



ESCOM

ELECTRICAL SAFETY
COMMITTEE

GUIDELINES AND BEST PRACTICES FOR PUBLIC LIGHTING

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What is ESCOM?

The Safety, Health and Environment National Authority (SHENA) and Autoriti Elektrik Negara Brunei Darussalam (AENBD) established the Electrical Safety Committee or “ESCOM” in January 2023; with the objectives of promoting regulatory compliance and raising electrical safety standards within Brunei Darussalam.

Who are the ESCOM members?

Members of the ESCOM comprised of industry experts from both government institutions and private organisations with decades of collective experience and a shared passion to drive improvements and promote electrical safety in Brunei Darussalam. The committee is co-chaired by both SHENA and AENBD.

ELECTRICAL SAFETY BEST PRACTICES			
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Disclaimer:

This document was developed as a recommendation and as an industry reference of best practices to improve electrical safety practices.

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1 INTRODUCTION

1.1 Background

Numerous fatalities and electrical incidents resulting from electrocution which had occurred in the last decade highlighted the shortcomings with regards to public and personal safety in our outdoor electrical poles, (power/lightings) installation accessible to the public. The common causes are:

1.1.1 As a result of contact with live electrical installation (direct /or indirect);

1.1.2 Accidents that occur due to poor lighting such as car collisions; or

1.1.3 Improper design and poor installation/setup.

1.2 Validity

This document is valid for a period of five (5) years from the last revision date. Within this period, this document shall be assessed for relevance and re-validated following the review cycle and review process. Any suggestions for further improvement to this document can be sent to the Document Owner.

1.3 Introduction

This document and EIR (Electrical Installation Requirement, DES) provide the basic foundation for the requirement for any new installation and serve as guidance reference /or minimum safety for an existing installation.

1.4 Purpose

The purpose of this document is to describe the minimum technical requirements for the installation and erection of public lighting for outdoor permanent and temporary setups.

1.5 Scope

1.5.1 This scope covers all metallic poles/tower/pillars that are mounted with light fixtures in an open/unprotected outdoor environment, that is but not limited to, the following equipment/application:

1.5.1.1 Commercial
Shophouses/Offices/Restaurants/Signage/Billboards/Schools

1.5.1.2 Recreational/Clubs/Pools

1.5.1.3 Streetlights: Traffic Lights/ Zebra crossing lights/Solar-Lightings

1.5.2 The following equipment/application are excluded from the scope of this document:

- 1.5.2.1 industry:
quarry/onshore/offshore/factory/marine/ports/construction
- 1.5.2.2 homes/residential;
- 1.5.2.3 residential self-contained solar-power lightings;
- 1.5.2.4 intensity of traffic light;
- 1.5.2.5 illuminance on task area where visual work is critical, accuracy and erroneous is/are important, task related to unusually small size /low contrast, etc.;
- 1.5.2.6 luminance related to display screen equipment including VDUs;
- 1.5.2.7 Aviation Warning Lights (AWL);
- 1.5.2.8 marine lights/lanterns - inland waters and high seas; and
- 1.5.2.9 product safety requirements, product performance requirements, product tests, selection and system design methods, government energy regulation.

2 REFERENCES

2.1 Extracted from IEC 60598: Part 1

- 2.1.1 Clause 1.2.1 - “luminaire - apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes all the parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and where necessary, circuit auxiliaries together with the means for connecting them to the supply”.
- 2.1.2 Clause 1.2.16 - “basic insulation - insulation applied to live parts to provide basic protection against electric shock”.
- 2.1.3 Clause 1.2.17 - “supplementary insulation - independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation”.
- 2.1.4 Clause 1.2.18 - “double insulation - insulation comprising both basic insulation and supplementary insulation”.
- 2.1.5 Clause 1.2.19 - “reinforced insulation - single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation”.
- 2.1.6 Clause 1.2.22 - “class I luminaire - luminaire in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing)

conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation”.

- 2.1.7 Clause 1.2.23 - “class II luminaire - luminaire in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions”.
- 2.1.8 Clause 1.2.24 - “class III luminaire - luminaire in which protection against electric shock relies on supply at safety extra-low voltage (SELV) or protective extra-low voltage (PELV) and in which voltages higher than those of SELV or PELV are not generated”.
- 2.1.9 Clause 1.2.42 - “ELV extra-low voltage - voltage which does not exceed 50 V AC RMS or 120 V ripple free DC between conductors, or between any conductor and earth (voltage band I of IEC 60449)”.
- 2.1.10 Clause 1.2.42.2 - “SELV safety extra-low-voltage - electric system in which the voltage cannot exceed the value of extra-low voltage.
 - 2.1.10.1 Under normal conditions and
 - 2.1.10.2 Under single fault conditions, including earth faults in other electric circuits”.
- 2.1.11 Clause 1.2.42.3 - “PELV protective extra-low-voltage - electric system in which the voltage cannot exceed the value of extra-low voltage.
 - 2.1.11.1 Under normal conditions and
 - 2.1.11.2 Under single fault conditions, except earth faults in other electric circuits”.
- 2.1.12 Clause 1.2.47 - “terminal - that part of a luminaire or component which is necessary to make electrical connection to a conductor”.
- 2.1.13 Clause 1.2.47 - “ferrule - mechanical fixture, generally a rigid tube, used to confine the stripped end of a cable”.
- 2.2 Extracted from BS EN 60598-2-22
 - 2.2.1 Clause 22.3.1 - “emergency lighting - lighting for use when the supply to the normal lighting fails”.
- 2.3 Extracted from BS EN 12464-1: part 1.
 - 2.3.1 Clause 3.1 - “activity area - area which contains one or more visual tasks”.

