

C-8: Reduce Interior Lighting Allowances (C405.4.2.2)

Summary: Reduce lighting power in both the Building Area Method and the Space-by-Space Method for applications where new LED fixtures are found to be cost-effective. Lighting Power Allowances are reduced by a building type area weighted average of 12.8% and vary depending on the specific space or building type. More efficient lighting sources can provide the same lighting output with less power input. When LPD is reduced, it results in a proportional lighting energy savings.

DOE proposal C-8 was revised on December 18, 2015.

Stakeholder Feedback: There were nine public comments received for proposal C-8. Comments are summarized below, followed by a DOE review:

- Two comments requested that DOE's proposal align with 90.1, one of which requested a direct reference to 90.1 tables.

Review: The proposal is aligned with 90.1 levels and is intended to incorporate changes as they become available. The revisions now include modifications made following the second public review of addendum CH to ASHRAE Standard 90.1. Past efforts for IECC to simply reference tables from the 90.1 standard have been viewed as undesirable in the ICC process, so a valid proposal needs to modify IECC tables.

- One comment indicated that LPD limits create issues with the greater amount of lighting required by aging populations and suggested dimming be required throughout to allow lighting levels to be adjusted to the occupant need.

Review: The proposal incorporates a parallel 90.1 proposal that considers IES lighting levels required. Requiring dimming in all spaces may not be cost-effective. Note that energy code development groups have always struggled with the treatment of recommended light levels for differing age groups and in general have used a middle approach that addresses the majority of average occupants except possibly in specific situations such as spaces specifically designed for the visually impaired (including advanced age) where higher lighting level recommendations are incorporated.

- One comment requested information that changes in LPD allowances would still allow fluorescent and metal halide lamp types.

Review: The proposal is based on available technology that is shown to be cost-effective related to older technologies commonly used. The proposed requirement is not based upon the full theoretical reduction potential (based on newer technologies), so the inclusion of less efficient older technologies remains possible.

- Several comments questioned specific lighting levels that had either increased in dormitories and multifamily or decreased in lobbies.

Review: The proposal incorporates a parallel 90.1 proposal that considers IES lighting levels required. When 90.1 addressed a similar set of comments on lobbies and other areas, they made changes based on their rationale for the 2nd public review of Addendum CH. Each area was reviewed by the 90.1 lighting subcommittee and revised to meet the latest IES standards. A few adjustments were made to models to make them more closely represent realistic lighting application which resulted in LPD adjustments in a few specific situations.

- One comment suggested footnotes to the space-by-space tables to clarify lighting for sleeping units, dwelling units, and sports facilities.

Review: While the suggestions related to sleeping and dwelling areas provide clarification, they are redundant with charging language elsewhere in the IECC. Similar explanations to the suggested footnotes would be appropriate in the IECC commentary and should be suggested to ICC staff. The footnote clarifying sports arena classes will be covered by including a reference to the IES handbook based on the ASHRAE footnote referencing the IES handbook. A web search found that the IES sports arena class definitions are available in sports lighting design guides.

In response to these comments, DOE has revised its lighting allowance proposal to:

- Match the revisions proposed in the second public review of Addendum CH to ASHRAE Standard 90.1-2013.
- Include footnote suggestions clarifying sporting arena class.
- Reduce stated savings for office areas since the LPD reduction in offices was relaxed from the original proposal in order to align with the second public review of Addendum CH to ASHRAE Standard 90.1-2013. This did not change the cost-effectiveness, since the relaxed standards would result in fewer LED fixtures, and the net life-cycle cost reduction of LED fixtures due to reduced lamp replacement costs still applies on a fixture by fixture basis.

