



## **CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)**

2008 California Energy Commission Title 24 Building Energy Efficiency Standards  
May 16, 2006

# *Draft Report Outdoor Lighting*

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## Overview

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The major change for this CASE proposal is the revision of Table 147-A “Lighting Power Allowances for General Site Illumination” and Table 147-B “Lighting Power Allowances for Specific Applications”. In both cases, LPD’s (lighting power densities) will be reduced where appropriate. Rationale for reduction includes changing the 2005 Standard base metal halide lamp source from probe start to pulse start per the 2008 Appliance Standards. Additional rationale is supported by selecting appropriate IESNA (Illuminating Engineering Society of North America) recommendations and evaluating typical designs for compliance. These calculations will provide a more complete rationale and will make use of prototypical worst case examples of varying pole heights, lamp types and wattages, and luminaire spacing for the specific applications.

Additional proposed changes:

- Add a specific definition for the conditions when a security multiplier should apply to retail parking lots in Exception 2 to Section 147(c) 1B and clarify that retail parking lots do not include outdoor sales lot and outdoor sales frontage. Add additional language to clarify that ‘Emergency’ lighting is intended exclusively for emergency facility applications.
- Add a dimming or nighttime lighting reduction requirement in Section 132(c) for outdoor lighting that is operated during the daylight and at night;

Revise the definition of façade lighting such that at least 50% of the light emitted from the luminaire directly lights the façade. This will prevent “wall packs,” or other forward throw area lights being used as façade lighting.

Recommendations are based on selecting appropriate IESNA recommended practices, design guides or general documents that are applicable to the application, and the particular lighting zone, revising lamp efficacy (see CASE study on Lamp efficacy) and the development of a large quantity of examples and calculations to support the LPD values.

## Description

These changes do not increase the scope of the existing outdoor lighting requirements in Title 24, but updates previous regulations in Section 132 – Outdoor Lighting Controls and Equipment and Section 147 – Requirements for Outdoor Lighting.

## Energy Benefits

Lower LPD’s and lighting controls during curfew hours will reduce energy, thus reducing utility bills. Electricity costs are cheaper at night than during the day. The energy cost savings methodology accounts for this effect by using the Time Dependent Valuation (TDV) factors for electricity cost that vary by time of day and day of year.

Even accounting for the lower cost of off-peak electricity and typical curfew operation hours, the typical cost savings to be realized by the reduced LPD limits are reflect a substantial reduction under most circumstances. The annual kWh and dollar savings per 1,000 sf of each application is given in Table 1 below.

Table 1: Annual energy and LCC PV cost savings per 1,000 sf\* relative to the 2005 Title 24 standards by application (modelled with limited nighttime operation hours)

Lighting Application	Lighting Zone 1		Lighting Zone 2		Lighting Zone 3		Lighting Zone 4	
	kWh	LCC PV \$						
Hardscape for automotive vehicular use, including parking lots driveways and site roads	21	\$ 33	63	\$ 98	147	\$ 229	189	\$ 295
Hardscape for pedestrian use, including, plazas, sidewalks, walkways and bikeways	42	\$ 65	63	\$ 98	168	\$ 262	0	\$ 0
Building Entrances (without canopy)	315	\$ 491	315	\$ 491	315	\$ 491	629	\$ 982
Outdoor Sales Lot	315	\$ 491	210	\$ 327	839	\$ 1309	1258	\$ 1,964
Outdoor Sales Frontage*	NA	\$ 0	0	\$ 0	5243	\$ 8,181	20970	\$ 32,726
Vehicle Service Station with or without Canopies	315	\$ 491	210	\$ 327	0	\$ 0	0	\$ 0

\* Outdoor Sales Frontage is measured in 1,000 linear feet.

## Non-energy Benefits

The key non-energy impacts from standards that control the unnecessary over lighting of the outdoor environment can be summarized in to the following categories:

- Improved or equivalent effect on security
- Reduced glare and increased safety

This proposal would increase the stringency of the current outdoor lighting requirements. This stringency is accomplished in two ways: 1) requiring equipment with higher overall efficacy and 2) better matching the allowable light levels achievable in these standards with the IESNA recommended practices for lighting. If these recommended practices are followed we can expect greater uniformity of light within a given application, lower average and maximum levels of light outdoors at night and light levels that are appropriate to the application.

If peak outdoor light levels are lower, there is less adaptation required when transitioning from a lighted to an unlighted area. With more uniform lighting within an application, people (and security cameras) are better able to detect potential hazards.

Reduced LPD's will not affect security. As stated below, security lighting is a combination of illuminances, uniformity, obstructions, surface reflectances, contrast, degree of glare, spectral distribution, surveillance systems and surrounding area. All proposed LPD's will meet IESNA criteria. As stated in the IESNA 9<sup>th</sup> Edition Handbook, Chapter 29 Security Lighting, pages 29-17:

“To achieve the objectives of security lighting in both public and secure areas, attention has to be given to both vertical and horizontal illuminances, the uniformity of the illuminance distribution, the effect of obstructions, the reflectances of surfaces, background contrast, the degree of glare, the spectral power distribution of the light source, the interaction with electronic surveillance systems, and the effect on the surrounding area.”

Lighting is a part of an overall lighting system strategy and carefully designed to minimize disability glare and impact on surrounding properties. As stated in the IESNA 9<sup>th</sup> Edition Handbook, Chapter 29 Security Lighting, pages 29-18:

“The extent and type of lighting to be used as part of a security system is determined by several different factors:

*Crime status of the area.* If the site is in a high crime area, it is likely that many physical defenses, including lighting, are necessary to maintain overall security.

*Nature of the site:* The type of facility or business, the hours of operation or access, and surrounding conditions affect the approach to security. Lighting should be integrated into the overall goals for the site.

*Degree of obstruction:* Landscape design and building configurations should not retard detection and identification of unauthorized persons on premises. The means of the lighting should be designed to avoid strong shadows and permit observation of the activities of those that are permitted on the site.

*Ambient brightness of the surrounding area.* Security elements at one site affect the security elements on adjoining sites. If the illuminances are lower or of lower uniformity at one site compared to adjoining properties, the former may be more attractive to criminal activity.

*Impact on the surrounding area.* Stray light from a security lighting installation can be considered as light trespass by neighbors. There are also possible safety effects on neighboring roads and railroads due to glare. Where sign lights are used to control traffic on roads, railroads, rivers, or at sea, care should be taken to avoid confusion caused by disability glare directly from security lighting, veiling reflections on the signals from the security lighting or the identification of the security lighting as a signal. Local lighting ordinances should be consulted prior to any design work. Mounting height restrictions, source type, wattage limitations, shielding, and other local requirements must be followed.

It should be remembered that lighting cannot guarantee security. Crime occurs in daylight hours as well as at night. Also, as pointed out above, lighting is only one factor in security. Other elements are required for good security, including locks, doors, gates, and detection means such as cameras or personnel.”

## Statewide Energy Impacts

Statewide results pending statewide outdoor lighting estimates.

## Environmental Impact

The proposed change does not have any potential adverse environmental impacts. However, reducing outdoor lighting does have a positive environmental impact associated with reduced air emissions from electrical generation plants.

The primary environmental impact is based upon the tradeoff between the reduction in air emissions from power plants due to reduced electricity consumption and the increase in furnace or boiler emissions due to increased heating fuel (natural gas) consumption. We will base these estimates of reduced emissions by multiplying the statewide energy savings by the emissions factor values generated by the California Energy Commission for evaluating the environmental impacts of the 2005 standards as shown in Table 2 below.<sup>1</sup>

*Table 2: Emissions factors used to calculate the air emissions reductions resulting from reduced end-use electricity consumption*

Emissions factors	NOx	CO	CO2	PM10
Electricity, Western States (lbs/MWh)	0.383	0.23	1200	0.06

<sup>1</sup> Table 1, Appendix B page 2, Initial Study/Proposed Negative Declaration for the 2005 Building Energy Efficiency Standards for Residential and Nonresidential Buildings September 2003 P400-03-018. Values provided by the CEC System Assessment and Facilities Siting Division [http://www.energy.ca.gov/reports/2003-09-12\\_400-03-018.PDF](http://www.energy.ca.gov/reports/2003-09-12_400-03-018.PDF)

Given that this proposal will save approximately \_\_\_GWh/yr on the first year of new construction and that by the 10<sup>th</sup> year the savings are approximately 10 times that amount of \_\_ GWh/yr, we can expect that this proposal would save approximately the amounts listed in Table 3.

*Table 3 Annual emissions reductions from reduced outdoor lighting electricity consumption*

<b>Annual Emissions Savings</b>	<b>NOx lb/yr</b>	<b>CO lb/yr</b>	<b>CO2 Tons/yr</b>	<b>PM10 lb/yr</b>
First year's savings				
10 <sup>th</sup> year's savings				

These results pending statewide outdoor lighting estimates. To be completed

## **Type of Change**

This proposal recommends changes to the mandatory outdoor lighting control requirements in Section 132 and the prescriptive outdoor lighting power allowances in Section 147. These changes do not address new issues, but modifies previously regulated Section 132 -Outdoor Lighting Controls and Equipment and Section 147- Requirements for Outdoor Lighting.

2005 Building Energy Efficiency Standards Sections 132 and 147 will need modification in order to implement the proposed change. The modification includes amending code language and adjusting some of lighting power allowances to lower values. In addition ACM, manuals, and compliance forms will need modification in order to implement the proposed change.

## **Technology Measures**

In general, these measures do not require a particular technology. They only require reviewing existing lighting regulations and design documents identified as the standard of practice. Lighting power allowances for parking lot lighting are based upon metal halide light sources or other light sources with similar luminous efficacy (lm/W). Where technology permits (320 watts and below), metal halide lamps are changed from probe start to pulse start lamps due to 2008 Title 20 Appliance Standard.

### ***Measure Availability and Cost***

All commercial luminaire manufacturers have luminaires that will meet the standard for IESNA photometric distribution type, lamp type and wattage. Examples of major manufacturers include Lithonia, Holophane, Kim Lighting, Widelight, Cooper, Gardco, Lumec, Hadco, GE Lighting, Hubbell, LSI and American Electric. For luminaires, there are no apparent market impacts.

The cost of pulse start metal halide technology as compared to the older probe start technology is not considered here as this technology will be required by the 2008 Title 20 appliance standards.

In most cases, there is no incremental cost to decrease installed lighting watts. In all cases, this reduction in installed watts is accomplished by meeting an appropriate IESNA guideline. Lighting systems that exceed the IESNA recommendations are effectively applying excessive light and energy to the application.

These measures will not increase lighting installation costs or maintenance costs. Since the standards are for new construction, these changes will reduce energy consumption, thus decreasing operating costs, and in some cases decrease installed cost as well.

The baseline condition is the current 2005 Standard. The LPD measure cost will be less than the baseline condition. Performance verification is the same as the existing 2005 Standard. There are no commissioning costs.

## ***Useful Life, Persistence and Maintenance***

There is no need for life, frequency of replacement or maintenance procedure measures with these measures. Persistence energy savings could be calculated for the reduced lighting power allowances.

## **Performance Verification**

There is no performance verification that is required with these measures.

## **Cost Effectiveness**

This measure is cost effective. The modeled luminaires are readily available from multiple manufacturers. The lighting design approaches used for the recommendations are standard practice in the lighting design community. Cost savings will occur with reduced energy and maintenance.

There is no increase in cost for lighting equipment, and in many cases the installed cost of a compliant lighting system may be lower.

## **Analysis Tools**

Typical power allowances are calculated with a series of typical lighting layouts per use type area. Each calculation meets an IESNA recommended practice appropriate for each application and lighting zone. Variables in the calculations are mounting height, lamp wattage, luminaire spacing. Standard ready available equipment is used in the calculations. Illuminance calculation programs by Light Pro and AGI were used for these calculations. MS Excel Spreadsheets are used to extrapolate results of lighting models to various configurations of aspect ratios of the spaces as well as the energy savings and benefit cost ratios of the various designs.

## **Relationship to Other Measures**

No other measures are impacted by this change.

## **Methodology**

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The basic methodology for determining the allowing LPD's for *Table 147-A Lighting Power Allowances for General Site Illumination* is to evaluate typical design scenarios that use standard commonly used luminaires. These design scenarios are all based on meeting appropriate IESNA recommended practices. Many of the Lighting Applications categories in Title 24 match closely with specific lighting recommendations in various IESNA Recommended Practice documents; however, several do not have a direct match.

For lighting applications that do not have a direct match to IESNA recommended practices, the visual tasks and general conditions of the application were considered and the most appropriate IESNA recommended practice document was selected. In all cases, the hierarchy of the Lighting Zones was considered in the selection of the appropriate specific design criteria for an application.

This proposal has selected the IESNA documents for Lighting Zones 2 and 3 that are dedicated to a specific application. For example, RP-2-01 is used for retail and merchandising areas and RP-20-01 is used for parking areas. In some cases, documents such as RP-33-99 "Lighting for Exterior Environments" is used for Lighting Zone 1 since environmental sensitivity may be a strong design issue and G-1-03 "Security Lighting" is used for Lighting Zone 4 since security may be a strong design issue.

In the 2005 Code, IESNA G-1-03 "Guideline for Security Lighting for People, Property, and Public Spaces" values were used as the basis for Lighting Zone 3 and 4. For 2008, IESNA G-1-03 will be the basis for Lighting Zone 4

only in the base LPD values. For other Lighting Zone 3, the security multiplier will be used to meet IESNA G-1-03 values when security is an issue. The determination if “security is an issue” is described in IESNA G-1-03 and also states that lighting alone cannot be the only measure that is increased. The determination check list in IESNA G-1-03 is added in the code language.

“Note that throughout this guideline the phrase when *security is an issue* is used to differentiate the lighting design suggestions presented herein from those contained in other IESNA publications. While these other publications may make reference to security, in G-1 it is the only issue. Note too that when *security is an issue*, not only lighting, but all measures and system components are increased and/or strengthened; for example, personnel, surveillance, gates, locks and fences.”

For parking lots, the calculations are initially based on a typical grid. Preference is given to typical parking lot pole layouts that encourage one pole for every other lane of cars. This is a standard design that minimizes equipment.

The following provides rationale for the selection of IESNA lighting criteria for each particular Lighting Application category source criteria selected for Title 24. Refer to Appendix A for detailed discussions on IESNA lighting criteria selections.

Light loss factors used in the calculations were based on lamp lumen depreciation (LLD) at 40% of life or the mean lumen published data and on luminaire dirt depreciation factors of 0.70. There is not a consensus on how to determine LLD for design calculations. The IESNA 9<sup>th</sup> Edition Handbook suggests relamping at 70% of life, yet defers to manufacturer’s data in determining the LLD. Several lamp manufacturers suggested using mean lumens since these are published, and the lamp maintenance curves may not always be current or available. In some cases, these curves are an average of several lamp types in the group. Many practitioners use mean lumens since as lamps burn out, new ones are installed, thus averaging out the system. Luminaire dirt depreciation (LDD) of 0.7 is between dirty and good environments. If luminaires are rated IP65, the LDD would be 0.80 or above. In combination, using mean lumens since they are available for every lamp source in combination with a conservative LDD will equate to a reasonable light loss factor.

Listed below is the methodology process description:

- Select IESNA appropriate criteria (*refer to Appendix A for detailed discussion on Lighting Zones and IESNA criteria selection*).
- Select standard luminaires that are readily available from multiple manufacturers. Select IESNA full cutoff photometric distribution for all applications, except for walkways where cutoff distribution was used.
- Layout typical grid or linear arrangement of luminaires as appropriate for calculation. The pole spacing also takes into consideration typical geometries, especially for parking lots with standard parking lane and space dimensions.
- When reflectances are included in the calculations, typical reflectance materials in the models are used to develop a moderate-case (higher lighting power densities needed to meet IESNA requirements).
- Vary mounting height, lamp wattage and luminaire spacing while still meeting IESNA criteria.
- Use a high efficacy lamp source similar to pulse start metal halide if available or fluorescent, since it is shown by the PIER Outdoor Lighting Baseline Assessment report that the majority of outdoor lighting in California uses metal halide and fluorescent light sources. 150 watt and lower horizontal burn pulse start metal halide is used in these models. Metal halide lamps greater than 150 watt are probe start.
- Use metal halide (60 lumens per watt or greater) for outdoor retail and canopies.
- Use compact fluorescent (60 lumens per watt or greater) for entries and facades.

- Use mean lamp lumens per manufacturer’s lamp information.
- Use a luminaire dirt depreciation (LDD) factor of 0.7.
- Add initial wattage allowance for areas when required to account for unusual or difficult geometries or application aspect ratios. For small parking lots with one or two lanes of parking, one luminaire may not be enough to adequately light the parking. By allowing an initial wattage for the lot, an additional luminaire can be added. This allowance will be added once per site. For small entry canopies, a baseline wattage allowance will allow at least an 18 watt compact fluorescent downlight. This allowance may be added per entry.
- Compare the first cost and operating costs of systems that meet or exceed the IESNA lighting criteria within the constraint of the 2005 lighting power densities and proposed lower lighting power densities.
- Life cycle operating cost savings under the proposed lighting densities are compared to the incremental first cost of an outdoor lighting system that complies with the new lighting power densities. In cases where there is no cost increment and there are cost savings the B/C ratio is “infinite”.
- The lighting power density of a system that is providing the IESNA required minimum light levels and uniformity is compared to the proposed lighting power densities. This ratio indicates how much margin is available for designers to increase their light levels above the IESNA requirements while still complying with the proposed lighting power densities.

The results of the typical lighting layouts were entered into a spreadsheet (Microsoft Excel) and power densities were calculated per square foot. These allowances are reviewed for trends in order to decide on a suggested power density per use type per lighting zone.

Power densities are refined, and the energy and maintenance savings are predicted using a spreadsheet (Microsoft Excel) as a tool for these calculations.

The 2008 Table 147-C provides LPD limits for lighting equipment when associated with local ordinances that may have mandated specific light level requirements for safety and security. This table has been reviewed with the lighting scenarios established using the above procedures. The Pedestrian Hardscape and Vehicle Hardscape lighting applications were considered for this table specifically.

The simulations made for these two lighting applications were modified to interpolate data for lighting designs that will meet the specific target illuminance values in the 2008 Table 147-C. The LPD limit was then interpreted from a variety of lamping and pole height scenarios within these simulations, and represents a reasonable limit to enable a variety of wattage and pole height conditions to meet the target illuminance levels.

## Results

From a detailed mapping of the Title 24 applications for various lighting zones to the appropriate IESNA standards, the following lighting criteria in Table 147-A and Table 147-B were developed. The details of this mapping are contained in Appendix A.

The lighting application categories shown below were identified for analysis as specific areas that may provide improvements in statewide energy use based on the potential for reductions in the 2005 values to meet the selected IESNA Criteria cited. The rationale for IESNA Design Criteria Basis per Lighting Zone for Table 147-A is detailed in the Appendix.

Table 4: IESNA Design Criteria Basis per Lighting Zone for General Lighting Applications in 2008 Table 147-A

T-24 Lighting Application	IESNA Recommended Criteria per Lighting Zone			
	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Hardscape for automotive vehicular use, including parking lots, driveways, and site roads	RP-20-98 NO VERTICAL (.2 hfc min)	RP-20-98 Basic (.2 hfc min, .1 vfc)	RP-20-98 Enhanced (.5 hfc min, .25 vfc)	RP-20-98 Enhanced Security/Retail (1.0fc min, .25 vfc); G-1-03 Parking lots 3 hfc ave
Hardscape for pedestrian use, including plazas, sidewalks, walkways, and bikeways	DG-5-94 Specialized Residential - Medium (.5 fc)	DG-5-94 Village Center Walkway - Mixed (1 fc)	DG-5-94 Suburban Shopping Street - Mixed (2 fc)	DG-5-94 City Center Shopping Street - Mixed (2.5 fc); G-1-03 Park trails and walkways 0.6 hfc ave
Hardscape for driveways, side roads, sidewalks, walkways, and bikeways (Method II)	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian Low Conflict (.5 fc)	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian Medium Conflict (1 fc)	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian High Conflict (2 fc)	DG-5-94 City Center Shopping Street - Mixed (2.5 fc); G-1-03 Park trails and walkways 0.6 hfc ave
Building Entrances (without canopy)	DG-5-94 Village Center Walkways Mixed (1 fc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Low (5 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Medium (7 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation High (10 hfc)

Table 5: IESNA Design Criteria Basis per Lighting Zone for Selected Specific Lighting Applications in 2008 Table 147-B

Specific Lighting Application	IESNA Recommended Criteria per Lighting Zone			
	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Outdoor Sales Lot	RP-33-99 Secondary Business District General Display (5 hfc, 10:1 max:min)	RP-2-01 Auto Retail Lot Low Level (20 hfc)	RP-2-01 Auto Retail Lot Medium Level (30 hfc)	RP-2-01 Auto Retail Lot High Level (50 hfc)
Outdoor Sales Frontage (in linear feet)	NA	RP-2-01 Auto Dealership Feature Display (35 hfc)	RP-2-01 Auto Dealership Feature Display (50 hfc)	RP-2-01 Auto Dealership Feature Display (75 hfc)
Vehicle Service Station with or without canopies	RP-33-99 Service Station Pump Island (10 hfc)	RP-2-01 Service Station Gas Islands (20 hfc)	RP-2-01 Service Station Gas Islands (30 hfc)	RP-2-01 Service Station Gas Islands (50 hfc)

The results of the research and calculations show that many of the LPD's can be lowered and still meet the IESNA recommended values. In addition, the LPD's are consistent with current practice as verified in the California PIER Outdoor Lighting Assessment report.

Prototypes of applications under consideration were developed. These prototypes resulted in "in the field" simulations of lighting power density. The results were then considered for various difficult configurations of application geometry to develop lighting power allowances. One result of this study was to develop an Initial Wattage Allowance (IWA) table for each lighting application and lighting zone.

The IWA is designed to accommodate very small site conditions where an application may be too large for a certain amount of lamps to adequately meet the IESNA guidelines, but too small to permit the addition of enough lamps to meet the guidelines due to the LPD limits. The IWA is a small, flat wattage amount that is permitted only once per site, with the exception of building entrance canopies. As sites get larger, the IWA becomes less significant and is substantially inconsequential, but for small lots where site geometry and other conditions related to size become important, the IWA is helpful in enabling the lighting designer to meet their lighting design goals suitably.