- 2.3.2 Clause 3.2 - “background area - area adjacent to the immediate surrounding area”.
- 2.3.3 Clause 3.2 - “task area – area within which the visual task is carried out”.
- 2.4 Extracted from BS EN 12665
 - 2.4.1 Clause 3.2.15 - “maintained illuminance - value below which average luminance on the specified area should not fall. It is the average luminance at the time maintenance should be carried out. The engineering unit is Lux (lx)”.
 - 2.4.2 Clause 3.2.15 - “stroboscopic effect - appearance of moving object when the object is illuminated by a light of varying intensity”.
- 2.5 Extracted from BS EN 13201-2
 - 2.5.1 Clause 3.1 - “average road surface luminance - luminance of the road surface averaged over the carriageway. The engineering unit is candelas per square metre (cd/m²)”.
 - 2.5.2 Clause 3.2 - “longitudinal uniformity (of road surface luminance of a carriageway) - lowest of the ratios determined for each driving lane of the carriageway as the ratio of the lowest to the highest road surface luminance found in a line in the centre along the driving lane”.
 - 2.5.3 Clause 3.5 - “average illuminance (on the road) - horizontal illuminance averaged over a road area. Engineering unit is Lux (lx)”.
- 2.6 Autonomy time (of a battery) - this is the duration for which the battery can supply its rated load within its specified voltage limits, following a prolonged period.

3 PUBLIC LIGHTINGS

- 3.1 Light fixtures or luminaires produce illumination by converting electrical energy to reveal a subject in both indoor and outdoor, open environments perceived by the public. In this context, the lighting should be installed exclusively for people’s movement (i.e., work activity / task is excluded).
- 3.2 Luminaires for use with electrical lighting sources on supply voltages not exceeding 1000 V.
- 3.3 Outdoor public lightings are further categorised as follows:
 - 3.3.1 Luminaires for road and street lighting that consist of

- 3.3.1.1 luminaires for road, street lighting and other public outdoor lighting applications.
- 3.3.1.2 tunnel lighting.
- 3.3.1.3 column-integrated luminaires with a minimum total height above normal ground level of 2.5 m.
- 3.3.2 Luminaires erected outdoors other than the purpose for road and street lighting as 3.3.1 above.
 - 3.3.2.1 building decoration lights, inground lights.
 - 3.3.2.2 wall, hanging /garden/landscape lights.
 - 3.3.2.3 temporary lighting for festival stalls.
- 3.3.3 Typical application of public lighting is -
 - 3.3.3.1 Road/Streetlights.
 - 3.3.3.2 Advertisement Neon lights/Sodium lights – LED lights.
 - 3.3.3.3 Any temporary lighting for public use at seasonal stalls (e.g., Raya stall, Gerai).
 - 3.3.3.4 Corridors/toilets/alleyways/junctions, etc.
- 3.3.4 Electrical Light fixtures, luminaires as per clause 3.1, 3.2 above, that receive electrical power/connected to nominal supply voltage 230VAC +20/-10% 50Hz 2-wire (either via Grid or locally generated).
- 3.3.5 Lux is the SI unit (International Standard) of illuminance or illumination. It is defined as the amount of light received on an area of one square meter produced by a uniform distribution over the surface by a candle (one lumen), i.e., $\text{lux} = \text{lumen} / \text{m}^2$ emitted by a candle of one lumen at one meter away.
- 3.3.6 Maintained illuminance: minimum requirements of Lux perceived depending on the tasks and/or activities being performed in the space.

4 ELECTRICAL SAFETY AND REQUIREMENT

4.1 Electrical requirements

- 4.1.1 Light fixtures/luminaires shall be fully rated to nominal supply voltage in Brunei Darussalam, i.e., 230Vac +20/-10%, 50Hz.
- 4.1.2 Light fixtures/luminaires shall be protected from short circuits by MCB of 6-10A rating at the distribution board and as per DES Electrical Installation Requirements (EIR) and per latest Edition IEE Wiring Regulations.

4.1.3 On a case-by-case basis, further assessment may require additional safety protection e.g. 30 mA RCDs, surge protection devices (SPD), etc.

4.1.4 Electrical wire/cable for each final lighting shall

4.1.4.1 be connected by not less than 1.5mm² copper conductors wire, rated to 450/750 VAC.

4.1.4.2 be PVC /or Rubber insulation,

4.1.4.3 be colour-coded according to the latest edition IEE Wiring Regulation BS7671:2008

4.2 Outdoor lighting

4.2.1 Light fixtures/luminaires installed outdoors shall be dust-protected and protected from water splashing from any direction as per IEC 60529 ingress protection and Clause 4.1 of DES Electrical Installation Requirements.

4.2.1.1 Outdoor class I luminaire - In addition to Clause 4.1 Electrical Requirements, the use of outdoor class 1 luminaire shall be:

4.2.1.1.1 double insulated for single core wire (i.e., for both live and neutral), and equivalent; or

4.2.1.1.2 multicore cable inclusive earth wire of the same cross-section area (CSA); and

4.2.1.2 SWB or SWA (steel wire braided or armoured) cable for its main power cables, and interconnected cable between poles if the metallic pole is not earthed. Wire braided or wire armoured shall be earthed to the earth terminal at both ends.

4.2.2 Metallic enclosure and its metallic structural frame shall be equally bonded and effectively earthed to one (1) ohm max.

