

# **Purpose and Scope of Proposed Revisions to The City of Las Cruces, NM Outdoor Lighting Ordinance**

**by John Gilkison**

## History

In 1999, the Las Cruces Outdoor Lighting Ordinance Ad Hoc Committee was formed to draft an ordinance proposal for the city. The committee consisted of seven members. John Gilkison was elected by the committee as its chairman. In the spring of 2000, the committee had finished its work and placed the matter before the city council. The CLC Outdoor Lighting Ordinance (OLO) in its present form was voted into law on August 7, 2000.

## The Difference between a Lumen and a Foot Candle

As soon as Edison invented the electric light measuring light became a necessity. To define foot-candles, take a standard candle and imagine a sphere surrounding it with a one foot radius. Such a sphere would have a surface area of approximately 12.57 square feet. The shadow the stalk of the candle makes is subtracted from the square footage the candle illuminates and the candle is rated at 12 lumens of light output. A foot candle is the measured value of the light striking only one square foot of the imaginary sphere. Therefore, one footcandle = one lumen per square foot. At greater distances the intensity of the light falls off in intensity at a ratio of the inverse square of the distance. For example if you have a residential porch light that places 1.6 fc on the ground from a six foot mounting height, at a distance of 24 feet from the lamp only 0.1 fc will be read on a light meter.

## How Lighting Works

There are three levels of vision for the human eye. They are Photopic, Metopic, and Scotopic. Photopic vision is adaptation to higher levels of light involving color vision (Cones in the eye) like daylight or more color balance indoor lighting. Scotopic vision is the eye's adaptation to darkness involving the rods in the eye which are very light sensitive but do not see color. Dark adaptation can take up to 30 minutes to be completed and can be set back by exposure to white light. Metopic vision is a transitional state between dark adaptation (Scotopic) and the Photopic.

Light from any lighting source must strike the surface we intend to be illuminated and then be reflected to the eye for us to see said surface or objects. Light that travels directly from the source to the eye constitutes veiling glare (which takes place inside the eye) and reduces visual acuity at night. Often such unshielded lighting is a driver for more and lighting in an attempt to overcome glare with ever more lighting.

The original goals of street lighting (in the 1920's and earlier) were to reproduce the effects of full moon light (0.01 fc). Today streets are seldom lit to more than 2 fc. Most outdoor lighting at night unless intended for task needing high visual acuity (like sports or commercial activity) should be kept to Metopic levels. We are working against the ability of the eye to see in low light by lighting to Photopic levels everywhere. If we were to try to light everywhere to

Photopic levels, the cost would be astronomical.

## Purpose and Scope

There are two major purposes of any good outdoor lighting ordinance. First is to limit waste lighting directly to the sky (from the horizontal plane to the zenith). The second is to reduce the amount of waste light being broadcast to the glare zone (from the horizontal plane to 15 degrees below the horizontal plane).

Lighting above the horizontal plane is usually pure waste light as often it does not strike any intervening surfaces first. Such light merely illuminates the clouds, the bellies of birds, and contributes to the some \$6.00 per person per year average of wasted outdoor lighting. We calculated at the time of the passage of the CLC Outdoor Lighting Ordinance some \$420,000 a year in such waste light was being lost by the citizens of Las Cruces, NM to the sky. From a distance this waste light appears as a dome of light over the city called a light bubble. Only about 10% of the light striking the ground is reflected back into the sky, this is called ground reflectance. Not much can be done about ground reflectance except to limit light levels to the proper levels needed for the task the lighting is being used for in the first place.

Light broadcast from the horizontal plane and 15 degrees below the horizontal plane can also be classed as waste light because it strikes the ground at such a distance (if it strikes the ground at all) that it no longer can be considered to be useful illumination. It breaks the four/one rule which basically says you should not try to light beyond four mounting heights. See attached sheet on the four/one rule and how light levels decrease with distance. Lighting in this zone contributes mostly to glare which is never helpful to visual acuity at night. The Outdoor Lighting Ordinance tries to limit lighting in the glare zone because it impacts the safety of the public at night in some very negative way. Glare not only reduces visual acuity at night but also contributes to light trespass, and impacts quality of life issues. Good visual acuity at night can reduce the accident rate for cars and pedestrians which improves public safety. This is one of the reasons lighting is used in the first place.

## Why the Ordinance is a Full Cut Off Ordinance

For these enumerated reasons the CLC Outdoor Lighting ordinance is a Full Cut Off (FCO) ordinance. Full Cut Off lighting fixtures limit light to below the horizontal plane and only allow a small percentage of the light into the glare zone. Once most lighting is Full Cut Off lighting veiling glare is mostly eliminated. The Outdoor Lighting Ordinance also places limits on the maximum amount of light allowed (called a max cap) at ground level. This level was set at 70 fc in the OLO. This is a lighting level you will find almost no where other than retail convenience/gas station stores in the form of Metal Halide lighting under canopies. As noted before about 10% of all light that strikes the ground is reflected back into the sky. This makes a maximum cap on permissible light levels a good idea for controlling waste light to the sky which is one of the major purposes of the OLO. I will try to address later on why this particular max cap was set too high.

