VŠB - TECHNICAL UNIVERSITY OF OSTRAVA
FACULTY OF ELETRICAL ENGINEERING
AND COMPUTER SCIENCE
DEPARTMENT OF ELECTRICAL POWER ENGINEERING

MODELOVÁNÍ VYZAŘOVÁNÍ DO HORNÍHO POLOPROSTORU Z VELKÝCH SVĚTELNÝCH ZDROJŮ
RADIATION TO THE UPPER HEMISPHERE FROM LARGE LIGHT SOURCES MODELING

YEAR: 2019 **GOVINDARAJAN VIJAYASATHI**

VŠB - Technical University of Ostrava
Faculty of Electrical Engineering and Computer Science
Department of Electrical Power Engineering

Diploma Thesis Assignment

Student: **Vijaya Sarathi Govindarajan**

Study Programme: N2649 Electrical Engineering

Study Branch: 3907T001 Electrical Power Engineering

Title: Radiation to the Upper Hemisphere from Large Light Sources Modeling
Modelování vyzařování do horního poloprostoru z velkých světelných zdrojů

The thesis language: English

Description:

- Obtrusive Light - Definitions
- Obtrusive Light Sources - Description
- Modeling of Radiation to the Upper Hemisphere - Theory
- Calculation of Radiation to the Upper Hemisphere from Different Sources
- Comparison of Radiation to the Upper Hemisphere from Different Sources

References:

[1] Narisada, K.: Light Pollution Handbook, Springer
[2] CIE - Proceedings
[3] CIE - Technical Reports (CIE 150, CIE 126, ...)
[4] Building Design Software
[5] EN 12464-2, EN 13201

Extent and terms of a thesis are specified in directions for its elaboration that are opened to the public on the web sites of the faculty.

Supervisor: **doc. Ing. Tomáš Novák, Ph.D.**

Date of issue: 01.09.2018
Date of submission: 30.04.2019

VYSOKÁ ŠKOLA BÁŇSKÁ-TECHNICKÁ UNIVERZITA Fakulta elektrotechniky a informatiky 1D16 OSTRAVA

prof. Ing. Stanislav Rusek, CSc.
Head of Department

prof. Ing. Pavel Brandštetter, CSc.
Dean

Acknowledgements

First, all admire and magnificence are to god, only with his help and guidance this success has become possible. I like to give my thanks and appreciation to my supervisor, Ing. Thomas Novak, Ph.D, for his constant encouragement, helpful discussions and guidance throughout this project. His generosity with time and constructive comments were of vital support and were above the call of duty.
I would like to convey deepest love and obedience to my caring parents and elder sister for their support and guiding me all through my life until today, which keeps me strong and honest to do the things I needed to do.

Author
GOVINDARAJAN VIJAYASARATHI
GOV0001

ABSTRACT:

Article targets to show potential of software goniophotometer from point of view calculation of the luminous flux leads to upper hemisphere from road lighting system. Basis for this model is building in vyskovice. The thesis further focuses on modeling of radiation in the upper-half space from public lighting system, billboards, cars and windows. The calculation is done for the vyskovice region where the buildings, roads, pavements etc., are designed using AutoCAD as accurate as possible for maximum efficiency of calculation. The purpose of a goniophotometer is to measure luminous intensity or luminous intensity curves. The principle of a goniophotometer is that it allows measuring the luminous intensity in different planes and in different angles, which can be easily interpreted by a sphere with a network of calculation points. The goal of implementing such a network of calculation points is to extend the possibilities of a computational program for modeling the luminous intensity curves of existing luminaires as well as new luminaires. The main goal is calculating the radiation of the luminous flux flowing into the upper half from the outdoor lighting system. Based on the testing, it will be possible to create model of lighting system in city by inserting LDT data of real luminaires. From the resulting model it will be possible to quantify the proportion of the direct and indirect luminous flux flowing into the upper half space.

Keywords—software goniopgotometer, obtrusive light, road lighting, luminous flux, radiation, upper hemisphere

LIST OF FIGURES:

1. INTRODUCTION:

The aim of the article is to showcase the usage of the sphere network of computing points used to model the radiation of the luminous flux from a public lighting system that is pointing to a top of the half-space.

The obtrusive light formed a clash between astronomical public and illumination experts. Citizens normally complain because of the radiation of light intrudes their homes which fails to follow an energetic concept of individual states as well as multinational states. This obtrusive lighting is represented in terms of total luminous flux that spreads to the upper half-space which increases sky brightness. This sky brightness is formed by the terrain based on direct and indirect luminous flux.

The evaluation of the luminous flux is distributed directly to the upper half-space based on a ULR value, that is determined by the below given equation,

ULR = ULOR/ULOR+DLOR

Where:

ULR = Proportional direct luminous flux radiated to the top of the half- space.

ULOR = Luminous flux radiated directly from luminaire to the top of the half-space.

DLOR = Luminous flux reflected from the surfaces of the surrounding objects.

ULOR +DLOR = Sum of luminous flux radiated at the top of the half-space.

The software calculation uses inverse square law as follows,

$E=I/l^2$

E = ILLUMINANCE(lx)

I = LUMINOUS INTENSITY(cd)

l = DISTANCE (m)

1.1LIGHT SOURCES:

Light source is utilized to emit light in-terms of LUMENS that is not same as wattage of the source which is major cause of obtrusive light. Night time visual tasks are dependent on light radiated within a visual spectrum. Light from spectrum of the shorter wavelengths has more effects of both flora and fauna. A research proved that light emitted from blue end of the spectrum has non-visual effects on human body i.e. disturbing our sleep/wake pattern which must be minimized because night-time tasks like night-driving and sports need full alertness to aid to safety.

1.2OBTRUSIVE LIGHTING:

Obtrusive lightning or light trespass are known as the process in which light falls on unplanned territory that is occurred due to emission of excessive emission than targeted emission from luminaries. This excessive emission is caused by the luminaries due to poor lighting design i.e. lighting on the cheap. An example of the poor design is like increasing distance between the lighting fixtures to reduce the number of lighting poles that might substantially reduce the overall cost of the implementation process. The effect of the above discussed implementation is that the light is emitted at high angles which will cause glare and so it vastly degrades the visual ability which causes accidents. Due to the cause the design fails to

follow a basic rule in lightning that is to avoid occurrence of harm. The major disadvantage is impact of glare is greater on senior people that reduce quality of life.

1.3LIGHT TRESPASS:

Light trespass is effect of light entering a nearby territory i.e. neighbors bedroom window which causes a total failure of design in property rights of acrimonious encounters by harmonious communities that mitigates community lightning standards. This light trespass is occurred by street lights that are installed by municipalities in which the designer is more concerned about uniformity ratio than quality and effect of stray light. The glare occurred due to light trespass must be minimized by directing light in a specific target territory.

1.4SKY GLOW:

An up-light caused by poorly directed light or excessive illumination levels is determined as Sky glow which is artificial. This affects the research performed by astronomers to view faint objects in night sky that affects progress of civilization. The impact of artificial light at night has serious negative consequence on ecology of human health and wild life. The enormous wastage of energy that is used to emit enormous amount of unwanted light must be considered because they cause air pollution and global climate change. A research has improved that wide range of energy degradation is improving due to improper wastage of outdoor lightning.

1.5LUMINARIES:

Luminaries are important products that must be selected correctly to minimize glare and spill light that is caused by a light source. Lightning equipment's that are specifically designed within lightning rules to minimize upward spread of light near and above the horizontal plane. The deign to reduce sky glow is by making sensitive/critical zones between 90 and 100 degrees that are referred as upward light output zone.

1.6INSTALLATIONS:

Installation of the light sources must be done correctly. Basically sports and area lighting installations must be done with double-symmetric beams that is arranged near parallel to the surface being lit that ensures minimum obtrusive light. The basic installation of light must be installed high as possible to control glare on road. The glare is reduced by emitting main beam angle towards potential observer that is lesser than 70 degree. Higher mounting heights must be followed to lower main beam angles to assist reducing glare. The positioning of the light equipment's must be taken care in low ambient areas to realize domestic security lighting. The positioning angles are defined on the image given below

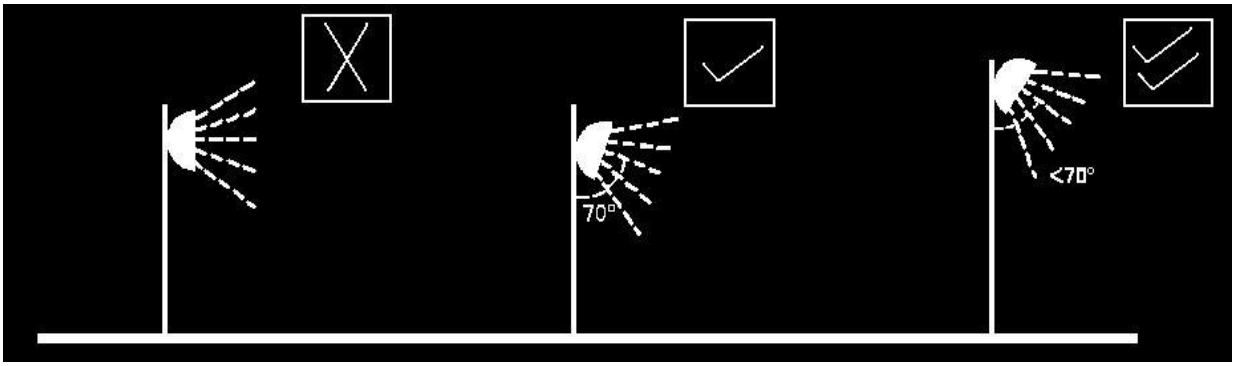


Figure 1 PROPER INSTALLATION

The above diagrams shows luminary aiming angles of light sources. The lightning structures in advertising signs must be positioned directly downwards as possible. In decorative lightings in buildings where there is no alternative for up-lightning effect then shields, baffles and louvers are used to reduce spill light over the structure. In rural areas full horizontal cut off luminaries installed at 0-degree to reduce to minimize visual intrusion in open landscape. In urban locations the luminaries are installed in more decorative bowl to provide better optical control.

1.7FACTS AND SOLUTIONS:

Artificial light is added to the list of statutory nuisances in England, Wales and Scotland since 2006. Environmental Health officers (EHO) are appointed to monitor the above nuisances based on separate guidance that is produced by the Local planning authorities (LPAs). The Scottish executives has published as design methodology document for controlling light pollution and reduce energy consumption to assist mitigating obtrusive light elements at design stage.

1.8POINTS TO CONSIDER BEFORE DESIGNING AND IMPLEMENTING LIGHTING FIXTURES:

a) UPWARD LIGHT RATIO:

Some lighting schemes like ground recessed luminaries, ground mounted floodlights and festive lighting must effectively calculate upward light ratio to avoid wastage of upward light by effectively applying suitable directional luminaries and light controlling attachments.

b) LIGHT INTRUSION LEVEL:

Some complaints have been received in highways where building facades are adjacent to lit highway in which required level cannot be obtained. In such cases the highway authorities must fit some shields and replacing an effective luminaire to minimize light intrusion into the window. The light intrusion level must be taken into consideration because the values are suggested to be maxima according to value recorded in point of measurement.

c) LUMINAIRE INTENSITY:

The intensity is measured for each luminaire on potentially obtrusive direction outside the area being lit. Proper intensity is tough to obtain in sports lighting applications with limited mounting heights.

d) BUILDING LUMINANCE:

The building luminance value must be minimized to avoid over lightning. This luminance is applicable to the building when light is directly illuminated on the buildings but in night-time this is not applicable due to spill light from adjacent luminaries.

