CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)

Nonresidential Lighting: Indoor LPDs

Measure Number: 2016-NR-LTG1-F

Nonresidential Lighting

2016 CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

California Utilities Statewide Codes and Standards Team

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Document Information

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EXECUTIVE SUMMARY

Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and Southern California Gas Company – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies.

The overall goal of this CASE Report is to propose a code change proposal for Nonresidential Indoor Lighting Power Densities (LPDs). The report contains pertinent information that justifies the code change including:

- Description of the code change proposal, the measure history, and existing standards (Section 2);
- Market analysis, including a description of the market structure for specific technologies, market availability, and how the proposed standard will impact building owners and occupants, builders, and equipment manufacturers, distributers, and sellers (Section 3);
- Methodology and assumption used in the analyses energy and electricity demand impacts, cost-effectiveness, and environmental impacts (Section 4);
- Results of energy and electricity demand impacts analysis, Cost-effectiveness Analysis, and environmental impacts analysis (Section 5); and
- Proposed code change language (Section 6).

Scope of Code Change Proposal

The Nonresidential Lighting – Indoor LPDs measure will affect the following code documents listed in Table 1.

Table 1: Scope of Code Change Proposal

Standards Requirements (see note below)	Compliance Option	Appendix	Modeling Algorithms	Simulation Engine	Forms
Ps	No	No	No	No	No

Note: An (M) indicates mandatory requirements, (Ps) Prescriptive, (Pm) Performance.

Measure Description

The Nonresidential Indoor LPDs measure is intended to revise the lighting power allowances assigned in Tables 140.6-B, 140.6-C, 140.6-D, and 140.6-G to adjust the values to be comparable in energy efficiency to the levels presented in ASHRAE 90.1-2013 if they prove to be cost effective.

As the process of evaluation is not intended to challenge the quality or nature of the lighting equipment employed to establish the allowances, there is no anticipation that the changes will trigger any additional costs, therefore the measure is expected to be cost effective.

Section 2 of this report provides detailed information about the code change proposal. ***Section 2.2 Summary of Changes to Code Documents*** provides a section-by-section description of the proposed changes to the standards, appendices, alternative compliance manual and other documents that will be modified by the proposed code change. See the following tables for an inventory of sections of each document that will be modified:

- Table 4: Scope of Code Change Proposal (page 4)
- Table 5: Sections of Standards Impacted by Proposed Code Change (page 4)

Detailed proposed changes to the text of the building efficiency standards, the reference appendices, and are given in ***Section 6 Proposed Language*** of this report. This section proposes modifications to language with additions identified with underlined text and deletions identified with ~~struck out~~ text.

Market Analysis and Regulatory Impact Assessment

This measure has little material impact because it relies on existing technology and design practices that have been improving over time to create the opportunity. As a result, it is possible to perform the same lighting tasks more efficiently now, and this measure captures these savings.

This proposal is cost effective over the period of analysis, as there are no incremental costs. Overall this proposal increases the wealth of the State of California. California consumers and businesses save more money on energy than they do for financing the efficiency measure. As a result this leaves more money available for discretionary and investment purposes.

The expected impacts of the proposed code change on various stakeholders are summarized below:

- **Impact on builders:** The proposed measures will have little to no impact on builders.
- **Impact on building designers:** The proposed code change is not expected to significantly impact building designers.
- **Impact on occupational safety and health:** The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by California Division of Occupational Safety and Health. All existing health and safety rules will remain in place. Complying with the proposed code changes

is not anticipated to have any impact on the safety or health occupants or those involved with the construction, commissioning, and ongoing maintenance of the building.

- **Impact on building owners and occupants:** Over the 15-year evaluation period the energy cost savings from this measure are higher than the incremental costs. The building owners and occupants who pay energy bills are expected to benefit from cost savings over the life of the building.
- **Impact on equipment retailers (including manufacturers and distributors):** No impact anticipated.
- **Impact on energy consultants:** The proposed code change is not expected to significantly impact energy consultants.
- **Impact on building inspectors:** As compared to the overall code enforcement effort, this measure has negligible impact on the effort required to enforce the building codes.
- **Statewide Employment Impacts:** The proposed changes to Title 24 are expected to result in positive job growth as noted below in Section 3.5. The particular measures proposed in this report are not expected to have an appreciable impact on employment in California.
- **Impacts on the creation or elimination of businesses in California:** The proposed measure is not expected to have an appreciable impact on California businesses.
- **Impacts on the potential advantages or disadvantages to California businesses:** In general California businesses would benefit from an overall reduction in energy costs. This could help California businesses gain competitive advantage over businesses operating in other states or countries and increase in investment in California. This particular measure is not expected to have an appreciable impact on any specific California business.
- **Impacts on the potential increase or decrease of investments in California:** As described in Section 3.5 of this report, the California Air Resources Board (CARB) economic analysis of greenhouse gas reduction strategies for the State of California indicates that higher levels of energy efficiency and 33 percent Renewable Portfolio Standard (RPS) will increase investment in California by about 3 percent in 2020 compared to 20% RPS and lower levels of energy efficiency. After reviewing the CARB analysis, the Statewide CASE Team concluded that the majority of the increased investment of the more aggressive strategy is attributed to the benefits of efficiency (CARB 2010b Figures 7a and 10a). The specific code change proposal presented in this report is not expected to have an appreciable impact on investments in California.
- **Impacts on incentives for innovations in products, materials or processes:** Updating Title 24 standards could encourage innovation through the adoption of new technologies to better manage energy usage and achieve energy savings. It is not anticipated that this measure will have a significant impact on innovation.

- **Impacts on the State General Fund, Special Funds and local government:** The proposed measure is not expected to have an appreciable impact on the State General Fund, Special Funds, or local government funds.
- **Cost of enforcement to State Government and local governments:** All revisions to Title 24 will result in changes to Title 24 compliance determinations. State and local code officials will be required to learn how buildings can comply with the new provisions included in the 2016 Standards, however the Statewide CASE Team anticipates that the cost of training is part of the regular training activates that occur every time the code is updated. These proposed changes would not affect the complexity of the code significantly. Therefore, on-going costs are not expected to change significantly.
- **Impacts on migrant workers; persons by age group, race, or religion:** This proposal and all measures adopted by CEC into Title 24, part 6 do not advantage or discriminate in regards to race, religion or age group.
- **Impact on Homeowners (including potential first time home owners):** The proposal does not impact residential buildings. There is no expected impact on homeowners.
- **Impact on Renters:** The energy cost savings from the proposed measures might be passed on to tenants.
- **Impact on Commuters:** This proposal and all measures adopted by CEC into Title 24, Part 6 are not expected to have an impact on commuters.

Statewide Energy Impacts

Table 2 shows the estimated energy savings over the first twelve months of implementation of the Nonresidential Lighting – Indoor LPDs.

Table 2: Estimated First Year Energy Savings

	First Year Statewide Savings			TDV Dollar Savings ($ Millions)
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	
TOTAL	24	5.7	N/A	53

Section 4.6.1 discusses the methodology and Section 5.1.1 shows the results for the per unit energy impact analysis.

Cost-effectiveness

These savings are cost effective, because they are achieved without an increase in construction costs through the use of readily-available industry-standard technological and equipment solutions. In many cases, the reductions in LPD values will result in lower first costs.

Section 4.7 discusses the methodology and section 5.2 shows the results of the Cost Effectiveness Analysis

Greenhouse Gas and Water Related Impacts

For a more detailed and extensive analysis of the possible environmental impacts from the implementation of the proposed measure, please refer to Section 5.3 of this report.

Greenhouse Gas Impacts

Table 3 presents the estimated avoided greenhouse gas (GHG) emissions of the proposed code change for the first year the standards are in effect.

Table 3: Estimated First Year Statewide Greenhouse Gas Emissions Impacts

	Avoided GHG Emissions ($MTCO_2e/yr$)
TOTAL	8,589

Section 4.8.1 discusses the methodology and assumptions used in developing the GHG savings and Section 5.3.1 shows the results of the greenhouse gas emission impacts analysis.

Water Use and Water Quality Impacts

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

Acceptance Testing

Acceptance testing is not required for the proposed changes.

1. INTRODUCTION

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and Southern California Gas Company – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies.

The overall goal of this CASE Report is to propose a code change proposal for Nonresidential Lighting – Indoor LPDs. The report contains pertinent information that justifies the code change.

Section 2 of this CASE Report provides a description of the measure, how the measure came about, and how the measure helps achieve the state's zero net energy (ZNE) goals. This section presents how the Statewide CASE Team envisions the proposed code change would be enforced and the expected compliance rates. This section also summarized key issues that the Statewide CASE Team addressed during the CASE development process, including issues discussed during a public stakeholder meeting that the Statewide CASE Team hosted in May 2014 and a CEC pre-rulemaking meeting in July 2014.

Section 3 presents the market analysis, including a review of the current market structure, a discussion of product availability, and the useful life and persistence of the proposed measure. This section offers an overview of how the proposed standard will impact various stakeholders including builders, building designers, building occupants, equipment retailers (including manufacturers and distributors), energy consultants, and building inspectors. Finally, this section presents estimates of how the proposed change will impact statewide employment.

Section 4 describes the methodology and approach the Statewide CASE Team used to estimate energy, demand, costs, and environmental impacts. Key assumptions used in the analyses can be also found in Section 4.

Results from the energy, demand, costs, and environmental impacts analysis are presented in Section 5. The Statewide CASE Team calculated energy, demand, and environmental impacts using two metrics: (1) per unit and (2) statewide impacts during the first year buildings complying with the 2016 Title 24 Standards are in operation. Time Dependent Valuation (TDV) energy impacts, which accounts for the higher value of peak savings, are presented for the first year both per unit and statewide. The incremental costs relative to existing conditions are presented as the present value of year TDV energy cost savings and the overall cost impacts over the 30-year period of analysis, as required by CEC.

The report concludes with specific recommendations for language for the Standards, Appendices, Alternative Calculation Method (ACM) Reference Manual and Compliance Forms.

2. MEASURE DESCRIPTION

2.1 Measure Overview

2.1.1 Measure Description

The Indoor LPDs measure is intended to revise the lighting power allowances assigned in Tables 140.6-B, 140.6-C, 140.6-D, and 140.6-G to adjust the values to be comparable in energy efficiency to the levels presented in ASHRAE 90.1-2013 if they prove to be cost effective.

As the process of evaluation is not intended to challenge the quality or nature of the lighting equipment employed to establish the allowances, there is no anticipation that the changes will trigger an issue with cost effectiveness.

These space type categories that appear to have an opportunity for revision include:

- Auditorium Area
- Auto Repair Area
- Convention, Conference, Multipurpose, and Meeting Center
- Dining Area
- Electrical, Mechanical, Telephone Rooms
- Exhibit, Museum Areas
- Financial Transaction Area
- Hotel Function Area
- Kitchen, Food Preparation Areas
- Laundry Area
- Library Area – Reading Areas
- Lobby Area – Main Entry Lobby
- Lobby Area – Hotel Lobby
- Locker / Dressing Room
- Lounge Area
- Malls and Atria (based on RCR issues)
- Transportation Function Areas
- Waiting Area
- "All Other Areas"

This measure will review the recommendations for the general illuminance portion of the Tailored Method as provided in Table 140.6-G. This table will be revised to incorporate the newest light source technology as required in the code (HP T8 lamps), plus the inclusion of

LED lighting products where these have become the industry standard (replacing low-wattage CFL downlights).

This measure may also incorporate recommendations intended to streamline the code language, in particular for the alterations segment of the code (Section 141.0) if there are recommended modifications.

2.1.2 Measure History

This measure is primarily a code maintenance measure. It is intended to ensure that Title 24 is at least as aggressive as other national codes or standards. As a result, the changes should not be considered controversial by the design or manufacturing segments of the lighting industry, as the 90.1 process is consensus based and includes representation by these stakeholders in that process. In many cases, the Title 24 stakeholders are the same people and organizations as the 90.1 stakeholders.

The current design practice in California is to use up to the LPD limits available in the code.

This measure is similar to measures that have occurred in the past when LPD values have been re-evaluated due to advancements in lighting technology. Portions of this measure may overlap with other nonresidential lighting measures in that all of these measures need to treat the consideration of a new baseline in a consistent manner to reduce confusion and discontinuity in the measures.

There are no pre-emption concerns associated with this measure.

2.1.3 Existing Standards

The existing standards regulate the LPD values in exactly the same manner that this measure intends to employ. This measure intends to compare the precedent established in ASHRAE 90.1-2013 for LPD values as a basis for re-evaluation of the LPD values in Section 140.6. ASHRAE uses a similar, but not exactly identical manner for LPD calculations and allowances, so most values between the two documents are comparable.

2.1.4 Alignment with Zero Net Energy Goals

The Statewide CASE Team and the CEC are committed to achieving California's zero-net-energy (ZNE) goal. This measure will help achieve ZNE goals by reducing the lighting load in nonresidential interior spaces to the minimum possible while still meeting current IES recommended design practices. This measure will also set the foundation for future code changes that will help ensure ZNE goals are achieved. In particular, this measure could lead directly to the following code changes in the 2019 and 2022 code change cycles:

- Additional reductions in LPD as light source technologies mature and make continuing efficacy improvements. As LED technology improves, the baseline for design can be shifter over to that technology, and as a result, further LPD reductions will be possible.

2.1.5 Relationship to Other Title 24 Measures

There are no other measures that focus on Section 140.6, however there is a measure that focuses on nonresidential indoor lighting controls, which may have an impact on this measure (and vice-versa) when calculating Statewide Energy Impacts.

This measure has no other anticipated overlaps with any other measures.

2.2 Summary of Changes to Code Documents

The sections below provide a summary of how each Title 24 document will be modified by the proposed change. See Section 6 of this report for detailed proposed revisions to code language.

2.2.1 Catalogue of Proposed Changes

Scope

Table 4 identifies the scope of the code change proposal. This measure will impact the following areas (marked by a "Yes").

Table 4: Scope of Code Change Proposal

Mandatory	Prescriptive	Performance	Compliance Option	Trade-Off	Modeling Algorithms	Forms
No	Yes	No	No	No	No	No

Standards

The proposed code change will modify the sections of the California Building Energy Efficiency Standards (Title 24, Part 6) identified in Table 5.

Table 5: Sections of Standards Impacted by Proposed Code Change

Title 24, Part 6 Section Number	Section Title	Mandatory (M) Prescriptive (Ps) Performance (Pm)	Modify Existing (E) New Section (N)
140.6	Prescriptive Requirements for Indoor Lighting	Ps	E

Appendices

The proposed code change is not expected to have an effect on the appendices.

Nonresidential Alternative Calculation Method (ACM) Reference Manual

The proposed code change is not expected to have an effect on the Residential or Nonresidential Alternative Calculation Method References.

Simulation Engine Adaptations

The proposed code change can be modeled using the current simulation engine. Changes to the simulation engine are not necessary.

2.2.2 Standards Change Summary

This proposal would modify the following sections of the Building Energy Efficiency standards as shown below. See ***Section 6.1 Standards*** of this report for the detailed proposed revisions to the standards language.

Changes in Prescriptive Requirements

- Reduce the LPD values in Tables 140.6-B, 140.6-C, 140.6-D, and 140.6-G based on the possibility to meet recognized IES criteria for illuminance with current technology lighting products, focused on the list of candidate areas identified through a review of the allowances in comparison with ASHRAE 90.1-2013. Make minor modifications to add clarity to certain design circumstances.

SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

Tables 140.6-B, 140.6-C, 140.6-D, and 140.6-G: The proposed regulations reduce the LPD values of candidate use categories based on analysis.

Subsection 140.6(a)3C: The proposed regulations add language to exempt makeup and costume preparation lighting for performance arts facilities.

Table 140.6-C: The proposed regulations split the Transportation Function Area into two categories; "Concourse & Baggage" and "Ticketing", and then provides values for these new categories.

2.2.3 Standards Reference Appendices Change Summary

This proposal will not modify the appendices of the Standards.

2.2.4 Nonresidential Alternative Calculation Method (ACM) Reference Manual Change Summary

The proposed code change will not modify the ACM Reference Manuals.

2.2.5 Compliance Forms Change Summary

The proposed code change will not modify the Compliance Forms.

2.2.6 Simulation Engine Adaptations

The simulation engine will not require modification to accommodate the proposed modifications.

2.2.7 Other Areas Affected

No other areas affected.

2.3 Code Implementation

2.3.1 Verifying Code Compliance

The existing code enforcement methods will remain in effect. No new compliance documents will be required, and no additional field verification or acceptance tests will be required.

2.3.2 Code Implementation

The code compliance methods currently employed by designers and builders will remain the same with this new measure. Title 24 is currently regulating LPD for buildings in a manner that is compatible with the changes intended with this measure. The building industry is accustomed to using the LPD limits approach that has been established in the previous versions of Title 24, and this measure maintains this infrastructure.

This measure does not add significant expense to the design or construction process.

This measure makes no changes in the building inspection process.

There is no anticipated resistance to this measure from the building industry beyond the normal reluctance to lower LPD values.

2.3.3 Acceptance Testing

Acceptance testing is not required for the proposed changes.

2.4 Issues Addressed During CASE Development Process

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the code change proposal presented in this report. In addition to personal outreach to key stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposals. The issues that were addressed during development of the code change proposal are summarized below.

The first stakeholder meeting introduced some minor details for clarification, mostly surrounding the equipment used as the basis of design. This measure was presented as evaluating existing lighting criteria with current light source technology; not requiring an upgrade to LED products as these are not universally cost effective in interior lighting products for nonresidential applications at this point. It is possible that most LED products may be fully cost effective by 2017, but there are enough product categories in nonresidential indoor applications to propose an LED baseline for the 2016 revisions of Title 24. This is a different circumstance from the residential lighting measure and also the nonresidential outdoor lighting LPA measure.

Further, the lighting calculations were made to meet general lighting requirements, not specific task requirements like focal point lighting and other specific needs that are generally required for the tailored method approach. Therefore, in the tailored method, the only changes are to Table 140.6-G, which is the table for general lighting allowances.

This measure is not a complicated extension of the existing code language. It is a refinement of the values in the existing infrastructure, so it is well understood by most stakeholders, and is somewhat non-controversial.

3. MARKET ANALYSIS

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. The Statewide CASE Team considered how the proposed standard may impact the market in general and individual market players. The Statewide CASE Team gathered information about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with key stakeholders including utility program staff, CEC, and a wide range of industry players who were invited to participate in a public stakeholder that the Statewide CASE Team sponsored in May 2014.

3.1 Market Structure

This measure does not impact the manufacturing or specification market in any substantial manner, so no impacts are expected based on the adjustments of LPD values.

3.2 Market Availability and Current Practices

There are some possible barriers to adoption of lower LPD values in Tables 140.6-B, 140.6-C, 140.6-D, and 140.6-G.

- The lighting design community may resist any changes to the LPD tables because of the perception that their task in meeting the current code is already difficult. Title-24 is an aggressive lighting standard, so this perspective is possibly valid in certain circumstances, but this measure is primarily meant to keep step with the ASHRAE 90.1 code, which has already established levels of performance.
- The luminaire manufacturers may resist any modifications to the LPD on grounds that the reductions will reduce the potential market for lighting sales somewhat.

3.3 Useful Life, Persistence, and Maintenance

This measure makes no changes to the useful life of specified lighting equipment. The energy savings associated with a reduction in the LPD will persist the entire length of the installation of the lighting equipment. There is no field verification, maintenance, or commissioning required to ensure that the savings are maintained.

The methodology the Statewide CASE Team used to determine the costs associated with incremental maintenance costs, relative to existing conditions, is presented in Section 4.7.1. The incremental maintenance costs of the proposed code change are presented in Section 5.2.1.

3.4 Market Impacts and Economic Assessments

There are no anticipated barriers to code enforcement. The main infrastructure of Section 140.6 will remain as currently established. Only changes to the LPD values in various tables are currently being considered for evaluation and revision. This does present the possibility that inspectors will need to reset their basic expectations for lighting design layouts when spot-checking submittals, because a change in the allowances will result in different luminaire density conditions than previously available.

However, the changes proposed do not represent a fundamental change in philosophy that would necessitate a change in design approach or technology applied to meet the LPD values. Mostly, the LPD adjustments are incremental in nature and are designed to keep up with the advancing light source technology improvements that have occurred recently.

3.4.1 Impact on Builders

The proposed measures will have little to no impact on builders.

3.4.2 Impact on Building Designers

No substantial impacts are anticipated. The reductions will result in differences in the total LPD allowances in the building design process, but the structure for compliance will remain the same.

3.4.3 Impact on Occupational Safety and Health

The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Department of Occupational Safety and Health (Cal/OSHA). All existing health and safety rules will remain in place. Complying with the proposed code change is not anticipated to have any impact on the safety or health occupants or those involved with the construction, commissioning, and ongoing maintenance of the building.

3.4.4 Impact on Building Owners and Occupants

Over the 15-year evaluation period the energy cost savings from this measure are higher than the incremental costs. The building owners and occupants who pay energy bills are expected to benefit from cost savings over the life of the building.

3.4.5 Impact on Retailers (including manufacturers and distributors)

The proposed code change is not expected to have a significant impact on retailers.

3.4.6 Impact on Energy Consultants

The proposed code change is not expected to significantly impact energy consultants.

3.4.7 Impact on Building Inspectors

As compared to the overall code enforcement effort, this measure has negligible impact on the effort required to enforce the building codes.

3.4.8 Impact on Statewide Employment

The proposed changes to Title 24 are expected to result in positive job growth as noted below in Section 3.5. The particular measures proposed in this report are not expected to have an appreciable impact on employment in California.

3.5 Economic Impacts

The proposed Title 24 code changes, including this measure, are expected to increase job creation, income, and investment in California. As a result of the proposed code changes, it is anticipated that less money will be sent out of state to fund energy imports, and local spending is expected to increase due to higher disposable incomes due to reduced energy costs.[1]

These economic impacts of energy efficiency are documented in several resources including the California Air Resources Board's (CARB) Updated Economic Analysis of California's Climate Change Scoping Plan, which compares the economic impacts of several scenario cases (CARB, 2010b). CARB include one case (Case 1) with a 33% renewable portfolio standard (RPS) and higher levels of energy efficiency compared to an alternative case (Case 4) with a 20% RPS and lower levels of energy efficiency. Gross state production (GSP)[2], personal income, and labor demand were between 0.6% and 1.1% higher in the case with the higher RPS and more energy efficiency (CARB 2010b, Table 26). While CARB's analysis does not report the benefits of energy efficiency and the RPS separately, we expect that the benefits of the package of measures are primarily due to energy efficiency. Energy efficiency measures are expected to reduce costs by $2,133 million annually (CARB 2008, pC-117) whereas the RPS implementation is expected to cost $1,782 million annually, not including the benefits of GHG and air pollution reduction (CARB 2008, pC-130).

Macroeconomic analysis of past energy efficiency programs and forward-looking analysis of energy efficiency policies and investments similarly show the benefits to California's economy of investments in energy efficiency (Roland-Holst 2008; UC Berkeley 2011).

This measure is not anticipated to have a large economic impact on the industry because it functions as a reduction in LPD allowances in the current code infrastructure. In most cases, the greatest impact might be a slight reduction in the number of luminaires that are specified, which may result in a slightly lower cost of construction.

