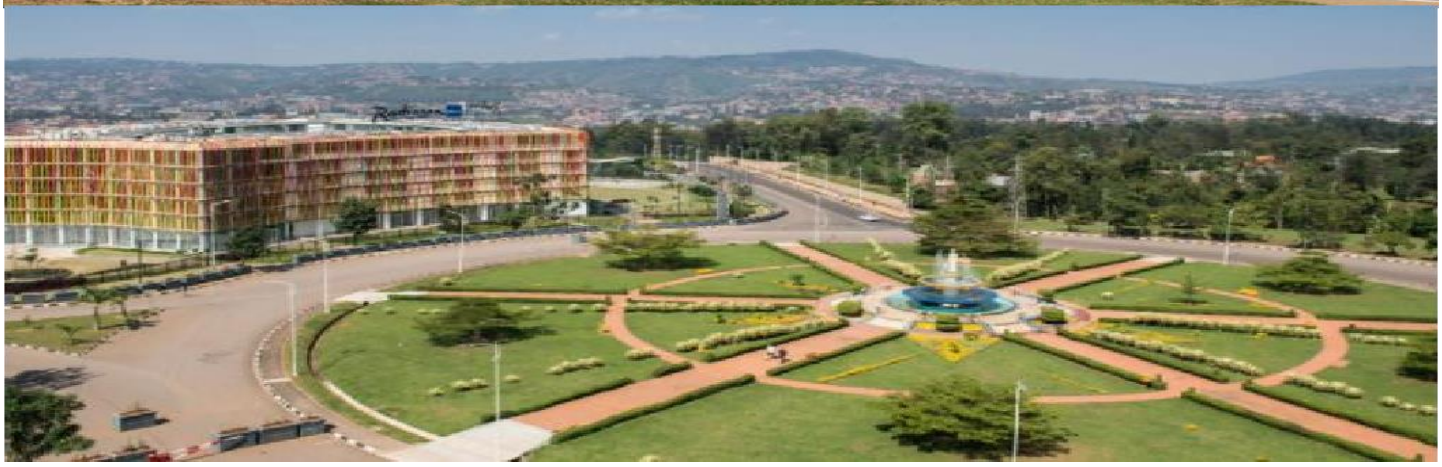
RETICULATION STANDARDS FOR STREET LIGHTS DESIGN, CONSTRUCTION AND MAINTENANCE



March, 2022, VERSION 1

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APPROVAL

	NAMES	TITLE	SIGNATURE
Prepared By:	**Yvette Peace**	Standards Engineer, EUCL	Digitally signed by EUCL(Standards Engineer)Date: 2022.02.08 12:28:50 +02'00'
	Jean Baptiste RWIGIMBA	Senior Engineer Standards and Quality assurance, EUCL	Digitally signed by EUCL(Sen Engineer Standards) Date: 2022.02.08 12:19:25 +02'00'
	Maurice RUGABA	Manager Street Lights, EUCL	
	Casmir NYIRINKINDI	Senior Engineer Generation, Transmission, Distribution & Access, EDCL	Digitally signedby NYIRINKINDI Casmir Date: 2022.02.10 07:30:17 +02'00'
	Lameck NIYOMUGABO	Quality Assurance and Standards Specialist, REG	
Checked by	**Frederic HABINEZA**	Chief Engineer Planning, EUCL	Digitally signed by EUCL(Chief Engineer Planning) Date: 2022.02.10 07:42:52 +02'00'
	Claver GAKWAVU	Director Planning, EUCL	Digitally signed byEUCL(Director Planning) Date: 2022.02.10 09:11:29 +02'00'
	Esdras RUGIRA	Ag. Director of Planning, EDCL	Digitally signed by Rugira Esdras Date: 2022.03.07 15:04:56 +02'00'
	Clementine UMUGWANEZA	Strategic Planning Director, REG	Digitally signed by REG(Planning Director) Date: 2022.03.08 08:53:33 +02'00'
Approved by:	**Armand ZINGIRO**	Managing Director, EUCL	Digitally signed by EUCL(MANAGING DIRECTOR) Date: 2022.03.09 09:44:45 +02'00'
	Felix GAKUBA	Managing Director, EDCL	Digitally signed by EDCL(EDCL Managing Director) Date: 2022.04.08 18:54:43 +02'00'
	RON WEISS	Chief Executive Officer, REG	Digitally signed by Ron WEISS (CEO) Date: 2022.05.04 11:25:32 +02'00'

ACRONYMS

ABC: Aerial Bundled cable

AL: Average lumen

Auto CAD: Auto computer aided design

PLS CADD: Power line system computer aided design and draft

CB: Circuit breaker

CCT: Collerated colour temperature

CU: Copper

DB: Distribution Board

EWP: Elevated work platform

Ftcd: Foot candle

Hz: Hertz

K: Kelvin

kA: Kilo Amp

KW: Kilo watt

LDD: Luminaire dirt depreciation

LED: Lamp emetted diod

LL: Lamp out of the lamp

LLD: Lamp lumen depreciation

Lm: Lumen

LV: Low voltage

MCB: Miniature circuit breaker

MCCB: Molded case circuit breaker

MEN: Multiple Earthed Neutral

Mf: Maintenance factor

MV: Medium voltage

PVC: Polyvinyl chloride

REG: Rwanda Energy Group

RTDA: Rwanda Transport Development Agency

Uf: Utilization factor

XLPE: Cross-linked polyethylene

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1. INTRODUCTION

This document shall be the guiding principle for the design, construction and maintenance of roadways lighting systems in Rwanda.

1.1 About this Document

These lighting installations include not only roadways, but also off-roadway facilities such as parking areas, sidewalks, pedestrian walkways, and bikeways, excluding traffic lighting, flashing beacons, lighted pedestrian crossovers, park walkway lighting, parking lot lighting, sports lighting, area lightingand bus shelters.

This document presents the recommended standard practices and design guidelines for roadway and related lighting systems. At all times, good engineering practices and sound engineering judgment shall be used in determining the required solutions for the lighting designs. The Street Lighting Engineers & Managers will consider variations to these recommended practices.

For all concerning street lighting best practices not specified in this document, the REG latest reticulation standards and technical specifications are normative references.

This Document is divided into 2 main Parts and Annexes:

A. Street lighting Design and Construction Standards and Guidelines

B. Street lightings Maintenance Standards

C. ANNEXES:

- Construction / Survey and Maintenance format Streetlights Forms
- LED lamps specifications, illumination table and Standard incandescence

1.2 Objective

The purpose of this street lighting standard is to provide guidelines and information required for design, construction and maintenance of Roadways lighting systems to achieve the following objectives in an economical and cost-effective manner:

- ✓ To provide adequate and standard illumination on roadways to ensure safety and security of road users,
- ✓ To ensure energy efficient roadways lighting system,
- ✓ To provide uniformity and consistency in lighting designs throughout the country while meeting the industry standard,
- ✓ To avoid high cost of street lighting Operation and maintenance.

1.3 Scope

The scope of this reticulation standards is inclusive of all roadway lighting including lighted pedestrian crossovers, parking lighting, excluding traffic lighting, flashing beacons, park walkway lighting, parking lot lighting, sports lighting, area lighting and bus shelters.