*Table 6: Recommended Adjustments to Lighting Power Allowances for General Site Illumination, 2008 Table 147-A (W/Ft<sup>2</sup> Unless Otherwise Noted)*

Lighting Application	2005 LZ1	Proposed 2008 LZ1	2005 LZ2	Proposed 2008 LZ2	2005 LZ3	Proposed 2008 LZ3	2005 LZ4	Proposed 2008 LZ4
Hardscape for automotive vehicular use, including parking lots driveways and site roads	0.05	0.04	0.08	0.05	0.15	0.08	0.19	0.1
Hardscape for pedestrian use, including, plazas, sidewalks, walkways and bikeways	0.06	0.04	0.09	0.06	0.17	0.09	0.21	No Change
Hardscape for driveways, site roads, sidewalks, walkways and bikeways	1.0 w/lf	No Change	1.5 w/lf	No Change	4.0 w/lf	No Change	5.0 w/lf	No Change
Building Entrances (without canopy)	0.35	0.2	0.5	0.35	0.7	0.55	1	0.7
Outdoor Sales Lot	<i>This Application Moved to 2008 Table 147-B</i>							

*Table 7: Recommended Addition of 2008 Table 147-A1; Initial Wattage Allowance for General Site Illumination (Watts)*

Lighting Application	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Hardscape for automotive vehicular use, including parking lots driveways and site roads	190	190	290	370
Hardscape for pedestrian use, including plazas, sidewalks, walkways and bikeways	90	130	190	290
Hardscape for driveways, site roads, sidewalks, walkways and bikeways	---	---	---	---
Building Entrances (without canopy)	---	---	---	---

Table 8: Recommended Adjustments to Lighting Power Allowances for Specific Applications, 2008  
Table 147-B1 (W/Ft<sup>2</sup> Unless Otherwise Noted)

Lighting Application	2005 LZ1	Proposed 2008 LZ1	2005 LZ2	Proposed 2008 LZ2	2005 LZ3	Proposed 2008 LZ3	2005 LZ4	Proposed 2008 LZ4
Building Facades	Not allowed	No Change	0.18	0.18	0.35	0.35	0.5	0.5
Outdoor Sales Lot	0.35	0.2	0.7	0.6	1.25	0.85	2.0	1.4
Outdoor Sales Frontage (Frontage in linear feet)	Not allowed	No Change	22.5 w/lf	No Change	38.5 w/lf	36 w/lf	55 w/lf	45 w/lf
Vehicle Service Station with or without Canopies	0.7	0.55	1.15	1.05	1.45	1.45	2.4	2.4

Table 9: Recommended Addition of 2008 Table 147-B1; Initial Wattage Allowances for Specific Applications (Watts)

Lighting Application	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Building Facades	---	---	---	---
Outdoor Sales Lot	190	190	290	370
Outdoor Sales Frontage	---	---	---	---
Vehicle Service Station with or without Canopies	130	190	290	370
Vehicle Service Station Hardscape	190	190	290	370
All Other Sales Canopies	90	130	190	290
Non-sales canopies	20	40	70	90
Ornamental Lighting	---	---	---	---
Drive Up Windows	70	90	130	190
Guarded Facilities	---	---	---	---
Outdoor Dining	90	130	190	290

## Energy and Cost Savings

The energy savings can be modeled simply without the Initial Wattage Allowance included as a direct reduction in the LPD limit from the 2005 values to the proposed 2008 values. The IWA will slightly reduce the actual energy and cost savings, but the effect is expected to be minimal because the IWA is limited to one allowance per lighting application per site. The IWA values are also minimal wattage limits to permit the addition of a single reasonable lamp and ballast to the lighting application, so under most properties this value will be small compared to the total watts permitted on the site based on square footage allowances.

The anticipated energy and cost savings are provided in the table below. These values are calculated for a typical limited hours operation of nighttime-only photocell and timeclock controlled operation, with the lights in operation until 2300 hours during the week, and until 0100 hours for weekend days.

Table 10: Annual Energy, LCC PV Cost, and kBtu/yr per 1,000 sf\* Savings for the Proposed 2008 Tables 147-A & 147-B Relative to the 2005 Tables 147-A & 147-B Standards for General and Specific Lighting Applications and Lighting Zones (modelled with limited hours of operation)

Application	2005 T-24	2008 T-24	Incremental Cost per 1,000 sf	Ltd. Hours Schedule Savings per 1,000 sf			
	Current Allowance W/sf	Proposed Allowance W/sf		Energy Savings kWh/yr	TDV Savings kBtu/yr	15 yr Savings PV \$	Benefit/Cost Ratio
Automotive Hardscape - LZ1	0.05	0.04	none	21	388	\$33	Immediate
Automotive Hardscape - LZ2	0.08	0.05	none	63	1,164	\$98	Immediate
Automotive Hardscape - LZ3	0.15	0.08	none	147	2,715	\$229	Immediate
Automotive Hardscape - LZ4	0.19	0.10	none	189	3,491	\$295	Immediate
Pedestrian Hardscape - LZ1	0.06	0.04	none	42	776	\$65	Immediate
Pedestrian Hardscape - LZ2	0.09	0.06	none	63	1,164	\$98	Immediate
Pedestrian Hardscape - LZ3	0.17	0.09	none	168	3,103	\$262	Immediate
Pedestrian Hardscape - LZ4	0.21	0.21	none	0	0	\$0	
Building Entrance, NC - LZ1	0.35	0.20	none	315	5,819	\$491	Immediate
Building Entrance, NC - LZ2	0.50	0.35	none	315	5,819	\$491	Immediate
Building Entrance, NC - LZ3	0.70	0.55	none	315	5,819	\$491	Immediate
Building Entrance, NC - LZ4	1.00	0.70	none	629	11,638	\$982	Immediate
Outdoor Sales Lot - LZ1	0.35	0.20	none	315	5,819	\$491	Immediate
Outdoor Sales Lot - LZ2	0.70	0.60	none	210	3,879	\$327	Immediate
Outdoor Sales Lot - LZ3	1.25	0.85	none	839	15,517	\$1,309	Immediate
Outdoor Sales Lot - LZ4	2.00	1.40	none	1,258	23,275	\$1,964	Immediate
Outdoor Sales Front - LZ2	22.50	22.50	none	0	0	\$0	
Outdoor Sales Front - LZ3	38.50	36.00	none	5,243	96,979	\$8,181	Immediate
Outdoor Sales Front - LZ4	55.00	45.00	none	20,970	387,918	\$32,726	Immediate
Vehicle Service Station - LZ1	0.70	0.55	none	315	5,819	\$491	Immediate
Vehicle Service Station - LZ2	1.15	1.05	none	210	3,879	\$327	Immediate
Vehicle Service Station - LZ3	1.45	1.45	none	0	0	\$0	
Vehicle Service Station - LZ4	2.40	2.40	none	0	0	\$0	

Table 11: Annual Energy, LCC PV Cost, and kBtu/yr per 1,000 sf\* Savings for the Proposed 2008 Table 147-C Relative to the 2005 Table 147-C Standards for Alternative Power Allowance for Ordinance Requirements (modelled with limited hours of operation)

Application	2005 T-24	2008 T-24	Incremental Cost per 1,000 sf	Ltd. Hours Schedule Savings per 1,000 sf			
	Current Allowance W/sf	Proposed Allowance W/sf		Energy Savings kWh/yr	TDV Savings kBtu/yr	15 yr Savings PV \$	Benefit/Cost Ratio
Automotive Hardscape - LZ1	0.05	0.04	none	21	388	\$33	Immediate
Automotive Hardscape - LZ2	0.07	0.06	none	21	388	\$33	Immediate
Automotive Hardscape - LZ3	0.10	0.08	none	42	776	\$65	Immediate
Automotive Hardscape - LZ4	0.12	0.10	none	42	776	\$65	Immediate
Pedestrian Hardscape - LZ1	0.19	0.12	none	147	2,715	\$229	Immediate
Pedestrian Hardscape - LZ2	0.25	0.20	none	105	1,940	\$164	Immediate

## Cost-effectiveness

The equal or lower installed cost of a suitable lighting system that meets the adjusted values in 2008 Tables 147-A and 147-B indicates an immediate payback for the measure for all changes recommended. All recommendations are cost effective.

The adjusted lighting power density limits in 2008 Tables 147-A and 147-B may reduce installed cost in some cases, and may also reduce maintenance costs throughout the life of the lighting system as well, due to lower light levels and the associated reduction in equipment or lamp wattage normally associated with lower light levels. In all cases the cost of a comparable compliant lighting system will not increase. Thus cost-effectiveness is infinite and simple payback immediate.

## Statewide Energy Savings

Statewide energy savings estimates are based on unit energy savings multiplied by estimates of statewide quantities of total areas by application type and lighting zone (LZ).

*Results pending estimate of total new outdoor lighting systems.*

## Recommendations

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Listed below is a summary of the specific recommendations.

### Proposed Standards Language

#### **SECTION 132 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT**

- (a) **Outdoor Lighting.** All permanently installed outdoor luminaires employing lamps rated over 100 watts shall either: have a lamp efficacy of at least 60 lumens per watt; or be controlled by a motion sensor.

**EXCEPTIONS to Section 132 (a):**

1. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
  2. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.
  3. Searchlights.
  4. Theme lighting for use in theme parks.
  5. Lighting for film or live performances.
  6. Temporary outdoor lighting.
  7. Light emitting diode, neon and cold cathode lighting.
- (b) **Luminaire Cutoff Requirements.** All outdoor luminaires that use lamps rated greater than ~~175~~ 150 watts in hardscape areas including parking lots, building entrances, sales and non-sales canopies, and all outdoor sales areas shall be designated Cutoff for light distribution. To comply with this requirement the luminaire shall be rated Cutoff in a photometric test report that includes any tilt or other non-level mounting condition of the installed luminaire. Cutoff is a luminaire light distribution classification where the candela per 1000 lamp lumens does not numerically exceed 25 at or above a vertical angle of ninety degrees above nadir, and 100 at or above a vertical angle of eighty degrees above nadir. Nadir is in the direction of straight down, as would be indicated by a plumb line. Ninety degrees above nadir is horizontal. Eighty degrees above nadir is 10 degrees below horizontal.

**EXCEPTIONS to Section 132 (b):**

1. Internally illuminated, externally illuminated, and unfiltered signs.
2. Lighting for building facades, public monuments, statues, and vertical surfaces of bridges.
3. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
4. Temporary outdoor lighting.
5. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.

**(c) Controls for Outdoor Lighting**

1. All permanently installed outdoor lighting shall be controlled by a photocontrol or astronomical time switch that automatically turns off the outdoor lighting when daylight is available.

**EXCEPTION to Section 132 (c) 1:** Lighting in ~~parking garages~~, tunnels, and large covered areas that require illumination during daylight hours

2. For lighting of building facades, parking lots, ~~garages~~, sales and non-sales canopies, and all outdoor sales areas, where two or more luminaires are used, an automatic time switch shall be installed that (1) turns off the lighting when not needed and (2) reduces the lighting power (in watts) by at least 50% but not exceeding 80% or provides continuous dimming through a range that includes 50% through 80% reduction. This control shall meet the requirements of Section 119 (c).

**EXCEPTIONS to Section 132 (c) 2:**

1. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
2. Lighting for steps or stairs that require illumination during daylight hours.
3. Lighting that is controlled by a motion sensor and photocontrol.
4. Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously.
5. Temporary outdoor lighting.
6. Internally illuminated, externally illuminated, and unfiltered signs.

**SECTION 147 – REQUIREMENTS FOR OUTDOOR LIGHTING**

This section applies to all outdoor lighting, whether attached to buildings, poles, structures or self supporting, including but not limited to, hardscape areas including parking lots, lighting for building entrances, sales and non-sales canopies; lighting for all outdoor sales areas; and lighting for building facades.

**EXCEPTIONS to Section 147:**

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways, and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children’s playground.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.

6. Automated Teller Machine lighting.
  7. Lighting of public monuments.
  8. Internally illuminated, externally illuminated, and unfiltered signs.
  9. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.
  10. Lighting of tunnels, bridges, stairs, and ramps.
  11. Landscape lighting.
  12. In theme parks: outdoor lighting for themes and special effects
- (a) **Outdoor Lighting Power.** An outdoor lighting installation complies with this section if the actual outdoor lighting power calculated under Subsection (b) is no greater than the allowed outdoor lighting power calculated under Subsection (c). The allowed outdoor lighting shall be calculated by Lighting Zone as defined in Section 10-114. Local governments may amend lighting zones in compliance with Section 10-114. Trading off lighting power allowances with any indoor areas shall not be permitted.
- (b) **Calculation of Actual Lighting Power.** The wattage of outdoor luminaires shall be determined as specified by § 130 (c) or by a method approved by the Commission.
- (c) **Calculation of Allowed Lighting Power.** The allowed lighting power shall be calculated as follows:
1. Determine the allowed lighting power for general illumination of the site as follows:
    - A. In plan view of the site, determine the illuminated area. The illuminated area is defined as any area within a square pattern around each luminaire or pole that is six times the luminaire mounting height, with the luminaire in the middle of the pattern, less any area that is within a building, under a canopy, beyond property lines, obstructed by a sign or structure, [or falls into any of the specific application categories listed in Table 147-B.](#)
    - B. Determine a lighting application from Table 147-A for each portion of the illuminated area. Determine the allowed area for each application. Note that the allowed area only applies to illuminated areas. Only portions of the site that are inside the illuminated area determined in step A qualify for allowed lighting power for general illumination. Multiply the allowed area of each lighting application by the allowed lighting power density from Table 147-A. Only applications listed in Table 147-A shall be included. Each portion of the illuminated area shall only be assigned one lighting application, and the assigned lighting applications shall be consistent with the actual use of the area. The allowed area of a site roadway, driveway, sidewalk, walkway or bikeway shall be determined by either of the following methods.
      - i. The actual paved area plus 5 foot perimeter of adjacent unpaved land, not including areas beyond the property line. Includes planters and landscaped areas that are less than 10 feet wide and are enclosed by hardscape on at least three sides; or
      - ii. A 25 foot wide area running along the axis of the path of travel and including as much of the paved area of the site roadway, driveway, sidewalk, walkway or bikeway as possible. Any overlapping area of another lighting application shall be subtracted from the area of the other lighting application. In this case the allowed lighting power is the length of the centerline of the path times the allowed power per unit length.

**EXCEPTION 1 to Section 147 (c) 1 B:** For hardscape including parking lots, site roadways, driveways, sidewalks, walkways or bikeways, when specific light levels are required by law through a local ordinance, the allowed lighting power densities specified in Table 147-C may be used to calculate the allowed lighting power.

**EXCEPTION 2 to Section 147 (c) 1 B:** For retail parking lots in lighting zones 1, 2, and 3, hardscape areas within 100 feet of the entrance of senior housing facilities, and parking lots and walkways in lighting zones 1, 2 and 3 within 60 feet of [police stations, fire stations, hospitals and emergency vehicle facilities](#) ~~building entrances for law enforcement, fire, ambulance and emergency~~

vehicle facilities, and other pedestrian hardscape or parking areas in lighting zone 3 deemed to have special security requirements, the allowed lighting power densities specified in Table 147-A may be adjusted by applying the multipliers for special security requirements in Table 147-D to establish allowed lighting power for these special applications. Retail parking lots do not include outdoor sales lots or outdoor sales frontage. Luminaires qualifying for these adjusted allowances shall not be used to determine allowed power for general illumination. The adjusted lighting power allowances shall be separate allotments, which shall be complied with separately without tradeoffs. An area is deemed to have special security requirements when it meets all of the following conditions:

- i.
- ii.
- iii.

<These conditions are under review awaiting input from stakeholders and CEC staff>

- C. Add Initial Wattage Allowance (IWA) to each respective lighting application that occurs on the site. Refer to Table 147-A1 for information on allowances. All lighting applications listed in Table 147-A are permitted a single IWA per site.
  - D. Determine the sum of the allowed power for all general illuminated areas of the site as determined in Section 147(c)1.
2. Determine the allowed lighting power for specific applications as follows:
- A. Determine the allowed lighting power for building façade. The allowed lighting power for lighting the facade shall be the smaller of the product of the area of the façade and the allowed lighting power density for it from Table 147-B, or the actual power used to illuminate the facade. Only areas of the façade that are illuminated without obstruction or interference, by one or more luminaires, shall be used. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
  - B. Determine the allowed lighting power for outdoor sales lots. The allowed lighting power shall be the smaller of the actual portion of uncovered outdoor sales lot used exclusively for display of vehicles or other merchandise for sale plus 5' perimeter of adjacent unpaved land, not including areas beyond the property line, per Table 147-B or the actual power used for lighting the sales lot. All adjacent access drives, walkway areas, customer parking areas, vehicle service or storage areas that are not surrounded on at least three sides by sales area shall be considered vehicle or pedestrian hardscape. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
  - C. Determine the allowed lighting power for outdoor sales frontage. The allowed lighting power for outdoor sales frontage shall be the smaller of the product of the frontage (in feet), and the allowed lighting power density per foot from Table 147- B, or the actual power used to illuminate the frontage. Sales frontage shall be immediately adjacent to the principal viewing location and unobstructed for its viewing length. A corner sales lot may include both sides provided that a different principal viewing location exists for each side. Measured in plan view, only sections of the outdoor sales area that are along the frontage and are within 3 mounting heights of frontage luminaires shall be eligible for this power allowance. Luminaires qualifying for this allowance shall be located in plan view between the principal viewing location and the frontage outdoor sales area, and shall not be used to determine allowed lighting power for general illumination.
  - D. Determine the allowed lighting power for ornamental lighting. The allowed lighting power for ornamental lighting shall be the smaller of the product of the total area of the site external to buildings, and the allowed lighting power density for ornamental lighting from Table 147- B, or the actual power used for ornamental lighting. Luminaires qualifying for this allowance shall employ lamps rated 100 watts or less, and shall not be used to determine allowed lighting power for general illumination.

- E. Determine the allowed lighting power for lighting under canopies. The allowed lighting power for lighting under a canopy shall be the smaller of the product of the area in plan view of the horizontal projection of the canopy and the allowed lighting power density for either a vehicle service station with or without canopies, for all other sales canopies, or for non-sales canopies from Table 147- B or the actual power used for lighting mounted beneath the canopy. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
- F. Determine the allowed lighting power for lighting of vehicle service stations without canopies. The allowed lighting power for a service station without canopy shall be the smaller of the product of the allowed lighting power density [from Table 147-B](#) for a vehicle service station with or without canopies and 500 square feet per double-sided fuel dispenser, or the actual power used to illuminate this area (in cases where the site only allows fuel to be dispensed on one side of the dispenser, the allowed lighting power shall be the smaller of the product of the allowed lighting power density and 250 square feet per dispenser or the actual power). Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
- G. Determine the allowed lighting power for lighting of vehicle service station hardscape areas. The allowed lighting power for vehicle service station hardscape areas shall be the smaller of the product of the area of the vehicle service station hardscape and the allowed lighting power density foot from Table 147- B, or the actual power used to illuminate this area. Vehicle service station hardscape areas include all vehicle service station outdoor hardscape areas beyond the horizontal projection of the canopy in plan view. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
- H. Determine the allowed lighting power for drive-up windows. The allowed lighting power for drive-up windows shall be the smaller of the product of the area of the drive-up window and the allowed lighting power density foot from Table 147-B, or the actual power used to illuminate this area. Drive-up window area is the product of the width of the window plus six feet and the distance 30 feet outward from the window, or to the property line, whichever is closer. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
- I. Determine the allowed lighting power for guarded facilities. The allowed lighting power for guarded facilities shall be the smaller of the product of the area for the guarded facility and the allowed lighting power densities specified in Tables 147- B. The guarded facility area includes the guardhouse interior area plus the product of the entrance width of 25 feet and length of 80 feet, or to the property line, whichever is closer. Guarded facilities include the entrance driveway, gatehouse, and guardhouse interior areas that provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants including, identification documentation, vehicle license plates, and vehicle contents. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.
- J. Determine the allowed lighting power for outdoor dining. The allowed lighting power for outdoor dining shall be the smaller of the product of the outdoor dining area and the allowed lighting power density from Table 147-B, or the actual power used to illuminate this area. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination.

[K. Add Initial Wattage Allowance \(IWA\) to each specific lighting application that occurs on the site. Refer to Table 147-B1 for information on allowances. All lighting applications listed in Table 147-B are permitted a single IWA per site, except Non-Sales Canopies that are associated with building entries, which are permitted one IWA per entry.](#)

- 3. The Allowed Lighting Power shall be the total of the allowed power for general illumination of the site as determined in Section 147 (c) 1 C and the sum of all the allowed power for specific applications determined under Section 147 (c) 2. The allowed outdoor power and the allowed indoor power determined in Section 146 (b) shall be separate allotments, which shall be met separately without tradeoffs between the separate allotments.

