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This lighting standard is valid for all ŠKODA AUTO plants.

Content

1	Introduction.....	3
1.1	Regulations	3
2	Basics of lighting	4
2.1	Vision.....	4
2.2	Basic terms and variables	4
3	Workplace illumination	5
3.1	Introduction	5
3.2	Illuminance values	6
3.3	Light systems	7
4	Light system requirements.....	7
4.1	Illuminance around the site of a visual task.....	7
4.2	Outdoor areas	8
4.3	Administrative and training areas.....	9
4.4	Control workplace	9
4.5	Production areas.....	9
5	Light sources	10
6	Lighting system quality requirements.....	10
6.1	Evaluation of existing condition.....	10
6.2	Lighting system design	11
6.3	Luminaire and light source requirements.....	11
6.4	Legal and other requirements	11
7	Choosing lighting technical solution	12
7.1	Hand-over documents	12
8	Technical requirements.....	12
8.1	General requirements (interior lighting)	12
8.2	Control and operating system, IT	13
8.3	Lighting system distributors – in accordance with ITS 1.11	15
8.4	Emergency lights	15
8.5	Hand-over documents	16
8.6	Public lighting requirements (VO)	16
8.7	Documentation.....	16
9	Release list of component manufacturers.....	17
10	Annexes.....	18



The latest updated version of this ITS is available at the “<http://cts.skoda-auto.com/>” web site, the company is not obliged to notify their business partners on the ITS update. Therefore, we strongly recommend that everybody checks the ITS regularly. These documents become valid on the date of their last update. For the contracts signed is decisive the validity of the ITS at the time of the order.

Note: In case of any differences between the Czech, English or German language mutation of this ITS, the Czech version takes precedence.

Change - number:	Date:	Note:
	06. 05. 2002	first edition
1.	23. 03. 2003	additions to article 1.2 Regulations
2.	01. 11. 2010	a/ article 1.2 Regulations updated b/ new article 3. Workplace Illuminance
3.	21. 12. 2010	completely revised
4.	08. 11. 2013	completely revised
5.	10. 08. 2016	completely revised
6.	21. 11. 2016	update of articles 5 and 9
7.	12. 12. 2017	update of article 8.2
8.	13. 2. 2018	update of articles 1.1, 4, 6.1, 7, 8.1, 10
9.	17. 06. 2020	completely revised

1 Introduction

This standard defines requirements on illuminance of indoor and outdoor areas in all plants of ŠKODA AUTO.

1.1 Regulations

It is necessary to comply with the ITS of ŠKODA AUTO for control and wiring of the illumination technology. Further, it is necessary to comply with the following:

- EU Declaration of conformity, including the CE marking under the provision of Act no. 22/1997 Coll., as amended by Act no. 91/2016 Coll.
- Directive EC 2014/30/EU on technical requirements on products from the point of view of their electromagnetic compatibility.
- Directive EC 2014/35/EU setting the technical requirements for low-voltage electric equipment.
- Government Decree no. 361/2007 Coll., laying down conditions for the protection of health at work, as amended by Government Decree no. 68/2010 Coll., Government Decree no. 93/2012 Coll., and Government Decree no. 9/2013 Coll. and 32/2016 Coll., and Government Decree no. 246/2018 Coll., and Government Decree no. 41/2020 Coll.
- Act no. 258/2000 Coll. on the protection of public health, as amended
- Decree of Ministry of Health no. 432/2003 Coll. laying down the conditions for dividing jobs into categories (such as visual stress, etc.), as amended by decrees 107/2013 and 181/2015.
- TKP-15 Ministry of Transport – Technical and qualitative terms of building roads – Chapter 15 – Road and street lighting
- Technical standards and related regulations, as amended:
 - ČSN EN 12464-1 - Light and lighting – Lighting of work places, Part 1: Indoor work places
 - ČSN EN 12464-2 - Light and lighting – Lighting of work places, Part 2: Outdoor work places
 - ČSN EN 13032-2 - Light and lighting – Measurement and presentation of photometric data of lamps and luminaires,
 - Part 2: Presentation of data for indoor and outdoor work places
 - ČSN EN 12665 - Light and lighting – Basic terms and criteria for specifying lighting requirements
 - ČSN EN 1837+A1 - Safety of machinery – Integrated lighting of machines
 - ČSN EN 1838 - Light and lighting – Emergency lighting
 - ČSN EN 50171 - Central power supply systems
 - ČSN EN 50172 - Emergency escape lighting systems
 - ČSN EN 60598-2-22 - Luminaires – Particular requirements – Luminaires for emergency lighting – Part 2-22
 - ČSN CEN/TR 13201-1 - Road lighting – Part 1
 - ČSN EN 13201-2,3,4,5 - Road lighting – Part 2, 3, 4 a 5
 - ČSN 36 0455 - Road lighting – Additional information
 - ČSN 73 0580-1 - Daylighting in buildings – Part 1: Basic requirements
 - ČSN 73 0580-4 - Daylighting in buildings – Part 4: Daylighting in industrial buildings
 - ČSN EN 17037 - Daylight in buildings
 - ČSN 36 0020 - Integral lighting
 - TNI 36 0450 - Discomfort glare in interior lighting
 - TNI 36 0451 - Maintenance of Indoor Electric Lighting Systems

All components used have to comply with the Government Decree no. 117/2016 Coll. A written approval of ŠKODA AUTO is necessary to employ used (old) materials which may influence electrical serviceability of the device.



2 Basics of lighting

2.1 Vision

People receive up to 80-90% of information through eyesight. The ability to see is active with the lighting level ranging from hundredths to tens of thousands of lux. This ability is vital for human movement during the day as well as during dark night times or during dusk. At the same time, the observer is unable to determine the luminance level. This is related to the adaptive ability of eyesight. People can execute an activity with low lighting intensity seemingly as easily as with higher intensity of lighting, which would be more appropriate for the activity. The consequence is that the person in question will perform the work, however with greater effort necessary, over a longer period of time and with less precision.

With the decreasing level of lighting (lighting, glare, lighting uniformity, colour of the light, flashing, etc.) the productivity of work and its quality decreases as well; exhaustion of employees increases. In critical cases, health problems might arise.

Technical regulations introduce parameters for specific standard conditions (age of the observer, sight condition, and size of the critical detail, etc.). In non-standard cases, the parameters are adjusted. They are increased, but also lowered (e.g. in case of an unusually high contrast or substantially short period for performance of the visual task).

2.2 Basic terms and variables

Light

A visible radiation in the wavelength of 380 to 780 nm, evaluated by human sight.