The document shall be annually reviewed or at any time user departments submit a written request clearly indicating the points to be amended. Once the amendments are agreed upon, the existing version of standards shall be updated and submitted to REG Management for approval.

The equipment consists of transformers, poles, luminaires, brackets (cross arms), controlling / distribution boards, circuits protecting devices, cables and conductors.

PART ONE: DESIGN AND INSTALLATION

2. DESIGN

2.1 Design Process

Designers shall determine, discuss, and confirm the required lighting design criteria with different stakeholders before proceeding with the Roadways lighting system design. All street lighting designs must:

- ❖ Be submitted to REG for approval,
- ❖ Comply with REG standard design criteria for distribution networks
- ❖ Be consistently designed and documented with appropriate design software such as Auto- CADD, PLS-CADD, Archi-CAD, DIALUX, RELUX etc.
- ❖ The designer/developer must design lighting in accordance with the road category LightingDesign.
- ❖ The designer/developer must provide a soft copy of calculations for lighting designs to allow validation of the installation.

2.2 Design Considerations:

2.2.1. General requirements

- All lights shall be controlled for lighting duration by time switches or any other monitoring and switching systems approved by REG
- As a general requirement, use LED luminaires in all areas or any other economical luminaires
- There are generally three (3) types of poles (based on material) used to support streetlight luminaires and associated hardware, namely, wooden, reinforced concrete, and metallic poles
- Street Light poles and underground cabling shall not conflict with any infrastructure, including storm water pits, pedestrian crossing points or driveways.
- Where LED luminaires are to be fixed to REG power poles, all connection arrangements must be fully designed, structurally certified by developer/contractor, and be submitted to REG for approval.
- Design drawings must be prescriptive and legible and must include schematic diagrams with allocated phases and a detailed lighting schedule with pole numbers, types, outreach arm details, luminaire details.

2.2.2. Road requirements

- All intersections on urban arterial roads or on urban sections of National Highways require street lighting
- Where a subdivision road, District roads or a property development connects to a rural arterial roador section of National Highway in a rural environment, street lighting will also be required at the intersection.
- The lighting level requirement at these rural environment intersections will be subjected to the following factors:

✓ Location,

✓ Type of intersection,

✓ Projected traffic volumes,

✓ Nature of abutting property development, and

✓ Characteristics of the affected arterial road or National Highway, including speed environment and road geometry.

- The lighting standard for sub divisional roads, where required, shall cater for the following:

✓ all intersections, including signalized intersections, with raised traffic control devices orwhere the traffic volumes and speed environment justify its installation.

✓ the end of all walkways or cycle paths not adjacent to roads

✓ every traffic calming device

✓ Delineation of pedestrian crossing and all on road hazards

2.2.3 Pedestrian and Cycle Path Requirements

- Pedestrian/cycle paths located immediately adjacent to roads or on road cycle paths are to be adequately illuminated by the roadway lighting
- Paths adjacent to roads but separated by wide nature strips or should be checked to ensure adequate luminance from the roadway lighting. If the roadway lighting is insufficient or shielded by trees, then additional pathway lighting should be provided

2.2.4 Main Components

Conductor/Cable:

- Whether underground or overhead, there are two categories of streetlight cable, one cable that runs between streetlight poles (bus) and the other that supplies power to the luminaires (service drop) and these cables must comply to REG technical specifications
- For overhead streetlight network, the bus (cable that runs between streetlight poles) shall be aerial bundled cable (Aluminum) where neutral carrier is also insulated
- For underground streetlight network, the bus (cable that runs between streetlight poles) shall be copper, XLPE insulation and PVC sheathed
- Size: Once the conductor material is selected, the size of the conductor is governed by the required circuit ampacity and voltage drop.
- The conductor shall be sized such that the voltage drop in the circuit from the service entrance pointto the last Street Light on the circuit will not exceed the accepted voltage regulation of the driver

Poles:

- When selecting a pole for streetlight application, the pole must be able to withstand the mechanical loading of the attached components (luminaire and bracket). the weather loading and maintenance related loading
- Two (2) types of poles (based on material) that shall be used to support streetlight luminaires and associated hardware, namely, reinforced concrete and steel. Wooden poles and any other poletypes shall be used where the need is justified and approved by the design Engineer
- If flags, banners, or any items that can add excessive wind or mechanical load to the pole will be attached to the pole in the future, then the selected pole must have sufficient strength to restrict the loading of these appurtenances
- The setting depth for direct buried poles depends on the pole length and soil condition
- When underground cable is in use, the poles shall have window with closure dispositive identic for all poles, for inside pole connection of the base cable and service drop cable for luminary.
- Re-enforced concrete poles can be manufactured in round shape and in different lengths with pre-drilled holes to ease installation
- When used in corrosive environment, concrete poles shall be treated with special coating to inhibit corrosion

- Steel pole shall be galvanized
- The use of the metal pole as a grounding electrode must also be approved by REG.

Luminaires

- Luminaires for street lighting generally consist of one or more of the following components:

a) Light source and socket

b) Ballast assembly or driver

c) Reflecting elements

d) Refracting glassware or plastic enclosure

e) Housing or body complete with bird stop and optical filter where necessary

- The luminaries shall be LED luminaires with cobra head
- Luminaires of different coulor are not allowed for one street light project/ coulor of lights shall be the same/harmonized.

Brackets/ Crossarms

- The brackets/ crossarms to be used in streetlight applications with cobra head luminaries shall be galvanized.
- When selecting a bracket/ cross arm we shall consider:

a. **Pole location** with respect to curb or roadway (length of bracket).

b. **Bracket strength** - the bracket must have sufficient strength to support the weight of luminaire and wind loading on the luminaires effective projected area.

c. **Type of pole** - Wood or metal pole plate required.

d. **Bracket rise** – beware of maintaining proper clearances on distribution poles.

e. **Bracket length** – this impacts the reach required to position the luminaire

Supply, protection, and control

- The design Voltage will be 400/230 Volt.
- The maximum permitted Voltage fluctuation shall be ± 10% of nominal Voltage.
- The power transformers, protection devices, overhead / underground conductors shall be always determined by the use of appropriate Softwares and the calculation must be submitted to REG for approval prior to implementation.
- Whatever size and type of cables, LED lamp wattage and transformer size, the street light line shall be extended up to the distance where the voltage at the farthest LED lamp will not be less than 380/207 V and the transformer

shall not be loaded above 80%(all LED on). The mentioned voltage and load limits shall be subject to the appropriate verification during approval of design and testing& measurements during commissioning of the new constructed street lighting project.

- The rating of protection equipment should be well sized to accommodate the half load of nearby transformer in case this transformer has failed.

As a standard, the following ratings must be applied where required:

Transformer rating	Number of Phases	LV Circuit Breaker
10 kVA	Single Phase	50 A
15 kVA	Single Phase	80 A
25 kVA	Three phase	40 A
50 kVA	Three Phase	80 A

For higher ratings, reference shall be made to the Reticulation Standard for Electricity Distribution.

