CALIFORNIA STATEWIDE
UTILITY CODES AND STANDARDS PROGRAM

2016 Title 24 Codes & Standards Enhancement (CASE) Proposal

Nonresidential Lighting – Indoor LPDs

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Proposed Code Change History

- Title 24 is required to be at least the equal in energy efficiency to the national level codes (IECC/ASHRAE).
  - The ASHRAE 90.1 model code sets LPD values for spaces; some of these allowances are more stringent than currently set in Title 24.

Proposed Code Change Overview

Nonresidential Lighting – Indoor LPDs

- Adjust existing LPD values in the:

  Area Category Method table

  Complete Building Method table

  Tailored Method tables

  – This CASE will affect some NR building types, but not all, depending on affected spaces.

  – This will be a change to Prescriptive requirements.

Proposed Code Change Overview

- Impacts LPD values in the Area Category Method (Table 140.6-C), Complete Building Method (Table 140.6-B), and Tailored Method (Table 140.6 G).
  - **Directly,** the area category LPD allowances are compared between Title 24 and ASHRAE 90.1
  - **Indirectly,** adjust the Complete Building LPD allowance for some impacted building types
  - **Indirectly,** calibrate the Tailored Method LPD to keep consistent performance through all three methods

Current Code Requirements – Table 140.6-C

TABLE 140.6-C AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²)

PRIMARY FUNCTION AREA		ALLOWED LIGHTING POWER (W/ft²)	PRIMARY FUNCTION AREA		ALLOWED LIGHTING POWER (W/ft²)
Auditorium Area		1.5 [3]	Library Area	Reading areas	1.2 [3]
Auto Repair Area		0.9 [2]		Stack areas	1.5 [3]
Beauty Salon Area		1.7	Lobby Area	Hotel lobby	1.1 [3]
Civic Meeting Place Area		1.3 [3]		Main entry lobby	1.5 [3]
Classroom, Lecture, Training, Vocational Areas		1.2 [5]	Locker/Dressing Room		0.8
Commercial and Industrial Storage Areas (conditioned and unconditioned)		0.6	Lounge Area		1.1 [3]
Commercial and Industrial Storage Areas (refrigerated)		0.7	Malls and Atria		1.2 [3]
Convention, Conference, Multipurpose and Meeting Center Areas		1.4 [3]	Medical and Clinical Care Area		1.2
Corridor, Restroom, Stair, and Support Areas		0.6	Office Area	> 250 square feet	0.75
Dining Area		1.1 [3]		≤ 250 square feet	1.0
Electrical, Mechanical, Telephone Rooms		0.7 [2]	Parking Garage Area	Parking Area	0.14
Exercise Center, Gymnasium Areas		1.0		Dedicated Ramps	0.3
Exhibit, Museum Areas		2.0		Daylight Adaptation Zones [9]	0.6
Financial Transaction Area		1.2 [3]	Religious Worship Area		1.5 [3]
General Commercial and Industrial Work Areas	Low bay	0.9 [2]	Retail Merchandise Sales, Wholesale Showroom Areas		1.2 [6 and 7]
	High bay	1.0 [2]			
	Precision	1.2 [4]	Theater Area	Motion picture	0.9 [3]
Grocery Sales Area		1.2 [6 and 7]		Performance	1.4 [3]
Hotel Function Area		1.5 [3]	Transportation Function Area		1.2
Kitchen, Food Preparation Areas		1.6	Videoconferencing Studio		1.2 [8]
Laboratory Area, Scientific		1.4 [1]	Waiting Area		1.1 [3]
Laundry Area		0.9	All other areas		0.6

Footnotes for this table are listed below.

FOOTNOTES FOR TABLE 140.6-C:

See Section 140.6(c)2 for an explanation of additional lighting power available for specialized task work, ornamental, precision, accent, display, decorative, and white boards and chalk boards, in accordance with the footnotes in this table. The smallest of the added lighting power listed in each footnote below, or the actual design wattage, may be added to the allowed lighting power only when using the Area Category Method of compliance.

