NEW HAMPSHIRE
OEP
OFFICE OF ENERGY AND PLANNING

OUTDOOR LIGHTING

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Contents:

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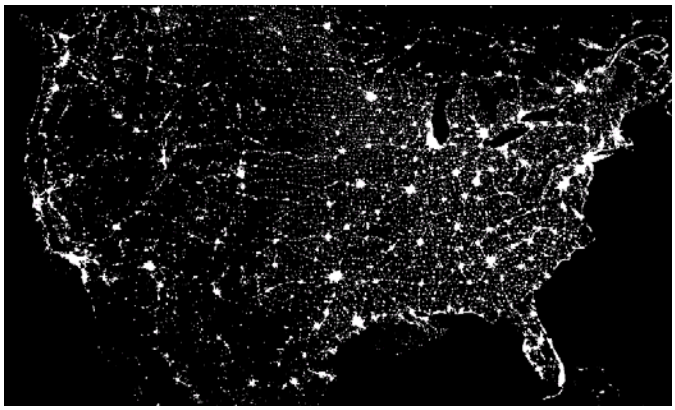
INTRODUCTION

This Technical Bulletin focuses on informing communities on the issues surrounding outdoor lighting. The first section provides information on the science and use of outdoor lighting, and highlights important issues. The second section summarizes some technical information on specific kinds of lighting, describes how to apply this technology, and provides model ordinance language.

BACKGROUND

Effective outdoor lighting benefits us in many ways. It can be used to increase pedestrian and vehicular safety, enhance a community's night time character, advertise commercial businesses and provide security. Appropriately designed and properly installed, outdoor lighting contributes to the safety and welfare of residents and visitors alike. However, inappropriate outdoor lighting applications in rural and urban areas of New Hampshire result in glare, over-lighting, light escalation, sky glow and wasted energy. Light pollution, a relatively new term describing the cumulative effects of inappropriate outdoor lighting, is an increasing concern as the landscape continues to be developed. While light pollution is something that few of us may have given much thought to, it is important to remember that light pollution alters the "rural character" so frequently referenced in community master plans.



Satellite photo of light in the US. An estimated $1 billion is spent lighting the sky each year in the USA.

New Hampshire's characteristic rural landscape is appealing to both its residents and to the many tourists that visit each year. We should strive to maintain part of that rural heritage by minimizing the amount of light cast onto the night sky. This will allow current and future generations to view the night sky, an experience that is virtually gone from many urbanized states and localities.

THE SCIENCE OF LIGHTING

In order to understand the impact of lighting on humans, it is important to highlight a few basic concepts about the human eye. The eye adapts continuously and automatically to different light levels throughout the day and night. These changes are not instantaneous! When going from a very bright area to a dark area the eye may require several minutes to adjust. As a rule it takes the eye longer to adapt to a change from light to dark than from dark to light. Understanding the adaptation process and its limitations in outdoor lighting conditions is relevant to the design of outdoor lighting installations.

The purpose of outdoor lighting is to enhance the visual process needed to perform a task. Using a large quantity of light does not guarantee good visibility. In fact, over-lighting is often the cause of glare and other problems that hinder good vision in a nighttime environment.

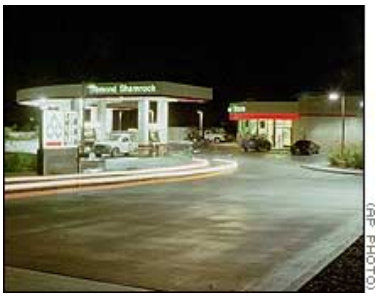
Design Issues

Example of Night Glare

Glare - Glare is very common in the nighttime environment and possibly the most important lighting issue facing communities. Glare is excessive brightness that makes it difficult to see or causes discomfort. Glare is caused by luminaires that do not properly control the light they cast. Instead of directing the light toward the intended surface, part of the light shines directly into the individual's eyes.

The two basic types of glare are discomfort glare and disability glare. Discomfort glare does not necessarily prevent the viewer from the intended task but does cause constant adaptation of the eye to the varying light levels which in turn causes discomfort. Disability glare may prevent the viewer from seeing the intended object because stray light is cast into the eye causing the retina to lose focus. The use of proper luminaries and positioning will reduce glare and offer improved visibility while reducing the light required for illumination. Glare is a particular problem to people with eye diseases such as cataracts; glare lighting entering such an eye greatly limits what can be seen, often times making nighttime driving difficult for people with such afflictions.

In New Hampshire, municipalities have the authority under Chapter Law 236, RSA 236:55 to have any unsafe light removed.



Example of Over-lighting

Over-lighting/Light Escalation - Lighting problems often occur between neighboring uses when they are illuminated at very different levels. Often when one business appears darker than a neighboring business, the latter may decide to increase their lighting. This may begin a cycle of ratcheting up light levels. In the end, both businesses suffer by paying more for lighting equipment and higher energy bills. Maintaining balanced light levels between properties is very important. When the lighting is uniform the eye can adapt and see better. Less light is needed, and balanced lighting levels make the area safer and more comfortable for all users.