- Feeder pillar / distribution board shall be of stainless steel with at least have the following sizes (Height: 80cm, Width: 60cm, Depth: 30 cm), to be able to accommodate the necessary equipment for energy metering, protection, and command.
- In the control cabinet there shall be digital timers, contactors, and LV surge arrester/diverter
- Line design shall be in two definite categories namely:
- Three phase line construction with ABC conductors/underground cables 35 mm^2 or 25 mm^2 conductor. Construction with underground cable shall be applied in Kigali and urban areas in otherdistricts unless otherwise recommended by the design Engineer and approved by REG. Concrete poles must possess 2 holes at top and bottom ends where will pass the earthing wire inside the pole.
- Concrete poles to support the three phases transformer shall be normally of 12m of height
- Other pole types and sizes shall be used where the need is justified by the design Engineer.
- All streetlights luminaires shall be earthed by flexible copper conductor of 16mm^2 minimum or Steel wire with at least 25mm^2 in areas of risk of theft for copper wire
- Only LED lamps shall be used.
- For overhead supply system, the same poles shall be used to support LV cable to supply nearby customers by upgrading the existing transformer, protection system and separating metering system.

2.2.5. Street illumination level calculations.

E (lux)= $\frac{\mathbf{Al \times Uf \times Mf}}{\mathbf{w \times d}}$ Where;

- E = The illumination in Lux
- Al=Average lumens.
- Uf = Utilization factor; which is dependent on the type of fixture, mounting height, width of roadway and the length of mast arm of outreach.

Mf=Maintenance factor (normally 0.7 to 0.9).

- w = Width of the roadway
- d = Distance between luminaries
- The value of Al varies depending upon the type of lamp specified.

From the Formulae above, it is easy to calculate the Average Lumen Al=

(E x w x d) / Uf x Mf

2.2.6. Spacing between two light poles calculations.

$$\boldsymbol{Luminaries\ spacing(S)} = \frac{\mathbf{LL \times Uf \times LLD \times LDD}}{\mathbf{E \times w}}$$ Where

- LL: Lamp output of the Lamp (in Lumens)
- Uf: Utilization factor (constant)
- LLD: Lamp Lumen Depreciation Factor (constant)
- LDD: Luminaries dirt Depreciation Factor (constant)
- E: Required Lux Level (in Lux)
- w: Width of the road (in meter)
- H: Height of the pole (in meter)

2.2.7. Pole to Pole Distance vs Lux Level

Pole Height(m)	Lamp (watt)	Pole to Pole Distance (m)	Max. Illumination (lux)	Average (lux)
4	15	12 to 18	25	18
5	18	14 to 20	30	18
6	30	18 to 24	32	20
7	50	21 to 28	32	20
8	100	24 to 32	40	22
9	110	27 to 35	34	20
10	140	30 to 40	35	22
12	180	30 to 40	33	23
14	200	30 to 40	30	21

2.2.8. Street Light Luminaire calculations.

The streetlight luminaire calculation *is expressed in* ***Average Lumens (Al).***

The value of Al varies depending upon the type of lamp specified.

$$Al = \frac{\mathbf{E \times w \times d}}{\mathbf{Mf \times Uf}}$$

$$Efficacy = \frac{\text{Lumens}}{\text{Wattage}}; \qquad Wattage = \frac{\text{Lumens}}{\text{Efficacy}};$$

$$Space\ to\ height\ ratio = \frac{\text{Distance between poles}}{\text{Road width}} \ ;$$

where

- E = The illumination in Lux
- w = Width of the roadway
- d = Distance between luminaries
- Uf = Utilization factor, which is dependent on the type of fixture, mounting height, width of roadway and the length of mast arm of outreach.
- Mf=Maintenance factor (normally 0.7 to 0.9).

2.2.9. Sizing of protection devices / MCCB

The sizing of MCCB shall be following IEE regulations:

$I_l \leq I_b \leq I_c$Where:

2.2.9.1. I_l = Design current of the circuit.

2.2.9.2. I_b = Nominal current or current setting of the protective device.

2.2.9.3. I_c = Current carrying capacity of the conductor in the particular installation conditions.

Also, the choice of the MCCB shall take in account the short circuit current calculation.

2.2.10. Estimation of the required power for the streetlight area.

Required Street Light power for illumination on a Square Meter

Required street light watt = **Lux per Sq.meter x Surface Area of Surface Area of street Light**
Lumen per Watt

2.2.11. Street lights powered by Solar system

PV powered street light utilizing LED is also accepted in Rwanda. Where it is required solar street light system can be adopted either standalone or centralized solar system.

Standalone

The configuration of solar street light system must be designed to be robust and must be good enough to withstand the harsh environmental condition as the system are installed in road where it is continuously exposed to sun, rain, fog, pollution etc

A basic solar powered LED street light system components are:

1. Solar Panel or Photovoltaic Module
2. Lighting Fixture – LED lamp set
3. Rechargeable Deep Cycle Battery
4. Solar Charge Controller
5. Light Pole

Composition of a Solar LEDs lighting system

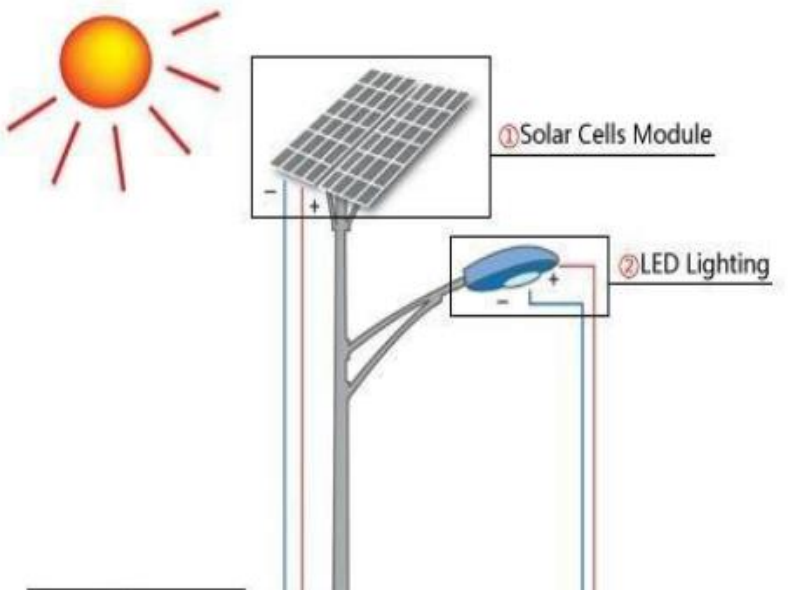
1-Tilted solar modules placed on a mounting structure facing the sun path

2- LED lighting unit suspended on a pole short arm

3- Vented steel enclosure, (contains the battery/ies and the solar charge controller)

4- Structural anticorrosion parts consists of the pole, the affixing base, the short arm and the modules mounting structure

This figure is a typical solar street light



Only Lead-Acid (LA) and Nickel-Cadmium (Ni-Cad) Batteries shall be used in solar powered street light projects