Current Code Requirements – Table 140.6-B

TABLE 140.6-B COMPLETE BUILDING METHOD LIGHTING POWER DENSITY VALUES

TYPE OF BUILDING	ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)
Auditorium Building	1.5
Classroom Building	1.1
Commercial and Industrial Storage Building	0.6
Convention Center Building	1.2
Financial Institution Building	1.1
General Commercial Building/Industrial Work Building	1.0
Grocery Store Building	1.5
Library Building	1.3
Medical Building/Clinic Building	1.1
Office Building	0.8
Parking Garage Building	0.2
Religious Facility Building	1.6
Restaurant Building	1.2
School Building	1.0
Theater Building	1.3
All others buildings	0.6

Current Code Requirements

- ASHRAE 90.1-2013
  - ASHRAE 90.1-2013 is the comparison standard

Common Space Types[1]	LPD, W/ft^2
Atrium	
… that is <20 ft in height	0.03/ft total height
… that is ≥20 ft and ≤40 ft in height	0.03/ft total height
… that is >40 ft in height	0.40 + 0.02/ft 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
… in a religious building	1.53
… in a sports arena	0.43
… all other audience seating areas	0.43
Banking Activity Area	1.01

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	LPD, W/ft^2
Automotive facility	0.80
Convention center	1.01
Courthouse	1.01
Dining: Bar lounge/leisure	101
Dining: Cafeteria/fast food	0.90
Dining: Family	0.95
Dormitory	0.57
Exercise center	0.84
Fire station	0.671
Gymnasium	0.94
Health-care clinic	0.90
Hospital	1.05
Hotel/Motel	0.87
Library	1.19
Manufacturing facility	1.17

Typical Practices

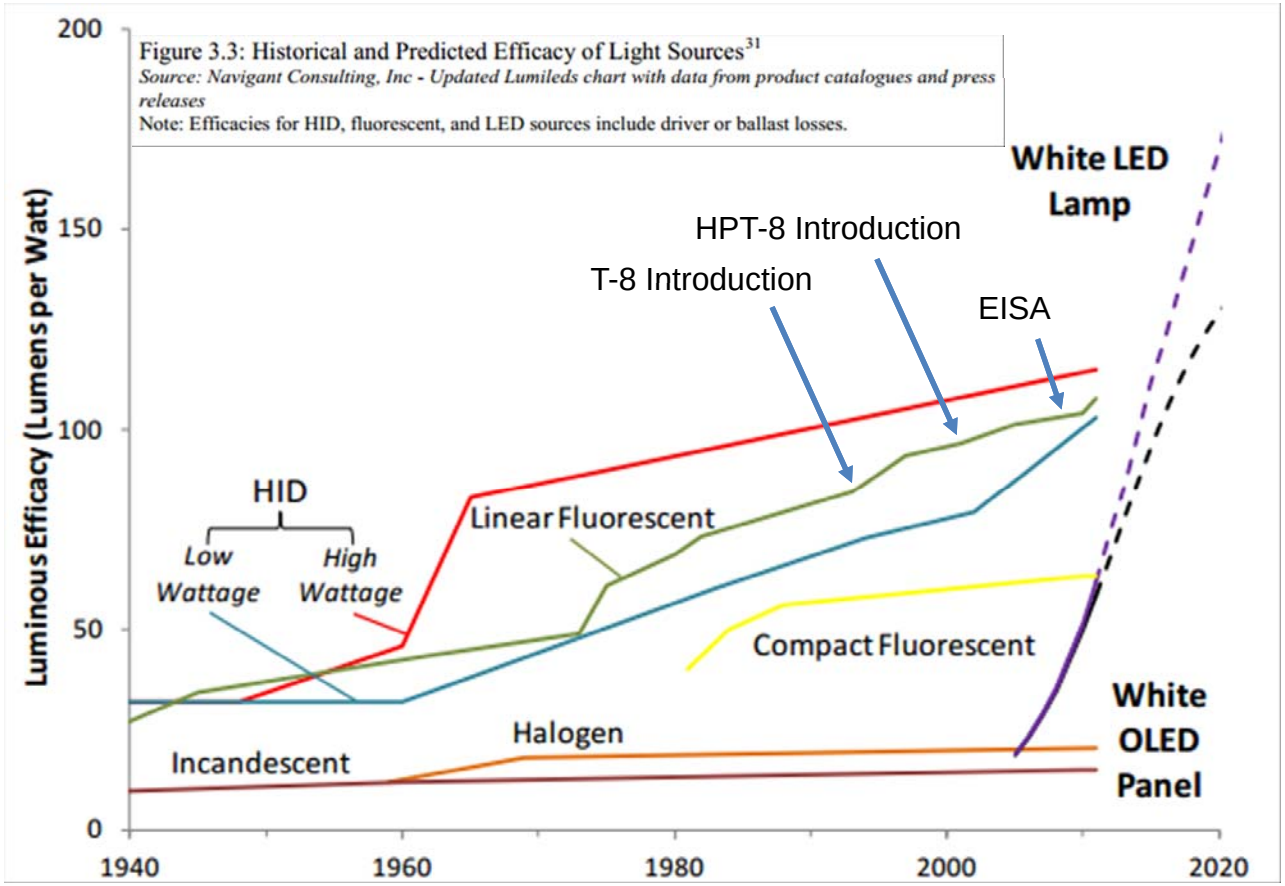
- Designers typically use “up to” the available LPD allowance.
  - Interior lighting is tradable within conditioned/unconditioned spaces, so any overage produced in one area can be “banked” for use in other areas.
  - Alternatively, a designer can over-design a space to meet the LPD, resulting in higher light levels than needed per IES criteria.