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[1] Energy efficiency measures may result in reduced power plant construction, both in-state and out-of-state. These plants tend to be highly capital-intensive and often rely on equipment produced out of state, thus we expect that displaced power plant spending will be more than off-set from job growth in other sectors in California.

[2] GSP is the sum of all value added by industries within the state plus taxes on production and imports.

3.5.1 Creation or Elimination of Jobs

CARB's economic analysis of higher levels of energy efficiency and 33% RPS implementation estimates that this scenario would result in a 1.1% increase in statewide labor demand in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b, Tables 26 and 27). CARB's economic analysis also estimates a 1.3% increase in small business employment levels in 2020 (CARB 2010b, Table 32).

3.5.2 Creation or Elimination of Businesses within California

CARB's economic analysis of higher levels of energy efficiency and 33% RPS implementation (as described above) estimates that this scenario would result in 0.6% additional GSP in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b, Table ES-2). We expect that higher GSP will drive additional business creation in California. In particular, local small businesses that spend a much larger proportion of revenue on energy than other businesses (CARB 2010b, Figures 13 and 14) should disproportionately benefit from lower energy costs due to energy efficiency standards. Increased labor demand, as noted earlier, is another indication of business creation.

Table 6 below shows California industries that are expected to receive the economic benefit of the proposed Title 24 code changes. It is anticipated that these industries will expand due to an increase in funding as a result of energy efficiency improvements. The list of industries is based on the industries that the University of California, Berkeley identified as being impacted by energy efficiency programs (UC Berkeley 2011 Table 3.8).[3]

This list provided below is not specific to one individual code change proposal; rather it is an approximation of the industries that may receive benefit from the 2016 Title 24 code changes.

[3] Table 3.8 of the UC Berkeley report includes industries that will receive benefits of a wide variety of efficiency interventions, including Title 24 Standards and efficiency programs. The authors of the UC Berkeley report did not know in 2011 which Title 24 measures would be considered for the 2016 adoption cycle, so the UC Berkeley report was likely conservative in their approximations of industries impacted by Title 24. The Statewide CASE Team believes that industries impacted by utilities efficiency programs is a more realistic and reasonable proxy for industries potentially affected by upcoming Title 24 Standards. Therefore, the table provided in this CASE Report includes the industries that are listed as benefiting from Title 24 and utility energy efficiency programs.

Table 6: Industries Receiving Energy Efficiency Related Investment, by North American Industry Classification System (NAICS) Code

Industry	NAICS Code
Residential Building Construction	2361
Nonresidential Building Construction	2362
Roofing Contractors	238160
Electrical Contractors	23821
Plumbing, Heating, and Air-Conditioning Contractors	23822
Boiler and Pipe Insulation Installation	23829
Insulation Contractors	23831
Window and Door Installation	23835
Asphalt Paving, Roofing, and Saturated Materials	32412
Manufacturing	32412
Other Nonmetallic Mineral Product Manufacturing	3279
Industrial Machinery Manufacturing	3332
Ventilation, Heating, Air-Conditioning, & Commercial Refrigeration Equipment Manufacturing	3334
Computer and Peripheral Equipment Manufacturing	3341
Communications Equipment Manufacturing	3342
Electric Lighting Equipment Manufacturing	3351
Household Appliance Manufacturing	3352
Other Major Household Appliance Manufacturing	335228
Used Household and Office Goods Moving	484210
Engineering Services	541330
Building Inspection Services	541350
Environmental Consulting Services	541620
Other Scientific and Technical Consulting Services	541690
Advertising and Related Services	5418
Corporate, Subsidiary, and Regional Managing Offices	551114
Office Administrative Services	5611
Commercial & Industrial Machinery & Equip. (exc. Auto. & Electronic) Repair & Maintenance	811310

3.5.3 Competitive Advantages or Disadvantages for Businesses within California

California businesses would benefit from an overall reduction in energy costs. This could help California businesses gain competitive advantage over businesses operating in other states or countries and an increase in investment in California, as noted below.

3.5.4 Increase or Decrease of Investments in the State of California

CARB's economic analysis indicate that higher levels of energy efficiency and 33% RPS will increase investment in California by about 3% in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b Figures 7a and 10a).

3.5.5 Incentives for Innovation in Products, Materials, or Processes

Updating the Title 24 Standards will encourage innovation through the adoption of new technologies to better manage energy usage and achieve energy savings. Significant impact on product innovation is not expected through these proposed changes, as they are primarily clarifications to improve compliance.

3.5.6 Effects on the State General Fund, State Special Funds and Local Governments

The Statewide CASE Team expects positive overall impacts on state and local government revenues due to higher GSP and personal income resulting in higher tax revenues, as noted earlier. Higher property valuations due to energy efficiency enhancements may also result in positive local property tax revenues. The Statewide CASE Team has not obtained specific data to quantify potential revenue benefits for this measure.

3.5.6.1 Cost of Enforcement

There are no projected impediments to, or incentives for, innovation that would result from the proposed measures.

Cost to the State

State government already has budget for code development, education, and compliance enforcement. While state government will be allocating resources to update the Title 24 Standards, including updating education and compliance materials and responding to questions about the revised Standards, these activities are already covered by existing state budgets. The costs to state government are small when compared to the overall costs savings and policy benefits associated with the code change proposals.

Cost to Local Governments

All revisions to Title 24 will result in changes to Title 24 compliance determinations. Local governments will need to train permitting staff on the revised Title 24 Standards. While this re-training is an expense to local governments, it is not a new cost associated with the 2016 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining. For example, utilities offer compliance training such as "Decoding" talks to provide training and materials to local permitting departments. As noted earlier, although retraining is a cost of the revised Standards, Title 24 Standards are expected to increase economic growth and income with positive impacts on local revenue.

3.5.6.2 Impacts on Specific Persons

The proposed changes to Title 24 are not expected to have a differential impact on any of the following groups relative to the state population as a whole:

- Migrant Workers
- Persons by age
- Persons by race
- Persons by religion
- Commuters

Renters will typically benefit from lower energy bills if they pay energy bills directly.

4. METHODOLOGY

This section describes the methodology and approach the Statewide CASE Team used to estimate energy, demand, costs, and environmental impacts. The Statewide CASE Team calculated the impacts of the proposed code change by comparing existing conditions to the conditions if the proposed code change is adopted. This section of the CASE Report goes into more detail on the assumptions about the existing and proposed conditions, prototype buildings, and the methodology used to estimate energy, demand, cost, and environmental impacts.

4.1 Existing Conditions

To assess the energy, demand, costs, and environmental impacts, the Statewide CASE Team compared current design practices to design practices that would comply with the proposed requirements.

There is an existing Title 24 Standard that covers the building system in question, so the existing conditions assume a building complies with the 2013 Title 24 Standards.

Refer to Section 2.2 and 2.3 for more information on the standard practice of design in the industry.

4.2 Proposed Conditions

The proposed conditions are defined as the design conditions that will comply with the reduced lighting power densities, presented in the rightmost columns of Table 7 and Table 8. Specifically, the proposed code change will slightly reduce the LPD allowance for specific space types and complete building types based on meeting design criteria using currently available lamps and luminaires.

Table 7: Proposed Changes to Table 140.6-C, Area Category Method

Title 24 2013 Table 140.6-C Values		Title 24 2016 Proposed Table 140.6-C Values
Primary Function Area	**LPD**	**LPD**
Auditorium Area	1.5	1.4
Auto Repair Area	0.9	0.9 (Remain as-is)
Convention, Conference, Multipurpose and Meeting Center Areas	1.4	1.2
Dining Area	1.1	1.0
Electrical, Mechanical, Telephone Rooms	0.7	0.55
Exhibit, Museum Areas	2	1.8 (Includes display ltg.)
Financial Transaction Area	1.2	1.0
Hotel Function Area	1.5	1.4
Kitchen, Food Preparation Areas	1.6	1.2
Laundry Area	0.9	0.7
Library Area – Reading Areas	1.2	1.1
Lobby Area – Main Entry Lobby	1.5	0.95
Lobby Area – Hotel Lobby	1.1	0.95
Locker/Dressing Room	0.8	.7 (Add exemption)
Lounge Area	1.1	0.9
Malls and Atria	1.2	0.95
Transportation Function Area	1.2	0.5 concourse & baggage 1.0 ticketing
Waiting Area	1.1	0.8
All Other Areas	0.6	0.5

Table 8: Proposed Changes to Table 140.6-B, Whole Building Method

Title 24 2013 Table 140.6-B Values		Title 24 2016 Proposed Table 140.6-B Values
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
All Other Buildings	0.6	0.50

Additional changes are proposed to Table 140.6-G; the general lighting allowance tables for the Tailored Method calculation approach, and a variety of smaller code language changes throughout Section 140.6.

The lighting calculations that support the proposal are built on average illuminance criteria for the various space types under evaluation. Since these are general illuminance conditions, a lumen method calculation is suitable to calculate the lighting power density necessary to meet the established design illuminance criteria.

This calculation entails evaluating the range of reasonably likely spaces that are expected to occur and applying reasonable assumptions for a variety of design variables that occur in the typical lighting design, using relatively conservative assumptions where there is a range of reasonable values that may be applied.

The list of assumptions include:

- Spaces that are impacted and their correlating IES design criteria
- Room dimensions through the proxy of Room Cavity Ratio (RCR)
- Room reflectances
- Luminaire selection suitable for the space type under evaluation
- Lamp maintained lumen values for the respective luminaires

Once the range of calculations are complete, the results are used to generate a table of RCR values that provide information on the tipping point where a particular LPD allowance will ‘fail’ to permit the desired target illuminance.

Since the dimensions of a room heavily impact the results it is not possible to produce a single LPD value that efficiently meets the requirements for all space dimensions. Thus it is important to map the results and understand at what point the LPD values begin to fail the criteria. At that point, the judgment is made regarding what set of conditions are necessary to pass, and which conditions are sufficiently atypical to be permitted to fail. This information is used to determine the new LPD values that are recommended in this CASE Report.

Note that this approach is the same for the specific room types as described here, and for the general allowance table in the Tailored Method, 140.6-G. The only difference is that the Tailored Method calculations are done for a specific illuminance target without the context of the specific room use, so the calculations are more generically applied. These calculations are completed for the range of target illuminance from 50 lux to 1000 lux.

Refer to Appendix C: Lighting Calculation Results for a more complete description of the process and the results for each individual line item of the code table recommendations.

4.3 Prototype Building

This measure does not require whole building modeling to establish the savings estimates for each space and climate zone.

4.4 Climate Dependent

This lighting measure is not climate dependent in its specific direct energy impacts, but is climate dependent when considering the impacts of the reductions in TDV.

4.5 Time Dependent Valuation

The TDV (Time Dependent Valuation) of savings is a normalized format for comparing electricity and natural gas savings that takes into account the cost of electricity and natural gas consumed during different times of the day and year. The TDV values are based on long term discounted costs (30 years for all residential measures and nonresidential envelope measures and 15 years for all other nonresidential measures). In this case, the period of analysis used is 15 years. The TDV energy estimates are based on present-valued cost savings but are normalized in terms of "TDV kBTUs" so that the savings are evaluated in terms of energy units and measures with different periods of analysis can be combined into a single value.

CEC derived the 2016 TDV values that were used in the analyses for this report (CEC 2014). The TDV energy impacts are presented in Section 5.1 of this report, and the statewide TDV cost impacts are presented in Section 5.2.

4.6 Energy Impacts Methodology

The Statewide CASE Team calculated per unit impacts and statewide impacts associated with all new construction, alterations, and additions during the first year buildings complying with the 2016 Title 24 Standards are in operation.

This is achieved by estimating the component space types in typical buildings that represent impacted LPD values, and then extrapolating this estimate to the entire state through CEC building construction forecasts.

4.6.1 Per Unit Energy Impacts Methodology

The Statewide CASE Team estimated the electricity savings associated with the proposed code change. The energy savings were calculated on a per square foot basis.

The energy savings for this measure will act primarily as a function of reductions in LPD allowances. As a result, the primary basis for calculating energy savings will be a spreadsheet-based analysis that will take into account a variety of variables:

- Reductions in LPD values within the Tables
- Statistical breakdown of space use types within various building use types
- Occupancy and use profiles for various building use types
- Projections of new construction per building use type in California
- Projections for existing constructions alterations and renovations per building use type in CA
- TDV calculations as required to provide a consistent analysis basis for cost-effectiveness

Analysis Tools

The analysis is completed using percentages of composite building spaces comprised of impacted spaces, and predicted through the TDV calculation based on energy use curves sourced through the DEER database for the appropriate building type in conjunction with the assumptions as listed below.

Key Assumptions

As mentioned, CEC provided a number of key assumptions to be used in the energy impacts analysis (CEC 2014). Some of the assumptions included in CEC's Lifecycle Cost Methodology Guidelines (LCC Methodology) include hours of operation, weather data, and prototype building design. The key assumptions used in the per unit energy impacts analysis that are not already included in the assumptions provided in the LCC Methodology, are presented in Table 9.

Table 9: Key assumptions for per unit Energy Impacts Analysis

Parameter	Assumption	Source	Notes
Impacted square footage	Engineering estimate of component sf based on project design conditions	Designer experience and interviews with design resources to make reasonable predictions of sf values	Detailed room composition per building type is not typically available for all impacted area and building types. See Table 8, below.

The area weighted average LPD savings presented in the bottom row of Table 10 are the estimated savings, in Watts per square foot of new construction of each building type. These

weighting factors are based on expert opinion, as there was no data source found to contain a sufficient level of granularity to accurately estimate the square footage of the area categories as a percentage of the building types.

Table 10: Unit Energy Impacts Analysis Building Weighting Factors

Percentage of Impacted Building Area, by Bulding Forcast Category															
Impacted Area Category	Baseline LPD	Modified LPD	LPD Delta	Small Office	Rest.	Retail	Food (Groc.)	NR Warehs.	Ref. Warehs.	School	College	Hospital	Hotel /Motel	Other	Large Office
Auditorium Area	1.5	1.4	0.1							5%	2%			1%	
Convention, Conference, Multipurpose	1.4	1.2	0.2	5%						2%	3%		2%	2%	3%
Dining Area	1.1	1	0.1		75%								2%	2%	1%
Electrical, Mechanical, Telephone	0.7	0.55	0.15	2%	2%	1%				2%	1%		1%	1%	2%
Exhibit, Museum Areas	2	1.8	0.2											1%	
Financial Transaction Area	1.2	1	0.2											1%	
Hotel Function Area	1.5	1.4	0.1										8%		
Kitchen, Food Preparation	1.6	1.2	0.4		10%					5%	1%		3%	1%	1%
Laundry Area	0.9	0.7	0.2										2%	1%	
Library - Reading Areas	1.2	1.1	0.1							5%	2%			2%	
Lobby - Hotel Main	1.1	0.95	0.15										2%		
Lobby - Main Entry	1.5	0.95	0.55	2%	3%	2%							1%	2%	2%
Locker/Dressing Room	0.8	0.7	0.1			5%				5%	1%		1%	1%	1%
Lounge Area	1.1	0.9	0.2							2%	1%			1%	1%
Malls and Atria	1.2	0.95	0.25			10%								3%	
Transportation Function - Concourse	1.2	0.5	0.7											5%	
Transportation Function - Ticketing	1.2	1	0.2											1%	
Waiting Area	1.1	0.8	0.3	2%										2%	
All Other Areas	0.6	0.5	0.1	1%	1%	1%				1%	1%		2%	3%	2%
Area Weighted Average LPD Savings				**0.031**	**0.136**	**0.044**	**0**	**0**	**0**	**0.047**	**0.020**	**0**	**0.043**	**0.088**	**0.030**

4.6.2 Statewide Energy Impacts Methodology

First Year Statewide Impacts

The Statewide CASE Team calculated the statewide savings in 2017 (the first year the standards take effect) by multiplying the per unit savings, which are presented in Section 5.1.1, by the statewide new construction forecast for 2017.

The CEC Demand Analysis Office provided the Statewide CASE Team with the nonresidential new construction forecast for 2017, broken out by building type and forecast climate zones (FCZ). The Statewide CASE Team translated this data to building climate zones (BCZ) using the same weighting of FCZ to BCZ as the previous code update cycle (2013), as presented in Table 13. The projected nonresidential new construction forecast is presented in Table 14.

Table 11 provides a more complete definition of the various space types used in the forecast, and Table 12 presents the assumed percent of new construction that would be impacted by the proposed code change.

The proposed code change applies to all new construction, and additions or alterations that meet the threshold requirements as described in Section 141.0.

Table 11: Description of Space Types used in the Nonresidential New Construction Forecast

OFF-SMALL	Offices less than 30,000 ft^2
OFF-LRG	Offices larger than 30,000 ft^2
REST	Any facility that serves food
RETAIL	Retail stores and shopping centers
FOOD	Any service facility that sells food and or liquor
NWHSE	Nonrefrigerated warehouses
RWHSE	Refrigerated Warehouses
SCHOOL	Schools K-12, not including colleges
COLLEGE	Colleges, universities, community colleges
HOSP	Hospitals and other health-related facilities
HOTEL	Hotels and motels
MISC	All other space types that do not fit another category

Table 12: Percent of New Construction Impacted by the Proposed Measure

Space Type	Percent of New Construction in 2017 Impacted by Proposed Code Change	Climate Zones Impacted by Proposed Code Change
OFF-SMALL	12%	All Climate Zones (1 – 16)
OFF-LRG	13%	
REST	91%	
RETAIL	19%	
FOOD	0%	
NWHSE	0%	
RWHSE	0%	
SCHOOL	27%	
COLLEGE	12%	
HOSP	0%	
HOTEL	24%	
MISC	30%	

Table 13. Translation from FCZ to BCZ

Source: CEC Demand Analysis Office

Forecast Climate Zones (FCZ)	Building Standards Climate Zones (BCZ)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1	22.5%	20.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.8%	33.1%	0.2%	0.0%	0.0%	13.8%	100%
2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.0%	75.7%	0.0%	0.0%	0.0%	2.3%	100%
3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.0%	22.8%	54.5%	0.0%	0.0%	1.8%	100%
4	0.2%	13.7%	8.4%	46.0%	8.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.8%	0.0%	0.0%	0.0%	0.0%	100%
5	0.0%	4.2%	89.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.6%	0.0%	0.0%	0.0%	0.0%	100%
6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100%
7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	75.8%	7.1%	0.0%	17.1%	100%
8	0.0%	0.0%	0.0%	0.0%	0.0%	40.4%	0.0%	51.1%	8.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	100%
9	0.0%	0.0%	0.0%	0.0%	0.0%	7.0%	0.0%	24.5%	57.9%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	4.0%	100%
10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	74.9%	0.0%	0.0%	0.0%	12.3%	7.9%	4.9%	100%
11	0.0%	0.0%	0.0%	0.0%	0.0%	33.0%	0.0%	24.8%	42.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
12	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	20.2%	75.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%	100%
13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	69.6%	0.0%	0.0%	28.8%	0.0%	0.0%	0.0%	1.6%	0.1%	0.0%	100%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	99.9%	0.0%	100%
16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
17	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.1%	100%

Table 14: Estimated New Nonresidential Construction in 2017 by Climate Zone and Building Type (Million Square Feet)

Source: CEC Demand Analysis Office

Climate Zone	New Construction in 2017 (Million Square Feet)												
	OFF-SMALL	REST	RETAIL	FOOD	NWHSE	RWHSE	SCHOOL	COLLEGE	HOSP	HOTEL	MISC	OFF-LRG	TOTAL
1	0.058	0.016	0.041	0.014	0.040	0.002	0.046	0.018	0.028	0.031	0.094	0.069	0.457
2	0.227	0.088	0.630	0.163	0.327	0.031	0.244	0.163	0.200	0.350	0.742	1.140	4.306
3	0.728	0.408	2.913	0.677	2.518	0.183	1.000	0.625	0.729	1.400	3.894	4.952	20.026
4	0.484	0.190	1.586	0.413	0.595	0.071	0.541	0.408	0.490	0.890	1.641	2.935	10.245
5	0.094	0.037	0.308	0.080	0.116	0.014	0.105	0.079	0.095	0.173	0.319	0.570	1.990
6	0.811	0.825	3.072	0.756	2.649	0.122	0.659	0.649	0.508	0.571	4.144	2.264	17.030
7	0.959	0.300	1.635	0.502	1.004	0.013	0.772	0.448	0.325	1.059	3.077	1.253	11.347
8	1.078	1.106	4.241	1.034	3.588	0.162	0.856	0.931	0.773	0.872	5.860	3.186	23.686
9	0.971	0.916	3.975	0.937	3.287	0.119	0.600	1.095	1.127	1.329	5.376	5.675	25.408
10	1.372	0.707	2.995	0.839	2.630	0.074	0.883	0.580	0.528	1.056	8.010	1.496	21.170
11	0.333	0.088	0.770	0.268	0.875	0.089	0.504	0.156	0.239	0.197	0.737	0.629	4.885
12	1.710	0.502	3.656	1.014	3.157	0.202	1.687	0.678	1.048	1.480	3.637	4.721	23.493
13	0.668	0.205	1.606	0.544	1.706	0.286	1.401	0.390	0.520	0.359	1.884	0.817	10.387
14	0.224	0.138	0.609	0.162	0.527	0.025	0.156	0.128	0.115	0.185	1.472	0.431	4.171
15	0.349	0.096	0.675	0.238	0.761	0.022	0.192	0.098	0.133	0.204	1.123	0.289	4.180
16	0.199	0.106	0.506	0.142	0.449	0.042	0.205	0.122	0.125	0.144	0.931	0.394	3.367
TOTAL	10.264	5.729	29.218	7.784	24.228	1.457	9.852	6.570	6.983	10.301	42.941	30.821	186.148

4.7 Cost-effectiveness Methodology

This measure proposes a prescriptive requirement. As such, a lifecycle cost analysis is required to demonstrate that the measure is cost-effective over the 15-year period of analysis.

CEC's procedures for calculating lifecycle cost-effectiveness are documented in LCC Methodology (CEC 2011). The Statewide CASE Team followed these guidelines when developing the Cost-effectiveness Analysis for this measure. CEC's guidance dictated which costs were included in the analysis. Incremental equipment and maintenance costs over the 15-year period of analysis were included. The TDV energy cost savings from electricity savings were considered. Each of these components is discussed in more detail below.

Design costs were not included nor are incremental cost of verification.

4.7.1 Incremental Cost Methodology

This measure does not propose additional requirements that are likely to incur incremental costs for the industry. The lighting calculations reflect the advancement of light source technology; permitting the reduction of lighting power density while still achieving the desired light levels. As a result, the proposed changes may actually result in a reduction in lighting equipment costs, but for this measure, is considered cost neutral.

4.7.2 Cost Savings Methodology

Energy Cost Savings Methodology

The present value (PV) of the energy savings were calculated using the method described in the LCC Methodology (CEC 2014). The hourly energy savings estimates for the first year of building operation were multiplied by the 2016 TDV cost values to arrive at the PV of the cost savings over the period of analysis. The hours of operation used for the various building types employ the 'occupancy' schedules in the 2008 Alternative Calculation Method Approval Manual, which categorizes buildings into the primary categories; 'General Nonresidential', 'Hotel', and 'Retail' (T24 ACM).

