



Lighting

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INTRODUCTION

Energy used for lighting accounts for about seventeen percent of all United States electricity use. This number rises to about 38 percent for the commercial sector. Energy-efficient lighting can result in a significant conservation of energy thus reducing the quantity of greenhouse gases released into the environment.

There are many different types of artificial lights, all of which have different applications and uses. Types of lighting include (from the [Department of Energy](#) website):

- [Fluorescent lighting](#)
- [High-intensity discharge lighting](#)
- [Incandescent lighting](#)
- [Low-pressure sodium lighting](#)
- [LED lighting \(light-emitting diodes\)](#)

REGULATIONS

In 2009, the United States Department of Energy (DOE) issued efficacy standards for general service fluorescent lamps and incandescent lamps. This federal rule, [10 CFR Part 430 \(2009\)](#), “[Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps](#),” introduces standards that will phase out the least efficient lamps over the next few years, beginning in 2012. The federal government began regulating fluorescent and incandescent lamps with the passage of the [Energy Policy Act of 1992 \(& 2005\)](#), expanded by the [Energy Independence and Security Act of 2007](#), and finally with the DOE rules.

The Department of Energy’s analyses indicate that on average residential and commercial consumers would see benefits from the proposed standards when considering the life-cycle cost savings of products. This analysis takes into account the higher purchase price of high-efficacy lamps and the energy efficiency gains that would result in lower energy costs which more than offset the higher costs for the majority of consumers.

USAGE HISTORY AND EXPERIENCE

King County’s [2010 Energy Plan](#) and [Ordinance 16769](#) address using more efficient lamps and ballasts. In response to this directive, the county’s energy task force produced the King County 2012 Lighting Implementation Plan.

One of the strategies in the Energy Plan is to reduce the use of inefficient lighting and prepare for product changes as a result of 2009 federal lighting standards.

The Ordinance asks that “lighting purchases for the county for which there is a federal efficiency standard established in 10 CFR Sec. 430.32 (2009) shall meet or exceed those energy efficiency standards to the maximum extent feasible.” It also requires “analysis of a policy to establish mercury and lead content standards for all new lighting products purchased by King County; including a recommended content standard and a financial analysis of the costs to the county of such a standard.”

In response to the mercury and lead standards, the county (through the state contract) asked the vendors to state mercury content, which was a weighted factor in the bid award with the awarded bidder having the least overall amount of mercury. The bid also used the European Union Restriction of Hazardous Substances (RoHS) as its lead standard.

BID AND CONTRACT LANGUAGE

King County worked closely with the State of Washington in 2011 on a new solicitation for lamps and ballasts. The bid included evaluation of “non-cost” factors of lighting including environmental factors: mercury content; lamp recycling; VISA card acceptance; electronic ordering; sales coverage; and RoHS compliance

Following are excerpts from the contract:

[State of Washington Contract – Lamps and Ballasts #07510](#)

PURPOSE

The Office of State Procurement, with this Solicitation and resulting Contract, seeks to encourage the sale and purchase of products that meet its customers’ need for healthy, pleasant and ample lighting in the State’s offices, worksites and public areas.

These products should offer long life and low day-to-day energy-usage costs; guarantee safety to human life and health during operation; and have a minimal impact to the environment at the end of their useful lives.

This Contract encourages the development and use of new technologies that will help the State meet its budgetary and environmental goals – with products that last longer; are safer for workers, the public and the environment; and consume less energy.

In addition, this Contract offers a structure for the recycling of mercury-containing lamps. The Awarded Contractor will report quarterly to OSP the quantity of fluorescent lamps delivered to State Agencies. The Office of State Procurement intends to use the information to produce a recycling report for Contract-using Agencies and the Department of Ecology. State law (RCW 70.275) clearly calls on all parties to act aggressively to minimize mercury released to the environment by State entities. Agencies that fail to recycle spent fluorescent lamps will be subject to audit findings.

Last, this is a performance-based Contract (Appendix B, Section 1). Contract customers will be asked to report superior or poor performance to the State’s Contract Coordinator.

This contract defines the suppliers of lamps and ballasts for all state agencies and political subdivision members of the Washington State Purchasing Cooperative. This contract does not include lighting fixtures.

As technology evolves and improves and manufacturing practices become more efficient, this Contract can evolve, as well, to respond to opportunities to save energy and dollars, to embrace new products and new thinking, to offer better light at a better value. It is the State’s intention to encourage new or emerging technologies, and therefore the State reserves the right to add to commodity categories or add new categories at a later time.

NON-COST SCORING AND EVALUATION

In addition to price evaluation, a total of 800 points have been allotted to non-cost consideration and some pass-fail elements have been established. An evaluation team will score Bidder responses to non-cost considerations. In scoring non-cost considerations, the State may request and schedule an interview to provide additional clarification.

Mercury Content (Available points = 720)

A total cost of ownership formula will be used to calculate net mercury content.

The number that represents warranted lamp life per line item on the Market Basket will be divided into an arbitrary lamp life number to yield the number of lamps necessary to reach that number. The resulting product will be multiplied by the listed mercury in milligrams per lamp, the product of which is multiplied by the estimated number of lamps to be purchased to yield a number that represents net mercury, which can be thought of as the potential mercury risk to the environment over time.

The Bidder with the lowest calculated net mercury score will receive the maximum allotted points for mercury, with the other Bidders receiving proportionately fewer points based on how much higher (by percentage) they are than the first Bidder's net mercury number.

Lamp Recycling (Pass/Fail)

Bidders are required to include in their Letter of Proposal (Appendix E) their company's plan for working with the State's recycling Contractor to achieve maximum recycling of spent lamps. Bidders with a response deemed unsatisfactory will be found non-Responsible and will receive no further consideration.

VISA Bankcard Acceptance (Pass/Fail)

Bidders will be required to accept VISA purchasing card transactions. Level 3 reporting is desired for this commodity. Bidders will cover this capability in their Letter of Proposal (Appendix E), and provide a statement detailing their plan for having level 3 reporting available. Bidders with a response deemed unsatisfactory will be found non-Responsible and will receive no further consideration.