Long-term stay

People staying at an indoor space or its functionally designated part for more than four hours per one day (in daylight) repeatedly more than once a week (under provisions of ČSN 73 0580-1 art. 3.1.3).

Long-term work

Work at work places that is performed for a period of 4 hours in the shift and longer. (according to Government Regulation 361/2007 Section 7(6))

Luminous flux, Φ unit lumen (lm)

Expresses the ability of the radiation flux to cause a sight perception. The kilolumen (1 klm = 1000 lm) unit is used as well.

Luminous intensity, I , unit candela (cd)

Until certain point, equal to the luminous flux contained in a unit of a solid angle. Luminous intensity is used to describe optical parameters of light sources and luminaires.

Illuminance (lighting intensity), E , unit lux (lx)

Is an areal density of luminous flux incident on an elementary surface area.

Maintained illuminance, \bar{E} , \bar{E}_m , (lx)

It is the lowest permissible average luminance of the reference plane at the point of the visual task upon inclusion of the age and condition of the lighting system.

Maintained luminance series, (lx)

It is defined in such a manner that the differences between the individual levels discernible by the human eye are as follows: 20–30–50–75–100–150–200–300–500–750–1.000–1.500–2.000–3.000–5.000 lx.

Maintenance factor, z , MF, dimensionless variable

It expresses the debasement of the lighting system due to age and debasement of their elements. It depends on the operational characteristics of the lamps and ballasts, luminaires, surfaces the delimit the interior space, environment and on the maintenance plan. The calculations usually respect ageing (and soiling) of the lamps (z_z , LLMF), luminaires (z_s , LMF), surfaces (z_p , RSMF) and the factor of functional reliability of the lamps (z_{fr} , LSF). Usually, other influences are not included in the calculations.

Note on the factor of light source ageing

Information about its progress depending on the lighting time is provided by the manufacturer of the light fitting (luminaire).

Note on the factor of light source contamination

The fact, that luminaires with LED light sources get contaminated the same as luminaires with other light sources, mustn't be forgotten.

Overall uniformity of illuminance, U_0 , dimensionless variable

This is the ratio of the minimum and average illuminance on the reference plane at the task site.

Longitudinal uniformity of illuminance, mark U_L , dimensionless variable

The ratio of the minimum and maximum illuminance on the reference plane at the task site. It is mainly used as a quality criterion of road lighting.

Immediate surroundings of the visual task area

Area surrounding the visual task area within the field of vision. Its width has to be no less than 0,5 m.

Illuminance of the immediate surroundings of the visual task area

Is chosen based on the maintained illuminance of the visual task site in accordance with the table 1 of the ČSN EN 12464-1 standard.

Lighting uniformity must be at least 0.40.

Visual task background

Space in the immediate vicinity of the visual task. Within the limits of the illuminated space, its width is at least three metres from the border of the immediate surroundings of the visual task.

Visual task background lighting

The maintained illuminance must be at least a third of the maintained illuminance of the immediate surroundings of the visual task. The uniformity of the illuminance has to be no less than 0.10.

Contrast, mark K , dimensionless variable



Evaluation of the difference between two or more visual perceptions observed simultaneously or in a time sequence (contrast of brightness, colour, illuminance). It is usually expressed as a ratio of the difference in values to one of them: $(L_1 - L_2)/L_2$; L_1/L_2 .

Luminance, L , unit candela per square meter (cd.m^{-2})

It is a quantity the eye reacts directly to (or, to be more precise, the eye reacts to the contrast of luminance). It depends on the distance of the observer from the illuminated surface.

Glare

The sensation caused by excessively bright surfaces in the field of vision (illuminating surfaces of luminaires, lighted surfaces with unsuitable reflection properties, windows). It may be the cause of errors, fatigue and accidents. It may be perceived as discomfort glare or disability glare.

Discomfort glare, UGR , dimensionless variable

Caused directly by luminaires. If it exceeds the permissible value, it is then possible to delimit space where it is possible to locate the work place in the room. Glare may be also limited by further shuttering in accordance with the table 2 of the ČSN EN 12464-1 standard. The glare rate is critical when using bright light sources, for example, LED lamps.

Directional lighting of the visual task

Using a proper fall of light on the visual task workplace the visibility improves, and so makes carrying out the visual work easier. It is required to limit occurrence of sharp shadows; nevertheless, in some cases shadows improve the distinguishing part of a visual task.

Reflection factor, ρ , dimensionless variable

It is a ratio of a reflected luminous flux and the flux impacting a specific surface.

Colour of light

The quality of the colour of light (light sources) is described by the colour temperature and colour rendering quality. It affects the colour appearance of the illuminated objects and people even if the perception of the colours is individual in character.

Hue of light

It is the apparent colour of the light emitted, which is quantified by its *correlated colour temperature (chromaticity)* – T_{CP} , the scale unit is the Kelvin (K). We differentiate three hues: warm white (usually under 3.300 K), neutral white (usually 3.300 to 5.300 K), cold white (usually over 5.300 K). The choice of colour appearance is a matter of psychology, habit and aesthetics. It depends on the illuminance level, colours and character of the space. Warmer hues are better for relaxing activities (common rooms, canteens), neutral white for work activities.

Colour rendering quality

It is given by the size of the general colour rendering index R_a (CRI). The maximum value is 100. Sources of light with the colour rendering index less than 80 must not be used in inner spaces where people work or stay long-term. It is necessary to ensure reliable differentiation of the safety colours.

Influencing the perception of colour

Small areas seem darker and less intensive as compared with large areas. The colour perception and lightness of the colour also depends on the angle of observation and direction from which the light falls on the assessed object. This is especially true of objects with a mirrored reflection element (e.g. metallic or pearlescent paint). Comparison of various colour perceptions is possible assuming unchanged observation conditions.

Flicker and stroboscopic effects

Timed changes of illuminance levels due to electric or mechanic reasons. Has a negative impact on visual performance and fatigue, causes blurred vision. May cause headaches. May cause seizures in people with photosensitive epilepsy. With specific frequency of flashing the stroboscopic effect occurs, i.e. seeming slow-down, change of direction, or stop of rotating objects.

General lighting

Are uniform illumination of a space regardless of special local requirements.

Staggered lighting

This is light that ensures a higher luminance in part of the space, e.g. areas where visual work is performed.

Local lighting

This is an independently operated lighting for a specific visual task (spatial limitation).

Combined lighting

This general or staggered lighting supplemented with local lighting at the sites of more demanding visual work (e.g. lighting of a working machine).