4.2.3 Be protected by RCD of fixed sensitivity of 30 mA for personal protection, and operating time not exceeding 40 ms at a residual of $5 \times I_{\Delta n}$ (nominal current)

4.2.3.1 For lighting installation not more than 2.5-meter height,

4.2.3.2 For compound/gate/decoration lighting and Clause 3.3.2 above.

4.2.4 Outdoor class II luminaire

Where basic protection and fault protection are provided by double insulation or reinforced insulation, any outdoor electrical luminaire that is/are to be used in public shall be:

- 4.2.4.1 Fully PAT (Portable Appliance Testing) tested not less than 500V in accordance with SHENA Portable Appliance Testing (PAT) Guideline.
 - 4.2.4.2 Any nonpermanent (i.e. portable, handheld, suspended type, etc.) shall not be used if the PAT verification sticker is not adhered to/provided, failed or “validity test due”.
 - 4.2.4.3 Non-permanent appliances that passed the PAT test, marked or attached with “Green” identification and signed by an authorized tester shall only be used in public. (i.e., like weight measuring units).
 - 4.2.4.4 An RCD of 30mA shall be provided to every loop of circuit where the outdoor electrical luminaires are connected to a socket outlet.
 - 4.2.4.5 All outdoor socket outlets shall be of industrial type IP55.
- 4.3 Indoor lighting
- 4.3.1 General purpose recessed type indoor lighting mounted in the ceiling shall comply with Electrical Installation Requirements and IEE wiring regulation BS 7671.
- 4.4 Emergency and escape lighting
- 4.4.1 Emergency lighting shall be provided and installed at strategic points, which includes first-aid rooms, watchmen's offices, the main entrances, and all other buildings and areas where they are required for evacuation and safety reasons.
 - 4.4.2 It is required that emergency lighting is designed/installed in such a way that in the event of power failure, the escape routes are lit.
 - 4.4.3 Emergency lighting may be one or a combination of the following -
 - 4.4.3.1 Integrated as part of standard luminaires of the normal lighting.
 - 4.4.3.2 Fed via circuit having a stand-by supply from an emergency generator or inverter having a battery with an autonomy time of 1 hour.
 - 4.4.4 A minimum of 20% emergency luminaires shall be provided in different types of areas.
 - 4.4.5 Escape luminaires shall be provided at exit doors in all buildings to light the way for personnel leaving a location or building along defined escape routes to defined muster points, which shall also be illuminated and include the following locations:

- 4.4.5.1 every exit doorway.
- 4.4.5.2 external escape ways (stairways and walkways).
- 4.4.5.3 internal escape ways (escape routes, corridors, and galley).
- 4.4.5.4 embarkation areas (access to helideck and survival craft stations).
- 4.4.5.5 muster areas (waiting room, cinema, lounge, dining room and the emergency response team muster points).
- 4.4.6 The escape luminaires could be part of the emergency installation, but in addition, the luminaires shall have integral batteries rated to maintain the lighting.
- 4.4.7 Escape lighting units shall have integral batteries that provide an autonomy time of 60 minutes.
- 4.4.8 All obstacles on the escape route shall be lit.
- 4.4.9 Escape lighting shall be fed and equipped in the same fashion as the rest of the emergency lighting.
- 4.5 Special lighting
 - 4.5.1 Lighting house lighting – excluded.
 - 4.5.2 Obstacle lighting - excluded.

5 LUMINANCE LEVEL

- 5.1 Illuminance (Lux) level
 - 5.1.1 Recommended steps of illuminance as per EN 12665, Table 5.1 below provides a perceptual difference on the “Scale of illuminance (lux)”.

Table 5-1: Scales/steps of illuminance (lux)

No.	Tenth	Hundreds	Thousands
1	10	100	1000
2	15	150	1500
3	20	200	2000
4	30	300	3000
5	50	500	5000
6	75	750	7500

- 5.1.2 Recommended illuminances over task area are provided in Tables 5.2 to 5.7, which indicate the average illuminances for each task. It shall not be

lower regardless of the age and conditions of the installation. Where needed, the required illuminances should be increased when:

- 5.1.2.1 visual work is critical.
- 5.1.2.2 errors are costly to rectify.
- 5.1.2.3 accuracy or higher productivity is of great importance.
- 5.1.2.4 the visual capacity of the worker is below normal.
- 5.1.2.5 task details are of unusually small size or low contrast.
- 5.1.2.6 the task is undertaken for an unusually long time.

5.1.3 On the other hand, the required *maintained illuminance* may be decreased when:

- 5.1.3.1 task details are of an unusually large size or high contrast,
- 5.1.3.2 the task is undertaken for an unusually short time.

5.1.4 It should be noted that in continuously occupied areas, the maintained illuminance shall be not less than 200 lx.

5.1.5 The table below extracted from EN 12464-2:2014: provides a guide on the maintained illuminance lux level for outdoor public lighting, U_o is the uniformity and diversity of the task which shall be evenly distributed.

5.1.5.1 Lighting requirements for areas, tasks and activities.

Table 5-2: General requirements for outdoor workplaces.

No.	Type of area, task or activity	Em lx	U_o
1	Walkways exclusively for pedestrians	5	0.25
2	Traffic areas for slow-moving vehicles (max. 10 km/h), e.g. bicycles, trucks and excavators	10	0.4
3	Regular vehicle traffic (max. 40 km/h)	20	0.4
4	Pedestrian passages, vehicle turning, loading and unloading points	50	0.4
5	Cleaning and servicing	50	0.25

Table 5-3: Parking Areas

No.	Type of area, task or activity	Em lx	U_o
1	Light traffic, e.g. parking areas of shops, terraced and apartment houses; cycle parks	5	0.25

No.	Type of area, task or activity	Em lx	U _o
2	Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.25
3	Heavy traffic, e.g. parking areas of major shopping centres, major sports and multipurpose building complexes	20	0.25

5.1.6 The table below extracted from EN 12464-1:2014: provides a guide on the maintained illuminance lux level for indoor public lighting which shall be evenly distributed.

