Lighting Calculations

Inverse-square law

The skilled application of computerized point lighting calculations can optimize lighting levels in both the task and ambient domains in order to minimize energy consumption. The lighting professional should consider the use of point lighting calculations, both to design more energy-efficient spaces, and to create spaces with more drama and visual interest.

Point calculations are an exceptionally accurate way to compare general lighting systems. While the easier lumen method allows the comparison of average illuminance, point calculations permit the comparison of uniformity of light on the work plane, the patterns of light produced on ceilings and walls, and task contrast rendering. More specifically, point calculations allow consideration of the effects listed below.

- **Effect on Room Surfaces.** By evaluating the patterns of light on a wall caused by a row of compact fluorescent down lights, an aesthetic evaluation can be made. Artwork locations may be selected or lighting may be designed to highlight artwork. It may also be possible to determine whether the pattern created on a wall will produce luminance extremes that will cause glare or reflections in VDT screens.
- **Indirect Lighting Effects on Ceiling.** When they are too close to the ceiling, indirect lighting systems may create definite stripes or pools of light on the ceiling that are distracting and that may image in VDT screens. Careful ceiling luminance calculations can help identify the problem, and allow comparison of lighting products with various optical distributions and suspension lengths to reduce the effect. Gray-scale printouts or shaded VDT screen output of luminance make visual assessments possible.
- **Interior Task-Ambient Lighting.** Point calculations should be used for any type of lighting design where the task locations and types are well known and are unlikely to move without a lighting redesign. They may also be used for lighting designs where tasks that move end up in predefined locations.

Cautions for Point Calculations. In the case where a task light is used, or where an indirect fixture is mounted within 12 inches of the ceiling, point calculations are not always appropriate. In general, if the luminaire is close to the surface where lighting patterns are to be evaluated, a near field situation exists. A shortcoming of the mathematics used in point calculations is that these near field calculations are comparatively inaccurate unless near field photometric data is available from the luminaire manufacturer, or the computer program is capable of adjusting the

characteristics of the luminaires to improve the accuracy of the results. Otherwise, it may be more accurate to evaluate the light patterns from the task light or indirect fixture empirically.

The most common methods used for lighting calculations are:

(1) Watts Per Square Meter Method. This is principally a „rule of thumb" method very handy for rough calculations or checking. It consists of making an allowance of watts/m^2 of area to be illuminated according to the illumination desired on the assumption of an average figure of overall efficiency of the system.

(2) Lumen or Light Flux Method. This method is applicable to those cases where the sources of light are such as to produce an approximate uniform illumination over the working plane or where an average value is required. Lumens received on the working plane may be determined from the relation.

Lumens received on the working plane = Number of lamps X wattage of each lamp X lamp efficiency (lumens/watt) X coefficient of utilization/depreciation factor.

(3) Point-To-Point or Inverse Square Law Method. This method is applicable where the illumination at a point due to one or more sources of light is required, the candle power of sources in the particular direction under consideration being known. This method is not much used because of its complicated and cumbersome applications.

Design of lighting system:

Direct lighting

Lighting provided from a source without reflection from other surfaces. In daylighting, this means that the light has travelled on a straight path from the sky (or the sun) to the point of interest. In electrical lighting it usually describes an installation of ceiling mounted or suspended luminaires with mostly downward light distribution characteristics.

Indirect lighting

Lighting provided by reflection usually from wall or celiling surfaces. In daylighting, this means that the light coming from the sky or the sun is reflected on a surface of high reflectivity like a wall, a window sill or a special redirecting device. In electrical lighting the luminaires are suspended from the ceiling or wall mounted and distribute light mainly upwards so it gets reflected off the ceiling or the walls.

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