Integral lighting

Deliberate concurrent lighting by daylight and additional artificial lighting. It is desirable to devote special attention to the design and operation of lighting systems especially in rooms with side lighting openings. In premises with integral lighting, there are special requirements for eventual regulation of artificial lighting.

Determination of the condition of the parameters of the lighting systems

In most cases, it is possible to assess the real conditions on the basis of measurement. This must be done according to the methodology stated in the technical standards of the instrument with valid calibration or verification. Based on facts verified in this manner, the lighting systems are evaluated and this forms the background document for any correction of the maintenance plan or design of savings measures.

3 Workplace illumination

3.1 Introduction

The principles of illuminance of inner spaces (workplaces + spaces where employees stay) are for the inside workplaces stated in the European technical standard ČSN EN 12464-1. In case the requirements on day light for the given space are not met (ČSN 73 0580-1 and ČSN 73 0580-4, and ČSN EN 17037), an artificial lighting is proposed in accordance with ČSN 36 0020.



The ČSN EN 12464-2 is valid for the outside workplaces, and for communications connecting individual workplaces are valid standards for lighting of road communications ČSN CEN/TR 13201-1, ČSN EN 13201-2 to 5, and ČSN 36 0455 (will become valid during 2016).

The given technical standards are binding, or are binding standard values and requirements.

The standard value is the specific value of daylight, artificial and integral lighting contained in the corresponding Czech technical standard regulating daylight, integral and artificial lighting. A standard requirement is a technical requirement contained in the corresponding Czech technical standard.

3.2 Illuminance values

The minimum value of the maintained luminance of general artificial lighting of 200 lx (hygienic minimum) must be observed at a workplace where work is performed permanently with suitable daylight. In case of unsuitable daylight, but under conditions of fulfilment of the requirements for integral lighting, the required minimum maintained luminance value supplementing the overall artificial luminance is 200 lx.

In all the given cases where the corresponding technical standard brings a higher requirement, the value stated in such a regulation shall apply. For integral lighting provided mainly via the side lighting openings, the prescribed value is raised by one level of the luminance rate in the event that the maintained luminance requirement for the performed work is 200 to 500 lux inclusive.

At workplaces without a requirement for fulfilment of daylight quality and quantity requirements, or integral lighting, permanent work is permissible only in cases concerning spaces:

- exclusively with night operation;
- where the presence of daylight is not permissible for technological or health reasons;
- where it is not possible to procure an adequate number or size of lighting openings for technological or structural reasons.

The minimum overall artificial lighting value equivalent to a maintained luminance of 300 lx must be observed at the given workplaces. If a maintained luminance requirement of 300 to 500 lux inclusive exists for the performed work, the luminance is increased by one level of the luminance rate.

The maintained luminance values stated in the standards are the minimum permissible. In substantiated cases, it is possible to increase the luminance rates. Maintained luminance must be increased in cases where:

- visual activity is decisive for the working task;
- repair of any defects (incompatible part) would be costly;
- precision or high labour productivity is decisive;
- the work requires higher concentration;
- a low contrast visual task or very little critical detail is concerned;
- a task is performed for an unusually long time;
- the worker's eyesight has deteriorated.

The required maintained luminance may be reduced in cases where:

- the critical detail of a visual task is unusually large or highly contrasting;
- a task is performed for an unusually short time.

It is generally non-permissible at a workplace with a permanent presence of people to reduce the maintained luminance below the hygienic minimum (200 or 300 lx) pursuant to Government Regulation No. 361/2007 Coll.

If permanent work is not concerned, it is necessary to document the non-observance of the minimum standard values at the workplaces with a snapshot of the working day.

It is always necessary to ensure that the workers are not blinded by glare. In case a shiny or highly reflective surface is in the field of view, it is desirable to pay attention to reduce glare from the reflection of light from such articles.

In case of increase of the luminance, the risk of glare may increase because it is necessary to use luminaires with light sources that have a higher luminous flux. The luminaire brightness increases. Similarly, there is a higher risk of glare also in the case of reduction of the luminance level because this reduces the capability of eyesight to adapt to luminance and glare may occur also from luminaires with a lower luminance (which it has achieved thanks to light sources with a lower luminous flux).

In connection with glare, higher attention is necessary when using LED lamps. The LED are small light sources that emit a substantial luminous flux. For this reason their brightness is very high and the risk of glare increases.

It is necessary to ensure suitable distribution of the luminance in the field of vision. For creation of the balanced distribution of the luminance of all surfaces, suitable reflectance and luminance of the surfaces.

- for the ceiling, the suitable reflectance is in the range 0.7 to 0.9



- for walls 0.5 to 0.8
- for floors 0.2 to 0.4
- for fixtures and fittings (furniture, machinery) 0.2 to 0.7

Reflectance is determined as the weighted average of the individual areas, which are present on a given surface (e.g. for the walls, these are the window openings, furniture, pictures, etc.).

It is necessary that the ceiling and wall surfaces should be light. This ensures their adequate illumination. The maintained luminance of the ceiling should be greater than 30 lx; in the case of the walls, it should be greater than 50 lx. In both cases, it is necessary that the uniformity of the luminance should be at least 0.1.

It is sometimes necessary that the walls and ceiling should be lighter – e.g. in the offices, educational and health facilities, public entrance areas, in the corridors, staircases and similar. It is then suitable that the maintained luminance on the ceiling should be greater than 50 lx and on the walls greater than 75 lx.

3.3 Light systems

The lighting of the premises is usually done by means of the overall lighting system. In the event that there are some places with different visual intensity in the illuminated premises, it is possible to use a staggered lighting system.

Where the requirements are higher in terms of visual load, it is also possible to design a combined lighting system

The combined lighting system is not recommended for a required maintained luminance of up to 500 lx (inclusive). For higher maintained luminance, but which is lower than 2,000 lx the basic lighting (general, staggered) must provide at least 30% of the required luminance. For values above 2,000 lx, it suffices that the basic lighting provides at least 10% of the required luminance.

The lighting system must be designed to ensure all the quantitative and qualitative requirements stipulated by the applicable regulations or this document.

In case the light system consists of independent unanchored light sources with illuminance calculations done for a specific position of the luminaire, it is not possible to manipulate such a luminaire or change its position at will without expert evaluation.

4 Light system requirements

Values of maintained illuminance, uniformity, glare rate (UGR), and hue index defined in the standards and ITS are binding.

Inspection of lighting systems is done by measurement and evaluation of the basic data provided by the manufacturer (table of the UGR, Ra, Tc, ...).