Electronic Ordering (Pass/Fail)

Electronic ordering is required for this commodity. Bidders are required to offer customers the option of ordering electronically from a real-time online catalog, or be prepared to have the capability in place within 180 days of Award of the Contract. Bidders will cover this capability in their Letter of Proposal (Appendix E), and provide a statement detailing their plan for having this capability available. Bidders with a response deemed unsatisfactory will be found non-Responsible and will receive no further consideration.

Sales coverage (80 points)

Bidders are to identify and describe store locations and capabilities in Washington that are available to supply Contract items to walk-in customers. The State requires walk-in capability to serve customers along the Interstate 5 and Interstate 90 corridors. Bidders will provide store location data in their Bidder Profile (Appendix C) and describe store capabilities in their Letter of Proposal (Appendix E). Bidders with a response deemed unsatisfactory will be found non-Responsible and will receive no further consideration.

RoHS compliance (Pass/Fail)

Bidders must demonstrate compliance with the Restriction of Hazardous Substances (RoHS) directive for lamps and bulbs listed in the Market Basket (Appendix D) by marking "Yes" or "No" in Column I of the Market Basket. Bidders must explain any "No" answers in the Letter of Proposal (Appendix E), and explanations deemed inadequate may be grounds for disqualification.

FOR MORE INFORMATION

In addition to the lamps and ballast contract, the State of Washington also maintains a “[Fluorescent Lamp Recycling Contract](#).” The new contractor for supply has pledged to work closely with the local recycler, Ecolights Northwest to boost compliance with recycling fluorescent tubes and ballasts at the end of life.

[Lighting Facts](#)

Lighting Facts® is a program of the U.S. Department of Energy that showcases LED products for general illumination from manufacturers who commit to testing products and reporting performance results according to industry standards. For lighting buyers, designers, and energy efficiency programs, the Lighting Facts label provides information essential to evaluating products and identifying the best options.

[King County 2010 Energy Plan](#)

King County [King County Ordinance 16769](#)

VENDOR INFORMATION

Lamps and Ballasts:

[Consolidated Electrical Distributors](#) (CED) – several outlets

On contract: Fluorescent lamps, ballasts, compact fluorescent lights (CFL), high-intensity discharge (HID) lights, metal halide and halogen lamps and light-emitting diode (LED) lamps.

Lamp and Ballast Recycling Services:

[Ecolights Northwest](#) – Seattle, WA

Holds the statewide service contract for collection and disposal of lamps and ballasts. Recycled kits are available for lighting for easy shipping. Disposal sites have been reviewed a state hazardous technical committee.

KING COUNTY LIGHTING IMPLEMENTATION PLAN

OVERVIEW

Background

In 2009, the federal government passed laws requiring increased efficiency standards for many types of lighting equipment, to be phased in beginning in 2012. In response to this development, the County Council enacted Ordinance 16769, to ensure the County would replace lights proactively as needed for compliance with these standards while improving lighting efficiency in its facilities to reduce energy waste. At the same time, the Council determined that reducing outdoor light pollution is beneficial for a number of reasons, and included in the Ordinance a request for lighting application guidelines to reduce outdoor light pollution from County facilities.

The Council directed the County Executive to develop an implementation plan for the cost-effective replacement of lighting that does not meet the new federal energy standards. Review of the applicable federal statutes indicated that these standards will result in phased removal of certain lighting products from the market (some lamps and lighting fixtures will no longer be available). The County will need to plan for lighting replacements considering implementation timing of these new federal standards. At the same time, it is important to ensure that King County is applying best practices in procurement of lights, minimizes the use of toxic materials in lights and recycles as much of these products as is practically possible. This plan provides direction to achieve these objectives.

To address minimizing outdoor light pollution from County facilities, staff with expertise in lighting researched options. No current regulatory requirements for either light pollution or trespass reduction were identified as in force in either King County or the State of Washington, although regulatory codes do exist in other jurisdictions and these were studied. Fortunately there is a body of research on this topic, and current best practices are documented. Also, many organizations (including some County divisions) have some policies in place to minimize light pollution, and many high quality products exist to help mitigate the problem.

Plan Objectives

This King County Lighting Implementation Plan (Plan) is intended to provide a consolidated source of application information and guidance to King County staff responsible for lighting design, installation, operation and maintenance in its facilities, on five important subjects:

1. New federal lighting efficiency standards that will begin phased implementation in 2012, and will impact choices of lighting products available to the County;
2. King County's planned processes to replace obsolete lighting for efficiency and compliance with the federal standards;
3. The County's procurement and disposal/recycling requirements, and standards for efficiency and mercury and lead content;
4. The County's guidelines for best practices in outdoor lighting, to reduce nighttime light pollution, light trespass and glare; and
5. Exceptions allowed, including safety and productivity considerations, and feasibility determination by Department Directors.

This Plan also supports other King County efforts regarding energy conservation:

- 2010 King County Strategic Plan that calls for the County to minimize the carbon footprint, and incorporate sustainable development, design, construction and operation practices for all County facilities;
- King County Green Building and Sustainable Development Ordinance and King County Code chapter 2.95 that requires King County buildings and capital projects to utilize the Leadership in Energy and Environment Design (LEED) Rating System or the King County Infrastructure Scorecard.

Under either of the aforementioned rating systems, specific credits can be achieved that relate to reducing light pollution (Appendix E).

In response to the Council's direction, this lighting implementation plan includes the following specific information and guidelines:

1. An implementation plan for the cost effective replacement of lighting in County facilities that do not meet federal energy efficiency standards established in 10 CFR Part 430 (2009). The implementation plan includes general guidelines to divisions for when noncompliant lighting should be replaced and addresses the proper disposal of spent lighting;
2. Procurement standards for lighting equipment, which at a minimum meet the new federal energy efficiency standards established in 10 CFR Sec.430.32 (2009);
3. A summary of the current and planned activities of the Solid Waste Division related to educating citizens on the proper disposal of spent compact fluorescent light bulbs and linear tubes;
4. Analysis of policies to establish mercury and lead content standards for all new lighting products purchased by King County, and recommended content standard and a financial analysis of the costs to the County of such a standard;
5. A summary of activities related to working with the state to solicit vendors for the state lamp and ballast contract who will take back spent lamps, preferably at no additional cost;
6. Guidelines to reduce the light pollution from outdoor lighting on county facilities that is misdirected, excessive or unnecessary, while maintaining the lighting essential for public safety.