Table 5-4: Traffic zones inside buildings

No.	Type of area, task or activity	Em lx	U _o
1	Corridors and circulation areas	100	0.4
2	Stairs, escalators, travelators, Elevators, lifts	100	0.4
3	Loading ramps/bays	150	0.4

Table 5-5: General areas inside buildings – Rest, sanitation and first aid rooms

No.	Type of area, task or activity	Em lx	U _o
1	Canteens, pantries	200	0.4
2	Resting rooms, Cloakroom (area), washrooms, bathrooms, dressing-rooms, lockers, shower, sinks and toilet areas	100	0.4
3	Rooms for physical exercise	300	0.4
4	Sickbay, Rooms for medical attention	500	0.6

Table 5-6: Educational premises – Nursery school, play school.

No.	Type of area, task or activity	Em lx	U _o
1	Playroom, Nursery	300	0.4
2	Handicraft room	300	0.6

Table 5-7: Educational premises – Educational buildings

No.	Type of area, task or activity	Em lx	U _o
1	Classrooms, Tutorial rooms, Music practice rooms, Computer practice rooms (menu driven), Language laboratory, Teachers rooms, Sports halls, gymnasiums, swimming pools	300	0.6

No.	Type of area, task or activity	Em lx	U ₀
2	Classroom for evening classes and adults' education, Auditorium, lecture halls, Art rooms, Practical rooms and laboratories, Handicraft rooms, Teaching workshop, Preparation rooms and workshops, Library: reading areas, Kitchen	500	0.6
3	Black, green and white boards, Demonstration table	500	0.7
4	Art rooms in art schools, technical drawing rooms	750	0.7
5	Entrance halls, Student common rooms and assembly halls, School canteens	200	0.4
6	Circulation areas, corridors, and Stock rooms for teaching materials	100	0.4
7	Stairs	150	0.4
8	Library: bookshelves	200	0.6

Notes:

1. Illuminance lux levels are provided for both outdoor and indoor tasks or activities but can be used as a reference when a similar task is performed either outdoors or indoors. Lux level can be increased or decreased subject to the need.
2. Illuminance lux level for non-work activity i.e., bullet 1&2 Clause 3.3.2 are not provided in this scope; however, the electrical requirement shall be abided.

5.2 Street / Road lighting

5.2.1 The table below extracted from the International Commission on Illumination CIE:180:2007 suggests for areas where most of the traffic consists of pedestrians and non-motorized vehicles the figures are for illuminance; for recognized traffic routes the figures are for luminance, but roughly equivalent values of illuminance, for moderately dark road surfaces, are given in parenthesis.

Table 5-8: Street Lightings

No.	Category	Average Level	U ₀ Dry	U ₀ Wet	U ₁
1	Residential areas, pedestrians, and many non-motorized vehicles	1-2 lux	0.2	0.15	n/a
2	Largely residential, but some motorized vehicles	4-5 lux	0.2	0.15	n/a
3	Major access roads, distributors and minor main roads	0,5 cd/m ² (~8 lux)	0.4	0.15	0.5

No.	Category	Average Level	U_0 Dry	U_0 Wet	$U1$
4	Important rural and urban traffic routes	1,0 cd/m ² (~15 lux)	0.4	0.15	0.6
5	High-speed roads, dual carriageways	1,5 cd/m ² (~25 lux)	0.4	0.15	0.7

5.2.2 Illumination on the surrounding area below provides a basic relationship of illuminances on the immediate surroundings to the illuminance on the task area or activity area for a public indoor area.

Table 5-9: Basic relationship of illuminances

Outdoor workplaces EN 12464-2		Indoor workplaces EN 12464-1	
Task Illuminance lx	Illuminance on surrounding areas lx	Illuminance on the task area or activity area (\bar{E}_m) lx	Illuminance on immediate surrounding areas lx
		≥ 750	500
≥ 500	100	500	300
300	75	300	200
200	50	200	150
150	30	≤ 150	equal to task area
$50 \leq \bar{E}_m \leq 100$	20		
< 50	No specification		

5.3 Extracted from EN12464 Part 1 and EN12464 Part 2, for outdoor workplaces. “The surrounding area should be a band with a width of at least 2 m around the task area within the visual field”.

5.4 For indoor workplaces, the immediate surrounding area should be a band with a width of at least 0,5 m around the task area within the visual field.

5.4.1 The background area is a horizontal area on floor level. It is adjacent to the immediate surrounding area within the limits of space and shall be

illuminated with a maintained illuminance of 1/3 of the value of the immediate surrounding area.