## High Intensity Discharge Lighting (HID)

Because FCO fixtures are often difficult to find for the residential sector the FCO lower limit in the OLO was set at 1,800 lumen's which is the equivalent of a 100 watt incandescent bulb's light output. Essentially we were trying to limit the imposition of a requirement for FCO fixtures to the commercial sector which normally uses that class of lighting called High Intensity Discharge (HID) lighting. This class of lighting is ballasted lighting that uses lamps that need to strike a arc to be lighted and a ballast to regulate the lamp once the arc is initiated. High Pressure Sodium (HPS), Mercury Vapor (MV), Metal Halide (MH), and Low Pressure Sodium (LPS) are examples of this class of High Intensity Discharge lighting. However technically LPS and Fluorescent lighting are not HID Lighting because they are low pressure lighting.

### The Floodlight Aiming Template

In our ordinance consideration the issue of HID Floodlighting was considered. I argued successfully that this class of lights could be made to act as if they were Full Cut Off if they were properly aimed. Considering a maximum beam width of 110 degrees it can be shown that the centerline of the beam should be aimed 65 degrees below the horizontal plane to make flood lighting FCO complaint. If 90 degrees is straight down, the formula is  $CPA = 110 \text{ degrees over } 2 + 10 \text{ degrees}$ . Unfortunately we have not been able to get the floodlight aiming clause of the OLO enforced due to the lack of penalties. Most of the problem lights were existing pre ordinance. We can not stress enough that improperly aimed HID Floodlighting are in violation of the spirit and intent Outdoor Lighting Ordinance and will remain so if they are not brought into compliance.

### Billboards and Sign Lighting

One class of lighting needed to be directly dealt with in the OLO because of the practice or up lighting and that was signs and billboards. Since the OLO called for all lighting of over 1,800 lumen's of output to be FCO the ordinance in order to be consistent had to call for all lighting of signs and billboards to be from the top down. In other words all up lighting had to be limited to 1,800 lumen's or less. The only other restriction on signs would be the 70 fc max cap at ground level which they seldom if ever even approach.

## **Proposed Changes to the CLC Outdoor Lighting Ordinance**

### Gas Station / Convenience Store Excessive Lighting

When the ordinance was being considered in year 2000, the max cap proposal (originally set at 50 fc) was controversial. Mayor Ruben Smith decided on a compromise level of 70 fc which was a number picked out of the air simply to compromise with the opposition to any max cap levels being set at all. The Illuminating Engineers Society of North America (IESNA) says in their Recommended Practices -33-99 (RP-33-99) that 20 to 1 max to mins are the most they would recommend for car dealerships. For commercial activities they recommend 10 to 1 max to mins. If the streets are only lit to 2 foot candles, then all that would be necessary for gas stations / convenience stores would be 20 fc. See attached IESNA RP-33-99 table on max to mins for exterior environments. Even allowing them the 20 to 1 max to mins as stated in RP-33-99 for car dealerships would only amount to 40 fc. Our recommendation for a 50 fc max cap is not only

generous, it also allows a built in factor for lumen's depreciation common in MH Lighting. The 70 fc max cap needs to be changed to 50 fc where it belongs.

The human eye simply can not transition from very bright light level back to the lower levels of the street fast enough for safety. We have all experienced this phenomenon at the movie theater when we left our seats to go to the lobby. Our eyes adapt fairly rapidly from the dark theater to the bright lobby. However when we try to get back to our seats it often takes several seconds to adapt back to the darkness just to find our seat. The older we get the longer this process of adaption can take.

Now imagine an older citizen's vision trying to adapt back to the relatively darker streets after leaving a over 70 fc gas station while driving a 3000 LB. automobile. In the name of public safety we simply can not allow these facilities to be lit to such high levels even if they want to do it for commercial reasons. A 50 fc maximum light level is more then enough for task such as pumping gasoline. In fact 50 fc is the recommended levels for school desk or any task involving high visual acuity. FCO canopy lighting at 50 fc such facilities will cease to create obtrusive lighting for the traveling public. At 50 fc such facilities will still feel well lit, comfortable, and safe, with good adaption back to the darker streets for all our citizens.

#### Light Trespass for the Residential Sector

A light trespass clause for the residential sector of 0.2 fc was considered for the original lighting ordinance but was dropped after we encountered opposition to it because it exempted street lighting. Since the ordinance was passed Codes Enforcement in Las Cruces has had to field numerous complaints about light trespass from neighbor to neighbor. Codes simply has nothing in the ordinance to deal with these complaints. The proposed 0.2 fc light trespass clause was taken from RP-33-99 which on page twelve recommends as follows.

