BSR/ASHRAE/IES Addendum bb
to ANSI/ASHRAE/IES Standard 90.1-2016

Public Review Draft

Proposed Addendum bb to Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings

First Public Review (August 2018)
(Draft Shows Proposed Changes to Current Standard)

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FOREWORD

The Lighting Subcommittee (LSC) has performed a wholesale review of the existing model for determining LPDs. Each space type LPD has been evaluated for compliance with the ANSI lighting standards.

The 90.1 Lighting Subcommittee model fundamentally works as a reverse engineered version of the lighting standard formula, Zonal Lumen Method Calculation. As outlined in the Journal of Illuminating Engineering Society, "An Empirical Data Based Method for Development of Lighting Energy Standards", a high-level concept of the model is the following formula:

$$LPD = \frac{Illuminance}{Fixture\ (or\ Source)\ Efficacy\ x Coefficient\ of\ Utilization\ x\ Light\ Loss\ Factors}$$

Illuminance

The model was updated to adopt new guidance from the Illuminating Engineering Society (IES) (*The IES is a co-sponsor of the ANSI/ASHRAE/IES Standard 90.1 Within the building trade, construction, and other jurisdictions, the IES is the often cited body for lighting recommendations*). For example, RP-28-16, Recommended Practice for Visual *Environment* for Seniors and the Low Vision Population, was published in 2016. This document increased certain illuminance values from the last version of the model. As a result, when illuminance increases, this can change the LPD. Beyond incorporating all of the current lighting recommended illuminance values in the model, the model adopted lighting guidance were applicable as well. For example, spaces with people with low vision can be negatively affected by lighting from recessed downlights. As a result, the model changed certain fixtures within the model to address this guidance. Fixture changes can also affect other variables as discussed further in the document.

Fixture or Source Efficacy

Lighting efficacy is the conversion of power into visible light. Light source selection can inherently affect the efficacy of the lighting systems.

There are various lighting energy programs and metrics that inform our LED light fixture efficacy. For example, ENERGY STAR sets a downlight efficacy of 55 lm/W for downlights. The DesignLights Consortium (DLC) sets minimum values of 100 – 105 lm/W for their "standard" category. LED Lighting Facts, a national program, analyzed over 70,000 products and the typical median efficacy within the Lighting Facts data set was 105 lm/W.

Coefficient of Utilization (CU)

Coefficient of Utilization (CU) is a mathematical calculation characterizing the distribution of a light fixture. CU values vary by room geometries as well as the reflectance values of the materials. The 2016 model typically used a reflectance value of 70% for ceilings, 50% for walls, and 20% for floors – this is abbreviated within the industry as 70/50/20. For certain space types, the reflectance values were 50/30/20. The 2019 revised model also introduced a reflectance value of 30/10/20. These three sets of reflectance values are consistent with or similar to other energy efficiency programs (source: NEMA LE6-2014, Procedure for Determining Target Efficacy Ratings for Commercial, Industrial, and Residential Luminaires).

Beyond modifying reflectance values, the LSC reviewed the room geometries (*Within the lighting industry, room geometries for the CU calculation are Room Cavity Ratios (RCR). RCR takes in account the space height, fixture mounting, room perimeter, and room area*). Upon an updated review of the LSC model some RCR values changed. Manufacturing low bay, manufacturing high bay, and manufacturing extra high bay all had the same RCR value in the 2016 values. These RCR values were changed. As a result of the change in ceiling height, the RCR increased. As RCR increases, the LPD is affected.

Light Loss Factors (LLF)

Light Loss Factors (LLF) are values factored into lighting calculations to account for the performance of the lighting system over time. As mentioned in "An Empirical Data Based Method for Development of Lighting Energy Standards", there are many possible LLF inputs. The LSC model includes room surface dirt deprecation, lamp lumen deprecation, and luminaire dirt depreciation.

The 2019 LSC model now moves the RSDD to apply to the entire space, not individual fixture types. The standardized value of RSDD is 0.96.

The lamp lumen depreciation values varied for LED fixtures in the 2016 model. Upon review, it was standardized on 0.85 across all LED fixtures. This a standardized value as well as within lighting industry guidelines.