5.4.2 For larger rooms, the band shall be at least 3 m wide”.

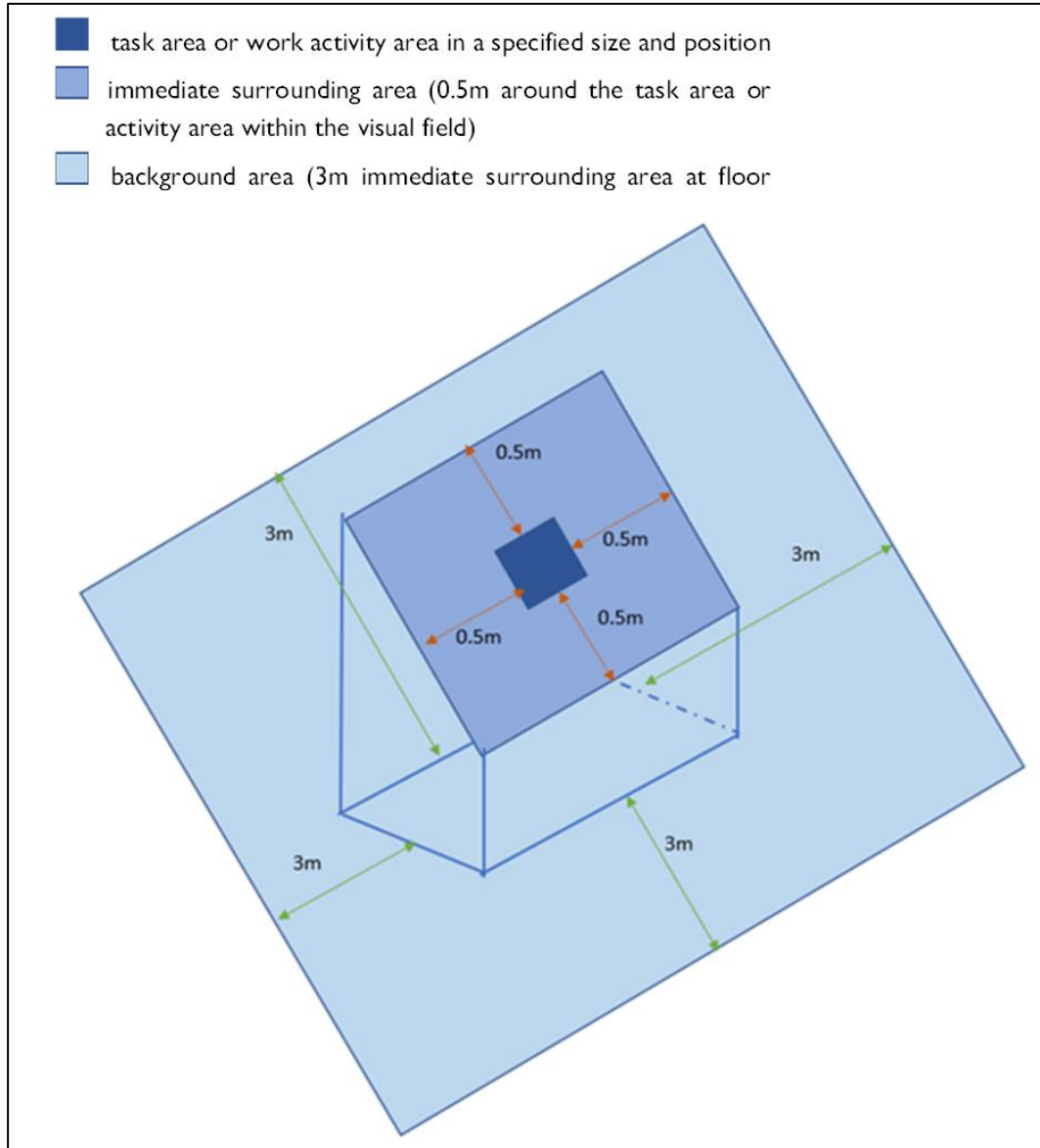


Figure 5-1 Minimum dimensions of immediate surrounding and background area.

5.5 Illuminance Uniformity

5.5.1 In order to prevent eye fatigue, the minimum uniformity as provided in Tables 4.1 to 4.6 shall be adhered to. However,

5.5.2 BS EN 12464-1:2011 Light and lighting – lighting of workplaces indicated illuminance uniformity for lighting from artificial lighting or roof lights should be:

- 5.5.2.1 $U_0 \geq 0.4$ in the immediate surrounding
- 5.5.2.2 $U_0 \geq 0.1$ on the background area
- 5.5.3 EN 12464-2:2014 Light and lighting – lighting of workplaces indicated illuminance uniformity of the surroundings shall not be less than 0.10.
- 5.5.4 Lit surface. $U_1 = L_{\min} / L_{\max}$ measured on the central lane line passing through the observer position.
- 5.5.5 A uniformity of 1 will prevent driver vision fatigue due to the eye trying to adapt itself to different levels of lighting which will be tired quickly.

6 LIGHTING DESIGN

6.1 Reserve

- 6.1.1 Reflectance
- 6.1.2 Color
- 6.1.3 Glare
- 6.1.4 Energy efficiency
- 6.1.5 Other consideration
- 6.1.6 Longitudinal uniformity: it is a measure of dark band and bright band on road calculation factor.
- 6.1.7 Flicker and stroboscopic effects.
 - 6.1.7.1 Flicker causes distraction and may give rise to physiological effects such as headaches.
 - 6.1.7.2 Stroboscopic effects can lead to dangerous situations by changing the perceived motion of rotating or reciprocating machinery.
 - 6.1.7.3 Lighting systems should be designed to avoid flicker and stroboscopic effects.

7 INSTALLATION REQUIREMENTS

7.1 Safe Siting of street light lamp pole/column

- 7.1.1 British standard BS 5489 provides guidance on the location or siting of street lighting lamp posts.

- 7.1.2 The minimum recommended clearance from the edge of the carriageway to the face of the lighting column in accordance with design speed is as per Table 7-1.