Light Trespass - Light trespass occurs when a source emits too much light at high angles or projects light too far from where it is intended. A common cause of light trespass is the inappropriate selection, tilting, or aiming of luminaires for the particular lighting task. With the luminaires available today there is no reason for a property to be lit by an adjacent property's lighting.

Sky Glow - The term "sky glow" is defined as the glow, visible in the night sky over cities and brightly lit developed areas. Small communities and large developments often create their own distinct glow. Sky glow is light pollution that is reflected off atmospheric particles such as fog, dust, or smog. In New Hampshire, the reflectivity of snow cover also significantly contributes to increased winter sky glow.

According to the U.S. Department of Defense, satellite images of New Hampshire show the highest concentration of light pollution is presently within the Seacoast area and along the Route 93 and Route 3 corridors.

Sky glow is not just a local problem because it does not respect boundaries. Sky glow from any one town or inappropriately lit commercial development may be seen 20 or more miles away.

Practical Issues

Environmental - The environmental impacts of outdoor lighting have been studied extensively in some fields, and very little in others. We do know that light pollution currently obscures the nighttime sky in some parts of the state. Several studies have also indicated that extensive outdoor lighting can alter the behavior of certain kinds of plants and animals. The production of energy to power wasted light also results in unnecessary impacts.

Energy - Light that shines into the sky or beyond a property line is wasted light energy. An effective fixture will properly redirect light to where it is intended, but this may not reduce the energy consumed. In some cases, when semi-cutoff luminaires are replaced with full cut-off luminaires in an attempt to improve the effectiveness of a system, there is a need to increase the number of luminaires used.

Cost - Because each installation is unique, a total cost analysis provides the means to examine the initial purchase, installation costs, and the annual operating costs. For existing situations where over-lighting exists, a reduction in wattage size or removal of fixtures can reduce costs. In cases where a fixture does not offer enough coverage (tight lighting pattern) additional fixtures may be required, and this affects the associated costs. The wasteful nature of light pollution results in resource depletion and the additional impacts associated with generating the electricity to produce this light. Saving costs through effective lighting and energy conservation is only one approach to saving money through effective outdoor lighting.

Example of Light Trespass

Example of Sky Glow

THE TECHNICAL SIDE OF LIGHTING

There are several clear-cut measures that can be taken to improve energy savings and reduce the negative impacts of outdoor lighting applications. New, much improved light sources are now available that provide considerably more light per unit of energy. Most new luminaires also offer better light control by putting light where it is needed, both horizontally and vertically. Replacement of older luminaires and lamps with the newer, improved ones can greatly improve efficiency. As with all light sources, one should not use more wattage than is necessary for the application. "More light" is not always better. In many applications, it is counterproductive to visibility, especially if it is also producing glare.

Light Sources

There are many lamp types available and they are distinctly different in wattage, color rendering, efficiency, life span, and cost. Lamp efficiency is measured in lumens per watt. A lumen is a unit for measuring the amount of light; a watt is a unit for measuring the amount of electrical energy used. The lamp (and ballast) that gives the most lumens per watt is the most energy efficient lamp.

The table on page 5 was developed by the Office of Energy and Planning and lists the lighting efficacy (lumens/watt) of various outdoor lighting systems. These are the light sources only and do not take into account the fixture efficiencies. "System Watts" include both the lamp and the ballast for a calculation of the total wattage. The "Initial Efficacy" of the lamp/ballast system is the initial light output (lumens/watt) of a new system. The "End of Life Efficacy" of most systems is considerably lower than their initial efficacy. Exceptions include the new T5 and T8 fluorescent lamps, the halogen lamp and the low-pressure sodium lamp. The average "Lamp Life" is provided for each system in hours. The "S/P Ratio Factor" is a factor which affects vision and productivity. You will notice that newer T5 and T8 fluorescent light sources rate the highest in this category and are now considered superior to metal halide lamps. Both high and low pressure sodium light sources have very low S/P Ratios and are not as efficient as once thought. The "Adjusted, End of Life Efficacy" is the end of life efficacy (lumen/watt) multiplied by the S/P ratio.

Incandescent - Provides a warm white light with an instant-on feature. It is thought to be good for small scale installations and can be enhanced by the use of timers or sensors for automatic shutoff. The wattage can range from 25 - 1000. It is the most common type of lamp used in homes, indoors and outdoors. It is the most energy inefficient of the common lamp types. It produces light by electrical energy heating a filament of fine wire that glows white-hot when the current flows through it. It produces a great deal of heat relative to the amount of light; only 10 percent of the energy goes to producing light. It has been called a heat source that happens to produce some light at the same time. The 40 watt bulb is often adequate for most lighting applications, such as a porch light, especially if it is used in a luminaire that actually controls the light output rather than scattering it everywhere. Many of