Data is based on a large sample of readily available luminaires. These are products that are in the market and already being specified widely. As such, we believe these proposed values are cost-effective.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum bb to 90.1-2016

Modify the standard as follows (IP and SI Units)

Note: Other portions of table not shown are unchanged.

Table 9.6.1 *Lighting Power Density* Allowances Using the Space-by-Space Method and Minimum *Control* Requirements Using Either Method

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**		
Common *Space* Types[1]	***LPD* Allowances, W/ft²**	***RCR* Threshold**
Atrium		
<20 ft in height	~~0.03/ft total height~~ 0.48	NA
≥20 ft and ≤40 ft in height	~~0.03/ft total height~~ 0.57	NA
>40 ft in height	~~0.40 + 0.02/ft total height~~ 0.70	~~NA~~ 11
Audience Seating Area		
Auditorium	~~0.63~~ 0.61	6
Convention center	~~0.82~~ 0.25	4
Gymnasium	~~0.65~~ 0.23	6
Motion picture theater	~~1.14~~ 0.27	4
Penitentiary	~~0.28~~ 0.67	4
Performing arts theater	~~2.03~~ 1.06	8
Religious facility	~~1.53~~ 0.72	4
Sports arena	~~0.43~~ 0.33	4
All other audience seating areas	~~0.43~~ 0.23	4
Banking Activity Area	~~0.86~~ 0.61	6
Breakroom (See Lounge/Breakroom)		
Classroom/Lecture Hall/Training Room		
Penitentiary	~~1.34~~ 1.38	4
All other classrooms/lecture halls/training rooms	~~0.92~~ 0.84	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**		
Common *Space* Types[1]	***LPD*, W/ft²**	***RCR* Threshold**
Conference/Meeting/Multipurpose Room	~~1.07~~ 0.97	6
Confinement Cells	~~0.81~~ 0.70	6
Copy/Print Room	~~0.56~~ 0.31	6
Corridor[2]		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~0.92~~ 0.71	width <8 ft
Hospital	~~0.92~~ 0.71	width <8 ft
~~Manufacturing facility~~	~~0.29~~	~~width <8 ft~~
All other corridors	~~0.66~~ 0.41	width <8 ft
Courtroom	~~1.39~~ 1.25	6
Computer Room	~~1. 33~~ 1.00	4
Dining Area		

Penitentiary	~~0.96~~ 0.42	6
Facility for the visually impaired (and not used primarily by staff)[3]	~~2.00~~ 1.38	4
Bar/lounge or leisure dining	~~0.93~~ 0.86	4
Cafeteria or fast food dining	~~0.63~~ 0.40	4
Family dining	~~0.71~~ 0.60	4
All other dining areas	~~0.63~~ 0.43	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD*, W/ft²**	***RCR* Threshold**
Electrical/Mechanical Room[7]	~~0.43~~ 0.42	6
Emergency Vehicle Garage	~~0.41~~ 0.52	4
Food Preparation Area	~~1.06~~ 1.29	6
Guest Room	~~0.77~~ 0.41	6
Laboratory		
In or as a classroom	~~1.20~~ 1.17	6
All other laboratories	~~1.45~~ 1.70	6
Laundry/Washing Area	~~0.43~~ 0.59	4
Loading Dock, Interior	~~0.58~~ 0.88	6
Lobby		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~2.03~~ 2.49	4
Elevator	~~0.69~~ 0.71	6
Hotel	~~1.06~~ 0.51	~~4~~ 5
Motion picture theater	~~0.45~~ 0.23	4
Performing arts theater	~~1.70~~ 1.25	~~6~~ 8
All other lobbies	~~1.00~~ 1.11	4
Locker Room	~~0.48~~ 0.52	6
Lounge/Breakroom		
Healthcare facility	~~0.78~~ 0.42	6
All other lounges/breakrooms	~~0.62~~ 0.59	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD*, W/ft²**	***RCR* Threshold**
Office		
Enclosed and ≤250 ft²	~~0.93~~ 0.88	8
Enclosed and >250 ft²	~~0.93~~ 0.79	8
Open plan	~~0.81~~ 0.67	4
Parking Area, Interior	~~0.14~~ 0.15	4
Pharmacy Area	~~1.34~~ 1.90	6
Restroom		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~0.96~~ 1.26	8
All other restrooms	~~0.85~~ 0.63	8
Sales Area[4]	~~1.22~~ 1.12	6
Seating Area, General	~~0.42~~ 0.23	4
Stairway		
Stairwell	~~0.58~~ 0.49	10