Centralized Solar Street Lighting System

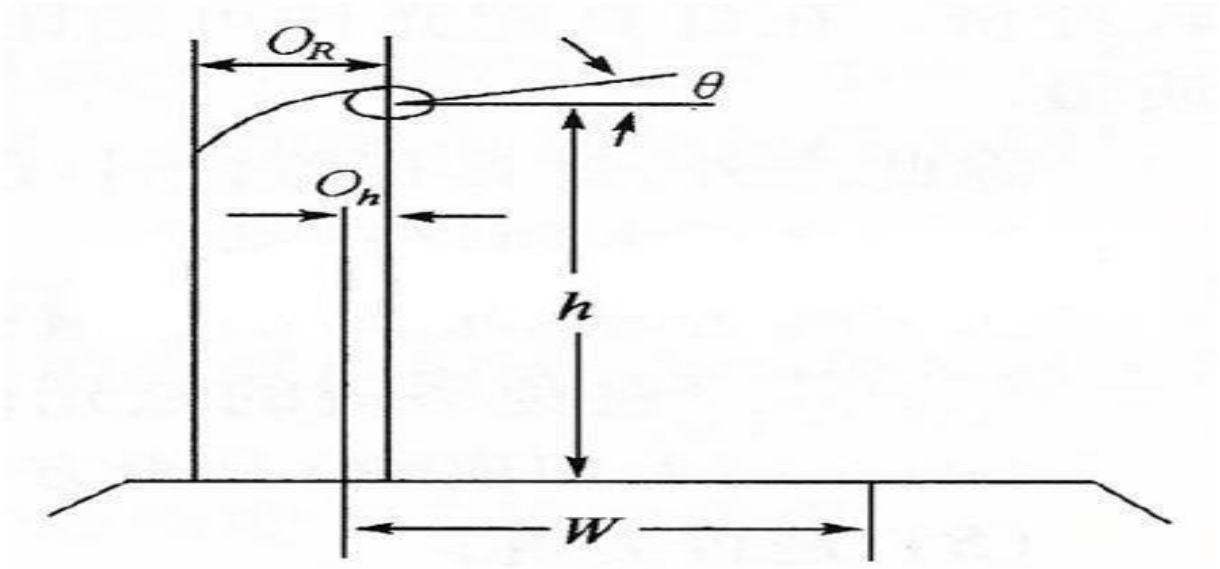
- For the roads that do not have enough shadow free areas, standalone solar street lighting system is not recommended and only centralized solar PV system shall be adopted.
- To this type of street lighting scheme, site specific detail technical survey and design has to be carried out.
- The centralized system power output shall be of AC power and therefore the selected LED lamp must be of AC type.
- In centralized system, arrays of PV panels shall be fixed at a convenient location and the power output from the source is distributed to the lights in a particular group via distribution lines.
- Since the battery will be installed at one place as one battery bank, use of flooded tubular deep cycle battery in addition to the battery type mentioned above (Gel Tubular and LI Ion) can also be used.

3. CONSTRUCTION

3.1. Installation Parameters

3.1.1. Installation Height of Street Lamp (h)

It refers to the vertical distance from the center of the lamp to road surface. The installation height fallswithin the range of 6 to 14 meters depending on the width of the road. In general, the greater the installation height, the fewer the glare, the better the uniformity, and the wider the spacing between thepoles. However, it also means that we will need the luminaries having higher power and lumen output.



3.1.2. Cantilever Length of Luminaries (Oh)

It refers to the horizontal distance from the edge of road to the center of light source. Increasing the cantilever length can also increase the brightness of road surface; however, the brightness of sidewalkswill be decreased in this case. This parameter affects the lux level on the lane and pavement. If the cantilever length of the lamp post is fixed, we will need to apply asymmetric optics on the streetlights to balance the difference.

3.1.3. Lamp Elevation Angle (θ)

It indicates the angle between the opening (surface) of the luminary and the horizontal plane. By increasing the elevation angle of the luminary on the light pole, the light can project farther; however,it also aggregates the glare which irritates the pedestrian and drivers. In general, the elevation angle is controlled within 15°.

3.1.4. Streetlight Spacing

It refers to the distance between the adjacent lamp post. To decide the best street lighting installation spacing, we need to consider the positioning of the pole, size of road grid (distance between adjacent crosswalk), terrain of the road as well as the surrounding buildings.

The installation spacing to be adopted falls within the range of 30 to 35 meters depending on the widthof the road.

3.2 Planting of Poles

- Survey of pole positions must be done by experienced surveyors. Pegged pole positions must be approved by the REG Construction Engineer/Supervisor before excavation or construction works commence.
- Pole holes must be excavated to the correct width and depth to ensure stability of the poles.
- Foundation depths are as listed in table below($deph = \frac{\text{Height of the pole}}{6}$)

Pole height (m)	Hole depth minimum in normal soil (m)
9	1.5
10	1.7
12	2
14	2.3
16	2.5

***Table 0-2**: Pole foundation Depths*

- Erection must be done with the correct equipment for the safety of workers and for pole protection.
- Planting depth must be measured correctly.
- Different soil types must be considered so that the necessary reinforcement can be done.
- Pole (steel and concrete) foundation must be concreted.
- The concrete level shall be up higher against the pole base (above normal ground level) so water can flow away from the pole to prevent damming of water around the pole.
- Open holes, when not attended to, must be covered or enclosed with barrier tape to prevent accidents.
- Special care must be taken when digging close to existing cables or other services.
- When replacing a pole, the new pole must be planted next to the old pole. The old pole must be uprooted and the hole properly backfilled and compacted to prevent leaning of the new pole towardsthe old pole position.

- Numbering plate shall be fixed on each pole.
- Storing, loading, off-loading, transport and handling of the pole must be done as per REG specifications.
- Transportation of poles is limited to the capacity of the truck and the safety precautions, on road, for staff and equipment.

3.3 Stringing the ABC Cables and laying LV underground Cables

- The cable drum shall be properly mounted on jacks, or on a cable wheel at a suitable location
- Special care must be taken to handle and install the conductor as per the manufacturer's specifications (pulleysizes, no dragging of cable on the ground, etc.)
- The average span length for LV ABC construction will be as per the table Pole to Pole Distance vs Lux Level.
- The neutral conductor of the low voltage system shall be multiply earthed (MEN System). Every lamp must be earthed.
- The LV Neutral shall be earthed at the first pole away from the transformer, at every seventh span and at each end pole on the radial system. The Overall LV Earthing resistance shall be equal or lower than 10 Ohm.
- In the City of Kigali and urban areas in other districts, the streetlights underground cables shall be used and preferably laid through the PVC flexible pipes.
- The underground cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch.
- After the underground cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one end by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.
- On completion of underground cable laying, the cable shall be tested for continuity and insulation resistance per testing procedures laid out in the relevant standards before covering the trench.
- Underground Cables laid in trenches shall have a covering of dry sand of not less than 20cm above the base cushion of sand before the protective cover is laid and the cable route marker locations are determined before the trenches are backfilled.