PROPOSED OUTDOOR LUMINAIRE CLASSIFICATION SYSTEM:

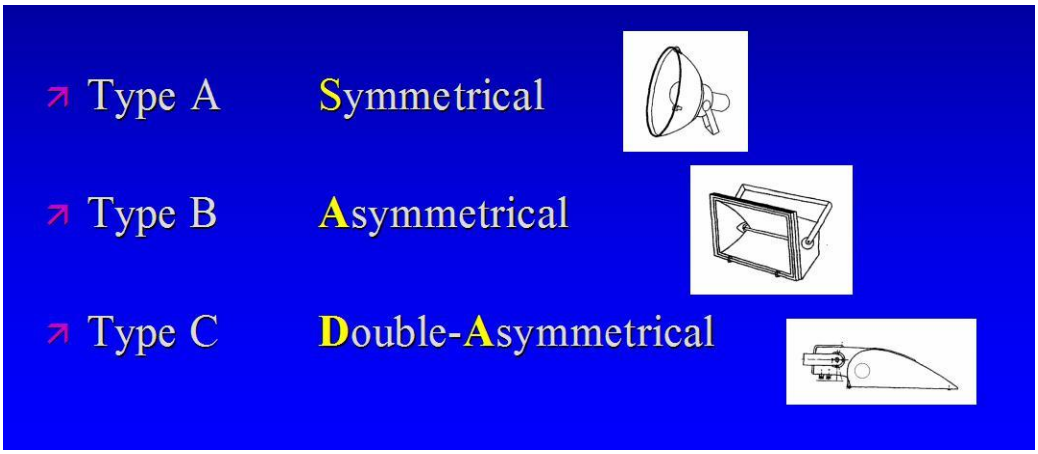


Figure 2 OUTDOOR LUMINAIRE CLASSIFICATION

1.9PROPOSED LABELLING SYSTEM:

Fixed position luminaires **Variable aim luminaires**

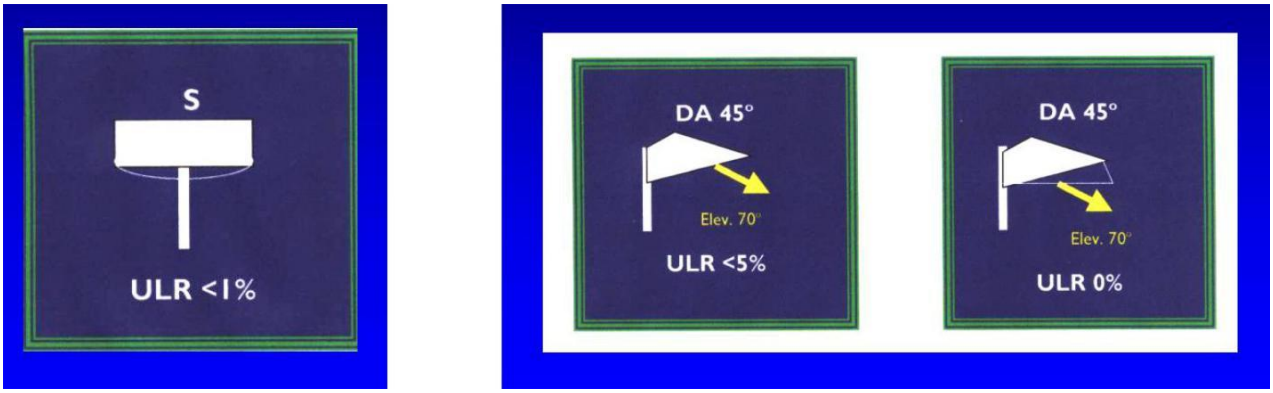


Figure 3 LABELLING SYSTEM

1.10ILLUSTRATION OF LUMINIARE ACCESSORIES FOR LIMITING OBTRUSIVE LIGHT:

Cowl **External Louvre**

Figure 4 LIMITING OBTRUSIVE LIGHT

Shield **Barn Doors**

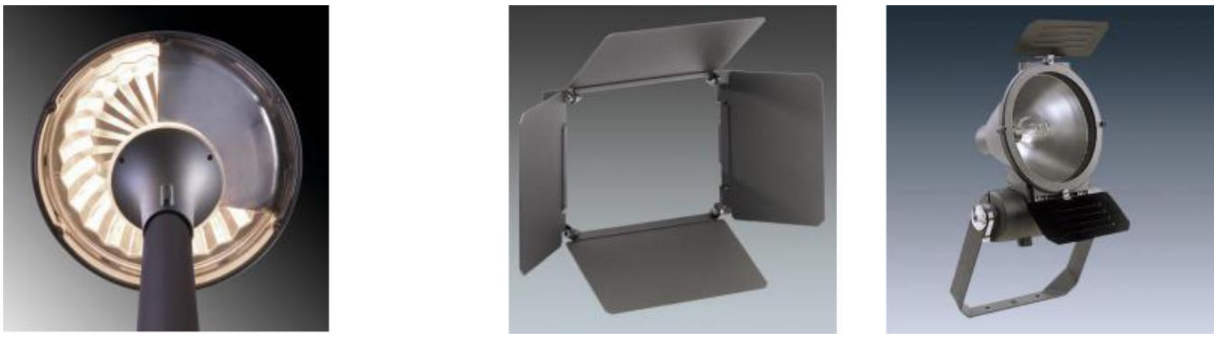


Figure 5 LIMITING OBTRUSIVE LIGHT USING SHIELD AND BARN DOORS

2. MODEL OF VYSKOVICE USING WILS SOFTWARE:

A city with a road and build up-area was used as based of a design. The class of the road was named as M5, where the build-up area is build-up of a residential area and an industrial building near the road. The built-up area and the road are built with a payment to act as obstacles based on a certain reflectivity for the lighting system which spreads the luminous flux.

Figure 6 MODEL OF VYSKOVICE

GROUND PLANS AND THE PARAMETERS OF THE MODEL CITY CREATED IN THE PROGRAM WILS ARE SHOWN BELOW:

Parameter	Reflectivity (%)

Road	**10**
Pavement	**30**
House	**30**
Industrial building	**30**
Grass	**10**

TABLE-1 DESIGN PARAMETERS

The computing points of the network for both direct and reflected components are set five time of the longest dimension in the model city so as to allow match as a point source.

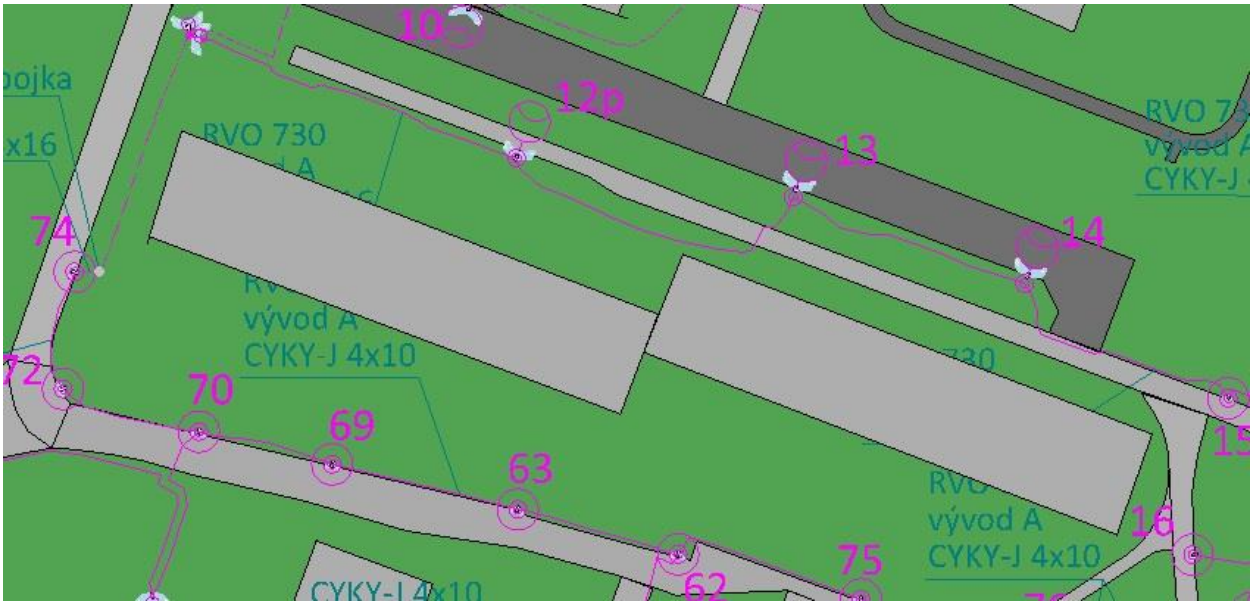


Figure 7 BUILDINGS, PAVEMENTS, GRASS, ROADS AMD LAMPS DESIGN

The computation operation is done with maintenance factor which gives comparison between input and output data. The maintenance factor was calculated because to make sure that aging of the luminaires and light sources would not affect the recorded computation data, where the lighting system was designed to work with maintenance factor in real situation.

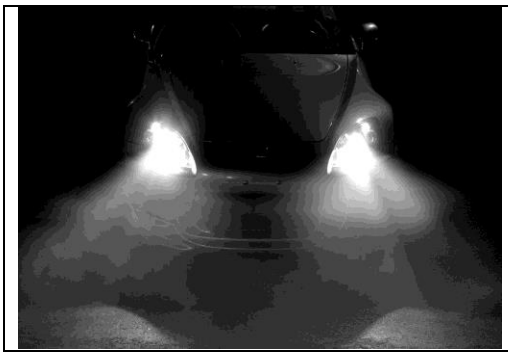
TABLE-2 LUMINAIRES TYPES AND PARAMETERS

Source Of Obtrusive Lighting	System Power(kW)	System luminous flux (klm)	ULOR (klm)	DLOR (klm)	ULOR + DLOR (klm)	ULOR + DLOR

						(%)
Schréder - LED SCHR Voltana 2 28W 	1.988	198.942	0	161.143	161.143	80.9
-	-	-	-	-	-	-
Schréder - LED SCHR Voltana2 20W 	.700	72.660	0	58.854	58.854	80.9
Schréder - LED SCHR Voltana3 41W 	.492	24.912	0	20.178	20.178	80.9
Schréder - LED SCHR Voltana3 55W 	.440	43.968	0	35.614	35.614	80.9
Schréder - LED SCHR Voltana4 75W	.575	462.283	0	388.318	388.318	84

						
Philips - PHILIPS LUMA 1 40 LED 57,1W 	.3997	58.562	0	52.120	52.120	89
Philips - PHILIPS LUMA MINI 12 LED 15,3W 	.153	20.020	0	18.218	18.218	91
Philips - PHILIPS LUMA MINI 12 LED 25,4W 	1117.6	158.400	0	142.560	142.560	90
Thorn - LED THORN R2L2 21W 12	.693	86.856	0	86.856	86.856	100

						
Thorn - LED THORN R2L2 36W 55 	.324	47.196	0	47.196	47.196	100
Thorn - LED THORN R2L2 53W 24 	.901	116.161	0	116.161	116.161	100
WINDOWS 	----------	10.800	4.536	3.888	8.424	77.9
BILLBOARDS 	----------	73.350	36.675	32.274	68.949	94
CARS	----------	29.340	4.107	1.467	5.574	18.9

3. DETAILED SPECIFICATION AND LUMINOUS FLUX DISTRIBUTION OF OBTRUSIVE LIGHT SOURCE:

3.1 INSTALLED WINDOWS:

The windows are built on pre-determined and calculated guidance. The illuminators are placed around the building as per real life scenario as possible. The lighting system is composed of 400 windows with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

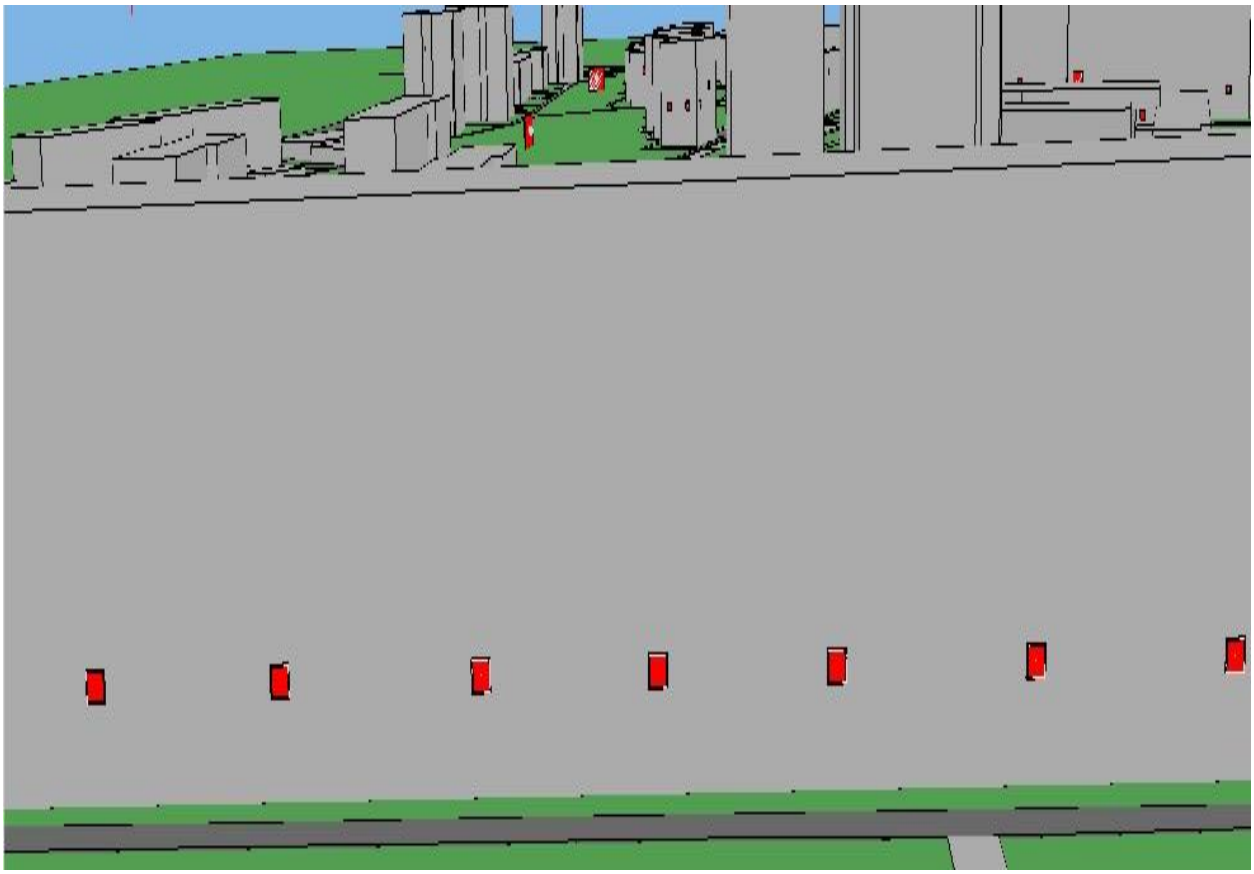


Figure 8 INSTALLED WINDOWS

TABLE-3 PARAMETERS OF THE WINDOWS

Luminaire	**400x WINDOWS**
Size of the luminaire (mm)	**1200X1200**
Power consumption of the luminaires (W)	**30**
Power consumption of the lighting system (W)	**12000**
Luminous flux of the source (lm)	**27**
Luminous flux of the lighting system sources (lm)	**10800**
Efficiency (%)	**100**
Luminous flux of the luminaire (lm)	**27**
Luminous flux of the lighting system(lm)	**10800**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system.

