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# Lighting Changes in ASHRAE/IES Standard 90.1-2022

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Many elements related to lighting were made in the 2022 edition of ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*. The updated standard saves energy via reduced lighting power values, expanded control requirements and expansion of its scope to cover more exterior lighting applications such as walkways on campuses and parking lots that serve building occupants but that are not powered by a building electrical service. The updated standard also introduces efficiency requirements for horticultural lighting.

## Scope Expansion

One of the most significant changes affecting lighting in Standard 90.1-2022 was the expansion of the standard's scope from buildings to buildings *and* building sites. The scope in previous versions of the standard was limited to buildings and the related exterior areas directly connected to the building. This meant lighting powered via electrical service, e.g., the parking lot, was covered only if it was powered by the building's electrical service. Any parking lots or other exterior areas such as walkways not powered by a building were not in scope. However, many exterior lighting applications are not directly powered by the building's electrical service. Common examples include lighting on a campus powered by a central

plant, lighting between buildings, plazas or even parking lot lighting where the lighting is powered by the utility.

This scope change does not modify other aspects of the prescriptive lighting requirements. The new scope addresses exterior areas that may be in a "gray zone" of coverage. Beyond reducing this "gray zone," additional energy savings are achieved because new spaces that were not previously covered are now covered by the standard.

## Horticultural Lighting

Another important inclusion is mandatory efficiency requirements (Section 9.4.4) for horticultural lighting (addendum *ar*). The proliferation of indoor-grow

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spaces, greenhouses, controlled environmental agriculture and similar spaces have increased in the last five years and, as a result, Standard 90.1-2022 now addresses these applications.

Other parts of the standard use (or are based on) the term “lumens,” but lumens are for humans. Lumens are based on the human visual system (a mathematical function based on cones in the retina of the eye), but plants do not have cones and need a different metric. The standard has adopted photosynthetic photo efficacy (PPE) as the metric for the horticultural lighting requirements. PPE recognizes that plants create energy via photosynthesis. PPE is the measure of the visible, infrared and ultraviolet light produced per unit of energy. The unit for PPE is micromole ( $\mu\text{mol}$ ) per joule (J). You don’t have to dust off your chemistry textbooks—the higher the  $\mu\text{mol}/\text{J}$  value, the more efficiently the light source provides photosynthetic photon flux per input electric power. PPE is a metric developed in ANSI/ASABE S640, *Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)*.

This requirement does not apply to small indoor horticultural or greenhouse spaces/buildings. A facility must have at least 40 kW of connected load dedicated to horticultural lighting, which is probably on the order of 1,000 ft<sup>2</sup> (93 m<sup>2</sup>) of indoor grow facility or greenhouse, before the requirement needs to be considered.

Greenhouses have glass roofs and allow daylight to enter the space. Therefore, the PPE requirement for greenhouses is 1.7  $\mu\text{mol}/\text{J}$ . In contrast, indoor grow buildings that have opaque roofs as a result have higher PPE requirements of at least 1.9  $\mu\text{mol}/\text{J}$ .

The required PPE values are achievable with some high-pressure sodium lamps. Very few metal halide lamps meet the requirement. Many LED sources and fixtures can meet the horticultural lighting requirements; however, verify the information—which reputable vendors should be able to provide—to determine if the product under consideration can meet the requirement.

## Alterations

Moving into the main body of Section 9, Lighting, Standard 90.1-2022 Addendum p revised the alterations (Section 9.1.3) requirements for interior

lighting. Previous versions of Standard 90.1 included some vagaries when determining if an alteration met the requirements to increase the energy efficiency of the lighting system.

The 2022 edition established specific thresholds to determine if the project meets the conditions for an alteration. Within an interior space, if 2,000 W of existing interior lighting is replaced, the project must meet all the requirements of Section 9. If less than 2,000 W is replaced, the new lighting must meet certain lighting controls requirements of Section 9.4.1 and either use 50% less power than the existing system being replaced or comply with the Space-by-Space (Table 9.5.2.1-1 and 9.5.2.1-2) compliance method.

Exterior alterations are a little different. If more than 10 luminaires or more than 20 linear ft (6 linear m) of luminaires are being replaced, the new lighting must meet all the requirements of Section 9. If not, any new lighting must meet a subset of lighting controls in Section 9.4.1 and either have 50% lower wattage or meet the wattage requirements of Table 9.4.2-2.

## Luminaire Wattage

Standard 90.1-2022 Addendum z revised the methodology for determining the power allotment for track lighting. Track lighting can be a challenge for lighting projects. Lighting drawings often do not indicate the number of track heads, but rather just the linear amount (feet) of track. Track is designed to be functional and allow occupants to add or subtract track heads as necessary. For line-voltage track, e.g., track that is directly supplied with either 120 V or 277 V, Standard 90.1 has long established a maximum allowable power per linear foot (W/linear foot).