KING COUNTY LIGHTING IMPLEMENTATION PLAN

CHAPTER 1: Lighting Efficiency and Compliance with Federal Standards

I: Background

In 2009, the United States Department of Energy (DOE) issued efficacy standards for general service fluorescent lamps and incandescent lamps. This federal rule, 10 CFR Part 430 (2009), “Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps,” introduces standards that will phase out the least efficient lamps over the next few years, beginning in 2012. The federal government began regulating fluorescent and incandescent lamps with the passage of the Energy Policy Act of 1992 (& 2005), expanded by the Energy Independence and Security Act of 2007, and finally with the DOE rules that are referenced in the King County 2010 Energy Plan and Ordinance 16769.

The Department of Energy’s analyses indicate that on average residential and commercial consumers would see benefits from the proposed standards when considering the life-cycle cost savings of products. This analysis takes into account the higher purchase price of high-efficacy lamps and the energy efficiency gains that would result in lower energy costs which more than offset the higher costs for the majority of consumers.

Incandescents

Federal standards require all general-purpose light bulbs that produce 310–2600 lumens (40-watt to 100-watt) of light be 30 percent more energy efficient than current incandescent bulbs by 2012 to 2014. The efficiency standards will start with 100-watt bulbs in January 2012, followed by 75-watt bulbs in January 2013 and end with 60-watt and 40-watt bulbs in January 2014 [Table 1]. Light bulbs outside of this range are exempt from the restrictions, as well as several classes of specialty lights, including appliance lamps, 3-way, colored lamps, and plant lights. The law requires increased efficiency. It does not ban incandescents or mandate Compact Fluorescent Lamps (CFLs).



Table 1. General-Service Incandescent Lamps

Current Wattage ¹	Rated Lumen Ranges	Future Maximum Rated Wattage	Minimum Rated Lifetime ²	Effective Date
100w	1490-2600	72	1,000 hours	January 1, 2012
75w	1050-1489	53	1,000 hours	January 1, 2013
60w	750-1049	43	1,000 hours	January 1, 2014
40w	310-749	29	1,000 hours	January 1, 2014

Notes:


1) Light bulbs outside of this range are exempt from the restrictions, as well as several classes of specialty lights, including appliance lamps, 3-way, colored lamps, and plant lights.

2) County staff has noted that the minimum rated life of 1000 hours is large reduction from that of most commercial lamps, and purchase of such short life lamps would be a poor strategy for the County. County purchasing standards should consider life-cycle costs, including equipment replacement costs as well as labor.

Halogens

Also affected by federal law are the standard halogen lamps, including the Parabolic Aluminized Reflector (PAR) PAR20, PAR30 and PAR38 which will be regulated within the 40 – 205 watt range by minimum Lumen per Watt (LPW) standards, effective July 14, 2012.


Table 2: Halogen PAR Lamps

Lamp Wattage	Lamp Type	Diameter	Voltage	Minimum LPW; expressed here as a range for 40W through 205W, as LPW is derived from a formula based on lamp watts
40W-205W 	Standard Spectrum	> 2.5 inches (PAR30, PAR38, BR30 & ER30, BR40 & ER40)	≥ 125 (130V)	6.8 X lamp watts ^{0.27} 18.4 to 31.9 LPW
			< 125 (120V)	5.9 X lamp watts ^{0.27} 16.0 to 27.6 LPW
		>2.25 inches & ≤ 2.5 inches (R20 & PAR20)	≥ 125 (130V)	5.7 X lamp watts ^{0.27} 15.4 to 26.7 LPW
			< 125 (120V)	5.0 X lamp watts ^{0.27} 13.5 to 23.4 LPW
40W-205W	Modified Spectrum	Standards are approximately 17% less stringent than for Standard Spectrum Lamps. Exemptions		
Lamps not impacted include: lamps under 40 watts, lamps over 205 watts, colored, rough/vibration service, shatter resistant and heat lamps				
*Example: 60 Watt PAR 38: $LPW = 5.9 \times 60^{0.27} = 17.8$ Lumens Per Watt				

Fluorescents

Effective July 14, 2012, General Service Fluorescent Lamps (GSFL), including linear T12, T8 and T5, and U-bend lamps, must meet minimum LPW requirements set by the 2009 DOE regulations. The new standards will result in the elimination of many inefficient 4-foot T12 and 2-foot T12 U-bend lamps, most 8-foot T12 lamps and some 4-foot T8 lamps from the marketplace. These new efficiency standards also require that ballast manufacturers meet minimum Ballast Efficacy requirements (BEF's), which already resulted in the phase-out of the largest and least efficient tubular fluorescent ballasts (T-12s) in 2010. The T-12 fluorescent replacement tubes will no longer be available, effective on July 14, 2012.

Table 3: General Service Fluorescent Lamps (GSFL)

Lamp Type	Correlated Color Temperature (CCT)	Energy Conservation Standard (Lumens/Watt)
	≤4500K	89
	>4500K and <7000K	88
2-foot (T8-T12) U-shaped ≥ 25W	≤4500K	84
	>4500K and <7000K	81

8-foot (T8-T12) single pin slimline \geq 52W	\leq 4500K	97
	$>$ 4500K and $<$ 7000K	93
8-foot (T8-T12) High Output	\leq 4500K	92
	$>$ 4500K and $<$ 7000K	88
4-foot (T5) miniature bi-pin standard output \geq 26W	\leq 4500K	86
	$>$ 4500K and $<$ 7000K	81
4-foot (T5) miniature bi-pin high output \geq 49W	\leq 4500K	76
	$>$ 4500K and $<$ 7000K	72

II: Guidelines/Plan Progress

Replacement Process

King County can address many of these efficiencies by adopting the practice of when replacing each lighting fixture or bulb in the normal course of maintenance of public buildings to replace with a lighting fixture or bulb that is as energy efficient as practical and always exceeding the federal standards described in this document. Also, the County should prioritize the purchase of energy-efficient technology when doing whole building upgrades and capitalize on energy efficiency programs through utility companies. These actions will all pay back in time because the new lamps will use less energy.