This measure is not climate sensitive, but the energy cost savings were calculated in each climate zone using TDV values for each unique climate zone. This analysis is not calculating interaction effects between reduced lighting gains and increased heating loads and decreased air conditioning loads. In most cases, the interaction effects are small and the heating load increases are offset by the cooling load decreases.

Other Cost Savings Methodology

This measure does not have any non-energy cost savings.

4.7.3 Cost-effectiveness Methodology

The Statewide CASE Team calculated the cost-effectiveness using the LCC Methodology (CEC 2014). According to CEC's definitions, a measure is cost effective if it reduces overall lifecycle cost from the current base case (existing conditions). The LCC Methodology clarifies

that absolute lifecycle cost of the proposed measure does not need to be calculated. Rather, it is necessary to calculate the change in lifecycle cost from the existing conditions to the proposed conditions.

If the change in lifecycle cost is negative then the measure is cost-effective, meaning that the present value of TDV energy savings is greater than the cost premium, or the proposed measure reduces the total lifecycle cost as compared to the existing conditions. Propane TDV costs are not used in the evaluation of energy efficiency measures.

The Planning Benefit to Cost (B/C) Ratio is another metric that can be used to evaluate cost-effectiveness. The B/C Ratio is calculated by dividing the total present value TDV energy cost savings (the benefit) by the present value of the total incremental cost (the cost). If the B/C Ratio is greater than 1.0 (i.e. the present valued benefits are greater than the present valued costs over the period of analysis), then the measure is cost effective.

4.8 Environmental Impacts Methodology

4.8.1 Greenhouse Gas Emissions Impacts Methodology

Greenhouse Gas Emissions Impacts Methodology

The Statewide CASE Team calculated avoided GHG emissions assuming an emission factor of 353 metric tons of carbon dioxide equivalents ($MTCO_2e$) per gigawatt hour (GWh) of electricity savings. As described in more detail in Appendix A, the electricity emission factor represents savings from avoided electricity generation and accounts for the GHG impacts if the state meets the Renewable Portfolio Standard (RPS) goal of 33 percent renewable electricity generation by 2020. Avoided GHG emissions from natural gas savings were calculated using an emission factor of 5,303 $MTCO_2e$/million therms (U.S. EPA 2011).

4.8.2 Water Use Impacts Methodology

There are no impacts on water use or water quality.

4.8.3 Material Impacts Methodology (Optional)

The Statewide CASE Team did not develop estimates of material impacts.

4.8.4 Other Impacts Methodology

There are no other impacts from the proposed code change.

5. ANALYSIS AND RESULTS

Results from the energy, demand, cost, and environmental impacts analyses are presented in this section.

This proposal reduces the area category LPD values by an average of 10%. These values are applied whenever the specific area use type is applied, but the overall impact of the changes will be much less clear as individual area use types are not tracked in the construction forecasts.

5.1 Energy Impacts Results

5.1.1 Per Unit Energy Impacts Results

Per unit energy and demand impacts of the proposed measure are presented in Table 15. Energy savings per square foot are expected to be 0.13 kilowatt-hours per year (kWh/yr). Demand savings are expected to be 0.031 Watts (W).

It is estimated that the TDV electricity over the 15-year period of analysis will be $0.284 per square foot. The TDV methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 15: Energy Impacts per Square Foot[1]

Climate Zone	Per Unit First Year Savings[2]			Per Unit First Year TDV Savings[3]
	Electricity Savings[4] (kWh/yr)	Demand Savings (kW)	Natural Gas Savings (Therms/yr)	TDV Savings[5] **(2017 PV$)**
TOTAL	0.13	0.000031	N/A	0.284

1. Unit is one square foot of newly constructed space.
2. Savings from one unit for the first year the building is in operation.
3. TDV energy savings is the present value savings over 15 years per square foot of impacted floor space.
4. Site electricity savings.
5. Calculated using CEC's 2016 TDV factors and methodology. Includes savings from electricity and natural gas.

5.1.2 Statewide Energy Impacts Results

First Year Statewide Energy Impacts

The statewide energy impacts of the proposed measure are presented in Table 16. During the first year buildings complying with the 2016 Title 24 Standards are in operation, the proposed measure is expected to reduce annual statewide electricity use by 24 GWh and reduce demand by 5.7 megawatts (MW).

Table 16: Statewide Energy Impacts

	First Year Statewide Savings[1]			TDV Savings[2]
	Electricity Savings[3] (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	TDV Electricity Savings[4] (Million PV $)
TOTAL	24	5.7	N/A	53

1. First year savings from all buildings built statewide during the first year the 2016 Standards are in effect.
2. 15 year present value TDV savings from all buildings built statewide during the first year the 2016 Standards are in effect.
3. Site electricity savings.
4. Calculated using CEC's 2016 TDV factors and methodology.

All assumptions and calculations used to derive per unit and statewide energy and demand savings are presented in Section 4.6 of this report.

5.2 Cost-effectiveness Results

5.2.1 Incremental Cost Results

There are no anticipated incremental costs associated with this measure.

5.2.2 Cost Savings Results

Energy Cost Savings Results

The per unit TDV energy cost savings over the 15-year period of analysis are presented in Table 17. Lighting energy savings are not climate zone dependent.

Table 17: TDV Energy Cost Savings Over 15-year Period of Analysis - Per Square Foot

Climate Zone	TDV Electricity Cost Savings (2017 PV $)	TDV Natural Gas Cost Savings (2017 PV $))	Total TDV Energy Cost Savings (2017 PV $))
All Climate Zones	.284	N/A	.284

Given data regarding the new construction forecast for 2017, the Statewide CASE Team estimates that TDV energy cost savings (15 year) of all buildings built during the first year the 2016 Standards are in effect will be $53 million.

Other Cost Savings Results

This measure does not have any non-energy cost savings.

5.2.3 Cost-effectiveness Results

These savings are cost effective, because they are achieved without an increase in construction costs through the use of readily-available industry-standard technological and equipment

solutions. In many cases, the reductions in LPD values may result in lower first costs, however the CASE team estimated an incremental cost of zero dollars as a conservative value.

Given data regarding the new construction forecast for 2017, the Statewide CASE Team estimates that that lifecycle cost savings (15 year) of all buildings built during the first year the 2016 Standards are in effect will be $53 million.

5.3 Environmental Impacts Results

5.3.1 Greenhouse Gas Emissions Results

Table 18 presents the estimated first year avoided GHG emissions of the proposed code change. During the first year the 2016 Standards are in effect the proposed measure will result in avoided GHG emissions of 8589 $MTCO_2e$.

Table 18: Statewide Greenhouse Gas Emissions Impacts

	Avoided GHG Emissions[1] ($MTCO_2e$/yr)
TOTAL	8589

1. First year savings from buildings built in 2017; assumes 353 $MTCO_2e$/GWh.

5.3.2 Water Use and Water Quality Impacts

Impacts on water use and water quality are presented in Table 19. The proposed changes do not impact water use or water quality.

Table 19: Impacts of Water Use and Water Quality

	On-Site Water Savings[1] (gallons/yr)	Embedded Energy Savings[2] (kWh/yr)	Impact on Water Quality Material Increase (I), Decrease (D), or No Change (NC) compared to existing conditions			
			Mineralization (calcium, boron, and salts)	Algae or Bacterial Buildup	Corrosives as a Result of PH Change	Others
Impact (I, D, or NC)	NC	NC	NC	NC	NC	NC
Per Unit Impacts[3]	N/A	N/A	N/A	N/A	N/A	N/A
Statewide Impacts (first year)	N/A	N/A	N/A	N/A	N/A	N/A
Comment on reasons for your impact assessment	N/A	N/A	N/A	N/A	N/A	N/A

1. Does not include water savings at power plant
2. Assumes embedded energy factor of 10,045 kWh per million gallons of water.
3. Specify the type of unit such as per building, per square foot, per prototype building. For description of prototype buildings refer to Methodology section below.

5.3.3 Other Impacts Results

No other impacts are anticipated with this proposal.

6. PROPOSED LANGUAGE

The proposed changes to the Standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2013 documents are marked with underlining (new language) and ~~strikethroughs~~ (deletions).

6.1 Standards

Tables 140.6-B, 140.6-C, and 140.6-G will be revised with new LPD values based on the calculations. Section 140.6(a)3C will be modified to provide a specific exception for theatrical makeup lights in dressing rooms.

SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

Section 140.6(a)3C will be modified in the following manner:

C. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for 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 control 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.

Table 140.6-B will be modified in the following manner:

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~~ 1.4
Classroom Building	1.1
Commercial and Industrial Storage Building	0.60
Convention Center Building	~~1.2~~ 1.0
Financial Institution Building	~~1.1~~ 1.0
General Commercial Building/Industrial Work Building	1.0
Grocery Store Building	1.5
Library Building	~~1.3~~ 1.2
Medical Building/Clinic Building	~~1.1~~ 1.0
Office Building	0.80
Parking Garage Building	0.20
Religious Facility Building	~~1.6~~ 1.5
Restaurant Building	~~1.2~~ 1.1
School Building	~~1.0~~ 0.95
Theater Building	1.3
All others buildings	~~0.6~~ 0.50

Table 140.6-C will be modified in the following manner:

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~~ 1.4 [3]		Library Area	Reading areas	~~1.2~~ 1.1 [3]
Auto Repair Area		0.90 [2]			Stack areas	1.5 [3]
Beauty Salon Area		1.7		Lobby Area	Hotel lobby	~~1.1~~ 0.95 [3]
Civic Meeting Place Area		1.3 [3]			Main entry lobby	~~1.5~~ 0.95 [3]
Classroom, Lecture, Training, Vocational Areas		1.2 [5]		Locker/Dressing Room		~~0.8~~ 0.70
Commercial and Industrial Storage Areas (conditioned and unconditioned)		0.60		Lounge Area		~~1.1~~ 0.90 [3]
Commercial and Industrial Storage Areas (refrigerated)		0.70		Malls and Atria		~~1.2~~ 0.95 [3]
Convention, Conference, Multipurpose and Meeting Center Areas		~~1.4~~ 1.2 [3]		Medical and Clinical Care Area		1.2
Corridor, Restroom, Stair, and Support Areas		0.60		Office Area	> 250 square feet	0.75
Dining Area		~~1.1~~ 1.0 [3]			≤ 250 square feet	1.0
Electrical, Mechanical, Telephone Rooms		~~0.7~~ 0.55 [2]		Parking Garage Area	Parking Area	0.14
Exercise Center, Gymnasium Areas		1.0			Dedicated Ramps	0.30
Exhibit, Museum Areas		~~2.0~~ 1.8			Daylight Adaptation Zones [9]	0.60
Financial Transaction Area		~~1.2~~ 1.0 [3]		Religious Worship Area		1.5 [3]
General Commercial and Industrial Work Areas	Low bay	0.90 [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	0.90 [3]
Grocery Sales Area		1.2 [6 and 7]			Performance	1.4 [3]
Hotel Function Area		~~1.5~~ 1.4 [3]		Transportation Function Area	Concourse & Baggage	~~1.2~~ 0.50
					Ticketing	1.0
Kitchen, Food Preparation Areas		~~1.6~~ 1.2		Videoconferencing Studio		1.2 [8]
Laboratory Area, Scientific		1.4 [1]		Waiting Area		~~1.1~~ 0.80 [3]
Laundry Area		~~0.9~~ 0.70		All other areas		~~0.6~~ 0.50

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.		
Footnote number	Type of lighting system allowed	Maximum allowed added lighting power. (W/ft^2 of task area unless otherwise noted)
1	Specialized task work	0.20 W/ft^2
2	Specialized task work	0.50 W/ft^2
3	Ornamental lighting as defined in Section 100.1 and in accordance with Section 140.6.(c)2.	0.50 W/ft^2
4	Precision commercial and industrial work	1.0 W/ft^2
5	Per linear foot of white board or chalk board.	5.5 W per linear foot
6	Accent, display and feature lighting - luminaires shall be adjustable or directional	0.30 W/ft^2
7	Decorative lighting - primary function shall be decorative and shall be in addition to general illumination.	0.20 W/ft^2
8	Additional Videoconferencing Studio lighting complying with all of the requirements in Section 140.6(c)2Gvii.	1.5 W/ft^2
9	Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage	

Table 140.6-G will be modified in the following manner:

TABLE 140.6-G ILLUMINANCE LEVEL (LUX) POWER DENSITY VALUES (WATTS/FT²)

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~~ 0.22	~~0.4~~ 0.32	~~0.6~~ 0.46
100	~~0.4~~ 0.30	~~0.6~~ 0.38	~~0.8~~ 0.56	~~1.2~~ 0.84
200	~~0.6~~ 0.48	~~0.8~~ 0.64	~~1.3~~ 0.88	~~1.9~~ 1.34
300	~~0.8~~ 0.64	~~1.0~~ 0.82	~~1.4~~ 1.12	~~2.0~~ 1.76
400	~~0.9~~ 0.78	~~1.1~~ 0.98	~~1.5~~ 1.34	~~2.2~~ 2.08
500	~~1.0~~ 0.90	~~1.2~~ 1.10	~~1.6~~ 1.52	~~2.4~~ 2.32
600	~~1.2~~ 1.06	~~1.4~~ 1.26	~~2.0~~ 1.74	~~2.9~~ 2.60
700	~~1.4~~ 1.24	~~1.7~~ 1.46	~~2.3~~ 1.82	~~3.3~~ 2.96
800	~~1.6~~ 1.44	~~1.9~~ 1.70	~~2.6~~ 2.28	~~3.8~~ 3.30
900	~~1.8~~ 1.66	~~2.2~~ 2.00	~~3.0~~ 2.64	~~4.3~~ 3.74
1000	~~1.9~~ 1.84	~~2.4~~ 2.20	~~3.3~~ 2.90	~~4.8~~ 4.06

6.2 Reference Appendices

There are no proposed changes to the Reference Appendices.

6.3 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

6.4 Compliance Manuals

Chapter 5 of the Nonresidential Compliance Manual will need to be revised to update the values in the examples and Tables represented.

No new forms are anticipated at this time, and no forms are anticipated to require revision.

6.5 Compliance Forms

There are no proposed changes to the Compliance Forms.

7. REFERENCES AND OTHER RESEARCH

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APPENDIX A: ENVIRONMENTAL IMPACTS METHODOLOGY

Greenhouse Gas Emissions Impacts Methodology

The avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents ($MTCO_2e$) per GWh of electricity savings. The Statewide CASE Team calculated air quality impacts associated with the electricity savings from the proposed measure using emission factors that indicate emissions per GWh of electricity generated.[4] When evaluating the impact of increasing the Renewable Portfolio Standard (RPS) from 20 percent renewables by 2020 to 33 percent renewables by 2020, California Air Resources Board (CARB) published data on expected air pollution emissions for various future electricity generation scenarios (CARB 2010). The Statewide CASE Team used data from CARB's analysis to inform the air quality analysis presented in this report.

The GHG emissions factor is a projection for 2020 assuming the state will meet the 33 percent RPS goal. CARB calculated the emissions for two scenarios: (1) a high load scenario in which load continues at the same rate; and (2) a low load rate that assumes the state will successfully implement energy efficiency strategies outlined in the AB32 scoping plan thereby reducing overall electricity load in the state.

To be conservative, the Statewide CASE Team calculated the emissions factors of the incremental electricity between the low and high load scenarios. These emission factors are intended to provide a benchmark of emission reductions attributable to energy efficiency measures that could help achieve the low load scenario. The incremental emissions were calculated by dividing the difference between California emissions in the high and low generation forecasts by the difference between total electricity generated in those two scenarios. While emission rates may change over time, 2020 was considered a representative year for this measure.

Avoided GHG emissions from natural gas savings were calculated using an emission factor of 5,303 $MTCO_2e$/million therms (U.S. EPA 2011).

Water Use and Water Quality Impacts Methodology

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

[4] California power plants are subject to a GHG cap and trade program and linked offset programs until 2020 and potentially beyond.

APPENDIX B: LED STATE OF INDUSTRY INFORMATION

A review of the current state of lighting equipment performance was made in the industry to determine what advances have occurred in the past three years, and determine what opportunities are anticipated in the near future.

This research focused on the inevitable adoption of LED lighting products as the primary event horizon that is moving toward the lighting industry.

State of the Technology

There are two technologies that consist of solid state lighting: the organic polymeric-based light emitting diode (OLED) and the inorganic semiconductor-based light emitting diode (LED). (NRC 2013)

The development of OLED luminaires is progressing and initial efficacies are similar to that of compact fluorescents. The advantage of OLED panels is that they have the ability to allow for luminaire form factors that have been inconceivable with traditional sources. The lifetime of OLEDs is limited as the technology is sensitive to exposure to both air and moisture. The efficacy of OLEDs in 2012 fell within a range of 57-75 lumens per Watt. The goal of the technology is to reach 190 lumens per watt. The 2013 cost for an OLED luminaire was $2400 per 1000 lumens. (DOE 2013)

The efficacy of white LED chips has been increasing rapidly and is expected to approach 200 lumens per watt by 2020. The highly efficacious source inherently functions well in cold temperatures and is not negatively impacted by vibration. (NRC 2013) Table 20 below illustrates raw LED chip efficacies and costs.

Table 20: Summary of LED Package Price and Performance Projections (Table 2.4) (DOE 2013)

Metric	2012	2013	2015	2020	Goal
Cool-White Efficacy (lm/W)	150	164	190	235	266
Cool-White Price ($/klm)	6	4	2	0.7	0.5
Warm-White Efficacy (lm/W)	113	129	162	224	266
Warm-White Price ($/klm)	7.9	5.1	2.3	0.7	0.5

Note: Projections for cool-white packages assume CCT=4746-7040 K and CRI >70, while projections for warm-white packages assume CCT=2580-3710 K and CRI >80. All efficacy projections assume that packages are measured at 25 °C with a drive current density of 35 A/cm^2.

In a 2013 trend analysis, the DOE found that LED downlight luminaire efficacies were 53-63 lumens per watt, LED troffer luminaires were 93-97 lumens per watt, and LED highbay and lowbay luminaires were 91-98 lumens per watt. The average efficacy for parking garage luminaires was found to be 72 lumens per watt. LED lamp cost per 1000 lumens is expected to decrease approximately 55% by 2017. LED luminaires are expected to experience a 30% decrease in cost per 1000 lumens by 2017. (PNNL 2013)

State of the Market

The high cost of production of OLED luminaires and the truncated lifetimes make the technology a non-viable solution for general illumination. (DOE 2013) In contrast, the market is primed for the onset of LED products. It is expected that nearly all LEDs could account for over half of all of the light produced in the United States by 2025. (DOE 2013) And by 2030, it is forecasted that LED lighting will represent over 75 percent of all lighting sales, saving 3.4 quads of energy annually. (Navigant 2012)

The indoor luminaire market is comprised of many different applications. Three indoor applications consume over 50 percent of the total lighting electricity use in the United States. These applications include: downlights, troffers, and high-bay luminaires. (Adoption report). LED luminaires, not only in these applications, have the potential to save a significant amount of energy because many of the new products on the market meet or exceed the efficacy performance of products that use conventional light sources. One indicator of such progress in performance is an annual competition that is co-sponsored by the Department of Energy, Next Generation Luminaires. The indoor luminaires winners reported having an efficacy of 75 lumens per watt (2013), 65 lumens per watt (2012) and 37 lumens per watt (2008). (Navigant 2013)

LED downlight luminaire efficacies have been found to be on par with typical CFL downlight luminaires. This application has minimal market penetration at this time, with LED downlights representing less than 1 percent of the total 708 million downlight luminaires in 2012. As policy regulations take effect limiting traditional technologies, such as incandescent, it is expected that LED downlights will consume a larger portion of the market. If LED downlights were to saturate the market, approximately 278 trillion BTUs (tBtu) of annual energy savings could be realized. (Navigant 2013)

LED products in troffer applications meet or exceed the performance of traditional linear fluorescent troffer luminaires. While the performance exists, as of 2012, the market penetration of LED troffer luminaires was less than 0.1 percent of the 964 million troffer luminaires. If LED troffer luminaires saturated the market, approximately 1,146 tBtu annual energy savings could be realized. (Navigant 2013)

Traditionally, high intensity discharge and high output linear fluorescent luminaires have dominated the high-bay luminaire market because the large lumen packages required. A 2010 CALiPER report found that LED luminaires struggled to compete with incumbent technologies. As of 2013, the DOE's database of lighting facts reports that there are over 100 listed LED luminaires that deliver the required lumen packages for this application. As of 2012, LED luminaires in high-bay applications represent less than one percent of the 67

million installed high-bay luminaires. If LED high-bay luminaires were to saturate the market, approximately 483 tBtu of annual energy savings could be realized. (Navigant 2013)

Issues Affecting Market Adoption

While the luminaire efficacy has already surpassed the incumbent technology, there are some limitations of the technology that is preventing quicker, wide-scale adoption.

The higher cost of the LED technology is one of the leading market barriers. In 2012, CFL reflector prices average at roughly $10 per lamp, while the average LED reflector price in $46 per lamp. (Navigant 2013) There are two main drivers for the cost of LED products: the binning process which reduces the variability of color between individual LED chips and thermal management. (NRC 2013)

The stated lifetimes are also a limitation of the technology. Being that the reported lifetimes span such a long period of time, with the warranty of the product often being shorter than the expected lifetime, there is speculation within the market if the claims are valid.

As the technology develops into electronics components, adopters want to ensure that the whole lighting system performance works in sync. The market requires dimming compatibility between LED module and LED driver, regardless of manufacturer. As components of the system reach their lifetimes, interchangeability becomes essential.

Future Technology Developments

It is expected that as the cost of LED luminaires continues to decrease, manufacturers may begin investing back into the products with more features imbedded in to luminaire. LED products have been undergoing testing on lumen depreciation over time. Given the long rated lifetimes of the products, it is unknown at what point in the luminaire's rated life when lumen depreciation takes place and by what magnitude. Coupled with the common design practice to design spaces with maintained light output levels, there is great potential for many spaces to be overlighted from the point of installation for a period of time until lumen depreciation takes place. One way to alleviate this overlighting from the beginning, is to have onboard controls which provide a constant lumen output for the duration of the luminaire's life by automatically adjusting the drive current.

APPENDIX C: LIGHTING CALCULATION RESULTS

Lighting Assumptions and Design Standards

Calculation Basis

These lighting calculations are built primarily on average illuminance criteria for the various space types in question. As a result, a simple lumen method calculation is suitable to calculate the adequacy of lighting power density to meet the established design illuminance criteria.

The criteria are selected from the IES Handbook, 10th Edition, and other Recommended Practice documents.