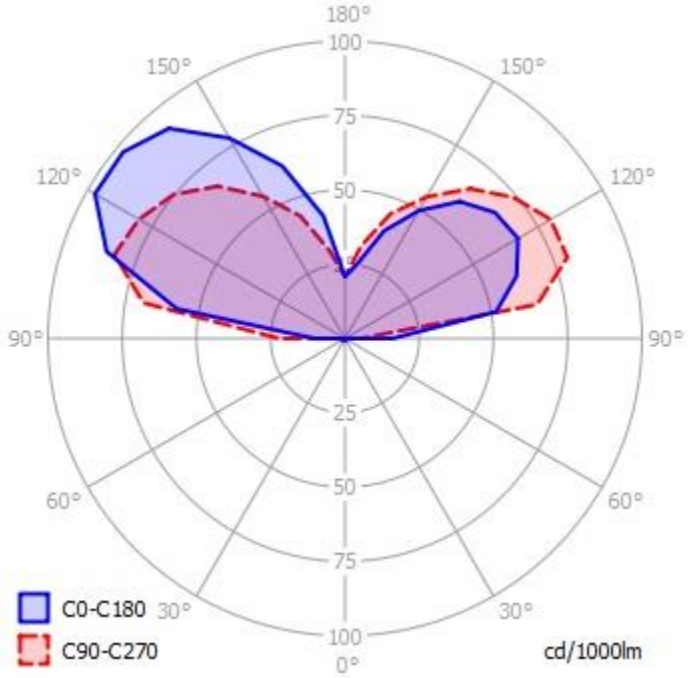


Figure 9 WINDOWS - DIRECT + REFLECTED PART OF THE LUMINOUS FLUX

The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

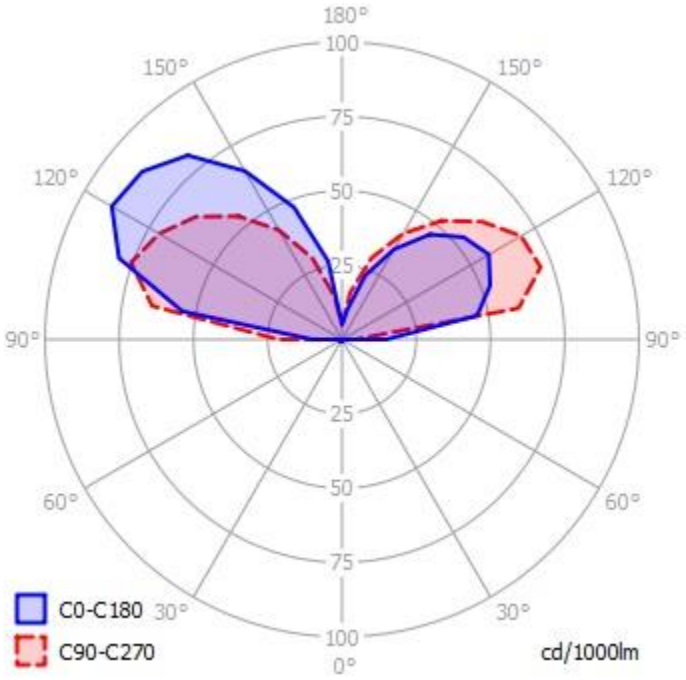


Figure 10 WINDOWS - DIRECT LUMINOUS FLUX

42% from 10800 lm for complete radiation to the upper hemisphere is 4536, 36% from 10800 lm only for direct part is 3888, so the reflected part of the luminous flux is 648 i.e. 6%

3.2 INSTALLED BILLBOARDS:

The billboards are built on pre-determined and calculated guidance. The illuminators are placed around the roads and bridges as per real life scenario as possible. The lighting system is composed of 10 billboards with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

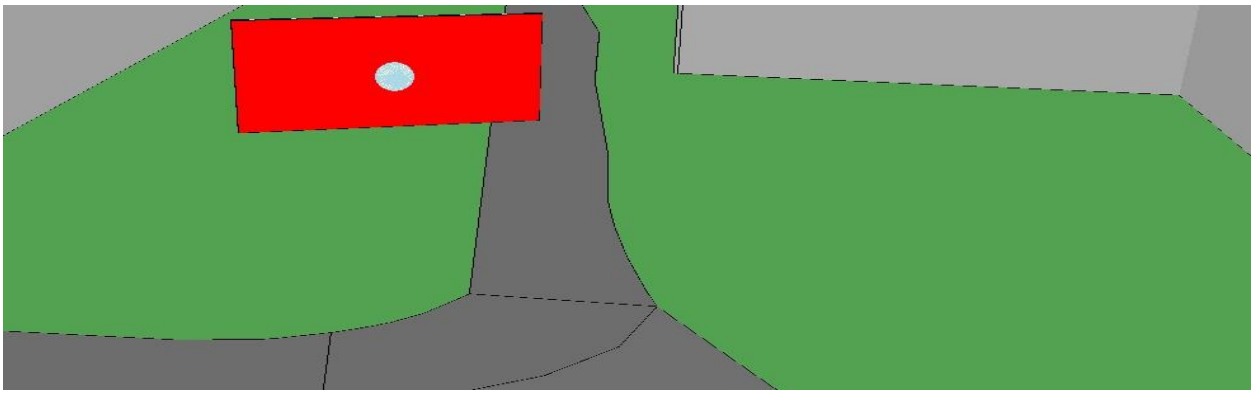


Figure 11 INSTALLED BILLBOARDS

TABLE-4 PARAMETERS OF THE BILLBOARDS

Luminaire	**10x BILLBOARDS**
Size of the luminaire (mm)	**9600X4800**
Power consumption of the luminaires (W)	**200**
Power consumption of the lighting system (W)	**2000**
Luminous flux of the source (lm)	**7365**
Luminous flux of the lighting system sources (lm)	**73650**
Efficiency (%)	**99.6**
Luminous flux of the luminaire (lm)	**7335**
Luminous flux of the lighting system(lm)	**73350**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system.

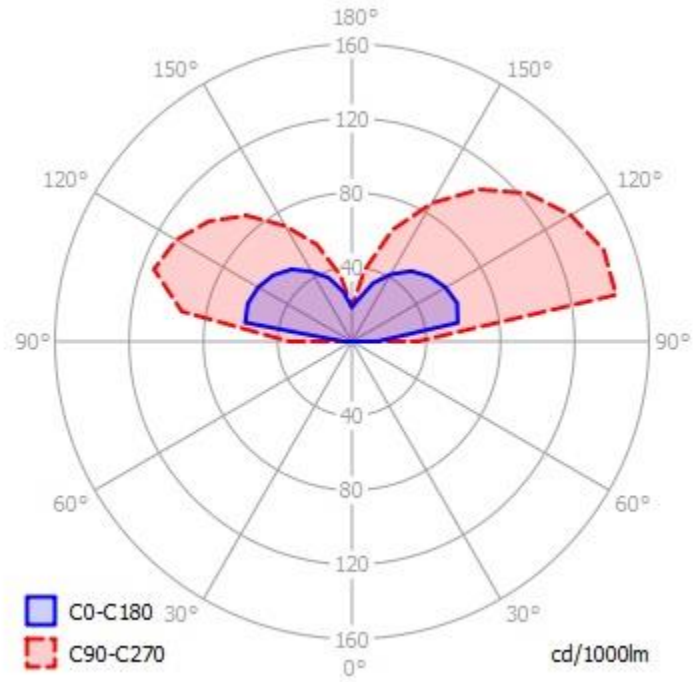


Figure 12 DIRECT + REFLECTED PART OF THE LUMINOUS FLUX - BILLBOARDS

The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

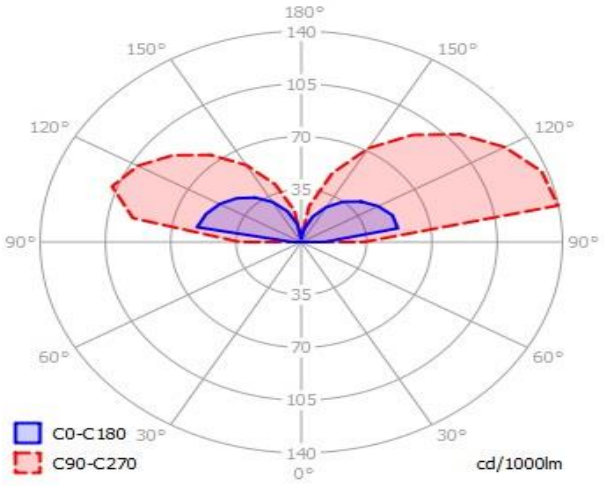


Figure 13 DIRECT PART OF THE LUMINOUS FLUX OF BILLBOARD

50% from 73350 lm for complete radiation to the upper hemisphere is 36675, 44% from 73350 lm only for direct part is 32274 , so the reflected part of the luminous flux is 4401 i.e. 6%

3.3 INSTALLED CARS IN WILS:

The cars are designed on pre-determined and calculated guidance. The illuminators are placed around the roads and bridges as per real life scenario as possible. The lighting system is composed of 20 cars with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

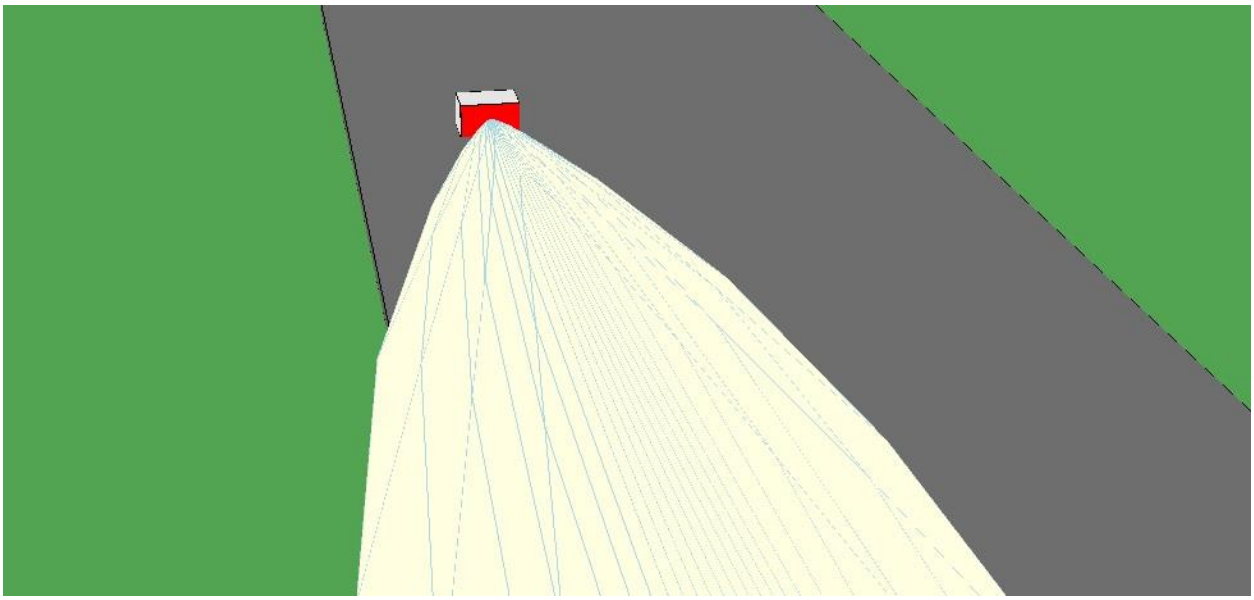


Figure 14 INSTALLED CARS

TABLE-5 PARAMETERS OF THE LED

Luminaire	**20x CARS**
Size of the luminaire (mm)	**200X350**
Power consumption of the luminaires (W)	**66.4**
Power consumption of the lighting system (W)	**1328**
Luminous flux of the source (lm)	**1472**
Luminous flux of the lighting system sources (lm)	**29440**
Efficiency (%)	**99.7**
Luminous flux of the luminaire (lm)	**1467**
Luminous flux of the lighting system(lm)	**29340**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system.