3.4 Backfilling

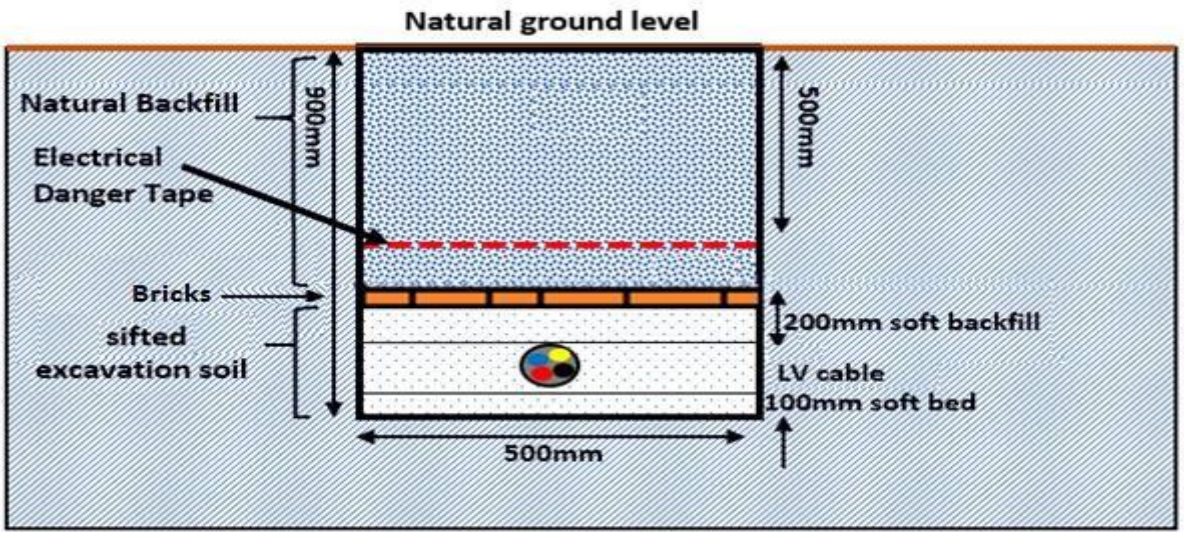
- All trenches shall be back-filled with excavated soil, free from stones or other sharp ended debris and shall be rammed and watered, if necessary in successive layers not exceeding 20cm depth.Unless otherwise specified, a crown of soil not less than 50mm and not exceeding 100mm in the center and tapering towards the sides of the trench shall be left to allow for subsidence.
- The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required. After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer.
- Where road beams or lawns have been cut out of necessity, or curbstones displaced, the same shall be repaired and made good to the satisfaction of the Engineer and all the surplus earth or rock shall be removed.

The above requirements for backfilling shall also apply for trenches with pipes/ ducts at road crossings.

3.5 Cable Protection

The underground cable trench shall be at least 900 mm depth and 500 mm width.

A layer danger tape marked "**Danger –electrical cable below**" shall be laid at a depth of 500mm below final ground level to serve as warning when the ground is excavated in future. The danger tape must be laid across the entire width of the trench. Bricks must be laid at 200mm (of soft backfill) from cable laid.

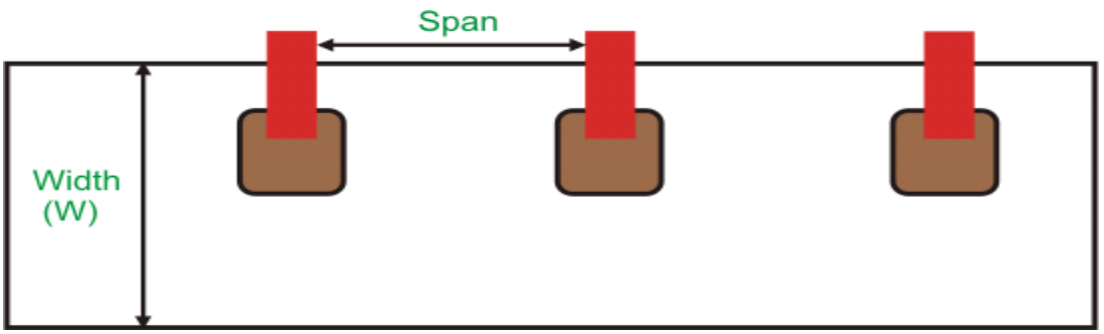


3.6 Cable Route Identification

The start and end positions of each cable trench, as well as all turning points, must be clearly marked with a permanent route marker made of metal with engraving, planted in a small concrete foundation. The cable identification must include the “From” and “To” positions of the cable as well as the voltageand depth. Road crossings shall be clearly and permanently marked on either side of the road by means of a nameplate or engraving in the concrete of the curb. The depth of the cable under curb level must be indicated.

3.7 Pole Arrangement Schemes in Street (Road) Lighting Design

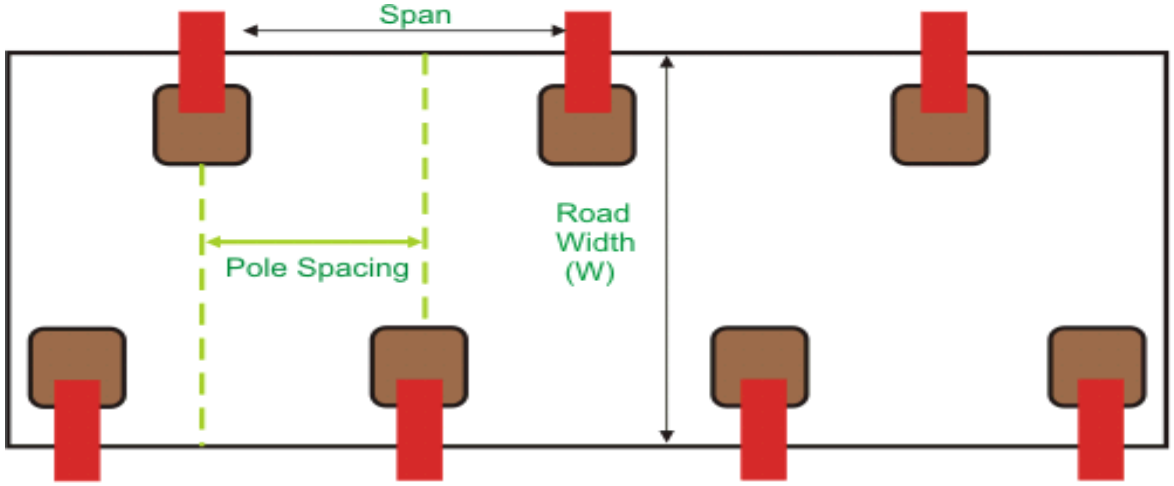
When the width (W) of the street (road) is nearly equal to the pole height (H), i.e.
W = H then the poles are arranged in one side only. Generally, pole height is available of 9-10 meter.



Staggered Sided or Zigzag Pattern

When the width (W) of the street (road) is nearly 1.5 times of the pole height (H), i.e., W = 1.5 H thenthe poles are arranged in both sides in zigzag manner.

The span between two poles may not be equal to the road width.