Trends

- Lighting technology is improving.
  - HPT8 lamps are marginally better than they were 5 years ago, but much more prevalent.
  - LED light sources are rapidly improving.
- Due to EISA-2007, the basis of design is now HPT8 lamps.
- LPD allowances are going to become increasingly less restrictive to design if they remain unchanged as new light source technologies continue to improve (LED).

Trends – Light Source Technology

LEDs Are Improving Rapidly…



… While Others Are Slowly Improving

Trends – Luminaire Technology

LEDs are going to be the Best Source…

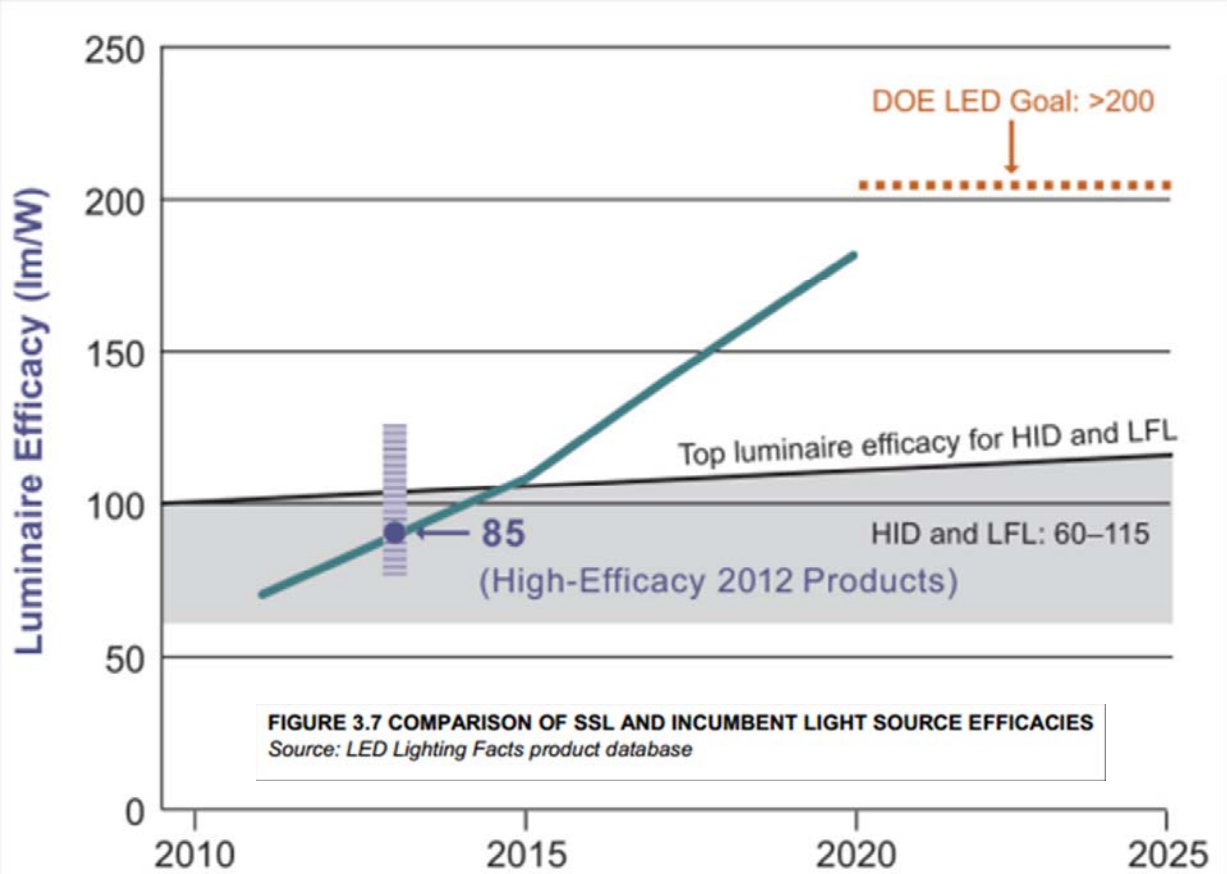


FIGURE 3.7 COMPARISON OF SSL AND INCUMBENT LIGHT SOURCE EFFICACIES
Source: LED Lighting Facts product database

… Possibly Sometime This Year!

Methodology for Analysis

1. Establish Lighting Design Criteria
   - Adjust for specific design criteria if specific criteria will require additional design consideration (vertical illuminance requirements, etc.).
2. Determine Reasonable Baseline Conditions
   - Light source baseline (mostly HPT8 lamps)
   - Luminaire baseline (mostly commodity-grade fluorescent products)
   - Space conditions (70-50-20 mostly for reflectances)
   - Light Loss Factors (based on lamp data and reasonable luminaire factors)
3. Run Lumen-Method Calculations to establish LPD associated with general illuminance design criteria.

Methodology for Savings Analysis

Energy and Demand Impacts

- Spreadsheet analysis (not building simulation)
- Determine LPD reductions (W/sf) compared to current T24 (2013)
- Statewide energy and demand impacts (kWh/kW)
  - for new/retrofit systems