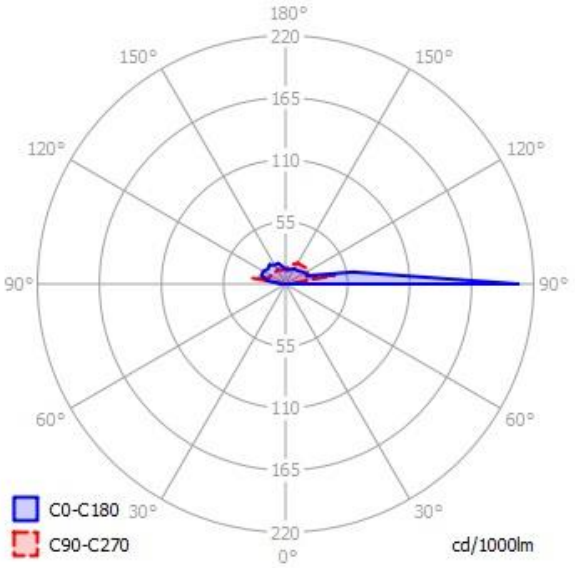


Figure 15 DIRECT + REFLECTED PART OF THE LUMINOUS FLUX FOR CARS

The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

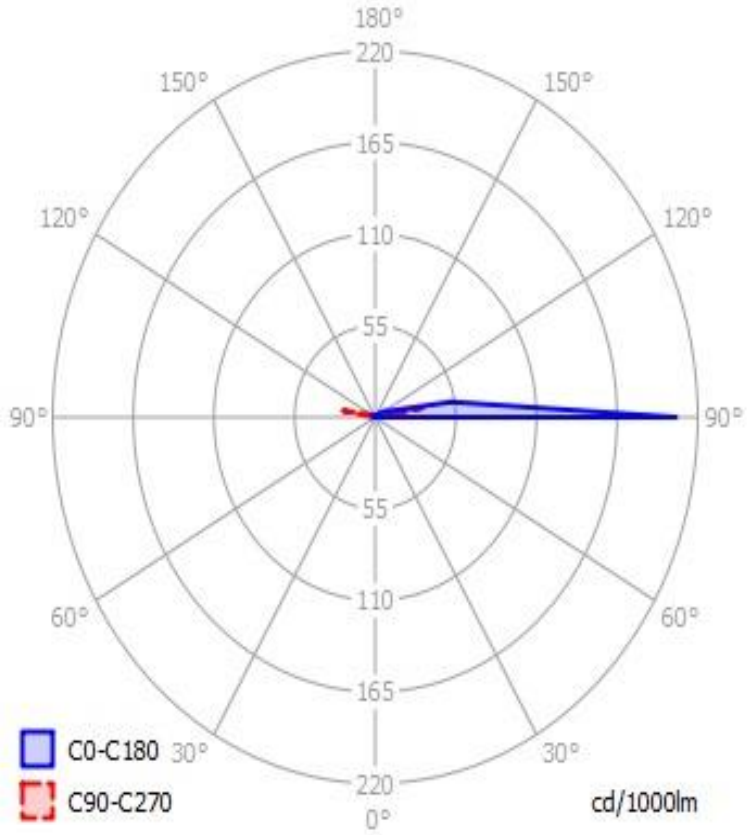


Figure 16 DIRECT PART OF THE LUMINOUS FLUX OF CARS

14% from 29340 lm for complete radiation to the upper hemisphere is 4107, 5% from 29340 lm only for direct part is 1467, so the reflected part of the luminous flux is 2640 i.e. 8.9%.

3.4ILLUMINATION OF THE ROAD USING LED LUMINARIES:

SHREDER LED SCHR VOLTANA 2 28W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 71 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

TABLE-6 PARAMETERS OF THE LED ILLUMINATION

Luminaire	71x Artechnic schreder VOLTANA 2 28W
Size of the luminaire (mm)	518x240x108
Power consumption of the luminaires (W)	28
Power consumption of the lighting system (W)	1988
Luminous flux of the source (lm)	3456
Luminous flux of the lighting system sources (lm)	245376
Efficiency (%)	81.1
Luminous flux of the luminaire (lm)	2802
Luminous flux of the lighting system(lm)	198942

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

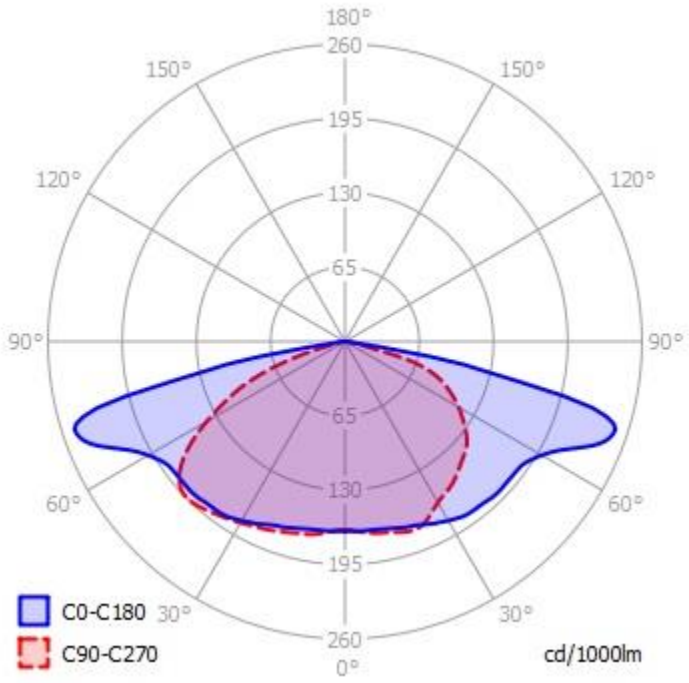


Figure 17 Schréder - LED SCHR Voltana 2 28W – LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The

reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

SHREDER LED SCHR VOLTANA 2 20W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 35 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

TABLE-7 PARAMETERS OF THE LED ILLUMINATION SYSTEM Artechnic schreder VOLTANA 2 20W:

Luminaire	**35x Artechnic schreder VOLTANA 2 20W**
Size of the luminaire (mm)	**518x240x108**
Power consumption of the luminaires (W)	**20**
Power consumption of the lighting system (W)	**700**
Luminous flux of the source (lm)	**2560**
Luminous flux of the lighting system sources (lm)	**89600**
Efficiency (%)	**81.1**
Luminous flux of the luminaire (lm)	**2076**
Luminous flux of the lighting system(lm)	**72660**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

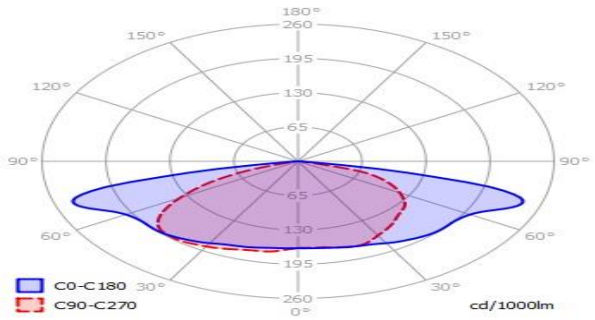


Figure 18 Schréder - LED SCHR Voltana 2 20W – LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space are designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The

reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

SHREDER LED SCHR VOLTANA 3 41W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 12 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

TABLE-8 PARAMETERS OF THE LED ILLUMINATION SYSTEM Artechnic schreder VOLTANA 3 41W:

Luminaire	**12x Artechnic schreder VOLTANA 3 41W**
Size of the luminaire (mm)	**655x518x240**
Power consumption of the luminaires (W)	**41**
Power consumption of the lighting system (W)	**492**
Luminous flux of the source (lm)	**5145**
Luminous flux of the lighting system sources (lm)	**61740**
Efficiency (%)	**81.8**
Luminous flux of the luminaire (lm)	**2076**
Luminous flux of the lighting system(lm)	**24912**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

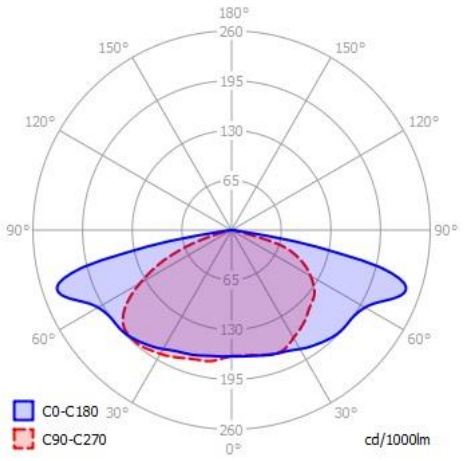


Figure 19 Schréder - LED SCHR Voltana 3 41W – LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space are designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

SHREDER LED SCHR VOLTANA 3 55W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 8 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

TABLE-9 PARAMETERS OF THE LED ILLUMINATION SYSTEM Artechnic schreder VOLTANA 3 55W:

Luminaire	**8x Artechnic schreder VOLTANA 3 55W**
Size of the luminaire (mm)	**655x518x240**
Power consumption of the luminaires (W)	**55**
Power consumption of the lighting system (W)	**440**
Luminous flux of the source (lm)	**6720**
Luminous flux of the lighting system sources (lm)	**53760**
Efficiency (%)	**81.8**
Luminous flux of the luminaire (lm)	**5496**
Luminous flux of the lighting system(lm)	**43968**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

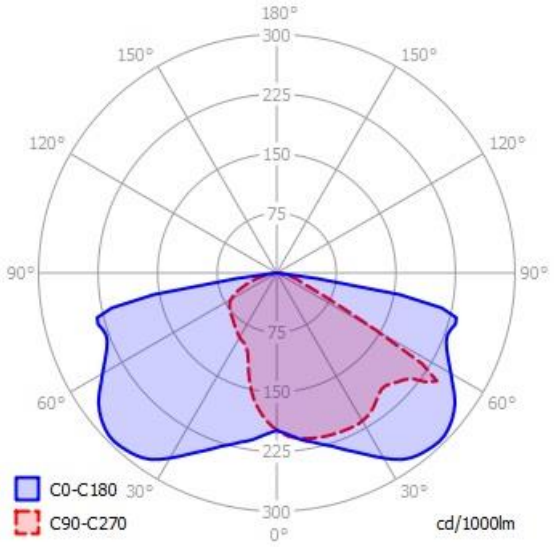


Figure 20 Schréder - LED SCHR Voltana 3 55W – LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space are designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

SHREDER LED SCHR VOLTANA 4 75W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 61 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

TABLE-10 PARAMETERS OF THE LED ILLUMINATION SYSTEM Artechnic schreder VOLTANA 4 75W:

Luminaire	**61x Artechnic schreder VOLTANA 4 75W**
Size of the luminaire (mm)	**650x310x120**
Power consumption of the luminaires (W)	**75**
Power consumption of the lighting system (W)	**575**
Luminous flux of the source (lm)	**9011.2**
Luminous flux of the lighting system sources (lm)	**549683.2**
Efficiency (%)	**84.1**
Luminous flux of the luminaire (lm)	**7578.41**
Luminous flux of the lighting system(lm)	**462283.01**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

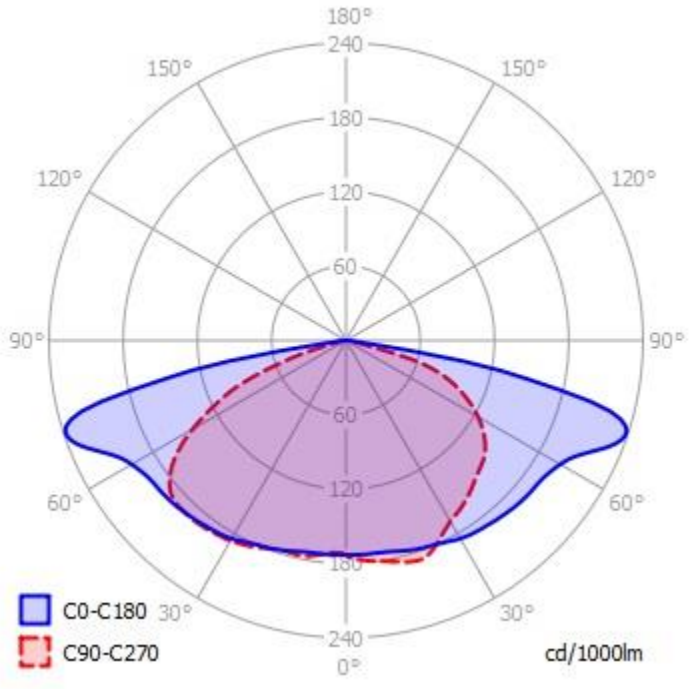


Figure 21 Schréder - LED SCHR Voltana 4 75W – LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

PHILIPS LUMA 1 40LED 57.1W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 7 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems is reflected from the model objects to the specified surfaces.