Table 7-1: Recommended Minimum Space

Design speed (km/h)	Horizontal clearance (m)
50	0.8
80	1.0
>=100	1.5

7.2 Height of Lamp pole / mounting height

- 7.2.1 The recommended selection of the lighting poles is:

- 7.2.1.1 For residential and subsidiary road mounting/pole height = 5m or 6m
- 7.2.1.2 For traffic routes, mounting/pole height =8 m, 10m and 12m
- 7.2.1.3 For highspeed dual carriages etc., mounting/pole height =12m & 15m

Table 7-2: Recommended Lamp Pole Heights

Type of Roads	Mounting Height (m)	Minimum Average illuminance (lux)
Residential & Subsidiary Roads	5 - 6	10 lux
Traffic routes & Conflict Roads	8 – 10	15 lux)
High Speed Dual Carriages	10 – 12	20 lux

7.3 Installation as per classification

- 7.3.1 The installation technician shall ensure that the lighting fixtures / luminaire is installed accordingly and meets the classification of the luminaire.
- 7.3.1.1 Selected luminaires / light fixtures are fit and suitable for direct mounting on normally flammable or on non-combustible surfaces.
- 7.3.1.2 Where the supply cord / cable is entering metallic Class 1 luminaire, the proper cable gland shall be selected not to void Class 1 earthing requirement and ingress protection. The same applies to Class II luminaire.

7.3.1.3 That IP rating of protection against dust, solid objects and moisture remains unchanged.

7.3.1.4 Durability and weather resistance: All materials and finishes selected shall withstand local environmental conditions; UV-resistant, corrosion-resistant, and rated for specific weather conditions.

7.4 Selection of cables/wires

7.4.1 The following types of cables/wires shall be used:

7.4.1.1 Low smoke (with a maximum halogen gas emission of 0.5%, per IEC 60754-1 and IEC 60754-2), zero halogen (with a minimum light transmission value of 60% per IEC 61034-2), with reduced flame propagation (per IEC 60332) properties.

7.4.1.1.1 In normally manned areas.

7.4.1.1.2 Escape to an area with clean air is not possible.

7.4.1.2 Low smoke, zero halogen with fire resistance (per IEC 60331) properties.

7.4.1.2.1 Required to continue in operation during fire.

7.5 Attached foreign object on light poles / columns

7.5.1 Unless approval is obtained, it is not recommended to attach any foreign object on street lighting pole/column.

7.6 Installation Safety Requirements

7.6.1 Definition, Labels, Voltages, Sizes, Colour, location of labels, ISO 7010, References to DES practices, WSHO Regulations (General Provisions), Yellow Sticker (Lightning).

8 REFERENCES

8.1 WORKPLACE SAFETY AND HEALTH (GENERAL PROVISIONS) REGULATIONS, 2014, Regulation 6

8.2 WORKPLACE SAFETY AND HEALTH (CONSTRUCTION) REGULATIONS, 2014, Regulation 32

A. APPENDIX

Measured outdoor Luminance on Brunei Roads.

Table A-1: Luminance Levels on Brunei Roads

Point (Pt)	Figure A1 Average Lux	Figure A2 Average Lux (10m poles)	Figure A3 Average Lux (6-8m poles)
1	28.6	26.3	27.6
2	38.6	30.4	42.5
3	29.3	28.3	28.3
4	20.8	25.5	15.5
5	28.6	26.3	27.8