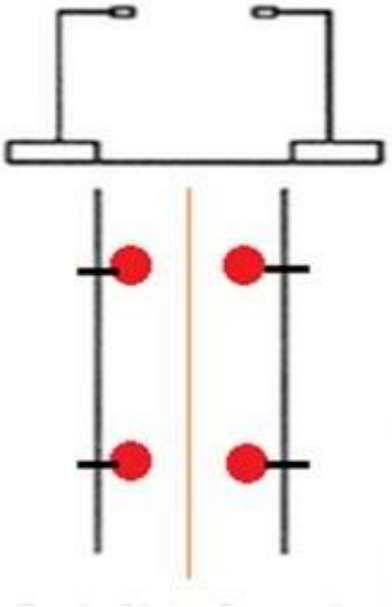


- **Both Side Opposite Pole Layout**

▪ In Both Side Opposite Pole Layout, the luminaries are located on both sides of the road opposite to one another.

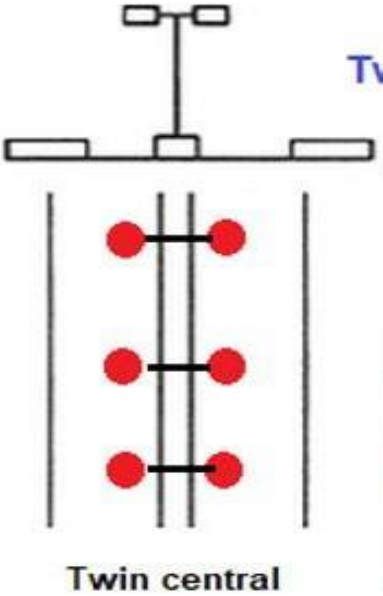
▪ **Road Width:** For Medium Size roads.

▪ **Pole Height:** The installation height of the lamp will be 2 to 2.5 times the effective width of the road.



Twin-central Pole Layout:

- **Arrangement:** In Twin central arrangement, the luminaries are mounted on a T-shaped in the middle of the center island of the road. The central reserve is not too wide, both luminaires can contribute to the luminance of the road surface on either lane.
- **Road Width:** For Large Size roads.
- **Pole Height:** The installation height of the lamp be equal to the effective width of the road.



3.8. Lighting Levels

Roadways to be illuminated shall be separated into the following categories:

Roadway	**Definition**
Highway	Roadway systems that link traffic flows between major regional cities(this category fall into category of national roads as per RTDA's roads 'classification in Rwanda)
Major	Roadway systems that serves as principal network for through and highway traffic. (this category fall into category of districts and city of Kigali roads and that of other urban areas – Class 1, as per RTDA's roads 'classification in Rwanda)
Collector	Roadways servicing traffic between major and local streets(this category fall into category of districts and city of Kigali roads and that of other urban areas - Class 2, as per RTDA's roads 'classification in Rwanda)
Local	Streets primarily utilized for direct access to residential, commercial, industrialand other property(this category fall into category of specific roads as per RTDA's roads 'classification in Rwanda)

In line with the Objectives of the Standard stipulated above, there is a need to consider the incidence and likelihood of zones where vehicular and pedestrian traffic may conflict. If the likelihood of conflict is HIGH, a greater illumination is required as opposed to lower conflict zones. This is cateredfor in the illumination levels set in this standard.

The recommended illumination for Roadways in the categories above are tabulated below:

Road & Pedestrian Conflict Area		**Average Recommended Illumination** *(Lux/Foot-candles)*	**Uniformity Ratio** *(Eav/Emin)*
Road	**Pedestrian Conflict**		
Highway	High	14.0 / 1.4	3.0
	Medium	12.0 / 1.2	3.0
	Low	9.0 / 0.9	3.0
Major	High	17.0 / 1.7	3.0
	Medium	13.0 / 1.3	3.0
	Low	9.0 / 0.9	3.0
Collector	High	12 / 1.2	4.0
	Medium	9.0 / 0.9	4.0
	Low	6.0 / 0.6	4.0
Local	High	9.0 / 0.9	6.0
	Medium	7.0 / 0.7	6.0
	Low	4.0 / 0.4	6.0

Table – 1: Illumination Parameters

Lighting Pole details as per Road

Road	Road Width (Meter)	Pole Arrangement	Lamp (Watts)	Pole to pole Spacing (Meters)	Mounting Height, (Meters)	Arm Length, (Meters)
Expressway	10	Twin Central	250	25 to 35	12	1.5
	15		250	20 to 35	12	3.0
	20		250	20 to 45	12	1.5
	25		250	20 to 40	12	1.5
	30	Opposite	250	20 to 30	12	1.5
	36		250	20 to 25	12	1.5
	40		250	20 to 22	12	1.5
	10	One-side	250	10 to 40	10	1.5
	15		250	10 to 45	12	3.0
	10		150	20 to 37	10	1.5
	15	Twin Central	250	20 to 43	12	3.0
Major	20		150	20 to 40	10	3.0
	25		250	20 to 45	10	1.5
	30	Opposite	250	20 to 45	10	1.5
	36		250	20 to 45	12	3.0
	40		250	20 to 45	2	3.0
	10	One-side	150	10 to 40	10	1.5
	15		250	10 to 50	12	3.0
	10	Twin Central	150	20 to 40	10	1.5
Collector	15		150	20 to 37	12	3.0
	20	Opposite	150	20 to 47	10	1.5
	25		250	20 to 48	10	1.5
	8		150	10 to 38	8	1.5
	10	One-side	150	10 to 37	8	3.0
Rural Highway	15		150	15 to 38	10	3.0
	10		150	20 to 45	10	3.0
	15	Twin Central	150	20 to 39	12	3.0
	4		70	10 to 40	8	1.5
	6	One-side	70	10 to 40	8	1.5
	8		70	10 to 40	8	1.5
Minor	10		70	10 to 39	8	1.5
	10	Twin Central	70	20 to 35	8	1.5
	15	Staggered	70	10 to 20	8	1.5
	15	Opposite	70	20 to 40	8	1.5

3.9. LED lamps Characteristics

The Rwanda network shall employ LED lamps as its preferred option of lighting source for Street Lighting. The acceptable ratings for LED Lights on the Rwandan Network and their general districts are tabulated below:

Characteristics	**LED Lamp Basic Characteristics**				
	60W	**80W**	**120W**	**200W**	**250W**
Power (W)	60 W	80 W	120W	200 W	250W
Input voltage (V)	220/230	220/230	220/230	220/230	220/230
Input Freq (Hz)	50	50	50	50	50
Power factor	≥ 0,9	≥ 0,9	≥ 0,9	≥ 0,9	≥ 0,9
LED Output (Lm/W)	*≥110*	*≥110*	*≥110*	*≥110*	*≥110*
Luminous flux (Lm)	*6,600*	*8,800*	*13,200*	*18,000*	*27,500*

Table – 2: LED Lamp – Basic Characteristics

3.10 LED Lamp Deployment

3.10.1. Lamp Deployment (by Lighting Assembly)

LIGHTING ASSEMBLYSTYLE	**MAST / POLE HEIGHT**		
	Wattage	**Distribution**	**Mounting Height**
Cobra – Style	60 – 120W	Full / Semi Cut-off	10 – 15 mts
Ornamental	60 – 120W	360^0 Spread	15 – 20 mts
High – Mast	120 – 150W	360^0 Spread	20 – 30 mts