Complete Building Method Criteria Mapping						
Title 24 - 2013		IES 10th to Title 24	IES 10th Edition			
Area	LPA (W/ft^2)	LPW	Area	Specific	Horiz. Ill. (fc)	Vert. Ill. (fc)
Auditorium	1.50	67	Auditorium	Lecture Hall -	100	50
Classroom	1.10	91	Classroom	Lecture Halls - Demonstration	100	50
Commercial and Industrial Storage	0.60	50	Warehouse	Small (Small Labels	30	15
Convention Center	1.20	33	Conference Rooms	Faces	30	40
Financial Institution	1.10	45	Financial Facilities	Processing Centers	50	20
General Commercial/ Industrial Work	1.00	300	Manufacturing Facility	Exacting Detail	300	300
Grocery Store	1.50	33	Grocery / Supermarket	General Retail	50	20
Library	1.30	38	Library	Lending Desk - Staffed	50	20
Medical/Clinic	1.10	182	Health Care Facilities	Operating Room - General	200	75
Office	0.80	38	Office	Computer (Pos. Contrast)	30	15
Parking Garage	0.20	NA	Parking Garage	General	NA	NA
Religious Facility	1.60	19	Religious Facility	Contemporary Form-Participatory	30	15
Restaurant	1.20	17	Food Service	Restaurant - Fast Food	20	7.5
School	1.00	100	Classroom	Lecture Halls - Demonstration	100	50
Theater	1.30	12	Theater	Performance - Pre/Post Function	15	7.5
All Other	0.60					

A compilation of the various design criteria employed for the calculations in the Area Category Method is shown below:

Area Catrgory Method Criteria Mapping													
Title 24 - 2013			2008	2005	2001	1998	1995	1992	IES 10th to Title 24	IES 10th Edition			
Area (footnote)		LPA (W/ft^2)							LPW	Area	Specific	Horiz. Ill. (fc)	Vert. Ill. (fc)
Auditorium (3)		1.50	1.50	1.50	2.00	2.00	2.00	2.00	1	Auditoriums	Circulation - Peformance/AV	.2 min	1
									7		Lecture Hall - Audience	10	4
									67		Lecture Hall - Demonstration	100	50
									3		Lecture Hall - Screen	-	5 max
									33		Lecture Hall - Speaker	50	20
									3		Social (Dancing)	5	3
									20		Exhibition	30	20
									20		Study	30	10
									27		Testing - Paper	40	15
									5		Performance - Pre-function House	7.5	5
Auto Repair (2)		0.90	0.90	1.10	1.20	1.20			83	Garages - Service Repairs		75	75
Beauty Salon		1.70	1.70						18	Spa	Make-up Station	30	30
									12		Nails - General	20	10
									29		Nails - Painting	50	15
									44		Salon - Color Chair	75	20
									12		Salon - General	20	10
									29		Salon - Styling Chair	50	30
									18		Salon - Wash	30	10
Civic Meeting Place (3)		1.30	1.30	1.30	1.50	1.60			8	Courtroom	Public Seating area	10	5
									12		Judge/ Clerk Suite - General	15	5
									38		Evidence Table	50	20
									38		Podium	50	20
									23		Witness chair	30	15
									31	Fire Station	Turnout Gear Room	40	20
									15	Correctional Facilities	Cells	20	10
									31		Dayroom	40	15
									23	Post Office	Consumer - Postal Window	30	10
									38		Processing Center - Distribution	50	20
Classroom, Lecture, Training, Vocational (5)		1.20	1.20	1.20	1.60	1.60	2.00	2.00	33	Classrooms	Classroom - Writing	40	15
									25		Classroom - White Board	-	30
									42		Art Studies	50	30
									42		CAD - Drafting	50	10
									8		Lecture Halls - Audience	10	4
									83		Lecture Halls - Demonstration	100	50
									42		Science Room - Bench	50	30
									83		Science Room - Demonstration	100	50
									83		Shop Class	100	50
									25		Study Hall	30	20
Commercial and Industrial Storage	Cond. and Uncond.	0.60	0.60	0.60	0.60		0.60	0.60	8	Warehouse	Infrequent Use	5	2
									17		Bulky (Large Labels)	10	5
									50		Small (Small Labels	30	15
	Refridg.	0.70	0.70						14	Food Service	Food Storage - Nonrefrigerated	10 min	3 min
									14		Food Storage - Refrigerated	10 min	3 min
Convention, Conference, Multipurpose, and Meeting Center (3)		1.40	1.40	1.40		1.60	1.60	1.60	21	Conference Rooms	Discourse	30	7.5
									29		Faces	30	40
									2		Computer Presentation	3	3
Corridor, Restroom, Stair, and Support		0.60	0.60	0.60	0.60	0.60	0.80	0.80	8	Corridor		5	3
									8	Elevator	Freight	5	3
									8		Passanger	5	3
									17		Elevator Lobby	10	3
									8	Restroom	General	5	3
									33		For Grooming	15	20
									8	Stairway	General	5	3
									17		High Activity	10	5

Dining Area (3)		1.10	1.10	1.10	1.10	1.10	1.20	1.20	18	Food Service	Cashier	20	7.5
									9		Coffee Shop	10	3
									9		Bar/ Lounge	10	5
									18		Restaurant - Fast Food	20	7.5
									9		Restaurant - Casual	10	5
									3		Restaurant - Fine Dining	3	1
Electrical, Mechanical, Telephone		0.70	0.70	0.70		0.70			14	Electrical Closets		10	10
Exercise Center, Gymnasium		1.00	1.00	1.00	1.00	1.00			50	Gymnasium	Physical Education	50	20
									30		General Activities	30	10
									40		Exercise - Personal Training	40	15
Exhibit, Museum		2.00	2.00	2.00	2.00	2.00	2.30	2.30	25	Exhibition Halls	High Light Setting	50	20
									8		Low Light Setting	15	7.5
									0	Museum	Objects with Low Light Sensitivity	20 max	20 max
									0		Objects with High Light Sensitivity	5 max	5 max
									15		Conservation - General	30	30
									38		Conservation - Task area	75	75
Financial Transaction (3)		1.20	1.20	1.20	1.40	1.40		1.80	8	Financial Facilities	Lobby, General	10	5
									25		Lobby, Writing Area	30	10
									25		Teller's Stations	30	10
									17		ATM - Indoor	20	10
									42		Processing Centers	50	20
									17		Safe Deposit Boxes - Deposit Box	20	10
									42		Safe Deposit Boxes - Inspection	50	20
General Commercial and Industrial Work	Low bay (2)	0.90	0.90	1.10	1.00	1.00			56	Manufacturing Facility	Maintenance	50	15
									11		Conveyance Aisle	10	5
									33		Simple Detail	30	30
	High bay (2)	1.00	1.00	1.00	1.20	1.20	1.30	1.30	50		Medium Detail	50	50
									100		Fine Detail	100	100
	Precision (4)	1.20	1.20	1.30	1.50	1.50	2.00	2.00	250		Exacting Detail	300	300
Grocery Sales (6,7)		1.20	1.60	1.60	1.60	1.60	2.00	2.00	17	Grocery / Supermarket	Circulation	20	7.5
									0		Feature (Highlight)	25% of Display x5 (max)	25% of Display x5 (max)
									42		General Retail	50	20
									42		Perimeter	-	50
Library	Reading (3)	1.20	1.20	1.20	1.20	1.20			42	Library	Reading	50	10
											Stacks (30" AFF)	30	20
	Stack (3)	1.50	1.50	1.50	1.50	1.50			20		Lending Desk - Staffed	50	20
Lobby	Hotel Lobby (3)	1.10	1.10	1.10	1.70	2.20	2.30	2.30	9	Lobby - Hotel	Circulation	10	3
									14		Receptionist	15	5
	Main Entry Lobby (3)	1.50	1.50	1.50	1.50	1.50	1.60	1.60	7	Lobby - Office	Building Entry - Day	10	5
									3		Building Entry - Night	5	2
									7		Distant from Entry	10	5
									13		Security Screening - Public "Misc"	20	10
									27		Receptionist	40	15
									13		Waiting Area	20	10
Locker/Dressing Room		0.80	0.80	0.80	0.80	0.90			25	Performance	Dressing Room - General	20	10
									63		Dressing Room - Reading	50	30
									63		Dressing Room - Vanity	50	40
									38	Retail	Dressing Room - Typical	30	30
									63		Dressing Room - Upscale	30	50
									6	Locker Room	General	5	3
									13		Shower	10	5
									25		Vanity	15	20
Lounge (3)		1.10	1.10	1.10	1.10	1.10			4	Lounge/Reading	Club Lounge - General	4	1.5
									27		Club Lounge - Table Games	30	5
									14		Reading	15	5
									4		Social	4	1.5
Malls and Atria (3)		1.20	1.20	1.20	1.20	1.20	1.20	1.20	8	Malls (See Retail)	Mall Concourse	10	3
									25		Retail Kiosk	30	30
									25		Customer Service	30	10

Medical and Clinical Care		1.20	1.20	1.20	1.40	1.40	1.80	1.80	42	Health Care Facilities	Pharmacy - General	50	20
									63		Pharmacy - Medication Assignment	75	30
									8		Corridor	10	5
									25		Laundry/ Washing	30	15
									3		Lounge/ Recreation	4	1.5
									25		Medication - Storage	30	10
									42		Exam/ Treatment - General	50	15
									83		Exam/ Treatment - Table	100	30
									25		Radiology - Image Viewing	30	10
									8		Nursery - General	10	3
									25		Nursery - Observation	30	5
									42		Nurse's Station - Day	50	20
									8		Nurse's Station - Night	10	4
									167		Operating Room - General	200	75
									4		Patient Room - General	5	2
									42		Patient Room - Exam in Bed	50	20
									8		Physical Therapy - General	10	3
									42		Recovery Room - Observation	50	20
									8		Recovery Room - Rest	10	3
									13		Emergency - General Observation	10	15
Office	>250sqft	0.75	0.90						15	Office	Receptionist/ Copy	15	5
	≤250sqft	1.00	1.10	1.20	1.30	1.30	1.60	1.60	30		Computer (Positive Contrast)	30	15
									40		Written Task (Colored Pen)	40	7.5
Parking Garage	Parking	0.14	0.20	0.40					2	Parking Garage (RP-20)	Basic	1	0.5
	Dedicated Ramps	0.30	0.60						3		Ramps - Day	2	1
									2		Ramps - Night	1	0.5
	Daylight Adaptation	0.60							83		Entrance Areas - Day	50	25
									2		Entrance Areas - Night	1	0.5
Religious Worship (3)		1.50	1.60	1.50	2.10	2.10	2.20	2.20	1	Contemporary Form	Congregation - Dark House	.2 min	1
									0		Congregation - Typical	0.3x Liturgical Activity	
									7		Collective Meditation	10	5
									20		Participatory Action	30	15
									7		Sermon	10	5
									0		Focal Point	100 to 150	100 to 150
									1	Traditional Form	Congregation - Dark House	.2 min	1
									0		Congregation - Typical	0.3x Liturgical Activity	
									3		Collective Meditation	4	2
									7		Participatory Action	10	5
									3		Sermon	4	2
									0		Focal Point	50 to 100	50 to 100
									27	General Spaces	Reception Desk	40	15
									13		Lounge/ Waiting room	20	10
									7		Social/ Circulation	10	5
Retail Merchandise Sales, Wholesale, Showroom (6,7)		1.20	1.60	1.70	2.00	2.00	2.00	2.20	13	Department Store	Circulation	15	5
									0		Feature (Highlight)	25% of Display x5 (max)	25% of Display x5 (max)
									33		General Retail	40	15
									63		Perimeter	-	75
									6	Designer Boutique	Circulation	7.5	2
									0		Feature (Dazzle)	10% of Display x10 (max)	10% of Display x10 (max)
									17		General Retail	20	7.5
									17		Perimeter	-	20
									17	Drug/ Convenience	Circulation	20	7.5
									0		Feature (Highlight)	25% of Display x5 (max)	25% of Display x5 (max)
									42		General Retail	50	20
									42		Perimeter	-	50
									25	Retail	Fitting Room - Typical	30	30
									25		Kiosk Display	30	30

Theater	Motion Picture (3)	0.90	0.90	0.90	0.90	0.90	1.00	1.00	6	Theater	Film - Pre/Post-show	5	2
									0		Film - Previews	1.0 min	0.4
									0		Film - During Show	0.2 min	0.4
	Performance (3)	1.40	1.40	1.40	1.40	1.40	1.50	1.50	11		Performance - Pre/Post Function	15	7.5
									7		Performance - House (Pre-show, etc)	10	3
									0		Performance - House (During Show)	0.2 min	0.4
									3		Peformance - Green Room (General)	4	1.5
									11		Peformance - Green Room (Reading)	15	5
Hotel Function (3)		1.50	1.50	1.50	2.20	2.20	2.30	2.30	1	Guest Room	General	2	0.8
									3		Steps/ Stairs	4	-
									13		Reading - Desk	20	3
									10		Reading - Casual Chair	15	5
									13		Reading - Bed Headboard	20	10
Kitchen, Food Preparation		1.60	1.60	1.60	1.70	1.70	2.20	2.20	13	Food Service Facilities	Dishwashing	20	10
									9		Cafeteria	15	5
									13		Buffet Display	20 min	20 min
									31		Food Preparation	50 min	20 min
									13		Equipment Storage	20 min	10 min
									6		Refuse/ Soiled Ware Return	10 min	5
									3		Wine Cellar - Sommelier	5	5
									6		Wine Cellar - Display	10	10
Laboratory Area, Scientific (1)		1.40	1.40						36	Laboratory	Classroom - Science Bench	50	30
									21		Forensics - General	30	15
Laundry		0.90	0.90	0.90	0.90	0.90			33	Laundry	Dormitory	30	5
Transportation Function		1.20	1.20	1.20					17	Transportation Terminal	Baggage Claim - Belt	20	10
									4		Concourse - General	5	2
									13		Concourse - Seating	15	5
									8		Customs - Queuing	10	5
									33		Customs - Screening	40	20
									17		Security - Credentials	20	10
									17		Security - Public	20	10
									25		Ticketing - Agent Counter	30	15
									4		Ticketing - Queuing	5	2
									17		Ticketing - Service Kiosk	20	10
									8		Train Platform -Embark	10	3
Videoconferencing Studio (8)		1.20							0	Video Conferencing	Video Display	-	20 max
									33		Faces and 40% matte Table	30	40
Waiting Area (3)		1.10	1.10	1.10					14	Reading/ Work Areas		15	5
All Other Areas		0.60	0.60	0.60	0.60	0.60							

Footnotes	
1. Specialized task work	0.20
2. Specialized task work	0.50
3. Ornamental lighting as defined in Section 100.1 and in accordance with Section 140.6(c)2	0.50
4. Precision commercial and industrial work	1.00
5. Per linear foot of white board or chalk board	5.5W per lin. ft
6. Accent, display and feature lighting - luminaires shall be adjustable or directional	0.30
7. Decorative lighting - primary function shall be decorative and shall be in addition to general illumination	0.20
8. Additional Videoconferencing Studio lighting complying with all of the requirements in Section 140.6(c)2Gvii	1.50
9. Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage	

Light Source Efficacy Information

A variety of light sources were evaluated to establish the overall efficacy of the various light sources that were considered for this measure. Below is a summary sheet of mean efficacy for these light sources.

Typical Light Source Efficacy Comparison

Lamp Type	Mean Lumen Output	Efficacy		System Watts (Avg)	System Efficacy		Criteria
		Initial	Mean		Initial	Mean	
Incandescent (LOW)	260	-	8	34	-	8	≤ 50W
Incandescent (HIGH)	2000	-	14	171	-	14	> 50W
Halogen (LOW)	600	-	14	43	-	14	≤ 50W
Halogen (HIGH)	1500	-	16	102	-	16	> 50W
LED 3500K 2013 (≤300mA)	200	-	125	2	-	--	≤ 300mA
LED 3500K 2013 (>300mA, <1000mA)	1000	-	89	10	-	--	300mA - 1000mA
LED 3500K 2013 (≥1000mA)	2700	-	97	31	-	--	≥ 1000mA
CFL (LOW)	600	62	53	13	58	50	≤ 24W
CFL (HIGH)	1700	71	61	37	68	59	> 24W
CFL (Linear Biax)	2500	85	73	39	75	65	Biax Linear
Metal Halide (LOW)	4000	88	62	77	78	55	≤ 100W
Metal Halide (HIGH)	30000	96	68	435	85	60	> 100W
Metal Halide (PAR)	4150	56	56	90	49	49	PAR
Induction (LOW)	4300	-	71	64	-	67	≤ 90W
Induction (HIGH)	15000	-	73	230	-	69	> 90W
HPS (LOW)	5000	87	73	83	75	62	≤ 100W
HPS (HIGH)	43000	117	104	421	101	90	> 100W
Linear Fluorescent	2700	92	86	36	84	79	Standard Lumen Output
Linear Fluorescent (HO)	4000	93	87	51	83	77	High Lumen Output

0-25	25-50	50-75	>75
Efficacy Ranges (LPW)			

A review of each lamp type was performed to collect available lamp performance and other performance characteristics. A sample of these characteristic tables is shown below for compact fluorescent lamps and ballasts.

Representative Lamp and System Efficacy Values - Compact Fluorescent Options																
Lamp Values										System Values						
Lamp	Brand	Type	Wattage	Lumens (Initial)	Lumens (Mean)	Efficacy (Initial)	Efficacy (Mean)	Avg. Initial Efficacy	Avg. Mean Efficacy	Ballast	Brand	Wattage (Max)	Efficacy (Initial)	Efficacy (Mean)	Avg. Initial Efficacy	Avg. Mean Efficacy
Low Wattage (≤ 24)																
CF7DS/E/841	Os Sy	Bi	7	400	345	57	49			RMB-IP13-SI	Phillips	8	50	43		
CF9DS/E/841	Os Sy	Bi	9	580	500	64	56			RMB-IP13-SI	Phillips	10	58	50		
CF13DS/E/841	Os Sy	Bi	13	800	690	62	53			ICF-2S13-M1-BS	Phillips	16	50	43		
CF7DS/841/ECO	Os Sy	Bi	7	400	345	57	49			RMB-IP13-SI	Phillips	8	50	43		
CF9DS/841/ECO	Os Sy	Bi	9	580	500	64	56	62	53	RMB-IP13-SI	Phillips	10	58	50	58	50
CF13DS/841/ECO	Os Sy	Bi	13	800	690	62	53			ICF-2S13-M1-BS	Phillips	16	50	43		
CF9DD/835/ECO	Os Sy	Quad	9	535	450	59	50			RMB-IP13-SI	Phillips	10	54	45		
CF13DD/835/ECO	Os Sy	Quad	13	780	670	60	52			RMB-IP13-SI	Phillips	14	56	48		
CF18DD/E/835/ECO	Os Sy	Quad	18	1150	990	64	55			RMB-2P13-S2	Phillips	16	72	62		
CF18DD/835/ECO	Os Sy	Quad	18	1150	990	64	55			REB-118-M6-EL	Phillips	18	64	55		
CF18DT/E/IN/835/ECO	Os Sy	Tri	18	1200	1030	67	57			RMB-2P13-S2	Phillips	16	75	64		
				Avg	**655**							**Avg**	**13**			
High Wattage (> 24)																
CF26DD/E/835/ECO	Os Sy	Quad	26	1710	1470	66	57			RMB-IP26-S2	Phillips	26	66	57		
CF26DD/835/ECO	Os Sy	Quad	26	1710	1470	66	57			RMB-IP26-S2	Phillips	26	66	57		
CF26DT/E/IN/835/ECO	Os Sy	Tri	26	1800	1550	69	60	71	61	RMB-IP26-S2	Phillips	26	69	60	68	59
CF32DT/E/IN/835/ECO	Os Sy	Tri	32	2400	2065	75	65			RCF-2S26-HI-LD-QS	Phillips	36	67	57		
CF42DT/E/IN/835/ECO	Os Sy	Tri	42	3200	2750	76	65			RCF-2S26-M1-BS-QS	Phillips	46	70	60		
CF57DT/E/IN/835/ECO	Os Sy	Tri	57	4300	3700	75	65			ICF-2S42-M2-BS	Phillips	59	73	63		
				Avg	**1667**							**Avg**	**37**			
Biax Linear Low-Draw																
FT40DL/28W/835/SS/ECO	Os Sy	Bi Lin	28	2800	2410	100	86			ICF-2S26-H1-LD	Phillips	36	78	67		
FT40DL/25W/835/SS/ECO	Os Sy	Bi Lin	25	2500	2300	100	92			ICF-2S26-H1-LD	Phillips	29	86	79		
Biax Linear																
FT18DL/835/ECO	Os Sy	Bi Lin	18	1250	1075	69	60			RMB-1P26-S2	Phillips	23	54	47		
FT24DL/835/ECO	Os Sy	Bi Lin	24	1800	1550	75	65	85	73	RMB-1P26-S2	Phillips	26	69	60	75	65
FT36DL/835/ECO	Os Sy	Bi Lin	36	2900	2495	81	69			ICN-2S39	Phillips	36	81	69		
FT40DL/835/RS/ECO	Os Sy	Bi Lin	40	3150	2710	79	68			ICN-2TTP40-SC	Phillips	41	77	66		
FT50DL/835/RS/ECO	Os Sy	Bi Lin	50	4300	3655	86	73			ICN-2S54	Phillips	61	70	60		
FT55DL/835/ECO	Os Sy	Bi Lin	55	4800	4130	87	75			ICN-2S54	Phillips	58	83	71		
				Avg	**2541**							**Avg**	**39**			

System is based on 120V where available Linear Fluorescent (based on 3500K lamps where available)	Lamp Efficacy assumes BF=1.0, and no losses in ballast

Ballast Full-Load Information

A variety of linear fluorescent ballasts were considered in the calculations to produce a reasonable load for typical luminaires. Since Title 24 requires dimming or step-dimming ballasts in most circumstances, these are the basis of design. Following is a list of the information collected to inform the fixture load results for the variety of fluorescent lighting products selected for the power density calculations.

Linear Fluorescent Dimming/Step Ballast Performance Conparisons																				
1-Lamp					2-Lamp					3-Lamp					4-Lamp				
Mfr	Control Type	Lamp Type	BF (Full Power)	Input Watts (Full Power)	Mfr	Control Type	Lamp Type	BF (Full Power)	Input Watts (Full Power)	Mfr	Control Type	Lamp Type	BF (Full Power)	Input Watts (Full Power)	Mfr	Control Type	Lamp Type	BF (Full Power)	Input Watts (Full Power)
Philips	0-10V	T5HO	1.00	56	Philips	0-10V	T5HO	1.00	118										
Osram	0-10V	T5HO	1.00	62	Osram	0-10V	T5HO	1.00	120										
Philips	DALI	T5HO	1.00	63	Philips	DALI	T5HO	1.00	63										
Philips	L.Volt.	T5HO	1.00	63	Philips	L.Volt.	T5HO	1.00	125										
Osram	L.Volt.	T5HO	1.00	62	Osram	L.Volt.	T5HO	1.00	120										
					Osram	Step-Dim	T5HO	0.80	96										
Philips	0-10V	T8	1.00	35	Philips	0-10V	T8	1.00	68	Philips	0-10V	T8	1.00	96	Philips	0-10V	T8	0.88	116
Philips	DALI	T8	1.00	35	Philips	DALI	T8	1.00	68	Philips	DALI	T8	1.00	99	Philips	DALI	T8	0.88	116
Osram	DALI	T8	1.00	36	Osram	DALI	T8	1.00	72										
Osram	L.Volt.	T8	0.88	30	Osram	L.Volt.	T8	0.88	59	Osram	L.Volt.	T8	0.88	87	Osram	L.Volt.	T8	0.88	114
Philips	L.Volt.	T8	1.00	35	Philips	L.Volt.	T8	1.00	68	Philips	L.Volt.	T8	0.97	96					
Osram	Step-Dim	T8	0.77	25	Osram	Step-Dim	T8	0.77	48										
Philips	Step-Dim	T8	0.87	29	Philips	Step-Dim	T8	0.87	55										

Calculation Results by Space Type

The calculation results for each space type were performed using the Lumen Method, employing industry standard values for lamp lumen depreciation, luminaire dirt depreciation, and conservative values for surface reflectance.