  - Based on amount of impacted space types or building types (2006 CEUS data)
- TDV values (energy and demand) vary by climate zone

Initial Data and Findings

Functional areas under scrutiny:

Title 24 2013 Table 140.6-C		ASHRAE 90.1-2013 Table 9.6.1	
Primary Function Area	**LPD**	**Common Space Type**	**LPD**
Auditorium Area	**1.5**	Audience Seating Area in an Auditorium	**0.63**
Auto Repair Area	**0.9**	Vehicular Maintenance Area	**0.67**
Convention, Conference, Multipurpose and Meeting Center Areas	**1.4**	Conference/Meeting/Multipurpose Room	**1.23**
Dining Area	**1.1**	Dining Area (in a bar/lounge or leisure dining)	**1.07**
Electrical, Mechanical, Telephone Rooms	**0.7**	Electrical/Mechanical Room	**0.42**
Exhibit, Museum Areas	**2**	Museum (general exhibition area)	**1.05**
Financial Transaction Area	**1.2**	Banking Activity Area	**1.01**
Hotel Function Area	**1.5**	Conference/Meeting/Multipurpose Room	**1.23**
Kitchen, Food Preparation Areas	**1.6**	Food Preparation Area	**1.21**
Laundry Area	**0.9**	Laundry/Washing Area	**0.6**
Library Area – Reading Areas	**1.2**	Library (reading area)	**1.06**
Lobby Area – Main Entry Lobby	**1.5**	Lobby (all other lobbies)	**0.9**
Lobby Area – Hotel Lobby	**1.1**	Lobby (in a hotel)	**1.06**
Locker/Dressing Room	**0.8**	Locker Room	**0.75**
Lounge Area	**1.1**	Lounge/Breakroom (in a healthcare facility)	**0.92**
Malls and Atria	**1.2**	Retail Facilities (mall concourse)	**1.1**
Transportation Function Area	**1.2**	Transportation Facility (terminal ticket counter)	**0.8**
Waiting Area	**1.1**	Seating Area, General	**0.54**
All Other Areas	**0.6**		