== = IECC PROPOSAL:

Modify Tables C405.4.2(1) and C405.4.2(2) as follows:

**TABLE C405.4.2(1)
INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD**

BUILDING AREA TYPE	LPD (w/ft ²)
Automotive facility	0.80 <u>0.71</u>
Convention center ⁵	1.01 <u>0.76</u>
Courthouse	1.01 <u>0.90</u>
Dining: bar lounge/leisure	1.01 <u>0.90</u>
Dining: cafeteria/fast food	0.90 <u>0.79</u>
Dining: family	0.95 <u>0.78</u>
Dormitory	0.57 <u>0.61</u>
Exercise center	0.84 <u>0.65</u>
Fire station	0.67 <u>0.53</u>
Gymnasium	0.94 <u>0.68</u>
Health care clinic	0.90 <u>0.82</u>
Hospital	1.05
Hotel/Motel	0.87 <u>0.75</u>
Library	1.19 <u>0.78</u>
Manufacturing facility	1.17 <u>0.90</u>
Motion picture theater	0.76 <u>0.83</u>
Multifamily	0.51 <u>0.68</u>
Museum	1.02 <u>1.06</u>
Office	0.82 <u>0.79</u>
Parking garage	0.21 <u>0.15</u>
Penitentiary	0.81 <u>0.75</u>
Performing arts theater	1.39 <u>1.18</u>
Police station	0.87 <u>0.80</u>
Post office	0.87 <u>0.67</u>
Religious building	1.00 <u>0.94</u>
Retail	1.26 <u>1.06</u>
School/university	0.87 <u>0.81</u>
Sports arena	0.91 <u>0.87</u>
Town hall	0.89 <u>0.80</u>
Transportation	0.70 <u>0.61</u>
Warehouse	0.66 <u>0.48</u>
Workshop	1.19 <u>0.90</u>

TABLE C405.4.2(2)
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE TYPES ^a	LPD (watts/sq.ft)
Atrium	
Less than 40 feet in height	0.03 per foot in total height
Greater than 40 feet in height	0.40 + 0.02 per foot in total height
Audience seating area	
In an auditorium	0.63
In a convention center	0.82
In a gymnasium	0.65
In a motion picture theater	1.14
In a penitentiary	0.28
In a performing arts theater	2.43 <u>2.03</u>
In a religious building	1.53
In a sports arena	0.43
Otherwise	0.43
Banking activity area	1.04 <u>0.86</u>
Breakroom (See Lounge/Breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	1.34
Otherwise	1.24 <u>0.96</u>
Conference/meeting/multipurpose room	1.23 <u>1.07</u>
Copy/print room	0.72 <u>0.56</u>
Corridor	
In a facility for the visually impaired (and not used primarily by the staff) ^b	0.92
In a hospital	0.79 <u>0.92</u>
In a manufacturing facility	0.41 <u>0.29</u>
Otherwise	0.66
Courtroom	1.72 <u>1.39</u>
Computer room	1.74 <u>1.33</u>
Dining area	
In a penitentiary	0.96
In a facility for the visually impaired (and not used primarily by the staff) ^b	1.9 <u>2.00</u>
In bar/lounge or leisure dining	1.07 <u>0.93</u>
In cafeteria or fast food dining	0.65 <u>0.63</u>
In family dining	0.89 <u>0.71</u>
Otherwise	0.65 <u>0.63</u>
Electrical/mechanical room	0.95 <u>0.43</u>
Emergency vehicle garage	0.56 <u>0.41</u>