The following illustrates the process that was employed, and then the remainder of the spaces just show the calculation results and the initial comparison of allowances from ASHRAE and Title 24, along with the aligned criteria from the IES 10th Edition Handbook.

Auditorium

Following is a table comparing the room designations from the IES 10th Edition Handbook, ASHRAE 90.1, and Title 24 to provide an indication of how they align. In some cases, there are multiple values in a particular document that must be grouped in here, because they are possibly applicable, and have different LPD allowances. In the example below, this occurs in the ASHRAE 90.1 portion, with two specific categories designated with more narrowly defined criteria for applicability, and two separate LPD values.

Further, the IES 10th Edition Handbook design criteria for its own room type is provided. This is the basic general target illuminance targeted in the calculations.

Lastly, there is a column for room cavity ratio (RCR) adjustments. This indicates the first RCR value where an adjustment to the allowance is permitted as part of their calculation procedures. This value is normally a 20% increase in the LPD.

Note that this approach is not specifically accommodated in the Title-24 Area Category Method because it is addressed in the Tailored Method, so while the values are adjusted in the

ASHRAE table, they are not in the Title 24 table because if a high RCR situation occurs, a designer can opt to the Tailored Method for some space types to resolve to possible design difficulties associated with a very high ceiling condition.

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Auditorium Area	Audience seating	Auditoriums	Room with fixed seats used for public meetings or gatherings	1.5	0.63	0.2-100	1-50	6
	in a sports arena				0.43			4

There is also additional allowances that are available to a designer that are not explicitly listed in the general lighting allowance table in Title 24 (Table 140.6-B). These additional allowances are variable and dependent on conditions, so cannot universally be applied. ASHRAE 90.1 also includes a list of additional allowances for similar purposes.

These allowances that could be applied to auditorium spaces are shown in the following:

Additional LPD Allowances: Auditorium Spaces		
Code	**Adjustment**	**Allowance**
Title 24 2013:	Ornamental lighting	0.5W/sft of task area
Title 24 2013:	Control factors:	0.20 - (area ≤ 250sft enclosed by floor to ceiling partitions) partial ON occupant sensing control 0.25 - (area ≤ 250sft enclosed by floor to ceiling partitions) combined manual dimming plus partial ON occupant sensing control 0.05 - demand responsive control (building types less than 10000sft) 0.10 - manual dimming system 0.20 - multiscene programmable dimming system
ASHRAE 90.1-2013	Room geometry adjustment	When calculated RCR is greater than RCR threshold shown LPD increase = base space LPD x 0.2 i.e. new LPD = 0.63 + (0.63 x 0.2) = 0.756
ASHRAE 90.1-2013	Decorative / art lighting	1.0W/sft of room area

The calculations are performed with a variety of lighting products, selected for suitability for the lighting task, and then collected for the purposes of this analysis. The photometric files for the products provide the information on performance of the products in a space through the Coefficient of Utilization (CU) which is produced for various RCR conditions. These are input into the spreadsheet to produce a resultant number of luminaires per square foot, and the resultant wattage per square foot.

Since this is dependent on the ballast used, the ballast information was input into the calculations, and the subsequent light output from the lamps as a result of the ballast are input as well.

These calculations produce a table that provided this information:

Design Parameters:		
	E_{target}:	30
	Reflectances:	70/50/20

Fixture 1:		
	Manufacturer:	Luminaire 1
	Catalog Number:	XXX-XX-XXXX
	Lamp:	Osram FP54/835/HO/ECO
	Number of Lamps:	1
	Initial Lumens per lamp:	4450
	Mean lumens per lamp:	4140
	Ballast:	Osram Powersense
	Input Watts (total):	62
	BF:	1.000
	LLD:	0.930
	LDD:	0.900
	LLF:	0.837

	Fixture 1:								
RCR:	1.5	2	2.75	3.5	4	5.25	6	7	7.5
CU:	0.705	0.660	0.600	0.550	0.520	0.458	0.420	0.390	0.370
Luminaires/sf:	0.011	0.012	0.013	0.015	0.015	0.018	0.019	0.021	0.022
W/sf:	0.708	0.756	0.832	0.908	0.960	1.091	1.189	1.280	1.349
Approx OC:	9.357	9.054	8.632	8.265	8.036	7.538	7.222	6.960	6.779

The range of lighting products tested and their general description are provided in the results sheet, which is shown next.

The results sheet shows the various lighting products in rows, and compares the group to one of three standard allowances; the ASHRAE 90.1-2013 allowance, the Current Title 24 (2013) allowance, and finally, the proposed Title 24 (2016) allowance.

In this comparison, the calculations show indicate whether the lighting system is capable of meeting the general illuminance design criteria as established in the IES 10th Edition Handbook, by indicating the box as green. When a box is red, that represents a condition where that particular product is unable to meet the criteria.

Current T24:	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
	RCR									
	1.5	2	2.75	3.5	4	5.25	6	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.091	1.189	1.280	1.349	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.375	1.478	1.536	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.251	1.362	1.425	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.878	0.918	0.985	1.053	1.101	1.236	1.317	1.317	1.425	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.906	0.975	1.068	1.180	1.268	1.449	0.818	1.812	1.879	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.941	1.006	1.106	1.213	1.290	1.525	1.677	1.864	1.973	2T5HO Cove, Line Voltage Dim

90.1:	0.63	0.63	0.63	0.63	0.63	0.63	0.756	0.756	0.756	
	RCR									
	1.5	2	2.75	3.5	4	5.25	6	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.091	1.189	1.280	1.349	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.375	1.478	1.536	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.251	1.362	1.425	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.878	0.918	0.985	1.053	1.101	1.236	1.317	1.317	1.425	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.906	0.975	1.068	1.180	1.268	1.449	0.818	1.812	1.879	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.941	1.006	1.106	1.213	1.290	1.525	1.677	1.864	1.973	2T5HO Cove, Line Voltage Dim

Proposed T24:	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
	RCR									
	1.5	2	2.75	3.5	4	5.25	6	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.091	1.189	1.280	1.349	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.375	1.478	1.536	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.251	1.362	1.425	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.878	0.918	0.985	1.053	1.101	1.236	1.317	1.317	1.425	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.906	0.975	1.068	1.180	1.268	1.449	0.818	1.812	1.879	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.941	1.006	1.106	1.213	1.290	1.525	1.677	1.864	1.973	2T5HO Cove, Line Voltage Dim

The results are dependent on the efficiency of the luminaire, the efficacy of the light source, the room reflectance conditions, and most importantly in this table, the RCR of the space. As the ceilings increase in height compared to the room dimensions, the overall efficiency of the lighting system to achieve a target illuminance decreases, resulting in the need for more energy to meet the target illuminance level.

This approach uses a reasonable cross-section of lighting products and resultant calculations to gauge whether the LPD value is reasonably established, and also how that level compared to the previously set LPD values while using the same design parameters. Note that a result with a preponderance of red results would indicate a space that will be difficult to meet criteria. The more the red approaches the left side of the tables, the harder it will be to achieve target illuminance for general lighting.

However, note that this is not the only source of possible lighting in the spaces, and this presumes that there are no task/ambient approaches being employed to raise the light levels in the space at the task areas to the desired levels. This is especially important in work spaces, but less so in general circulation areas.

Note that in some spaces, the luminaires selected may reflect a range of light source types, including incandescent and halogen as well, so it is possible to compare how these less efficient sources will perform. However, it is typical for a lighting system that relies on these less efficient light sources to also not be attempting to actually achieve a uniform light level in the space, but to produce more focused locations of illuminance for the purposes of ambiance. So even when these less efficacious light sources are employed in design, it may be possible to achieve the design goals of the project team while meeting the LPD limits of Title 24. The calculations only show that it is less likely to achieve comparable illuminance levels for general lighting with lower efficacious sources, not that the sources are prohibited or discouraged.

Auto Repair

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Auto Repair Area	Vehicular Maintenance Area	Garages - Service Repairs	Room or area used to repair automotive equipment and/or vehicles	0.9	0.67	75	75	4

Current T24:	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	1.010	1.083	1.199	1.317	1.399	1.609	1.975	2.066	Lensed Narrow Wrap, 2-T8, Line-Voltage Dimming
Fixture 2	0.772	0.832	0.920	1.014	1.081	1.251	1.481	1.563	Open Industrial, 2-T8, Line-Voltage Dimming
Fixture 3	0.957	1.032	1.138	1.246	1.320	1.544	1.834	1.942	Recessed 1x4 Troffer, 3-T8, Line-Voltage Dimming
Fixture 4	0.753	0.802	0.879	0.959	1.016	1.160	1.357	1.395	Highbay Fluorescent, 6-T8 Line-Voltage Dimming
Fixture 5	1.110	1.180	1.291	1.413	1.504	1.735	2.072	2.169	Highbay Acrylic Refl PMH 400W, Step Dim
Fixture 6	1.299	1.407	1.567	1.736	1.857	2.172	2.653	2.772	Highbay Acrylic Refl 6-42CFL, 0-10V Dimming
Fixture 7	1.024	1.099	1.216	1.336	1.419	1.632	2.003	2.096	Lensed Narrow Wrap, 2-T8, Philips DALI
Fixture 8	0.786	0.846	0.936	1.032	1.100	1.273	1.507	1.591	Open Industrial, 2-T8, Philips DALI
Fixture 9	0.958	1.033	1.140	1.247	1.322	1.547	1.836	1.945	Recessed 1x4 Troffer, 3-T8, Philips DALI
Fixture 10	0.754	0.803	0.880	0.960	1.017	1.162	1.358	1.397	Highbay Fluorescent, 6-T8, Philips DALI
Fixture 11	1.412	1.529	1.704	1.887	2.019	2.361	2.884	3.013	Highbay Acrylic Refl 6-42CFL, Osram DALI

90.1:	0.67	0.67	0.67	0.67	0.804	0.804	0.804	0.804

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	1.010	1.083	1.199	1.317	1.399	1.609	1.975	2.066	Lensed Narrow Wrap, 2-T8, Line-Voltage Dimming
Fixture 2	0.772	0.832	0.920	1.014	1.081	1.251	1.481	1.563	Open Industrial, 2-T8, Line-Voltage Dimming
Fixture 3	0.957	1.032	1.138	1.246	1.320	1.544	1.834	1.942	Recessed 1x4 Troffer, 3-T8, Line-Voltage Dimming
Fixture 4	0.753	0.802	0.879	0.959	1.016	1.160	1.357	1.395	Highbay Fluorescent, 6-T8 Line-Voltage Dimming
Fixture 5	1.110	1.180	1.291	1.413	1.504	1.735	2.072	2.169	Highbay Acrylic Refl PMH 400W, Step Dim
Fixture 6	1.299	1.407	1.567	1.736	1.857	2.172	2.653	2.772	Highbay Acrylic Refl 6-42CFL, 0-10V Dimming
Fixture 7	1.024	1.099	1.216	1.336	1.419	1.632	2.003	2.096	Lensed Narrow Wrap, 2-T8, Philips DALI
Fixture 8	0.786	0.846	0.936	1.032	1.100	1.273	1.507	1.591	Open Industrial, 2-T8, Philips DALI
Fixture 9	0.958	1.033	1.140	1.247	1.322	1.547	1.836	1.945	Recessed 1x4 Troffer, 3-T8, Philips DALI
Fixture 10	0.754	0.803	0.880	0.960	1.017	1.162	1.358	1.397	Highbay Fluorescent, 6-T8, Philips DALI
Fixture 11	1.412	1.529	1.704	1.887	2.019	2.361	2.884	3.013	Highbay Acrylic Refl 6-42CFL, Osram DALI

Proposed T24:	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	1.010	1.083	1.199	1.317	1.399	1.609	1.975	2.066	Lensed Narrow Wrap, 2-T8, Line-Voltage Dimming
Fixture 2	0.772	0.832	0.920	1.014	1.081	1.251	1.481	1.563	Open Industrial, 2-T8, Line-Voltage Dimming
Fixture 3	0.957	1.032	1.138	1.246	1.320	1.544	1.834	1.942	Recessed 1x4 Troffer, 3-T8, Line-Voltage Dimming
Fixture 4	0.753	0.802	0.879	0.959	1.016	1.160	1.357	1.395	Highbay Fluorescent, 6-T8 Line-Voltage Dimming
Fixture 5	1.110	1.180	1.291	1.413	1.504	1.735	2.072	2.169	Highbay Acrylic Refl PMH 400W, Step Dim
Fixture 6	1.299	1.407	1.567	1.736	1.857	2.172	2.653	2.772	Highbay Acrylic Refl 6-42CFL, 0-10V Dimming
Fixture 7	1.024	1.099	1.216	1.336	1.419	1.632	2.003	2.096	Lensed Narrow Wrap, 2-T8, Philips DALI
Fixture 8	0.786	0.846	0.936	1.032	1.100	1.273	1.507	1.591	Open Industrial, 2-T8, Philips DALI
Fixture 9	0.958	1.033	1.140	1.247	1.322	1.547	1.836	1.945	Recessed 1x4 Troffer, 3-T8, Philips DALI
Fixture 10	0.754	0.803	0.880	0.960	1.017	1.162	1.358	1.397	Highbay Fluorescent, 6-T8, Philips DALI
Fixture 11	1.412	1.529	1.704	1.887	2.019	2.361	2.884	3.013	Highbay Acrylic Refl 6-42CFL, Osram DALI

Convention Space

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Convention, Conference, Multipurpose and Meeting Center Areas	Conference / Meeting /	Conference Rooms	Rooms or areas that are designed or used for meetings, conventions or events, and that have neither fixed seating nor fixed staging	1.4	1.23	3-30	3-40	6
	Audience seating in a convention ctr.			1.4	0.82			4

Current T24:	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recessed 2T8 2x4 Direct/Indirect, Osram DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2T5 2x4 Direct/Indirect, Osram DALI
Fixture 3	0.639	0.691	0.752	0.826	1.027	1.118	1.226	1.310	2T8 Pendant Direct/Indirect, Philips Step Dim
Fixture 4	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	1T5HO Pendant Direct/Indirect, Osram Powersense
Fixture 5	0.708	0.756	0.832	0.908	1.085	1.161	1.280	1.331	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	8" CFL Downlight with (2)26W TRTs, Osram DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	8" CFL Downlight with (1)42W TRT, Osram DALI
Fixture 8	0.738	0.789	0.872	0.959	1.299	1.299	1.450	1.540	Pendant Bowl with (4)26W TRTs , Philips Mark 10
Fixture 9	0.878	0.918	0.985	1.053	1.236	1.317	1.317	1.425	8" CFL Downlight with (2)42W TRTs, Osram DALI

90.1:	1.23	1.23	1.23	1.23	1.23	1.476	1.476	1.476	
	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recessed 2T8 2x4 Direct/Indirect, Osram DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2T5 2x4 Direct/Indirect, Osram DALI
Fixture 3	0.639	0.691	0.752	0.826	1.027	1.118	1.226	1.310	2T8 Pendant Direct/Indirect, Philips Step Dim
Fixture 4	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	1T5HO Pendant Direct/Indirect, Osram Powersense
Fixture 5	0.708	0.756	0.832	0.908	1.085	1.161	1.280	1.331	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	8" CFL Downlight with (2)26W TRTs, Osram DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	8" CFL Downlight with (1)42W TRT, Osram DALI
Fixture 8	0.738	0.789	0.872	0.959	1.299	1.299	1.450	1.540	Pendant Bowl with (4)26W TRTs , Philips Mark 10
Fixture 9	0.878	0.918	0.985	1.053	1.236	1.317	1.317	1.425	8" CFL Downlight with (2)42W TRTs, Osram DALI

Proposed T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recessed 2T8 2x4 Direct/Indirect, Osram DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2T5 2x4 Direct/Indirect, Osram DALI
Fixture 3	0.639	0.691	0.752	0.826	1.027	1.118	1.226	1.310	2T8 Pendant Direct/Indirect, Philips Step Dim
Fixture 4	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	1T5HO Pendant Direct/Indirect, Osram Powersense
Fixture 5	0.708	0.756	0.832	0.908	1.085	1.161	1.280	1.331	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	8" CFL Downlight with (2)26W TRTs, Osram DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	8" CFL Downlight with (1)42W TRT, Osram DALI
Fixture 8	0.738	0.789	0.872	0.959	1.299	1.299	1.450	1.540	Pendant Bowl with (4)26W TRTs , Philips Mark 10
Fixture 9	0.878	0.918	0.985	1.053	1.236	1.317	1.317	1.425	8" CFL Downlight with (2)42W TRTs, Osram DALI

Dining Space

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Dining Area	Dining area in a penitentiary	Correction facilities -	Room or area where meals that are served to the customers will be consumed	1.1	0.96	40	15	6
	in a facility for the visually impaired				2.65			4
	in a bar or leisure dining	Bar / lounge			1.07	10	5	4
	in a cafeteria or fast food dining	Restaurant - fast food			0.65	20	7.5	4
	in family dining	Restaurant - casual			0.89	10	5	4
	All other dining areas	Coffee Shop			0.65	10	3	4
		Fine dining				3	1	

Current T24:	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.717	0.773	0.848	0.928	0.986	1.151	1.232	1.408	Decorative Cylinder Pendant, 4-26CFL, Osram DALI
Fixture 2	0.689	0.740	0.819	0.898	0.951	1.109	1.210	1.331	Decorative Bowl Pendant, 4-26CFL, Osram DALI
Fixture 3	0.618	0.668	0.739	0.820	0.881	1.016	1.119	1.217	Decorative Pendant, 1-32CFL, Osram DALI
Fixture 4	0.642	0.668	0.702	0.739	0.767	0.849	0.920	0.986	Recessed 6" Downlight, 1-32CFL, Osram DALI
Fixture 5	0.774	0.812	0.876	0.941	0.986	1.119	1.217	1.294	Recessed 6" Downlight, 1-32TRT, Osram DALI
Fixture 6	1.510	1.543	1.583	1.615	1.634	1.704	1.736	1.804	Recessed 4" Downlight, 1-50MR16L
Fixture 7	0.781	0.845	0.946	1.048	1.119	1.294	1.427	1.533	Decorative Downlight, 1-32CFL, Osram DALI

90.1:	1.07	1.07	1.07	1.07	1.284	1.284	1.284	1.284

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.717	0.773	0.848	0.928	0.986	1.151	1.232	1.408	Decorative Cylinder Pendant, 4-26CFL, Osram DALI
Fixture 2	0.689	0.740	0.819	0.898	0.951	1.109	1.210	1.331	Decorative Bowl Pendant, 4-26CFL, Osram DALI
Fixture 3	0.618	0.668	0.739	0.820	0.881	1.016	1.119	1.217	Decorative Pendant, 1-32CFL, Osram DALI
Fixture 4	0.642	0.668	0.702	0.739	0.767	0.849	0.920	0.986	Recessed 6" Downlight, 1-32CFL, Osram DALI
Fixture 5	0.774	0.812	0.876	0.941	0.986	1.119	1.217	1.294	Recessed 6" Downlight, 1-32TRT, Osram DALI
Fixture 6	1.510	1.543	1.583	1.615	1.634	1.704	1.736	1.804	Recessed 4" Downlight, 1-50MR16L
Fixture 7	0.781	0.845	0.946	1.048	1.119	1.294	1.427	1.533	Decorative Downlight, 1-32CFL, Osram DALI

Proposed T24:	1	1	1	1	1	1	1	1

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.717	0.773	0.848	0.928	0.986	1.151	1.232	1.408	Decorative Cylinder Pendant, 4-26CFL, Osram DALI
Fixture 2	0.689	0.740	0.819	0.898	0.951	1.109	1.210	1.331	Decorative Bowl Pendant, 4-26CFL, Osram DALI
Fixture 3	0.618	0.668	0.739	0.820	0.881	1.016	1.119	1.217	Decorative Pendant, 1-32CFL, Osram DALI
Fixture 4	0.642	0.668	0.702	0.739	0.767	0.849	0.920	0.986	Recessed 6" Downlight, 1-32CFL, Osram DALI
Fixture 5	0.774	0.812	0.876	0.941	0.986	1.119	1.217	1.294	Recessed 6" Downlight, 1-32TRT, Osram DALI
Fixture 6	1.510	1.543	1.583	1.615	1.634	1.704	1.736	1.804	Recessed 4" Downlight, 1-50MR16L
Fixture 7	0.781	0.845	0.946	1.048	1.119	1.294	1.427	1.533	Decorative Downlight, 1-32CFL, Osram DALI

Electrical Room

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Electrical, Mechanical, Telephone Rooms	Electrical, Mechanical Room	Electrical Closets	Room in which the building's electrical switchbox or control panels, telephone switchbox, and/or HVAC controls or equipment is located	0.7	0.42	10	10	6

Current T24:	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.271	0.293	0.349	0.359	0.450	0.493	0.552	0.580	2 T8 Bare Strip, Instant Start Ballast
Fixture 2	0.349	0.374	0.414	0.455	0.555	0.610	0.682	0.713	2 T8 Acrylic Wrap, Instant Start Ballast
Fixture 3	0.276	0.297	0.329	0.362	0.447	0.479	0.529	0.559	2 T8 Industrial, Instant Start Ballast
Fixture 4	0.334	0.362	0.400	0.437	0.542	0.594	0.644	0.682	2 T8 1x4 Lensed Troffer, Instant Start Ballast
Fixture 5	0.362	0.386	0.423	0.464	0.569	0.627	0.682	0.724	2 T8 1x4 Parabolic Troffer, Instant Start Ballast
Fixture 6	0.377	0.405	0.448	0.492	0.601	0.660	0.738	0.772	1 T8 Acrylic Wrap, Line Voltage Dim
Fixture 7	0.294	0.316	0.350	0.385	0.476	0.510	0.563	0.594	2 T8 Industrial, Line Voltage Dim
Fixture 8	0.381	0.414	0.457	0.500	0.620	0.679	0.736	0.779	2 T8 1x4 Lensed Troffer, DALI
Fixture 9	0.414	0.442	0.484	0.530	0.650	0.716	0.779	0.828	2 T8 1x4 Parabolic Troffer, DALI

90.1:	0.42	0.42	0.42	0.42	0.42	0.504	0.504	0.504

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.271	0.293	0.349	0.359	0.450	0.493	0.552	0.580	2 T8 Bare Strip, Instant Start Ballast
Fixture 2	0.349	0.374	0.414	0.455	0.555	0.610	0.682	0.713	2 T8 Acrylic Wrap, Instant Start Ballast
Fixture 3	0.276	0.297	0.329	0.362	0.447	0.479	0.529	0.559	2 T8 Industrial, Instant Start Ballast
Fixture 4	0.334	0.362	0.400	0.437	0.542	0.594	0.644	0.682	2 T8 1x4 Lensed Troffer, Instant Start Ballast
Fixture 5	0.362	0.386	0.423	0.464	0.569	0.627	0.682	0.724	2 T8 1x4 Parabolic Troffer, Instant Start Ballast
Fixture 6	0.377	0.405	0.448	0.492	0.601	0.660	0.738	0.772	1 T8 Acrylic Wrap, Line Voltage Dim
Fixture 7	0.294	0.316	0.350	0.385	0.476	0.510	0.563	0.594	2 T8 Industrial, Line Voltage Dim
Fixture 8	0.381	0.414	0.457	0.500	0.620	0.679	0.736	0.779	2 T8 1x4 Lensed Troffer, DALI
Fixture 9	0.414	0.442	0.484	0.530	0.650	0.716	0.779	0.828	2 T8 1x4 Parabolic Troffer, DALI