Storage Room		
<50 ft^2	~~0.97~~ 0.40	~~6~~ 9
≥50 ft^2 and ≤1000 ft^2	~~0.46~~ 0.38	6
All other storage rooms	~~0.46~~ 0.38	6
Vehicular Maintenance Area	~~0.56~~ 0.60	4
Workshop	~~1.14~~ 1.26	6

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

***Building* Type Specific/*Space* Types[1]**	***LPD* W/ft^2**	***RCR* Threshold**
Facility for the Visually Impaired[3]		
Chapel (used primarily by residents)	~~1.06~~ 0.70	4
Recreation room/common living room (and not used primarily by staff)	~~1.80~~ 1.77	6
Automotive (See "Vehicular Maintenance Area")		
Convention Center—Exhibit *Space*	~~0.88~~ 0.50	4
Dormitory—Living Quarters	~~0.54~~ 0.84	8
Fire Station—Sleeping Quarters	0.20	6
Gymnasium/Fitness Center		
Exercise area	~~0.50~~ 0.90	4
Playing area	~~0.82~~ 0.85	4
Healthcare Facility		
Exam/treatment room	~~1.68~~ 1.40	8
Imaging room	~~1.06~~ 0.85	6
Medical supply room	~~0.54~~ 0.62	6
Nursery	~~1.00~~ 1.37	6
Nurse's station	~~0.81~~ 1.11	6
Operating room	~~2.17~~ 2.26	6
Patient room	~~0.62~~ 0.68	6

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

***Building* Type Specific/*Space* Types[1]**	***LPD* W/ft^2**	***RCR* Threshold**
Physical therapy room	~~0.84~~ 0.91	6
Recovery room	~~1.03~~ 1.25	6
Library		
Reading area	~~0.82~~ 0.96	4
Stacks	~~1.20~~ 1.16	4
Manufacturing Facility		
Detailed manufacturing area	~~0.93~~ 0.80	4
Equipment room	~~0.65~~ 0.76	6
Extra high bay area (>50 ft *floor*-to-ceiling height)	~~1.05~~ 1.42	~~4~~ 8
High bay area (25 to 50 ft *floor*-to-ceiling height)	~~0.75~~ 1.24	4 6
Low bay area (<25 ft *floor*-to-ceiling height)	~~0.96~~ 0.86	4 3
Museum		
General exhibition area	~~1.05~~ 0.31	6

Restoration room	~~0.85~~ 1.10	6
Performing Arts Theater—Dressing Room	~~0.36~~ 0.41	6
Post Office—Sorting Area	~~0.68~~ 0.76	4
Religious Facility		
Fellowship hall	~~0.55~~ 0.54	4
Worship/pulpit/choir area	~~1.53~~ 0.85	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

***Building* Type Specific/*Space* Types[1]**	***LPD* W/ft²**	***RCR* Threshold**
Retail Facilities		
Dressing/fitting room	~~0.5~~ 0.51	8
Mall concourse	~~0.9~~ 1.03	4
Sports Arena—Playing Area[8]		
Class I facility	~~2.47~~ 2.94	4
Class II facility	~~1.96~~ 2.01	4
Class III facility	~~1.70~~ 1.30	4
Class IV facility	~~1.13~~ 0.86	4
Transportation Facility		
Baggage/carousel area	~~0.45~~ 0.39	4
Airport concourse	~~0.31~~ 0.25	4
Ticket counter	~~0.62~~ 0.51	4
Warehouse—Storage Area		
Medium to bulky, palletized items	~~0.35~~ 0.33	4
Smaller, hand-carried items[5]	0.69	6

1. 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
2. In corridors, the extra *lighting power density* allowance is permitted when the width of the corridor is less than 8 ft and is not based on the *RCR*.
3. A "Facility for the Visually Impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support and/or people with special visual needs.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "Picking Area."
6. *Automatic* daylight responsive *controls* are mandatory only if the requirements of the specified sections are present.
7. An additional 0.52 W/ft² shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.43 W/ft². The additional 0.52 W/ft² allowance shall not be used for any other purpose.
8. Class of play as defined by IES RP-6.

