekend, and holiday schedules.
2. Document details for the owner about automatic time-switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
3. Verify that correct time and date are properly set in the time switch.
4. Verify that any battery backup (as applicable) is installed and energized.

Code reference

ASHRAE 90.1-2013—Section 9.4.3

2015 IECC Lighting Summary

Inspection Requirements

Verify that occupancy/vacancy sensors, daylight responsive controls, and time switches have been installed as required.

2015 IECC Lighting Summary Interior Lighting Controls

The 2015 IECC has many of the same interior lighting control requirements as ASHRAE 90.1. However, these requirements are organized and worded differently. Below is a summary of the key differences between the IECC and ASHRAE approach to interior lighting controls. Buildings following the IECC code will need to satisfy these requirements.

- Dwelling units in commercial buildings must comply by having 75% of permanently installed fixtures be high efficacy (via section R404.1).
- Occupancy sensor controls (C405.2.1) are required in 12 types of spaces. Some common spaces include classroom/conference rooms, breakrooms, private offices, restrooms, warehouses, and all spaces 300 sq. ft. or less.
- Areas of the building not required to have occupancy-sensing controls must be controlled with time switches (C405.2.2). Time switch controls must be capable of seven-day programming with different daily programs, automatic holiday OFF, 10-hour power backup for settings, and 2-hour manual override (maximum 5,000 sq. ft. area served).
- Each building space is required to have a control that reduces the lighting power in the space by at least 50% (C405.2.2.2). Daylight responsive automatic controls are required in sidelighted and toplighted zones (C405.2.3). All other spaces are permitted to have manual controls.
- Specialty lighting is required to have an ON/OFF switch that is independent from the general lighting in the space. Specialty lighting types include display and accent lighting, task lighting, food warming and other nonvisual lighting, sales displays, and display cases (C405.2.4).
- Sleeping units in hotel and motel rooms must have an automatic control that shuts OFF all lights and switched outlets in the space within 20 minutes of the occupants leaving. Rooms with captive key systems are exempted (C405.2.4).

Code reference

IECC 2015 - Section C405

2015 IECC Exterior Lighting Summary

Inspection Requirements

Verify that controls and time switches have been installed as required.

2015 IECC Lighting Summary Exterior Lighting

The 2015 IECC has many of the same exterior lighting control requirements as ASHRAE 90.1. However, these requirements are organized and worded differently. Below is a summary of the key differences between the IECC and ASHRAE approach to exterior lighting controls. Buildings following the IECC code will need to satisfy these requirements.

- Exterior lights must have a control device that will automatically turn OFF exterior lights when daylight is available (C405.2.5). A photo-sensing device will satisfy.
- Building and landscape lighting must have a control capable of automatic dusk/dawn and open/close shutoff.
- Other exterior lights must have controls which automatically reduce the lighting power by a minimum of 30% from midnight to 6 a.m. or from one hour after close and before opening of the business. Alternatively, the control system must turn lighting OFF when no activity is detected for 15 minutes.
- All controls and switches must be capable of retaining programming for a minimum of 10 hours during loss of power.

Code reference

IECC 2015 - Section C405.2.5

2015 IECC Interior Lighting Summary

Inspection Requirements

Verify that the lighting power budget was calculated using the proper space types and allowable lighting power density (LPD) for the space. Verify that the installed lighting power does not exceed the budget for the building/ space.

2015 IECC Lighting Summary Connected Power

Much like ASHRAE 90.1, the IECC uses lighting power densities (LPD) calculated using either the Building Area Method or the Space-by-Space method. The 2015 IECC also has some requirements for dwelling units and exit signs which are not part of the 90.1 standard.

Dwelling units in commercial buildings must comply by having 75% of permanently installed fixtures be high efficacy (via Section R404.1).

Exit signs are permitted a maximum of 5 watts per side (C405.3).

Per IECC 2015 LPD tables C405.4.2(1): Building Area Method and C405.4.2(2): Space by Space Method, the allowable watts per sq. ft. provided by the LPD tables are identical for ASHRAE 90.1 and 2015 IECC.

Additional interior lighting power may be calculated when using the space-by-space method under IECC 2015. This “bonus” lighting power must be calculated by the designer using the rules of Section C405.2.2.1. Additional lighting is primarily associated with retail, display, and sales lighting. These lights must be automatically controlled to turn OFF during non-business hours and must be separately controlled from general lighting in the space. Additionally, this “bonus” lighting is non-tradable, meaning it must be used only for the intended purpose and cannot be used elsewhere in the building to increase the overall lighting budget.

The exterior lighting power budget is calculated using Section C405.5.1. Much like ASHRAE 90.1, the IECC uses base-zone allowances for power in addition to allowances for “tradable” and “non-tradable” areas. The 2015 IECC does not have a “Zone 0.” It only includes Zones 1–4, which are similar to ASHRAE’s exterior lighting power zones. Many commercial buildings will fall into Zone 3. The 2015 IECC lighting power allowances for exterior Tradable and Non-Tradable surfaces (Table C405.5.1(2)) are identical to ASHRAE 90.1-2013.

Code reference

IECC 2015 - Section C405