Track that is powered by a transformer or driver is limited by the power rating of that device. In contrast, line-voltage track is not limited, and a power rating was necessary. An estimate of the power of the track was necessary. Previous versions of Standard 90.1 required users to assume 30 W/linear ft (98 W/linear m) for line-voltage track. This value was based on a mixture of incandescent, halogen and other light sources. Since 2015, LEDs have become more prevalent, and since 2019 they have been the de facto light source for lighting projects. Standard 90.1-2022 requires users to assume 10 W/linear ft (33 W/linear m) for line-voltage track.



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This power rating change does not directly save energy. The power requirements save energy. This power rating in track was necessary to reflect the change in technology. This change to line-voltage track allows for track projects to meet these new reduced lighting power requirements in the prescriptive sections.

### Lighting Exceptions

Additional lighting power exceptions were added to the existing list in Section 9. Some equipment is not included within the power calculations when determining the lighting power allowance for a site (Section 9.2.2.1). Table 9.2.2.1 lists the equipment that is exempted and the required lighting controls. Standard 90.1-2022 recognized germicidal luminaires. If a luminaire uses light or ultraviolet light for germicidal function to disinfect spaces, the power for the germicidal function does not need to be included in the lighting power budget calculations. Note that in a dual-function luminaire (e.g., general lighting and UVC lighting), only the power for the germicidal function is exempt.

Addendum *ac* also removed the previous exception for lighting in casinos and the daylight transition zone in parking garages (Figure 1) because new lighting power requirements for both casinos as well as the daylight transition zone in parking garages were added into Standard 90.1-2022.

### Exterior Lighting Power

Multiple changes were made to exterior lighting requirements in Table 9.4.2-2 (addendum *am*). First, a column was added to the table directly stating which exterior lighting control(s) apply to each exterior application. This change improved the clarity of the code because no changes were made to the existing exterior lighting control requirements.

Addendum *am* also reduced the exterior lighting power values by close to 30%. The values in this table had not been modified since the 2016 version during which time LED products have improved and design practices have changed.

Table 1 includes a sample of these new exterior lighting power density values from Standard 90.1-2022. Within the standard, exterior lighting is based on zones. The zones range from Zone 0 (national park and should be dark) to Zone 4 (major urban commercial core like Times Square or Las Vegas Strip). Values in Table 1 are for Zone 3. All the values in the exterior lighting table changed in similar proportions as shown in Table 1.

The exterior area, stairway, was removed from Table 9.4.2-2 because it was deemed hard to define in terms of what the area actually is to be illuminated, i.e., is it the stair treads only, the area before and after the stairs, etc. Exempting the area addressed the compliance issues at hand.

### Guest Room Controls

Standard 90.1 now requires all lighting and switched receptacles in guest rooms and suites in hotels, motels, boarding houses and/or similar buildings to be automatically controlled and turned off after 20 minutes of the space becoming unoccupied (Section 9.4.1.3). Previously the standard allowed spaces with key card controls to be exempt. Standard 90.1-2022 removed the exception for key cards and explicitly stated that card key controls could not be used to

EXTERIOR AREAS (ZONE 3)	90.1-2016, W/ft <sup>2</sup>	90.1-2019, W/ft <sup>2</sup>	90.1-2023, W/ft <sup>2</sup>
Parking Areas	0.06	0.06	0.037
Sales Canopy	0.60	0.60	0.50
Open Outdoor Sales	0.20	0.20	0.180
Loading Docks	0.35	0.35	0.260

comply with this provision. Within North America, key cards have significantly declined in use. The evaluation conducted in the development of the addendum to make this change revealed that this control method had not yielded the intended energy savings, explaining its declining use.

### Dwelling Units

Dwellings units have different requirements for both lighting fixtures and lighting controls from other spaces within Standard 90.1. Standard 90.1 defines dwelling units as a single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation. The luminaires and lamps for dwelling units have an efficacy requirement. Lighting efficacy is the “efficiency” of converting power into visible light (lumens per watt [lm/W]). Standard 90.1-2022 Addendum *br* increased the efficacy for luminaires in dwelling units to be no less than 50 lm/W and lamps in dwelling units to be no less than 75 lm/W for 75% of the permanently installed luminaires in the space (Section 9.4.3).

Standard 90.1-2022 also established a requirement for lighting controls for dwelling units. At least 50% of the permanently installed luminaires in dwelling units must be controlled with dimmers or devices that automatically turn off the lighting within 20 minutes of the space becoming unoccupied (Section 9.4.3).

Finally, Standard 90.1-2022 also established an exterior lighting control requirement for dwelling units. Permanently installed exterior luminaires (such as those on a balcony or patio) dedicated to a dwelling unit must have lighting controls that turn off the light during daylight hours as well as when no activity has been detected for 15 minutes in that area.