Lamp/Ballast System	System Watts	Initial Efficacy	End of Life Efficacy	Lamp Life (hours)	S/P Ratio Factor	Adjusted, End of Life Efficacy
28 watt T5 fluorescent, EB	28	104	94	20,000	1.62	152
32 watt T8 fluorescent 800 series, EB	32	102	93	24,000	1.62	151
400 watt clear MH, MB	455	80	40	20,000	1.49	60
54 watt T5 fluorescent, EB	54	92	83	20,000	1.62	134
40 watt T5 twin tube, EB	40	80	72	20,000	1.62	117
400 watt HPS, MB	460	101	81	24,000	0.62	50
250 watt clear MH, MB	295	78	37	10,000	1.49	56
175 watt clear MH, MB	205	70	47	10,000	1.49	89
1000 watt, clear MH, MB	1,075	100	60	12,000	1.49	89
400 watt pulse start MH, CWA	450	91	55	30,000	1.49	81
400 watt pulse start NH, Reactor	425	96	58	30,000	1.49	86
60 watt incandescent	60	14	14	1,000	1.26	18
15 watt compact fluorescent	15	62	49	10,000	1.24	61
23 watt compact fluorescent	23	69	55	10,000	1.24	68
34 watt T12 fluorescent, EEMag ballast	34	83	62	20,000	1.72	107
60 watt halogen	60	22	22	3,000	1.32	29
180 watt low pressure sodium, MB	225	133	132	16,000	0.38	50
2-215 watt T12 VHO fluorescent, MB	450	62	40	10,000	1.72	70
2-95 watt T12 HO fluorescent, MB	257	68	51	12,000	1.72	88
400 watt HPS, MB	460	109	76	24,000	0.76	58

Efficacy is the light output expressed as lumens per watt
Adjusted End of Life Efficacy is the end of life efficacy (lumens/watt) multiplied by the S/P ratio. It is sometimes called "task modified" efficacy.
EB = electronic ballast
MB = magnetic ballast
MH = metal halide
HPS = high pressure sodium
EEMag = energy efficient magnetic ballast
CWA and Reactor are ballast types

the existing luminaires are very inefficient and waste a good deal of the light (remember that the lamp is inefficient too). One way to reduce waste is to replace incandescent lamps with more energy-efficient lamps in good luminaires. One can use compact-fluorescent lamps in an efficient luminaire, or a low wattage Low Pressure Sodium (LPS) lamp in a well shielded luminaire, where color rendering is not as important.

Mercury Vapor - Emits a blue/white light, and is no longer frequently used. The wattage can range from 75 - 400. It is commonly used for a number of outdoor applications, such as "security" lighting, as well as indoors for some applications. It has a relatively long life compared to most other lamps, especially compared to incandescent. These lamps are a quartz tube filled with mercury gas under pressure. Light is produced when an electric current passes

through the mercury vapor. Like all such high intensity discharge (HID) lamps, a "ballast" is required to start and to operate the lamps at the correct voltage and current levels. Mercury Vapor lamps are now classified as hazardous waste and must be disposed of properly. Many municipalities have replaced their Mercury Vapor street lights with either High Pressure Sodium or Metal Halide lamps and ballasts.

Fluorescent - These are now the most efficient light source and are being used to replace HID lighting applications across the country. The new generation fluorescent lighting fixtures are up to 98% efficient and have the ability to direct light only where it is needed. Low outdoor temperature used to be a problem with fluorescent lamps but the latest generation, when combined with low temperature electronic ballasts, will work well in New Hampshire. Energy savings are possible here by using lower wattage lamps (using more efficient lamps such as T-8, for example), disconnecting or removing some of the luminaires (ballasts must be disconnected too rather than just removing the lamp), or replacing the existing ballasts with more energy efficient ones (electronic, solid state, or energy-saving ballasts).

Metal Halide (MH) - Provides light that is white in color. The wattage can range from 32 - 1000. These lamps are used for both indoor and outdoor applications. They produce light when an electric current flows through the gas within the lamp envelop. They are about twice as efficient as mercury lamps. This light source is often used at night when it is necessary to render colors closely to what they would appear in the daytime, but it does not have an instant-on or instant re-strike feature.

High Pressure Sodium (HPS) - Provides a yellow/orange light, but color correct lamps are also available. The wattage can range from 35 - 1000. Its main usage is outdoor for street lighting, parking lot lighting, and other such applications. It is more energy efficient than metal halide and is a good choice when true color is not critical. The light output is a golden-yellow color. It is very commonly used throughout the U.S.

Low Pressure Sodium (LPS) - The light from this lamp is deep orange in color. LPS lamps are rarely installed today due to high initial cost and poor color rendering that makes all colors appear to be yellow or a shade of gray. The wattage can range from 90 - 180. An LPS luminaire is the most energy efficient of all and is an excellent choice when used with a quality luminaire that controls the light output. For example, in equivalent luminaires (ones that offer good light control), a 175 watt mercury vapor luminaire could be replaced by a 100 watt HPS or a 55 watt LPS. A 35 watt LPS is equivalent to a 200 watt incandescent. It is easy to see that considerable energy saving is possible. The light from an LPS luminaire is produced from glowing sodium gas within a tube and so the LPS luminaire is an efficient choice for street lighting, parking lots, and security lighting. There is no color rendering at all, but adequate color rendering is quite possible with system designs that also use a few MH or florescent luminaires to improve color rendering.