**TABLE 147-A LIGHTING POWER ALLOWANCES FOR GENERAL SITE ILLUMINATION (W/FT<sup>2</sup> UNLESS OTHERWISE NOTED)**

Lighting Application	Allowed Area	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Hardscape for automotive vehicular use, including parking lots driveways and site roads	Method (i.) Actual paved area plus 5' perimeter of adjacent unpaved land. Includes planters and landscaped areas less than 10' wide that are enclosed by hardscape on at least three sides..	<del>0.05-0.04</del>	<del>0.08-0.05</del>	<del>0.15-0.08</del>	<del>0.19-0.10</del>
Hardscape for pedestrian use, including, plazas, sidewalks, walkways and bikeways	Method (i.) Actual paved area plus 5 feet of unpaved land on either side of path of travel. Shall include all continuous paved area before including adjacent grounds.	<del>0.06-0.04</del>	<del>0.09-0.06</del>	<del>0.17-0.09</del>	0.21
Hardscape for driveways, site roads, sidewalks, walkways and bikeways	Method (ii.) 25' wide path incorporating as much of the paved area of the site roadway, driveway, sidewalk, walkway or bikeway as possible.	1.0 w/lf	1.5 w/lf	4.0 w/lf	5.0 w/lf
Building Entrances (without canopy)	Width of doors plus 3 ft on each side times a distance of 18 feet outward, or to the property line, whichever is closer..	<del>0.35-0.20</del>	<del>0.50-0.35</del>	<del>.70-0.55</del>	<del>4.00-0.70</del>
<del>Outdoor Sales Lot</del>	<del>Actual portion of uncovered outdoor sales lot used exclusively for display of vehicles or other merchandise for sale. All adjacent access drives, walkway areas, customer parking areas, vehicle service or storage areas that are not surrounded on at least three sides by sales area shall be considered hardscape.</del>	<del>0.35</del>	<del>0.70</del>	<del>1.25</del>	<del>2.00</del>

**TABLE 147-A1 INITIAL WATTAGE ALLOWANCE FOR GENERAL SITE ILLUMINATION (WATTS)**

Lighting Application	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
<a href="#">Hardscape for automotive vehicular use, including parking lots driveways and site roads</a>	<a href="#">190</a>	<a href="#">190</a>	<a href="#">290</a>	<a href="#">370</a>
<a href="#">Hardscape for pedestrian use, including plazas, sidewalks, walkways and bikeways</a>	<a href="#">90</a>	<a href="#">130</a>	<a href="#">190</a>	<a href="#">290</a>
<a href="#">Hardscape for driveways, site roads, sidewalks, walkways and bikeways</a>	---	---	---	---
<a href="#">Building Entrances (without canopy)</a>	---	---	---	---

**TABLE 147-B LIGHTING POWER ALLOWANCES FOR SPECIFIC APPLICATIONS (W/ft<sup>2</sup> unless otherwise noted)**

Lighting Application	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Building Facades	Not allowed	0.18	0.35	0.50
<a href="#">Outdoor Sales Lot</a>	<a href="#">0.20</a>	<a href="#">0.60</a>	<a href="#">0.85</a>	<a href="#">1.40</a>
Outdoor Sales Frontage (Frontage in linear feet)	Not allowed	22.5 w/lf	<del>38.5</del> <a href="#">36</a> w/lf	<del>55</del> <a href="#">45</a> w/lf
Vehicle Service Station with or without Canopies	<del>0.70</del> <a href="#">0.55</a>	<del>4.15</del> <a href="#">1.05</a>	1.45	2.40
Vehicle Service Station Hardscape	0.05	0.20	0.40	0.60
All Other Sales Canopies	Not allowed	0.70	1.00	1.25
Non-sales canopies	0.12	0.25	0.50	0.70
Ornamental Lighting	Not allowed	0.01	0.02	0.04
Drive Up Windows	0.12	0.25	0.50	0.70
Guarded Facilities	0.19	0.40	0.80	1.10
Outdoor Dining	0.05	0.18	0.35	0.55

**TABLE 147-B1 INITIAL WATTAGE ALLOWANCES FOR SPECIFIC APPLICATIONS (WATTS)**

<a href="#">Lighting Application</a>	<a href="#">Lighting Zone 1</a>	<a href="#">Lighting Zone 2</a>	<a href="#">Lighting Zone 3</a>	<a href="#">Lighting Zone 4</a>
<a href="#">Building Facades</a>	---	---	---	---
<a href="#">Outdoor Sales Lot</a>	<a href="#">190</a>	<a href="#">190</a>	<a href="#">290</a>	<a href="#">370</a>
<a href="#">Outdoor Sales Frontage</a>	---	---	---	---
<a href="#">Vehicle Service Station with or without Canopies</a>	<a href="#">130</a>	<a href="#">190</a>	<a href="#">290</a>	<a href="#">370</a>
<a href="#">Vehicle Service Station Hardscape</a>	<a href="#">190</a>	<a href="#">190</a>	<a href="#">290</a>	<a href="#">370</a>
<a href="#">All Other Sales Canopies</a>	<a href="#">90</a>	<a href="#">130</a>	<a href="#">190</a>	<a href="#">290</a>
<a href="#">Non-sales canopies</a>	<a href="#">20</a>	<a href="#">40</a>	<a href="#">70</a>	<a href="#">90</a>
<a href="#">Ornamental Lighting</a>	---	---	---	---
<a href="#">Drive Up Windows</a>	<a href="#">70</a>	<a href="#">90</a>	<a href="#">130</a>	<a href="#">190</a>
<a href="#">Guarded Facilities</a>	---	---	---	---
<a href="#">Outdoor Dining</a>	<a href="#">90</a>	<a href="#">130</a>	<a href="#">190</a>	<a href="#">290</a>

**TABLE 147-C ALTERNATIVE POWER ALLOWANCE FOR ORDINANCE REQUIREMENTS**

Required light levels by law through a local ordinance (horizontal foot-candles, average)	Allowed Lighting Power Density (W/ft <sup>2</sup> )
0.5	<del>0.05</del> <u>0.04</u>
1.0	<del>0.07</del> <u>0.06</u>
1.5	<del>0.10</del> <u>0.08</u>
2.0	<del>0.12</del> <u>0.10</u>
3.0	<del>0.19</del> <u>0.13</u>
4.0 or greater	<del>0.25</del> <u>0.20</u>

**TABLE 147-D MULTIPLIERS FOR SPECIAL SECURITY REQUIREMENTS**

Function	Multiplier
Retail parking lots in lighting zones <del>1, 2 and 3</del>	1.25
Hardscape areas within 100 feet of the entrance of senior housing facilities in lighting zones 1, 2, and 3	1.25
Parking lots and walkways within 60 feet of entrances to <del>the building for</del> law enforcement, fire, ambulance and emergency vehicle facilities <del>in lighting zones 1,2 and 3</del>	2.00
<u>Parking lots in lighting zone 3 with special security requirements</u>	1.50
<u>Hardscape areas in lighting zone 3 with special security requirements</u>	2.00

## Alternate Calculation Manual

Not applicable

## Nonresidential Compliance Manual

Describe clarifications in the Nonresidential Compliance manual. Provide example of the use of IWA in calculated the lighting power allowances for outdoor lighting. Include discussion of requirements for consideration as having special security requirements.

Example – that area of a winding roadway can be reasonably approximately by its centerline distance multiplied by its width plus 10 feet (for the 5 foot width areas to each side of the roadway).

## Alternative Calculation Method Manual

Does not apply to this proposal as outdoor lighting is outside of the scope of the ACM Manual.

## Bibliography and Other Research

IESNA RP-2-01 Lighting Merchandising Areas. Illuminating Engineering Society of North America, New York.

IESNA RP-8-00 Roadway Lighting. Illuminating Engineering Society of North America, New York.

IESNA RP-20-98 Lighting for Parking Facilities. Illuminating Engineering Society of North America, New York.

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IESNA RP-33-99 Lighting for Exterior Environments. Illuminating Engineering Society of North America, New York.

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Nancy Clanton and Michael Mutmansky of Clanton Engineering Inc. performed most of the analysis and reporting presented here. The Heschong Mahone Group provided statewide energy impact analysis and technical and editorial review.

## Appendix A – IESNA Criteria Selection

For lighting applications that were considered for Lighting Power Density revisions, suitable IESNA design criteria were selected for applications as follows in the tables below.

Table 12: IESNA Design Criteria Basis per Lighting Zone for 2008 Table 147-A

T-24 Lighting Application	Lighting Zone			
	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Hardscape for automotive vehicular use, including parking lots, driveways, and site roads	RP-20-98 NO VERTICAL (.2 hfc min)	RP-20-98 Basic (.2 hfc min, .1 vfc)	RP-20-98 Enhanced (.5 hfc min, .25 vfc)	RP-20-98 Enhanced Security/Retail (1.0fc min, .25 vfc); G-1-03 Parking lots 3 hfc ave
Hardscape for pedestrian use, including plazas, sidewalks, walkways, and bikeways	DG-5-94 Specialized Residential - Medium (.5 fc)	DG-5-94 Village Center Walkway - Mixed (1 fc)	DG-5-94 Suburban Shopping Street - Mixed (2 fc)	DG-5-94 City Center Shopping Street - Mixed (2.5 fc); G-1-03 Park trails and walkways 0.6 hfc ave
Hardscape for driveways, side roads, sidewalks, walkways, and bikeways	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian Low Conflict (.5 fc)	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian Medium Conflict (1 fc)	RP-8-00 Walkway/Bikeway Mixed use - Pedestrian High Conflict (2 fc)	DG-5-94 City Center Shopping Street - Mixed (2.5 fc); G-1-03 Park trails and walkways 0.6 hfc ave
Building Entrances (without canopy)	DG-5-94 Village Center Walkways Mixed (1 fc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Low (5 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Medium (7 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation High (10 hfc)

Table 13: IESNA Design Criteria Basis per Lighting Zone for Selected Lighting Applications in 2008 Table 147-C

Specific Lighting Application	IESNA Recommended Criteria per Lighting Zone			
	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Building Facades	NA	RP-33-99 Dark Surrounds and Medium Light Surface (3 fc)	RP-33-99 Bright Surrounds and Light Surface (5 fc)	RP-33-99 Bright Surrounds and Dark Surface (10 fc)
Outdoor Sales Lot	RP-33-99 Secondary Business District General Display (5 hfc, 10:1 max:min)	RP-2-01 Auto Retail Lot Low Level (20 hfc)	RP-2-01 Auto Retail Lot Medium Level (30 hfc)	RP-2-01 Auto Retail Lot High Level (50 hfc)
Outdoor Sales Frontage (in linear feet)	NA	RP-2-01 Auto Dealership Feature Display (35 hfc)	RP-2-01 Auto Dealership Feature Display (50 hfc)	RP-2-01 Auto Dealership Feature Display (75 hfc)
Vehicle Service Station with or without canopies	RP-33-99 Service Station Pump Island (10 hfc)	RP-2-01 Service Station Gas Islands (20 hfc)	RP-2-01 Service Station Gas Islands (30 hfc)	RP-2-01 Service Station Gas Islands (50 hfc)
Vehicle Service Station Hardscape	RP-20-98 Basic (.2 hfc min, .1 vfc)	RP-2-01 Service Station Approach (5 hfc)	RP-2-01 Service Station Approach (10 hfc)	RP-2-01 Service Station Approach (15 hfc)
All other Sales Canopies	NA	RP-2-01 Seasonal Outdoor Merchandise Display Low (10 hfc)	RP-2-01 Seasonal Outdoor Merchandise Display Medium (20 hfc)	RP-2-01 Seasonal Outdoor Merchandise Display High (30 hfc)
Non-sales Canopies	DG-5-94 Sidewalk along Street - Commercial (1.0 fc ave. 4:1 ave:min)	RP-2-01 Seasonal Outdoor Merchandise Circulation Low (5 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Medium (7 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation High (10 hfc)
Ornamental Lighting Drive-Up Windows	NA	G-1-03 Fast Food Drive Up Window (6 hfc)	G-1-03 Fast Food Drive Up Window (6 hfc)	G-1-03 Fast Food Drive Up Window (6 hfc)
Guarded Facilities	G-1-03 Fast Food Drive Up Window (6 hfc)	RP-2-01 Seasonal Outdoor Merchandise Display Low (10 hfc)	RP-2-01 Seasonal Outdoor Merchandise Display Medium (20 hfc)	RP-2-01 Seasonal Outdoor Merchandise Display High (30 hfc)
Outdoor Dining	DG-5-94 Sidewalk along Street - Commercial (1.0 fc ave. 4:1 ave:min)	RP-2-01 Seasonal Outdoor Merchandise Circulation Low (5 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation Medium (7 hfc)	RP-2-01 Seasonal Outdoor Merchandise Circulation High (10 hfc)

### Hardscape for Vehicular Use

The IESNA *Recommended Practice for Parking Facilities (RP-20-1998)* addresses pedestrian and vehicular safety issues in parking lots and access roadways. The lighting recommendations are suitable for direct application in this Lighting Application category. Table 1 in RP-20-98 is identified as 'Recommended Maintained Illuminance Values for Parking Lots', and is the primary source of criteria for this Lighting Application category.

## **LZ4**

The highest recommended lighting levels in RP-20 are designated for high activity retail applications, which match appropriately with LZ4. The IESNA designates this highest level by identifying a level above the 'Enhanced Security' category through superscript #2 in the table. This indicates a specific minimum horizontal illuminance level of 1.0fc minimum for retail applications, and is the basis for the LZ4 target criteria. This criteria is similar to or greater than the criteria listed in G-1-03 for Open parking spaces.

## **LZ3**

The 'Enhanced Security' guideline from Table 1 in RP-20-98 is the source for the LZ3 target criteria. The recommendation indicates a light level of 0.5fc minimum.

## **LZ2**

The 'Basic' guideline from Table 1 in RP-20-98 is the source for the LZ2 target criteria. The recommendation indicates a light level of 0.2fc minimum.

## **LZ1**

The lowest recommended lighting levels in RP-20-98 are designated by Note #2 in the table, which indicates that vertical illuminance guidelines may not be possible to meet with full cutoff lighting equipment. For LZ1, the target criteria is the 'Basic' recommendation, but disregarding the vertical illuminance requirement. The recommendation indicates a light level of 0.2fc minimum.

### ***Hardscape for Pedestrian Use***

The IESNA document *Recommended Lighting for Walkways and Class I Bikeways (DG-5-1994)* addresses pedestrian and bicyclist safety on pedestrian and bicycle corridors. The lighting recommendations are suitable for direct application in this Lighting Application category.

## **LZ4**

The target criteria selected for this Lighting Zone is the highest recommendation provided in DG-5-94; 'City Center Walkway; Mixed Vehicle and Pedestrian.' The selection of this category accommodates the additional lighting necessary for potential pedestrian and vehicle conflict zones, and represents a substantial increase in light level to address the increased safety concern. The recommendation indicates a light level of 2.5fc average. These light levels exceed what is recommended in G-1-03 for park trails and walkways.

## **LZ3**

The second highest recommendation provided in DG-5-94 has been selected for application in LZ3; 'Suburban Shopping Street; Mixed Vehicle and Pedestrian'. It represents the middle level in the hierarchy of the IESNA city designations (*Village, Suburban, City*). This selection also accommodates vehicle and pedestrian conflict safety concerns. The recommendation indicates a light level of 2.0fc average.

## **LZ2**

The target criteria selected for LZ2 is the low level of the IESNA city designation hierarchy; 'Village Center Walkway; Mixed Vehicle and Pedestrian'. This selection also accommodates the vehicle and pedestrian safety concern. The recommendation indicates a light level of 1.0fc average.

## **LZ1**

The target criteria selected for LZ1 is ‘*Specialized Residential Area Walkways; Medium Usage*’. The recommendation indicates a light level of 0.5fc average.

### ***Building Entrances***

The IESNA does not have a specific Recommended Practice that addresses building entrances. However, it is logical that building entrances be suitably lighted for identification purposes, as well as safety reasons. The primary lighting model selected as the basis for entrance lighting levels is the general circulation recommendations built into the IESNA document *Lighting Merchandising Areas (RP-2-2001)*.

The lighting allowance represents a substantial increase in light level above general walkway lighting levels, which makes it possible for a building entrance to be a suitable visual focal point for wayfinding purposes.

## **LZ4**

The target criteria selected for this Lighting Zone is the highest general circulation recommendation from RP-2-01; ‘*Seasonal Outdoor Merchandise; High.*’ The recommendation indicates a light level of 10.0fc average.

## **LZ3**

The target criteria selected for this for this Lighting Zone is the second highest general circulation recommendation from RP-2-01; ‘*Seasonal Outdoor Merchandise; Medium.*’ It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 7.0fc average.

## **LZ2**

The target criteria selected for this for this Lighting Zone is the circulation recommendation from RP-2-01 ‘*Seasonal Outdoor Merchandise; Medium.*’ It represents the middle level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 5.0fc average.

## **LZ1**

The LZ1 target criteria was selected from the IESNA document *Recommend Lighting for Walkways and Class 1 Bikeways (DG-5-1994)*; ‘*Village Center Walkway; Mixed Vehicle and Pedestrian.*’ It was selected as a hierarchical increase in light level for building entrances based on the *Hardscape for Pedestrian Use; LZ1* Lighting Application target criteria. The recommendation indicates a light level of 1.0fc average.

## **2008 Table 147-B LIGHTING POWER ALLOWANCES FOR SPECIFIC APPLICATIONS**

### ***Building Facades***

The IESNA makes specific recommendations for outdoor sales lots in the document *Lighting for Exterior Environments (RP-33-1999)*. ‘*Table 2: Illuminance Levels for Floodlighting Buildings and Monuments*’ directly addresses these lighting situations, and the recommendations can be applied directly for this Lighting Application. Note that a *Building Façades* lighting allowance is not permitted in LZ1.

#### **LZ4**

The target criteria selected for this Lighting Zone is the highest recommended in RP-33-99; '*Bright Surroundings and Dark Surfaces*'. The recommendation indicates a light level of 10.0fc average.

#### **LZ3**

The target criteria selected for this Lighting Zone is '*Bright Surroundings and Light Surfaces*.' It represents a reduction from LZ4 of approximately 50%, to 5.0fc average.

#### **LZ2**

The target criteria selected for this Lighting Zone is '*Dark Surroundings and Medium Light Surfaces*.' It represents a reduction from LZ3 of approximately 40%, to 3.0fc average.

#### **LZ1**

No *Building Façades* lighting allowance is permitted in LZ1.

### ***Outdoor Sales Lot***

The IESNA makes specific recommendations for outdoor sales lots in the document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the merchandise area recommendations portion of the auto dealership recommendation section. The lighting target criteria for LZ1 were selected from the IESNA document *Lighting for Exterior Environments (RP-33-1999)*.

Specific feature lighting allowances are considered as part of the '*Outdoor Sales Frontage*' Lighting Application (Table 147-B) with an explanation of the additional feature allowances provided in that section.

#### **LZ4**

The target criteria selected for this Lighting Zone is the highest general merchandise recommendation in RP-2-01; '*Auto Dealerships, Merchandise; High Use*.' The recommendation indicates a light level of 50.0fc average.

#### **LZ3**

The target criteria selected for this Lighting Zone is the middle general merchandise recommendation in RP-2-01; '*Auto Dealerships, Merchandise; Medium Use*.' It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 30.0fc average.

#### **LZ2**

The target criteria selected for this Lighting Zone is the low general merchandise recommendation in RP-2-01; '*Auto Dealerships, Merchandise; Low Use*.' It is one step down from the LZ3 value in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 20.0fc average.

#### **LZ1**

The target criteria selected for this Lighting Zone is located in RP-33-99, '*Secondary Business District, Other Rows*.' It has been selected with the lighting target illuminance set to the top of the range recommended in the document (*2.5fc to 5fc*).

## ***Outdoor Sales Frontage***

The IESNA makes specific recommendations for outdoor sales lots in the document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the feature merchandise recommendations portion of the auto dealership recommendation section. Note that an *Outdoor Sales Frontage* lighting allowance is not permitted in LZ1.

### ***LZ4***

The target criteria selected for this Lighting Zone is the highest feature display recommendation in RP-2-01; '*Auto Dealerships, Feature Display; High Use.*' It is the highest illuminance recommendation provided within the RP-2-01 document (75fc average).

### ***LZ3***

The target criteria selected for this Lighting Zone is the middle feature display recommendation in RP-2-01; '*Auto Dealerships, Feature Display; Medium Use.*' It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 50.0fc average.

### ***LZ2***

The target criteria selected for this Lighting Zone is the low feature display recommendation in RP-2-01; '*Auto Dealerships, Feature Display; Low Use.*' It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 35.0fc average.

### ***LZ1***

No *Outdoor Sales Frontage* lighting allowance is permitted in LZ1.

## ***Vehicle Service Station with or without Canopies***

The IESNA makes specific recommendations for service station canopies in document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the '*Service Stations, Gas Islands*' category. These can be applied directly for three of the LZ levels. The lighting target criteria for LZ1 is selected from the IESNA document *Lighting for Exterior Environments (RP-33-1999)*.

### ***LZ4***

The target criteria selected for this Lighting Zone is the highest gas island recommendation in RP-2-01; '*Service Stations, Gas Islands; High Use.*' It is the highest illuminance recommendation provided within the RP-2-01 document suitable for service stations (50fc average).

### ***LZ3***

The target criteria selected for this Lighting Zone is the middle gas island recommendation in RP-2-01; '*Service Stations, Gas Islands; Medium Use.*' It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 30.0fc average.

### ***LZ2***



The target criteria selected for this Lighting Zone is the low gas island recommendation in RP-2-01; ‘*Service Stations, Gas Islands; Low Use.*’ It represents one step down from the LZ3 value in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 20.0fc average.

### ***LZ1***

The target criteria selected for this Lighting Zone is located in Table 8 of RP-33-99, ‘*Service Stations or Gas Pump Area Average Illuminance Levels.*’ The guideline selected is ‘*Pump Island Area with Light Surrounds.*’ The recommendation indicates a light level of 10.0fc average.

## ***Vehicle Service Station Hardscape***

The IESNA makes specific recommendations for outdoor sales lots in document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the ‘*Service Stations, Approach Lanes*’ category. These can be applied directly for three of the LZ levels. The lighting target criteria for LZ1 is selected from the IESNA document *Lighting for Parking Facilities (RP-20-1998)*. The target illuminance values represent a transition zone from the high light levels under the gas canopy for adaptation purposes.

### ***LZ4***

The target criteria selected for this Lighting Zone is the highest approach lane recommendation in RP-2-01; ‘*Service Stations, Approach Lane; High Use.*’ It is the highest illuminance recommendation provided within the RP-2 document suitable for service station approach lanes (15fc average).

### ***LZ3***

The target criteria selected for this Lighting Zone is the middle approach lane recommendation in RP-2-01; ‘*Service Stations, Approach Lane; Medium Use.*’ It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 10fc average.

### ***LZ2***

The target criteria selected for this Lighting Zone is the low approach lane recommendation in RP-2-01; ‘*Service Stations, Approach Lane; Low Use.*’ It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 5fc average.

### ***LZ1***

The target criteria selected for this Lighting Zone is located in Table 1 of RP-20-98, ‘*Recommended Maintained Values for Parking Lots.*’ The guideline selected is the full ‘*Basic*’ level, including the vertical illuminance guideline. The recommendation indicates a light level of approximately 1.5fc average.

## ***All Other Sales Canopies***

The IESNA makes specific recommendations for outdoor sales lighting in document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the ‘*Seasonal Outdoor Merchandise*’ category. These can be applied directly for the LZ levels. Note that an *All Other Sales Canopies* lighting allowance is not permitted in LZ1.