Proposed T24:	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.271	0.293	0.349	0.359	0.450	0.493	0.552	0.580	2 T8 Bare Strip, Instant Start Ballast
Fixture 2	0.349	0.374	0.414	0.455	0.555	0.610	0.682	0.713	2 T8 Acrylic Wrap, Instant Start Ballast
Fixture 3	0.276	0.297	0.329	0.362	0.447	0.479	0.529	0.559	2 T8 Industrial, Instant Start Ballast
Fixture 4	0.334	0.362	0.400	0.437	0.542	0.594	0.644	0.682	2 T8 1x4 Lensed Troffer, Instant Start Ballast
Fixture 5	0.362	0.386	0.423	0.464	0.569	0.627	0.682	0.724	2 T8 1x4 Parabolic Troffer, Instant Start Ballast
Fixture 6	0.377	0.405	0.448	0.492	0.601	0.660	0.738	0.772	1 T8 Acrylic Wrap, Line Voltage Dim
Fixture 7	0.294	0.316	0.350	0.385	0.476	0.510	0.563	0.594	2 T8 Industrial, Line Voltage Dim
Fixture 8	0.381	0.414	0.457	0.500	0.620	0.679	0.736	0.779	2 T8 1x4 Lensed Troffer, DALI
Fixture 9	0.414	0.442	0.484	0.530	0.650	0.716	0.779	0.828	2 T8 1x4 Parabolic Troffer, DALI

Exhibit Space

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Exhibit, Museum Areas	Museum - in a general exhibition area	Museum	Room or area in a museum that has for its primary purpose exhibitions, having neither fixed seating not fixed staging. An exhibit does not include a gallery or other place where are is for sale. An exhibit does not include a lobby, conference room, or other occupancies where the primary function is not exhibitions	2.0	1.05	5-20	5-20	6

Current T24:	2	2	2	2	2	2	2	2	**(General and display lighting)**

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.472	0.504	0.555	0.605	0.723	0.774	0.853	0.887	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.621	0.646	0.689	0.737	0.857	0.917	0.986	1.024	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.596	0.619	0.656	0.692	0.786	0.834	0.908	0.950	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.585	0.612	0.656	0.702	0.824	0.878	0.878	0.950	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.604	0.650	0.712	0.786	0.966	1.057	1.208	1.252	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.627	0.671	0.737	0.808	1.017	1.118	1.243	1.316	2T5HO Cove, Line Voltage Dim

90.1:	1.05	1.05	1.05	1.05	1.05	1.26	1.26	1.26	

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.472	0.504	0.555	0.605	0.723	0.774	0.853	0.887	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.621	0.646	0.689	0.737	0.857	0.917	0.986	1.024	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.596	0.619	0.656	0.692	0.786	0.834	0.908	0.950	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.585	0.612	0.656	0.702	0.824	0.878	0.878	0.950	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.604	0.650	0.712	0.786	0.966	1.057	1.208	1.252	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.627	0.671	0.737	0.808	1.017	1.118	1.243	1.316	2T5HO Cove, Line Voltage Dim

Proposed T24:	1	1	1	1	1	1	1	1	**+ 0.8 W/sf for display lighting**

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.472	0.504	0.555	0.605	0.723	0.774	0.853	0.887	Recessed 4" 1T5HO Lensed Slot, Line Voltage Dim
Fixture 2	0.621	0.646	0.689	0.737	0.857	0.917	0.986	1.024	8" Downlight with (2)26W TRTs, DALI
Fixture 3	0.596	0.619	0.656	0.692	0.786	0.834	0.908	0.950	8" Downlight with (1)42W TRT, DALI
Fixture 4	0.585	0.612	0.656	0.702	0.824	0.878	0.878	0.950	8" Downlight with (2)42W TRTs, DALI
Fixture 5	0.604	0.650	0.712	0.786	0.966	1.057	1.208	1.252	Fully Indirect 1T5HO Pendant, Line Voltage Dim
Fixture 6	0.627	0.671	0.737	0.808	1.017	1.118	1.243	1.316	2T5HO Cove, Line Voltage Dim

Financial Transaction Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Financial Transaction Areas	Banking Activity Area	Financial Facilties - lobby general, lobby writing area, teller's stations, indoor ATM	Room or area used by an institution which collects funds from the public and places them in financial assets, such as deposits, loans and bonds, and includes tellers, workstations, and customer's waiting areas; to complete financial transactions. Does not include private offices, hallways, restrooms or other support areas.	1.2	1.01	10-30	5-10	6

Current T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.749	0.808	0.884	0.927	C-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.694	0.745	0.826	0.864	A-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.950	1.027	1.118	1.169	C-Grade Recseed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.779	0.844	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 5	0.524	0.557	0.610	0.662	0.793	0.863	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	Recessed 8" Downlight with (2) 26W TRTs, DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

90.1:	1.01	1.01	1.01	1.01	1.01	1.212	1.212	1.212

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.749	0.808	0.884	0.927	C-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.694	0.745	0.826	0.864	A-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.950	1.027	1.118	1.169	C-Grade Recseed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.779	0.844	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 5	0.524	0.557	0.610	0.662	0.793	0.863	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	Recessed 8" Downlight with (2) 26W TRTs, DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

Proposed T24:	1	1	1	1	1	1	1	1

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.749	0.808	0.884	0.927	C-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.694	0.745	0.826	0.864	A-Grade Recessed 2x4 2T8 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.950	1.027	1.118	1.169	C-Grade Recseed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.779	0.844	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 5	0.524	0.557	0.610	0.662	0.793	0.863	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 6	0.931	0.970	1.033	1.105	1.286	1.375	1.478	1.536	Recessed 8" Downlight with (2) 26W TRTs, DALI
Fixture 7	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

Hotel Function Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Hotel Function Area	Convention Center - Exhibit Space	Various	Hotel room or area such as a hotel ballroom, meeting room, exhibit hall or conference room, together with pre-function areas and other spaces ancillary to its function	1.5	1.45	30	NA	6

Current T24:	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recseed 2x4 2T8 Direct/Indirect, DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2x4 2T5 Direct/Indirect, DALI
Fixture 3	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	D/I Pendant with 1T5HO, Dim
Fixture 4	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	1.033	1.109	1.229	1.346	1.664	1.816	1.997	2.102	Pendant Bowl with (4) 26W TRTs, DALI
Fixture 6	1.075	1.160	1.272	1.392	1.727	1.848	2.112	2.190	Pendant Drum with (4) 26W Quads, DALI
Fixture 7	1.156	1.251	1.401	1.551	1.915	2.113	2.269	2.403	Deco. Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 8	0.914	0.932	0.954	0.977	1.031	1.049	1.086	1.105	Recessed 6" Downlight with (1) 70W PAR CMH, Dim

90.1:	1.45	1.45	1.45	1.45	1.45	1.74	1.74	1.74

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recseed 2x4 2T8 Direct/Indirect, DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2x4 2T5 Direct/Indirect, DALI
Fixture 3	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	D/I Pendant with 1T5HO, Dim
Fixture 4	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	1.033	1.109	1.229	1.346	1.664	1.816	1.997	2.102	Pendant Bowl with (4) 26W TRTs, DALI
Fixture 6	1.075	1.160	1.272	1.392	1.727	1.848	2.112	2.190	Pendant Drum with (4) 26W Quads, DALI
Fixture 7	1.156	1.251	1.401	1.551	1.915	2.113	2.269	2.403	Deco. Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 8	0.914	0.932	0.954	0.977	1.031	1.049	1.086	1.105	Recessed 6" Downlight with (1) 70W PAR CMH, Dim

Proposed T24:	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.671	0.721	0.790	0.874	1.082	1.170	1.273	1.332	C-Grade Recseed 2x4 2T8 Direct/Indirect, DALI
Fixture 2	0.498	0.530	0.579	0.629	0.754	0.820	0.890	0.930	A-Grade Recessed 2x4 2T5 Direct/Indirect, DALI
Fixture 3	0.689	0.734	0.805	0.884	1.085	1.161	1.314	1.368	D/I Pendant with 1T5HO, Dim
Fixture 4	0.895	0.928	0.984	1.039	1.178	1.251	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	1.033	1.109	1.229	1.346	1.664	1.816	1.997	2.102	Pendant Bowl with (4) 26W TRTs, DALI
Fixture 6	1.075	1.160	1.272	1.392	1.727	1.848	2.112	2.190	Pendant Drum with (4) 26W Quads, DALI
Fixture 7	1.156	1.251	1.401	1.551	1.915	2.113	2.269	2.403	Deco. Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 8	0.914	0.932	0.954	0.977	1.031	1.049	1.086	1.105	Recessed 6" Downlight with (1) 70W PAR CMH, Dim

Kitchen Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Kitchen, Food Preparation Areas	Food Preparation Area	Food Service Facilities	Room or area with cooking facilities or an area where food is prepared	1.6	1.21	10-50	5-20	6

Current T24:	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.736	0.786	0.865	0.946	1.146	1.237	1.353	1.418	C-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 2	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 3	0.909	0.969	1.048	1.129	1.360	1.491	1.662	1.736	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 4	0.792	0.845	0.930	1.017	1.233	1.331	1.455	1.526	C-Grade 2T8 Lensed 2x4, Osram DALI
Fixture 5	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, DALI
Fixture 6	0.791	0.843	0.912	0.982	1.184	1.297	1.446	1.510	A Grade 2T8 Lensed 2x4, DALI
Fixture 7	0.542	0.579	0.632	0.689	0.822	0.887	0.993	1.017	C-Grade 3T8 Lensed 2x4, Osram DALI
Fixture 8	0.476	0.504	0.552	0.601	0.721	0.775	0.843	0.881	A-Grade 3T8 Lensed 2x4, DALI
Fixture 9	0.606	0.646	0.065	0.753	0.907	0.994	1.108	1.157	A-Grade 3T8 Lensed 2x4, DALI

90.1:	1.21	1.21	1.21	1.21	1.21	1.452	1.452	1.452

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.736	0.786	0.865	0.946	1.146	1.237	1.353	1.418	C-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 2	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 3	0.909	0.969	1.048	1.129	1.360	1.491	1.662	1.736	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 4	0.792	0.845	0.930	1.017	1.233	1.331	1.455	1.526	C-Grade 2T8 Lensed 2x4, Osram DALI
Fixture 5	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, DALI
Fixture 6	0.791	0.843	0.912	0.982	1.184	1.297	1.446	1.510	A Grade 2T8 Lensed 2x4, DALI
Fixture 7	0.542	0.579	0.632	0.689	0.822	0.887	0.993	1.017	C-Grade 3T8 Lensed 2x4, Osram DALI
Fixture 8	0.476	0.504	0.552	0.601	0.721	0.775	0.843	0.881	A-Grade 3T8 Lensed 2x4, DALI
Fixture 9	0.606	0.646	0.065	0.753	0.907	0.994	1.108	1.157	A-Grade 3T8 Lensed 2x4, DALI

Proposed T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.736	0.786	0.865	0.946	1.146	1.237	1.353	1.418	C-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 2	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 3	0.909	0.969	1.048	1.129	1.360	1.491	1.662	1.736	A-Grade 2T8 Lensed 2x4, Philips Step-Dim
Fixture 4	0.792	0.845	0.930	1.017	1.233	1.331	1.455	1.526	C-Grade 2T8 Lensed 2x4, Osram DALI
Fixture 5	0.701	0.746	0.808	0.881	1.062	1.140	1.264	1.322	A-Grade 2T8 Lensed 2x4, DALI
Fixture 6	0.791	0.843	0.912	0.982	1.184	1.297	1.446	1.510	A Grade 2T8 Lensed 2x4, DALI
Fixture 7	0.542	0.579	0.632	0.689	0.822	0.887	0.993	1.017	C-Grade 3T8 Lensed 2x4, Osram DALI
Fixture 8	0.476	0.504	0.552	0.601	0.721	0.775	0.843	0.881	A-Grade 3T8 Lensed 2x4, DALI
Fixture 9	0.606	0.646	0.065	0.753	0.907	0.994	1.108	1.157	A-Grade 3T8 Lensed 2x4, DALI

Laundry Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Laundry Area	Laundry / Washing Area	Laundry	Room or area primarily designed or used for laundering activities	0.9	0.6	30	5	4

Current T24:	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.360	0.377	0.402	0.428	0.446	0.489	0.555	0.575	A-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 2	0.488	0.512	0.547	0.582	0.606	0.661	0.758	0.782	C-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 3	0.463	0.505	0.564	0.622	0.661	0.778	0.933	0.983	2T8 Strip, Philips Step-Dim
Fixture 4	0.406	0.428	0.461	0.495	0.520	0.578	0.659	0.686	2T8 Industrial, Philips Step-Dim
Fixture 5	0.445	0.466	0.497	0.529	0.551	0.604	0.687	0.711	A-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 6	0.525	0.551	0.588	0.626	0.652	0.711	0.815	0.842	C-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 7	0.498	0.543	0.607	0.669	0.711	0.837	1.003	1.058	2T8 Strip, Philips T8 DALI
Fixture 8	0.437	0.460	0.495	0.532	0.559	0.622	0.709	0.738	2T8 Industrial, Philips T8 DALI

90.1:	0.6	0.6	0.6	0.6	0.72	0.72	0.72	0.72

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.360	0.377	0.402	0.428	0.446	0.489	0.555	0.575	A-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 2	0.488	0.512	0.547	0.582	0.606	0.661	0.758	0.782	C-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 3	0.463	0.505	0.564	0.622	0.661	0.778	0.933	0.983	2T8 Strip, Philips Step-Dim
Fixture 4	0.406	0.428	0.461	0.495	0.520	0.578	0.659	0.686	2T8 Industrial, Philips Step-Dim
Fixture 5	0.445	0.466	0.497	0.529	0.551	0.604	0.687	0.711	A-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 6	0.525	0.551	0.588	0.626	0.652	0.711	0.815	0.842	C-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 7	0.498	0.543	0.607	0.669	0.711	0.837	1.003	1.058	2T8 Strip, Philips T8 DALI
Fixture 8	0.437	0.460	0.495	0.532	0.559	0.622	0.709	0.738	2T8 Industrial, Philips T8 DALI

Proposed T24:	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.360	0.377	0.402	0.428	0.446	0.489	0.555	0.575	A-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 2	0.488	0.512	0.547	0.582	0.606	0.661	0.758	0.782	C-Grade Lensed 2T8 2x4 Troffer, Philips Step-Dim
Fixture 3	0.463	0.505	0.564	0.622	0.661	0.778	0.933	0.983	2T8 Strip, Philips Step-Dim
Fixture 4	0.406	0.428	0.461	0.495	0.520	0.578	0.659	0.686	2T8 Industrial, Philips Step-Dim
Fixture 5	0.445	0.466	0.497	0.529	0.551	0.604	0.687	0.711	A-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 6	0.525	0.551	0.588	0.626	0.652	0.711	0.815	0.842	C-Grade Lensed 2T8 2x4 Troffer, Philips T8 DALI
Fixture 7	0.498	0.543	0.607	0.669	0.711	0.837	1.003	1.058	2T8 Strip, Philips T8 DALI
Fixture 8	0.437	0.460	0.495	0.532	0.559	0.622	0.709	0.738	2T8 Industrial, Philips T8 DALI

Library Reading Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Reading Area	Reading Area	Reading	Room or area in a library containing tables, chairs or desks for patrons to use for the purpose of reading books and other reference documents. Library reading areas include reading, circulation and checkout areas. Reading areas do not include private offices, meeting, photocopy, or other rooms not used specifically for reading by library patrons	1.2	1.06	50	10 (20 at staffed lending desk)	4

Current T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.085	1.280	1.331	4" Recessed 1T5HO Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W Quad, Step Dim
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 4	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	Recessed 2T8 2x4 Direct/Indirect, Step Dim
Fixture 5	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 6	0.572	0.609	0.666	0.723	0.763	0.866	1.023	1.069	Pendant 2T5 Direct/Indirect, DALI
Fixture 7	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 8	0.513	0.542	0.593	0.648	0.689	0.787	0.944	1.002	Pendant 2T8 Direct/Indirect, Step Dim

90.1:	1.06	1.06	1.06	1.06	1.272	1.272	1.272	1.272

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.085	1.280	1.331	4" Recessed 1T5HO Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W Quad, Step Dim
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 4	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	Recessed 2T8 2x4 Direct/Indirect, Step Dim
Fixture 5	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 6	0.572	0.609	0.666	0.723	0.763	0.866	1.023	1.069	Pendant 2T5 Direct/Indirect, DALI
Fixture 7	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 8	0.513	0.542	0.593	0.648	0.689	0.787	0.944	1.002	Pendant 2T8 Direct/Indirect, Step Dim

Proposed T24:	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.708	0.756	0.832	0.908	0.960	1.085	1.280	1.331	4" Recessed 1T5HO Slot, Line Voltage Dim
Fixture 2	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W Quad, Step Dim
Fixture 3	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 4	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	Recessed 2T8 2x4 Direct/Indirect, Step Dim
Fixture 5	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 6	0.572	0.609	0.666	0.723	0.763	0.866	1.023	1.069	Pendant 2T5 Direct/Indirect, DALI
Fixture 7	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 8	0.513	0.542	0.593	0.648	0.689	0.787	0.944	1.002	Pendant 2T8 Direct/Indirect, Step Dim

Hotel Lobby

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Lobby Areas - Hotel Lobby	Lobby - in a hotel	Lobby - hotel	The contiguous area in a hotel/motel between the main entrance and the front desk, including reception, waiting and seating areas	1.1	1.06	10-15	3-5	4

Current T24:	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.538	0.580	0.636	0.696	0.739	0.863	1.056	1.095	Pendant Drum with (4) 26W Quads, DALI
Fixture 2	0.481	0.501	0.526	0.554	0.575	0.637	0.739	0.767	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 3	0.580	0.609	0.657	0.706	0.739	0.839	0.970	1.018	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	1.132	1.157	1.187	1.211	1.225	1.278	1.353	1.380	Recessed 4" Downlight with (1) 50W MR16
Fixture 5	0.229	0.244	0.264	0.288	0.306	0.347	0.413	0.432	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 6	0.306	0.328	0.359	0.393	0.417	0.489	0.572	0.598	Recessed 1T8 2x4 Direct/Indirect, Step Dim
Fixture 7	0.283	0.302	0.332	0.363	0.384	0.436	0.512	0.539	4" Recessed 1T5 Lensed Slot, Step Dim
Fixture 8	0.516	0.555	0.614	0.673	0.713	0.832	0.999	1.051	Pendant Bowl with (4) 26W TRTs, DALI

90.1:	1.06	1.06	1.06	1.06	1.272	1.272	1.272	1.272	
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.538	0.580	0.636	0.696	0.739	0.863	1.056	1.095	Pendant Drum with (4) 26W Quads, DALI
Fixture 2	0.481	0.501	0.526	0.554	0.575	0.637	0.739	0.767	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 3	0.580	0.609	0.657	0.706	0.739	0.839	0.970	1.018	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	1.132	1.157	1.187	1.211	1.225	1.278	1.353	1.380	Recessed 4" Downlight with (1) 50W MR16
Fixture 5	0.229	0.244	0.264	0.288	0.306	0.347	0.413	0.432	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 6	0.306	0.328	0.359	0.393	0.417	0.489	0.572	0.598	Recessed 1T8 2x4 Direct/Indirect, Step Dim
Fixture 7	0.283	0.302	0.332	0.363	0.384	0.436	0.512	0.539	4" Recessed 1T5 Lensed Slot, Step Dim
Fixture 8	0.516	0.555	0.614	0.673	0.713	0.832	0.999	1.051	Pendant Bowl with (4) 26W TRTs, DALI

Proposed T24:	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.538	0.580	0.636	0.696	0.739	0.863	1.056	1.095	Pendant Drum with (4) 26W Quads, DALI
Fixture 2	0.481	0.501	0.526	0.554	0.575	0.637	0.739	0.767	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 3	0.580	0.609	0.657	0.706	0.739	0.839	0.970	1.018	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	1.132	1.157	1.187	1.211	1.225	1.278	1.353	1.380	Recessed 4" Downlight with (1) 50W MR16
Fixture 5	0.229	0.244	0.264	0.288	0.306	0.347	0.413	0.432	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 6	0.306	0.328	0.359	0.393	0.417	0.489	0.572	0.598	Recessed 1T8 2x4 Direct/Indirect, Step Dim
Fixture 7	0.283	0.302	0.332	0.363	0.384	0.436	0.512	0.539	4" Recessed 1T5 Lensed Slot, Step Dim
Fixture 8	0.516	0.555	0.614	0.673	0.713	0.832	0.999	1.051	Pendant Bowl with (4) 26W TRTs, DALI

Hotel Main Lobby

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Main Entry Lobby	in a facility for the visually impaired	NA	The contiguous area in buildings other than hotel/motel that is directly located by the main entrance of the building through which persons must pass, including any ancillary reception, waiting and seating areas	1.5	1.8	Use Hotel Lobby Criteria 10-15	Use Hotel Lobby Criteria 3-5	6
	for an elevator				0.64			4
	theater				0.59			4
	performing arts				2.0			6
	all other lobbies				0.9			4

Current T24:	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.381	0.406	0.440	0.480	0.511	0.578	0.621	0.688	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.491	0.528	0.578	0.640	0.688	0.792	0.856	0.931	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 3	0.776	0.808	0.861	0.921	0.966	1.071	1.146	1.232	Recessed 6" Downlight with (2) 26W DTT, DALI
Fixture 4	0.745	0.774	0.820	0.865	0.896	0.982	1.042	1.135	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	0.532	0.576	0.627	0.688	0.736	0.856	0.931	1.021	I/D Perforated Pendant with 2T8, Step Dim
Fixture 6	0.427	0.452	0.494	0.540	0.574	0.656	0.706	0.787	D/I Pendant with 2T8, Step Dim
Fixture 7	0.802	0.835	0.877	0.924	0.958	1.061	1.150	1.232	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 8	0.590	0.630	0.693	0.756	0.800	0.904	0.967	1.067	Recessed 4" Linear Slot with (1) T5 lamp, Step Dim
Fixture 9	0.896	0.966	1.060	1.160	1.232	1.439	1.540	1.760	Deco. Pendant Cylinder with (4) 26W DTT, DALI