Types of Luminaires

Cut-off Luminaires - Control glare and skyglow by directing light below the horizontal plane. Wall -mounted luminaires like the "Shoe Box" luminaire have incorporated cut-off features that focus light down and out from the building. When teamed with Low Pressure Sodium lamps these luminaries produce the least amount of skyglow and glare while having the lowest operating costs.

Semi-cut-off Luminaires - A partially shielded lamp, and reasonable glare control is provided. Approximately 10 percent of the light shines above the horizontal plane. This luminaire provides a wider illuminated pattern on the lighted surface.

Non-cut-off Luminaires - Allow considerable light to be cast above the horizontal plane, and few of these effectively control glare. Many of these luminaires are designed to be decorative or historic, and the effect of glare can be minimized with relatively low wattage. Recently, several companies have begun producing decorative "historic looking" luminaires that are actually near full cutoff luminaires.

Floodlight - Designed to provide a focused beam of light. The type of reflector, positioning, and wattage of these luminaires can easily create or minimize glare. Luminaires are now available that reduce the broad cone of light produced by this type to illuminate only the area desired.

Lighting Controls

Controlling when and where the lights are used, how long they are on, and how bright they are all can be a major factor in conserving energy. Devices range from a simple on/off switch to computers programmed to activate lights automatically. The general rule should be to turn lights off when not needed. Use individual controls and use timers rather than lighting large areas off of one switch. Don't burn outdoor lights in the daytime. Instead, use photo-sensors when possible. Some newer applications also use motion sensors for outdoor applications.

Pole/Mount Height

The height of poles and luminaire mounts should be compatible with the scale and architecture within and surrounding the site. A large space can often be lit more evenly and efficiently with high wattage lamps on fewer tall (25-35

foot) poles. If a site is located at the top of a rise and will be viewed from below this may result in a problem with glare. Lights on lower poles and mounts (10-15 foot) can create a more intimate space, especially for pedestrians. Lower mounts also allow for lower lamp wattages. Bollards (42 inches) are very low mounts that provide another lighting option and are often used along walkways. It should be noted that lower mounting heights may require additional lights to provide equivalent or minimal levels of illumination and may be more susceptible to vandalism.

Maintenance

Do not forget lamp and luminaire maintenance as a factor! Keep the luminaire clean from dust and dirt. Such contamination can reduce light output - in some cases up to 50 percent.

For assistance in finding solutions to your outdoor lighting issues, you can contact your regional planning commission.

NH Regional Planning Commissions

North Country Council
(603) 444-6303

Lakes Region Planning Commission
(603) 279-8171

Upper Valley Lake Sunapee Regional Planning Commission
(603) 448-1680

Central New Hampshire Regional Planning Commission
(603) 226-6020

Southwest Region Planning Commission
(603) 327-0557

Southern New Hampshire Planning Commission
(603) 669-4664

Nashua Regional Planning Commission
(603) 424-2240

Strafford Regional Planning Commission
(603) 742-2523

Rockingham Planning Commission
(603) 778-0885

SOLUTIONS FOR EFFECTIVE OUTDOOR LIGHTING

To be considerate of the human eye's adaptability and the lighting needs of an area, a good lighting installation should be designed with the following characteristics:

- Illumination levels that are appropriate for the visual task;
- Reasonably uniform horizontal and vertical illumination levels;
- Limit trespassing upon adjacent properties;
- Limit direct production of sky glow; and
- Absence of glare.

Outdoor Lighting Applications

Each lighting system is intended to serve one or more of the following: pedestrian safety, security, advertising, recreation, or roadway turning movements. Effective outdoor lighting applications must consider the necessary horizontal and vertical illuminance required to aid people with their visual tasks. Ideally, lighting systems and levels are designed for a specific set of tasks and the unique characteristics of the site. Unfortunately, this is often not the case.

If a site is remote and security surveillance opportunities by passersby are lacking, there may be little need for an extensive outdoor lighting system. Many safety and security applications can therefore make good use of sensor-controlled lights. Sensor lights are often much more effective in attracting attention for security purposes and can significantly reduce the operating costs of the system. In some instances, lighting systems designed for other visibility or safety applications could be enhanced with the use of sensors. Little-used parking lots near schools may be good examples.

In other instances, encouraging the use of public and private space is best served by providing effective lighting. In urban and/or commercial developments it is very important to give the individual a sense of comfort during the evening hours. The ability to see your surroundings and approaching pe-

destrians contributes to a sense of security and encourages evening foot traffic. On the other hand, over-lighting and glare often produce shadowed areas where the pedestrian cannot see easily.

The illumination of building facades and landscaping elements can contribute visually and can often meet several lighting needs within the area. Illumination of civic and historic buildings within downtown and village areas often contributes to the evening character of the area. On the other hand, the use of inappropriate light levels and designs can have a detrimental effect. In village and downtown areas it is important to define the type of structures that should be illuminated, and to identify a time that these elements may no longer be appreciated by the public. At such time each evening these luminaires could be turned off. This will help reduce the associated impacts. Generally, building façade lighting should be done from above rather than from below in order to limit sky glow. The images below show the well-lit new Plaistow Public Library, where parking lot lighting is all full cutoff and façade lights are all zero glare.