### ***LZ4***

The target criteria selected for this Lighting Zone is the highest outdoor sales recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Merchandise Display; High Use.'* It is the highest illuminance recommendation provided within the RP-2-01 document suitable for non-automotive outdoor sales (30fc average).

### **LZ3**

The target criteria selected for this Lighting Zone is the middle outdoor sales recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Merchandise Display; Medium Use.'* It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 20fc average.

### **LZ2**

The target criteria selected for this Lighting Zone is the low outdoor sales recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Merchandise Display; Low Use.'* It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 10fc average.

### **LZ1**

No *All Other Sales Canopies* lighting allowance is permitted in LZ1.

## ***Non-sales Canopies***

The IESNA makes specific recommendations for non-merchandise portions of exterior environments that are related to pedestrian circulation in document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the *'Seasonal Outdoor Merchandise, Circulation'* category. These can be applied directly for three of the LZ levels. LZ1 uses the IESNA document *Recommended Lighting for Walkways and Class I Bikeways (DG-5-1994)* to address canopies.

### **LZ4**

The target criteria selected for this Lighting Zone is the highest circulation recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Circulation; High Use.'* It is the highest illuminance recommendation provided within the RP-2 document suitable for non-automotive circulation areas (10fc average).

### **LZ3**

The target criteria selected for this Lighting Zone is the middle circulation recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Circulation; Medium Use.'* It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 7fc average.

### **LZ2**

The target criteria selected for this Lighting Zone is the low circulation recommendation in RP-2-01; *'Seasonal Outdoor Merchandise, Circulation; Low Use.'* It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 5fc average.

### **LZ1**

The target criteria selected for LZ1 is located in DG-5-94; *'Village Center Walkway; Mixed Vehicle and Pedestrian'*. This selection represents a lighting level higher than basic sidewalk levels, so a visual hierarchy can be

established. This recommendation also matches the illuminance values in the *Building Entrances (without canopy)*; LZ1 Lighting Application. The recommendation indicates a light level of 1fc average.

### ***Ornamental Lighting***

The IESNA makes no recommendations for ornamental lighting that will provide suitable average illuminance guidelines or watts per square foot (WPF) allowances. Ornamental lighting is not of a uniform nature, and it is therefore not possible to characterize suitable ornamental lighting with specific recommendations that use a measure of average illuminance. Note that no *Ornamental Lighting* allowance is permitted for LZ1.

### ***Guarded Facilities***

The IESNA makes specific several recommendations for security lighting in various documents, but in no case is there a hierarchical arrangement of recommendations that take into account the context of the surrounding lighting environment.

However, the document *Lighting Merchandising Areas (RP-2-2001)* does have a hierarchical arrangement, and the lighting recommendations in the ‘*Seasonal Outdoor Merchandise*’ category are a logical fit for this purpose. This set of recommendations are suitable for the general public to safely navigate an unfamiliar retail environment, so it is reasonable that an area where security is a concern and has a specific security detail or security-oriented activities would be well met by the lighting recommendations used for the retail portion of the RP-2-01 document.

These can be applied directly for the LZ levels. The recommendations also represent a light level somewhat higher than the typical sidewalk or parking lot, so there will be a suitable hierarchical capability when establishing light levels for different areas of a facility. The recommendation ‘*Fast Food Restaurants; Drive Up Window*’ is used for the LZ1 target criteria as this has the same safety and security visibility issues.

#### ***LZ4***

The target criteria selected for this Lighting Zone is the highest outdoor sales recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Merchandise Display; High Use.*’ It is the highest illuminance recommendation provided within the RP-2-01 document suitable for non-automotive outdoor sales (30fc average).

#### ***LZ3***

The target criteria selected for this Lighting Zone is the middle outdoor sales recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Merchandise Display; Medium Use.*’ It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation indicates a light level of 20fc average.

#### ***LZ2***

The target criteria selected for this Lighting Zone is the low outdoor sales recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Merchandise Display; Low Use.*’ It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 10fc average.

#### ***LZ1***

G-1 ‘*Fast Food Restaurants; Drive Up Window*’ is the target criteria applied to this Lighting Zone. The recommendation indicates a light level of 6fc average.

## ***Outdoor Dining***

The IESNA makes specific recommendations for non-merchandise portions of exterior environments that are related to pedestrian circulation in document *Lighting Merchandising Areas (RP-2-2001)*. The basis for these recommendations is the ‘*Seasonal Outdoor Merchandise, Circulation*’ category. These can be applied directly for three of the LZ levels. LZ1 uses the IESNA document *Recommended Lighting for Walkways and Class I Bikeways (DG-5-1994)* to address canopies.

In an attempt to create ambiance, many dining facilities will use exceedingly low light levels, much below what is provided in these recommendations.

### ***LZ4***

The target criteria selected for this Lighting Zone is the highest circulation recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Circulation; High Use.*’ It is the highest illuminance recommendation provided within the RP-2 document suitable for non-automotive circulation areas (10fc average).

### ***LZ3***

The target criteria selected for this Lighting Zone is the middle circulation recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Circulation; Medium Use.*’ It represents the middle level in the hierarchy of use categories defined by the IESNA (*Low, Medium, High*). The recommendation represents indicates a light level of 7fc average.

### ***LZ2***

The target criteria selected for this Lighting Zone is the low circulation recommendation in RP-2-01; ‘*Seasonal Outdoor Merchandise, Circulation; Low Use.*’ It represents the low level in the hierarchy of use categories defined by the IESNA. The recommendation indicates a light level of 5fc average.

### ***LZ1***

The target criteria selected for LZ1 is located in DG-5-94; ‘*Village Center Walkway; Mixed Vehicle and Pedestrian*’. This selection represents a lighting level higher than basic sidewalk levels, so a visual hierarchy can be established. The recommendation indicates a light level of 1fc average.

## **Appendix B Other Relevant Outdoor Lighting Standards**

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This section briefly describes other outdoor lighting criteria that might be considered when designing outdoor lighting systems. In general these criteria do not address lighting zones except for USGBC LEED criteria which references RP-33-99.. As a result, the recommendations may be appropriate for a particular lighting zone and not others. In general, the recommendations do correspond to the IESNA standards used in the analysis above for a particular lighting zone.

## Federal Highway Administration Chapter 900 Facilities and Features for Roadside Rest Areas

In reviewing other documents where security is a priority, Federal Highway Administration (FHWA), Chapter 900 Landscape Architecture Topic 903.5 Facilities and Features for Roadside Rest Areas states the following lighting criteria. The proposed LPD's for Lighting Zone 1 will meet this criteria.

“(11) Lighting. Rest areas are to be lighted ...

Average illumination should be 5 lx in the zone between the building and the auto parking area and all crosswalks, and 2 to 3 lx elsewhere. Strong shadows should be avoided, particularly along walkways and at the building.”

## CalTrans Roadside Rest Areas

CalTrans also consider Roadside Rest Areas as an area where security is very important. CalTrans lighting criteria are 1 footcandle average with a 4:1 average to minimum uniformity for all parking areas and walkways. The proposed LPD's for Lighting Zone 2 will meet this criteria.

## The Department of Defense Unified Facilities Criteria

The Department of Defense Unified Facilities Criteria UFC 3-530-01 Design: Interior and Exterior Lighting and Controls states illuminance and uniformity targets for outdoor areas as listed below. The proposed LPD's will comply with these criteria:

Area Description	Average Illuminance (footcandles)	Uniformity Maximum (max/min)
Entrances	5 fc	10:1
Housing Area Walkways	0.5 fc	10:1
General Pedestrian Area Walkways	0.5 fc	10:1
Pedestrian Plazas	0.5 fc	10:1
Marinas	5.0 fc	10:1

## US Green Building Council LEED 2.1 Site Credit

The US Green Building Council (USGBC) LEED 2.1 Site Credit #8 gives credit for site lighting that meets the following criteria. Since the illuminance levels refer to IESNA RP-33-99, the proposed LPD's will meet these criteria.

1. All exterior luminaires with more than 1000 initial lamp lumens are shielded and all luminaires with more than 3500 initial lamp lumens are Full Cutoff (IESNA Classification).
2. The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property.

3. Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light or brightness from the luminaire crosses the property boundary.
  
4. As demonstrated by the photometric site plan provided, the overall site illuminance meets the average illuminance levels and uniformity ratios recommended by the Illuminating Engineering Society of North America (IESNA) Recommended Practice Manual: Lighting for Exterior Environments (RP-33).

## Appendix C Detailed Simulation Results in Support of Outdoor Lighting Power Allowance Modifications

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# Parking Lot Maximum Spacing Calculations T-24 2008

Area calculations made in idealized parking lot grid per IESNA procedures for calculation uniformity  
 Minimum vertical illuminance is measured at the center of the parking lot grid

An attempt has been made to maintain reasonable row-to-row spacing for pole rows

All calculations made with clear lamp optics

LDD = .70

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	Performance Increase with Electronic Ballasts
1000	HPS		125000	112000	1100	
400	HPS		50000	45000	464	
250	HPS		30000	27000	310	
150	HPS		16000	14400	190	
100	HPS		9500	8550	138	
70	HPS		6300	5670	95	
50	HPS		4000	3600	66	
1000	MH		110000	71000	1080	
320	MH		29000	20300	368	
250	MH		21250	14300	291	
150	MH		12000	9000	185	
100	MH		8400	6300	129	
70	MH		5500	3850	90	
50	MH		3600	2450	73	
150	MH	ELECTRONIC	12000	10400	167	115.6%
100	MH	ELECTRONIC	8400	7300	113	115.9%
70	MH	ELECTRONIC	5500	4510	80	117.1%
50	MH	ELECTRONIC	3600	2880	58	117.6%



# LZ1 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Maximum Spacing to meet IESNA RP-20 .2fc minimum, 20:1 max:min (vertical illuminance not considered)						WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
					Grid	Dimensions	Avg. fc	Min. fc	Max:Min	WPF					
<b>15 foot pole</b>															
HPS	50	66	2	Type III	60	80	0.59	0.21	16.67	0.028	55%	69%	1.1	0.9	
HPS	70	95	2	Type III	60	85	0.88	0.3	17.99	0.037	75%	93%	1.2	0.9	
<b>20 foot pole</b>															
HPS	70	95	2	Type III	75	110	0.77	0.21	15.15	0.023	46%	58%	1.7	1.3	
HPS	70	95	4	Type III	80	110	1.45	0.27	18.81	0.043	86%	108%	1.7	1.3	
HPS	100	138	1	Type V	65	65	1.01	0.29	13.93	0.033	65%	82%	1.5	1.2	
HPS	100	138	2	Type III	80	110	1.1	0.25	18.66	0.031	63%	78%	1.8	1.4	
HPS	150	190	1	Type V	80	90	1.26	0.33	19.97	0.026	53%	66%	2.4	1.9	
HPS	150	190	2	Type III	90	100	1.97	0.39	19.73	0.042	84%	106%	2.3	1.9	
<b>25 foot pole</b>															
HPS	70	95	2	Type III	85	120	0.65	0.21	10.29	0.019	37%	47%	1.7	1.4	
HPS	70	95	4	Type III	110	120	0.96	0.2	16.51	0.029	58%	72%	1.7	1.3	
HPS	100	138	2	Type III	95	120	0.83	0.23	13.81	0.024	48%	61%	1.7	1.4	
HPS	100	138	4	Type III	115	120	1.38	0.26	19.01	0.040	80%	100%	1.7	1.4	
HPS	150	190	2	Type III	110	120	1.32	0.28	18.82	0.029	58%	72%	2.3	1.8	
HPS	150	190	4	Type III	110	120	2.64	0.51	19.37	0.058	115%	144%	2.3	1.8	
HPS	250	310	1	Type V	80	80	1.51	0.47	16.78	0.048	97%	121%	1.6	1.2	
HPS	250	310	2	Type III	115	120	2.37	0.51	18.42	0.045	90%	112%	2.6	2.1	
HPS	400	464	1	Type V	95	110	2.61	0.71	18.57	0.044	89%	111%	2.9	2.4	
<b>30 foot pole</b>															
HPS	100	138	4	Type III	120	160	0.98	0.2	17.09	0.029	58%	72%	1.7	1.4	
HPS	150	190	2	Type III	120	165	0.87	0.22	17.94	0.019	38%	48%	2.3	1.8	
HPS	150	190	4	Type III	120	165	1.75	0.36	19.45	0.038	77%	96%	2.3	1.8	
HPS	250	310	1	Type V	90	100	1.4	0.38	15.33	0.034	69%	86%	2.0	1.6	
HPS	250	310	2	Type III	130	165	1.51	0.34	19.34	0.029	58%	72%	2.6	2.1	
HPS	400	464	1	Type V	120	130	1.73	0.48	19.6	0.030	59%	74%	2.9	2.3	
HPS	400	464	2	Type III	120	190	2.28	0.55	18.94	0.041	81%	102%	2.8	2.2	
<b>35 foot pole</b>															
HPS	100	138	4	Type III	120	175	0.89	0.23	11.3	0.026	53%	66%	1.7	1.4	
HPS	150	190	2	Type III	120	190	0.75	0.23	12.43	0.017	33%	42%	2.3	1.8	
HPS	150	190	4	Type III	120	200	1.42	0.27	18.96	0.032	63%	79%	2.2	1.8	
HPS	250	310	1	Type V	105	120	0.99	0.24	17.35	0.025	49%	62%	2.0	1.6	
HPS	250	310	2	Type III	155	180	1.15	0.27	18.18	0.022	44%	56%	2.6	2.1	
HPS	400	464	1	Type V	120	145	1.52	0.37	18.7	0.027	53%	67%	2.9	2.3	
HPS	400	464	2	Type III	120	225	1.9	0.4	18.88	0.034	69%	86%	2.8	2.2	



# LZ1 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 .2fc minimum, 20:1 max:min (vertical illuminance not considered)									
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
										0.05	0.04			
<b>15 foot pole</b>														
MH	50	73	2	Type III	60 65	0.7	0.2	11.99	0.037	75%	94%	0.9	0.7	
MH	70	90	2	Type III	60 85	0.87	0.21	17.84	0.035	71%	88%	1.2	1.0	
MH	50	58	2	Type III	Electronic Ballast Estimate				0.025	51%	63%	3.0	2.4	
MH	70	80	2	Type III	Electronic Ballast Estimate				0.027	54%	67%	3.5	2.8	
<b>20 foot pole</b>														
MH	70	90	2	Type III	75 90	0.63	0.19	11.05	0.027	53%	67%	1.2	0.9	
MH	70	90	4	Type III	80 105	1.03	0.22	15.71	0.043	86%	107%	1.2	1.0	
MH	100	129	1	Type V	60 60	0.89	0.2	15.97	0.036	72%	90%	1.2	1.0	
MH	100	129	2	Type III	75 105	0.88	0.2	17.47	0.033	66%	82%	1.3	1.1	
MH	150	185	1	Type V	75 85	0.92	0.22	19.89	0.029	58%	73%	1.6	1.3	
MH	150	185	2	Type III	90 100	1.13	0.25	17.39	0.041	82%	103%	1.4	1.1	
MH	70	80	2	Type III	Electronic Ballast Estimate				0.020	40%	51%	1.6	1.2	
MH	70	80	4	Type III	Electronic Ballast Estimate				0.033	65%	81%	1.6	1.3	
MH	100	113	1	Type III	Electronic Ballast Estimate				0.027	54%	68%	1.6	1.3	
MH	100	113	2	Type III	Electronic Ballast Estimate				0.025	50%	62%	1.8	1.4	
MH	150	167	1	Type III	Electronic Ballast Estimate				0.026	52%	65%	2.0	1.6	
MH	150	167	2	Type III	Electronic Ballast Estimate				0.037	74%	93%	1.8	1.4	
<b>25 foot pole</b>														
MH	70	90	2	Type III	75 115	0.49	0.2	7.44	0.021	42%	52%	1.2	0.9	
MH	70	90	4	Type III	100 110	0.77	0.21	10.76	0.033	65%	82%	1.2	0.9	
MH	100	129	2	Type III	95 120	0.67	0.21	11.33	0.023	45%	57%	1.5	1.2	
MH	100	129	4	Type III	105 120	1.09	0.19	19.26	0.041	82%	102%	1.3	1.1	
MH	150	185	2	Type III	105 120	0.8	0.21	14.38	0.029	59%	73%	1.4	1.1	
MH	150	185	4	Type III	120 125	1.35	0.25	19.07	0.049	99%	123%	1.4	1.1	
MH	250	291	1	Type V	75 80	1.17	0.23	18.41	0.049	97%	121%	1.2	1.0	
MH	250	291	2	Type III	120 130	0.91	0.2	19.8	0.037	75%	93%	1.2	1.0	
MH	320	368	1	Type V	95 105	1.27	0.32	19.57	0.037	74%	92%	1.7	1.4	
MH	70	80	2	Type III	Electronic Ballast Estimate				0.016	32%	40%	1.5	1.2	
MH	70	80	4	Type III	Electronic Ballast Estimate				0.025	50%	62%	1.6	1.2	
MH	100	113	2	Type III	Electronic Ballast Estimate				0.017	34%	43%	2.0	1.6	
MH	100	113	4	Type III	Electronic Ballast Estimate				0.031	62%	77%	1.8	1.4	
MH	150	167	2	Type III	Electronic Ballast Estimate				0.023	46%	57%	1.7	1.4	
MH	150	167	4	Type III	Electronic Ballast Estimate				0.045	89%	111%	1.8	1.4	
<b>30 foot pole</b>														
MH	100	129	4	Type III	120 130	0.87	0.2	13.5	0.033	66%	83%	1.3	1.1	
MH	150	185	2	Type III	110 150	0.6	0.21	10.29	0.022	45%	56%	1.3	1.1	
MH	150	185	4	Type III	120 165	1.01	0.22	15.21	0.037	75%	93%	1.4	1.1	



# LZ1 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 .2fc minimum, 20:1 max:min (vertical illuminance not considered)									
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
										0.05	0.04			
MH	250	291	1	Type V	90	90	0.87	0.2	15.96	0.036	72%	1.2	1.0	
MH	250	291	2	Type III	125	165	0.68	0.2	14.45	0.028	56%	1.2	1.0	
MH	320	368	1	Type V	120	120	0.87	0.23	18.78	0.026	51%	1.7	1.4	
MH	320	368	2	Type III	115	150	1.32	0.27	17.38	0.043	85%	1.5	1.2	
MH	100	113	4	Type III	Electronic Ballast Estimate				0.025	50%	63%	1.7	1.4	
MH	150	167	2	Type III	Electronic Ballast Estimate				0.018	35%	44%	1.7	1.4	
MH	150	167	4	Type III	Electronic Ballast Estimate				0.029	58%	73%	1.7	1.4	
<b>35 foot pole</b>														
MH	100	129	4	Type III	120	160	0.7	0.2	9.79	0.027	54%	1.3	1.0	
MH	150	185	2	Type III	120	160	0.51	0.21	7.58	0.019	39%	1.3	1.1	
MH	150	185	4	Type III	120	180	0.92	0.22	11.26	0.034	69%	1.3	1.1	
MH	250	291	1	Type V	95	110	0.66	0.19	11.14	0.028	56%	1.2	0.9	
MH	250	291	2	Type III	135	180	0.57	0.19	10.57	0.024	48%	1.2	1.0	
MH	320	368	1	Type V	120	135	0.76	0.2	16.46	0.023	45%	1.7	1.3	
MH	320	368	2	Type III	130	180	0.97	0.21	16.7	0.031	63%	1.5	1.2	
MH	100	113	4	Type III	Electronic Ballast Estimate				0.020	41%	51%	1.7	1.4	
MH	150	167	2	Type III	Electronic Ballast Estimate				0.015	30%	38%	1.7	1.4	
MH	150	167	4	Type III	Electronic Ballast Estimate				0.027	54%	67%	1.7	1.4	



## LZ2 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Maximum Spacing to meet IESNA RP-20 .2fc minimum horizontal, .1fc minimum vertical at center, 20:1 max:min							% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
					Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF					
<b>20 foot pole</b>															
HPS	70	95	2	Type III	70	95	0.95	0.3	0.1	10.23	0.029	36%	57%	2.7	1.7
HPS	70	95	4	Type III	80	95	1.67	0.41	0.12	12.39	0.050	63%	100%	2.7	1.7
HPS	100	138	2	Type III	70	100	1.36	0.42	0.14	11.35	0.039	49%	79%	2.8	1.7
HPS	100	138	4	Type III	80	100	2.4	0.55	0.14	14.02	0.069	86%	138%	2.8	1.7
HPS	150	190	2	Type III	90	100	1.97	0.39	0.21	19.73	0.042	53%	84%	3.7	2.3
HPS	150	190	4	Type III	90	95	4.14	0.78	0.48	19.56	0.089	111%	178%	3.7	2.3
<b>25 foot pole</b>															
HPS	70	95	2	Type III	85	120	0.65	0.21	0.1	10.29	0.019	23%	37%	2.8	1.7
HPS	70	95	4	Type III	100	120	1.05	0.25	0.1	13.04	0.032	40%	63%	2.7	1.7
HPS	100	138	2	Type III	90	120	0.87	0.27	0.12	12.03	0.026	32%	51%	2.7	1.7
HPS	100	138	4	Type III	100	120	1.58	0.38	0.12	13.09	0.046	58%	92%	2.7	1.7
HPS	150	190	2	Type III	110	120	1.32	0.28	0.19	18.82	0.029	36%	58%	3.7	2.3
HPS	150	190	4	Type III	110	120	2.64	0.51	0.38	19.37	0.058	72%	115%	3.7	2.3
HPS	250	310	2	Type III	115	120	2.37	0.51	0.35	18.42	0.045	56%	90%	4.2	2.6
HPS	400	464	1	Type V	95	110	2.61	0.71	0.24	18.57	0.044	56%	89%	4.7	2.9
<b>30 foot pole</b>															
HPS	100	138	4	Type III	120	150	1.05	0.24	0.11	14.49	0.031	38%	61%	2.7	1.7
HPS	150	190	2	Type III	120	165	0.87	0.22	0.15	17.94	0.019	24%	38%	3.6	2.3
HPS	150	190	4	Type III	120	165	1.75	0.36	0.25	19.45	0.038	48%	77%	3.6	2.3
HPS	250	310	2	Type III	130	165	1.51	0.34	0.25	19.34	0.029	36%	58%	4.2	2.6
HPS	250	310	4	Type III	125	165	3.13	0.66	0.45	19.77	0.060	75%	120%	4.2	2.6
HPS	400	464	1	Type V	120	130	1.73	0.48	0.23	19.6	0.030	37%	59%	4.7	2.9
HPS	400	464	2	Type III	120	190	2.28	0.55	0.26	18.94	0.041	51%	81%	4.5	2.8
<b>35 foot pole</b>															
HPS	100	138	4	Type III	120	175	0.89	0.23	0.13	11.3	0.026	33%	53%	2.7	1.7
HPS	150	190	2	Type III	120	190	0.75	0.23	0.21	12.43	0.017	21%	33%	3.6	2.3
HPS	150	190	4	Type III	120	200	1.42	0.27	0.23	18.96	0.032	40%	63%	3.6	2.2
HPS	250	310	2	Type III	155	180	1.15	0.27	0.23	18.18	0.022	28%	44%	4.1	2.6
HPS	250	310	4	Type III	150	180	2.37	0.51	0.43	18.85	0.046	57%	92%	4.1	2.6
HPS	400	464	1	Type V	120	145	1.52	0.37	0.37	18.7	0.027	33%	53%	4.6	2.9
HPS	400	464	2	Type III	120	225	1.9	0.4	0.28	18.88	0.034	43%	69%	4.4	2.8
HPS	400	464	4	Type III	160	180	3.58	0.71	0.56	19.36	0.064	81%	129%	4.4	2.8
<b>20 foot pole</b>															
MH	70	90	2	Type III	65	90	0.73	0.27	0.11	7.74	0.031	38%	62%	1.9	1.2
MH	70	90	4	Type III	80	90	1.2	0.31	0.11	10.97	0.050	63%	100%	1.9	1.2
MH	100	129	2	Type III	65	100	1.06	0.29	0.1	12.37	0.040	50%	79%	2.1	1.3