Table–4: Deployment of LED Lamps

3.10.2 Light Placement

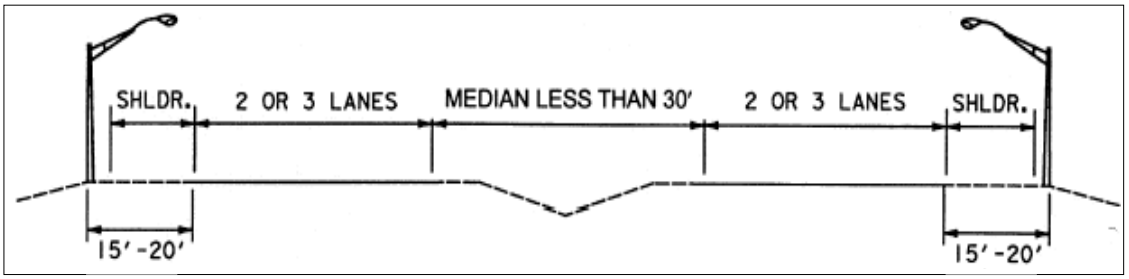
3.10.2.1 Curb Spacing

Areas with heavy traffic and significant numbers of pedestrians expected to be on the sidewalksor crossing the streets during darkness shall have adequate light to mitigate possible accidents. The lamp selection shall be driven by luminosity, energy consumption,location and lifetime:

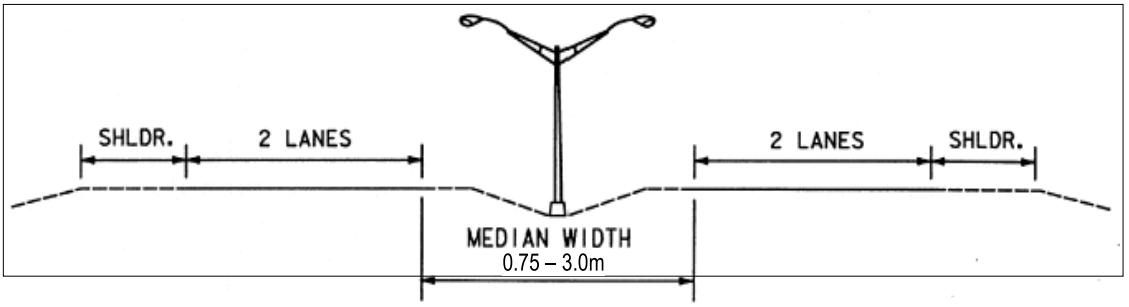
CATEGORY	**Alternate and Staggered Configuration** *(by Mast/Pole Type)*	
	Metallic	Concrete
Highway	3.0 – 6.0 m	3.0 – 6.0 m
Major	2.5 – 5.0 m	2.5 – 5.0 m
Collector	2.0 – 4.0 m	2.0 – 4.0 m
Local	1.5 – 3.0 m	1.5 – 3.0 m

Table–5: Mast / Pole to Curb Spacing

Typical Illustration if configurations for dual carriage roads

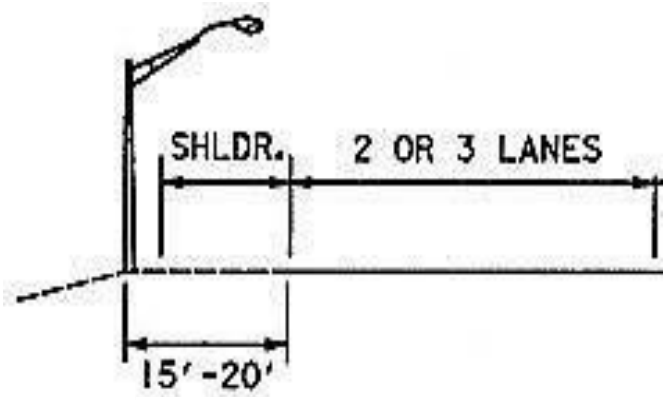


Fig–1: Dual Carriageway – Alternate & Staggered Configuration



Fig–2: Dual Carriageway – Median Configuration

Single Lane– Alternate & Staggered Configuration



Fig–3: Single Lane– Alternate & Staggered Configuration

3.10.2.2. Inter–Pole / Mast Spacing

The minimum spacing shall be determined by terrain and lamps but shall not be less than 35metersand maximum spacing on feeder roads with very light traffic shall be 60meters

The spacing of Poles / Masts from one another along a road / highway shall be dictated by:

- The level of incandescence required,
- The highway prescribed speed limits, and
- Installation Pattern

3.10.3. Installation Configurations – Roadways & Junctions

Having prescribed the spacing's for the Street Light Mast / Pole locations with respect. In all thediagrams below the guising parameter for spacing on location is:

S = ***Standard spacing*** (outlined in Table–6)

All references made in the illustrations below for locating / positioning Masts / Poles are expressed asa multiple or a fraction of the function ***'S'***.