### Lighting Controls

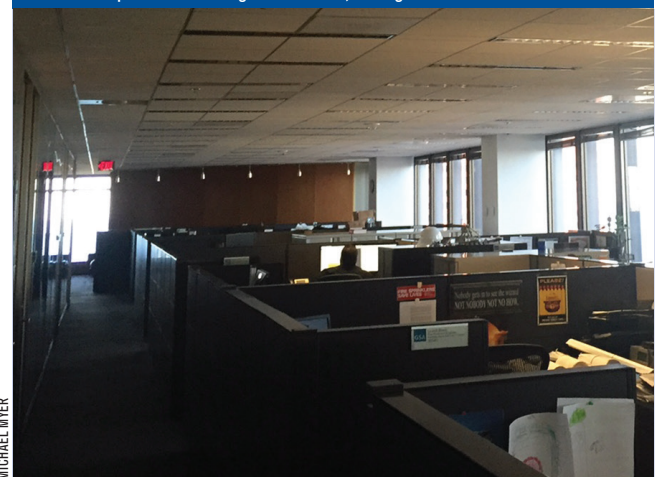
Multiple updates were made to lighting controls requirements, including the daylighting control wattage threshold (Section 9.4.1.1(e) and (f)); manual dimming requirements (Section 9.4.1.1(d)); automatic full off (Section 9.4.1.1(h)); and lighting controls in open offices (Section 9.4.1.1(b)).

Standard 90.1-2022 reduced the wattage threshold for daylight responsive controls to 75 W (addendum *o*) for the primary sidelighted zone and 150 W for the

secondary sidelighted zone. This change resulted from the evaluation of updates in technology as well as the cost and use of lighting controls. Projects determine the area of daylighted space, and if the luminaires in that calculated area sum to 75 W (150 W if secondary), daylight responsive controls are required. A similar change was made to the daylighting requirements in toplighted spaces.

Bi-level lighting control was removed in favor of multilevel control (addendum *ba*). Previous versions of the standard required that spaces have the option of a control point between 30% and 70% full lighting power, which could be achieved via a dimmer, multiple switch

FIGURE 2 Open office with lights turned off, Chicago.



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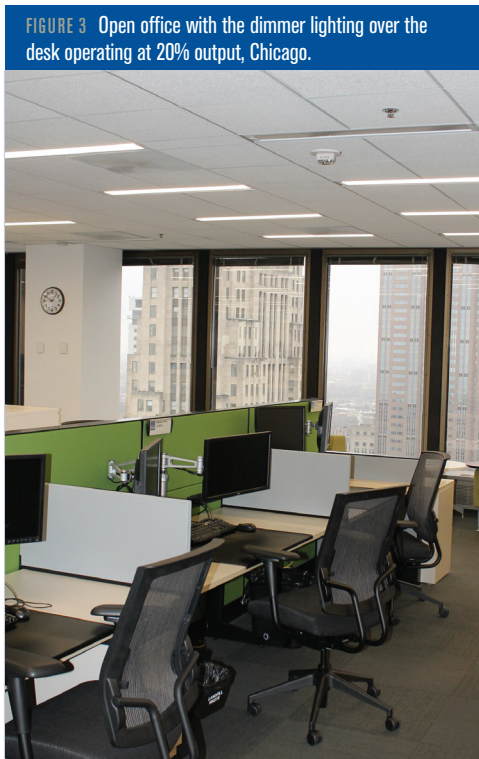
legs or step-ballasts. LEDs are more common and easily dimmed, so the standard was changed to require a manual dimmer that provides continuous dimming from full power to 10% (or less) output.

Automatic shutoff has long been required in Standard 90.1. Addendum *ba* revised the requirements for automatic full off, adding exemptions to full off for spaces where lighting is required for 24/7 operation and spaces where patient care is rendered.

Open offices larger than 300 ft<sup>2</sup> (28 m<sup>2</sup>) saw the most significant change. Standard 90.1-2022 revised Section 9.4.1.1(c) to address the needs of these large open plan spaces. Previously, the standard established 9.4.1.1(c) so no more than 50% of the lighting power could automatically turn on. This requirement also prevented all the lights from turning on to half power. As a result, large offices appeared dark in places (Figure 2). To remedy this, open offices greater than 300 ft<sup>2</sup> (28 m<sup>2</sup>) must now have occupancy controls

with zones that are limited to 600 ft<sup>2</sup> (56 m<sup>2</sup>). The general lighting in the occupied zone is permitted to automatically turn on to full upon occupancy, while the lighting in other unoccupied zones is also permitted to turn on, but to no more than 20% power (Figure 3).