# LZ2 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Maximum Spacing to meet IESNA RP-20 .2fc minimum horizontal, .1fc minimum vertical at center, 20:1 max:min							% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
					Grid Dimensions		Avg. fc	Min. fc	Vert. fc	Max:Min	WPF				
MH	100	129	4	Type III	80	95	1.83	0.37	0.1	15.85	0.068	85%	136%	2.2	1.3
MH	150	185	2	Type III	90	100	1.13	0.25	0.12	17.39	0.041	51%	82%	2.2	1.4
MH	150	185	4	Type III	90	110	2.07	0.37	0.16	20.39	0.075	93%	149%	2.2	1.4
MH	70	80	2	Type III	Electronic Ballast Estimate						0.023	29%	47%	2.5	1.6
MH	70	80	4	Type III	Electronic Ballast Estimate						0.038	47%	76%	2.5	1.6
MH	100	113	2	Type III	Electronic Ballast Estimate						0.030	38%	60%	2.8	1.8
MH	100	113	4	Type III	Electronic Ballast Estimate						0.051	64%	103%	2.9	1.8
MH	150	167	2	Type III	Electronic Ballast Estimate						0.032	40%	64%	2.8	1.8
MH	150	167	4	Type III	Electronic Ballast Estimate						0.067	84%	135%	2.5	1.5
<b>25 foot pole</b>															
MH	70	90	2	Type III	75	110	0.51	0.21	0.1	6.83	0.022	27%	44%	1.9	1.2
MH	70	90	4	Type III	100	110	0.77	0.21	0.1	10.76	0.033	41%	65%	1.9	1.2
MH	100	129	2	Type III	80	120	0.71	0.22	0.1	11.06	0.027	34%	54%	2.1	1.3
MH	100	129	4	Type III	95	120	1.2	0.27	0.1	13.81	0.045	57%	91%	2.1	1.3
MH	150	185	2	Type III	105	120	0.8	0.21	0.13	14.38	0.029	37%	59%	2.2	1.4
MH	150	185	4	Type III	120	125	1.35	0.25	0.16	19.07	0.049	62%	99%	2.2	1.4
MH	250	291	2	Type III	120	130	0.91	0.2	0.11	19.8	0.037	47%	75%	2.0	1.2
MH	320	368	1	Type V	95	100	1.33	0.39	0.11	15.87	0.039	48%	77%	2.7	1.7
MH	70	80	2	Type III	Electronic Ballast Estimate						0.017	21%	33%	2.5	1.5
MH	70	80	4	Type III	Electronic Ballast Estimate						0.025	31%	50%	2.5	1.6
MH	100	113	2	Type III	Electronic Ballast Estimate						0.020	25%	41%	2.8	1.7
MH	100	113	4	Type III	Electronic Ballast Estimate						0.034	43%	68%	2.8	1.8
MH	150	167	2	Type III	Electronic Ballast Estimate						0.023	29%	46%	2.8	1.7
MH	150	167	4	Type III	Electronic Ballast Estimate						0.045	56%	89%	2.4	1.5
<b>30 foot pole</b>															
MH	100	129	4	Type III	120	130	0.87	0.2	0.11	13.5	0.033	41%	66%	2.1	1.3
MH	150	185	2	Type III	110	150	0.6	0.21	0.14	10.29	0.022	28%	45%	2.1	1.3
MH	150	185	4	Type III	120	165	1.01	0.22	0.14	15.21	0.037	47%	75%	2.2	1.4
MH	250	291	2	Type III	125	165	0.68	0.2	0.13	14.45	0.028	35%	56%	1.9	1.2
MH	250	291	4	Type III	140	170	1.19	0.23	0.17	20.15	0.049	61%	98%	1.9	1.2
MH	320	368	1	Type V	120	120	0.87	0.23	0.1	18.78	0.026	32%	51%	2.7	1.7
MH	320	368	2	Type III	115	150	1.32	0.27	0.12	17.38	0.043	53%	85%	2.5	1.5
MH	100	113	4	Type III	Electronic Ballast Estimate						0.025	31%	50%	2.8	1.7
MH	150	167	2	Type III	Electronic Ballast Estimate						0.018	22%	35%	2.7	1.7
MH	150	167	4	Type III	Electronic Ballast Estimate						0.034	42%	67%	2.4	1.5
<b>35 foot pole</b>															
MH	100	129	4	Type III	120	160	0.7	0.2	0.11	9.79	0.027	34%	54%	2.1	1.3
MH	150	185	2	Type III	120	160	0.51	0.21	0.15	7.58	0.019	24%	39%	2.1	1.3



## LZ2 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Maximum Spacing to meet IESNA RP-20 .2fc minimum horizontal, .1fc minimum vertical at center, 20:1 max:min							% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
					Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF					
MH	150	185	4	Type III	120	180	0.92	0.22	0.18	11.26	0.034	43%	69%	2.1	1.3
MH	250	291	2	Type III	135	180	0.57	0.19	0.14	10.57	0.024	30%	48%	1.9	1.2
MH	250	291	4	Type III	165	180	0.94	0.2	0.18	16.77	0.039	49%	78%	1.9	1.2
MH	320	368	1	Type V	120	135	0.76	0.2	0.18	16.46	0.023	28%	45%	2.7	1.7
MH	320	368	2	Type III	130	175	0.99	0.22	0.1	15.43	0.032	40%	65%	2.4	1.5
MH	320	368	4	Type III	145	160	1.95	0.33	0.25	19.95	0.063	79%	127%	2.5	1.5
MH	100	113	4	Type III	Electronic Ballast Estimate						0.020	25%	41%	2.8	1.7
MH	150	167	2	Type III	Electronic Ballast Estimate						0.015	19%	30%	2.7	1.7
MH	150	167	4	Type III	Electronic Ballast Estimate						0.031	39%	62%	2.4	1.5

# LZ3 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 Enhanced Security Guidelines .5fc minimum horizontal, .25fc minimum vertical at center, 15:1 max:min										
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
											0.15	0.08			
<b>20 foot pole</b>															
HPS	70	95	2	Type III	60	85	1.22	0.53	0.28	5.93	0.037	25%	47%	4.9	2.6
HPS	70	95	4	Type III	80	80	1.97	0.56	0.24	9.2	0.059	40%	74%	5.0	2.7
HPS	100	138	2	Type III	65	90	1.61	0.61	0.25	7.79	0.047	31%	59%	5.1	2.7
HPS	100	138	4	Type III	80	90	2.66	0.7	0.24	11.04	0.077	51%	96%	5.2	2.8
HPS	150	190	2	Type III	85	90	2.3	0.52	0.32	14.97	0.050	33%	62%	6.9	3.7
HPS	150	190	4	Type III	80	90	4.87	1.1	0.69	14.02	0.106	70%	132%	6.9	3.7
HPS	250	310	2	Type III	80	105	3.93	1.08	0.55	13.57	0.074	49%	92%	8.0	4.3
<b>25 foot pole</b>															
HPS	100	138	4	Type III	90	110	1.9	0.59	0.29	8.53	0.056	37%	70%	5.1	2.7
HPS	150	190	2	Type III	90	120	1.6	0.51	0.35	10.31	0.035	23%	44%	6.8	3.6
HPS	150	190	4	Type III	95	120	3.04	0.73	0.53	13.62	0.067	44%	83%	6.8	3.6
HPS	250	310	2	Type III	105	120	2.58	0.67	0.48	14.03	0.049	33%	62%	7.9	4.2
HPS	400	464	1	Type V	95	100	2.86	0.92	0.42	14.36	0.049	33%	61%	8.8	4.7
HPS	400	464	2	Type III	110	120	3.95	0.98	0.64	15.01	0.070	47%	88%	8.4	4.5
<b>30 foot pole</b>															
HPS	100	138	4	Type III	105	120	1.48	0.49	0.37	7.48	0.044	29%	55%	5.1	2.7
HPS	150	190	4	Type III	120	130	2.2	0.52	0.45	13.57	0.049	32%	61%	6.8	3.6
HPS	250	310	2	Type III	120	150	1.79	0.5	0.4	13.23	0.034	23%	43%	7.8	4.2
HPS	250	310	4	Type III	120	145	3.7	0.91	0.72	14.49	0.071	48%	89%	7.8	4.2
HPS	400	464	1	Type V	110	120	2.03	0.71	0.35	13.02	0.035	23%	44%	8.7	4.6
HPS	400	464	2	Type III	120	165	2.62	0.7	0.67	14.84	0.047	31%	59%	8.4	4.5
HPS	400	464	4	Type III	130	145	5.49	1.29	0.94	14.51	0.098	66%	123%	8.4	4.5
<b>35 foot pole</b>															
HPS	100	138	4	Type III	110	120	1.39	0.52	0.41	5.05	0.042	28%	52%	5.0	2.7
HPS	150	190	4	Type III	120	160	1.77	0.5	0.38	10.38	0.040	26%	49%	6.7	3.6
HPS	250	310	2	Type III	120	180	1.47	0.53	0.41	9.24	0.029	19%	36%	7.7	4.1
HPS	250	310	4	Type III	135	180	2.63	0.65	0.52	14.92	0.051	34%	64%	7.7	4.1
HPS	400	464	1	Type V	120	130	1.69	0.53	0.54	13.16	0.030	20%	37%	8.5	4.5
HPS	400	464	2	Type III	120	215	1.99	0.51	0.36	14.97	0.036	24%	45%	8.3	4.4
HPS	400	464	4	Type III	145	180	3.94	0.93	0.69	14.71	0.071	47%	89%	8.3	4.4
HPS	1000	1100	1	Type III	130	160	3.18	1.04	0.7	14.6	0.053	35%	66%	9.0	4.8
HPS	1000	1100	2	Type III	120	160	6.63	1.96	1.44	14.25	0.115	76%	143%	8.7	4.6
<b>50 foot pole</b>															
HPS	400	464	4	Type III	210	240	2.01	0.5	0.45	13.58	0.037	25%	46%	8.2	4.4
HPS	1000	1100	1	Type III	180	210	1.5	0.52	0.4	14.31	0.029	19%	36%	7.7	4.1
HPS	1000	1100	2	Type III	180	220	3.16	0.95	0.79	14.37	0.056	37%	69%	8.5	4.6



# LZ3 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 Enhanced Security Guidelines .5fc minimum horizontal, .25fc minimum vertical at center, 15:1 max:min										
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
											0.15	0.08			

## 70 foot pole

HPS	1000	1100	1	Type III	240	260	1.02	0.51	0.42	7.65	0.018	12%	22%	8.7	4.6
HPS	1000	1100	2	Type III	240	310	1.66	0.53	0.44	13.3	0.030	20%	37%	8.4	4.5

## 20 foot pole

MH	70	90	4	Type III	70	80	1.52	0.5	0.23	6.99	0.064	43%	80%	3.5	1.9
MH	100	129	2	Type III	65	80	1.31	0.52	0.24	6.78	0.050	33%	62%	4.0	2.1
MH	100	129	4	Type III	75	80	2.28	0.67	0.26	8.75	0.086	57%	108%	4.0	2.1
MH	150	185	2	Type III	70	100	1.44	0.52	0.25	8.51	0.053	35%	66%	4.1	2.2
MH	150	185	4	Type III	80	105	2.42	0.58	0.25	13.17	0.088	59%	110%	4.1	2.2
MH	250	291	2	Type III	80	110	1.62	0.5	0.24	11.55	0.066	44%	83%	3.7	2.0
MH	70	80	4	Type III							0.049	33%	61%	4.0	2.1
MH	100	113	2	Type III							0.038	25%	47%	9.1	4.9
MH	100	113	4	Type III							0.065	43%	81%	3.3	1.8
MH	150	167	2	Type III							0.041	28%	52%	8.8	4.7
MH	150	167	4	Type III							0.069	46%	86%	3.5	1.9

## 25 foot pole

MH	100	129	4	Type III	90	95	1.58	0.5	0.25	7.59	0.060	40%	75%	3.9	2.1
MH	150	185	2	Type III	80	105	1.18	0.54	0.35	5.68	0.044	29%	55%	4.0	2.1
MH	150	185	4	Type III	100	110	1.82	0.5	0.33	9.6	0.067	45%	84%	4.1	2.2
MH	250	291	2	Type III	90	120	1.3	0.5	0.32	7.86	0.054	36%	67%	3.6	1.9
MH	320	368	1	Type V	85	90	1.63	0.59	0.27	10.57	0.048	32%	60%	5.1	2.7
MH	320	368	2	Type III	90	115	2.21	0.59	0.23	11.26	0.071	47%	89%	4.7	2.5
MH	100	113	4	Type III							0.046	30%	57%	5.2	2.8
MH	150	167	2	Type III							0.034	23%	43%	5.1	2.7
MH	150	167	4	Type III							0.053	35%	66%	5.2	2.8

## 30 foot pole

MH	100	129	4	Type III	95	110	1.28	0.48	0.31	5.66	0.049	33%	62%	3.9	2.1
MH	150	185	4	Type III	105	120	1.57	0.53	0.41	6.59	0.059	39%	73%	4.0	2.1
MH	250	291	2	Type III	100	120	1.15	0.51	0.39	5.79	0.049	32%	61%	3.6	1.9
MH	250	291	4	Type III	120	135	1.73	0.51	0.41	9.14	0.072	48%	90%	3.6	1.9
MH	320	368	1	Type V	95	100	1.29	0.53	0.48	8.28	0.039	26%	48%	5.0	2.7
MH	320	368	2	Type III	105	130	1.66	0.5	0.26	9.46	0.054	36%	67%	4.6	2.5
MH	320	368	4	Type III	120	125	3.03	0.64	0.45	13.88	0.098	65%	123%	4.6	2.5
MH	100	113	4	Type III							0.037	25%	47%	5.1	2.7
MH	150	167	4	Type III							0.046	31%	57%	5.1	2.7

## 35 foot pole



## LZ3 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 Enhanced Security Guidelines .5fc minimum horizontal, .25fc minimum vertical at center, 15:1 max:min										
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
											0.15	0.08			
MH	150	185	4	Type III	120 120	1.36	0.51	0.4	5.11	0.051	34%	64%	4.0	2.1	
MH	250	291	4	Type III	125 150	1.48	0.51	0.42	6.78	0.062	41%	78%	3.6	1.9	
MH	320	368	2	Type III	110 150	1.36	0.52	0.28	6.66	0.045	30%	56%	4.6	2.4	
MH	320	368	4	Type III	120 170	2.21	0.49	0.26	13.34	0.072	48%	90%	4.6	2.5	
MH	1000	1080	1	Type III	110 150	2.3	0.73	0.27	14.74	0.065	44%	82%	5.3	2.8	
MH	150	167	4	Type III						0.040	27%	50%	5.1	2.7	
<b>50 foot pole</b>															
MH	320	368	4	Type III	165 180	1.49	0.51	0.35	6.39	0.050	33%	62%	4.5	2.4	
MH	1000	1080	1	Type III	170 190	1.15	0.49	0.27	10.68	0.033	22%	42%	5.2	2.8	
MH	1000	1080	2	Type III	180 180	2.49	0.6	0.36	14.04	0.067	44%	83%	5.6	3.0	
<b>70 foot pole</b>															
MH	1000	1080	1	Type III	200 220	0.85	0.49	0.37	5.4	0.025	16%	31%	5.2	2.8	
MH	1000	1080	2	Type III	210 240	1.55	0.51	0.36	8.61	0.043	29%	54%	5.4	2.9	

# LZ4 Parking Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-20 Enhanced Security / Retail Guidelines 1.0fc minimum horizontal, .25fc minimum vertical at center, 15:1 max:min										
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Min. fc	Vert. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
											0.19	0.1			
<b>30 foot pole</b>															
HPS	250	310	4	Type III	120	135	3.96	1.01	0.84	13.09	0.077	40%	77%	9.8	5.2
HPS	400	464	1	Type V	95	115	2.43	1.02	0.54	9.24	0.042	22%	42%	10.9	5.7
HPS	400	464	2	Type III	110	150	3.12	1.03	0.77	10.14	0.056	30%	56%	10.5	5.5
HPS	400	464	4	Type III	130	145	5.49	1.29	0.94	14.51	0.098	52%	98%	10.6	5.6
<b>35 foot pole</b>															
HPS	250	310	4	Type III	120	160	3.31	1.01	0.78	9.47	0.065	34%	65%	9.7	5.1
HPS	400	464	2	Type III	120	160	2.65	1.02	0.83	7.56	0.048	25%	48%	10.4	5.5
HPS	400	464	4	Type III	140	180	4.08	1.01	0.73	13.65	0.074	39%	74%	10.5	5.5
HPS	1000	1100	1	Type III	130	160	3.18	1.04	0.7	14.6	0.053	28%	53%	11.4	6.0
HPS	1000	1100	2	Type III	120	160	6.63	1.96	1.44	14.25	0.115	60%	115%	11.0	5.8
<b>50 foot pole</b>															
HPS	400	464	4	Type III	180	180	3.1	1.05	0.93	6.67	0.057	30%	57%	10.3	5.4
HPS	1000	1100	1	Type III	170	185	2.05	1.04	0.8	7.37	0.035	18%	35%	11.1	5.9
HPS	1000	1100	2	Type III	180	215	3.24	1.01	0.84	13.58	0.057	30%	57%	10.8	5.7
<b>70 foot pole</b>															
HPS	1000	1100	1	Type III	180	220	1.6	1.07	0.7	3.9	0.028	15%	28%	10.9	5.8
HPS	1000	1100	2	Type III	190	280	2.31	1.06	0.74	6.74	0.041	22%	41%	10.6	5.6
<b>30 foot pole</b>															
MH	250	291	4	Type III	100	110	2.51	0.98	0.85	4.9	0.106	56%	106%	4.5	2.4
MH	320	368	4	Type III	105	120	3.58	1.02	0.61	8.68	0.117	61%	117%	5.8	3.1
MH	1000	1080	1	Type III	110	115	3.03	1.07	0.41	13.43	0.085	45%	85%	6.7	3.5
<b>35 foot pole</b>															
MH	250	291	4	Type III	110	110	2.26	1.02	0.77	3.6	0.096	51%	96%	4.5	2.3
MH	320	368	4	Type III	120	125	2.98	0.98	0.63	6.7	0.098	52%	98%	5.8	3.0
MH	1000	1080	1	Type III	120	130	2.43	1.06	0.57	10.08	0.069	36%	69%	6.7	3.5
MH	1000	1080	2	Type III	110	145	4.94	1.19	0.56	14.2	0.135	71%	135%	6.9	3.6
<b>50 foot pole</b>															
MH	320	368	4	Type III	120	170	2.15	1.01	0.94	3.47	0.072	38%	72%	5.7	3.0
MH	1000	1080	1	Type III	160	170	1.36	0.98	0.63	3	0.040	21%	40%	6.5	3.4
MH	1000	1080	2	Type III	160	240	2.01	0.96	0.55	4.67	0.056	30%	56%	6.8	3.6
<b>70 foot pole</b>															
MH	1000	1080	2	Type III	140	180	3.15	1.05	0.66	8.14	0.086	45%	86%	7.0	3.7
MH	1000	1080	4	Type III	200	200	3.97	1.06	0.71	11.88	0.108	57%	108%	7.0	3.7



# Pedestrian Hardscape COURTYARD Spacing Calculations T-24 2008

Area calculations made in idealized spacing grid per IESNA procedures for calculation uniformity  
 Minimum vertical illuminance is measured at the center of the parking lot grid

All calculations made with clear lamp optics

LDD = .70

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	Performance Increase with Electronic Ballasts
320	MH		29000	20300	368	
250	MH		21250	14300	291	
150	MH		12000	9000	185	
100	MH		8400	6300	129	
70	MH		5500	3850	90	
50	MH		3600	2450	73	
150	MH	ELECTRONIC	12000	10400	167	115.6%
100	MH	ELECTRONIC	8400	7300	113	115.9%
70	MH	ELECTRONIC	5500	4510	80	117.1%
50	MH	ELECTRONIC	3600	2880	58	117.6%