Note: other portions of table not shown are unchanged.

SI Units

Table 9.6.1 *Lighting Power Density* Allowances Using the Space-by-Space Method and Minimum *Control* Requirements Using Either Method

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD* Allowances, W/m²**	***RCR* Threshold**
Atrium		
<6.1 m in height	~~0.10W/m total height~~ 5.1	NA

≥6.1 m and ≤12.2 m in height	~~0.10/m total height~~ 6.1	NA
>12.2 m in height	~~0.40 + 0.07/m total height~~ 7.5	~~NA~~ 11
Audience Seating Area		
Auditorium	~~6.8~~ 6.5	6
Convention center	~~8.8~~ 2.7	4
Gymnasium	~~7.0~~ 2.5	6
Motion picture theater	~~12.3~~ 2.9	4
Penitentiary	~~3.0~~ 7.2	4
Performing arts theater	~~21.8~~ 12.7	8
Religious facility	~~16.5~~ 7.8	4
Sports arena	~~4.6~~ 3.5	4
All other audience seating areas	~~4.6~~ 2.5	4
Banking Activity Area	~~9.3~~ 6.5	6
Breakroom (See Lounge/Breakroom)		
Classroom/Lecture Hall/Training Room		
Penitentiary	~~14.4~~ 14.8	4
All other classrooms/lecture halls/training rooms	~~9.9~~ 9.1	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD*, W/m²**	***RCR* Threshold**
Conference/Meeting/Multipurpose Room	~~11.5~~ 10.5	6
Confinement Cells	~~8.7~~ 7.5	6
Copy/Print Room	~~6.0~~ 3.3	6
Corridor[2]		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~9.9~~ 7.7	width <2.4 m
Hospital	~~9.9~~ 7.7	width <2.4 m
~~Manufacturing facility~~	~~3.1~~	~~width <2.4 m~~
All other corridors	~~7.1~~ 4.4	width <2.4 m
Courtroom	~~15.0~~ 13.5	6
Computer Room	~~14.3~~ 1.7	4
Dining Area		
Penitentiary	~~10.3~~ 4.5	6
Facility for the visually impaired (and not used primarily by staff)[3]	~~21.5~~ 14.8	4
Bar/lounge or leisure dining	~~10.0~~ 9.3	4
Cafeteria or fast food dining	~~6.8~~ 4.3	4
Family dining	~~7.6~~ 6.5	4
All other dining areas	~~6.8~~ 4.7	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD*, W/m²**	***RCR* Threshold**
Electrical/Mechanical Room[7]	~~4.6~~ 4.5	6
Emergency Vehicle Garage	~~4.4~~ 5.6	4

Food Preparation Area	~~11.4~~ 12.6	6
Guest Room	~~8.3~~ 4.4	6
Laboratory		
In or as a classroom	~~12.9~~ 12.6	6
All other laboratories	~~15.6~~ 18.3	6
Laundry/Washing Area	~~4.6~~ 6.3	4
Loading Dock, Interior	~~6.2~~ 9.5	6
Lobby		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~21.8~~ 26.8	4
Elevator	~~7.4~~ 7.7	6
Hotel	~~11.4~~ 5.4	~~4~~ 5
Motion picture theater	~~4.8~~ 2.5	4
Performing arts theater	~~18.3~~ 13.5	~~6~~ 8
All other lobbies	~~10.8~~ 11.9	4
Locker Room	~~5.2~~ 5.6	6
Lounge/Breakroom		
Healthcare facility	~~8.4~~ 4.5	6
All other lounges/breakrooms	~~6.7~~ 6.3	4

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

Common *Space* Types[1]	***LPD*, W/m²**	***RCR* Threshold**
Office		
Enclosed and ≤23.2 m²	~~10.0~~ 9.5	8
Enclosed and >23.2 m²	~~10.0~~ 8.5	8
Open plan	~~10.0~~ 8.5	4
Parking Area, Interior	~~8.7~~ 7.2	4
Pharmacy Area	~~14.4~~ 20.4	6
Restroom		
Facility for the visually impaired (and not used primarily by the staff)[3]	~~10.3~~ 13.5	8
All other restrooms	~~9.1~~ 6.8	8
Sales Area[4]	~~13.1~~ 12.0	6
Seating Area, General	~~4.5~~ 2.5	4
Stairway		
Stairwell	~~6.2~~ 5.3	10
Storage Room		
<4.6 m²	~~10.4~~ 4.3	~~6~~ 9
≥4.60 m² and ≤305 m²	~~4.9~~ 4.1	6
All other storage rooms	~~4.9~~ 4.1	6
Vehicular Maintenance Area	~~6.0~~ 6.5	4
Workshop	~~12.3~~ 13.5	6

Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**

***Building* Type Specific/*Space* Types[1]**	***LPD* W/m²**	***RCR* Threshold**
Facility for the Visually Impaired[3]		
Chapel (used primarily by residents)	~~11.4~~ 7.5	4

Recreation room/common living room (and not used primarily by staff)	~~19 .4~~ 19.0	6
Automotive (See "Vehicular Maintenance Area")		
Convention Center—Exhibit *Space*	~~9.5~~ 5.4	4
Dormitory—Living Quarters	~~5.8~~ 9.0	8
Fire Station—Sleeping Quarters	0.22	6
Gymnasium/Fitness Center		
Exercise area	~~5.4~~ 9.6	4
Playing area	~~8.8~~ 9.2	4
Healthcare Facility		
Exam/treatment room	~~18.1~~ 15.1	8
Imaging room	~~11.4~~ 9.2	6
Medical supply room	~~5.8~~ 6.7	6
Nursery	~~10.8~~ 14.8	6
Nurse's station	~~8.7~~ 11.9	6
Operating room	~~23.3~~ 24.3	6
Patient room	~~6.7~~ 7.3	6
Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**		
***Building* Type Specific/*Space* Types[1]**	***LPD* W/m²**	***RCR* Threshold**
Physical therapy room	~~9.0~~ 9.8	6
Recovery room	~~1.03~~ 13.5	6
Library		
Reading area	~~8.8~~ 10.3	4
Stacks	~~12.9~~ 12.5	4
Manufacturing Facility		
Detailed manufacturing area	~~10.0~~ 8.6	4
Equipment room	~~7.0~~ 8.2	6
Extra high bay area (>15.2 m *floor*-to-ceiling height)	~~11.3~~ 15.3	~~4~~ 8
High bay area (7.6 to 15.2 m *floor*-to-ceiling height)	~~8.1~~ 13.4	~~4~~ 6
Low bay area (<7.6 m *floor*-to-ceiling height)	~~10.3~~ 9.3	~~4~~ 3
Museum		
General exhibition area	~~11.3~~ 3.3	6
Restoration room	~~9.1~~ 11.9	6
Performing Arts Theater—Dressing Room	~~3.9~~ 4.4	6
Post Office—Sorting Area	~~7.3~~ 8.1	4
Religious Facility		
Fellowship hall	~~5.9~~ 5.8	4
Worship/pulpit/choir area	~~16.5~~ 9.2	4
Informative Note: **This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.**		
***Building* Type Specific/*Space* Types[1]**	***LPD* W/m²**	***RCR* Threshold**
Retail Facilities		
Dressing/fitting room	5.4	8

Mall concourse	~~9.7~~ 11.1	4
Sports Arena—Playing Area[8]		
Class I facility	~~26.6~~ 31.6	4
Class II facility	~~21.1~~ 21.6	4
Class III facility	~~18.3~~ 13.9	4
Class IV facility	~~12.2~~ 9.3	4
Transportation Facility		
Baggage/carousel area	~~4.8~~ 4.2	4
Airport concourse	~~3.3~~ 2.7	4
Ticket counter	~~6.7~~ 5.5	4
Warehouse—Storage Area		
Medium to bulky, palletized items	~~3.8~~ 3.6	4
Smaller, hand-carried items[5]	7.4	6

1. 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
2. In corridors, the extra *lighting power density* allowance is permitted when the width of the corridor is less than 2.4 m and is not based on the *RCR*.
3. A “Facility for the Visually Impaired” is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support and/or people with special visual needs.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a “Picking Area.”
6. *Automatic* daylight responsive *controls* are mandatory only if the requirements of the specified sections are present.
7. An additional 5.6 W/m^2 shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 4.6 W/m^2. The additional 5.6 W/m^2 allowance shall not be used for any other purpose.
8. Class of play as defined by IES RP-6.