Occupants had expressed dissatisfaction with the zone size and the darkness within their field of view as they looked across the office toward unoccupied workstations. This change allows all the lighting to turn on, but to a low level (not more than 20%). Turning on the lighting allows for even distribution and reduces occupant dissatisfaction in spaces. Occupant-driven controls still enable energy savings.



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Standard 90.1 has a model used to develop the LPD values (which users reference to determine the lighting power budget). The model creates the LPD for the Space-by-Space method tables. The values for the Building Method and Simplified Building Methods are then based on the values in the Space-by-Space tables. The Standard 90.1 lighting model is updated each cycle to reflect changes in lighting practice, incorporate new luminaire data and reflect updates from more efficient equipment.

Table 2 shows a sample of spaces in the Space-by-Space table. The LPD values for some spaces (e.g., classroom,

corridor) increased between 2019 and 2022. The increase was due to a combination of factors including changes in lighting recommendations, revised inputs and assumptions and incorporation of new or modified design practices. Similarly, the LPD values reduced for many spaces (e.g., conference rooms, open plan offices) for the same reasons. Finally, in some spaces there was no change in value (e.g., warehouse-medium/bulky).

Overall, a 4% reduction in the interior lighting power density values occurred in Standard 90.1-2022 compared to Standard 90.1-2019.

### Interior Lighting Power

Three prescriptive compliance approaches, Simplified Building Method (Section 9.3), Building Area Method (Section 9.5.1) and Space-by-Space Method (Section 9.5.2) are available. Each method requires users to comply first with lighting power limits and then lighting controls.

For power, projects have a lighting power allowance (LPA). The LPA is determined by multiplying the area by a lighting power density (LPD) value. The LPD value is specified in each of the applicable compliance pathways.

### Lighting Power Allowances

Within the Space-by-Space Compliance Method, users have an option for additional power if the standard prescriptive values are not sufficient for their needs. Section 9.5.2.2 of Standard 90.1-2022 is Additional Interior Lighting Power (previously this was Section 9.6.3).

The lighting power density values for decorative lighting in this section were evaluated and resulted in a reduction from 0.75 W/ft<sup>2</sup> to 0.70 W/ft<sup>2</sup> (8 W/m<sup>2</sup> to 7.5 W/m<sup>2</sup>). The retail values were also reduced. Both changes result from LED luminaires becoming more efficient and allowing for potential savings.

**TABLE 2** Sample interior lighting power density values, Standards 90.1-2016, 2019 and 2023.

SPACE TYPE	90.1-2016, W/ft <sup>2</sup>	90.1-2019, W/ft <sup>2</sup>	90.1-2023, W/ft <sup>2</sup>
Classroom	0.92	0.71	0.72
Corridor	0.66	0.41	0.44
Conference Room	1.07	0.97	0.88
Enclosed Offices*	0.93	0.74	0.73
Large (Open Plan) Offices	0.81	0.61	0.56
Warehouse - Medium/Bulky	0.35	0.33	0.33

\*Enclosed office size designations changed from 250 ft<sup>2</sup> to 150 ft<sup>2</sup> in Standard 90.1-2023.

Additionally, Standard 90.1-2022 added an additional lighting power allowance for videoconferencing. With the rise of videoconferencing technologies, spaces may need more lighting for those dedicated lighting systems. If a project meets the lighting recommendations in ANSI/IES/AVIXA RP-38-17, Recommended Practice for Lighting Performance for Small to Medium Sized Videoconferencing Rooms, then the project is allowed to use a little more power (0.50 W/ft<sup>2</sup> [5.4 W/m<sup>2</sup>]) if needed.

Table 3 provides a comparison of the additional lighting power density values for the last three code cycles.

### Credits

The August ASHRAE Journal issue included a good overview article on the new Section 11 within Standard 90.1 on energy credits. Multiple lighting and control-related credits are offered, including credits for reduced interior lighting power, expanded use of daylighting, expanded use of occupancy controls and

TABLE 3 Additional lighting power density values, Standards 90.1-2016, 2019, and 2023.

SPACE TYPE	90.1-2016, W/ft <sup>2</sup>	90.1-2019, W/ft <sup>2</sup>	90.1-2023, W/ft <sup>2</sup>
Decorative Allowance	0.75	0.75	0.70
Retail Allowance			
Retail 1	0.45	0.45	0.40
Retail 2	0.45	0.45	0.40
Retail 3	1.05	1.05	0.70
Retail 4	1.88	1.88	1.00
Videoconferencing	---	---	0.50

new control options like task tuning and grid-related operations like demand response.

### Conclusion

The elements of Section 9 were revised, and several new subsections were added. The changes in 90.1-2022 related to Section 9 alone result in at least 1.5% energy savings in buildings. ■

*Advertisement formerly in this space.*