OSP Methodology – Glow and Trespass

Outdoor Site-Lighting Performance (“OSP”) is a calculation technique designed to help lighting specifiers limit light leaving their client’s site, while providing the flexibility to meet their client’s lighting needs. OSP will allow the specifier and the community to compare the performance of the lighting system relative to other, similar sites. OSP uses a hypothetical calculation “box” surrounding an outdoor lighting installation to predict light leaving the site.

Building the Site Several features of an OSP model may be additions to the standard procedures for lighting calculation.

Light Loss Factors = 1.0 If the user wishes to compare to other OSP results, assume all light loss factors are 1.0, as this would be the worst case scenario, when all lamps are new, luminaires are clean, etc.

Include basic building geometry Simplified building masses should be included in the three-dimensional model. For simplicity, users may assume a single reflectance for the entire building. Assume, for simplicity, that a building does not emit light from the interior. Create simplified masses for trees, walls, and other landscaping if they block light from leaving the site.

Surface reflectance assumptions Assign surface reflectances to the objects in the model. Consult other project information to learn basic material specifications. If reflectance of a material is unknown, consult Table 1 below.

Ground reflectance Assume for the OSP calculation that the ground is dry and new, not wet or covered in seasonal snow. (Exception: when the site is illuminated for use at night specifically for a weather condition, such as a ski slope or ice skating rink.)

Table 1: Typical reflectances, per 1984 IESNA Handbook

Material		Reflectance (%)	Material		Reflectance (%)
Bluestone, sandstone		18	Asphalt	(free from dirt)	7
Brick			Earth	(moist cultivated)	7
	light buff	48	Granolite Pavement		17
	dark buff	40	Grass	(dark green)	6
	dark red glazed	30	Gravel		13
Cement		27	Macadam		18
Concrete		40	Slate	(dark clay)	8
Mable (white)		45	Snow		
Paint (white)				new	74
	new	75		old	64
	old	55	Vegetation	(mean)	25

Surface topography Assume, for simplicity, that the site is flat, unless undulating topography is important to the strategy to block light from leaving the site, or unless a cliff location creates a site that is viewed from below. (A cliff location may have "sides" of the OSP box that are not of a constant height, but that accommodate the changes in elevation.)

Interreflections OSP calculations must assume interreflections, not just direct contribution from luminaires. (="full calculation mode")

Curfew If a lighting system has a separate mode for late-night use or after a community curfew, be prepared to recalculate with the secondary mode in use.

Building the OSP Box around the Site

Required calculation planes An OSP box requires calculation planes on the sides, top, and ground. Side and top planes should not block light (i.e. 100% transmittance).

Location of Sides Sides of OSP box follow the property boundary. (See "Roadways" for special rules.) For purposes of simplicity, calculation planes extend all the way to the ground, to measure total amount of light leaving the site. This forms a conservative estimate for glow; indeed the light leaving near the bottom of the box might be obstructed and absorbed before reaching the sky.

Location of Top Default should be set to 10 m above highest object (pole, roof peak, etc.) Therefore, all the sides of the box will have the same height, but different widths.

Size of ground calculation plane The "ground" calculation plane should extend all the way to edge of property, even if there is no illumination of the area, and even if an area is covered by a building.

Calculation Points

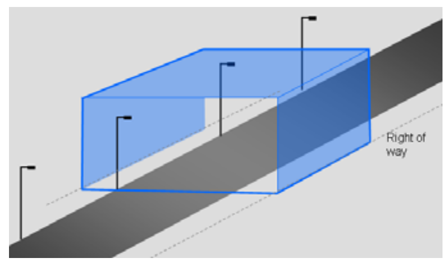
- Spacing:1 m apart horizontally and vertically, on all sides, top, and bottom
- Calculation points should be centered on each side of the box, thus, no overlapping corner calculation points.

Illuminance meter orientation

- Illuminance meters for calculation points are perpendicular to the surface, facing inward.
- Corners of the box. Since the calculation points will be centered on each plane of the box, there will not be calculation points at the corners.

Decimal precision

- For the top plane, users need enough decimal points to show at least one significant digit. (i.e., no "zero" values when the actual value is 0.04)
- For the side walls and ground, decimals are not as important, but should follow whatever convention is used with the top plane.



Roadway simplification If the roadway lighting layout is repetitive, users may select just the regular increment between two luminaires.

- Build the box to follow the right-of-way or other known boundary between the roadway and other properties
- Ignore the sides of the box that cut across the roadway. Therefore, only two "walls" will be used by OSP.
- Build the box around the repeated increment, from the centerline of one luminaire to the centerline of the next. This applies for both staggered layouts and same-side layouts.
- For all OSP calculations, measure ground illuminance all the way to the edge of the box, not just the active roadway.

Curved Roadway Sections If using OSP to model an entire complex roadway environment rather than just a repeated segment, curved roadway sections may be approximated using faceted sides.