If the ascertained value, including the interval of expanded uncertainty, is better than the required value, then the assessed parameter is suitable. If it is lower, it is unsatisfactory. If it lies in the extended limits, it is not possible to determine, whether it is satisfactory or not. In that case it is necessary to make the measurement procedure more precise. If the condition shall still be unsatisfactory even afterwards, it is necessary to take measures to improve the evaluated condition (e.g. more intensive maintenance, change of location of an unsuitable workplace, supplementation of the lighting systems).

Glare is evaluated on the basis of completely adjusted UGR tables and UGR forms, or supported by a calculation of the UGR values. For evaluation of the operational lighting systems, it is possible to set the UGR values by using luminance analysis that uses instruments to measure the luminance of a scene (ILMD). Any unsuitable condition must be solved individually by change of the workplace location, change of the direction of view, shielding from luminaire glare, elimination of shiny surfaces, etc.

The hue of light is evaluated based on documents of a producer/supplier of the light sources / luminaires, or using appropriate devices for measurement. The hue index must not be lower than the one proposed. It is non-permissible in one space to use light sources with a chromaticity difference of more than 10%.

It is necessary to remove or at least significantly reduce the stroboscopic effect at places where its manifestations are undesirable or even dangerous. This is possible in the case of mechanical causes by suitable fixture of the lamps or elimination of moving objects. In case of electric causes by using high-frequency electric ballasts or by thorough change of phase powering the individual luminaires. Lower quality LED lamps are dangerous because they can flicker.

4.1 Illuminance around the site of a visual task

The maintained luminance values in the immediate task surround and task background is selected depending on the luminous intensity of the visual task site itself according to the following table 1:

Table 1 – Maintained illuminance of the task site, its immediate surround and background



Illuminance (lx)		
Of the task workplace	Of the immediate surroundings of the task	Of the background of the task
≥750	500	200
500	300	100
300	200	75
200	150	50
150	150	50
100	100	50
≤50	≤50	50

The uniformity of illuminance in the immediate surrounding of the task has to be better than 0.4, and at least 0.1 for the background.

4.2 Outdoor areas

Table 2 – lighting requirements – outdoor spaces

Type of space, task or activity	E _m lx	GR _L -	U ₀ -	R _a -
accesses to buildings and parking areas, pedestrian communications forbidden to motor transport	5	50	0.25	20
regular vehicle traffic (max. 40 kmph)	20	45	0.4	20
average traffic, such as administrative buildings parking lots	10	50	0.25	20
heavy traffic – parking lots	20	50	0.25	20
parking areas for completed cars, employee parking lots, in general all areas monitored by a CCTV, gates	50	50	0.25	20
areas for loading finished cars onto trucks or trains, and for storing pallets and crates; during the performance of working operation, reading of addresses, guides, use of tools				
a/ only with vehicle operation				
- in short intervals, max 1 hour	50	50	0.4	20
- with continuous stay of employees, more than 4 hours	100	50	0.4	20
b/ with both vehicles and pedestrian operators present				
- in short intervals, max 1 hour	100	45	0.5	20
- with continuous stay of employees, more than 4 hours	200	45	0.5	20
loading platform and logistic shelters at buildings, material marking identification	200	45	0.5	20
Pedestrian crossings and places for crossing	Based on luminance of the background	45	0.4	20

Table 3 – Requirements for additional illuminance of pedestrian crossings and places for crossing

Maintained luminance value of the surface of a ground communication/background (cd.m ⁻²)	Average maintained vertical illuminance (lx)		
	Lowest area		Highest
	basic	additional	all areas
1.5	additional lighting is not established		
$1.0 \leq \bar{L} < 1.5$	75	50	200
$0.75 \leq \bar{L} < 1.0$	50	30	150
$0.5 \leq \bar{L} < 0.75$	30	20	100
$\bar{L} < 0.5$	15	10	50

Communications on the plant premises with motor transport are illuminated in accordance with the set of standards of the ČSN EN 13201-X series. Pedestrian crossings are illuminated in accordance with the requirements of the TKP-15 (Technical and qualitative terms of building roads – Chapter 15 – Road and street lighting – Ministry of Transport).



4.3 Administrative and training areas

Table 4 – Lighting requirements – administrative and training areas

Type of space, task or activity	E_m lx	UGR _L	U_0	R_a
corridors, entrances, elevators	100	28	0.4	80
staircases	100	25	0.4	80
staircases of administrative buildings and training facilities	150	25	0.4	80
medical waiting rooms	200	22	0.4	80
archives	200	25	0.4	80
changing rooms, toilets	200	25	0.4	80
document filing, copying, reception desks computer and language classrooms	300	19	0.6	80
writing, typing, reading, data processing, CAD work stations, conference and meeting rooms, lecturing halls, training workshops, rooms for practical training and laboratories	500	19	0.6	80
medical office	500	16	0.6	90
technical drawing	750	16	0.7	80
classrooms, consulting rooms	300	19	0.6	80
lecture rooms, auditories, evening lessons, andragogy	500	19	0.6	80
training workshops	500	19	0.6	80

4.4 Control workplace

Table 5 – Lighting requirements – control workplace

Type of space, task or activity	E_m lx	UGR _L	U_0	R_a
interoperation control of parts using etalons and callipers, visual control of part integrity with critical details size above 0.1 mm	500	22	0.60	80
control using micrometre gauges and exact surface assessment, work operations with critical detail size 0.1 mm and less.	750	19	0.70	80
audits, quality control, designer workplaces (minimum permissible value)	1,000	16	0.70	80
colour control	1,000	16	0.70	90

4.5 Production areas

Table 6 – lighting requirements – production areas

Type of space, task or activity	E_m lx	UGR _L	U_0	R_a
orientation lights in underground tunnels, cellars, shafts, inner spaces of buildings with terminated production	50	-	0.40	60
passage areas and walkway corridors, warehouses with no permanent operator presence, staircases, elevators, walkable grate platforms during use	100	25	0.40	60
communication for transporting and manipulating large burdens, automated production lines (welding, painting) with occasional manual manipulation	150	25	0.40	60
areas with continuous presence of people – loading, manipulation, and storage spaces, engine rooms, smelteries, sand preparation, casting cleaning	200	25	0.40	80
day rooms, rest areas, changing rooms, cafeterias, shower rooms, bathrooms, restrooms	200	22	0.40	80
machinery control stations with monitor screen watching	200	25	0.60	80
working operations with a critical detail size > 1 mm, operation of automatic machines – loading and unloading of parts, preparatory operations performed beside the manufacturing line cleaning of body surfaces, electric trains charging station, dispatch, packaging, vehicle maintenance	300	25	0.60	60
working operations with critical detail size 0.1÷1 mm, workplaces at manufacturing lines with forced tact, assembly and finishing lines, application of sealants and glues, spray application of paint coats, paint-coating cabins, manual spot-welding, welding, fitting and	500	22	0.60	80



rework of the body, grinding of the welded body surfaces, grinding cabins, manufacturing of models and dummies				
control rooms, monitoring rooms	500	19	0.60	80
first aid rooms	500	16	0.60	90
spray application of paint coats, paint-coating cabins, surface grinding, grinding cabins	750	22	0.70	80
painting – coat repair and inspection	1,000	19	0.70	90