90.1:	0.9	0.9	0.9	0.9	1.08	1.08	1.08	1.08

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.381	0.406	0.440	0.480	0.511	0.578	0.621	0.688	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.491	0.528	0.578	0.640	0.688	0.792	0.856	0.931	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 3	0.776	0.808	0.861	0.921	0.966	1.071	1.146	1.232	Recessed 6" Downlight with (2) 26W DTT, DALI
Fixture 4	0.745	0.774	0.820	0.865	0.896	0.982	1.042	1.135	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	0.532	0.576	0.627	0.688	0.736	0.856	0.931	1.021	I/D Perforated Pendant with 2T8, Step Dim
Fixture 6	0.427	0.452	0.494	0.540	0.574	0.656	0.706	0.787	D/I Pendant with 2T8, Step Dim
Fixture 7	0.802	0.835	0.877	0.924	0.958	1.061	1.150	1.232	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 8	0.590	0.630	0.693	0.756	0.800	0.904	0.967	1.067	Recessed 4" Linear Slot with (1) T5 lamp, Step Dim
Fixture 9	0.896	0.966	1.060	1.160	1.232	1.439	1.540	1.760	Deco. Pendant Cylinder with (4) 26W DTT, DALI

Proposed T24:	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.381	0.406	0.440	0.480	0.511	0.578	0.621	0.688	Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.491	0.528	0.578	0.640	0.688	0.792	0.856	0.931	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 3	0.776	0.808	0.861	0.921	0.966	1.071	1.146	1.232	Recessed 6" Downlight with (2) 26W DTT, DALI
Fixture 4	0.745	0.774	0.820	0.865	0.896	0.982	1.042	1.135	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	0.532	0.576	0.627	0.688	0.736	0.856	0.931	1.021	I/D Perforated Pendant with 2T8, Step Dim
Fixture 6	0.427	0.452	0.494	0.540	0.574	0.656	0.706	0.787	D/I Pendant with 2T8, Step Dim
Fixture 7	0.802	0.835	0.877	0.924	0.958	1.061	1.150	1.232	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 8	0.590	0.630	0.693	0.756	0.800	0.904	0.967	1.067	Recessed 4" Linear Slot with (1) T5 lamp, Step Dim
Fixture 9	0.896	0.966	1.060	1.160	1.232	1.439	1.540	1.760	Deco. Pendant Cylinder with (4) 26W DTT, DALI

Locker/Dressing Room

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Locker / Dressing Room	Locker Room	Locker Room	Room or area for changing clothing, sometimes equipped with lockers	0.8	0.75	5-15	3-20	6
	Performing Arts - Dressing Room	Performance - Dressing Room			0.61	20-50	10-30	6
	Retail Facilities - in a dressing / fitting room	Retail - Dressing Room			0.71	30	30-50	8

Current T24:	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
	RCR									
	1.5	2	2.75	3.5	5.25	6	7	7.5	8	
Fixture 1	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 2	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 3	0.315	0.335	0.364	0.395	0.476	0.520	0.566	0.593	0.621	2T5 Troffer, Philips Step-Dimming
Fixture 4	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips 0-10V Dimming
Fixture 5	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips 0-10V Dimming
Fixture 6	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips DALI
Fixture 7	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips DALI
Fixture 8	0.443	0.472	0.512	0.556	0.670	0.732	0.797	0.834	0.874	2T5 Troffer, Philips DALI
Fixture 9	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips DALI
Fixture 10	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips DALI

90.1:	0.75	0.75	0.75	0.75	0.75	0.9	0.9	0.9	0.9	
	RCR									
	1.5	2	2.75	3.5	5.25	6	7	7.5	8	
Fixture 1	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 2	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 3	0.315	0.335	0.364	0.395	0.476	0.520	0.566	0.593	0.621	2T5 Troffer, Philips Step-Dimming
Fixture 4	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips 0-10V Dimming
Fixture 5	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips 0-10V Dimming
Fixture 6	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips DALI
Fixture 7	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips DALI
Fixture 8	0.443	0.472	0.512	0.556	0.670	0.732	0.797	0.834	0.874	2T5 Troffer, Philips DALI
Fixture 9	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips DALI
Fixture 10	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips DALI

Proposed T24:	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
	RCR									
	1.5	2	2.75	3.5	5.25	6	7	7.5	8	
Fixture 1	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 2	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips 0-10V Dimming
Fixture 3	0.315	0.335	0.364	0.395	0.476	0.520	0.566	0.593	0.621	2T5 Troffer, Philips Step-Dimming
Fixture 4	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips 0-10V Dimming
Fixture 5	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips 0-10V Dimming
Fixture 6	0.456	0.484	0.526	0.571	0.688	0.740	0.825	0.854	0.885	A Grade 2T8 Troffer, Philips DALI
Fixture 7	0.477	0.511	0.558	0.610	0.729	0.789	0.864	0.907	0.955	C Grade 2T8 Troffer, Philips DALI
Fixture 8	0.443	0.472	0.512	0.556	0.670	0.732	0.797	0.834	0.874	2T5 Troffer, Philips DALI
Fixture 9	0.442	0.472	0.516	0.560	0.675	0.720	0.792	0.829	0.870	2T8 Wet Location Troffer, Philips DALI
Fixture 10	0.480	0.515	0.570	0.626	0.765	0.840	0.939	0.982	1.030	2T8 CA, Philips DALI

Lounge

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Lounge Area	Lounge / Breakroom - all other	Lounge / Reading	Room or area in a public place such as a hotel, airport, club, or bar, designated for people to sit, wait and relax	1.1	0.73	4-30	1.5-5	4
	in a healthcare facility	Healthcare - Lounge / Recreation			0.92	4	1.5	6

Current T24:	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 2	0.689	0.734	0.805	0.884	0.942	1.085	1.314	1.368	Pendant 1T5HO Direct/Indirect, Line Voltage Dim
Fixture 3	0.963	1.001	1.052	1.109	1.150	1.274	1.478	1.533	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	2.264	2.315	2.374	2.422	2.451	2.556	2.706	2.759	Recessed 4" Downlight with 50W MR16
Fixture 6	1.075	1.160	1.272	1.392	1.478	1.727	2.112	2.190	Pendant Drum with (2) 26W Quad, DALI
Fixture 7	0.671	0.721	0.790	0.874	0.941	1.082	1.273	1.332	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 8	0.526	0.559	0.611	0.664	0.701	0.796	0.940	0.981	Recessed 2T5 2x4 Direct/Indirect, DALI

90.1:	0.92	0.92	0.92	0.92	0.92	1.104	1.104	1.104	(In a healthcare facility)

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 2	0.689	0.734	0.805	0.884	0.942	1.085	1.314	1.368	Pendant 1T5HO Direct/Indirect, Line Voltage Dim
Fixture 3	0.963	1.001	1.052	1.109	1.150	1.274	1.478	1.533	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	2.264	2.315	2.374	2.422	2.451	2.556	2.706	2.759	Recessed 4" Downlight with 50W MR16
Fixture 6	1.075	1.160	1.272	1.392	1.478	1.727	2.112	2.190	Pendant Drum with (2) 26W Quad, DALI
Fixture 7	0.671	0.721	0.790	0.874	0.941	1.082	1.273	1.332	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 8	0.526	0.559	0.611	0.664	0.701	0.796	0.940	0.981	Recessed 2T5 2x4 Direct/Indirect, DALI

Proposed T24:	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

	RCR								
	1.5	2	2.75	3.5	5.25	6	7	7.5	
Fixture 1	0.639	0.691	0.752	0.826	0.884	1.027	1.226	1.310	Pendant 2T8 Direct/Indirect, Step Dim
Fixture 2	0.689	0.734	0.805	0.884	0.942	1.085	1.314	1.368	Pendant 1T5HO Direct/Indirect, Line Voltage Dim
Fixture 3	0.963	1.001	1.052	1.109	1.150	1.274	1.478	1.533	Recessed 6" Downlight with (1) 32W TRT, DALI
Fixture 4	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI
Fixture 5	2.264	2.315	2.374	2.422	2.451	2.556	2.706	2.759	Recessed 4" Downlight with 50W MR16
Fixture 6	1.075	1.160	1.272	1.392	1.478	1.727	2.112	2.190	Pendant Drum with (2) 26W Quad, DALI
Fixture 7	0.671	0.721	0.790	0.874	0.941	1.082	1.273	1.332	Recessed 2T8 2x4 Direct/Indirect, DALI
Fixture 8	0.526	0.559	0.611	0.664	0.701	0.796	0.940	0.981	Recessed 2T5 2x4 Direct/Indirect, DALI

Malls/Atria

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Malls and Atria	Retail facilities - in a mall concourse	Retail - mall concourse	Mall is a roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants. Atrium is a large-volume indoor space created by openings between two or more stories but is not used for an enclosed stairway, elevator hoistway, escalator opening, or utility shaft for plumbing, electrical, air-conditioning, or other equipment	1.2	1.1	10	3	4
	Atrium - less than 20ft high				0.03/ft total height			n/a
	Atrium - 20ft to 40ft high				0.03/ft total height			n/a
	Atrium - greater than 40ft high				0.40 + 0.02/ft			n/a

Current T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.665	0.697	0.753	0.808	0.847	0.961	1.111	1.166	Recessed 6" Downlight (1)42TRT, Osram 0-10V
Fixture 2	0.565	0.593	0.632	0.671	0.697	0.773	0.889	0.924	Recessed 8" Downlight (1)42TRT, Osram 0-10V
Fixture 3	0.671	0.697	0.753	0.808	0.847	0.955	1.111	1.166	Recessed 8" Downlight (2)42TRT, Osram 0-10V
Fixture 4	0.650	0.700	0.779	0.867	0.934	1.071	1.301	1.374	Pendant Acrylic Globe (4) 26W DTT, Osram 0-10V
Fixture 5	0.723	0.758	0.818	0.879	0.920	1.045	1.208	1.267	Recessed 6" Downlight (1)42TRT, DALI
Fixture 6	0.614	0.644	0.687	0.729	0.758	0.840	0.966	1.004	Recessed 8" Downlight (1)42TRT, DALI
Fixture 7	0.729	0.758	0.818	0.879	0.920	1.038	1.208	1.267	Recessed 8" Downlight (2)42TRT, DALI
Fixture 8	0.675	0.727	0.809	0.900	0.969	1.112	1.350	1.426	Pendant Acrylic Globe (4) 26W DTT, DALI

90.1:	1.1	1.1	1.1	1.1	1.32	1.32	1.32	1.32	(Malls)

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.665	0.697	0.753	0.808	0.847	0.961	1.111	1.166	Recessed 6" Downlight (1)42TRT, Osram 0-10V
Fixture 2	0.565	0.593	0.632	0.671	0.697	0.773	0.889	0.924	Recessed 8" Downlight (1)42TRT, Osram 0-10V
Fixture 3	0.671	0.697	0.753	0.808	0.847	0.955	1.111	1.166	Recessed 8" Downlight (2)42TRT, Osram 0-10V
Fixture 4	0.650	0.700	0.779	0.867	0.934	1.071	1.301	1.374	Pendant Acrylic Globe (4) 26W DTT, Osram 0-10V
Fixture 5	0.723	0.758	0.818	0.879	0.920	1.045	1.208	1.267	Recessed 6" Downlight (1)42TRT, DALI
Fixture 6	0.614	0.644	0.687	0.729	0.758	0.840	0.966	1.004	Recessed 8" Downlight (1)42TRT, DALI
Fixture 7	0.729	0.758	0.818	0.879	0.920	1.038	1.208	1.267	Recessed 8" Downlight (2)42TRT, DALI
Fixture 8	0.675	0.727	0.809	0.900	0.969	1.112	1.350	1.426	Pendant Acrylic Globe (4) 26W DTT, DALI

Proposed T24:	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.665	0.697	0.753	0.808	0.847	0.961	1.111	1.166	Recessed 6" Downlight (1)42TRT, Osram 0-10V
Fixture 2	0.565	0.593	0.632	0.671	0.697	0.773	0.889	0.924	Recessed 8" Downlight (1)42TRT, Osram 0-10V
Fixture 3	0.671	0.697	0.753	0.808	0.847	0.955	1.111	1.166	Recessed 8" Downlight (2)42TRT, Osram 0-10V
Fixture 4	0.650	0.700	0.779	0.867	0.934	1.071	1.301	1.374	Pendant Acrylic Globe (4) 26W DTT, Osram 0-10V
Fixture 5	0.723	0.758	0.818	0.879	0.920	1.045	1.208	1.267	Recessed 6" Downlight (1)42TRT, DALI
Fixture 6	0.614	0.644	0.687	0.729	0.758	0.840	0.966	1.004	Recessed 8" Downlight (1)42TRT, DALI
Fixture 7	0.729	0.758	0.818	0.879	0.920	1.038	1.208	1.267	Recessed 8" Downlight (2)42TRT, DALI
Fixture 8	0.675	0.727	0.809	0.900	0.969	1.112	1.350	1.426	Pendant Acrylic Globe (4) 26W DTT, DALI

Transportation – Concourse

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Transportation Function Area	Transportation Facility - in a baggage /	Transportation Terminal	The ticketing area, waiting area, baggage handling areas, concourse, in an airport terminal, bus or rail terminal or station, subway or transit station, or a marine terminal	1.2	0.53	5-40	2-20	4
	in an airport concourse				0.36			4
	at a terminal ticket counter				0.8			4

Current T24:	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.153	0.162	0.176	0.192	0.204	0.231	0.275	0.288	2 T8 1x4 Lensed Troffer, Step Dim
Fixture 2	0.161	0.171	0.187	0.203	0.214	0.243	0.287	0.300	Recessed 2T5 2x4 Direct/Indirect, Step Dim
Fixture 3	0.358	0.371	0.393	0.417	0.435	0.475	0.552	0.575	Recessed 6" Downlight with (2) 42W TRT, DALI
Fixture 4	0.339	0.349	0.361	0.372	0.379	0.403	0.433	0.442	Recessed 8" Downlight with (1) 100W PAR MH, Dim
Fixture 5	0.352	0.385	0.435	0.486	0.524	0.619	0.756	0.786	Pendant Acrylic Globe (4) 42W TRT, DALI
Fixture 6	0.250	0.270	0.298	0.329	0.351	0.419	0.539	0.576	Pendant Acrylic Globe (1) 150W CMH, Dim
90.1:	0.36	0.36	0.36	0.36	0.432	0.432	0.432	0.432	(Concourse)
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.153	0.162	0.176	0.192	0.204	0.231	0.275	0.288	2 T8 1x4 Lensed Troffer, Step Dim
Fixture 2	0.161	0.171	0.187	0.203	0.214	0.243	0.287	0.300	Recessed 2T5 2x4 Direct/Indirect, Step Dim
Fixture 3	0.358	0.371	0.393	0.417	0.435	0.475	0.552	0.575	Recessed 6" Downlight with (2) 42W TRT, DALI
Fixture 4	0.339	0.349	0.361	0.372	0.379	0.403	0.433	0.442	Recessed 8" Downlight with (1) 100W PAR MH, Dim
Fixture 5	0.352	0.385	0.435	0.486	0.524	0.619	0.756	0.786	Pendant Acrylic Globe (4) 42W TRT, DALI
Fixture 6	0.250	0.270	0.298	0.329	0.351	0.419	0.539	0.576	Pendant Acrylic Globe (1) 150W CMH, Dim
Proposed T24:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.153	0.162	0.176	0.192	0.204	0.231	0.275	0.288	2 T8 1x4 Lensed Troffer, Step Dim
Fixture 2	0.161	0.171	0.187	0.203	0.214	0.243	0.287	0.300	Recessed 2T5 2x4 Direct/Indirect, Step Dim
Fixture 3	0.358	0.371	0.393	0.417	0.435	0.475	0.552	0.575	Recessed 6" Downlight with (2) 42W TRT, DALI
Fixture 4	0.339	0.349	0.361	0.372	0.379	0.403	0.433	0.442	Recessed 8" Downlight with (1) 100W PAR MH, Dim
Fixture 5	0.352	0.385	0.435	0.486	0.524	0.619	0.756	0.786	Pendant Acrylic Globe (4) 42W TRT, DALI
Fixture 6	0.250	0.270	0.298	0.329	0.351	0.419	0.539	0.576	Pendant Acrylic Globe (1) 150W CMH, Dim

Waiting Area

Room Type			Title 24 2013 Room Description	Title 24 2013 LPD	ASHRAE 90.1-2013 LPD	IESNA 10th Edition		RCR Threshold (ASHRAE 90.1-2013 only)
Title 24 2013	ASHRAE 90.1-2013	IESNA 10th Edition				Horiz. FC	Vert. FC	
Waiting Area	Seating Area, General	NA	Area other than a hotel lobby or main entry lobby normally provided with seating and used for people waiting	1.1	0.54	NA	NA	4

Current T24:	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.655	0.749	0.884	0.927	C Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	A Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.679	0.779	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Dim
Fixture 5	0.518	0.555	0.614	0.676	0.721	0.824	0.984	1.030	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 6	0.524	0.557	0.610	0.662	0.699	0.793	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 7	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W DTT, DALI
Fixture 8	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

90.1:	0.54	0.54	0.54	0.54	0.648	0.648	0.648	0.648

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.655	0.749	0.884	0.927	C Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	A Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.679	0.779	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Dim
Fixture 5	0.518	0.555	0.614	0.676	0.721	0.824	0.984	1.030	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 6	0.524	0.557	0.610	0.662	0.699	0.793	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 7	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W DTT, DALI
Fixture 8	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

Proposed T24:	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

	RCR								
	1.5	2	2.75	3.5	4	5.25	7	7.5	
Fixture 1	0.481	0.513	0.565	0.618	0.655	0.749	0.884	0.927	C Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 2	0.458	0.487	0.528	0.576	0.613	0.694	0.826	0.864	A Grade Recessed 2T8 2x4 Lensed Troffer, Step Dim
Fixture 3	0.589	0.633	0.694	0.768	0.826	0.950	1.118	1.169	Recessed 2T8 2x4 Basket Troffer, Step Dim
Fixture 4	0.493	0.528	0.582	0.639	0.679	0.779	0.927	0.974	A-Grade Recessed 2x4 2T8 Direct/Indirect, Dim
Fixture 5	0.518	0.555	0.614	0.676	0.721	0.824	0.984	1.030	A-Grade Recessed 2x4 2T8 Direct/Indirect, Step Dim
Fixture 6	0.524	0.557	0.610	0.662	0.699	0.793	0.937	0.979	A-Grade Recessed 2x4 2T5 Direct/Indirect, Step Dim
Fixture 7	0.931	0.970	1.033	1.105	1.160	1.286	1.478	1.536	Recessed 8" Downlight with (2) 26W DTT, DALI
Fixture 8	0.895	0.928	0.984	1.039	1.075	1.178	1.362	1.425	Recessed 8" Downlight with (1) 42W TRT, DALI

APPENDIX D: TAILORED METHOD GENERAL LIGHTING ADJUSTMENT CALCULATIONS – TABLE 140.6-G

Calculation Basis

The calculations in Table 140.6-G reflect the revisions to the general lighting allowance portion of the Tailored Method allowance only; no adjustments are being made to the other allowances in the Tailored Method.

The calculation results for each space type were performed using the Lumen Method, employing industry standard values for lamp lumen depreciation, luminaire dirt depreciation, and conservative values for surface reflectance.

The calculations are performed with a variety of lighting products, selected for suitability for the lighting task, and then collected for the purposes of this analysis. The photometric files for the products provide the information on performance of the products in a space through the Coefficient of Utilization (CU) which is produced for various room cavity ratio (RCR) conditions. These are input into the spreadsheet to produce a resultant number of luminaires per square foot, and the resultant wattage per square foot.

Since this is dependent on the ballast used, the ballast information was input into the calculations, and the subsequent light output from the lamps as a result of the ballast are input as well.

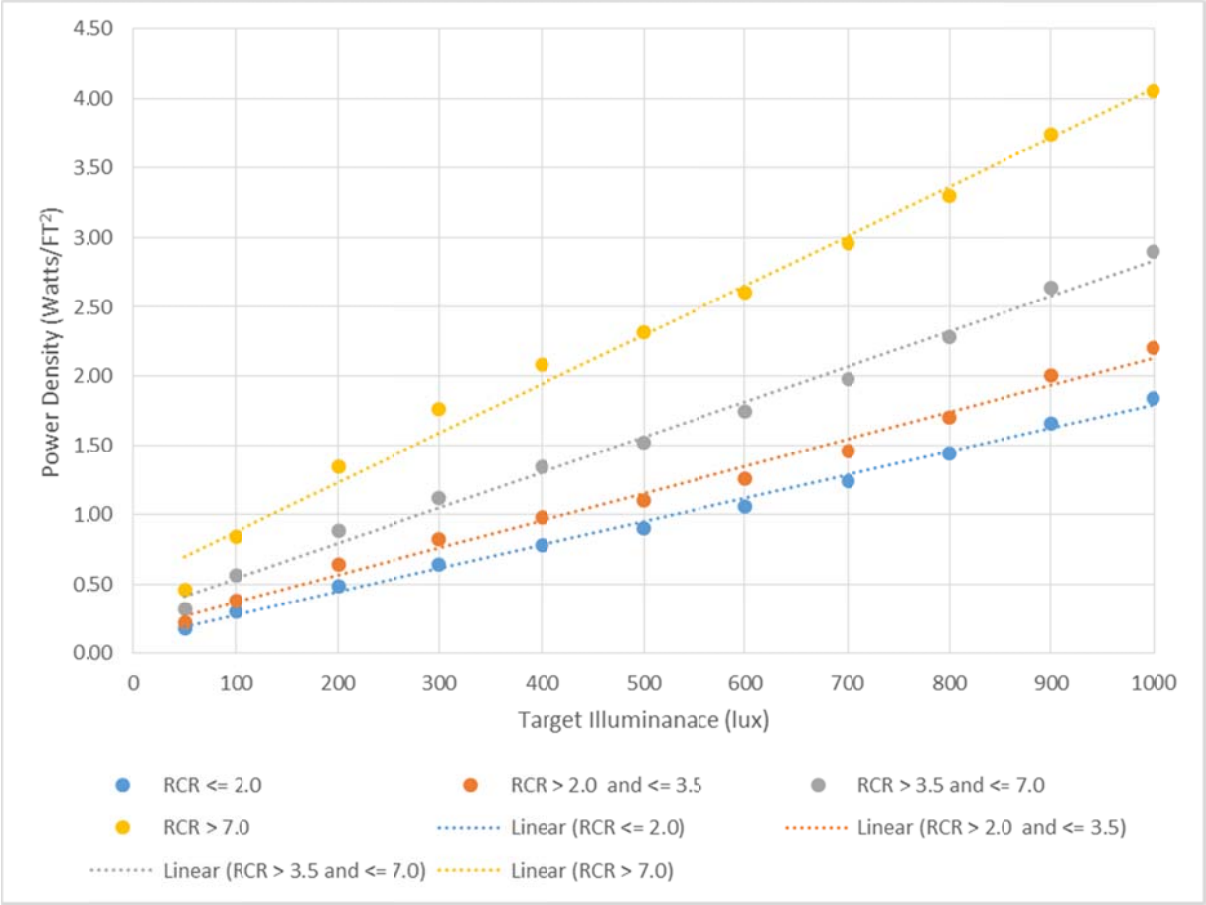
The adjustments are based on calculations that use a variety of luminaire types, and in some circumstances, the luminaires in the test may not be the most suitable for the illuminance task. In these cases, the results of those luminaires were not factored into the results, but they act as a good check on how other systems might perform in the space.