Note: Measured values are taken at approximately 0.7m

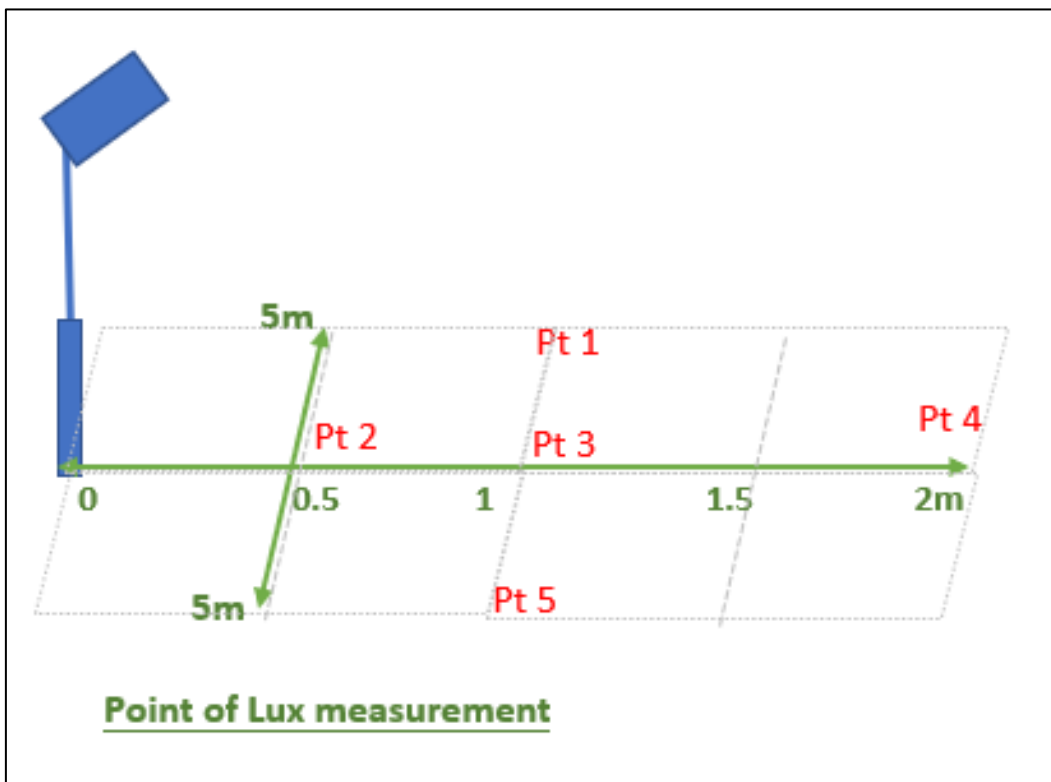


Figure A-1 Five (5) Point Lux Measurement

Table A-2: Actual Measurements at various locations

Lamp	HPS	HPS	HPS	HPS	LED	LED	HPS	HPS	HPS	HPS	HPS	LED	HPS	HPS	HPS	HPS
Pole height (m)	10	10	10	10	10	10	10	6-8	6-8	6-8	4	6-8	6-8	6-8	6-8	6-8
LOCATION	Highway1	Highway2	Highway3	Highway4	Highway5	Highway6	Road 1	Road Shell 1	Road Shell 2	Road Shell 3	Road Shell House	Road Seria Town	Road Police Seria Town	Road Lumut House1	Road Lumut House2	Road Lumut House3
L_{avg}	29	20	16	23	39	46	17	22	32	22	49	10	58	35	21	26
L_{min}	23	15	13	18	36	44	13	11	22	18	35	8	21	16	11	15
L_{max}	35	23	20	32	42	50	20	31	56	31	64	11	90	60	32	37
$U_0 = L_{min}/L_{avg}$	0.79	0.75	0.81	0.79	0.92	0.96	0.78	0.50	0.69	0.81	0.71	0.82	0.36	0.46	0.52	0.57
$U_1 = L_{min}/L_{max}$	0.66	0.65	0.65	0.56	0.86	0.88	0.65	0.35	0.39	0.58	0.55	0.73	0.23	0.27	0.34	0.41