Initial Data and Findings

It's been a while since values have changed…

Title 24 2013 Table 140.6-C		ASHRAE 90.1-2013 Table 9.6.1		Code Cycle Current Value Adopted
Primary Function Area	**LPD**	**Common Space Type**	**LPD**	
Auditorium Area	**1.5**	Audience Seating Area in an Auditorium	**0.63**	**2005**
Auto Repair Area	**0.9**	Vehicular Maintenance Area	**0.67**	**2008**
Convention, Conference, Multipurpose and Meeting Center Areas	**1.4**	Conference/Meeting/Multipurpose Room	**1.23**	**2005**
Dining Area	**1.1**	Dining Area (in a bar/lounge or leisure dining)	**1.07**	**2001**
Electrical, Mechanical, Telephone Rooms	**0.7**	Electrical/Mechanical Room	**0.42**	**2001**
Exhibit, Museum Areas	**2**	Museum (general exhibition area)	**1.05**	**2001**
Financial Transaction Area	**1.2**	Banking Activity Area	**1.01**	**2005**
Hotel Function Area	**1.5**	Conference/Meeting/Multipurpose Room	**1.23**	**2005**
Kitchen, Food Preparation Areas	**1.6**	Food Preparation Area	**1.21**	**2005**
Laundry Area	**0.9**	Laundry/Washing Area	**0.6**	**2001**
Library Area – Reading Areas	**1.2**	Library (reading area)	**1.06**	**2001**
Lobby Area – Main Entry Lobby	**1.5**	Lobby (all other lobbies)	**0.9**	**2001**
Lobby Area – Hotel Lobby	**1.1**	Lobby (in a hotel)	**1.06**	**2005**
Locker/Dressing Room	**0.8**	Locker Room	**0.75**	**2001**
Lounge Area	**1.1**	Lounge/Breakroom (in a healthcare facility)	**0.92**	**2001**
Malls and Atria	**1.2**	Retail Facilities (mall concourse)	**1.1**	**2001**
Transportation Function Area	**1.2**	Transportation Facility (terminal ticket counter)	**0.8**	**2005**
Waiting Area	**1.1**	Seating Area, General	**0.54**	**2005**
All Other Areas	**0.6**			**2001**

Initial Data and Findings

- Opportunity exists to reduce LPD values in many space types.
- It is not possible to reduce all spaces entirely to the level of the current ASHRAE values. Possible reasons:
  - Area categories are defined differently.
  - Different lighting design models and design assumptions.
  - Different code allowances or tradeoff assumptions – not completely equivalent building models to determine allowances.

Proposed Code Requirements

- Proposed Title 24 Revisions
  - LPD values in Table 140.6-C.
  - LPD values in Table 140.6-B (Complete Building Method) where the change in an area category impacts a large area of a building category.
    - Auditorium
    - Convention Center
    - Financial Institution
    - Library
    - Medical/Clinic Building
    - Restaurant
    - School
  - LPD values in Table 140.6-G (Tailored Method) to adjust for HPT8 lamps (10%, not done in previous revision cycle).

Proposed Code Requirements

- Recommended changes, Table 140.6-C

Title 24 2013 Table 140.6-C		ASHRAE 90.1-2013	Title 24 2016 PROPOSED Table 140.6-C
Primary Function Area	**LPD**		**LPD**
Auditorium Area	1.5	0.63	1.4
Auto Repair Area	0.9	0.67	0.9 (Remain as-is)
Convention, Conference, Multipurpose and Meeting Center Areas	1.4	1.23	1.2
Dining Area	1.1	1.07	1.0
Electrical, Mechanical, Telephone Rooms	0.7	0.42	0.55
Exhibit, Museum Areas	2	1.05	1.8 (Includes display ltg.)
Financial Transaction Area	1.2	1.01	1.0
Hotel Function Area	1.5	1.45	1.4
Kitchen, Food Preparation Areas	1.6	1.21	1.2
Laundry Area	0.9	0.6	0.7
Library Area – Reading Areas	1.2	1.06	1.1
Lobby Area – Main Entry Lobby	1.5	1.06	0.95
Lobby Area – Hotel Lobby	1.1	0.9	0.95
Locker/Dressing Room	0.8	0.75	.7 (Add exemption)
Lounge Area	1.1	0.92	0.9
Malls and Atria	1.2	1.1	0.95
Transportation Function Area	1.2	0.36 (concourse) 0.53 (baggage) 0.8 (ticketing)	0.5 concourse & baggage 1.0 ticketing
Waiting Area	1.1	0.54	0.8
All Other Areas	0.6	n/a	0.5

Proposed Code Requirements

- Table 140.6-C Issues
  - **Auto Repair Area** has a high target illuminance area and cannot be reduced without difficulty meeting criteria. **No change recommended.**
  - **Exhibit, Museum Area** is not directly comparable; ASHRAE exempts display lighting, Title 24 does not. Otherwise, the modified allowances are now very similar.
  - Propose a new exemption for lighting specifically intended for makeup, hair, and costume preparation in performing arts dressing rooms. This will allow the **Locker, Dressing Room** allowance to be reduced.
  - Propose splitting the **Transportation Function Area** into two categories; **Ticketing Area**, and **Concourse and Baggage**.