Required Calculation results

Area of each side of the box Note that units should be consistent; if calculating illuminance in lux, convert area of each side to m^2.

Glow = average illuminance on the side planes and the top plane, weighted by area, in units of lux (or footcandles). Multiply average illuminance on a side by the area of the side. Repeat for the other sides and for the top. Add these together, and divide by total area of the sides and top of the box. Glow can be used to evaluate performance *after* curfew.

Average ground illuminance Average illuminance across the entire bottom of the box, including areas that are not deliberately illuminated. Units of lux or footcandles.

Slope Glow slope calculation = (Glow) / (Average ground illuminance). Slope is a ratio, so it is unitless. This can be used to evaluate glow performance *before* curfew.

Trespass = Maximum illuminance on the relevant surfaces of the box. (Default assumes sides of the box, but the top may be important for some sites, so user needs to be able to override.) Trespass is measured in units of lux (or footcandles).

Location (x,y,z) of maximum illuminance on the side(s). User may wish to consider trespass on each side separately, but ultimately, OSP uses one maximum value for trespass.

Curfew Repeat the calculations described above for the “after-curfew” condition. An example would be a sports facility that is extensively illuminated in the early evening hours, but after closing, only a few security lights remain on. If a lighting system is designed to turn “off” entirely after curfew, it is not necessary to repeat calculations listed above; after-curfew values would therefore be assumed to be zero.

Frequently Asked Questions: Several engineers have reviewed the OSP concept and have voiced the following common questions.

What if a physical wall is defining a property boundary? Should the OSP calculation plane be inside the wall or outside? If an obstruction stops light from leaving a site, it should be included in the model. Therefore the wall should be inside the boundaries of a site and the calculation box should be behind the wall. The calculation points behind the wall would be “0.00 lux.”

Can I measure illuminance outside my property?

Yes, of course, but measurements outside the site do not factor into OSP limits. For instance, some jurisdictions have established limits on illuminance falling on the ground of a neighbor's property (horizontal), or at a neighbor's bedroom window (vertical). If these features are known in advance, lighting specifiers can calculate them using standard lighting software functions. If not known in advance, OSP will help establish limits at the property boundary.

What if there is no property boundary? What if site is a small part of a larger site? (e.g., one tennis court on a college campus)

An OSP box can always be made *smaller* than a site, but should not be made larger than a site. The OSP box should never extend onto a neighbor's property. The smaller the OSP box, the more challenging it is to adhere to suggested limits.

Where are property boundaries for roadways?

Roadways use "set-backs" or "right-of-ways" or other lines to distinguish between public roadway jurisdiction and property owned by other entities. Whatever line is the relevant division between properties should be used for OSP. Reviewers have commented that some roadways or park pathways may require lighting outside of the property, to allow advance warning of deer, other pedestrians, etc. Special exceptions can be made by the relevant authorities, but the OSP formula should be followed in a manner consistent with this document.

Will OSP predict actual sky glow?

Sky glow is affected by the interaction of light with many factors, including water vapor, dust, dirt, pollution, and/or other particulates in the atmosphere, as well as surrounding topography, foliage, and architecture. While OSP can predict how much light will leave the site, it cannot predict these other factors. OSP cannot predict what will happen to the light after it leaves the site, that is, whether it will be blocked or re-reflected by other obstructions. The OSP term "glow" is helpful because it will help a community place practical limits on glow without extensive modeling of surroundings and changing atmospheric conditions.

Will OSP create a photorealistic rendering of the appearance of my site at night when viewed from a distance? Will OSP predict the impact of my lighting design on the reduced view of the stars?

OSP is designed as a tool to help lighting specifiers limit light leaving their client's site, while providing the flexibility to meet their client's lighting needs. It is not designed to create photorealistic renderings, nor predictions of the view of stellar constellations. OSP will however allow the specifier and the community to compare the performance of the lighting system relative to other, similar sites, and therefore set limits on light leaving the site.

How important is spectral weighting in OSP?

OSP uses calculation software, which uses the standard V(λ) photopic spectral weighting function for calculations of illuminance. OSP does not penalize or encourage the use of any particular light source. As a starting point, OSP is intended to be a simple calculation technique. If the industry wishes to emphasize the impact of particular spectra on skyglow or on changes in vision with low light, OSP could eventually accommodate spectral weighting factors. Such weighting factors would first need to be agreed upon by the lighting industry and implemented in lighting calculation software.

Does OSP employ limits on distribution (e.g., cutoff classification)?

OSP is intended to be a simple estimate of all the light leaving a site. Although some consider near-horizontal angles of light to be more detrimental to astronomy than others, near-horizontal angles may also tend to be obstructed by features both inside and outside the site. OSP does not place limits on the *angle* of light leaving a luminaire or leaving the site; OSP limits the *quantity* of light leaving the site.