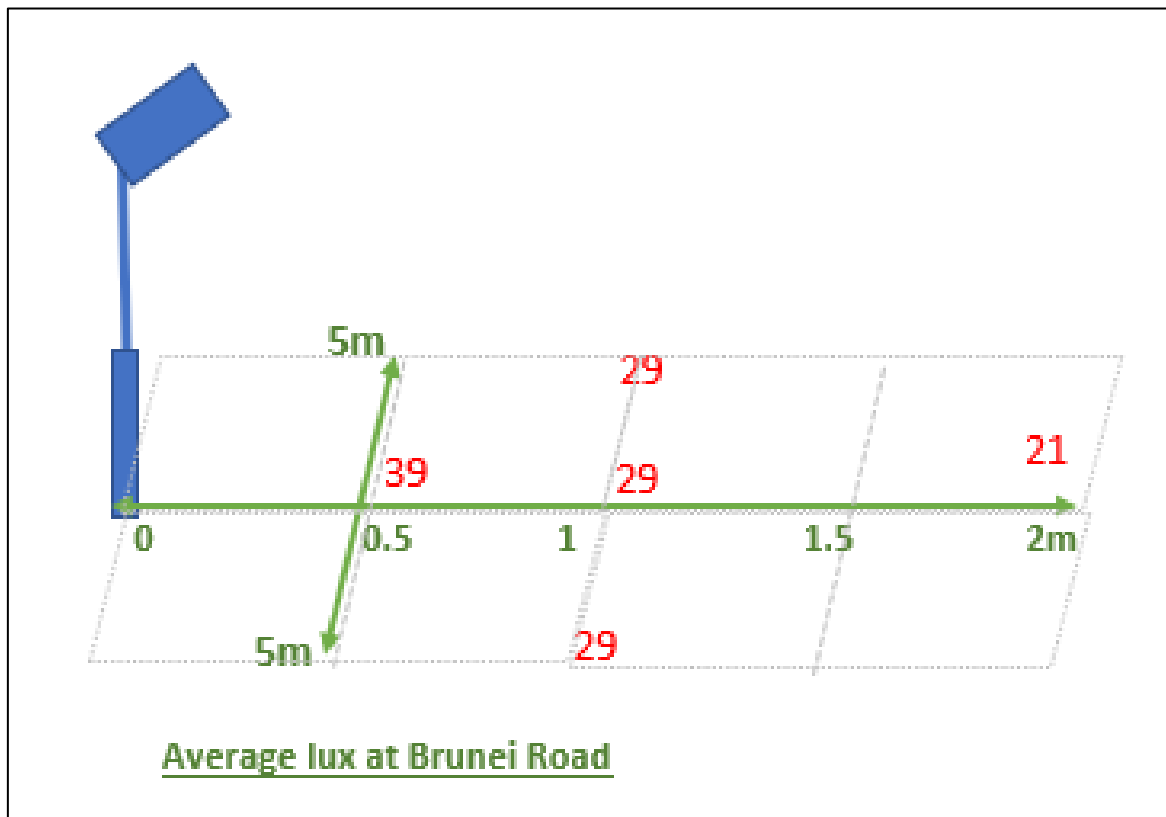


Figure A-2 Lux Measurements on Brunei Roads

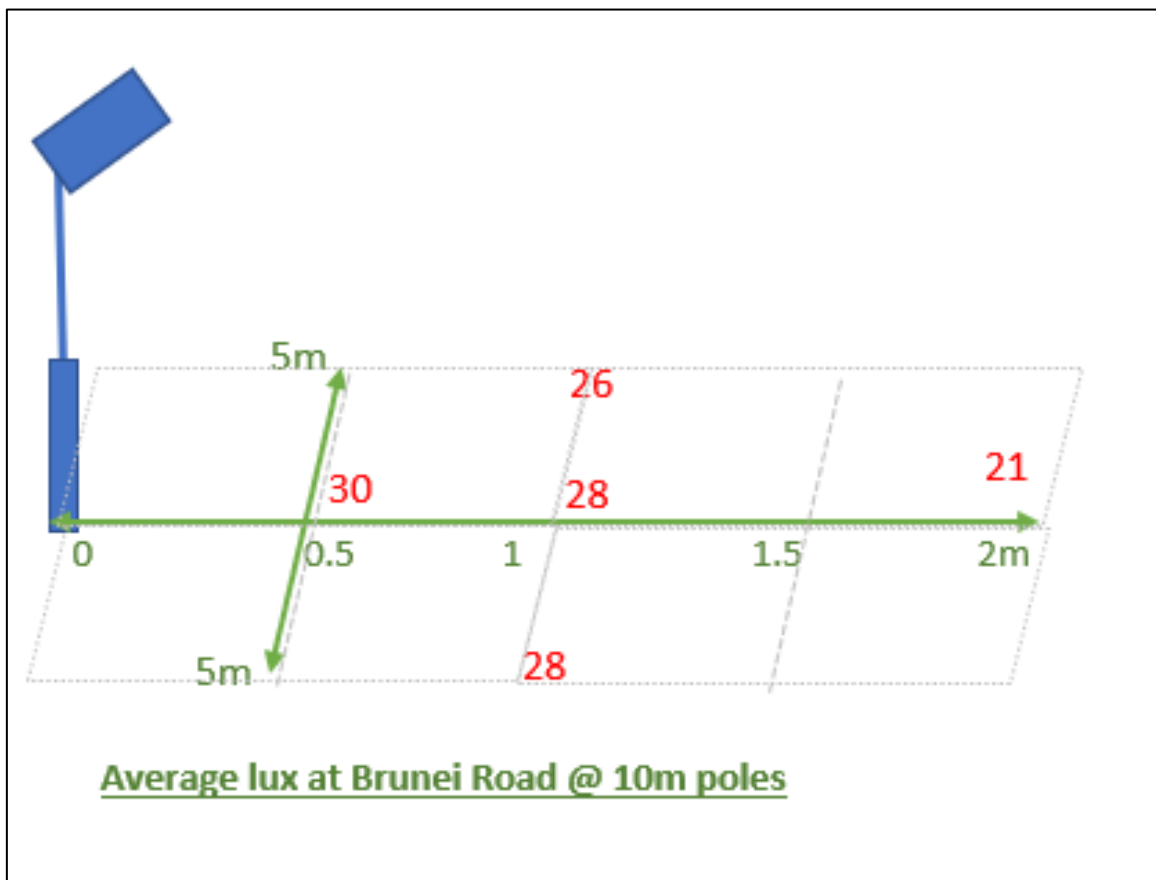


Figure A-3 Lux Measurement for 10 Poles

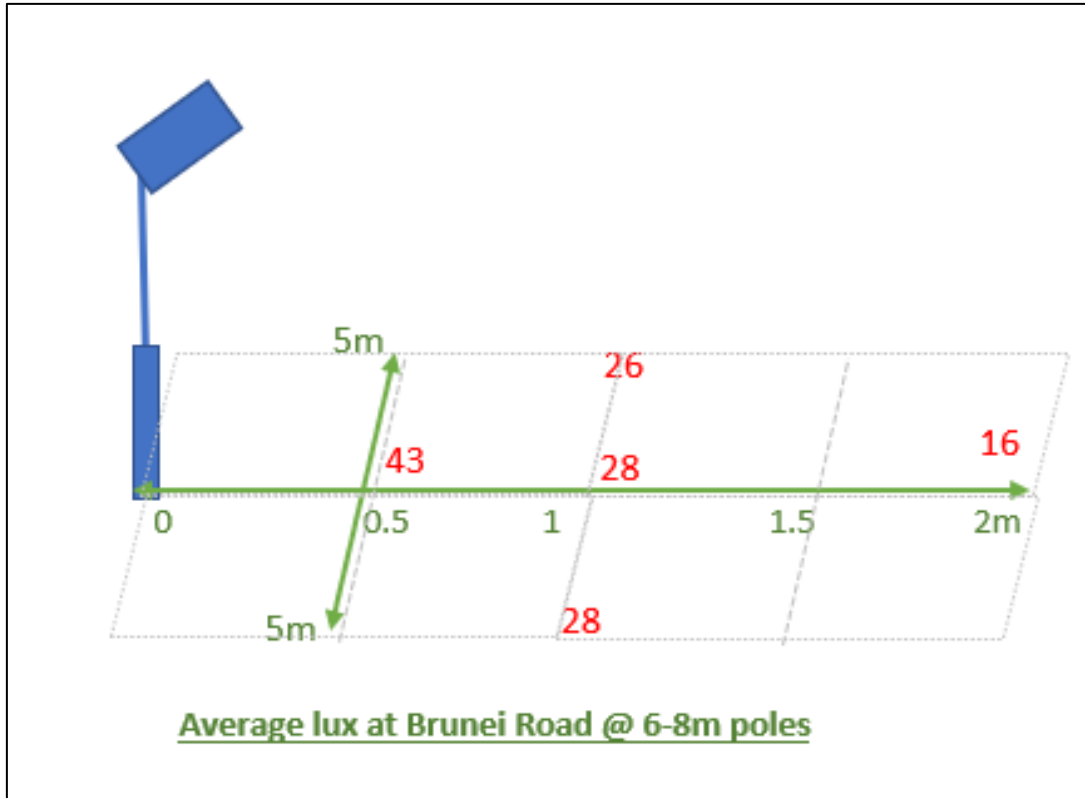


Figure A-4 Lux Measurements at 6-10 Poles