Plaistow, NH Public Library day and night images

The use of lighting for signage and outdoor advertising should also be carefully designed. Inappropriately angled floodlighting or excessive internal illumination of signs can produce glare which impairs visibility for nearby drivers and pedestrians. Effective lighting and the use of timers can dramatically reduce operating costs and impacts during late night and early morning hours. Gasoline station and convenience store canopies have become a widespread problem due to the associated intense lighting and glare from their luminaires. Addressing the excessive illumination levels and unshielded luminaires will significantly reduce glare, operating costs, and sky glow. Excessive lighting of outdoor display areas for automobile sales, heavy equipment sales, recreational vehicle sales, and landscaping materials, just to name a few, can also have an adverse effect. Most of these establishments do not operate at night. When excessively lit, these properties contribute to sky glow, the ratcheting up of neighboring properties' lighting levels, glare, and energy consumption.

Lighting for outdoor recreational facilities is another consideration in many communities and should be designed with the specific needs of the facility in mind while minimizing the impacts to the community. The lighting for such facilities is often highly visible and should be designed by a qualified designer to ensure adequate but not excessive lighting. Local regulations can be used to control the time that the lighting must be turned off.

Parking lot lighting allows people to locate and access their vehicles, avoid obstacles, and provides a sense of security. The design of these systems should provide a consistent level of illumination and accurate coloring. Over-illumination should be avoided. For most NH communities, the Illuminating Engineering Society of North America's (IESNA) minimum lighting levels will serve as good maximum levels. Timers can also be used to turn off lighting in certain sections of the lot after hours.

Street lighting should accommodate the needs of motorists and pedestrians. The design will differ depending on the needs you are trying to meet and the characteristics of the area. Guidelines for this type of lighting differ for different roadway classifications. In many cases the lighting is controlled by the utility company and does not fall under the community's regulations.

Towns have the right to specify that full cutoff or semi-cutoff energy efficient sodium lamps be used in street lighting.

CONCLUSION

Now you have a basic understanding of the issues related to outdoor lighting. This bulletin provides some technical information and terminology and should be a resource when you are reviewing applications at the local level. If your community is concerned about the effect that lighting can have on your nighttime environment, we have provided some model ordinances and additional sources of information at the end of this document for you to review.

Sources of Additional Information

Lighting for Exterior Environments, *Illuminating Engineering Society of North America, 1999.*

Light Pollution: Efforts to Bring Back the Night Sky, *Environmental Building News, Volume 7 Number 8, September 1998.*

Light Pollution - What's the Fuss?, *Mitch Manseau, 1999.*

Outdoor Lighting Manual for Vermont Municipalities*, Chittenden County Regional Planning Commission, 1996.*

White Paper on Outdoor Lighting Code Issues*, National Electrical Manufacturers Association, 2000.*

MODEL OUTDOOR LIGHTING REGULATION

Along with adoption of ordinances appropriate to each community, inclusion of outdoor lighting controls in the site plan review process would also give local planning boards the opportunity to determine whether new construction lighting is in keeping with the community's standards. Proper lighting is safe, secure, attractive and more efficient.

Two alternatives are offered here. Either ordinance could be adopted as an amendment to an existing zoning ordinance. The first is a basic lighting ordinance that may be suitable for smaller communities. This model was based on an ordinance from Bethlehem, NH. The second is more complex and rigorous. It may be more suitable for communities that are larger in size or are experiencing higher rates of development. The second ordinance also suggests the use of a "Lighting Committee" which could be the local planning board. The second ordinance is based on the outdoor lighting ordinance from Kennebunkport, Maine. Both of these models could be used as starting points, but should be carefully tailored to meet the needs of the community. The language in either can be incorporated into the current zoning ordinance or adopted as a separate zoning regulation.

BASIC LIGHTING ORDINANCE

In the interest of maintaining its historic character, and preventing further reduction of visibility of the night sky, insuring efficient use of lighting, and reducing unsafe or annoying lighting conditions, the Town of ____ has adopted the following lighting ordinance:

Any new outside lighting whether for area illumination, sign illumination, building illumination, or other purpose, will project no more than 3 percent of its light rays above the horizon from the lamp, its lens structure or any associated reflector.

Exceptions:

A. All temporary lighting required for construction projects, related to road construction and repair, installation of sewer and water facilities, and other public infrastructure.

B. All temporary emergency lighting needed by the police or fire departments or other emergency services, as well as all vehicular luminaires, shall be exempt from the requirements of this article.

C. All hazard warning luminaires required by Federal regulatory agencies are exempt from the requirements of this article, except that all luminaires used must be red and must be shown to be as close as possible to the Federally required minimum lumen output requirement for the specific task.