5 Light sources

From the viewpoint of minimization of energy consumption, it is necessary to use light sources with the highest specific light output possible. Using LED technology is requested as a preference. Any substantiated requirement for other technologies (for outdoor lighting – high-pressure sodium or metal halide discharge lamps; for indoor premises – T5 fluorescent lamps) it is necessary to obtain prior approval from the PSU, PPB specialised departments of ŠKODA AUTO a.s. through the specialised department PSZ/1 – Methodology, standardization and service.

This part of technical requirements for lighting systems is valid mainly for construction lighting. In regards of technological lighting, specific requests are stated in individual Lastenhefts (technical requirements) of the PPx department, Brand Planning. In case the PPx – Brand Planning department will name ITS 2.00 Artificial lighting in their technical requirements, this ITS 2.00 is fully binding for the Contractor.

6 Lighting system quality requirements

To estimate the most technically and economically advantageous iteration of a new lighting system, it is necessary to map and process the current solution status of the current lighting system of the shop floor in question. The newly proposed solution has to be designed with taking normative lighting parameters (e.g. lighting of areas in question), operational requirements (such as covers, work environment), purchase costs, electricity consumption, life, maintenance costs and payback period of financial expenses. A feasibility study of the lighting system is requested for overall evaluation with all necessary documents and support data included. The feasibility study will be carried out by a high-voltage specialised department or a person assigned by the Investor (lighting technician). The purpose is, to determine the technically and economically advantageous version.

6.1 Evaluation of existing condition

To evaluate the current condition, most importantly the current project documentation of the lighting system (both hard copy and digital copy), as well as other documents mentioned below, has to be provided and submitted by the owner of the OU investment property for the shop floor in question.

Full list of documentation part for evaluating current condition of a lighting system:

- Light system project documentation;
- Raster of the luminaires layout to scale
- Types of luminaires used;
- Drawing of cable routes, types of cables
- Placement of light distributors and marking of their scope of operation (extent);
- Operational conditions – method of using the system, i.e. shifts, number of operational hours per year;
- Method of control regulation and its description;
- Daylight share usage (skylights, windows, sun pipes; if known, then also % of daylight share, how is the daylight share used – is the lighting controlled by a daylight sensor)
- Verification of light system technical condition by an inspecting electrotechnician – revision protocol, technical report of the operating party;
- Environment defining protocol;
- Protocol on definition of lighting areas – requirements
- Report on measurement of the illuminance of the individual spaces

Note: The operating party must always have at hand the current status of compliance with normative requirements for individual areas of object in question. In case the operating party is not able to submit these, it is necessary to include the measuring of both current and new lighting system into the Project Documentation Assessment report.

To provide a complete summarization of data required on the current condition of lighting systems – Annex see Sec. 10.1 and 10.2



6.2 Lighting system design

To create a design and/or a concept solution study of a new lighting system, it is necessary to include, beside the requirements for current conditions listed in Section 6.1, requirements of the operating party and users stemming from current conditions of the operations in question:

Ordering party requirements:

- Definition of lighting system requirements by the user of the given areas;
- Definition of the lighting system control and operation methods (for individual zones);
- Classify the lighting premises according to the light intensity requirements based on ITS 2.00, Sec. 4. Separately for general lighting, technological, working areas, storage areas, roads, etc.
- To mark individual zones clearly on the drawing of the area in question;
- Request for replacement of the electrical installations (cable routes, cable lines, distribution boards) – see the point on evaluation of the current state (conclusion, recommendations from the electric revision report);
- State all the necessary limitations – operating temperature, presence of chemicals, banned chemical compounds and elements (e.g. Silicone), etc.

6.3 Luminaire and light source requirements

Technical requirements for luminaires or light sources for the purpose of subsequent lighting-technical study by requested manufacturers (in accordance with this ITS Section 9) are defined by the lighting system administrator in cooperation with the operating party and the PSU, PPB specialised departments].

Neither requirements nor the luminaire cannot be defined in a binding manner without an external influences determination report.

The requirements to be defined in question are mainly:

- for the luminaire fitting (IP), temperature of the surroundings, resistance to chemicals, resistance to corrosion, resistance to UV radiation, forbidden chemical materials.
- required chromaticity of the light source (hue of light – see 2.2) and the hue interpretation Ra.
- light source type (LED, lamp, fluorescent tube – we prefer LED in accordance with the ITS), output of luminaires, radiating parameters of luminaires, control system and life of light sources (these are recommendations for the manufacturer in question, but they will be usually defined by the lighting-technical study).

To define these requirements may be used the form: “Tender documents for the supplier” – Annex no. 10.3.

6.4 Legal and other requirements

All luminaires, light sources, and other light system components have to be properly introduced to the EU market, and marked with the CE and ENEC marks.

The products have to pass the electromagnetic compatibility test – EMC.

The products have to fulfil specific conditions of individual installations.

The manufacturer has to submit additional documents upon request:

- Light flux measurement protocol, luminosity distribution measurement
- LED sources spectral characteristic measurement protocol
- warmth test and durability test protocol
- IP cover grade verification test protocol
- ENEC certificate
- electric safety test protocol – LVD
- electric test protocol (electric durability, insulation resistance, transition resistance, leakage and contact current)
- electromagnetic compatibility test protocol – EMC
- electromagnetic interference/emissions test protocol – EMI
- electromagnetic resistance/immunity (susceptibility) test protocol – EMS

All the tests must be issued by accredited test centres in the EU.

Note: The tests may be performed also in a non-accredited laboratory. However, in case of doubts the contracting authority without further ado reserves the right to request additional measurement by an accredited laboratory at the cost of the supplier.



7 Choosing lighting technical solution

Manufacturers requested or exclusive manufacturer representatives in accordance with this ITS, or realization companies, will submit the requested solution design in accordance with tendering conditions of the Ordering Party (object administrator or possibly the appropriate PPB department construction supervision) for creation of lighting-technical study.