- Use Compact Fluorescent Lamps (CFLs) - They are available now in the marketplace and are more energy efficient than incandescent lamps. These should be used now wherever practicable in place of incandescent bulbs, except in specialty applications where incandescents are still acceptable.
- Use more efficient halogen lamps – They are available now to replace those currently used and will be required starting July 14, 2012.
- Use more efficient tubular fluorescent lamps and ballasts - such as T8's and T5's; they are also currently available in the marketplace. Whenever T12 lamps are replaced with T8 lamps, the ballast must also be replaced because T8 lamps require electronic ballasts specifically designed to operate lamps at a lower current than T12 lamps. King County agencies can replace bulbs and fixtures as they fail, and during whole building upgrades. There will be fewer choices, as some lamps will no longer be available in the marketplace.
- Use the County's universal lamp and ballast contract for purchases of the most efficient lighting, which adhere to federal standards (new contract will be issued in Summer 2011).



Requirement for Lighting Systems Review and Replacement Plans

Since there will be a significant cost associated with replacing the oldest, least efficient lighting, most of which are expected to be T-12 - type, each division will need to inventory the lighting in the buildings that they are responsible for and produce a maintenance plan and available budget for replacement. If not currently in process, this work should commence immediately to identify possible added budget requirements for replacements in 2012 and beyond. Responsibilities include:

- Identify fluorescent lamps currently in use that will no longer be available after 2012
- Identify all locations where these lamps are still used

- Create a plan to replace, or retrofit, fixtures in a timely manner, including:
 - Timeline/Schedule
 - Budget/Costs
 - Utility rebates, if available
- Research utility rebate opportunities and use expeditiously – Utility rebates are currently available for upgrading many lighting types to premium efficiency. These may include some upgrades to meet the upcoming federal standards, but such rebates will not continue after the standards are enacted as they will become mandatory; therefore, facilities that need to replace lighting to meet the standards should act quickly to take advantage of cost reduction opportunities that will not be available later.
- Stock sufficient lamps for short-term replacements, if needed, until fixture replacements can be budgeted and scheduled. This strategy should only be pursued where justified based on critical shortage of budget.
- Implement plans according to created timeline

Procurement Standards for Efficiency and Mercury and Lead

King County Procurement and Contract Services are currently working with the State of Washington to insert our requirements into its new lamp and ballast solicitation to be bid in June 2011. The State of Washington has similar goals to be energy efficient and reduce mercury (HB 1002/RCW 70.95M.060) in products purchased and is also required to meet federal lamp efficiency requirements. The State of Washington is using “best value” contracting in its solicitation, where it takes into account many non-cost factors including mercury and lead content, lamp life, lamp efficiency and recycling. Since the federal government does not currently set mercury limits on lamps, the State is referencing the mercury limits on lamps set by the European Union’s Restriction of Hazardous Substances (RoHS) Directive. This directive also phases out the use of lead solder and U.S. manufacturers are eliminating lead solder to comply. King County anticipates that by combining its purchase volume with the State’s, it can secure better pricing, and intends to use this contract for most lighting purchases.

Recycling Requirement

King County agencies will continue to adhere to Executive Policy PUT 7-3 (AEP) Mercury-Containing Lamp Recycling and recycle spent lamps through the existing contract with Ecolights Northwest, a local company. Based on an earlier State of Washington solicitation for recycling services, King County maintains a universal contract for spent lamp recycling with Ecolights Northwest (ARMS B21907B and Oracle 443963).

In 2011, the State of Washington made the determination to keep the procurement contract for new lamps and ballasts separate from the existing recycling contract. The state recycling contractor does charge a small fee for recycling lamps and ballasts, but the state determined that it would cost more for the supplier of new lamps to take-back lamps, as they are not currently equipped to handle this demand. Instead, the new vendor of lamps will be required to educate end-users about the current recycling contract when they sell new lamps.

Proper Disposal Education for Citizens

- During 2011, the Solid Waste Division (SWD) will continue to promote proper recycling of spent fluorescent bulbs and tubes through its private sector network called the Take it Back Network. This program includes a website (www.takeitbacknetwork.org), brochure, and direct mail advertising that promote proper recycling and list the location of 68 recycling sites in King County.
- The King County Master Recycler Composters program will provide education about recycling fluorescent bulbs and tubes at selected events in King County.
- SWD will promote fluorescent bulb and tube recycling at the household hazardous waste collection facilities, through direct mail advertising to residents, and through its website postings and post cards, among other outreach efforts.
- SWD will continue to work with the garbage haulers in King County to educate residents about proper recycling of fluorescent lighting through its annual collection calendars and information on their websites.

KING COUNTY LIGHTING IMPLEMENTATION PLAN

CHAPTER 2: Reducing Lighting Pollution

I: Background

King County recognizes the importance of reducing lighting pollution. Light pollution is any adverse effect of artificial light, including sky glow, glare, and discomfort to the eye or diminished vision due to lighting, light trespass, decreased visibility at night, diminished ability to view the night sky, and energy waste. A lighting pollution reduction plan will decrease negative impacts on King County residents and wildlife by reducing the harmful effects on the natural environment, human health, and social ambiance. This document provides guidelines and best practices for all King County staff to follow and incorporate in division operation and maintenance plans.

Implementation

In accordance with King County Ordinance 16769, beginning July 1, 2015, all replacement lighting with output greater than 1,800 lumens on County facilities must be fully shielded, except as described in this document under section C. Exceptions.

Although the primary focus of these guidelines is on outdoor lighting needs, interior building lights also contribute to the light pollution that can be environmentally damaging and create a visually intrusive nuisance. Therefore, consistent with energy conservation best practices, unnecessary lighting in buildings should be switched off at all times.

Reasons to limit night lighting pollution

Environmental Effects

Most terrestrial and aquatic species live according to day and night cycles constituting periods of rest and activity which are generally synchronized with sunlight. Exposure to artificial light causes harmful effects that can modify behavior, disrupt navigational ability, and increase or decrease predation levels (Appendix E).

Health Effects

Light and dark periods are essential to human physiological and biological wellbeing. Changes in light exposure can shift the timing of the circadian system disrupting sleeping patterns and the normal production of hormones (Appendix E).