## LZ1 Pedestrian Hardscape Maximum Spacing Calculations - COURTYARD - 2008

Yellow is the limiting factor

Maximum Spacing to meet DG-5 Commercial-Special Conditions Guidelines  
0.2fc average, 10:1 avg:min horizontal illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions		Avg. fc	Avg:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>15 foot pole</b>												0.06	0.04		
MH	50	73	3600	2450	1	Type V	52.5	55	0.43	8.7	0.025	42%	63%	1.0	0.7
MH	50	73	3600	2450	2	Type III	70	90	0.46	9.6	0.023	39%	58%	1.2	0.8
MH	70	90	5500	3850	1	Type V	52.5	55	0.67	8.7	0.031	52%	78%	1.3	0.9
<b>20 foot pole</b>															
MH	50	73	3600	2450	2	Type III	90	125	0.25	8.87	0.013	22%	32%	1.2	0.8
MH	70	90	5500	3850	2	Type III	92.5	125	0.37	9.68	0.016	26%	39%	1.4	1.0
MH	100	129	8400	6300	1	Type V	62.5	67.5	0.72	7.66	0.031	51%	76%	1.4	0.9
MH	150	185	12000	9000	1	Type V	90	95	0.69	8.96	0.022	36%	54%	1.9	1.3

## LZ2 Pedestrian Hardscape Maximum Spacing Calculations - COURTYARD - 2008

Yellow is the limiting factor

Maximum Spacing to meet DG-5 Commercial-Special Conditions Guidelines  
0.5fc average, 4:1 avg:min horizontal illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions		Avg. fc	Avg:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>15 foot pole</b>												0.09	0.06		
MH	50	73	3600	2450	1	Type V	45	50	0.55	3.48	0.032	36%	54%	1.5	1.0
MH	50	73	3600	2450	2	Type III	55	82.5	0.61	3.67	0.032	36%	54%	1.7	1.1
MH	70	90	5500	3850	1	Type V	45	50	0.87	3.48	0.040	44%	67%	2.0	1.3
<b>20 foot pole</b>															
MH	50	73	3600	2450	2	Type III	67.5	80	0.49	2.43	0.027	30%	45%	1.6	1.1
MH	70	90	5500	3850	2	Type III	75	100	0.57	3.55	0.024	27%	40%	2.1	1.4
MH	100	129	8400	6300	1	Type V	57.5	60	0.89	3.55	0.037	42%	62%	2.1	1.4
MH	100	129	8400	6300	2	Type III	75	100	0.92	3.86	0.034	38%	57%	2.4	1.6
MH	150	185	12000	9000	1	Type V	75	80	0.97	3.74	0.031	34%	51%	2.8	1.9

## LZ3 Pedestrian Hardscape Maximum Spacing Calculations - COURTYARD - 2008

Yellow is the limiting factor

Maximum Spacing to meet DG-5 Commercial-Special Conditions Guidelines  
1fc average, 4:1 avg:min horizontal illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions		Avg. fc	Avg:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>15 foot pole</b>												0.17	0.09		
MH	70	90	5500	3850	1	Type V	45	42.5	1.02	3.14	0.047	28%	52%	3.7	2.0
MH	70	90	5500	3850	2	Type III	60	70	1.05	3.95	0.043	25%	48%	4.2	2.2
MH	100	129	8400	6300	1	Type V	42.5	45	1.72	3.6	0.067	40%	75%	4.3	2.3
MH	100	129	8400	6300	2	Type III	57.5	70	1.81	3.95	0.064	38%	71%	4.8	2.5
MH	150	185	12000	9000	1	Type V	55	60	1.82	3.5	0.056	33%	62%	5.5	2.9
MH	150	185	12000	9000	2	Type III	60	90	1.95	3.98	0.069	40%	76%	4.8	2.6
MH	250	291	20500	13500	1	Type V	40	42.5	3.7	3.59	0.171	101%	190%	3.7	1.9
<b>20 foot pole</b>															
MH	70	90	5500	3850	2	Type III	60	70	0.99	2.14	0.043	25%	48%	3.9	2.1
MH	100	129	8400	6300	1	Type V	50	60	1.05	2.41	0.043	25%	48%	4.2	2.2
MH	100	129	8400	6300	2	Type III	75	90	1.02	3.66	0.038	22%	42%	4.5	2.4
MH	150	185	12000	9000	1	Type V	70	80	1.04	3.26	0.033	19%	37%	5.4	2.8
MH	150	185	12000	9000	2	Type III	85	100	1.2	3.96	0.044	26%	48%	4.7	2.5
MH	250	291	20500	13500	1	Type V	55	62.5	1.95	3.65	0.085	50%	94%	3.9	2.1
MH	320	368	29000	20300	1	Type V	72.5	85	2.02	3.97	0.060	35%	66%	5.8	3.0



## LZ4 Pedestrian Hardscape Maximum Spacing Calculations - COURTYARD - 2008

Yellow is the limiting factor

							Maximum Spacing to meet DG-5 Commercial-Special Conditions Guidelines 2fc average, 5:1 avg:min vertical illuminance									
Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	Avg. Vert. fc	Vert. Avg:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
													0.21	0.21		
<b>15 foot pole</b>																
MH	100	129	8400	6300	2	Type III	30 35	6.19	1.39	1.98	4.15	0.246	117%	117%	5.3	5.3
MH	150	185	12000	9000	2	Type III	30 37.5	8.48	1.81	2.89	3.15	0.329	157%	157%	5.4	5.4
MH	250	291	20500	13500	1	Type V	22.5 25	11.14	1.37	2.88	4.77	0.517	246%	246%	4.5	4.5
<b>20 foot pole</b>																
MH	100	129	8400	6300	2	Type III	30 35	5.96	1.17	2	1.9	0.246	117%	117%	5.1	5.1
MH	100	129	8400	6300	4	Type III	45 45	6.41	1.57	2.43	4.27	0.255	121%	121%	5.3	5.3
MH	150	185	12000	9000	2	Type III	40 40	5.84	1.31	2.04	2.51	0.231	110%	110%	5.3	5.3
MH	150	185	12000	9000	4	Type III	55 55	6.42	1.93	2.7	3.95	0.245	116%	116%	5.5	5.5
MH	250	291	20500	13500	1	Type V	27.5 30	7.47	1.36	2.11	2.71	0.353	168%	168%	4.4	4.4
MH	250	291	20500	13500	2	Type III	45 52.5	5.39	1.44	1.98	3.14	0.246	117%	117%	4.6	4.6
<b>25 foot pole</b>																
MH	100	129	8400	6300	4	Type III	50 50	5.13	1.39	1.99	2.47	0.206	98%	98%	5.2	5.2
MH	150	185	12000	9000	4	Type III	60 65	4.93	1.7	2.1	3.19	0.190	90%	90%	5.5	5.5
MH	250	291	20500	13500	4	Type III	75 75	4.6	2.07	2.04	4.23	0.207	99%	99%	4.7	4.7
MH	320	368	29000	20300	1	Type V	45 45	5.8	1.43	2.01	2.62	0.182	87%	87%	6.7	6.7
MH	320	368	29000	20300	2	Type III	55 60	6.63	1.59	2.13	4.17	0.223	106%	106%	6.2	6.2

## Building Entrance Calculations NO CANOPY T-24 2008

Area calculated is width of door plus 3' on each side  
 Multiple doors are calculated for full width of doors plus 3' on each side.  
 Depth away from door is 18'.

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	MH Performance Increase with Electronic Ballasts
13	CFL	Electronic			16	
18	CFL	Electronic			20	
26	CFL	Electronic			28	
32	CFL	Electronic			35	
42	CFL	Electronic			46	
25	FL	Electronic			25	
32	FL	Electronic			32	
150	MH		12000	9000	185	
100	MH		8400	6300	129	
70	MH		5500	3850	90	
50	MH		3600	2450	73	
150	MH	ELECTRONIC	12000	10400	167	115.6%
100	MH	ELECTRONIC	8400	7300	113	115.9%
70	MH	ELECTRONIC	5500	4510	80	117.1%
50	MH	ELECTRONIC	3600	2880	58	117.6%



## Building Entrance NO CANOPY Lighting Calculations T-24 2008

Lt. Grey is TARGET value

Entrance NO Canopy - Maximum Lamp Combinations for LZ Lighting Allowances														
Calculations based on Gardco 100 Series Sconce over door														
Width of Entry	Depth Allowance	Number of Lamps	Connected Wattage	Avg. fc	Max:Min	WPF	Percentage of LZ Allowance				Percentage of Proposed 2008 Allowance			
							LZ1	LZ2	LZ3	LZ4	LZ1	LZ2	LZ3	LZ4
							0.35	0.5	0.7	1	0.2	0.35	0.55	0.7
							(1 fc)	(5 fc)	(7 fc)	(10 fc)				

### Single 3' Door

Single 13 watt CFL cutoff area light	9	18	1	16			0.099	28%	20%	14%	10%	49%	28%	18%	14%
Single 26 watt CFL cutoff area light	9	18	1	28	3.33	4.68	0.173	49%	35%	25%	17%	86%	49%	31%	25%
Single 32 watt CFL cutoff area light	9	18	1	35	4.44	4.68	0.216	62%	43%	31%	22%	108%	62%	39%	31%
Single 50 watt MH cutoff area light	9	18	1	73	5.1	4.81	0.451	129%	90%	64%	45%	225%	129%	82%	64%
Single 70 watt MH cutoff area light	9	18	1	90	8	4.81	0.556	159%	111%	79%	56%	278%	159%	101%	79%

### Double 3' Doors

Single 32 watt CFL cutoff area light	12	18	1	35	3.94	6.33	0.162	46%	32%	23%	16%	81%	46%	29%	23%
Single 50 watt MH cutoff area light	12	18	1	73	4.64	5.73	0.338	97%	68%	48%	34%	169%	97%	61%	48%
Single 70 watt MH cutoff area light	12	18	1	90	7.27	5.73	0.417	119%	83%	60%	42%	208%	119%	76%	60%
Single 100 watt MH cutoff area light	12	18	1	129	10.82	5.73	0.597	171%	119%	85%	60%	299%	171%	109%	85%

### (3) Sets of Double 3' Doors with 4' Sidelight Between

(2) Single 42 watt CFL cutoff area lights	32	18	2	46	4.21	6.13	0.160	46%	32%	23%	16%	80%	46%	29%	23%
(2) Double 32 watt CFL cutoff area lights	32	18	2	70	3.88	3.18	0.243	69%	49%	35%	24%	122%	69%	44%	35%
(2) Single 70 watt MH cutoff area lights	32	18	2	90	6.33	5.33	0.313	89%	63%	45%	31%	156%	89%	57%	45%
(3) Single 70 watt MH cutoff area lights	32	18	2	90	9.79	4.87	0.313	89%	63%	45%	31%	156%	89%	57%	45%



## Outdoor Sales Lot Maximum Spacing Calculations T-24 2008

Area calculations made in idealized parking lot grid per IESNA procedures for calculation uniformity

An attempt has been made to maintain reasonable row-to-row spacing for pole rows

All calculations made with clear lamp optics

LDD = .70

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	Performance Increase with Electronic Ballasts
1000	MH		110000	71000	1080	
320	MH		29000	20300	368	
250	MH		21250	14300	291	
150	MH		12000	9000	185	
150	MH	ELECTRONIC	12000	10400	167	115.6%

# LZ1 Outdoor Sales Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA								
					RP-33 Secondary Business District General Display (5 hfc, 10:1 max:mi)								
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance	
<b>15 foot pole</b>													
MH	150	185	4	Type III	60 65	5.28	9.03	0.190	54%	95%	9.7	5.6	
MH	150	167	4	Type III	Electronic Ballast Estimate			0.171	49%	86%	12.5	7.1	
<b>20 foot pole</b>													
MH	150	185	4	Type III	60 65	5.04	3.82	0.190	54%	95%	9.3	5.3	
MH	250	291	4	Type III	60 90	5.19	5.86	0.216	62%	108%	8.4	4.8	
MH	320	368	2	Type III	60 70	5.04	4.73	0.175	50%	88%	10.1	5.8	
MH	150	167	4	Type III	Electronic Ballast Estimate			0.171	49%	86%	0.0	0.0	
<b>25 foot pole</b>													
MH	320	368	4	Type III	60 120	6.26	9.86	0.204	58%	102%	10.7	6.1	
<b>30 foot pole</b>													
MH	320	368	4	Type III	75 120	4.96	5.61	0.164	47%	82%	10.6	6.1	
MH	1000	1080	1	Type V	70 105	5.11	5.07	0.147	42%	73%	12.2	7.0	



## LZ2 Outdoor Sales Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot Low Level (20 hfc)								
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions		Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>20 foot pole</b>													
MH	1000	1080	2	Type III	60	65	20.56	7.21	0.554	79%	92%	26.0	22.3
<b>25 foot pole</b>													
MH	1000	1080	3	Type III	60	100	20.18	6.55	0.540	77%	90%	26.2	22.4



## LZ3 Outdoor Sales Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot Medium Level (30 hfc)								
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions		Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>20 foot pole</b>													
MH	1000	1080	2	Type III	60	45	29.35	5.08	0.800	64%	94%	45.9	31.2
<b>25 foot pole</b>													
MH	1000	1080	4	Type III	60	85	30.88	5.24	0.847	68%	100%	45.6	31.0

## LZ4 Outdoor Sales Lot Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot High Level (50 hfc)							
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>20 foot pole</b>												
MH	1000	1080	4	Type III	60 53	50.49	5.02	1.358	68%	97%	74.3	52.0



## Sales Lot FRONTAGE Maximum Spacing Calculations T-24 2008

Illuminance calculations made in parking lot with perimeter poles intended to light perimeter cars to target illuminance levels. Rest of parking lot uses spacing determined for sales lot allowance.

Illuminance calculations made for first 15' of parking lot from curb. Area considered frontage row assigned 1/2 depth to second row of lights.

All calculations made with clear lamp optics  
LDD = .70  
Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available  
Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	Performance Difference with Electronic Ballasts
1000	MH		110000	71000	1080	



## LZ1 Outdoor Sales Lot FRONTAGE Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot Low Level Feature Display (35 hfc)						
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Perimeter Spacing	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	AVG. ILL*SQFT /WATTS

LZ1 DOES NOT PERMIT SALES LOT FRONTAGE AREA - USE SALES LOT ALLOWANCES

## LZ2 Outdoor Sales Lot FRONTAGE Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Maximum Spacing to meet IESNA RP-2 Auto Retail Lot Low Level Feature Display (35 hfc)							% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ W/LF Allowance
					Perimeter Spacing	Spacing to Inner Pole	Avg. fc	Inner WPF	Max:Min	W/SF	W/LF		
<b>20 foot pole</b>													
MH	1000	1080	2	Type III	55	60	34.56	0.554	3.26	0.755	22.653	101%	101%
<b>25 foot pole</b>													
MH	1000	1080	2	Type III	55	60	34.2	0.54	2	0.769	23.073	103%	103%

## LZ3 Outdoor Sales Lot FRONTAGE Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot Medium Level Feature Display (50 hfc)									
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Perimeter Spacing	Spacing to Inner Pole	Avg. fc	Inner WPF	Max:Min	W/SF	W/LF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ W/LF Allowance	
<b>20 foot pole</b>												38.5	36	
MH	1000	1080	3	Type III	55	60	51.2	0.8	3.52	1.164	34.909	91%	97%	
<b>25 foot pole</b>														
MH	1000	1080	3	Type III	55	60	50.02	0.847	2.12	1.117	33.499	87%	93%	

# LZ4 Outdoor Sales Lot FRONTAGE Maximum Spacing Calculations T-24 2008

Yellow is the limiting factor

					Maximum Spacing to meet IESNA RP-2 Auto Retail Lot High Level Feature Display (75 hfc)								
Lamp	Lamp Wattage	System Wattage	# of Heads	Photometric Type	Perimeter Spacing	Spacing to Inner Pole	Avg. fc	Inner WPF	Max:Min	W/SF	W/LF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ W/LF Allowance
<b>20 foot pole</b>													
MH	1000	1080	4	Type III	55	53	75.05	1.358	3.05	1.606	42.558	77%	95%



# Gas Canopy Maximum Spacing Calculations - T-24 2008

Area calculations made to drip line of canopy

FLAT GLASS luminaire is RUUD MCL0417 175w MH, output modified for lamp wattage.

Fixture meets FULL CUTOFF roadway classification.

DROP LENS luminaire is Cooper CS-CL 400w MH, output modified for lamp wattage.

Fixture meets CUTOFF roadway classification.

Small canopy has 14' ground to canopy height

Large canopy has 17' ground to canopy height

Canopy is white, with 70% reflectance

Concrete is calculated with a 20% reflectance

Edges of calculation limits are presumed to be open, with a 5% reflectance for introduction of lighting from beyond calculation area.

Lamps used are Pulse Start MH where currently available

Lamp lumens used:

		Initial	Maintained	System watts	Performance Increase with Electronic Ballasts
320w		29000	20300	368	
250w		21250	14300	291	
150w		12000	9000	185	
100w		8400	6300	129	
150w	ELECTRONIC	12000	10400	167	115.6%
100w	ELECTRONIC	8400	7300	113	115.9%



# LZ1 Gas Canopy Maximum Spacing Calculations T-24 2008

RED lines represent estimated performance with electronic ballasts

							Maximum Spacing to meet RP-33 Service Station Pump Island Upper guideline limit - 10fc average						
Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>SMALL - 60x56 Canopy - FLAT GLASS</b>													
MH	100	129	8400	6300	14	Full cutoff	10.02	3.74	0.538	77%	98%	13.0	10.3
MH	150	185	12000	9000	9	Full cutoff	9.37	4.4	0.496	71%	90%	13.2	10.4
MH	250	291	20500	13500	6	Full cutoff	10.12	11.14	0.520	74%	94%	13.6	10.7
MH	100	113	8400	6300	12	Full cutoff	10.0		0.404	58%	73%	17.3	13.6
MH	150	167	12000	9000	8	Full cutoff	9.6		0.398	57%	72%	16.9	13.2
<b>SMALL - 60x56 Canopy - DROP LENS</b>													
MH	100	129	8400	6300	15	Cutoff	9.86	3.45	0.576	82%	105%	12.0	9.4
MH	150	185	12000	9000	11	Cutoff	10.32	3.79	0.606	87%	110%	11.9	9.4
MH	250	291	20500	13500	6	Cutoff	9.34	4.36	0.520	74%	94%	12.6	9.9
MH	100	113	8400	6300	13	Cutoff	9.9		0.437	62%	79%	15.9	12.5
MH	150	167	12000	9000	9	Cutoff	9.7		0.447	64%	81%	15.2	11.9
<b>LARGE - 84x76 Canopy - FLAT GLASS</b>													
MH	100	129	8400	6300	26	Full cutoff	10.22	6.25	0.525	75%	96%	13.6	10.7
MH	150	185	12000	9000	18	Full cutoff	9.81	4.31	0.522	75%	95%	13.2	10.3
MH	250	291	20500	13500	12	Full cutoff	10.6	6.79	0.547	78%	99%	13.6	10.7
MH	100	113	8400	6300	22	Full cutoff	10.0		0.389	56%	71%	18.0	14.2
MH	150	167	12000	9000	16	Full cutoff	10.0		0.419	60%	76%	16.8	13.2
<b>LARGE - 84X76 Canopy - DROP LENS</b>													
MH	100	129	8400	6300	30	Cutoff	10.54	4.07	0.606	87%	110%	12.2	9.6
MH	150	185	12000	9000	20	Cutoff	10.24	4.41	0.580	83%	105%	12.4	9.7
MH	250	291	20500	13500	14	Cutoff	10.63	3.14	0.638	91%	116%	11.7	9.2
MH	100	113	8400	6300	24	Cutoff	9.8		0.425	61%	77%	16.1	12.7
MH	150	167	12000	9000	17	Cutoff	10.0		0.445	64%	81%	15.8	12.4



## LZ2 Gas Canopy Maximum Spacing Calculations T-24 2008

RED lines represent estimated performance with electronic ballasts

							Maximum Spacing to meet RP-2 Service Station - Low Use Guidelines 20fc average						
Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>SMALL - 60x56 Canopy - FLAT GLASS</b>										<b>1.15</b>	<b>1.05</b>		
MH	150	185	12000	9000	20	Full cutoff	20.82	4.56	1.101	96%	105%	21.7	19.9
MH	250	291	20500	13500	12	Full cutoff	19.91	6.29	1.039	90%	99%	22.0	20.1
MH	320	368	29000	20300	9	Full cutoff	21	5.56	0.986	86%	94%	24.5	22.4
MH	150	167	12000	10400	18	Full cutoff	21.5		0.895	78%	85%	27.7	25.3
<b>SMALL - 60x56 Canopy - DROP LENS</b>													
MH	150	185	12000	9000	20	Cutoff	18.85	4.23	1.101	96%	105%	19.7	18.0
MH	250	291	20500	13500	14	Cutoff	20.73	3.13	1.213	105%	115%	19.7	18.0
MH	320	368	29000	20300	10	Cutoff	21.24	5.14	1.095	95%	104%	22.3	20.4
MH	150	167	12000	10400	18	Cutoff	19.5		0.895	78%	85%	25.1	22.9
<b>LARGE - 84x76 Canopy FLAT GLASS</b>													
MH	150	185	12000	9000	35	Full cutoff	19.8	7	1.014	88%	97%	22.4	20.5
MH	250	291	20500	13500	23	Full cutoff	20.23	5.25	1.048	91%	100%	22.2	20.3
MH	320	368	29000	20300	16	Full cutoff	20.04	4.16	0.922	80%	88%	25.0	22.8
MH	150	167	12000	10400	30	Full cutoff	19.5		0.785	68%	75%	28.6	26.1
<b>LARGE - 84x76 Canopy DROP LENS</b>													
MH	150	185	12000	9000	41	Cutoff	20.98	4.4	1.188	103%	113%	20.3	18.5
MH	250	291	20500	13500	26	Cutoff	20.38	3.39	1.185	103%	113%	19.8	18.1
MH	320	368	29000	20300	18	Cutoff	21.01	5.48	1.038	90%	99%	23.3	21.3
MH	150	167	12000	10400	35	Cutoff	20.6		0.916	80%	87%	25.9	23.6