List of documents for the lighting technical study documents necessary for full evaluation:

- Calculation of lighting in PDF format
- Calculation of lighting in electronic (computational) program format
- Full corrected UGR table and filled UGR form (Annex no. 10.5)
- A DWG format drawing with marked luminaires and main components (DWG with current state will be provided by the user)
- Luminaire catalogue sheets with the manufacturer's identification
- Itemized price offer
- Itemized specification of luminaires, all accessories, control elements, ...
- Cost overview table in accordance with the supplied sample (Tender conditions for the supplier.xls)

Luminaires proposed by the manufacturer or the realization company (Contractor) have to comply mainly with the following:

- Guarantee period of min. 5 years
- Post-guarantee supply of spare parts with a guarantee of min. 10 years
- During the period between bringing the lighting system into operation and proper hand-over, the Contractor guarantees service of lighting within 2 hours from reporting the malfunction.
- Deadlines, such as the delivery date, always have to be negotiated at technical meetings. It may vary, based on the user's requests.

An integral part of realisation shall be a revision report and determination of the state of the lighting system parameters at the cost of the Contractor. The measurement of lighting will be carried out by an independent person approved by the contractual party.

7.1 Hand-over documents

- Actual implementation documentation;
- Revision protocol;
- Illuminance intensity measuring protocol;
- Operator training protocol (there isn't a uniform template);
- Operation and maintenance manual with service organisation contacts;
- Service agreement proposal (price offer) for one year of maintenance;
- Declaration of conformity in accordance with the provision of §13, art. 5. Act no. 22/1997 Coll.
- .xls luminaire list – will include:
 - Luminaire designation as per layout;
 - Power distributor;
 - Power circuit breaker;
 - Location (DALI driver mark);
 - DALI channel no.;
 - DALI address.
- All documents are required to be in Czech.

8 Technical requirements

8.1 General requirements (interior lighting)

- The supplied luminaires and components must comply with the regulations for commissioning on the market and applicable Czech technical standards
- For adequate use, the construction must generally have a stable shape and be resistant to twisting, corrosion and ageing; for this reason, it must have adequately thick material, construction and manufacturing procedure.
- All the parts of the luminaire must be made of corrosion resistant material or permanently protected against corrosion. The painted metal parts must be pre-treated to ensure flawless and durable painting. Coating must be done in such a manner that all quality parameters of the surface finish correspond to state-of-the-art technology. The surfaces must be free of any defects, which would deteriorate their appearance.
- Plastic luminaire fittings, like trays, plates, protective tubes, etc., must be UV-stable with antistatic finish.
- It is prohibited to use substances that disrupt the wettability of paints (cause of craters), especially silicones and polytetrafluoroethylene. A document of compatibility with paints must be provided, especially on the absence of silicone.
- Luminaires must carry a type label according to EN 60598.



- Luminaire hangers, e.g. ceiling hooks, must carry 5-fold the weight of the installed lamp but no less than 10 kg, without deformation.
- For LED luminaires (exterior lamps, High Bay, strip lamps) in uncontrolled lighting systems, use industrial LED power supply sources with CLO (constant light output) function, with constant nominal net luminous flux for the duration of nominal life cycle; the manufacturer shall state the ballast efficiency and luminaire input at the beginning and end of the nominal life cycle.
- Luminaires for DALI control systems installed at ŠKODA AUTO a.s will be fitted with LED drivers of DALI standard, certified by DiiA for DALI2, at least as per Section 101, 102 and 207, of the DALI2 standard in accordance with the IEC 62386. It is possible to verify, whether the LED driver has DALI2 standard certification, at the following web site at the Products section: <https://www.digitalilluminationinterface.org/products>
- Use of LED tubes to replace fluorescent tubes is not permissible.
- The lighting system must have an electric power consumption metering system with its subsequent integration into the control and operating system, including transfer to a higher energies system (such as Energis).

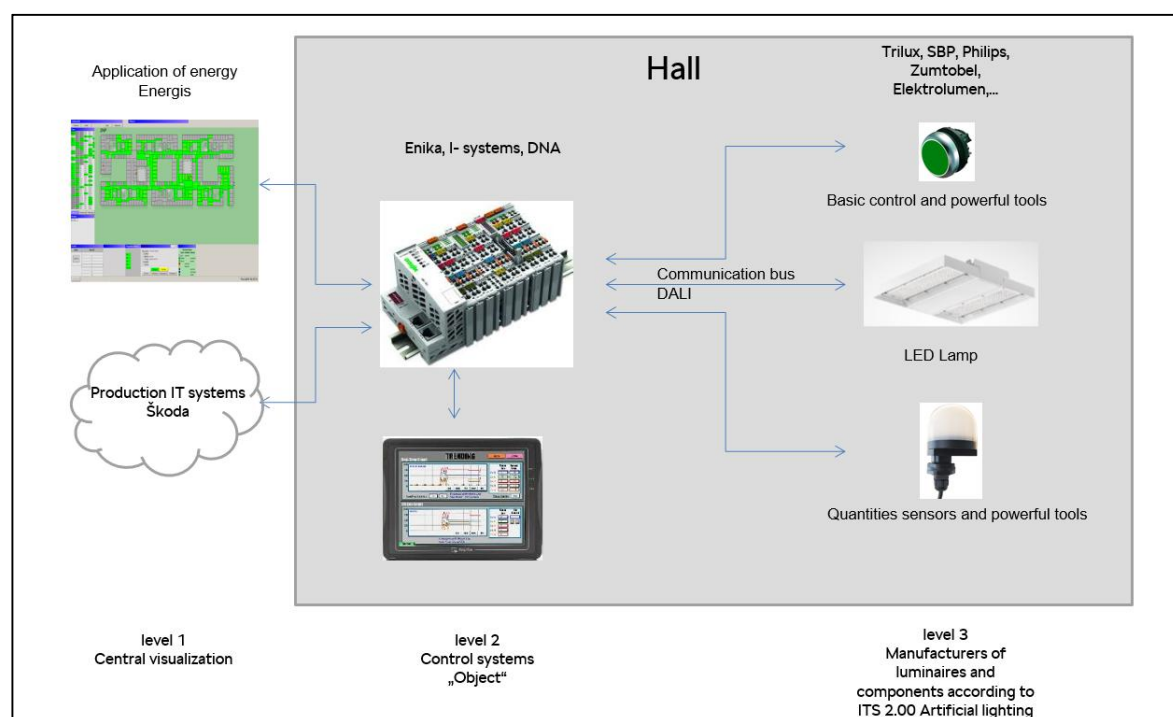
8.2 Control and operating system, IT

Control system used for control of the larger lighting units according to the ROI calculations. A DALI, DALI2 system is required for controlling light systems, in accordance of the standard series ČSN EN 62386-X. A different system may be used only in well-founded cases pending consultation and approval of a specialized ŠKODA AUTO a.s. department (PSU, PPB).