#### Zone E3: medium ambient brightness

The suggested recommendation is that subject lighting be restricted to 2 lux (0.2 fc) or less.

We added that the detector should be aimed at the lighting source in question as a method of measurement from five feet inside the property. We also are suggesting that the 1,800 lumen permit for unshielded lighting be lowered to 1,100 lumen's in order to reduce complaints in the residential sector first place. When a complaint is lodged reducing lumen's is the best way to address it short of using a FCO fixture. Street lighting is exempted because even though they are FCO their 20 to 25 ft mounting heights could generate complaints that would then have to be addressed. Since FCO lighting of this type does not create a glare situation at distances less then four mounting heights due their height (unless a person is looking up) they should be exempt.

Finally we are recommending that all flood lighting be motion sensor activated rather being allowed to be lit continuously. A five minute dwell time should be sufficient for most applications. Floodlights should be aimed down as much as the fixture will allow, and if that is not sufficient to address a light trespass complaint the fixture should be replaced.

Residential lighting should be limited to between 1 fc to 2 fc on the ground directly below the fixture. The formula for calculating one fc would be  $1fc = 12 \times \text{Mounting height squared}$ . Two fc would be  $24 \times \text{Mounting Height squares}$ . A good half way point of 1.5 fc would be  $18 \times \text{Mounting Height squared}$ . See the attached sheet for our recommendations for residential sector lighting mounting heights, lumen's packages, and bulb types.

### Up Lighting Flags and Signs

The reduction of the lower limit for unshielded lighting from 1,800 lumen's to 1,100 lumen's means permitted up lighting allowance must be lowered also. Since the flag is a small target to be lit from the ground we are recommending that narrow spots be used for this purpose limited to lumen's packages of 1,100 lumen's each with no more than two narrow spot lights used to light a flag. This will allow more of the light to go towards illuminating the flag and less simply being broadcast to the sky as waste light. A limit per entity of 3,300 lumen's was recommended to allow for 3 such fixtures of 1,100 lumen's each. Personally I would like to see this number set at 3,600 lumen's to allow for four 900 lumen's lights (60 watt incandescent or equivalent Compact Fluorescent) to be used in a residential setting. A separate limit would need to be considered for a commercial up lighting permit involving HID Flood lighting.

### **Summary of Progress with the CLC Outdoor Lighting Ordinance**

In the eight years since the OLO was adopted there has been a sea change in the outdoor lighting in Las Cruces, NM for the good. The city of Las Cruces has made very good progress in converting it's street lighting to Full Cut Off lights in advance of the ten year grand fathering clause of the original ordinance. Newman Signs has made good progress in converting their existing billboards from up lit signs to down lit signs.

There are numerous HID Floodlights around the city that are not in compliance however. The original intent of the ordinance to allow this kind of lighting to continue to be used and to simply be adjusted to a 65 degree down angle to make them FCO complaint has not worked because of a lack of enforcement penalties. It is hoped that the proposed addition of enforcement penalties to the OLO will facilitate getting entities that operate flood lighting to comply and aim their flood lights correctly.

A reduction of the max cap of permissible light levels from 70 fc to 50 fc which are more grounded on actual needs rather than expediency will do much to tone down the excessive lighting of gas / convenience stores. This could be instituted immediately because all that is needed is the removal of some of the light fixtures from the electrical circuit to meet compliance if a facility is too bright.

The institution of a light trespass clause should help reduce neighbor to neighbor glare complaints and would give codes enforcement a way to deal with existing complaints. Guidelines on residential flood lights and flag and small sign lighting should help reduce this class of under regulated lighting.

We would like to compliment the City of Las Cruces for having the wisdom to pass the CLC Outdoor Lighting Ordinance in August of 2000. Nightscapes in the city have been greatly improved. The traveling public can see much better since the near elimination of unshielded lighting from many of our city streets and adjacent businesses. Even though the city has grown quite a bit since the adoption of the OLO light pollution and sky glow has been significantly reduced. The changes we are proposing the OLO are minor and are more in the way of tweaking the ordinance and covering gaps that were inadvertently left in the original ordinance.

## Outdoor Lighting and Crime

There is no direct link between high levels of lighting and crime levels. No crime and justice study ever done has been able to make any statistical correlation between outdoor lighting and crime. In 1996, the National Institute of Justice in the USA conducted an assessment of crime and violence, and published their work in *Preventing Crime: What Works, What Doesn't, What's Promising*. The study found little support to support the misconception that "brighter is safer", and even suggested that poorly designed lighting might actually increase personal vulnerability. The report states:

*"The problematic relationship between lighting and crime increases when one considers that offenders need lighting to detect potential targets and low-risk situations. Consider lighting at outside ATM machines, for example. An ATM user might feel safer when the ATM and its immediate surrounding area are well lit. However, this same lighting makes the patron more visible to passing offenders. Whom the lighting serves is unclear."*

We would like to suggest that there is a difference between safety and security. Seeing well at night can keep you from stepping into a hole or running into something. This is the real meaning of safety. Security in your property and your person is probably better accomplished by other measures such as alarm systems, better locks, or a neighborhood watch program.