Social Effects

Reducing light pollution will create safer night visibility, enhance the nighttime aesthetics and experiences for the public, and improve the ability to view the night sky. Good visibility of the stars is necessary for stellar investigations by astronomers. Light pollution, especially glare can also cause temporary blindness which is especially hazardous to vision impaired and senior populations.

II: King County Outdoor Lighting Uses

King County government uses lighting in a wide variety of its facilities and operations. The purpose of lighting varies depending on the needs and requirements of department, state, and federal mandates. Outdoor lighting is used principally to increase visibility for safety and operations, deter crime, and improve aesthetics. Basic indoor lighting in building may also contribute to outdoor light pollution if the

lights are left on at night. Most exterior lighting is permanent, but occasional lighting is required for short-term needs such as civic celebrations or promotions, emergency response, or nighttime construction.

Transportation

The Department of Transportation uses lighting at its facilities and along its infrastructure. The Road Services Division (RSD) provides street lights along roadways in more urban areas to support safe vehicle and non-motorized transportation. In rural areas, street lighting is typically placed at intersections, traffic merging sections, or other areas with safety risks such as curves or crosswalks. It also uses lighting for signals that manage traffic flow and non-motorized users, such as pedestrians and equestrians, and requires lights at its regional maintenance complex as well as several satellite facilities.

The Metro Transit Division uses outdoor lighting at its passenger and public facilities such as park-and-ride lots, bus zones, layover areas, as well as training facilities, operations bases, vehicle maintenance bases, and facilities maintenance bases. The Airport Division provides lighting for runways, taxiways, ramps, aircraft navigation, passenger/cargo terminals, and hanger facilities in compliance with Federal Aviation Administration (FAA) mandate and regulation.

Natural Resources and Parks

The Department of Natural Resources and Parks (DNRP) provides outdoor lighting for its public amenities as well as its waste processing facilities. The DNRP Parks and Recreation Division uses lighting at its sports and recreation fields, such as Marymoor Park, as well as to light parking lots and walkways at other park facilities.

The Solid Waste and Wastewater Treatment Divisions uses outdoor lighting at all operational locations such as transfer stations, landfills, treatment plants, pump stations, and parking areas to satisfy safety and security standards. Wastewater treatment plants are staffed 24 hours a day, requiring illumination for operations and safety and security standards around the clock.

Executive Services

The Facilities Management Division operates and manages many of the County's facilities for other divisions. It is also responsible for helping construct many county facilities and thus, include lighting in the design of buildings and other county facilities. Buildings, such as the detention facilities operated by Department of Adult and Juvenile Detention or public offices providing permits, licenses, and health services, require lighting to maintain safe and secure operations. Additionally, County buildings such as various district court offices have lighting for spot lighting monuments, flags, or historical buildings.

Some departments have facility-specific lighting plans and practices or lighting is governed by another agency such as Washington State Department of Transportation, FAA, or Corp of Engineers.

III: Guidelines and Best Practices

Modern light fixtures are much more efficient and provide considerably more light per unit of energy consumed. They also provide better directional control in aiming the light downward toward the surface where the light is needed rather than letting it scatter upward. Replacement of older fixtures with new luminaires can greatly improve overall efficiency while reducing light pollution.

The goal of this plan is to reduce King County's use of inefficient lighting and the occurrence of evening light pollution from county operations. The following are design and operation guidelines for reducing light pollution.

To minimize impacts to the environment, placement of light near aquatic resources in particular should be assessed and addressed on a case-by-case basis, depending on the location and species present. Lighting should also be minimized along the County's Wildlife Habitat Network <http://your.kingcounty.gov/dnrp/library/water-and-land/shorelines/map-folio-draft3/technical-appendix/forest-value-wildlife-network-e7c.pdf>. These measures will help reduce the negative impacts on wildlife, while retaining an optimal level of lighting for human activities and safety.

Those responsible for lighting designs should naturally be familiar with regulations, codes and standards ensuring safe and appropriate lighting levels and application of lights. Review of Occupational Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Act (WISHA) regulations and requirements (Appendix E), is recommended.

NOTE: The King County Green Operation and Maintenance Handbook – scheduled for publication in late 2011– will provide additional guidelines and tools for lighting.

A. Design Related Guidelines

Project managers should assess the optimal lighting needs of any project to see if lighting is needed, how much, and where, before prescriptively requiring lighting. Designing for new or replacement lighting projects, careful consideration should be given to light fixture selection. A poorly chosen light fixture can result in unnecessary energy use, and can also contribute to light pollution. Changing the source and or re-evaluating the source can yield reductions in pollution. The Backlight, Up-light, and Glare (BUG) Rating (Appendix A), the LEED Rating System, and the Sustainable Infrastructure Scorecard should be considered during the design stage of the projects (Appendix A). Following are the general design guidelines for lighting in a project:

1. Eliminate all bare bulbs and any light pointing upward;
2. Use only the minimal required amount of light warranted for safety and security (consult OSHA and WISHA standards – see Appendix E);
3. Shield lighting to ensure that light reaches only areas needing illumination; and
4. Design interior building lighting to minimize light trespass when lights are on at night.

All exterior lighting implementation plans that are 30 percent or less complete at the time of plan adoption should attempt to comply with the guidelines.

Fixtures/Luminaires

New lighting or replacement installations should consider at a minimum, the following components:

1. Provide safe roadways for motorists, cyclists and pedestrians;
2. Protect against direct glare and excessive lighting;
3. Ensure that sufficient lighting can be provided where needed for safety and security;

4. Prevent light trespass from county facilities by installing total cutoff fixtures that stop illumination at King County property lines;
5. Protect and reclaim the ability to view the night sky;
6. Design outdoor lighting to provide a uniform distribution of light without compromising safety and security;
7. Ensure that all lighting is directed to the objects or surfaces to be illuminated and not to the surrounding properties or the night sky;
8. Illuminate only stretches of roads that are considered high-risk, such as intersections and channelization or where required for pedestrian/non-motorized security;
9. Use embedded road lights to illuminate road in sensitive areas, if possible;
10. Art and monument lighting should be controlled to reduce the effect of light pollution on the night sky;
11. All unnecessary lighting should be turned off or reduced thirty (30) minutes after the facility is no longer in service; and
12. Use low wattage lamps where possible and timers and daylight sensors to minimize light use.