## LZ3 Gas Canopy Maximum Spacing Calculations T-24 2008

							Max. Spacing to meet RP-2 Service Station - Medium Use Guidelines 30fc average						
Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>SMALL - 60x56 Canopy - FLAT GLASS</b>													
MH	250	291	21250	14300	18	Full cutoff	30.08	7.03	1.559	108%	108%	28.0	28.0
MH	320	368	29000	20300	13	Full cutoff	30.97	6.19	1.424	98%	98%	31.5	31.5
<b>SMALL - 60x56 Canopy - DROP LENS</b>													
MH	250	291	20500	13500	19	Cutoff	29.6	3.58	1.646	113%	113%	26.1	26.1
MH	320	368	29000	20300	14	Cutoff	29.9	4.5	1.533	106%	106%	28.3	28.3
<b>LARGE - 84x76 Canopy FLAT GLASS</b>													
MH	250	291	20500	13500	35	Full cutoff	30.05	4.75	1.595	110%	110%	27.3	27.3
MH	320	368	29000	20300	24	Full cutoff	30.28	5.05	1.383	95%	95%	31.7	31.7
<b>LARGE - 84x76 Canopy DROP LENS</b>													
MH	250	291	20500	13500	36	Cutoff	30.64	4.2	1.641	113%	113%	27.1	27.1
MH	320	368	29000	20300	26	Cutoff	30.05	3.94	1.499	103%	103%	29.1	29.1

## LZ4 Gas Canopy Maximum Spacing Calculations T-24 2008

							Maximum Spacing to meet RP-2 Service Station - High Use Guidelines 50fc average						
Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Avg. fc	Max:Min	WPF	% of 2005 LZ WPF Allowance	% of Proposed 2008 LZ WPF Allowance	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
<b>SMALL - 60x56 Canopy - FLAT GLASS</b>										<b>2.4</b>	<b>2.4</b>		
MH	320	368	29000	20300	22	Full cutoff	51.93	5.15	2.410	100%	100%	51.7	51.7
<b>SMALL - 60x56 Canopy - DROP LENS</b>													
MH	320	368	29000	20300	24	Cutoff	50.77	3.99	2.629	110%	110%	46.4	46.4
<b>LARGE - 84x76 Canopy - FLAT GLASS</b>													
MH	320	368	29000	20300	42	Full cutoff	52.5	5.09	2.421	101%	101%	52.0	52.0
<b>LARGE - 84x76 Canopy - DROP LENS</b>													
MH	320	368	29000	20300	46	Cutoff	50.78	3.12	2.652	110%	110%	46.0	46.0

## Building Entrance Canopy Calculations T-24 2008 (Non-Sales Canopy)

Area calculations made to drip line of canopy

20W Initial Wattage Allowance added into calculation in second spreadsheet

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	MH Performance Increase with Electronic Ballasts
13	CFL	Electronic			16	
18	CFL	Electronic			20	
26	CFL	Electronic			28	
32	CFL	Electronic			35	
42	CFL	Electronic			46	
25	FL	Electronic			25	
32	FL	Electronic			32	
150	MH		12000	9000	185	
100	MH		8400	6300	129	
70	MH		5500	3850	90	
50	MH		3600	2450	73	
150	MH	ELECTRONIC	12000	10400	167	115.6%
100	MH	ELECTRONIC	8400	7300	113	115.9%
70	MH	ELECTRONIC	5500	4510	80	117.1%
50	MH	ELECTRONIC	3600	2880	58	117.6%



## Building Entrance Canopy Calculations T-24 2008

Lt. Grey is TARGET value Yellow is Problem performance		Entrance Canopies - Maximum Lamp Combinations for LZ Lighting Allowances									
	Area of canopy	# of Lamps	Lamp Wattage	Total Wattage	Approximate Performance			Percentage of LZ Allowance			
					Avg. fc	Max:Min	WPF	LZ1	LZ2	LZ3	LZ4
								0.12	0.25	0.5	0.7
<b>Small Canopy at Entrance (9' wide, 5' deep, 9' high)</b>											
Fluorescent downlight option LZ1 LZ2	45	1	13	16	3.66	3.21	0.356	296%	142%	71%	51%
Fluorescent downlight option LZ3	45	1	18	20	3.78	3.13	0.444	370%	178%	89%	63%
Fluorescent downlight option LZ4	45	1	32	35	6.36	2.91	0.778	648%	311%	156%	111%
50w MH downlight option	45	1	50	73	19.13	5.07	1.622	1352%	649%	324%	232%
<b>Medium Canopy at Entrance (28' wide, 15' deep, 12' high)</b>											
Fluorescent downlight option LZ1	420	4	13	16	2.57	8.33	0.152	127%	61%	30%	22%
Fluorescent downlight option LZ2	420	4	26	28	3.89	7.41	0.267	222%	107%	53%	38%
Fluorescent downlight option LZ3	420	12	18	20	6	3.46	0.571	476%	229%	114%	82%
Fluorescent downlight option LZ4	420	12	26	28	10.86	3.44	0.800	667%	320%	160%	114%
MH downlight option LZ1	420	1	50	73	3.49	301	0.174	145%	70%	35%	25%
MH downlight option LZ2	420	2	50	73	6.84	30.43	0.348	290%	139%	70%	50%
MH downlight option LZ3	420	4	50	73	12.1	13.12	0.695	579%	278%	139%	99%
MH downlight option LZ4	420	6	50	73	17.51	4.61	1.043	869%	417%	209%	149%
MH downlight option LZ1 ELECT BALL	420	1	50	58			0.138	115%	55%	28%	20%
MH downlight option LZ2 ELECT BALL	420	2	50	58			0.276	230%	110%	55%	39%
MH downlight option LZ3 ELECT BALL	420	4	50	58			0.552	460%	221%	110%	79%
MH downlight option LZ4 ELECT BALL	420	6	50	58			0.829	690%	331%	166%	118%
Linear fluorescent option LZ1	420	2	25	25	2.32	2.74	0.119	99%	48%	24%	17%
Linear fluorescent option LZ2	420	4	25	25	4.65	2.73	0.238	198%	95%	48%	34%
Linear fluorescent option LZ3	420	6	32	32	9.65	2.86	0.457	381%	183%	91%	65%
Linear fluorescent option LZ4	420	10	32	32	16.3	3.61	0.762	635%	305%	152%	109%
<b>Large Canopy at Entrance (50' wide, 75' deep, 20' high)</b>											
Fluorescent downlight option LZ1	3750	18	26	28	2.33	4.31	0.134	112%	54%	27%	19%
Fluorescent downlight option LZ2	3750	36	26	28	4.62	4.6	0.269	224%	108%	54%	38%
Fluorescent downlight option LZ3	3750	45	42	46	9.22	6.37	0.552	460%	221%	110%	79%
Fluorescent downlight option LZ4	3750	63	42	46	12.84	5.73	0.773	644%	309%	155%	110%
MH downlight option LZ1	3750	9	50	73	3.37	18.63	0.175	146%	70%	35%	25%
MH downlight option LZ2	3750	14	70	90	7.02	5.31	0.336	280%	134%	67%	48%
MH downlight option LZ3	3750	12	150	185	13	6.55	0.592	493%	237%	118%	85%
MH downlight option LZ4	3750	18	150	185	18.79	4.29	0.888	740%	355%	178%	127%
MH downlight option LZ1 ELECT BALL	3750	9	50	58			0.139	116%	56%	28%	20%
MH downlight option LZ2 ELECT BALL	3750	14	70	80			0.299	249%	119%	60%	43%
MH downlight option LZ3 ELECT BALL	3750	12	150	167			0.534	445%	214%	107%	76%
MH downlight option LZ4 ELECT BALL	3750	18	150	167			0.802	668%	321%	160%	115%

### Building Entrance Canopy Calculations T-24 2008 - Adjusted for LZ1 Initial Wattage Allowance (IWA)

Lt. Grey is TARGET value Yellow is Problem performance		Entrance Canopies - Maximum Lamp Combinations for LZ Lighting Allowances											Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance			
	Area of canopy	# of Lamps	Lamp Wattage	Total Wattage	Approximate Performance			Percentage of 2005 LZ Allowance				Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance				
					Avg. fc	Max:Min	WPF	LZ1	LZ2	LZ3	LZ4	(1 fc)	(5 fc)	(7 fc)	(10 fc)	1	5	7	10	
<b>Small Canopy at Entrance (9' wide, 5' deep, 9' high)</b>																				
Fluorescent downlight option LZ1 LZ2	45	1	13	16	3.66	3.21	0.000	0%	0%	0%	0%	0.00	0.04	0.24	0.53	0%	17%	47%	75%	
Fluorescent downlight option LZ3	45	1	18	20	3.78	3.13	0.000	0%	0%	0%	0%		0.38	0.73			76%	104%		
Fluorescent downlight option LZ4	45	1	32	35	6.36	2.91	0.333	278%	133%	67%	48%			0.78					111%	
50w MH downlight option	45	1	50	73	19.13	5.07	1.178	981%	471%	236%	168%			0.40					58%	
<b>Medium Canopy at Entrance (28' wide, 15' deep, 12' high)</b>																				
Fluorescent downlight option LZ1	420	4	13	16	2.57	8.33	0.105	87%	42%	21%	15%	0.01	0.25	0.37	0.55	10%	100%	73%	78%	
Fluorescent downlight option LZ2	420	4	26	28	3.89	7.41	0.219	183%	88%	44%	31%		0.30	0.43	0.64		118%	86%	91%	
Fluorescent downlight option LZ3	420	12	18	20	6	3.46	0.524	437%	210%	105%	75%			0.62	0.90			124%	129%	
Fluorescent downlight option LZ4	420	12	26	28	10.86	3.44	0.752	627%	301%	150%	107%			0.69					98%	
MH downlight option LZ1	420	1	50	73	3.49	301	0.126	105%	50%	25%	18%	0.00	0.20	0.30	0.45	2%	81%	60%	64%	
MH downlight option LZ2	420	2	50	73	6.84	30.43	0.300	250%	120%	60%	43%		0.21	0.31	0.46		83%	62%	66%	
MH downlight option LZ3	420	4	50	73	12.1	13.12	0.648	540%	259%	130%	93%			0.35	0.53			71%	75%	
MH downlight option LZ4	420	6	50	73	17.51	4.61	0.995	829%	398%	199%	142%			0.55					78%	
MH downlight option LZ1 ELECT BALL	420	1	50	58			0.090	75%	36%	18%	13%								Extrapolation of magnetic ballast data	
MH downlight option LZ2 ELECT BALL	420	2	50	58			0.229	190%	91%	46%	33%								Extrapolation of magnetic ballast data	
MH downlight option LZ3 ELECT BALL	420	4	50	58			0.505	421%	202%	101%	72%								Extrapolation of magnetic ballast data	
MH downlight option LZ4 ELECT BALL	420	6	50	58			0.781	651%	312%	156%	112%								Extrapolation of magnetic ballast data	
Linear fluorescent option LZ1	420	2	25	25	2.32	2.74	0.071	60%	29%	14%	10%	0.00	0.21	0.31	0.47	3%	84%	62%	67%	
Linear fluorescent option LZ2	420	4	25	25	4.65	2.73	0.190	159%	76%	38%	27%		0.21	0.31	0.46		83%	62%	66%	
Linear fluorescent option LZ3	420	6	32	32	9.65	2.86	0.410	341%	164%	82%	59%			0.28	0.43			57%	61%	
Linear fluorescent option LZ4	420	10	32	32	16.3	3.61	0.714	595%	286%	143%	102%			0.42					60%	
<b>Large Canopy at Entrance (50' wide, 75' deep, 20' high)</b>																				
Fluorescent downlight option LZ1	3750	18	26	28	2.33	4.31	0.129	108%	52%	26%	18%	0.05	0.28	0.40	0.57	44%	113%	80%	82%	
Fluorescent downlight option LZ2	3750	36	26	28	4.62	4.6	0.263	220%	105%	53%	38%		0.29	0.40	0.58		114%	80%	82%	
Fluorescent downlight option LZ3	3750	45	42	46	9.22	6.37	0.547	456%	219%	109%	78%			0.41	0.59			83%	85%	
Fluorescent downlight option LZ4	3750	63	42	46	12.84	5.73	0.767	640%	307%	153%	110%			0.60					85%	
MH downlight option LZ1	3750	9	50	73	3.37	18.63	0.170	142%	68%	34%	24%	0.05	0.25	0.36	0.51	39%	102%	72%	74%	
MH downlight option LZ2	3750	14	70	90	7.02	5.31	0.331	276%	132%	66%	47%		0.23	0.33	0.47		94%	66%	68%	
MH downlight option LZ3	3750	12	150	185	13	6.55	0.587	489%	235%	117%	84%			0.31	0.45			63%	64%	
MH downlight option LZ4	3750	18	150	185	18.79	4.29	0.883	736%	353%	177%	126%			0.47					67%	
MH downlight option LZ1 ELECT BALL	3750	9	50	58			0.134	112%	54%	27%	19%								Extrapolation of magnetic ballast data	
MH downlight option LZ2 ELECT BALL	3750	14	70	80			0.293	244%	117%	59%	42%								Extrapolation of magnetic ballast data	
MH downlight option LZ3 ELECT BALL	3750	12	150	167			0.529	441%	212%	106%	76%								Extrapolation of magnetic ballast data	
MH downlight option LZ4 ELECT BALL	3750	18	150	167			0.796	664%	319%	159%	114%								Extrapolation of magnetic ballast data	



### Building Entrance Canopy Calculations T-24 2008 - Adjusted for LZ2 Initial Wattage Allowance (IWA)

Lt. Grey is TARGET value Yellow is Problem performance		Entrance Canopies - Maximum Lamp Combinations for LZ Lighting Allowances										Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance				
Area of canopy	# of Lamps	Lamp Wattage	Total Wattage	Approximate Performance			Percentage of 2005 LZ Allowance				Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance					
				Avg. fc	Max:Min	WPF	LZ1	LZ2	LZ3	LZ4	(1 fc)	(5 fc)	(7 fc)	(10 fc)	1	5	7	10		
<b>Small Canopy at Entrance (9' wide, 5' deep, 9' high)</b>																				
Fluorescent downlight option LZ1 LZ2	45	1	13	16	3.66	3.21	0.000	0%	0%	0%	0%	0.00	0.04	0.24	0.53	0%	17%	47%	75%	
Fluorescent downlight option LZ3	45	1	18	20	3.78	3.13	0.000	0%	0%	0%	0%		0.38	0.73		76%	104%			
Fluorescent downlight option LZ4	45	1	32	35	6.36	2.91	0.000	0%	0%	0%	0%			0.78					111%	
50w MH downlight option	45	1	50	73	19.13	5.07	0.733	611%	293%	147%	105%			0.40						58%
<b>Medium Canopy at Entrance (28' wide, 15' deep, 12' high)</b>																				
Fluorescent downlight option LZ1	420	4	13	16	2.57	8.33	0.057	48%	23%	11%	8%	0.01	0.25	0.37	0.55	10%	100%	73%	78%	
Fluorescent downlight option LZ2	420	4	26	28	3.89	7.41	0.171	143%	69%	34%	24%		0.30	0.43	0.64	118%	86%	91%		
Fluorescent downlight option LZ3	420	12	18	20	6	3.46	0.476	397%	190%	95%	68%			0.62	0.90			124%	129%	
Fluorescent downlight option LZ4	420	12	26	28	10.86	3.44	0.705	587%	282%	141%	101%				0.69				98%	
MH downlight option LZ1	420	1	50	73	3.49	301	0.079	65%	31%	16%	11%	0.00	0.20	0.30	0.45	2%	81%	60%	64%	
MH downlight option LZ2	420	2	50	73	6.84	30.43	0.252	210%	101%	50%	36%		0.21	0.31	0.46	83%	62%	66%		
MH downlight option LZ3	420	4	50	73	12.1	13.12	0.600	500%	240%	120%	86%			0.35	0.53			71%	75%	
MH downlight option LZ4	420	6	50	73	17.51	4.61	0.948	790%	379%	190%	135%				0.55				78%	
MH downlight option LZ1 ELECT BALL	420	1	50	58			0.043	36%	17%	9%	6%									Extrapolation of magnetic ballast data
MH downlight option LZ2 ELECT BALL	420	2	50	58			0.181	151%	72%	36%	26%									Extrapolation of magnetic ballast data
MH downlight option LZ3 ELECT BALL	420	4	50	58			0.457	381%	183%	91%	65%									Extrapolation of magnetic ballast data
MH downlight option LZ4 ELECT BALL	420	6	50	58			0.733	611%	293%	147%	105%									Extrapolation of magnetic ballast data
Linear fluorescent option LZ1	420	2	25	25	2.32	2.74	0.024	20%	10%	5%	3%	0.00	0.21	0.31	0.47	3%	84%	62%	67%	
Linear fluorescent option LZ2	420	4	25	25	4.65	2.73	0.143	119%	57%	29%	20%		0.21	0.31	0.46	83%	62%	66%		
Linear fluorescent option LZ3	420	6	32	32	9.65	2.86	0.362	302%	145%	72%	52%			0.28	0.43			57%	61%	
Linear fluorescent option LZ4	420	10	32	32	16.3	3.61	0.667	556%	267%	133%	95%				0.42				60%	
<b>Large Canopy at Entrance (50' wide, 75' deep, 20' high)</b>																				
Fluorescent downlight option LZ1	3750	18	26	28	2.33	4.31	0.124	103%	49%	25%	18%	0.05	0.28	0.40	0.57	44%	113%	80%	82%	
Fluorescent downlight option LZ2	3750	36	26	28	4.62	4.6	0.258	215%	103%	52%	37%		0.29	0.40	0.58	114%	80%	82%		
Fluorescent downlight option LZ3	3750	45	42	46	9.22	6.37	0.541	451%	217%	108%	77%			0.41	0.59			83%	85%	
Fluorescent downlight option LZ4	3750	63	42	46	12.84	5.73	0.762	635%	305%	152%	109%				0.60				85%	
MH downlight option LZ1	3750	9	50	73	3.37	18.63	0.165	137%	66%	33%	24%	0.05	0.25	0.36	0.51	39%	102%	72%	74%	
MH downlight option LZ2	3750	14	70	90	7.02	5.31	0.325	271%	130%	65%	46%		0.23	0.33	0.47	94%	66%	68%		
MH downlight option LZ3	3750	12	150	185	13	6.55	0.581	484%	233%	116%	83%			0.31	0.45			63%	64%	
MH downlight option LZ4	3750	18	150	185	18.79	4.29	0.877	731%	351%	175%	125%				0.47				67%	
MH downlight option LZ1 ELECT BALL	3750	9	50	58			0.129	107%	51%	26%	18%									Extrapolation of magnetic ballast data
MH downlight option LZ2 ELECT BALL	3750	14	70	80			0.288	240%	115%	58%	41%									Extrapolation of magnetic ballast data
MH downlight option LZ3 ELECT BALL	3750	12	150	167			0.524	436%	209%	105%	75%									Extrapolation of magnetic ballast data
MH downlight option LZ4 ELECT BALL	3750	18	150	167			0.791	659%	316%	158%	113%									Extrapolation of magnetic ballast data



### Building Entrance Canopy Calculations T-24 2008 - Adjusted for LZ3 Initial Wattage Allowance (IWA)

Lt. Grey is TARGET value Yellow is Problem performance		Entrance Canopies - Maximum Lamp Combinations for LZ Lighting Allowances										Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance			
Area of canopy	# of Lamps	Lamp Wattage	Total Wattage	Approximate Performance			Percentage of 2005 LZ Allowance				Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance				
				Avg. fc	Max:Min	WPF	LZ1	LZ2	LZ3	LZ4	(1 fc)	(5 fc)	(7 fc)	(10 fc)	1	5	7	10	
<b>Small Canopy at Entrance (9' wide, 5' deep, 9' high)</b>																			
Fluorescent downlight option LZ1 LZ2	45	1	13	16	3.66	3.21	0.000	0%	0%	0%	0%	0.00	0.04	0.24	0.53	0%	17%	47%	75%
Fluorescent downlight option LZ3	45	1	18	20	3.78	3.13	0.000	0%	0%	0%	0%			0.38	0.73			76%	104%
Fluorescent downlight option LZ4	45	1	32	35	6.36	2.91	0.000	0%	0%	0%	0%				0.78				111%
50w MH downlight option	45	1	50	73	19.13	5.07	0.067	56%	27%	13%	10%				0.40				58%
<b>Medium Canopy at Entrance (28' wide, 15' deep, 12' high)</b>																			
Fluorescent downlight option LZ1	420	4	13	16	2.57	8.33	0.000	0%	0%	0%	0%	0.01	0.25	0.37	0.55	10%	100%	73%	78%
Fluorescent downlight option LZ2	420	4	26	28	3.89	7.41	0.100	83%	40%	20%	14%		0.30	0.43	0.64		118%	86%	91%
Fluorescent downlight option LZ3	420	12	18	20	6	3.46	0.405	337%	162%	81%	58%			0.62	0.90			124%	129%
Fluorescent downlight option LZ4	420	12	26	28	10.86	3.44	0.633	528%	253%	127%	90%				0.69				98%
MH downlight option LZ1	420	1	50	73	3.49	301	0.007	6%	3%	1%	1%	0.00	0.20	0.30	0.45	2%	81%	60%	64%
MH downlight option LZ2	420	2	50	73	6.84	30.43	0.181	151%	72%	36%	26%		0.21	0.31	0.46		83%	62%	66%
MH downlight option LZ3	420	4	50	73	12.1	13.12	0.529	440%	211%	106%	76%			0.35	0.53			71%	75%
MH downlight option LZ4	420	6	50	73	17.51	4.61	0.876	730%	350%	175%	125%				0.55				78%
MH downlight option LZ1 ELECT BALL	420	1	50	58			0.000	0%	0%	0%	0%								Extrapolation of magnetic ballast data
MH downlight option LZ2 ELECT BALL	420	2	50	58			0.110	91%	44%	22%	16%								Extrapolation of magnetic ballast data
MH downlight option LZ3 ELECT BALL	420	4	50	58			0.386	321%	154%	77%	55%								Extrapolation of magnetic ballast data
MH downlight option LZ4 ELECT BALL	420	6	50	58			0.662	552%	265%	132%	95%								Extrapolation of magnetic ballast data
Linear fluorescent option LZ1	420	2	25	25	2.32	2.74	0.000	0%	0%	0%	0%	0.00	0.21	0.31	0.47	3%	84%	62%	67%
Linear fluorescent option LZ2	420	4	25	25	4.65	2.73	0.071	60%	29%	14%	10%		0.21	0.31	0.46		83%	62%	66%
Linear fluorescent option LZ3	420	6	32	32	9.65	2.86	0.290	242%	116%	58%	41%			0.28	0.43			57%	61%
Linear fluorescent option LZ4	420	10	32	32	16.3	3.61	0.595	496%	238%	119%	85%				0.42				60%
<b>Large Canopy at Entrance (50' wide, 75' deep, 20' high)</b>																			
Fluorescent downlight option LZ1	3750	18	26	28	2.33	4.31	0.116	96%	46%	23%	17%	0.05	0.28	0.40	0.57	44%	113%	80%	82%
Fluorescent downlight option LZ2	3750	36	26	28	4.62	4.6	0.250	208%	100%	50%	36%		0.29	0.40	0.58		114%	80%	82%
Fluorescent downlight option LZ3	3750	45	42	46	9.22	6.37	0.533	444%	213%	107%	76%			0.41	0.59			83%	85%
Fluorescent downlight option LZ4	3750	63	42	46	12.84	5.73	0.754	628%	302%	151%	108%				0.60				85%
MH downlight option LZ1	3750	9	50	73	3.37	18.63	0.157	130%	63%	31%	22%	0.05	0.25	0.36	0.51	39%	102%	72%	74%
MH downlight option LZ2	3750	14	70	90	7.02	5.31	0.317	264%	127%	63%	45%		0.23	0.33	0.47		94%	66%	68%
MH downlight option LZ3	3750	12	150	185	13	6.55	0.573	478%	229%	115%	82%			0.31	0.45			63%	64%
MH downlight option LZ4	3750	18	150	185	18.79	4.29	0.869	724%	348%	174%	124%				0.47				67%
MH downlight option LZ1 ELECT BALL	3750	9	50	58			0.121	100%	48%	24%	17%								Extrapolation of magnetic ballast data
MH downlight option LZ2 ELECT BALL	3750	14	70	80			0.280	233%	112%	56%	40%								Extrapolation of magnetic ballast data
MH downlight option LZ3 ELECT BALL	3750	12	150	167			0.516	430%	206%	103%	74%								Extrapolation of magnetic ballast data
MH downlight option LZ4 ELECT BALL	3750	18	150	167			0.783	652%	313%	157%	112%								Extrapolation of magnetic ballast data