Currently, the following control systems are used and approved for ŠKODA AUTO a.s. shop floors:

Manufakturer	Product	Dealership
Enika	Poseidon	Enika
Helvar	Helvar	DNA Central Europe
Philips	Dynalite	Philips CZ
WAGO	WAGO-O/I- systems	i- systems
Zumtobel	Luxmate	Zumtobel CZ

Lighting system topology



The control system must allow:

- Shop floor control systems must allow for connection into an energies information system (e.g. IS Energis)
- Individual local control
- Remote control option
- Option to switch the entire lighting system on and off
- Control of the lighting in relation to daylight intensity
- Control of the lighting in relation to the use of the premises (motion sensors)
- Time control of the lighting
- Diagnostics of the individual components of the lighting system with error messages
- Local and remote configuration of parameters
- Option to allocate various levels of authorisation to control the lighting
- Visualisation of consumption (current + historical)
- Visualisation of the current condition of the lighting
- Option to control the individual luminaires
- User interface in the Czech language
- Interconnection of lighting system management (lights, control elements) in metal version, in case of economical and technical advantage a **wireless control may only be used pending approval by specialized PSU, PPB departments.**
- Simple and transparent operation
- Option for the user to set the parameters of the lighting system
- Expandable modular system
- For all changes in the configuration of parameters, a user non-erasable record of the person, time and changes made must be created

Inspection of observance of the illuminance must be ensured at least every 2 years (inspection and adjustment of the lighting system parameters). This is an obligation for the user of the lighting system.

IT network connection requirements for the system

For applications concerning the lighting control system with requirements for connection to ŠKODA AUTO (hereinafter referred to as ŠA) data network is valid

- adherence to the ITS 1.05 Information Systems and Technologies

HW components

Devices used as HW components for lighting control requiring ŠA network integration have to be approved by the FIO specialized department authorized to do so. For approval it is necessary to submit

- catalogue sheets from the device control system manufacturer
- HW components have to be included on the IT list
- in case the component is not on the IT approved list, these devices have to be supplied to the IT department (FIO) for testing the connection to ŠA infrastructure (cooperation with the Contractor's IT Integrator)

Note: Shall the device pass the test and get approved by the IT FIO, it will be registered for connecting to data network. Without these physical tests by the specialized department the device could not be implemented (this should be handled by some internal policy, etc.).

Data networks

- In accordance with the ITS 1.05, it is not permissible to create one's own data network at shop floors of ŠA plants.
- Individual devices required for communication to ŠA network will be connected to a data socket using structured cabling (1 device per 1 port) – design and implementation by IT FIO
- Inclusion into already existing VLAN for lighting control (defining the necessary VLAN range and interconnections to already functional VLAN Energis, etc.).
- It is not possible to use any devices for "switching" and connecting further IT devices within the ŠA network.

Note: Allowed are, at the most, e.g. external panels intended for direct communication with the device of the lighting control system in question that do not require communication with the network and is only intended as a display unit, such as for the distributor in question. Even here only local use is assumed, such as within the distributor, and no other UTP cable can be included in the ŠKODA AUTO installation network wiring. Even though it is intended for the application. Shall a request for external placement of such a device occur, ŠA network will be used for communication and the device will be considered under the above-mentioned requirements and ITS 1.05

Projects



- Ensure high-voltage, MaR, etc. professions coordination for implementation of other shop-floor lighting projects in cooperation with the FIO data network designer. During the project preparation stage, the Investor has to provide an HV designer coordinated by the FIO/33 construction supervision.
- The coordination will ensure a compromise solution for placement of power distributors, of devices requiring ŠA network connection close to devices providing data network (taking data cable routes into account for optimization and minimization of costs for creating requested number of data sockets at the distributor or shop-floor location in question)

Note: The lighting designer will be provided by FIO/33 upon request with IT areas locations at the shop floor in question.

- If possible, other power wiring distributors for lighting will be placed close to current technical areas or units already equipped with data connectivity.
- A virtual network dedicated to lighting control systems or lighting in general will be created for the data sockets, pending an internal agreement with the IT FIO.
- A device approved by IT for this specific application will be automatically included in such a virtual data network upon plugging.

Note 1: This fact will be created mainly to keep transparency for network administrator, as well as security reasons and due to possible impact to other devices within the data network.

Note 2: Prefer technologies with option of peripheries integration under one device IP within the design proposal of individual technologies.

Rules for connecting to ŠKODA AUTO IT network

Regulators (PLC), data concentrators, converters, and other devices transferring data to appropriate measuring system servers must be connected to ŠKODA AUTO ethernet network. An ethernet socket must be created for their connection. The FIO/34 supervises creation of the socket (financial covering is to be ensured by the Investor) and it will delegate the realization to the appropriate authorized company. Every data socket is assigned a unique number upon creation. After the socket has been created, it is necessary to request its activation. The request is sent to the Call Centre by e-mail.

If possible, the sockets have to be activated in the technological network – then it is not necessary to ask for network passage through firewalls.

For connection is necessary:

- Request for assignment of device name and SAP registration
- Request for assignment of an IP address in DNS, see ŠKODA AUTO Intranet, form no. 9038
- A MAC address has to be entered or the IP has to be set physically, then location has to be entered too. Approval takes approx. 1 day from submitting the request.
- Request for FIREWALL passage to DMZ server (if necessary); form no. 9031. Ports requested have to be listed. Network names of clients and servers have to be listed. Approval takes approx. 1 week; activation is done once per week by the FIO/2 department.