TABLE C405.4.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES ^a	LPD (watts/sq.ft)
Food preparation area	1.24 <u>1.06</u>
Guest room	0.47 <u>0.77</u>
Laboratory	
In or as a classroom	1.43 <u>1.20</u>
Otherwise	1.84 <u>1.45</u>
Laundry/washing area	0.60 <u>0.43</u>
Loading dock, interior	0.47 <u>0.58</u>
Lobby	
In a facility for the visually impaired (and not used primarily by the staff) ^b	1.80 <u>2.03</u>
For an elevator	0.64 <u>0.68</u>
In a hotel	1.06
In a motion picture theater	0.59 <u>0.45</u>
In a performing arts theater	2.00 <u>1.70</u>
Otherwise	0.90 <u>1.00</u>
Locker room	0.75 <u>0.48</u>
Lounge/breakroom	
In a healthcare facility	0.92 <u>0.78</u>
Otherwise	0.73 <u>0.62</u>
Office	
Enclosed	1.14 <u>0.93</u>
Open plan	0.98 <u>0.81</u>
Parking area, interior	0.19 <u>0.14</u>
Pharmacy area	1.68 <u>1.34</u>
Restroom	
In a facility for the visually impaired (and not used primarily by the staff) ^b	1.24 <u>0.96</u>
Otherwise	0.98 <u>0.85</u>
Sales area	1.50 <u>1.22</u>
Seating area, general	0.54 <u>0.42</u>
Stairway (See space containing stairway)	
Stairwell	0.69 <u>0.58</u>
Storage room	0.63 <u>0.46</u>
Vehicular maintenance area	0.67 <u>0.56</u>
Workshop	1.50 <u>1.14</u>
BUILDING TYPE SPECIFIC SPACE TYPES ^a	LPD (watts/sq.ft)
Facility for the visually impaired ^b	
In a chapel (and not used primarily by the staff)	2.24 <u>1.06</u>
In a recreation room (and not used primarily by the staff)	2.44 <u>1.80</u>
Automotive (See Vehicular Maintenance Area above)	
Convention Center—exhibit space	1.45 <u>0.88</u>
Dormitory—living quarters	0.38 <u>0.54</u>
Fire Station—sleeping quarters	0.22 <u>0.20</u>
Gymnasium/fitness center	
In an exercise area	0.72 <u>0.50</u>
In a playing area	1.20 <u>0.82</u>

TABLE C405.4.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

BUILDING TYPE SPECIFIC SPACE TYPES ^a	LPD (watts/sq.ft)
healthcare facility	
In an exam/treatment room	4.66 <u>1.68</u>
In an imaging room	4.64 <u>1.06</u>
In a medical supply room	0.74 <u>0.54</u>
In a nursery	0.88 <u>1.00</u>
In a nurse's station	0.74 <u>0.81</u>
In an operating room	2.48 <u>2.17</u>
In a patient room	0.62
In a physical therapy room	0.94 <u>0.84</u>
In a recovery room	4.15 <u>1.03</u>
Library	
In a reading area	4.06 <u>0.82</u>
In the stacks	4.74 <u>1.20</u>
Manufacturing facility	
In a detailed manufacturing area	4.29 <u>0.93</u>
In an equipment room	0.74 <u>0.65</u>
In an extra high bay area (greater than 50' floor-to-ceiling height)	1.05
In a high bay area (25-50' floor-to-ceiling height)	4.23 <u>0.75</u>
In a low bay area (less than 25' floor-to-ceiling height)	4.19 <u>0.96</u>
Museum	
In a general exhibition area	4.05 <u>1.05</u>
In a restoration room	4.02 <u>0.85</u>
Performing arts theater—dressing room	0.64 <u>0.36</u>
Post Office—Sorting Area	0.94 <u>0.68</u>
Religious buildings	
In a fellowship hall	0.64 <u>0.55</u>
In a worship/pulpit/choir area	1.53
Retail facilities	
In a dressing/fitting room	0.74 <u>0.50</u>
In a mall concourse	4.19 <u>0.90</u>
Sports arena—playing area^c	
For a Class I facility	3.68 <u>2.47</u>
For a Class II facility	2.40 <u>1.96</u>
For a Class III facility	4.80 <u>1.70</u>
For a Class IV facility	4.20 <u>1.13</u>
Transportation facility	
In a baggage/carousel area	0.53 <u>0.45</u>
In an airport concourse	0.36 <u>0.31</u>
At a terminal ticket counter	0.80 <u>0.62</u>
Warehouse—storage area	
For medium to bulky, palletized items	0.58 <u>0.35</u>
For smaller, hand-carried items	0.95 <u>0.69</u>

- a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
- b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.
- c. Class of play as defined in IES RP-6.