Shielding

Shielding is an approach designed to minimize light trespassing onto areas where darkness is desired. All exterior lighting should use full cutoff luminaires with the light source downcast and fully shielded, as shown in Appendices C and D. All area lights are encouraged to be eighty five degree (85°) full cutoff type luminaires.

Bulbs

All bulbs will comply with applicable specifications in Chapter 1 of this document.

Placement

The placement of lighting can influence the amount of light pollution generated by the lighting. Lighting can be placed under or behind existing structures to reduce the amount of light escaping to adjacent areas. Pedestrian lighting can also be situated close to the surface where illumination is needed. Placing flashing lights within the roadway or a crosswalk can be more visible than an overhead light if triggered as needed by pedestrians.

B. Operation-Related Guidelines

A poorly operated light fixture, regardless of the advanced technology, will continue to consume energy. Therefore, its operation needs to be monitored and modified as needed to reduce light pollution as well as reduce energy use. Evaluation of existing lighting plans for King County Facilities will help to determine the extent to which fixtures need to be updated or switched-out. This may result in conserving energy, while reducing light pollution.

For facilities that are LEED-eligible, selecting replacement options that also meet LEED Existing Buildings: Operation & Maintenance (EBOM) requirements will make it easier for possible LEED certification in the future. See references in Appendix E.

Timers, sensors and triggers

Photocells with motion sensors that allow a floodlight to go on at dusk and off by dawn are encouraged. Sensors should shut down the light fixture five (5) minutes after people leave (where applicable).

Sensor-activated luminaires should be used to the extent possible to reduce energy consumption and light pollution. These lights are motion-triggered to turn on when necessary thereby reducing light pollution and energy use.

1. Luminaires should not be triggered by activity off King County property. Lighting should only turn on when activated and turn off within five (5) minutes after activation has ceased.
2. Luminaires should be located in such a manner as to prevent glare and lighting onto properties of others or into a public right-of-way.

Adjustments

Some lighting needs are not consistent or uniform throughout the night. The lighting system control should activate or deactivate according to function and usage. Turning off or adjusting the amount of light a luminaire produces can reduce the amount of light escaping into the surroundings in addition to saving energy.

C. Exceptions

The following lighting categories are exempt from the light pollution and light trespass considerations of this plan; however, divisions should still attempt to comply with energy-efficient lighting criteria:

1. Temporary lighting for construction projects;
2. Temporary emergency lighting used by police, fire departments or other emergency services;
3. Hazard warning lights required by federal law and regulatory agencies;
4. Seasonal and decorative lighting displays that use multiple low wattage bulbs;
5. Navigation lights used for marine and aviation safety, obstruction lighting and airport, marine port security lighting;
6. Historical buildings that meet the requirements of RCW 19.27.120, Buildings or structures having special historical or architectural significance.
7. Road and park-and-ride lot lighting if shielded lighting is in conflict with state or federal requirements;
8. Ball field lights, but only if the Department of Natural Resources and Parks has taken steps to minimize glare and light trespass;
9. Egress lighting such as exit signs;

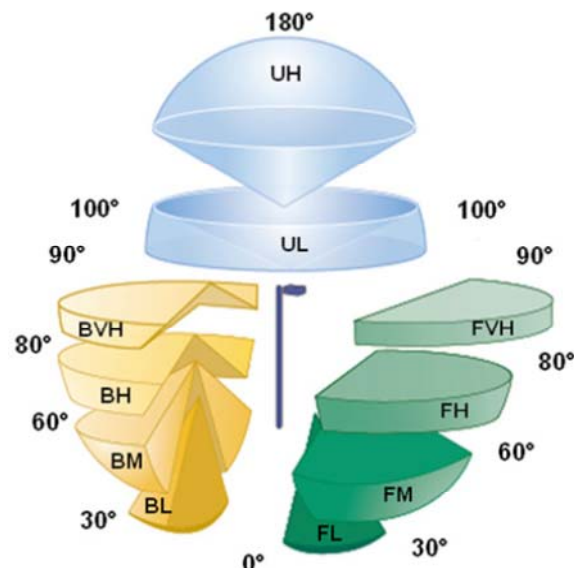
10. Up-lighting for flags, provided the flag is of a government and the maximum lumen output is one thousand three hundred (1,300) lumens. Flags are encouraged to be taken down at sunset to avoid the need for lighting;
11. Monuments and art lighting should be on timers; and
12. Lighting required to meet OSHA and WISHA regulations and requirements (Appendix E).

Exceptions from shielding requirements

1. Luminaires that have a maximum output of four hundred (400) lumens per fixture, regardless of number of lamps (equal to one 40-watt incandescent light), may be left unshielded, provided the luminaire has an opaque top or is under an opaque structure.
2. Luminaires that have a maximum output of one thousand (1,000) lumens per fixture, regardless of number of lamps (equal to one 60 watt incandescent light), the bulb is not visible, and the luminaire has an opaque top or is under an opaque structure (enclosed with in a fixture).
3. Floodlights with external shielding should be angled; provided, that no light is directed above a twenty five degree (25°) angle measured from the vertical line from the center of the light extended to the ground, and only if the luminaire does not cause glare or light to shine on adjacent property or public rights-of-way.

Appendix A – BUG System

In 2005, the Illuminating Engineers Society (IES) started work on the Backlight, Up-light and Glare (BUG) system. The BUG system is a new rating system developed to address increasing demand for control of up-light and light trespass in addition to glare. Older design criteria and concepts may be inadequate for the complex tasks of controlling light pollution. IES recommends that the new system be used exclusively.