TABLE-11 PARAMETERS OF THE LED ILLUMINATION SYSTEM PHILIPS LUMA 1 40LED 57.1W:

Luminaire	**7x PHILIPS LUMA 1 40LED 57.1W**
Size of the luminaire (mm)	**650x310x120**
Power consumption of the luminaires (W)	**57.1**
Power consumption of the lighting system (W)	**399.7**
Luminous flux of the source (lm)	**9400**
Luminous flux of the lighting system sources (lm)	**65800**
Efficiency (%)	**89**
Luminous flux of the luminaire (lm)	**8366**
Luminous flux of the lighting system(lm)	**58562**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

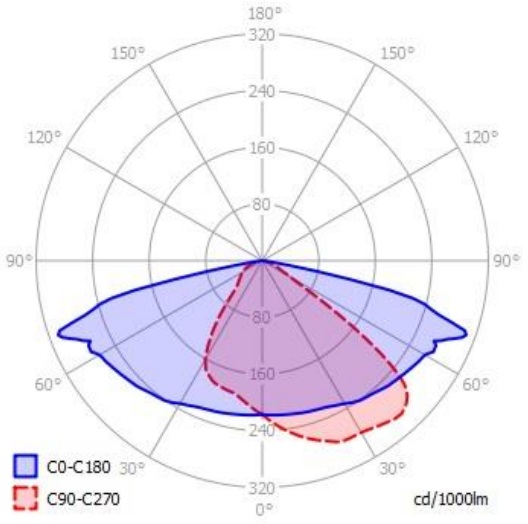


Figure 22 PHILIPS LUMA 1 40 LED 57,1W LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

PHILIPS LUMA MINI 12LED 15.3W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 10 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

TABLE-12 PARAMETERS OF THE LED ILLUMINATION SYSTEM PHILIPS LUMA MINI 12LED 15.3W:

Luminaire	**10x PHILIPS LUMA MINI 12LED 15.3W**
Size of the luminaire (mm)	**622x290x120**
Power consumption of the luminaires (W)	**15.3**
Power consumption of the lighting system (W)	**153**
Luminous flux of the source (lm)	**2200**
Luminous flux of the lighting system sources (lm)	**22000**
Efficiency (%)	**91**
Luminous flux of the luminaire (lm)	**2002**
Luminous flux of the lighting system(lm)	**20020**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

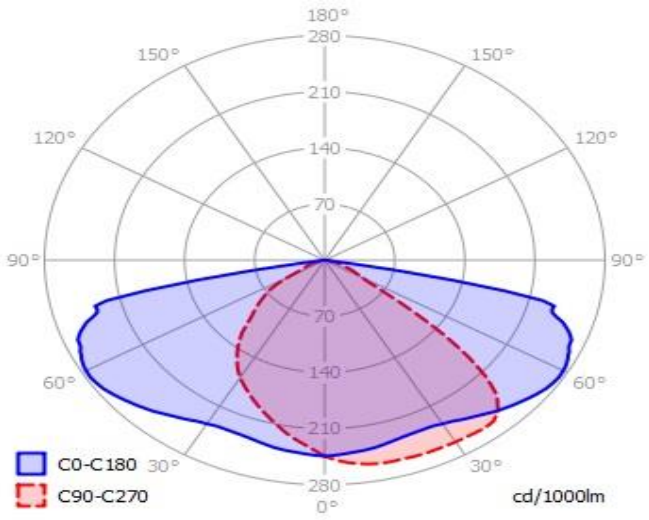


Figure 23 PHILIPS LUMA 1 12 LED 15.3W LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

PHILIPS LUMA MINI 12 LED 25.4W:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 44 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

TABLE-13 PARAMETERS OF THE LED ILLUMINATION SYSTEM PHILIPS LUMA MINI 12LED 25.4W:

Luminaire	**44x PHILIPS LUMA MINI 12LED 25.4W**
Size of the luminaire (mm)	**350x310x120**
Power consumption of the luminaires (W)	**25.4**
Power consumption of the lighting system (W)	**1117.6**
Luminous flux of the source (lm)	**4000**
Luminous flux of the lighting system sources (lm)	**176000**
Efficiency (%)	**90**
Luminous flux of the luminaire (lm)	**3600**
Luminous flux of the lighting system(lm)	**158400**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

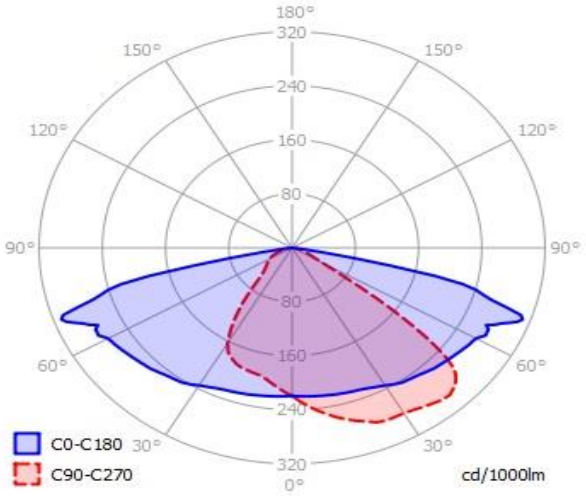


Figure 24 PHILIPS LUMA 1 12 LED 25.4W LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

THORN LED R2L2 21W 12LED:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 33 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

TABLE-14 PARAMETERS OF THE LED ILLUMINATION SYSTEM THORN LED R2L2 21W 12LED:

Luminaire	**33x THORN LED R2L2 21W 12LED**
Size of the luminaire (mm)	**655x362x155**
Power consumption of the luminaires (W)	**21**
Power consumption of the lighting system (W)	**693**
Luminous flux of the source (lm)	**2632**
Luminous flux of the lighting system sources (lm)	**86856**
Efficiency (%)	**100**
Luminous flux of the luminaire (lm)	**2632**
Luminous flux of the lighting system(lm)	**86856**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

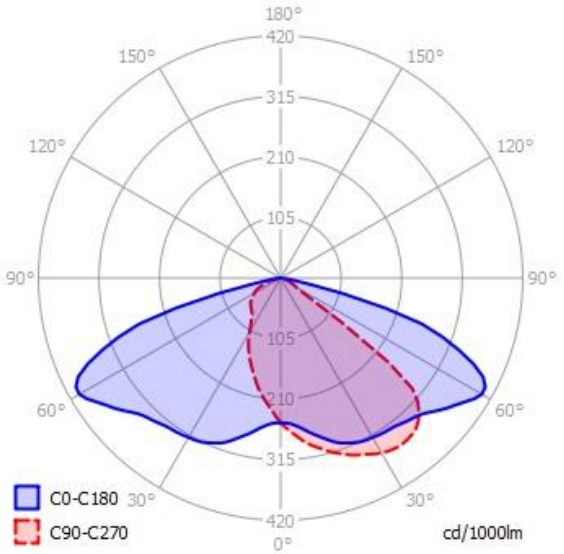


Figure 25 Thorn - LED THORN R2L2 21W 12 led LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

THORN LED R2L2 36W 55LED:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 9 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

TABLE-15 PARAMETERS OF THE LED ILLUMINATION SYSTEM THORN LED R2L2 36W 55LED:

Luminaire	**9x THORN LED R2L2 36W 55LED**
Size of the luminaire (mm)	**655x362x155**
Power consumption of the luminaires (W)	**36**
Power consumption of the lighting system (W)	**324**
Luminous flux of the source (lm)	**5244**
Luminous flux of the lighting system sources (lm)	**47196**
Efficiency (%)	**100**
Luminous flux of the luminaire (lm)	**5244**
Luminous flux of the lighting system(lm)	**47196**

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

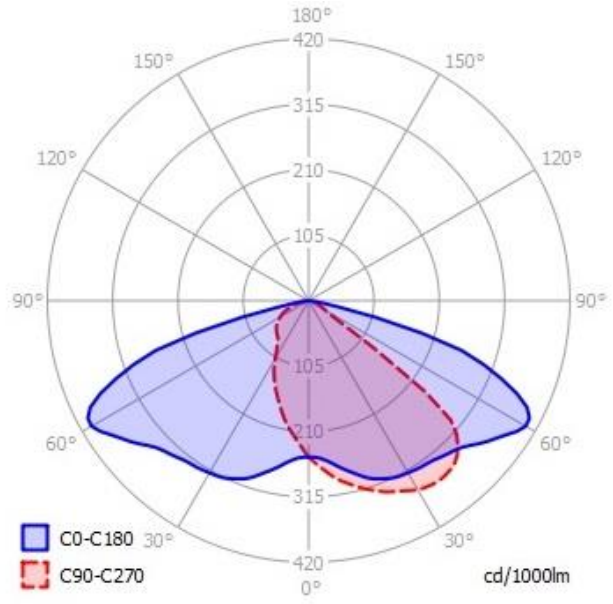


Figure 26 Thorn - LED THORN R2L2 36W 55 led LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

THORN LED R2L2 53W 24LED:

The road M5 was built on pre-determined and calculated guidance. The illuminators are placed on poles with interference distance of 30m away from each other at a height of 7m. The lighting system is composed of 17 poles with luminaries. These luminaries are designed to radiate only on bottom surface of the half-space and roads. The entire radiation from the lighting systems are reflected from the model objects to the specified surfaces.

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

TABLE-16 PARAMETERS OF THE LED ILLUMINATION SYSTEM THORN LED R2L2 53W 24LED:

Luminaire	**17x THORN LED R2L2 53W 24LED**
Size of the luminaire (mm)	**655x362x155**
Power consumption of the luminaires (W)	**53**
Power consumption of the lighting system (W)	**901**
Luminous flux of the source (lm)	**6833**
Luminous flux of the lighting system sources (lm)	**116161**
Efficiency (%)	**100**
Luminous flux of the luminaire (lm)	**6833**
Luminous flux of the lighting system(lm)	**116161**

Luminous intensity values are recorded and computed by the software goniophotometer to construct distribution curves of the city with the LED lighting systems. Parameters obtained based on distribution curves are used to determine reflective surfaces from the goniophotometer.

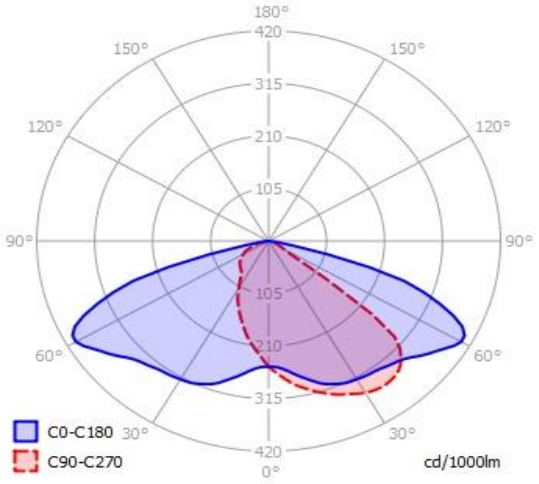


Figure 27 Thorn - LED THORN R2L2 53W 24 led LUMINOUS FLUX DISTRIBUTION

Shape and size of the city are determined based on the distribution curves obtained from luminous intensity and previous assumption. Shape of the half-space is designed similar to a diffusing radiator based on computed luminous intensity. The pre-assumed deviations from the shape of the diffusion radiator are visible on the curves created by the asymmetric radiation of the lighting system. The reflective characteristic of the materials causes deformation on the curve which makes it visible in the planes C0-C180.

FINAL MODEL OF VYSKOVICE WITH CALCULATION POINTS:

Figure 28 FINAL MODEL OF VYSKOVICE WITH CALCULATION POINTS

Old lightning system is manufactured with high pressure sodium lamps (HPS). These systems radiate light directly to the upper hemisphere that causes nearly 50% of luminous flux of their total luminous flux. The above action causes increase in sky lightning which causes obtrusive lightning, so creating light systems with downward radiation will reduce the above effect. The obtrusive lightning light is also formed because of indoor lightning i.e. industrial buildings, parking places and sports facilities so the examples states that the artificial lightning causes negative influence that causes unpleasant effect on astronomers and environmentalists. Luminous flux that is radiated to the upper hemisphere must be calculated to perform the maintenance factor.