Proposed Code Requirements

- Recommended changes - Complete Building Method, Table 140.6-B

Title 24 2013 Table 140.6-B		Title 24 2016 PROPOSED Table 140.6-B
Building Type	**LPD**	**LPD**
Auditorium	**1.5**	**1.4**
Convention Center	**1.2**	**1.0**
Financial Institution	**1.1**	**1.0**
Library	**1.3**	**1.2**
Medical/Clinic Building	**1.1**	**1.0**
Religious Facility	**1.6**	**1.5**
Restaurant	**1.2**	**1.1**
School	**1.0**	**0.95**

Proposed Code Requirements

- Recommended changes – Tailored Method, Table 140.6-G

Illuminance Level (lux)	RCR <= 2.0	RCR > 2.0 and <= 3.5	RCR > 3.5 and <= 7.0	RCR > 7.0
50	~~0.2~~ 0.18	~~0.3~~ 0.28	~~0.4~~ 0.36	~~0.6~~ 0.55
100	~~0.4~~ 0.36	~~0.6~~ 0.55	~~0.8~~ 0.75	~~1.2~~ 1.1
200	~~0.6~~ 0.55	~~0.8~~ 0.75	~~1.3~~ 1.2	~~1.9~~ 1.75
300	~~0.8~~ 0.75	~~1.0~~ 0.9	~~1.4~~ 1.3	~~2.0~~ 1.8
400	~~0.9~~ 0.85	~~1.1~~ 1.0	~~1.5~~ 1.35	~~2.2~~ 2.0
500	~~1.0~~ 0.9	~~1.2~~ 1.1	~~1.6~~ 1.45	~~2.4~~ 2.2
600	~~1.2~~ 1.1	~~1.4~~ 1.3	~~2.0~~ 1.8	~~2.9~~ 2.65
700	~~1.4~~ 1.3	~~1.7~~ 1.55	~~2.3~~ 2.1	~~3.3~~ 3.0
800	~~1.6~~ 1.45	~~1.9~~ 1.75	~~2.6~~ 2.35	~~3.8~~ 3.45
900	~~1.8~~ 1.65	~~2.2~~ 2.0	~~3.0~~ 2.7	~~4.3~~ 3.9
1000	~~1.9~~ 1.75	~~2.4~~ 2.2	~~3.3~~ 3.0	~~4.8~~ 4.35

Proposed Code Change Language

Section 140.6(a)3C edits:

C. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used in religious worship, provided that these lighting systems are additions to a general lighting system and are separately controlled by a multiscene or theatrical cross-fade station accessible only to authorized operators.

Lighting intended for makeup, hair, and costume preparation in performing arts facility dressing rooms, provided that the lighting is separately switched from the general lighting system, switched independently at each dressing station, and is controlled with a Vacancy Sensor.

Feedback from Stakeholders

- [Comment] High-ceiling applications require special lighting solutions, where LED is not currently a cost-effective solution
  - [CASE Team] These calculations are technology neutral, and in most cases, this is being solved by CMH lamps, and possibly LED. The calculations do not require LED to meet the illuminance targets as a rule.
- [Comment] The ‘Waiting Area’ and ‘Lobby Area’ may be considered comparable design target conditions, why different values in LPD?
  - [CASE team] The IES has criteria for a Lobby area, and does not specifically have one for a Waiting area. They could be considered similar, but have been interpreted in the past as different criteria spaces.

Feedback from Stakeholders

- [Comment] At 0.7 WPF, equipment rooms are already dimly lit.
  - [CASE Team] The goal of the lighting in an equipment room is to provide safe light levels for simple tasks, not for work on equipment, where supplemental lighting is required. For this task, the general lighting allowance is adequate, but the lighting will need to accommodate the large mechanical equipment in layout.
- [Comment] The general trend in energy codes is to tighten controls requirements and not reduce LPD values further.
  - [CASE team] There has been this trend, but as noted, many of these values were established nearly a decade ago, the light source technology has improved considerably since then. So these values reflect the improvements, and not a tightening of the allowances.

Questions?

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