Most break ins take place during the day when there is plenty of light, but people are not home. Resources are probably better directed towards really addressing the real problem than in a false panacea such as excessively bright lighting. Such lighting is often left on all night long in the belief that it offers a degree of protection that it does not. If good quality FCO lighting is used it will increase visual acuity at night, not reduce it. Good visual acuity at night should be the goal of all outdoor lighting, used only when and where it is needed.

## **Residential Mounting Height Lumen's Table**

by John Gilkison

Lumen's = 18 X Mounting Height squared or  
L = 18 X H squared, yields 1.5 foot candles below the fixture

**Mounting Height Lumen's Package Table**

:6 Ft = 600 Lumen's ( 40 watt Incandescent or 11 watt CF )

:7 Ft = 900 Lumen's ( 60 watt Incandescent or 15 watt CF ), yellow bug lights are recommended.

Motion sensor timer activated lighting recommended at 8 Ft or above unless only switched on when needed.

:8 Ft = 1,100 Lumen's ( 75 watt Incandescent or 20 watt CF )

**Recommend all lighting 1,800 Lumen's or more be Full Cut Off or the equivalent.**

:10 Ft = 1,800 Lumen's ( Full Cut Off fixtures for 100 watt Incandescent or 23 or 25 watt CF )

:12 Ft = 2,500 Lumen's 150 watt QH Flood pointed down at a 70 degree angle.

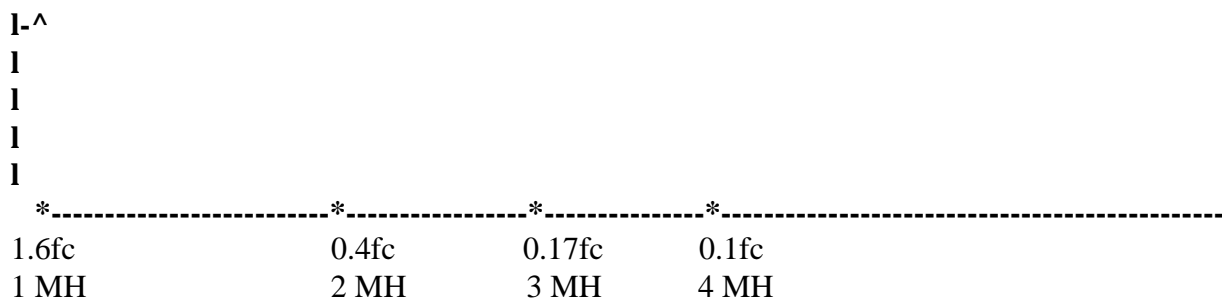
Flood lighting is not generally recommended unless pointed down

and motion sensor activated or only switched on when needed.

Higher mounting heights require Full Cut Off fixture HID lighting.

**Mounting Height / Mounting Height distance light intensity drop off diagram.**

Fixture shown below with 1.6 fc at the base and the inverse square light drop off at one, two, three and four mounting heights (Mounting Heights = MH ) note beyond four mounting light on the ground is no longer considered to be useful illumination.



<b>Lighting for Exterior Environments</b>									
<b>RP-33-99</b>	<i>Sidewalks</i>	Commercial Areas		1		2		10:1	
	<i>(Roadside)</i>								

and Type A  
Bikeways

	Intermediate Areas		0.5		1		10:1	
	Residential Areas		0.2		0.5		10:1	
	<i>Walkways Distant from Roadways and Type B Bikeways</i>	Commercial Areas		0.5		0.5	10:1	
		Intermediate Areas		0.5		1	10:1	
		Residential Areas		2		0.5	10:1	
<b>RP-33-99</b>	<i>Car Dealerships</i>							
<b>RP-33-99</b>	<i>Secondary Business Districts</i>							
	Adjacent to roadway		5 - 10				5:1	
	Other rows		2.5 - 5				10:1	
	Entrances		2.5 - 5				5:1	
	Driveways		1 - 2				10:1	
<b>RP-33-99</b>	<i>Service Stations or Gas Pump Area</i>							
	Approach		1.5 - 2					
	Driveways		1.5 - 2					
	Pump Island		5					
	Building facades		2 - 3					
	Service Areas		2 - 3					
<b>RP-33-99</b>	<i>Signs</i>							
	Dark Surroundings and Light Surfaces				2			