FUNCTION OF SOFTWARE GONIOPHOTOMETER:

Sphere shaped calculation grid are inserted on the intensity calculating areas or points. The calculating points define normal luminance in the direction of the real goniophotometer. Basic principle of the goniophotometer is to measure luminous intensity in different direction and different angles. This luminous intensity is interrupted by the sphere calculation grid. The software goniophotometer duplicates the above function to insert LDT file of luminaire or city LDT file of unbounded size. The software goniophotometer has an option to select density of the calculating grid according to standard used levels for luminaire measurement. Each object are selected as simple point source to realize better calculation accuracy because each objects has insignificant dimensions and distance against calculating point. The normal luminance at direction to middle of sphere must be displayed on the calculating grid to represent the imagine lux-meter sensors.

$$E = \frac{I}{L * L} \quad \text{(please check)}$$

Where -E = IL-luminance (lx)

I = Luminous intensity (cd)

L = Distance (m)

RESULTS FROM CALCULATION OF DISTRICT RADIATION:

The software calculates both direct element of the luminous flux and reflected luminous flux so as to determine total luminous flux that is radiated to the upper hemisphere. The value of the reflected luminous flux is valid only when the reflection values are calculated by diffused reflection. The result established based on the above information is that the calculated shape and size of the luminous intensity from district model is a presumption. The calculated luminous intensity determines distribution rate only to the upper hemisphere, where the shapes of the intensity approximates to cosine of the diffused reflection. The ratio between luminous flux radiated to the upper hemisphere and total luminous radiated from the system is calculated by the software based on 17% of the entire lightning system. The above facts states that approximately 50% of the luminous flux is directly reflected to the upper hemisphere. The reflected elements is collected and calculated to determine total luminous flux. The above facts prove that influence of direct luminous flux is higher than reflected flux.

4. CALCULATION AND MEASUREMENT:

CALCULATING TECHNICAL PARAMETERS OF LIGHT:

The technical parameters of light that is associated with outdoor lighting are determined to determine limiting values. The limiting values are applied on specified vertical planes of the lighting system based on the time of the operation. The values are applied only to the direct illuminators. The above calculations are avoided at places where the direct light is obstructed by a high opaque fence or a retaining wall.

COMPUTER PROGRAMS:

The computer programs used for calculating luminance must be created based on inverse square law method. The program must be compatible with a system that has photometry to drive the luminaire photometric data. The luminous data are inputted for the programs must cover all the data of the light emitted by the luminaires.

CALCULATION CONDITION:

The Il-luminance calculation must be performed on the grid of points in specified vertical planes that are spaced at intervals lesser than 5m in azimuth and 1m in elevation. The height of the grid is determined by the intersection of the vertical plane on a boundary of the installation. The line of sight between the luminaries and relevant points on the adjacent properties must be determined to perform the calculation. The height difference caused from the topography of the area must be taken into consideration before the calculation. The calculated record must identify the locations of the applicable plane or windows to determine the relevant values.

DETERMINATION OF THE LUMINOUS INTENSITY:

The values of the luminous intensity that are applied to the above specified places must be calculated. The luminous intensity must be calculated directly from photometric data so as to accurately calculate luminous intensity distribution data. The luminous intensity distribution data must be calculated by using the light emitted by the luminaire. The above data are applicable for specific lamp combination under evaluation. A geometric relationship to particular luminaires of relevant direction with the angles is determined based on the luminous intensity data. The data must be interpolated with care because the intensity distribution undergoes rapid change. The luminous intensities must be separately determined where multiple luminaires are installed at same place i.e. head frame of a pole so as to neglect the maximum luminance at the specified places. The size of the bright part of the luminaire that is directed to

the observer is determined. The geometric data of the luminaire are used for determining the projected area in relevant direction.

CALCULATION OF THE LUMINOUS INTENSITY:

The luminous intensity of the subject luminaire in directions of the bright surfaces must be determined that are likely to be troublesome for the residents. The luminous intensities are calculated for determining actual locations and direction of the luminous flux.

DETERMINATION OF VEILING LUMINANCE:

The veiling luminance values are determined and applied for specific locations and viewing directions so as to determine potentially reason for reduction in visibility caused by the lighting installations. The compliance in the limiting values must be assessed.

DETERMINATION OF THE UPWARD FLUX RATIO:

The upward flux ratio is defined as the ratio between the luminous flux above the horizontal plane. The upward flux ratio uses lighting installations to determine the light reflected upwards from the ground surfaces. The ratio is calculated when flux is directly reflected from the luminaries, the flux intentionally reflected from the surface area and the flux reflected from the surrounding surface areas that are lit unintentionally due to spill light. The luminous flux that is formed above the horizon in the hypothetical ideal situation has no direct light radiated above the horizon, where all their light is intentionally concentrated to the surface area to obtain required lighting level on that area. The UFR values is 1 in the hypothetical ideal situation. The larger the UFR values of a real lighting the higher the degree of sky glow. The UFR is dependent on the geometry of mounting angles of the luminaries and the light distribution, where the light distribution is determined by proportion of the total lamp luminous flux of the luminaires emitted above the horizontal plane passing through the luminaires in their installed position (ULOR). The proportion of the total lamp luminous flux of the luminaries emitted under the horizontal plane passing through the luminaries that are installed in the position (DLOR).

FUNCTIONAL ROAD LIGHTING:

The average maintained luminance by the carriageway is determined based on a utilization factor. The utilization factor is important if immediate adjacent areas are to be lit by the carriageway based on the road lighting specifications.

MEASUREMENT OF THE LIGHT TECHNICAL PARAMETERS:

The light technical parameters associated with the outdoor lighting are calculated to determine compliance of the lighting values. The compliance of the lighting system is used at the designing stage of the lighting system. The compliance of the existing system are calculated based on measurements of the technical parameters.

TYPES OF MEASUREMENTS:

1) Initial check for compliance at commissioning: The measurements must be made from the drawings that is associated with the luminaires which is sited and aimed accordance with the design.
2) In-service check measurements: The measurements must be made on the installation time. This measurement provides assessment of complaints received in relation to the light installation.

The luminaires must be operated for about 15 min for tungsten filament lamps and 30 min for discharge lamps before measurement operation is started to realize normal operating conditions.

RECORD OF MEASUREMENTS:

The major points that must be recorded in the measurement are

1) Description about the luminaire i.e. location and purpose.
2) Date and time of measurement.
3) Type and geometric installation of the installation.
4) Number of lamps, control gears, dimmers and luminaires.
5) Effective supply voltage values.
6) Aiming of the luminaires that are not operated during the survey.
7) Age of luminaires and lamps to determine how much hours the lamp was been operated.
8) Time when the lamps were previously cleaned.
9) Climatic condition at the time of measurement.
10) Type of measuring instrument i.e. makes serial number and class.
11) Measurement locations and values obtained.

INTERPRETATION OF THE MEASUREMENT:

The discrepancies that might occur between the calculated values and measured values of the light technical parameters are;

1) The accuracy of the measured values are low because even when high quality products are used error up to 10% are recorded due to instrument calibration.
2) The uncertain error occurred from positioning and alignment of the photocell by the installations people.
3) Variation on supply voltage occurred relative to the rated voltage of the luminaire because the actual voltage supplied to the luminaire cane be different from the rated value where lower supply voltage will cause lower spill light.
4) The differences between the installed luminaires and the samples from which the photometric data is obtained may differ which might cause variations in the product.
5) Different calculation method used on different procedures which might cause deviation in the recordings.

MEASUREMENTS OF ILLUMINANCES:

The limiting values of the illuminance are defined in terms of vertical illuminance. The measurement must be taken at same test points that are employed during calculation.

MEASURING INSTRUMENTS:

The illuminance meter must be selected based on its accuracy and repeatability of measurements. The measuring instruments must be regularly re-calibrated.

MEASUREMENT CONDITIONS:

The measurement process must be conducted when the atmosphere is clear. The photocells must be placed on the nominated grid points and aligned based on the relevant vertical plane. Extreme care must be taken to avoid the shadow casted on block light of the photocell by the operator which are excluded some light from installation from review and also when reflected light are measured from light based on number of installations where the above conditions are accounted separately to avoid occurrence of error.

MEASUREMENT OF LUMINOUS INTENSITY:

The limiting values of intensity must be recorded to determine whether the lightning must be used on pre-crew or post-crew. The measurement must be performed at directions that is assigned for calculation. The measurement records must identify the appropriate plans by reference at points at which the measurement is performed.

MEASUREMENT PROCEDURES:

The luminous intensity emitted by the luminaire in a specific direction can be measured based on the illuminance in a plane that is perpendicular to the direction. The illuminance measurement must be made based on position of measurement, position of the photocell in the plane perpendicular to the line of sight from the position of measurement and the photocell must be screened based on the direct component that is placed in the measurement place. The to-be-measured luminaire must be isolated from other luminaires if multiple luminaires are installed close together and pointed at the same direction. The luminance meter must be periodically calibrated if the measurement field embraces the luminaire but the above separation is impossible in head-frames where the luminaires are attached tightly together. In the above state the mean intensity for the luminaires can be deduced by dividing the intensity based on the number of luminaires but the location for such a distance from the luminaire the luminance is too low to perform accurate determination of the luminous intensity so the measurement must be taken from the point that is closer to the luminaire. The location where the above stated procedure is used are:

1) The location where the original measurement place is inferred.
2) To determine alternative location for measurement.

MEASUREMENT OF VEILING LUMINANCE:

The veiling luminance can be directly measured by a CCD-based instruments but it cannot be performed if an in-service assessment is performed. The luminaires intensities from each luminaires in the field of view from the relevant directions must be measured based on the values compared with the original design calculations.

MEASUREMENT OF UPWARD LIGHT PARAMETERS:

Measuring the ULR or UFR are impossible in onsite locations so in-service assessment the types and aiming angles of luminaires must be recorded to determine where the above values commensurate with the required values to fulfill the limiting values in the particular locations.

MEASUREMENT OF SURFACE LUMINAIRES:

The limiting values of luminance in vertical surfaces are expressed in-terms of the average value over the entire surface from the view point. Allowance must be paid for taking series of measurements on the surface from view-points relevant to the particular situation.

MEASUREMENT CONDITIONS AND PROCEDURES:

The luminance meter must be ideally mounted on the grid tripod with allowance for smooth horizontal and vertical scanning of the surface. The instruments field view must be stabilized to realize maximum measurement precision and minimum luminance patterns. A minimum of nine readings of the set grid must be recorded if possible but at-least three sets of reading must recorded so as to choose and equate to determine maximum, minimum and average value.

5. LIGHT POLLUTIONS AND ENERGY CONSERVATION:

SPILL LIGHT AND LIGHT POLLUTION:

The light that falls on the place that it is not designed to fall is called spill light. The utility of the outdoor lighting is to increase visibility of the aesthetics. The effectiveness of the lighting is determined based on the degree of fulfillment of the desired work. The benefits of the outdoor lighting are to avoid accident at night time, criminal offences and other economic losses. Light pollution leads to loss electric energy. Light that is generated by the source and not utilized for the specific purpose is represented as waste of energy. Good lighting represents the lighting system which generates light and made it fall on the desired location that it is built. The bad lighting that falls on the places that is covered within the design is the reason for major discomfort and disturbance. The light invades into the private sphere of people. The above incident of light is also called as intrusive light and light trespass. The light pollution increases to a state where it causes an action called as sky glow. Light pollution is the reason for scattering of upward light in the atmosphere which is redirected downward to earth and falls on human eye. Light pollution is majorly caused by two reasons light emission and scattering particle abundance. The light pollution is also formed from industries by obsolete installation of the application where the output is difficult to control.

LIGHT POLLUTION AND AIR POLLUTION:

The urban sky glow is formed due to the light that is emitted upward and scattered back to the surface of earth so on earth the scatter caused by light affects the air molecules which affects the clear light fall during the day. The densest layers of aerosols influence the localized lighting installations. The assessment of the light that is emitted horizontally is determined based on the luminance that is utilized to build the lighting system. The luminous intensity that falls on the horizontal plane is determined based on the entire luminous flux that is installed in the lighting system. The facts states that the aerosols concentrations are higher in the big cities are higher that an open country.

The astronomers are worried about the light that is projected upwards and reflected back to the surface of the earth which results in dread sky glow, where majorly the dread sky glow is caused on poor lighting design. The astronomers consider both direct light and the reflected light as waste of resources that must avoided.

ENERGY CONSUMPTION FOR OUTDOOR LIGHTING:

The environment impact due to light pollution is higher in-terms of global energy usage i.e. amount of CO2 that is generated and issued to the atmosphere. Literally 90% of power generated by a particular country is utilized for road transportation and heating.