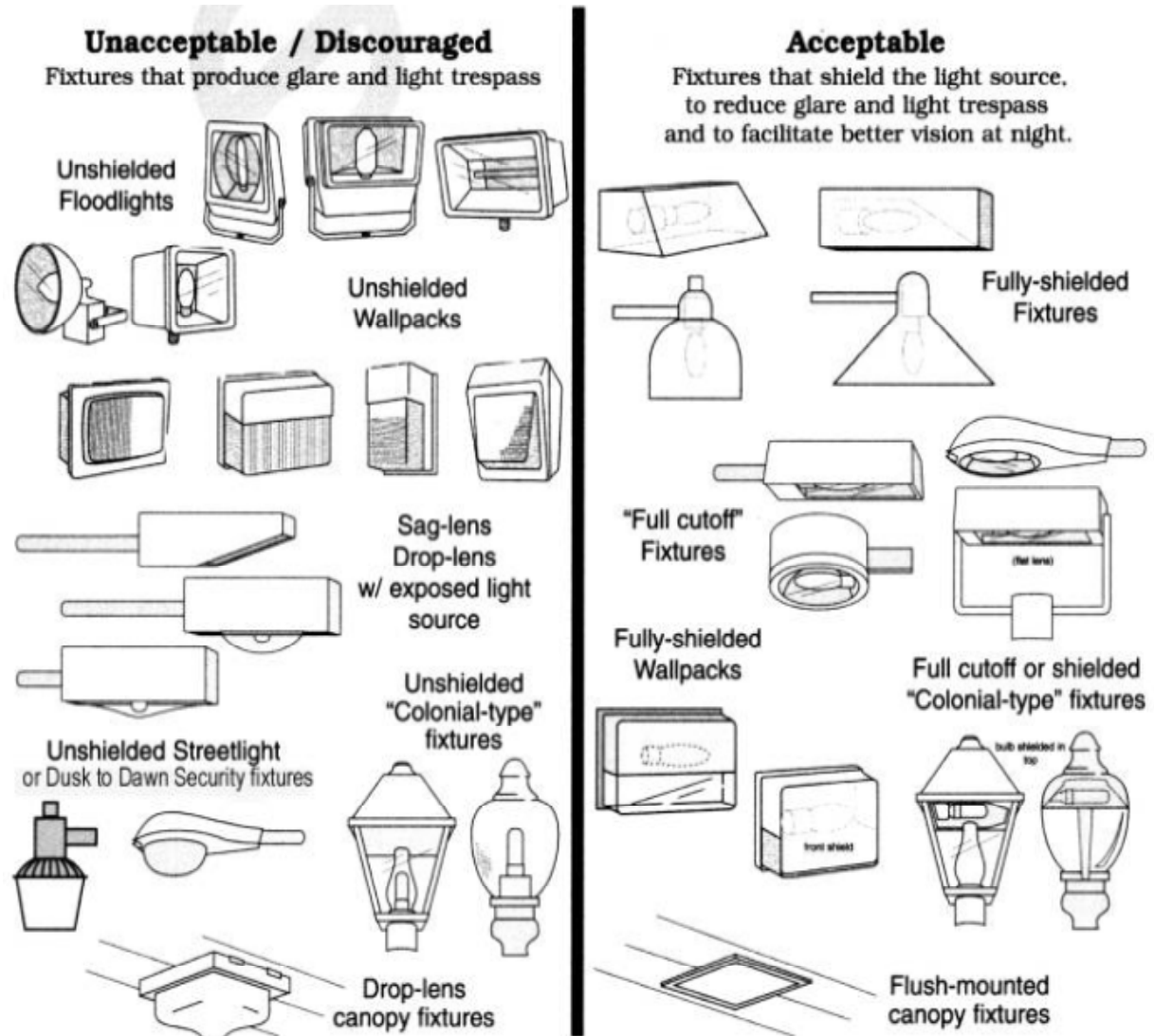
The BUG rating limits also take into consideration the distance the luminaire is installed from the property line or intended object in multiples of the mounting height.

Backlight, creates light trespass onto adjacent sites. The B rating takes into account the amount of light in the BL, BM, BH and BVH zones, which are in the direction of the luminaire OPPOSITE from the area intended to be lighted.

Up-light, causes artificial sky glow. Lower up-light (zone UL) causes the most sky glow and negatively affects professional and academic astronomy. Upper up-light (UH) zone which is not reflected off a surface is mostly energy waste. The U rating defines the amount of light into the upper hemisphere with greater concern for the light at or near the horizontal angles.

Glare, can be annoying or visually disabling. The G rating takes into account the amount of front-light in the FH and FVH zones as well as BH and BVH zones.

APPENDIX B – Lighting Fixtures



*Diagrams courtesy of Bob Crelin,
"Guidelines for Good Exterior Lighting Plans", Dark Sky Society*

APPENDIX C - "What is a full cutoff outdoor lighting fixture?"

Full cutoff fixtures do not allow light to be emitted at or above the horizontal plane running through the lowest point of the fixture.

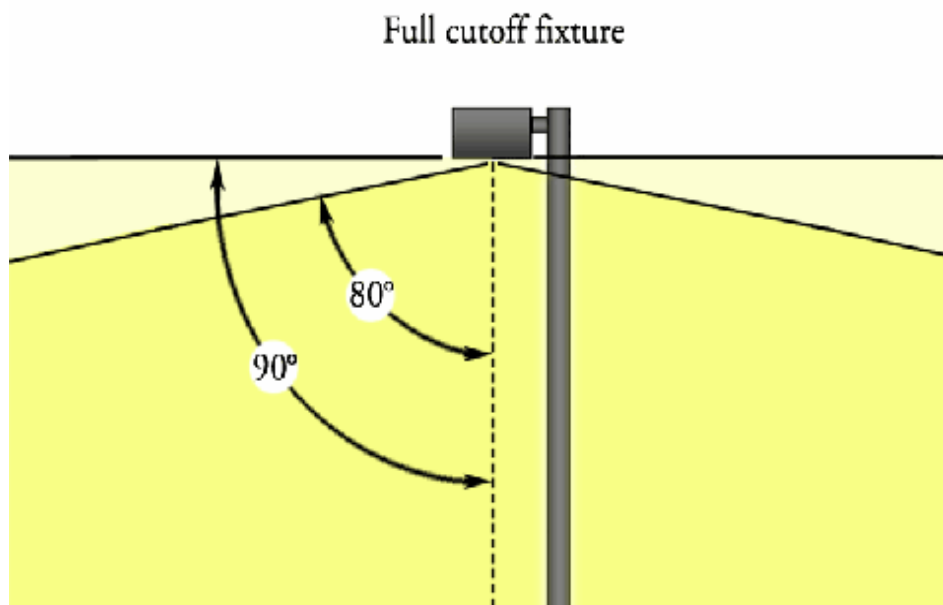
Fully shielded fixtures only allows light to be emitted below the horizontal either:

- Directly from the lamp;
- By a diffusing element below the horizontal; or by
- Indirect reflection or refraction from any part of the fixture.