D. Seasonal/decorative lighting displays using multiple low wattage bulbs are exempted from this ordinance.

New signs or newly lit signs may be illuminated only by continuous indirect white light, with illumination from above, and with light sources shielded so that they will not constitute a nuisance or hazard caused by glare to neighbors, pedestrians, or drivers. An exception to overhead sign lighting can be made if the illumination is confined to the area of the sign.

Other Agencies and Organizations

Illuminating Engineering Society of North America (IESNA)
120 Wall Street, Floor 17
New York, NY 10005
212-248-5000

International Dark-Sky Association
3225 N. First Avenue
Tucson, AZ 85719
ida@darksky.org

Lighting Research Center at Rensselear Polytechnic Institute
21 Union Street
Troy, NY 12180-3352
518-687-7100
www.lrc.rpi.edu

National Electrical Manufacturers Association (NEMA)
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209
703-841-3200

New England Light Pollution Advisory Group (NELPAG)
M.S. 18, Harvard Observatory, 60 Garden Street
Cambridge, MA 02138

New Hampshire Citizens for Responsible Lighting (NHCRL)
65 Green Acres Drive
Manchester, NH 03109
603-867-8557
www.mv.com/users/lopez/nhcrl/

MORE COMPLEX OUTDOOR LIGHTING ORDINANCE

STATEMENT OF NEED AND PURPOSE:
The benefits of good outdoor lighting are increased safety, energy efficiency, enhancement of the towns' evening character and improved security. New technologies have created extremely powerful lights which can inadvertently lead to excessive glare, light trespass and higher energy use. Concerns resulting from excessive glare and light trespass include safety issues, loss of privacy and increased energy costs for everyone. The goal of this lighting ordinance is to recognize the benefits of outdoor lighting and provide clear guidelines for its installation. Appropriately regulated and properly installed, outdoor lighting will maintain and complement the towns' character and contribute to the safety and welfare of the residents of the town.

The intent of this ordinance is to reduce the problems created by improperly designed and installed outdoor lighting by establishing regulations which limit the area that certain outdoor lighting luminaires can illuminate and by limiting the total allowable illumination of lots located in the Town of _____.

ARTICLE 1

1.1. DEFINITIONS: For the purposes of this Ordinance, terms used shall be defined as follows:

Direct Light: Light emitted directly from the lamp, off of the reflector or reflector diffuser, or through the refractor or diffuser lens of a luminaire.

Fixture: The assembly that houses the lamp or lamps and can include all or some of the following parts: a housing, a mounting bracket or pole socket, a lamp holder, a ballast, a reflector or mirror, and/or a refractor or lens.

Flood or Spot light: Any light fixture or lamp that incorporates a reflector or a refractor to concentrate the light output into a directed beam in a particular direction.

Glare: Light emitting from a luminaire with an intensity great enough to reduce a viewer's ability to see, and in extreme cases causing momentary blindness.

Height of Luminaire: The height of a luminaire shall be the vertical distance from the ground directly below the centerline of the luminaire to the lowest direct-light-emitting part of the luminaire.

Indirect Light: Direct light that has been reflected or has scattered off of other surfaces.

Lamp: The component of a luminaire that produces the actual light.

Light Trespass: The shining of light produced by a luminaire beyond the boundaries of the property on which it is located.

Lumen: (A unit of luminous flux.) One foot-candle is one lumen per square foot. For the purposes of this Ordinance, the lumen-output values shall be the INITIAL lumen output ratings of a lamp.

Luminaire: This is a complete lighting system and includes a lamp or lamps and a fixture.

Outdoor Lighting: The nighttime illumination of an outside area or object by any man-made device located outdoors that produces light by any means.

Temporary Outdoor Lighting: The specific illumination of an outside area of object by any man-made device located outdoors that produces light by any means for a period of less than 30 days, with at least 180 days passing before being used again.

ARTICLE 2

2.1. REGULATIONS: All public and private outdoor lighting installed in the Town of _____ shall be in conformance with the requirements established by this Ordinance.

2.2. CONTROL OF GLARE - LUMINAIRE DESIGN FACTORS:

A. Any luminaire with a lamp or lamps rated at a total of MORE than 1800 lumens, and all flood or spot luminaires with a lamp or lamps rated at a total of MORE than 900 lumens, shall not emit more than 3% direct light above a horizontal plane through the lowest direct-light-emitting part of the luminaire.

B. Any luminaire with a lamp or lamps rate at a total of MORE than 1800 lumens, and all flood or spot luminaires with a lamp or lamps rated at a total of MORE than 900 lumens, shall be mounted at a height equal to or less than the value 3 + (D/3), where D is the distance in feet to the nearest prop-

erty boundary. The maximum height of the luminaire shall not exceed 25 feet.

2.3. EXCEPTIONS:

A. Any luminaire with a lamp or lamps rated at a total of 1800 lumens or LESS, and all flood or spot luminaires with a lamp or lamps rated at 900 lumens or LESS, may be used without restriction to light distribution or mounting height, except that if any spot of flood luminaire rated 900 lumens or LESS is aimed, directed, or focused so as to cause direct light from the luminaire to be directed toward residential buildings on adjacent or nearby land, or to create glare perceptible to persons operating motor vehicles on public ways, the luminaire shall be redirected or its light output controlled as necessary to eliminate such conditions.