ENERGY LOSSES DUE TO LIGHT POLLUTION:

The energy losses that occurred due to sky glow that is caused by in-proper design of lighting system. The major part of the sky glow is caused based on the reflected part of the light that is observed from the sky

glow which is highly difficult to be avoided. The facts state that there is a loss of one billion dollars as energy loss due to light pollution in US. The facts also states that only 50% of the light emitted from the lighting system reaches the target based on the requirement and the design and so the other 50% of the light is emitted upwards due to bad deign which causes sky glow at higher rate. The electric energy that is utilized to charge the lighting system is also lost due to improper emission of light.

ENVIRONMENTAL IMPACT OF LIGHT POLLUTION:

The electric energy that are generated to charge the lighting system are mostly done by thermal power stations and fossilized fuel which results in emission of CO2. In UK 20% of electricity that is generated by the country is utilized for the lighting systems. As CO2 is a green-house gas so the increase in CO2 in atmosphere leads to increase in temperature in world-wide. The measures must be taken to reduce the losses that are caused for the lighting operation.

REMEDIAL MEASURES:

The major measure that can be taken to perform light control

1) Switching off the lights if not in use is the final solution that is provided based on the astronomical observations which cannot be full-filled in a place where night-time activities and artificial light is highly required. The modern electronic ballasts realize less drastic solutions and the gas-discharging lamps are equipped with a dimmer.
2) Gated viewing is a process of shuttering or blocking a photo apparatus at the telescope in which the block or shutter is opened when the light system is required to operate. This process is used on the gas discharge lamps which are operated only when electricity is passed through the plasma. The gate viewing is old process which is still not made in public practice. This allows us to place a dimmer at the emitting part of the light to reduce the light emissions. These dimmers are standard equipment's that can be used in most types of lamps.

Another major aspects to take into consideration is outdoor lighting installations i.e. lighting system in whole village is charged by a single-phase alternating current sources because a separate electric generating plant which uses high frequency source that eliminates visual stroboscopic effect. The above statement is not clear that high frequency lamps do increases efficiency of the lighting system so the lamps of the outdoor lighting system must be provided with a no afterglow effect. The major drawback of the gated viewing system is that it is not tested for large scale applications so it is not feasible for large-part of outdoor lighting is owned privately. The gate viewing technique is also costly. This can be only used for small village.

3) Light control is the process of preventing light from falling on the un-planned area or above the desired horizon. An appropriate lighting model must be designed so that necessary steps must be taken to avoid falling of light on the unplanned territory. The best optical design must be produced for optimizing the light distribution based on the positioning of the devices. The luminaires must be selected based on their light distributions factors. The steps that is taken to reduce the light trespass helps us to enhance the economic efficiency of the lighting installation.
4) Reduction of reflection is major step to reduce the amount of sky-glow. The possibilities to reduce the reflective effect of the light are minimum. The reflection of the road surface is reduced to realize counter-productivity because the luminous flux aimed at the road surface must be higher which will increase amount of stray light.
5) Monochromatic light is the most effective way to reduce interference of the low pressure sodium lamps. These lamps emits narrow spectral band. The minor problem for the above process is that it is hard to adapt the weighing factors when comparing with multiple light sources.

6) Filtering the light is the process of reducing the width of the spectral range of the emitted light in an effective way by measuring the interference of light which is helpful for the astronomical observations.

IMPLEMENTING REMEDIAL MEASURES:

The above discussed remedies are tough to apply in real-time applications so remedial measures are taken that are shown below:

1) ATTITUDE CHANGES

   The attitude of the lighting engineers and astronomers are different because of the requirements of both set of people are also different, so they hardly understand each other because the astronomers think in mathematical terms but the electrical engineers think in-terms of technical costs. The zoning and curfew concepts are utilized because of the above described conflicts.

2) FUNCTIONAL REQUIREMENTS:

   A single type of protection cannot be used in multiple requirements, so a system of functional requirements are derived based on the operation by the observatory. The functional requirements are derived based on type of observations, management plans, staff, time and equipment. The above options can be derived from the classification of observatories.

3) OBTRUSIVE LIGHT AUDITS:

   Audits are a common tool to find whether the aims and goals of the policy decision is met by the design. The policy decisions of outdoor lighting are made by the authorities based on the sophistication of the city. The decision making process depends on the objective criteria. The goals of the lighting installations are performed based on general policy principles such as road and public safety and to enhance economy of the region.

   The audit takes place based on the below described steps;

   1) To establish the policy goals of the government for the outdoor lighting.
   2) To establish the standards and ordinance based on the surroundings.
   3) To establish the photometric characteristics of the lighting installation
   4) To establish the type of light that has been installed in the area. This is done by making an inventory of the outdoor lighting.

   The above steps helps us to compare effect of obtrusive light in the region.

   Environmental audit must be performed based on:

   1) Establishing an environmental management system.
   2) Establishing an environmental policy
   3) Establishing environmental program
   4) Analyzing the present situation
   5) Periodical control of environmental checkpoints.
   6) Continuous adaption of environmental objectives.
   7) Establishing environmental declaration
   8) Check of the environmental management syste,
   9) Check of the audit report
   10) Registration

6. AIM AND PROGRESS OF OUTDOOR LIGHTING:

Outdoor lighting is defined as the fixed artificial lighting system that is used to illuminate the areas. The main application of the lighting visual performance of the person conducting human activities. The visual performance is defined as the speed and accuracy with which visual task is performed. The purpose of the outdoor lighting is to increase efficiency of human activities during night time, transportation time, construction society and beautification.

CONTRIBUTION OF OUTDOOR LIGHTING TO THE EFFICIENCY OF THE HUMAN ACTIVITIES:

FUNCTIONAL ACTIVITIES:

Basically in technical matters the efficiency is referred as relationship between the amount energy that is inputted to the system and the amount of light emitted from the lighting system. The efficiency of the lighting system that is used for human activities are discussed qualitatively. The efficiency of the lighting system that are used in the surroundings of human activities will be influenced based on the below given four factors:

1) The photometric conditions of the visual environment provided by the outdoor lighting
2) The physical condition of the lighting environment
3) The physiological conditions of the people who are conduction the activities
4) The physiological conditions of these people

These four possible ways are always interrelated in a complex way. The photometric conditions provided by the outdoor lighting are closely related to the physiological performance of vision to detect, size, shape, color and texture of the objects. The photometric conditions influences the physiological conditions of the human activities in the environment so based on the photometric conditions the efficiency of the human activities are improved.

NON-FUNCTIONAL ACTIVITIES:

The facts states that the widely accepted concept of efficiency may not be required by the non-functional requirements. An appropriate amount of lighting is enough to improve human efficiency to enjoy human activities.

INDIRECT CONTRIBUTION OF OUTDOOR LIGHTING TO THE EFFICIENCY OF HUMAN ACTIVITIES:

All the production activities in the outdoor spaces cannot be effectively performed without an outdoor lighting i.e. construction works and continuous program in the chemical industry. If there is no outdoor lighting loading and unloading of cargos for trains, ships and airplanes are not possible in night time so due to the above reason huge amount of time, energy and labor are wasted.

CONTRIBUTION OF OUTDOOR LIGHTING TO COMMERCIAL ACTIVITIES AT NIGHT:

Outdoor lighting has special contribution to commercial activities in night. The outdoor lightings are used in commercial shops to make sure the customer feel safe to travel from the parking spaces to the shop without any hesitation. High quality outdoor lighting on the streets in front of the doors encourages the customers to go shopping in the current shop. Luminous lights and illuminated advertisements are used in-front of the shops to attract the shoppers. A better outdoor lighting provides safety to the suppliers to deliver their products to the shop.

7. GENERAL CHARACTERISTICS OF OUTDOOR LIGHTING:

The outdoor lighting installations are referred as roofless lighting which acts as crucial part in light pollution. The outdoor lighting is mostly designed based on functional, so it states that the design measurements are majorly calculated based on the functionality of the lighting system. The outdoor lighting system is majorly designed by considering visual performance rather than aesthetic and visual comfort. The basic consideration of the lighting system is realized based on the luminaires that are required in the area. In indoor lighting the glare is avoided in-terms of discomfort where the glare in the outdoor lighting is reduced based visual efficiency.

The main sources of stray light that may interferences with astronomical observation:

1) Lighting of industrial sites, airports and buildings
2) Road and street lighting
3) Advertising signs
4) Floodlighting of buildings, discos and monuments
5) Lighting of billboards
6) Lighting of greenhouse
7) Lighting of sports facilities
8) Area lighting of sales areas

CITY BEAUTIFICATION:

Outdoor lighting makes cities or towns at night beautiful i.e. lighted landscapes, buildings, monuments if the arrangements of the lighted buildings in the city or town are carefully planned then the whole city looks beautiful and attractive in night. The city beautifications schemes encourage inhabitants and visitors of the city to enter the city at night. The reason that many municipal authorities pay attention to city beautification is primarily to promote the city has an environment that is better to live in i.e. Ramblas in Barcelona, Time square in New York, the Todaji temple in Nara and the red square in Moscow. The technical aspects of the city beautifications are critical like improving ample literature at nighttime.

STREETS AND SQUARES:

1) Streets :

   The outdoor lighting in the streets of the towns and cities are installed for the convenience, safety and security of the pedestrians. The next updating level of the safety level of the pedestrians is improved by providing orientation and current position on the street of the unknown town, so for the above application flood-lights are placed in multiple outdoor places i.e. churches, temples, railway stations, bus stops and commercial buildings.

2) Squares:

   Squares are important places in the city. Car traffic from various directions meets in a complex way. To show the visitors the orientation of the streets for entering and leaving the city a floodlight at tall buildings acts as the major component in the above described operation. A high level and a high quality outdoor lighting is necessary to make the drivers able to see the directional signs, names of the buildings, other visitors, approaching automobiles, statues, flower beds and fountains. High level outdoor lighting improves safety of the square.

HISTORICAL BUILDINGS AND SITES:

The historical buildings such as castles, churches, palaces, museums, temples, shrines and old bridges have unique shapes. In daytime the above buildings are viewed as colorful monuments of the cities but in the night if the external walls of the above buildings are lit with colorful lights and artificial outdoor lighting so as to improve beauty of the buildings and make it visible to see in the night time. Flood lights may highlight the parts of the building that are in the shadows during day time. The different appearance of the buildings based on the day time and night time lightings gives different appearance which is a joy to the visitors.

TREES, FLOWERS AND GARDENS:

In night if the outdoor lighting properly highlights the old magnificent trees in the dark which displays beauty of the region in the night time.

MONUMENTS:

If the important monuments are lit in the night time because small monuments are overlooked by the surrounded trees and bushes so by the help of the lighting the visitors can recognize the details of the historical monuments. The lighting helps the monuments contributes to the city space.

RIVERS, PONDS, FOUNTAINS AND BRIDGES:

Brilliant reflections of the luminous surfaces or the luminaires of various colors on the rippling water surface visualizes the beautiful landscape at night. The luminaires that are located at the banks or bridges of the river must be carefully selected to get better beautification of the river. The lights are projected on the fountains at night to represent the size and dynamics of the water jets of the fountains.

LIGHTING MOTORIZED ROAD TRAFFIC:

ROAD LIGHTING AS FUNCTIONAL LIGHTING:

The modern society with modern people tends to perform many activities at night when natural day light is absent. Road transport takes place open in the open surface where lighting is necessary for a safety travel. The lighting must be functional in which enhancement of visibility is derived as the important fact to consider in the design of lighting.

ACCIDENT PREVENTIONS:

The situation regarding road safety varies considerably different based on various factor, so detailed research efforts has been undergone by leading scientific institutes and spanning several decades to represent a better design for outdoor lighting. The results that are shown below are provided based on the studies can be summarized as:

1) On major urban thoroughness better road lighting results in a reduction of night time causalities of about 30%. Similar type of facts is realized in rural trunk roads and motorways.
2) The light level is increased to decrease the accident risk, so by doubling the road surface luminance leads to reduction of the night time risk of about 13%.

RELATION BETWEEN PUBLIC LIGHTING AND CRIME PREVENTION:

Poor outdoor lighting is not useful for the for the pedestrians but it will be useful for the criminals for planning crimes because the criminal eyes are trained and adapted to low dim light whereas normal pedestrians are adopted only for the high luminance light that is used to view in the better lit area, So the criminals have the advantage of hiding in dark places with high precision. The normal whose pedestrian whose eye-sight is not adapted to the low luminance cannot see the criminals lurking in the dark which gives the criminals a good place to rob the pedestrians.