For example, a cove lighting system is viable for lower general illuminance levels, but is not suitable for higher levels without combining downlights or some other form of illumination to more efficiently provide the illuminance needed in the space.

Analysis Results

The calculation results for this analysis should produce a linear progression related to the illuminance target if all things were ideally possible, however the luminaires that are the most appropriate at different illuminance targets have different efficiencies associated with them, and this impacts the linearity of the results. The new recommended values are plotted in Table 21, providing a general sense regarding the linearity of the recommendations. The points represent the recommend code values, while the dashed lines represent the values that would result from a completely linear relationship with room cavity ratios and illuminance targets.

Table 21: Recommend 2016 Table 140.6-G Values Plotted to Graph Linearity



The recommend lighting power density for the 2016 Title 24 Standards and the corresponding values from the 2013 Standards are presented side by side in Table 22.

Table 22: Title 24 2013 Table 140.6 Values and Recommended 2016 Values (Watts/FT^2)

Title 24 2013				
Illuminance Level (lux)	RCR <= 2.0	RCR > 2.0 and <= 3.5	RCR > 3.5 and <= 7.0	RCR > 7.0
50	0.2	0.3	0.4	0.6
100	0.4	0.6	0.8	1.2
200	0.6	0.8	1.3	1.9
300	0.8	1.0	1.4	2.0
400	0.9	1.1	1.5	2.2
500	1.0	1.2	1.6	2.4
600	1.2	1.4	2.0	2.9
700	1.4	1.7	2.3	3.3
800	1.6	1.9	2.6	3.8
900	1.8	2.2	3.0	4.3
1000	1.9	2.4	3.3	4.8

Proposed 2016				
Illuminance Level (lux)	RCR <= 2.0	RCR > 2.0 and <= 3.5	RCR > 3.5 and <= 7.0	RCR > 7.0
50	0.18	0.22	0.32	0.46
100	0.30	0.38	0.56	0.84
200	0.48	0.64	0.88	1.34
300	0.64	0.82	1.12	1.76
400	0.78	0.98	1.34	2.08
500	0.90	1.10	1.52	2.32
600	1.06	1.26	1.74	2.60
700	1.24	1.46	1.98	2.96
800	1.44	1.70	2.28	3.30
900	1.66	2.00	2.64	3.74
1000	1.84	2.20	2.90	4.06

The calculation results show the various lighting systems that were tested and the results compared to the allowance for the respective RCR. Note that the higher the RCR, the more light (and thus energy) is required to meet a particular target light level, so in the case of the allowance values in Table 140.6-G, the higher RCR end of the range controls the calculation.

In the table, the range for the four columns of the LPD values are:

RCR <= 2.0

RCR > 2.0 and <= 3.5

RCR > 3.5 and <= 7.0

RCR > 7.0

The values in the right table show the percentage of the allowance at that particular RCR compared to the allowance for the range that the RCR falls into. Green values are below the allowance. Red values are above the allowance. The graphs show a continuum of results in shaded color, so the closer to 100% the results get, the value becomes more yellow looking.

Calculation Results – 50 Lux

Illuminance	50	lux

T24 2013:	0.2	0.3	0.4	0.6
Proposed 2016:	0.18	0.22	0.32	0.46

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.202	0.212	0.229	0.246	0.292	0.338	0.355	6" 1-Lamp CFL Downlight, 18W	112%	118%	104%	112%	91%	106%	77%
Fixture 2	0.108	0.133	0.168	0.230	0.461	0.872	1.026	Cove, (1) T5	60%	74%	76%	104%	144%	273%	223%
Fixture 3	0.127	0.137	0.151	0.168	0.208	0.253	0.265	6" LED Downlight, 900 lumens	70%	76%	69%	76%	65%	79%	58%
Fixture 4	0.118	0.128	0.141	0.157	0.194	0.237	0.250	6" LED Downlight, 600 lumens	66%	71%	64%	71%	61%	74%	54%

Calculation Results – 100 Lux

Illuminance	100	lux

T24 2013:	0.4	0.6	0.8	1.2
Proposed 2016:	0.30	0.38	0.56	0.84

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.327	0.343	0.371	0.398	0.473	0.547	0.574	6" 1-Lamp CFL Downlight, 32W	109%	114%	98%	105%	84%	98%	68%
Fixture 2	0.350	0.364	0.387	0.414	0.479	0.569	0.597	6" 2-Lamp CFL Downlight, (2) 26W	117%	121%	102%	109%	86%	102%	71%
Fixture 3	0.278	0.292	0.311	0.330	0.381	0.438	0.455	8" 1-Lamp CFL Downlight, 32W	93%	97%	82%	87%	68%	78%	54%
Fixture 4	0.404	0.424	0.458	0.492	0.585	0.676	0.709	6" 1-Lamp CFL Downlight, 18W	135%	141%	120%	129%	104%	121%	84%
Fixture 5	0.158	0.170	0.185	0.201	0.239	0.281	0.294	Industrial, (1) T5HO	53%	57%	49%	53%	43%	50%	35%
Fixture 6	0.217	0.266	0.335	0.460	0.922	1.744	2.052	Cove, (1) T5	72%	89%	88%	121%	165%	311%	244%
Fixture 7	0.253	0.274	0.302	0.335	0.416	0.507	0.529	6" LED Downlight, 900 lumens	84%	91%	80%	88%	74%	90%	63%
Fixture 8	0.220	0.238	0.266	0.297	0.370	0.455	0.476	8" LED Downlight, 1500 lumens	73%	79%	70%	78%	66%	81%	57%
Fixture 9	0.217	0.234	0.262	0.292	0.365	0.448	0.469	8" LED Downlight, 1200 lumens	72%	78%	69%	77%	65%	80%	56%

Calculation Results – 200 Lux

Illuminance	200	lux

T24 2013:	0.6	0.8	1.3	1.9
Proposed 2016:	0.48	0.64	0.88	1.34

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.655	0.687	0.741	0.796	0.946	1.094	1.148	6" 1-Lamp CFL Downlight, 32W	136%	143%	116%	124%	108%	124%	86%
Fixture 2	0.700	0.728	0.775	0.827	0.958	1.138	1.194	6" 2-Lamp CFL Downlight, (2) 26W	146%	152%	121%	129%	109%	129%	89%
Fixture 3	0.173	0.186	0.204	0.222	0.271	0.325	0.342	2"-Deep Parabolic 2x4, (2) T8	36%	39%	32%	35%	31%	37%	26%
Fixture 4	0.556	0.584	0.623	0.661	0.761	0.875	0.910	8" 1-Lamp CFL Downlight, 32W	116%	122%	97%	103%	87%	99%	68%
Fixture 5	0.557	0.586	0.626	0.673	0.790	0.919	0.957	8" 2-Lamp CFL Downlight, (2) 32W	116%	122%	98%	105%	90%	104%	71%
Fixture 6	0.307	0.328	0.358	0.388	0.463	0.543	0.569	Industrial, (2) T5HO	64%	68%	56%	61%	53%	62%	42%
Fixture 7	0.317	0.339	0.370	0.401	0.479	0.561	0.588	Industrial, (1) T5HO	66%	71%	58%	63%	54%	64%	44%
Fixture 8	0.433	0.533	0.671	0.919	1.844	3.488	4.103	Cove, (2) T5	90%	111%	105%	144%	210%	396%	306%
Fixture 9	0.433	0.533	0.671	0.919	1.844	3.488	4.103	Cove, (1) T5	90%	111%	105%	144%	210%	396%	306%
Fixture 10	0.440	0.476	0.531	0.593	0.741	0.909	0.952	8" LED Downlight, 1500 lumens	92%	99%	83%	93%	84%	103%	71%

Calculation Results – 300 Lux

Illuminance	300	lux

T24 2013:	0.8	1.0	1.4	2.0
Proposed 2016:	0.64	0.82	1.12	1.76

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	1.050	1.092	1.162	1.241	1.437	1.706	1.790	6" 2-Lamp CFL Downlight, (2) 26W	164%	171%	142%	151%	128%	152%	102%
Fixture 2	0.260	0.279	0.306	0.333	0.406	0.487	0.513	2"-Deep Parabolic 2x4, (2) T8	41%	44%	37%	41%	36%	43%	29%
Fixture 3	0.356	0.377	0.410	0.449	0.544	0.655	0.682	2"-Deep Parabolic 2x4, (3) T8	56%	59%	50%	55%	49%	59%	39%
Fixture 4	0.414	0.452	0.469	0.535	0.641	0.765	0.798	2"-Deep Parabolic 2x4, (4) T8	65%	71%	57%	65%	57%	68%	45%
Fixture 5	0.834	0.875	0.934	0.991	1.142	1.313	1.364	8" 1-Lamp CFL Downlight, 32W	130%	137%	114%	121%	102%	117%	78%
Fixture 6	0.836	0.879	0.940	1.010	1.186	1.378	1.436	8" 2-Lamp CFL Downlight, (2) 32W	131%	137%	115%	123%	106%	123%	82%
Fixture 7	0.475	0.579	0.720	0.970	1.868	3.361	3.935	Industrial, (2) T5HO	74%	90%	88%	118%	167%	300%	224%
Fixture 8	0.491	0.599	0.744	1.003	1.931	3.473	4.066	Industrial, (1) T5HO	77%	94%	91%	122%	172%	310%	231%
Fixture 9	0.629	0.680	0.750	0.828	1.029	1.269	1.336	Cove, (2) T5	98%	106%	91%	101%	92%	113%	76%
Fixture 10	0.629	0.680	0.750	0.828	1.029	1.269	1.336	Cove, (1) T5	98%	106%	91%	101%	92%	113%	76%

Calculation Results – 400 Lux

Illuminance	400	lux

T24 2013:	0.9	1.1	1.5	2.2
Proposed 2016:	0.78	0.98	1.34	2.08

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.347	0.372	0.409	0.444	0.542	0.649	0.685	2"-Deep Parabolic 2x4, (2) T8	44%	48%	42%	45%	40%	48%	33%
Fixture 2	0.474	0.503	0.547	0.598	0.726	0.874	0.910	2"-Deep Parabolic 2x4, (3) T8	61%	65%	56%	61%	54%	65%	44%
Fixture 3	0.552	0.602	0.625	0.713	0.854	1.020	1.065	2"-Deep Parabolic 2x4, (4) T8	71%	77%	64%	73%	64%	76%	51%
Fixture 4	1.114	1.172	1.253	1.346	1.581	1.837	1.915	8" 2-Lamp CFL Downlight, (2) 32W	143%	150%	128%	137%	118%	137%	92%
Fixture 5	0.620	0.664	0.724	0.785	0.937	1.099	1.151	Industrial, (3) T5HO	79%	85%	74%	80%	70%	82%	55%
Fixture 6	0.613	0.657	0.716	0.776	0.927	1.087	1.138	Industrial, (2) T5HO	79%	84%	73%	79%	69%	81%	55%
Fixture 7	0.633	0.679	0.740	0.802	0.958	1.123	1.176	Industrial, (1) T5HO	81%	87%	75%	82%	71%	84%	57%
Fixture 8	0.867	1.066	1.341	1.839	3.687	6.976	8.207	Cove, (2) T5	111%	137%	137%	188%	275%	521%	395%
Fixture 9	0.867	1.066	1.341	1.839	3.687	6.976	8.207	Cove, (1) T5	111%	137%	137%	188%	275%	521%	395%

Calculation Results – 500 Lux

Illuminance	500	lux

T24 2013:	1.0	1.2	1.6	2.4
Proposed 2016:	0.90	1.10	1.52	2.32

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.434	0.466	0.511	0.555	0.677	0.812	0.856	2"-Deep Parabolic 2x4, (2) T8	48%	52%	46%	50%	45%	53%	37%
Fixture 2	0.593	0.629	0.683	0.748	0.907	1.092	1.137	2"-Deep Parabolic 2x4, (3) T8	66%	70%	62%	68%	60%	72%	49%
Fixture 3	0.690	0.753	0.781	0.891	1.068	1.275	1.331	2"-Deep Parabolic 2x4, (4) T8	77%	84%	71%	81%	70%	84%	57%
Fixture 4	1.393	1.465	1.566	1.683	1.976	2.296	2.393	8" 2-Lamp CFL Downlight, (2) 32W	155%	163%	142%	153%	130%	151%	103%
Fixture 5	0.775	0.830	0.905	0.981	1.171	1.374	1.439	Industrial, (3) T5HO	86%	92%	82%	89%	77%	90%	62%
Fixture 6	0.766	0.821	0.895	0.970	1.158	1.358	1.423	Industrial, (2) T5HO	85%	91%	81%	88%	76%	89%	61%
Fixture 7	0.792	0.848	0.925	1.003	1.197	1.404	1.471	Industrial, (1) T5HO	88%	94%	84%	91%	79%	92%	63%

Calculation Results – 600 Lux

Illuminance	600	lux

T24 2013:	1.2	1.4	2.0	2.9
Proposed 2016:	1.06	1.26	1.74	2.60

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.520	0.559	0.613	0.667	0.813	0.974	1.027	2"-Deep Parabolic 2x4, (2) T8	49%	53%	49%	53%	47%	56%	39%
Fixture 2	0.712	0.755	0.820	0.898	1.089	1.311	1.365	2"-Deep Parabolic 2x4, (3) T8	67%	71%	65%	71%	63%	75%	52%
Fixture 3	0.828	0.903	0.938	1.070	1.281	1.530	1.597	2"-Deep Parabolic 2x4, (4) T8	78%	85%	74%	85%	74%	88%	61%
Fixture 4	1.671	1.758	1.879	2.019	2.371	2.756	2.872	8" 2-Lamp CFL Downlight, (2) 32W	158%	166%	149%	160%	136%	158%	110%
Fixture 5	0.930	0.996	1.086	1.177	1.405	1.648	1.727	Industrial, (3) T5HO	88%	94%	86%	93%	81%	95%	66%
Fixture 6	0.920	0.985	1.074	1.164	1.390	1.630	1.708	Industrial, (2) T5HO	87%	93%	85%	92%	80%	94%	66%
Fixture 7	0.950	1.018	1.110	1.203	1.436	1.684	1.765	Industrial, (1) T5HO	90%	96%	88%	95%	83%	97%	68%

Calculation Results – 700 Lux

Illuminance	700	lux

T24 2013:	1.4	1.7	2.3	3.3
Proposed 2016:	1.24	1.46	1.98	2.96

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.607	0.652	0.715	0.778	0.948	1.137	1.198	2"-Deep Parabolic 2x4, (2) T8	49%	53%	49%	53%	48%	57%	40%
Fixture 2	0.830	0.881	0.957	1.047	1.270	1.529	1.592	2"-Deep Parabolic 2x4, (3) T8	67%	71%	66%	72%	64%	77%	54%
Fixture 3	0.967	1.054	1.094	1.248	1.495	1.785	1.863	2"-Deep Parabolic 2x4, (4) T8	78%	85%	75%	85%	75%	90%	63%
Fixture 4	1.085	1.162	1.267	1.374	1.640	1.923	2.014	Industrial, (3) T5HO	87%	94%	87%	94%	83%	97%	68%
Fixture 5	1.073	1.149	1.253	1.358	1.622	1.902	1.992	Industrial, (2) T5HO	87%	93%	86%	93%	82%	96%	67%
Fixture 6	1.109	1.188	1.294	1.404	1.676	1.965	2.059	Industrial, (1) T5HO	89%	96%	89%	96%	85%	99%	70%

Calculation Results – 800 Lux

Illuminance	800	lux

T24 2013:	1.6	1.9	2.6	3.8
Proposed 2016:	1.44	1.70	2.28	3.30

	RCR								Percentage of Proposed Allowance							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description	1.5	2	2.75	3.5	5.25	7	7.5
Fixture 1	0.694	0.745	0.817	0.889	1.084	1.299	1.369	2"-Deep Parabolic 2x4, (2) T8	48%	52%	48%	52%	48%	57%	41%
Fixture 2	0.949	1.006	1.093	1.197	1.452	1.748	1.820	2"-Deep Parabolic 2x4, (3) T8	66%	70%	64%	70%	64%	77%	55%
Fixture 3	1.105	1.204	1.250	1.426	1.708	2.040	2.129	2"-Deep Parabolic 2x4, (4) T8	77%	84%	74%	84%	75%	89%	65%
Fixture 4	1.240	1.328	1.448	1.570	1.874	2.198	2.302	Industrial, (3) T5HO	86%	92%	85%	92%	82%	96%	70%
Fixture 5	1.226	1.314	1.432	1.552	1.853	2.173	2.277	Industrial, (2) T5HO	85%	91%	84%	91%	81%	95%	69%
Fixture 6	1.267	1.357	1.479	1.604	1.915	2.246	2.353	Industrial, (1) T5HO	88%	94%	87%	94%	84%	99%	71%

Calculation Results – 900 Lux

Illuminance	900	lux

T24 2013:	1.8	2.2	3.0	4.3
Proposed 2016:	1.66	2.00	2.64	3.74

	RCR							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description
Fixture 1	1.067	1.132	1.230	1.346	1.633	1.966	2.047	2"-Deep Parabolic 2x4, (3) T8
Fixture 2	1.243	1.355	1.407	1.605	1.922	2.296	2.395	2"-Deep Parabolic 2x4, (4) T8
Fixture 3	1.395	1.494	1.628	1.766	2.108	2.472	2.590	Industrial, (3) T5HO
Fixture 4	1.379	1.478	1.611	1.747	2.085	2.445	2.562	Industrial, (2) T5HO
Fixture 5	1.425	1.527	1.664	1.805	2.154	2.527	2.647	Industrial, (1) T5HO

Percentage of Proposed Allowance						
RCR						
1.5	2	2.75	3.5	5.25	7	7.5
64%	68%	62%	67%	62%	74%	55%
75%	82%	70%	80%	73%	87%	64%
84%	90%	81%	88%	80%	94%	69%
83%	89%	81%	87%	79%	93%	68%
86%	92%	83%	90%	82%	96%	71%

Calculation Results – 1000 Lux

Illuminance	1000	lux

T24 2013:	1.9	2.4	3.3	4.8
Proposed 2016:	1.84	2.20	2.90	4.06

	RCR							
	1.5	2	2.75	3.5	5.25	7	7.5	Luminaire Description
Fixture 1	1.186	1.258	1.367	1.496	1.815	2.185	2.275	2"-Deep Parabolic 2x4, (3) T8
Fixture 2	1.381	1.505	1.563	1.783	2.135	2.551	2.661	2"-Deep Parabolic 2x4, (4) T8
Fixture 3	1.550	1.660	1.809	1.962	2.342	2.747	2.878	Industrial, (3) T5HO
Fixture 4	1.533	1.642	1.790	1.941	2.317	2.717	2.846	Industrial, (2) T5HO

Percentage of Proposed Allowance						
RCR						
1.5	2	2.75	3.5	5.25	7	7.5
64%	68%	62%	68%	63%	75%	56%
75%	82%	71%	81%	74%	88%	66%
84%	90%	82%	89%	81%	95%	71%
83%	89%	81%	88%	80%	94%	70%

APPENDIX E: STATEWIDE IMPACTS INFORMATION

Assumptions

Calculation Basis

The statewide analysis is performed using the TDV process, employing use curves from the 2008 Alternative Calculation Method Approval Manual. (T24ACM) As a result, there are three primary building types that have been employed:

- General Nonresidential
- Hotel
- Retail

All of the building types in the construction forecast were compiled into one of those three categories.

Below in Table 23, Table 24, and Table 25 are provided the occupancy profile curves for the three building types employed in the calculations.

Table 23: Occupancy Profile Curve for Building Type 'General Nonresidential'

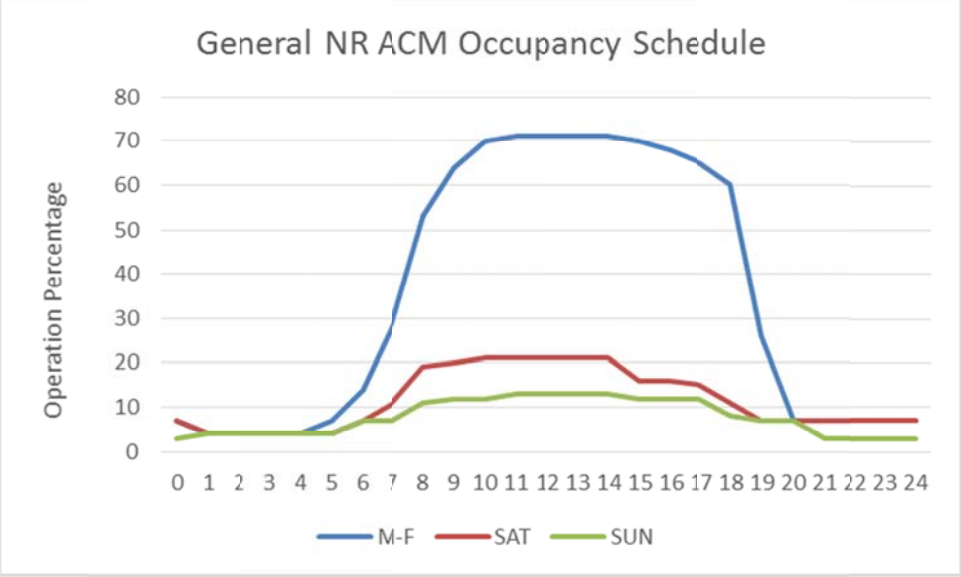


Table 24: Occupancy Profile Curve for Building Type 'Hotel'

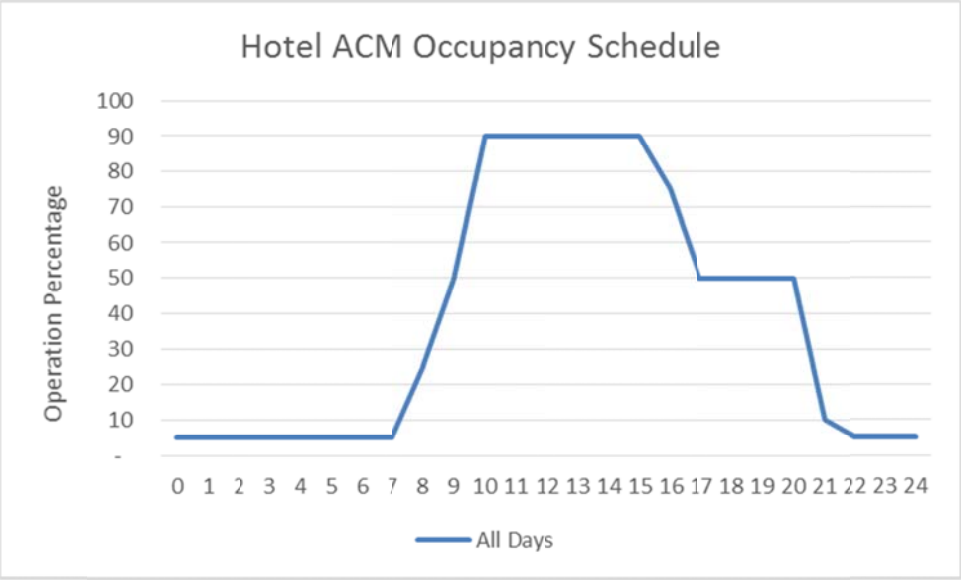


Table 25: Occupancy Profile Curve for Building Type 'Retail'