Light directed towards the sky does not improve night vision. Choose luminaries emitting less than 1 percent of luminous flux above the horizon. Examples of good choices include:

- Flat lens and/or a shield that completely shades the upper surface of the bulb;
- Fixture classified as full cutoff (FCO) by IESNA;
- Lighting installed under balconies, eaves, etc.

- **No light at or about 90 degrees**
- **Less than 100 cd (candela) per 1000 lamp lumens at or above 80 degrees**



Diagrams courtesy, *"Guidelines for Good Exterior Lighting Plans"*,
Dark Sky Society

APPENDIX D – GLOSSARY

Unless specifically defined below, words or phrases used in this chapter shall be interpreted so as to give them the meanings they have in common usage and to give this chapter the most reasonable application.

AREA LIGHT: A luminaire equipped with a lamp that produces over one thousand eight hundred (1,800) lumens. Area lights include, but are not limited to, streetlights, parking lot lights and yard lights.

BULB or LAMP: The source of electric light. To be distinguished from the whole assembly (see luminaire).

CANDELA (cd): Unit of luminous intensity describing the intensity of a light source in a specific direction. One candela is one lumen per steradian. Formerly called the candle.

FIXTURE: The assembly that holds the lamp in a lighting system. It includes the elements designed to give light output control, such as a reflector (mirror) or refractor (lens), the ballast, housing, and the attachment parts.

FULL CUTOFF LUMINARIES: A luminaire designed and installed where no light is emitted at or above a horizontal plane running through the lowest point on the luminaire.

FULLY SHIELDED: The luminaire incorporates a solid barrier (the shield), which permits no light to escape through the barrier.

IES or IESNA: Illuminating Engineering Society of North America, the professional society of lighting engineers, including those from manufacturing companies, and others professionally involved in lighting.

LIGHT POLLUTION: Adverse effects of manmade light including, but not limited to, discomfort to the eye or diminished vision due to glare, light trespass, up lighting, the uncomfortable distraction to the eye, or any manmade light that diminishes the ability to view the night sky.

LIGHT TRESPASS: Light falling where it is not wanted or needed, on the property of another or the public right of way when it is not required. Also called spill light or obtrusive light.

LUMEN: The unit used to quantify the amount of light energy produced by a lamp at the lamp. Lumen output of most lamps is listed on the packaging. For example, a sixty (60) watt incandescent lamp produces nine hundred fifty (950) lumens while a fifty five (55) watt low pressure sodium lamp produces eight thousand (8,000) lumens.

LUMINAIRE: The complete lighting unit, including the lamp, the fixture, and the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power. When used, includes ballasts and photocells. Luminaries are commonly referred to as "fixtures".

APPENDIX E – References

General References

International Dark-Sky Association provides education and solutions to light pollution,

www.darksky.org

www.nwf.org/smartgrowth/pdfs/light.Pdf

<http://fwie.fw.vt.edu/jlw/light.htm>

Building and Construction References

LEED BD+C (LEED Building, Design, and Construction), NC (New Construction), EBOM (LEED Existing Buildings: Operations & Maintenance), SS credit 8, Light Pollution Reduction, pgs. 129-142. Credits related to reducing lighting pollution can be earned using either the:

- Sustainable Sites Credit 8 for LEED NC/EBOM; or
- Preserve and Maintenance Natural Site Amenities Credit 7.0 for King County Sustainable Infrastructure Scorecard.

King County Metro Transit has referenced IES RP 20-1998, “Lighting for Parking Facilities” as the lighting standard.

The Sustainable Infrastructure Scorecard uses basic concepts of the LEED® rating system, adapted to apply to infrastructure projects in King County.

<http://your.kingcounty.gov/solidwaste/greenbuilding/scorecard.asp?CategoryID=4>

The WAC/WISHA Standard used for lighting is WAC 296-800-210 (link below under LNI Core Rules which also references ANSI/IES RP7-1979). The standard has a big impact at King County Operation & Maintenance facilities, the WAC requirement is "To provide and maintain adequate lighting in your workplace." Similarly, all equipment must comply with federal OSHA standards (link below).

<http://www.lni.wa.gov/wisha/rules/corerules/HTML/296-800-210.htm>

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10630

RPA Road Illumination Standards and Section 5.05 of the KC Road Design and Construction Standards.

Washington State Energy Codes (go to Washington State Building Code, scroll down to Energy Codes.

<https://fortress.wa.gov/ga/apps/sbcc/Page.aspx?nid=14>

Buildings or structures having special historical or architectural significance - Exception

<http://apps.leg.wa.gov/rcw/default.aspx?cite=19.27.120>

City of Seattle Energy Code

http://www.seattle.gov/dpd/Codes/Energy_Code/Overview/

Environmental References

Predation: Saleh, Tiffany. 2007. *Effects of Artificial Lighting on Wildlife*. Road-RIPorter Issue: Summer Solstice 2007, Volume 12 #2 July 19, 2007.

<http://your.kingcounty.gov/dnrp/library/water-and-land/shorelines/map-folio-draft3/technical-appendix/forest-value-wildlife-network-e7c.pdf>

Health Effects References

The American Medical Association unanimously passed Resolution 516 to combat the effects of Light Pollution. *Source: American Medical Association House of Delegates - Resolution: 516 -- (A-09)*

http://www.physics.fau.edu/observatory/lightpol-prevent.html#AMA_resol

<http://data.nextrionet.com/site/idsa/breastcancerstevens.pdf>

"Lighting and the Visual Environment for Senior Living," IESNA Recommended Practice No. 28, 1998. Prepared by the IESNA Committee on Lighting for the Aged and Partially Sighted. Chair: E. Noell, Center of Design for an Aging Society, 6205 SW Hood Ave, Portland, OR 97201.

"Lighting for Aging Vision and Health," Proceedings of the 3rd International Symposium, March 22-23, 1995, Orlando, FL. Sponsored by the Lighting Research Institute.