8.3 Lighting system distributors – in accordance with ITS 1.11

8.4 Emergency lights

- Proposal and operation of emergency and safety light systems will be in accordance with technical standards as amended, mainly ČSN EN 1838, ČSN EN 50172, and ČSN EN 60598-2-22 as amended PBR and ITS 2.11 requirements. The designer and the Contractor are responsible for correctness.
- As a technical standard for emergency and safety luminaires, LED light source with a minimum design life of 50,000 hours is used; it is not recommended to use general lighting system lamps as emergency lights as well.
- When using luminaires with own batteries, the minimum technical standard shall be automatic lamp testing controlled by an integrated timing and test module with indication of the lamp status using a signal LED indicator. It is not allowed to newly install luminaires with NiCd (or containing Pb) accumulators.
- For all the new or reconstructed objects where more than 20 emergency and safety lights will be used, due to reduction of the operating and maintenance/operational inspection costs, it is recommended to use of a central battery power source in compliance with ČSN EN 50171 with option of remote supervision and administration via the Ethernet.
- When using a central battery system, communication between the individual luminaires and the battery unit shall run on the power line with option of programmable control of the modes of selected lamps via the battery unit or host computer/system.
- The designer and the Contractor have to select emergency lighting components of the highest quality.
 - CBS accumulators guarantee no less than 5 years
 - Autonomous luminaire accumulator guarantee no less than 3 years
 - Luminaire guarantee no less than 5 years
 - CBS and luminaire electronics guarantee no less than 5 years
- During the period between bringing the lighting system into operation and proper hand-over, the Contractor guarantees service of lighting within 48 hours from reporting the malfunction.
- CBS will include zero-potential contact signalling summary malfunction for the option of EPS (electronic fire signalization system) connection. Option of EPS connection has to be discussed with and approved by the SO department.
- The operating party is obliged to properly care of the EL device in accordance with the hand-over documentation requirements. Otherwise the warranty is voided.



8.5 Hand-over documents

- Actual implementation documentation;
- Revision protocol;
- Intensity of emergency lighting measuring protocol;
- Operator training protocol (there isn't a uniform template);
- Operation and maintenance manual with service organisation contacts;
- Service agreement proposal (price offer) for one year of maintenance;
- Hard-copy emergency lighting operation log;
- Installation protocol, functional test and fire safety device operational protocol, in accordance with the Decree no. 246/2001 Coll., §6, §7;
- Certificates for cables and cable routes used with functional integrity in case of fire;
- Declaration of conformity in accordance with the provision of §13, art. 5. Act no. 22/1997 Coll.
- .xls luminaire list – will include:
 - Luminaire designation as per layout;
 - Power distributor (CBS);
 - Power circuit breaker (CBS module);
 - Luminaire address;

All documents are required to be in Czech.

8.6 Public lighting requirements (VO)

Cable lines

- For underground lines (distribution routes), the requirement is a CYKY 4x16mm²/ 5x16mm² cable that is installed in guards over its full length. Guards off the paths and roads – PVC Ø60 – 110. Guards in the roads and paths: concrete two-component, PVC with concreting or steel with concreting. Earthing strap FeZn 30/44 mm running together with the cable, mounting and connection according to ČSN.
- The cable must be circuited in case of failure.
- Cable from the pole equipment to the lamp - CYKY3x2.5mm².

Parking lot and street poles

- Conical, hot galvanized + two-component polyurethane coat of Comaxit Ral: 9006
E.g. STK 76/xx/x, manufacturer ELV.S.MORAVA s.r.o.

Pole foundations

- According to the manufacturer's recommendations depending on the peak thrust and load.

Markings

- Luminaire cables must be marked according to the ČSN.
- Markings must also be resistant to poor weather conditions.
- Each installed pole must carry a label with the following data:
 - connection from VO distribution board no...
 - electric circuit number
 - pole number

RVO distribution boards

- Plastic exterior design
- Basic equipment
 - Electric meter
 - Manual/automatic switch
 - Switching clock
 - Photocell
 - Contactors
 - Circuit-breakers including accessories
 - Luminaire for the interior lighting of the distribution board
 - Min. 30% connection and space reserve

8.7 Documentation

- Requirements in accordance with the ITS 1.01
- The artificial and emergency light measurement report (the measurement shall be done by an autonomous entity approved by the Ordering Party to the charge of the Contractor)
- Calculation of the lighting in PDF format
- Calculation of the lighting in electronic (computational) program format
- DWG or DGN format drawing including the luminaires and main components
- Distribution board item test report
- Operating and Maintenance Instructions



9 Release list of component manufacturers

The listed components are generally specified and prescribed for all lighting deliveries, but also for general repairs and reconstruction. The list of specific released components can be specified in the technical assignment.

For the components not specified in this regulation, the supplier has the obligation to use the components released according to ITS 1.11.

In case use of non-released components is necessary, or technologies other than LED, the supplier is obliged to submit a request for issue of an exception from ITS with additional justification of application in ŠKODA AUTO a.s., for approval and revision by the PSZ/1 expert department - Methodology, standardization and service.

The supplier has to submit a list of selected components to the user for approval.

9.1 Luminaires for lighting work areas – recommended technology: LED

Beghelli	Trevos
Elektro Lumen	Trilux
Elkovo Čepelík	Vyrtych
Philips	Waldmann
Regiolux	Zumtobel
SBP	

9.2 Shop-floor luminaires – lights within the height of 8m – recommended technology: LED

Elektro Lumen	SBP
Philips	Trilux
Regiolux	Zumtobel

9.3 Shop-floor luminaires – lights above 8m – recommended technology: LED

Philips	Trilux
SBP	Zumtobel

9.4 Indoor communication – free-standing luminaires – recommended technology: LED

Beghelli	Regiolux
Elektro Lumen	SBP
Elkovo Čepelík	Trevos
Lucis	Trilux
Osmont	Vyrtych
Philips	Zumtobel

9.5 Indoor communications – luminaires on strips – recommended technology: LED

Elektrolumen	Trilux
Regiolux	Zumtobel

9.6 Office luminaires – recommended technology: LED

Beghelli	Philips
Elektro Lumen	Trevos
Elkovo Čepelík	Trilux
Halla	Vyrtych
Lucis	

9.7 Luminaires - Social and rest areas – recommended technology: LED

Deos	Osram
HALLA	Trevos
Lucis	Trilux
Osmont	

9.8 Luminaires - Exterior areas – recommended technology: LED



IGuzzini	Siteco
Philips	Trilux
Regiolux	Zumtobel
SBP	

9.9 Luminaires - Exterior roads – recommended technology: LED

IGuzzini	Siteco
Philips	Trilux
SBP	Zumtobel

9.10 Emergency luminaires – recommended technology: LED

AVEX	TM Technologie
Beghelli	Trevos
Elektro Lumen	Vyrtych
ENSTO	Zumtobel

9.11 Central battery stations

Beghelli	Snow
Eaton	
Ensto	

10 Annexes

- 10.1 Evaluation of existing condition - description
- 10.2 Evaluation of existing condition - calculation data overview
- 10.3 Tender documents for the supplier
- 10.4 Supplier Offer - data summary
- 10.5 UGR value setting table