AMENITY:

The beneficial effects of the functions mentioned above are considered important. The subjective aspects of the society safety of residents and pedestrians and the amenity for residents are considered very important. These aspects are the most important facts that are considered for the decision to lit the streets and roads in both urban and rural. Surveys pointed out that the opinion of residents about lighting and crime has three important aspects:

1) Amenity
2) Subjective estimates for crime reduction.
3) Fear of crime.

So based on the above visibility in the surroundings is very important to reduce crimes.

CONSTRUCTIONS OR MAINTENANCE SITES OF ROADS:

The road is blocked for road constructions and maintenance which causes delay in time. The traffic must sometimes negotiate steep curves on temporary roads. Vehicles for the works are un-expectedly placed or parked on the locations close to the driving lanes on the site. The lighting traffic signs for guidance of the traffic to correct directions and the appropriate outdoor lighting that improves visual condition can reduce accidents at night.

INTERSECTIONS AND JUNCTIONS:

INTERSECTION:

The intersection of roads is dangerous at night time if no signals are placed because of motorized traffic and the pedestrian traffic cross each other. The accident rates are higher in the intersections than other road sections. The drivers might arrive faster at the large intersection in which the driver may not be able to stop the vehicle at correct time, where the outdoor lighting at the intersection which indicates the existence of the road layout of the intersection. The traffic safety at night is maintained by the outdoor lighting, so when the vehicles or pedestrians approach the actual intersection realizes the road-layout to minimize the speed of the vehicle. The outdoor lighting makes the carriageway brighter which reduces an error of judgment, so the outdoor lighting on the intersection reduces traffic accidents at night.

JUNCTIONS:

Major traffic junctions are defined as the place where multiple roads meet. The interchanges in the places where main roads join a motorway that are designed such a way that the vehicle that are leaving or joining the road may not meet each other which is built with multiple curved paths. To select the correct road the road junctions must be visible to the driver. As discussed earlier the driver must know the junctions 10 seconds prior so as to realize the junctions and stop the car at correct place.

The advance information about the road is difficult to collect when the lighting from the head light which diverges from the direction of travel on a curved stretch of road. The visual information of the diverging point of the road intersection must be visible for the driver at a sufficient distance ahead, which is performed by the efficient outdoor lighting.

BUS TERMINALS:

The configuration of roads, movements of buses and passengers in the bus terminal are complex. The movements of the buses must be recognized by the passengers. The bus drivers must be able to see the other buses. Appropriate outdoor lighting makes the bus terminal makes the bus terminal safer and more convenient for passengers.

AUTOMOBILE LIGHTING:

Car lighting is not fixed lighting mostly is called as automobile lighting. The safety effects of headlights have never been thoroughly investigated called as self-evident that they constitute an effective accident counter measure. The above fact stares that huge amount of cars in traffic on the roads causes light pollution through the head lamps of the cars. As said earlier the contribution of light pollution that is caused by the cars are not recorded previously because it shows clearly that satellite pictures cannot be taken clearly due to high concentrations of light pollutions sensitive areas on near vertical observation.

SPORTS LIGHTING:

The sports lovers enjoy sports by watching them in stadiums or on televisions.

LIGHTINGS FOR RECREATIONAL SPORTS:

Sports lighting are needed in night as many people watch and enjoy sports in the evening after work. If lighting is not provided efficiently the enjoyment and visibility of sports are reduced. The above action causes waste of energy, labor, materials and energy that are used for maintenance and service. The point that must be considered in the sports facilities that poor lighting may cause discomfort and disability glare for road users. As sports is the most important part in the human activities in spare time those wastage of energy and low efficiency must be avoided.

LIGHTING FOR LARGE SIZED SPORT STADIUM:

Watching large-scale sports event in the large stadiums is also fun for many sports lovers. They watch either from the rows of the seats in the stadium where the sports events are taking place or watch on the broadcast sports events in TV, so better lighting effect must be provided to the sports stadium.

INDUSTRY AND COMMERCE:

INDUSTRY:

Industry is one of the important parts of human life in the technology-oriented society. There are many kinds of industries from open mining to dust free factories. The products that are required to perform on the above described industries are transported from other industries like outdoor plant, where the outdoor plants requires better outdoor lighting to realize batter production efficiency because if the production plants are unable to produce the required product in specified time it might cause huge economic loss to the company so the outdoor lighting is very important in the industry to improve the efficiency of the production in the production line.

The outdoor lighting that is installed in the outdoor plants must at least provide the following aims:

1) To make possible the production activities at night efficiently and safely
2) To make possible the large scale maintenance work at night, efficiently and safely
3) To maintain the required security level of the production plant also at night
4) To carry out emergency actions and rescue efforts in case of explosions, fire outburst of hazardous products, chemical material, fuels, gases or water, collapse of construction, earthquakes, terrorist attacks and other accidents in the production plant efficiently and safely.
5) To allow safe transportation of products out of the plant and materials into the plant also at night

OUTDOOR LIGHTING FOR PRODUCTION WORKS AT NIGHT:

Industries like chemical industries and metal industries cannot stop their production process except for special maintenance period. Although most of the process are automated in these types of industries some assessment and maintenance process must be performed manually by humans. To carry out the previous actions at night the outdoor lighting must be provided with high efficiency. If outdoor lighting is not provided to these plants then their production must be halt at night time which causes loss of many materials and energy. The production yields of these industries will be seriously reduced and many investors cannot accept to continue their production activities.

OUTDOOR LIGHTING FOR MAINTENANCE WORKS AT NIGHT:

The maintenance work is very important as that of production in every production plants. During large-scale maintenance works the production work must be stopped or interrupted, so in the most case the maintenance in the large-scale are performed at night. To conduct maintenance process efficiently and safely better lighting effects must be provided.

OUTDOOR LIGHTING FOR SECURITY:

Any plant or factory maybe targeted for terrorism, so as to reduce the chance of the terrorist attack not only better outdoor lighting is needed but also the premises of factory must be lit with better efficient light. The roads that are adjacent to the industry must be lit with lights so as to avoid parking of vehicles that are used by terrorists, so as to identify the color, type and license number of the vehicle parked. The above provision may reduce the crime rate that is occurred in night.

OUTDOOR LIGHTING FOR EMERGENCY ACTIONS AT NIGHT:

An emergency event may occur unexpectedly in night at the production plants. Under emergency condition multiple actions must be performed simultaneously and rapidly. The director of the rescue operation must watch the entire scenario, so they need better lighting effects in the whole area of the plants. The rescue teams must find where the origin of the event has occurred to determine how many people have been wounded so as to get enough help to the place and to realize how to access rescue parties reliably and clearly for which a better lighting effect is required.

OUTDOOR LIGHTING FOR TRANSPORTATION:

Products must be transported from place to place as soon as possible under reasonable conditions. Some materials are transported at night for which the outdoor lighting is very helpful to perform the above process at high efficiency.

LIGHT POLLUTION:

Sky glow is represented as a background luminance caused over the sky against which the astronomical objects are to be observed. The interference of astronomical observations is caused by resulting reduction in luminance contrast. The solar radiation changes during the well-known 11-year-period that influences the brightness of the sky as well. In most places in the world the contribution of artificial light exceeds based on the natural background radiation. Residents suffer the most when the light invades their private space. Sky glow is the effect caused by upward emission of light and then scattered back to light. The environmental approach towards reduction of light intrusion includes two principles like zoning and curfew.

Natural background radiation:

The above radiation is caused by non-directional scatter of light by particles in space in the atmosphere. The natural background radiation is defined as the luminance resulting fro the scatter of light by the natural particles, so to earth bound observatories the natural background luminance is the absolute lower limit for observations. The major contribution to the natural background luminance is described below based on Levasseur-Regourd:

1) The light from sub-liminal stars
2) Interstellar dust
3) Dust in the solar system
4) Air molecules
5) Dust in atmosphere
6) Water vapor in atmosphere

Direct light and light intrusion:

A good lighting system is described based on the light is emitted and falls on the specific target product, if the above action is not performed accurately then spill light is realized. The spill light in the outdoor lighting system causes disturbance and discomfort to the humans, where the light invades to the private area of the people and intrudes to the living spaces of the people.

Effect of sky glow:

The major light pollution that is caused in the world is realized by the sky glow effect. The sky glow effect is caused by the luminaires that emits light upwards and the light is reflected back to the surface of the earth. The sky glow is the main reason which causes an disturbance in the measurement and viewing of objects by the astronomers. The influence of stray light on astronomical observations where a small portion of the sky surrounding the target is always included in the measurement which must be removed from the data. The difference between the blank sky data from the data of the previous calculation provides the astronomers with clean measurement of the target object, do based on the above calculation artificial sky glow reduces efficiency of the telescope. The stray light is projected upwards which is majorly caused by poor installations and design. The reflected light is the major cause of the sky glow effect because of the light that are reflected back to the surface of the earth, so to reduce the sky glow effect of the people the reflection of light from the atmosphere must be reduced.

8. CONCLUSION:

The above project describes the overview calculation parameters which deal with luminous flux radiation to the upper hemisphere. It was to calculate on the base of the district vyskovice model with real lighting system. In software it is possible to change old lighting system with the same parameters and observe difference in luminous flux radiation to the upper hemisphere.

Aim for the future is to complete model for all potential source of obtrusive light and calculate ratio of luminous flux from those sources against road lighting systems.

The major measure that can be taken to perform light pollution control

1) Switching off the lights if not in use is the final solution that is provided based on the astronomical observations which cannot be full-filled in a place where night-time activities and artificial light is highly required. The modern electronic ballasts realize less drastic solutions and the gas-discharging lamps are equipped with a dimmer.
2) Gated viewing is a process of shuttering or blocking a photo apparatus at the telescope in which the block or shutter is opened when the light system is required to operate. This process is used on the gas discharge lamps which are operated only when electricity is passed through the plasma. The gate viewing is old process which is still not made in public practice. This allows us to place a dimmer at the emitting part of the light to reduce the light emissions. These dimmers are standard equipment's that can be used in most types of lamps.

Another major aspects to take into consideration is outdoor lighting installations i.e. lighting system in whole village is charged by a single-phase alternating current sources because a separate electric generating plant which uses high frequency source that eliminates visual stroboscopic effect. The above statement is not clear that high frequency lamps do increases efficiency of the lighting system so the lamps of the outdoor lighting system must be provided with a no afterglow effect. The major drawback of the gated viewing system is that it is not tested for large scale applications so it is not feasible for large-part of outdoor lighting is owned privately. The gate viewing technique is also costly. This can be only used for small village.

9. REFERENCES:

[1] P.Becak. T.Novak, R.Baleja, K.Sokansky, "Radiation of the luminous flux into the Upper Half-Space in WILS – Building Design". Proceedings of 7th Lighting Conference of the Visegrad Countries, LUMEN V4 2018, 2018, Grand HotelTrebic Czech Republic, ISBN: 978-153867923-4

[2] P.Becak. Jana Wlosokova, Jan Picha, T.Novak, K.Sokansky, "Modeling of Luminous Flux Radiations the Upper Hemisphere from Real Model of Town", VSB-TU Ostrava, Czech Republic.

[3]M. Kocifaj, F. Kundracik, "Modeling the night sky brightness distribution via new SkyGlow Simulator", Proceedings of 2016 IEEE Lighting Conference of the Visegrad Countries, Lumen 2016 Karpacz, Poland, DOI: 10.1109/LUMENV.2016.7745553

[4]L. Lipnický, D. Gašparovský, R. Dubnička, "Influence of the calculation grid density to the selected photometric parameters for road lighting", Proceedings of 2016 IEEE Lighting Conference of the Visegrad Countries, Lumen 2016 Karpacz, Poland, DOI: 10.1109/LUMENV.2016.7745555

[5]F. Dostal, K. Sokansky, T. Novak," Long-term measurements of night sky illuminance", 2010, 1 2010 9th International Conference on Environment and Electrical Engineering, DOI: 10.1109/EEEIC.2010.5489919

[6]S. Darula, P. Oberman, "Jas okna v noci", Kurz osvětlovací techniky XXVII, Kouty nad Desnou, ISBN 978-80-248-2087-3

[7]P. Žák, S. Vodráčková, "Conception of public lighting", Proceedings of 2016 IEEE Lighting Conference of the Visegrad Countries, Lumen 2016 Karpacz, Poland, DOI: 10.1109/LUMENV.2016.7745514

[8]R. Dubnička, L. Lipnický, M. Barčík, D. Gašparovský, "Comprehensive view of LED products in luminaires", Published in: Diagnostic of Electrical Machines and Insulating Systems in Electrical Engineering (DEMISEE), 2016 Papradno, Slovakia, DOI: 10.1109/DEMISEE.2016.7530467

[9]T. Pavelka, M. Ptacek, P. Baxant, "Static model of LED behaviour depending on operating conditions", Published in: Electric Power Engineering (EPE), 2016 17th International Scientific Conference, 2016 Prague, Czech Republic, DOI: 10.1109/EPE.2016.7521774