B. Luminaires used for public-roadway illumination may be installed at a maximum height of 25 feet and may be positioned at that height up to the edge of any bordering property.

C. All temporary lighting required for construction projects, related to road construction and repair, installation of sewer and water facilities, and other public infrastructure.

D. All temporary emergency lighting needed by the police or fire departments or other emergency services, as well as all vehicular luminaires, shall be exempt from the requirements of this article.

E. All hazard warning luminaires required by Federal regulatory agencies are exempt from the requirements of this article, except that all luminaires used must be red and must be shown to be as close as possible to the Federally required minimum lumen output requirement for the specific task.

F. Luminaires used primarily for sign illumination may be mounted at any height to a maximum of 25 feet, regardless of lumen rating.

2.4. TEMPORARY OUTDOOR LIGHTING

A. Any temporary outdoor lighting that conforms to the requirements of this Ordinance shall be allowed. Nonconforming temporary outdoor lighting may be permitted by the Board of Selectmen after considering: (1) the public and/or private benefits that will result from the temporary lighting; (2) any annoyance or safety problems that may result from the use of the temporary lighting; and (3) the duration of the temporary nonconforming lighting. The applicant shall submit a detailed description of the proposed temporary nonconforming lighting to the Board of Selectmen, who shall consider the request at a duly called meeting of the Board of Selectmen. Prior notice of the meeting of the Board of Selectmen shall be given to the applicant and to the Lighting Committee. The Board of Selectmen shall render its decision on the temporary lighting request within two weeks of the date of the meeting. A failure by the Board of Selectmen to act on a request within the time allowed shall constitute a denial of the request.

ARTICLE 3

3.1. EFFECTIVE DATE AND GRANDFATHERING OF NONCONFIRMING LUMINAIRES:

A. This ordinance shall take effect immediately upon approval by the voters of the Town of _____ at an annual or special Town Meeting and shall supersede and replace all previous ordinances pertaining to outdoor lighting.

B. All luminaires lawfully in place prior to the date of the Ordinance shall be grandfathered. However, any luminaire that replaces a grandfathered luminaire, or any grandfathered luminaire that is moved, must meet the standards of this Ordinance.

ARTICLE 4

4.1. NOTIFICATION REQUIREMENTS:

A. The Town of _____ building permit shall include a statement asking whether the planned project will include any outdoor lighting.

B. Within 30 days of the enactment of this ordinance, the Code Enforcement Officer shall send a copy of the Outdoor Lighting Ordinance, with cover letter to all local electricians and the local electric utility (including at least those in the towns of _____, _____, and _____ as listed in the _____ Yellow Pages).

ARTICLE 5

5.1. VIOLATIONS, LEGAL ACTIONS, AND PENALTIES:

A. **Violations and Legal Actions:** If, after investigation, the Code Enforcement Officer finds that any provision of the Ordinance is being violated, he shall

give notice by hand delivery or by certified mail, return-receipt requested, of such violation to the owner and/or to the occupant of such premises, demanding that violation be abated within thirty (30) days of the date of hand delivery or of the date of mailing of the notice. If the violation is not abated within the thirty-day period, the Code Enforcement Officer may institute actions and proceedings, either legal or equitable, including those pursuant to RSA 502-A:11-a(b), to enjoin, restrain, or abate any violations of this Ordinance and to collect the penalties for such violations.

B. **Penalties:** A violation of this Ordinance, or any provision thereof, shall be punishable by a civil penalty of fifty dollars ($50), and each day of violation after the expiration of the thirty-day period provided in paragraph 1 shall constitute a separate offense for the purpose of calculating the civil penalty.

TERMS AND DEFINITIONS

The following terms and definitions are from the Illuminating Engineering Society of North America (IESNA):

Accent Lighting - directional lighting to emphasize a particular object or to draw attention to a part of the field of view.

Aeronautical Light - any luminous sign or signal specially provided as an aid to air navigation.

Ambient Lighting - lighting throughout an area that produces general illumination.

Baffle - a single opaque or translucent element to shield a source from direct view at certain angles, or to absorb unwanted light.

Ballast - a device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, and waveform) for starting and operating.

Bollards - luminaires having the appearance of a short, thick post, used for walkway and grounds lighting. The optical components are usually top mounted.

Bulb - a source of electrically powered light. This term is used to distinguish between an assembled unit consisting of a light source in a housing called a lamp and the internal source.

Candela - a measure of luminous intensity in a certain direction. Useful in determining how much light is shining out of a fixture and in what direction.

Candela Diagram - diagram of light power produced by a source and the value of luminous intensity in given directions. A picture of how much light is shining out of a fixture and in what direction.

Candlepower - luminous intensity expressed in candelas.

Color Rendering Index (CRI) - a measurement of the amount of color shifts that objects undergo when lighted by a light source as compared with the color of those same objects when seen under a reference light source of comparable color temperature. CRI values generally range from 0 to 100.