## Building Entrance Canopy Calculations T-24 2008 - Adjusted for LZ4 Initial Wattage Allowance (IWA)

Lt. Grey is TARGET value		Entrance Canopies - Maximum Lamp Combinations for LZ Lighting Allowances											Approx. WPF at target Illuminance				Approx. % Allowance at Target Illuminance										
Yellow is Problem performance		Area of canopy	# of Lamps	Lamp Wattage	Total Wattage	Approximate Performance			Percentage of 2005 LZ Allowance				(1 fc)	(5 fc)	(7 fc)	(10 fc)	1	5	7	10	17%	47%	75%	76%	104%	111%	58%
Avg. fc						Max:Min	WPF	LZ1	LZ2	LZ3	LZ4																
<b>Small Canopy at Entrance (9' wide, 5' deep, 9' high)</b>																											
Fluorescent downlight option LZ1 LZ2	45	1	13	16	3.66	3.21	0.000	0%	0%	0%	0%	0.00	0.04	0.24	0.53	0%	17%	47%	75%								
Fluorescent downlight option LZ3	45	1	18	20	3.78	3.13	0.000	0%	0%	0%	0%		0.38	0.73													
Fluorescent downlight option LZ4	45	1	32	35	6.36	2.91	0.000	0%	0%	0%	0%			0.78													
50w MH downlight option	45	1	50	73	19.13	5.07	0.000	0%	0%	0%	0%			0.40													
<b>Medium Canopy at Entrance (28' wide, 15' deep, 12' high)</b>																											
Fluorescent downlight option LZ1	420	4	13	16	2.57	8.33	0.000	0%	0%	0%	0%	0.01	0.25	0.37	0.55	10%	100%	73%	78%								
Fluorescent downlight option LZ2	420	4	26	28	3.89	7.41	0.052	44%	21%	10%	7%		0.30	0.43	0.64												
Fluorescent downlight option LZ3	420	12	18	20	6	3.46	0.357	298%	143%	71%	51%			0.62	0.90												
Fluorescent downlight option LZ4	420	12	26	28	10.86	3.44	0.586	488%	234%	117%	84%			0.69													
MH downlight option LZ1	420	1	50	73	3.49	301	0.000	0%	0%	0%	0%	0.00	0.20	0.30	0.45	2%	81%	60%	64%								
MH downlight option LZ2	420	2	50	73	6.84	30.43	0.133	111%	53%	27%	19%		0.21	0.31	0.46												
MH downlight option LZ3	420	4	50	73	12.1	13.12	0.481	401%	192%	96%	69%			0.35	0.53												
MH downlight option LZ4	420	6	50	73	17.51	4.61	0.829	690%	331%	166%	118%			0.55													
MH downlight option LZ1 ELECT BALL	420	1	50	58			0.000	0%	0%	0%	0%																
MH downlight option LZ2 ELECT BALL	420	2	50	58			0.062	52%	25%	12%	9%																
MH downlight option LZ3 ELECT BALL	420	4	50	58			0.338	282%	135%	68%	48%																
MH downlight option LZ4 ELECT BALL	420	6	50	58			0.614	512%	246%	123%	88%																
Linear fluorescent option LZ1	420	2	25	25	2.32	2.74	0.000	0%	0%	0%	0%	0.00	0.21	0.31	0.47	3%	84%	62%	67%								
Linear fluorescent option LZ2	420	4	25	25	4.65	2.73	0.024	20%	10%	5%	3%		0.21	0.31	0.46												
Linear fluorescent option LZ3	420	6	32	32	9.65	2.86	0.243	202%	97%	49%	35%			0.28	0.43												
Linear fluorescent option LZ4	420	10	32	32	16.3	3.61	0.548	456%	219%	110%	78%			0.42													
<b>Large Canopy at Entrance (50' wide, 75' deep, 20' high)</b>																											
Fluorescent downlight option LZ1	3750	18	26	28	2.33	4.31	0.110	92%	44%	22%	16%	0.05	0.28	0.40	0.57	44%	113%	80%	82%								
Fluorescent downlight option LZ2	3750	36	26	28	4.62	4.6	0.245	204%	98%	49%	35%		0.29	0.40	0.58												
Fluorescent downlight option LZ3	3750	45	42	46	9.22	6.37	0.528	440%	211%	106%	75%			0.41	0.59												
Fluorescent downlight option LZ4	3750	63	42	46	12.84	5.73	0.749	624%	300%	150%	107%			0.60													
MH downlight option LZ1	3750	9	50	73	3.37	18.63	0.151	126%	60%	30%	22%	0.05	0.25	0.36	0.51	39%	102%	72%	74%								
MH downlight option LZ2	3750	14	70	90	7.02	5.31	0.312	260%	125%	62%	45%		0.23	0.33	0.47												
MH downlight option LZ3	3750	12	150	185	13	6.55	0.568	473%	227%	114%	81%			0.31	0.45												
MH downlight option LZ4	3750	18	150	185	18.79	4.29	0.864	720%	346%	173%	123%			0.47													
MH downlight option LZ1 ELECT BALL	3750	9	50	58			0.115	96%	46%	23%	16%																
MH downlight option LZ2 ELECT BALL	3750	14	70	80			0.275	229%	110%	55%	39%																
MH downlight option LZ3 ELECT BALL	3750	12	150	167			0.510	425%	204%	102%	73%																
MH downlight option LZ4 ELECT BALL	3750	18	150	167			0.778	648%	311%	156%	111%																



## Ordinance Minimum Average Spacing Calculations T-24 2008

Area calculations made in idealized spacing grid per IESNA procedures for calculation uniformity  
 Minimum vertical illuminance is measured at the center of the parking lot grid

All calculations made with clear lamp optics

LDD = .70

Maintained lamp lumens per manufacturer's literature

MH lamps used are Pulse Start where currently available

Lamp lumens used:

Wattage	Lamp Type	Ballast	Initial Lumens	Maintained Lumens	System Watts	Performance Increase with Electronic Ballasts
320	MH		29000	20300	368	
250	MH		21250	14300	291	
150	MH		12000	9000	185	
100	MH		8400	6300	129	
70	MH		5500	3850	90	
50	MH		3600	2450	73	
150	MH	ELECTRONIC	12000	10400	167	115.6%
100	MH	ELECTRONIC	8400	7300	113	115.9%
70	MH	ELECTRONIC	5500	4510	80	117.1%
50	MH	ELECTRONIC	3600	2880	58	117.6%



## Minimum Average Illuminance Ordinance 0.5fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											<b>0.05</b>	<b>0.04</b>		
<b>15 foot pole</b>														
MH	50	73	3600	2450	1	Type V	52.5 55	0.43	8.7	0.025	51%	63%	0.9	0.7
MH	50	73	3600	2450	2	Type III	70 90	0.46	9.6	0.023	46%	58%	1.0	0.8
MH	70	90	5500	3850	1	Type V	52.5 55	0.67	8.7	0.031	62%	78%	1.1	0.9
<b>20 foot pole</b>														
MH	50	73	3600	2450	2	Type III	90 125	0.25	8.87	0.013	26%	32%	1.0	0.8
MH	70	90	5500	3850	2	Type III	92.5 125	0.37	9.68	0.016	31%	39%	1.2	1.0
MH	100	129	8400	6300	1	Type V	62.5 67.5	0.72	7.66	0.031	61%	76%	1.2	0.9
MH	150	185	12000	9000	1	Type V	90 95	0.69	8.96	0.022	43%	54%	1.6	1.3

# Minimum Average Illuminance Ordinance 1.0fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											<b>0.07</b>	<b>0.06</b>		
<b>15 foot pole</b>														
MH	50	73	3600	2450	1	Type V	45 50	0.55	3.48	0.032	46%	54%	1.2	1.0
MH	50	73	3600	2450	2	Type III	55 82.5	0.61	3.67	0.032	46%	54%	1.3	1.1
MH	70	90	5500	3850	1	Type V	45 50	0.87	3.48	0.040	57%	67%	1.5	1.3
<b>20 foot pole</b>														
MH	50	73	3600	2450	2	Type III	67.5 80	0.49	2.43	0.027	39%	45%	1.3	1.1
MH	70	90	5500	3850	2	Type III	75 100	0.57	3.55	0.024	34%	40%	1.7	1.4
MH	100	129	8400	6300	1	Type V	57.5 60	0.89	3.55	0.037	53%	62%	1.7	1.4
MH	100	129	8400	6300	2	Type III	75 100	0.92	3.86	0.034	49%	57%	1.9	1.6
MH	150	185	12000	9000	1	Type V	75 80	0.97	3.74	0.031	44%	51%	2.2	1.9



## Minimum Average Illuminance Ordinance 1.5fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											<b>0.1</b>	<b>0.08</b>		
<b>15 foot pole</b>														
MH	70	90	5500	3850	1	Type V	45 42.5	1.02	3.14	0.047	47%	59%	2.2	1.7
MH	70	90	5500	3850	2	Type III	60 70	1.05	3.95	0.043	43%	54%	2.5	2.0
MH	100	129	8400	6300	1	Type V	42.5 45	1.72	3.6	0.067	67%	84%	2.6	2.0
MH	100	129	8400	6300	2	Type III	57.5 70	1.81	3.95	0.064	64%	80%	2.8	2.3
MH	150	185	12000	9000	1	Type V	55 60	1.82	3.5	0.056	56%	70%	3.2	2.6
MH	150	185	12000	9000	2	Type III	60 90	1.95	3.98	0.069	69%	86%	2.8	2.3
MH	250	291	20500	13500	1	Type V	40 42.5	3.7	3.59	0.171	171%	214%	2.2	1.7
<b>20 foot pole</b>														
MH	70	90	5500	3850	2	Type III	60 70	0.99	2.14	0.043	43%	54%	2.3	1.8
MH	100	129	8400	6300	1	Type V	50 60	1.05	2.41	0.043	43%	54%	2.4	2.0
MH	100	129	8400	6300	2	Type III	75 90	1.02	3.66	0.038	38%	48%	2.7	2.1
MH	150	185	12000	9000	1	Type V	70 80	1.04	3.26	0.033	33%	41%	3.1	2.5
MH	150	185	12000	9000	2	Type III	85 100	1.2	3.96	0.044	44%	54%	2.8	2.2
MH	250	291	20500	13500	1	Type V	55 62.5	1.95	3.65	0.085	85%	106%	2.3	1.8
MH	320	368	29000	20300	1	Type V	72.5 85	2.02	3.97	0.060	60%	75%	3.4	2.7

# Minimum Average Illuminance Ordinance 2.0fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											<b>0.12</b>	<b>0.1</b>		
<b>15 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	6.19	1.39	0.246	205%	246%	3.0	2.5
MH	150	185	12000	9000	2	Type III	30 37.5	8.48	1.81	0.329	274%	329%	3.1	2.6
MH	250	291	20500	13500	1	Type V	22.5 25	11.14	1.37	0.517	431%	517%	2.6	2.2
<b>20 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	5.96	1.17	0.246	205%	246%	2.9	2.4
MH	100	129	8400	6300	4	Type III	45 45	6.41	1.57	0.255	212%	255%	3.0	2.5
MH	150	185	12000	9000	2	Type III	40 40	5.84	1.31	0.231	193%	231%	3.0	2.5
MH	150	185	12000	9000	4	Type III	55 55	6.42	1.93	0.245	204%	245%	3.1	2.6
MH	250	291	20500	13500	1	Type V	27.5 30	7.47	1.36	0.353	294%	353%	2.5	2.1
MH	250	291	20500	13500	2	Type III	45 52.5	5.39	1.44	0.246	205%	246%	2.6	2.2
<b>25 foot pole</b>														
MH	100	129	8400	6300	4	Type III	50 50	5.13	1.39	0.206	172%	206%	3.0	2.5
MH	150	185	12000	9000	4	Type III	60 65	4.93	1.7	0.190	158%	190%	3.1	2.6
MH	250	291	20500	13500	4	Type III	75 75	4.6	2.07	0.207	172%	207%	2.7	2.2
MH	320	368	29000	20300	1	Type V	45 45	5.8	1.43	0.182	151%	182%	3.8	3.2
MH	320	368	29000	20300	2	Type III	55 60	6.63	1.59	0.223	186%	223%	3.6	3.0



# Minimum Average Illuminance Ordinance 3.0fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											<b>0.19</b>	<b>0.13</b>		
<b>15 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	6.19	1.39	0.246	129%	189%	4.8	3.3
MH	150	185	12000	9000	2	Type III	30 37.5	8.48	1.81	0.329	173%	253%	4.9	3.4
MH	250	291	20500	13500	1	Type V	22.5 25	11.14	1.37	0.517	272%	398%	4.1	2.8
<b>20 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	5.96	1.17	0.246	129%	189%	4.6	3.2
MH	100	129	8400	6300	4	Type III	45 45	6.41	1.57	0.255	134%	196%	4.8	3.3
MH	150	185	12000	9000	2	Type III	40 40	5.84	1.31	0.231	122%	178%	4.8	3.3
MH	150	185	12000	9000	4	Type III	55 55	6.42	1.93	0.245	129%	188%	5.0	3.4
MH	250	291	20500	13500	1	Type V	27.5 30	7.47	1.36	0.353	186%	271%	4.0	2.8
MH	250	291	20500	13500	2	Type III	45 52.5	5.39	1.44	0.246	130%	189%	4.2	2.8
<b>25 foot pole</b>														
MH	100	129	8400	6300	4	Type III	50 50	5.13	1.39	0.206	109%	159%	4.7	3.2
MH	150	185	12000	9000	4	Type III	60 65	4.93	1.7	0.190	100%	146%	4.9	3.4
MH	250	291	20500	13500	4	Type III	75 75	4.6	2.07	0.207	109%	159%	4.2	2.9
MH	320	368	29000	20300	1	Type V	45 45	5.8	1.43	0.182	96%	140%	6.1	4.1
MH	320	368	29000	20300	2	Type III	55 60	6.63	1.59	0.223	117%	172%	5.6	3.9



## Minimum Average Illuminance Ordinance 4.0fc Calculations T-24 2008

Gray is the Target Illuminance

Lamp	Lamp Wattage	System Wattage	Initial Lamp Lumens	Maint Lamp Lumens	# of Heads	Photometric Type	Grid Dimensions	Avg. fc	Avg:Min	WPF	% of 2005 WPF Allowance	% of Proposed 2008 WPF	Approx. Average Illuminance @ 2005 Allowance	Approx. Average Illuminance @ 2008 Allowance
											0.25	0.2		
<b>15 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	6.19	1.39	0.246	98%	123%	6.3	5.0
MH	150	185	12000	9000	2	Type III	30 37.5	8.48	1.81	0.329	132%	164%	6.4	5.2
MH	250	291	20500	13500	1	Type V	22.5 25	11.14	1.37	0.517	207%	259%	5.4	4.3
<b>20 foot pole</b>														
MH	100	129	8400	6300	2	Type III	30 35	5.96	1.17	0.246	98%	123%	6.1	4.9
MH	100	129	8400	6300	4	Type III	45 45	6.41	1.57	0.255	102%	127%	6.3	5.0
MH	150	185	12000	9000	2	Type III	40 40	5.84	1.31	0.231	93%	116%	6.3	5.1
MH	150	185	12000	9000	4	Type III	55 55	6.42	1.93	0.245	98%	122%	6.6	5.2
MH	250	291	20500	13500	1	Type V	27.5 30	7.47	1.36	0.353	141%	176%	5.3	4.2
MH	250	291	20500	13500	2	Type III	45 52.5	5.39	1.44	0.246	99%	123%	5.5	4.4
<b>25 foot pole</b>														
MH	100	129	8400	6300	4	Type III	50 50	5.13	1.39	0.206	83%	103%	6.2	5.0
MH	150	185	12000	9000	4	Type III	60 65	4.93	1.7	0.190	76%	95%	6.5	5.2
MH	250	291	20500	13500	4	Type III	75 75	4.6	2.07	0.207	83%	103%	5.6	4.4
MH	320	368	29000	20300	1	Type V	45 45	5.8	1.43	0.182	73%	91%	8.0	6.4
MH	320	368	29000	20300	2	Type III	55 60	6.63	1.59	0.223	89%	112%	7.4	5.9

# TDV Calculations for Respective Lighting Applications and Lighting Zones T-24 2008

per TDVkBtu \$ 0.08436

Application	2005 T-24	2008 T-24	Limited Schedule Savings per 1,000 sf				Benefit/ Cost Ratio
	Current Allowance W/sf	Proposed Allowance W/sf	Incremental Cost per 1,000 sf	Energy Savings kWh/yr	TDV Savings kBtu/yr	15 yr Savings PV \$	
Automotive Hardscape - LZ1	0.05	0.04		21	388	\$33	Immediate
Automotive Hardscape - LZ2	0.08	0.05		63	1,164	\$98	Immediate
Automotive Hardscape - LZ3	0.15	0.08		147	2,715	\$229	Immediate
Automotive Hardscape - LZ4	0.19	0.10		189	3,491	\$295	Immediate
Pedestrian Hardscape - LZ1	0.06	0.04		42	776	\$65	Immediate
Pedestrian Hardscape - LZ2	0.09	0.06		63	1,164	\$98	Immediate
Pedestrian Hardscape - LZ3	0.17	0.09		168	3,103	\$262	Immediate
Pedestrian Hardscape - LZ4	0.21	0.21		0	0	\$0	
Building Entrance, NC - LZ1	0.35	0.20		315	5,819	\$491	Immediate
Building Entrance, NC - LZ2	0.50	0.35		315	5,819	\$491	Immediate
Building Entrance, NC - LZ3	0.70	0.55		315	5,819	\$491	Immediate
Building Entrance, NC - LZ4	1.00	0.70		629	11,638	\$982	Immediate
Outdoor Sales Lot - LZ1	0.35	0.20		315	5,819	\$491	Immediate
Outdoor Sales Lot - LZ2	0.70	0.60		210	3,879	\$327	Immediate
Outdoor Sales Lot - LZ3	1.25	0.85		839	15,517	\$1,309	Immediate
Outdoor Sales Lot - LZ4	2.00	1.40		1,258	23,275	\$1,964	Immediate
Outdoor Sales Front - LZ2	22.50	22.50		0	0	\$0	
Outdoor Sales Front - LZ3	38.50	36.00		5,243	96,979	\$8,181	Immediate
Outdoor Sales Front - LZ4	55.00	45.00		20,970	387,918	\$32,726	Immediate
Vehicle Service Station - LZ1	0.70	0.55		315	5,819	\$491	Immediate
Vehicle Service Station - LZ2	1.15	1.05		210	3,879	\$327	Immediate
Vehicle Service Station - LZ3	1.45	1.45		0	0	\$0	
Vehicle Service Station - LZ4	2.40	2.40		0	0	\$0	
Ordinance .5	0.05	0.04		21	388	\$33	Immediate
Ordinance 1	0.07	0.06		21	388	\$33	Immediate
Ordinance 1.5	0.10	0.08		42	776	\$65	Immediate
Ordinance 2	0.12	0.10		42	776	\$65	Immediate
Ordinance 3	0.19	0.12		147	2,715	\$229	Immediate
Ordinance 4	0.25	0.20		105	1,940	\$164	Immediate

24 Hour Schedule Savings per 1,000 sf			
Energy Savings kWh/yr	TDV Savings kBtu/yr	15 yr Savings PV \$	Benefit/ Cost Ratio
40	676	\$57	Immediate
120	2,027	\$171	Immediate
281	4,729	\$399	Immediate
361	6,080	\$513	Immediate
80	1,351	\$114	Immediate
120	2,027	\$171	Immediate
321	5,405	\$456	Immediate
0	0	\$0	
601	10,134	\$855	Immediate
601	10,134	\$855	Immediate
601	10,134	\$855	Immediate
1,202	20,267	\$1,710	Immediate
601	10,134	\$855	Immediate
401	6,756	\$570	Immediate
1,603	27,023	\$2,280	Immediate
2,405	40,535	\$3,420	Immediate
0	0	\$0	
10,020	168,895	\$14,249	Immediate
40,080	675,581	\$56,994	Immediate
601	10,134	\$855	Immediate
401	6,756	\$570	Immediate
0	0	\$0	
0	0	\$0	
40	676	\$57	Immediate
40	676	\$57	Immediate
80	1,351	\$114	Immediate
80	1,351	\$114	Immediate
281	4,729	\$399	Immediate
200	3,378	\$285	Immediate