Add to Chapter 6 under IES:

IES RP-6 (2015) Recommended Practice for Sports and Recreational Area Lighting Table C405.4.2(2)

Reason: This proposed change modifies the interior lighting power allowance for both space-by-space and building area methods by using Light Emitting Diode (LED) as the base technology in the lighting systems modeling analysis. PNNL reviewed current product availability, efficacy, distribution capability, and cost. In

cases where LED fixtures were available and capable of replacing a current technology product, their efficacy was included in the space models. Not all fixtures in the models are replaced with LED technology as in some cases there were not sufficient LED products or the LED technology was not specifically suited for the expected task. The proposal matches the second public review of addendum CH to ASHRAE standard 90.1. Overall the weighted average of lighting power densities (LPD) was reduced. In the process of developing the addendum and responding to comments on the first addendum, the lighting subcommittee of the ASHRAE 90.1 Standing Standards Project Committee revised lighting power densities based on reasonably conservative inclusion of more efficient lighting technology in their standard space models. Where appropriate, the space models LPD is revised as shown in Table C405.4.2(2). Then the building LPD tables are revised based on the space changes. In this process, four building types had small increases compared with the prior 90.1-2013 LPDs:

- The museum and motion picture theatre building type LPDs increased primarily because of the changes in the electric/mechanical room and elevator lobby space types. None of the other space types that make up the majority of the space in a museum (primarily exhibition space) and motion picture theatre (audience seating) had any significant reductions to offset the increases in these two space types. The electric/mechanical room and elevator lobby space type changes were a result of subcommittee discussions and analysis of comment responses that resulted in changes to the lighting models to more fairly represent the lighting power needed for the functions in these spaces.
- The multi-family building type LPD also went up slightly because of the changes in the electric/mechanical room and elevator lobby space types. The multi-family building type includes only the common spaces since private dwelling spaces are exempt. Therefore, the electric/mechanical room and elevator lobby spaces take up a more significant portion of the building areas.
- The dormitory building type LPD also went up because of the changes in the dormitory room space type. The dormitory building type is dominated by the dormitory room space type and therefore, the whole building value went up. The dorm room space type increased based on subcommittee changes to the model to better represent realistic current design practice which caused an increase in the power needed to effectively light that space type.

With the exception of the noted building LPDs, all other building LPDs were reduced or remained the same.

Energy Savings: An analysis of energy impact shows that annual savings from interior lighting power allowance reduction in the proposal ranges from \$10 to \$126 per thousand square feet of floor area in offices and stand alone retail buildings respectively in Climate Zone 8. Other climate zones will have greater savings, as there will be less heating impact. More details are found in the cost-effectiveness analysis referenced in the cost impact section.

The U.S. Department of Energy (DOE) develops its proposals through a public process to ensure transparency, objectivity and consistency in DOE-proposed code changes. Energy savings and cost impacts are assessed based on established methods and reported for each proposal, as applicable. More information on the process utilized to develop the DOE proposals for the 2018 IECC can be found at: <https://www.energycodes.gov/development/2018IECC>.

Cost Impact: The LED fixtures for use in interior light fixtures provide more lighting at a lower energy use. LEDs have a higher cost per lamp, but their expected life is longer, so their overall cost is lower. A study completed in 2014 (<http://www.cfm.va.gov/til/studies/LEDStudy.pdf>) by the U.S. Department of Veterans Affairs found that LED fixtures were cost-effective in most facility applications. LED prices are expected to continue to decrease, making this technology increasingly cost-effective.

Cost-effectiveness: PNNL performed a cost-effectiveness analysis using The established DOE methodology.¹ Results of the cost-effectiveness analysis showed that the savings-to-investment ratio (SIR) was infinite for typical retail establishments, as the present value of costs was negative due to a reduction in lamp replacement costs. A proposal is cost-effective when the SIR is greater than 1.0, indicating that the present value of savings is greater than the incremental cost. The complete cost-effectiveness analysis is available at: <https://www.energycodes.gov/development/2018IECC>.

¹ Hart, R., and Liu, B. (2015). *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes*. Pacific Northwest National Laboratories for U.S. Department of Energy; Energy Efficiency & Renewable Energy. PNNL-23923 Rev1. <https://www.energycodes.gov/development/commercial/methodology>.