Cutoff Angle (of a Luminaire) - the angle, measured up from nadir, between the vertical axis and the first line of sight at which the bare source is not visible.

Diffused Lighting - lighting provided on the work plane or on an object, that is not predominantly incident from any particular direction.

Disability Glare - the effect of stray light in the eye whereby visibility and visual performance are reduced. A direct glare source that produces discomfort may also produce disability glare by introducing a measurable amount of stray light in the eye.

Discomfort Glare - glare producing discomfort. It does not necessarily interfere with visual performance or visibility.

Efficacy - a measurement of the ratio of light produced by a light source to the electrical power used to produce that quantity of light, expressed in lumens per watt. Efficacy is an important determinant of energy efficiency in lighting equipment.

Floodlight - A light fixture designed to light a scene or object to a luminance greater than its surroundings. The beam spread of floodlights may range from narrow field angles of 10 degrees to wide angles (more than 100 degrees).

Foot-candle - a measure of light falling on a given surface. One foot-candle is equal to the amount of light generated by one candle shining on a square foot surface one foot away.

Footlambert - a measure of brightness from a surface.

Fully Shielded - refers to providing internal and/or external shields and louvers to prevent brightness from lamps, reflectors, refractors, and lenses from causing glare at normal viewing angles.

Glare - the sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility. Note: the magnitude of the sensation of glare depends upon such factors as the size, position, and luminance of the source and the luminance to which the eyes are adapted.

Globe - a transparent or diffusing enclosure intended to protect a lamp, to diffuse and redirect its light, or to range the color of the light.

Illuminance - the amount of light falling on a surface, expressed in lux (foot-candle).

Illumination - the act of illuminating or state of being illuminated. This term has been used for density of luminous flux on the surface (illuminance).

Illuminating Engineering Society of North America (IESNA) - an association of professionals in the field of lighting and related professions. This forum, organized for the exchange of ideas and information, has been in existence for over 80 years.

Isolux (Isofoot-candle) Line - a line plotted on any appropriate set of coordinates to show all the points on a surface where the illuminance is the same. A series of such lines for various illuminance values is called an isolux (isofoot-candle) diagram.

Lamp - a bulb. An outer glass envelope and metal base enclosing a filament or arctube and electrodes.

Lens - glass or plastic element used in luminaires to change the direction and control the distribution of light rays.

Light - radiant energy that is capable of exciting the retina and producing a visual sensation.

Light Meter - a device that measures the amount of light energy falling on a given surface.

Light Trespass - the shining of light produced by a luminaire beyond the boundaries of the property on which it is located.

Lumen Depreciation - the decrease in lumen output that occurs as a lamp is operated, until failure.

Lumen - a measure of light energy generated by a light source.

Luminaire - a complete lighting unit consisting of a lamp(s) and ballasting (when applicable) together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply. Often referred to as a "fixture."

Luminance - commonly called brightness or the light coming from a surface. Luminance is composed of the intensity of light striking an object or surface and the amount of that light reflected back toward the eye. Luminance is measured in foot-candles.

Lux - a measurement of light falling on a given surface. A metric measurement that is the equivalent of the amount of light generated by one candle falling on a square meter surface one meter way.

Noncutoff - the category when there is no candlepower limitation in the zone above maximum candlepower.

Nuisance Glare - glare that causes complaints.

Obtrusive Light - unwanted light, which, because of quantitative, directional, or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction, or a reduction in the ability to see essential information.

Semicutoff - when the candlepower per 1000 lamp lumens does not numerically exceed 50 (5 percent) at an angle of 90 degrees above nadir (horizontal), and 200 (20 percent) at a vertical angle of 80 degrees above nadir. This applies to any lateral angle around the luminaire.

Task Lighting - lighting directed to a specific surface or area that provides illumination for visual tasks.

Uniformity Ratio - the ratio of average illumination to minimum illumination.

Vertical Foot-candle - a measurement of illuminance intensity on a vertical surface, such as a wall or sign.

Watt (w) - a unit used to measure electric power

OFFICE OF ENERGY AND PLANNING - TECHNICAL BULLETINS

Available on the OEP website at: www.nh.gov/oep/resourcelibrary/TechnicalBulletins.htm or by calling the office at 603-271-2155.

Community Profile Project
(Revised 2001)

Formulating a Water Resources Management & Protection Plan
(Winter 1992)

Land Use and Transportation
(Fall 2005)

Master Planning
(Summer 2003 - Updated Spring 2007)

Outdoor Lighting
(Summer 2001 - Updated Spring 2007)

Planning for Wireless Telecommunications
(Spring 2001 - Updated Spring 2007)

Preservation of Scenic Areas and Viewsheds
(Spring 1993)

Preserving Rural Character: The Agriculture Connection
(Winter 2000)

Roads - Guidance on Design, Construction and Approval for Local Planning Boards (1998)

Tax Increment Financing
(Winter 2001 - Updated Spring 2007)

Wetlands Mitigation/Restoration Issues
(Spring 1988)

What is a Floodplain Forest?
(Spring 2001)