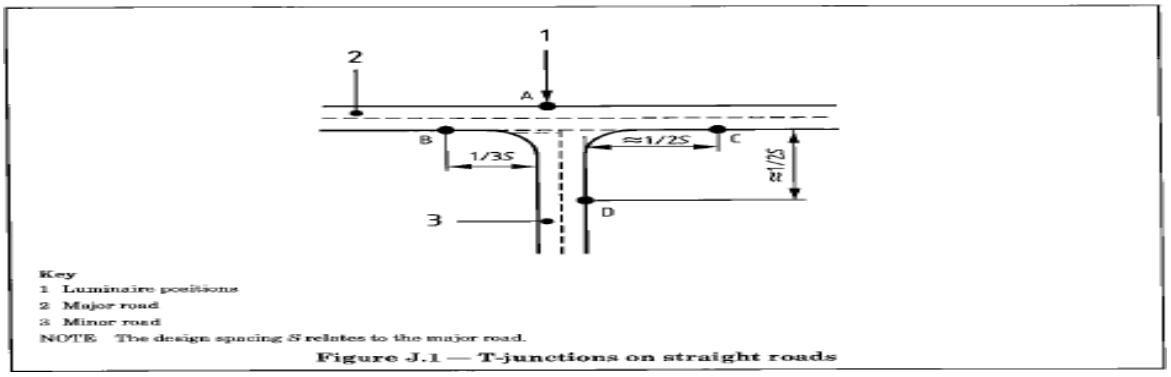


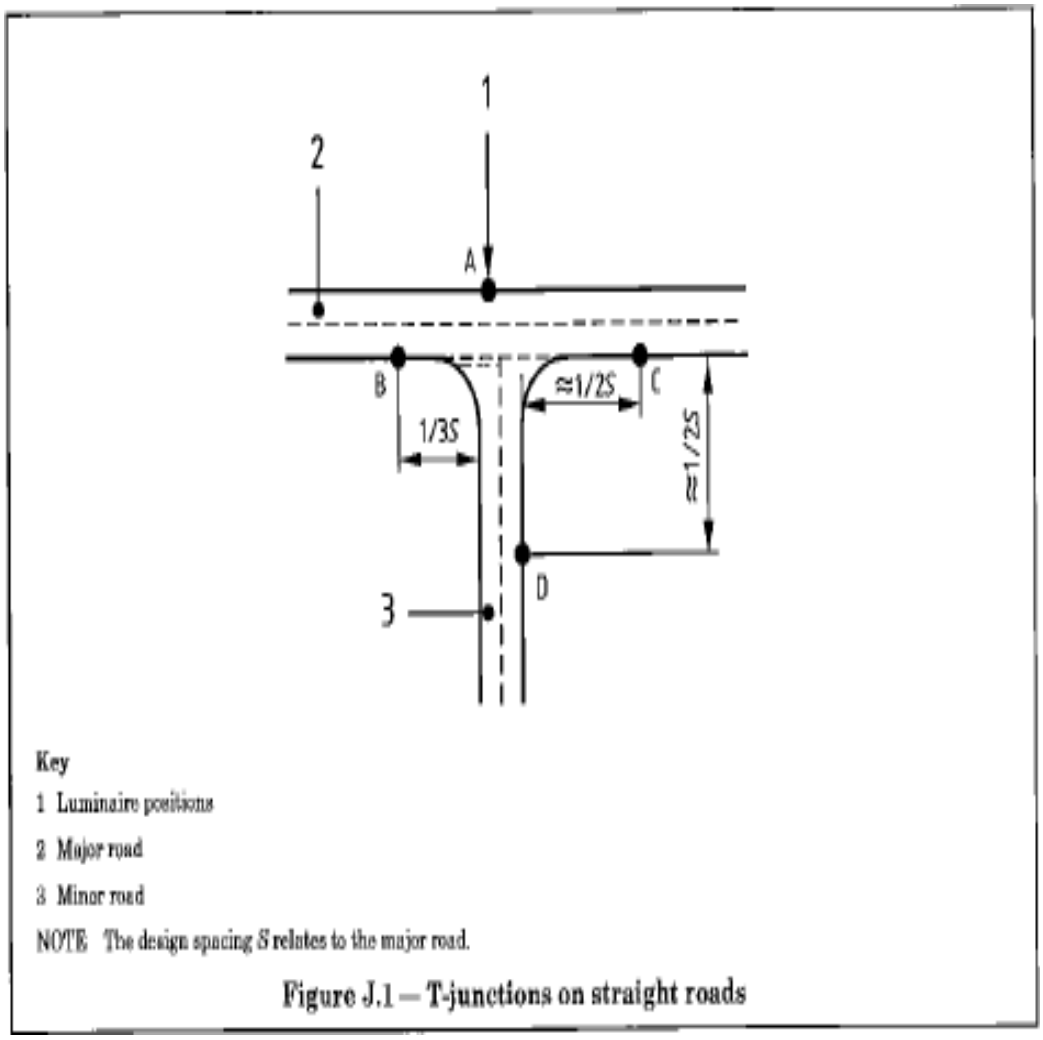
Figure J.1 — T-junctions on straight roads

3.10.3.1. Junction categories:

Y – Junctions Fork
Junctions
Triangular Junctions (minor road at obtuse angle)
Triangular Junctions (minor road at acute angle)
Junctions with traffic islands & left turn lanes on the Major Road

3.10.3.1.1. T-Junction Straight Road

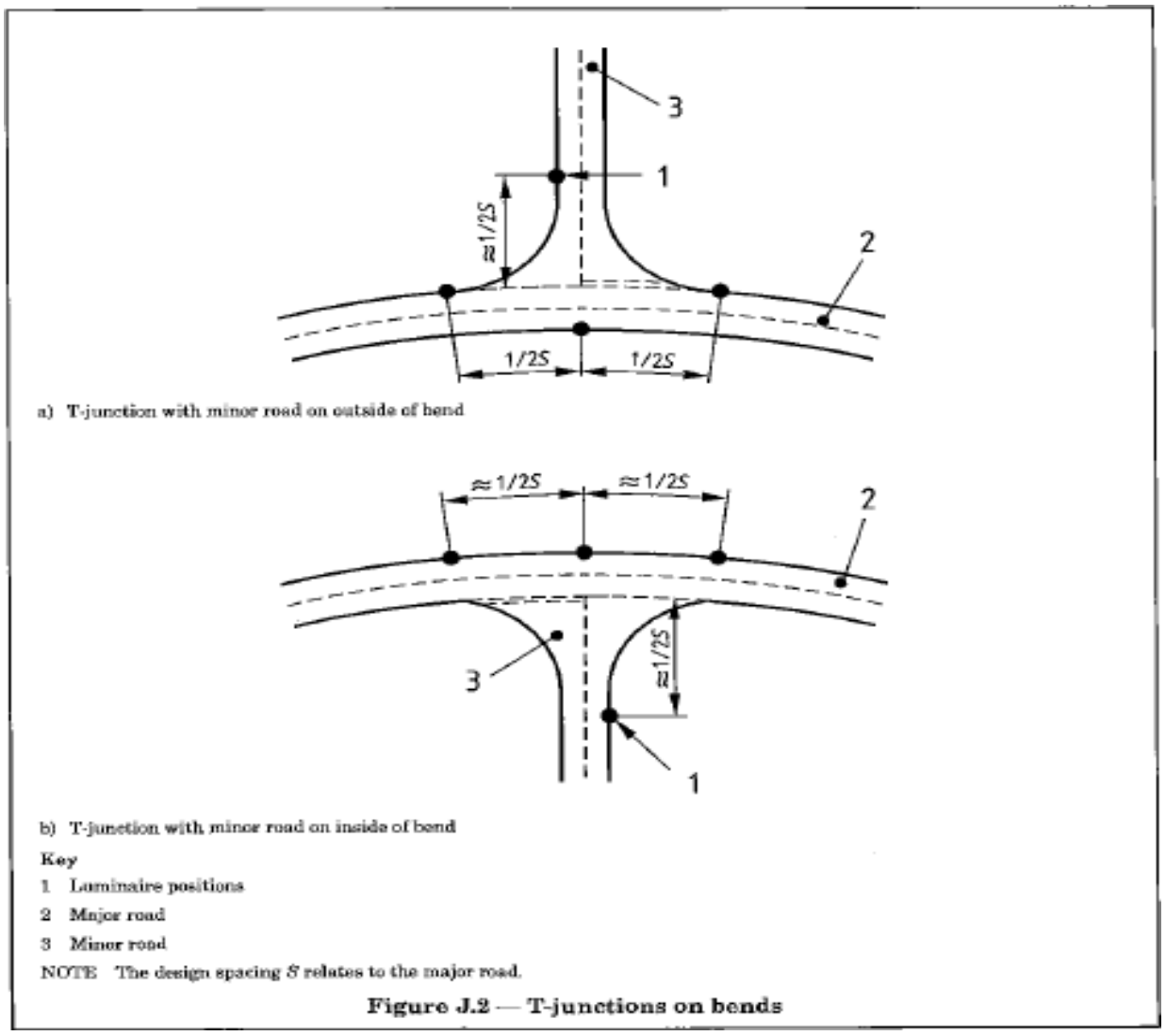
Fig–4: T-Junction Straight Road



Key
1 Luminaire positions
2 Major road
3 Minor road
NOTE The design spacing S relates to the major road.

Figure J.1 – T-junctions on straight roads

3.10.3.1.2. T-Junction on Bends



a) T-junction with minor road on outside of bend

b) T-junction with minor road on inside of bend

Key

1 Luminaire positions

2 Major road

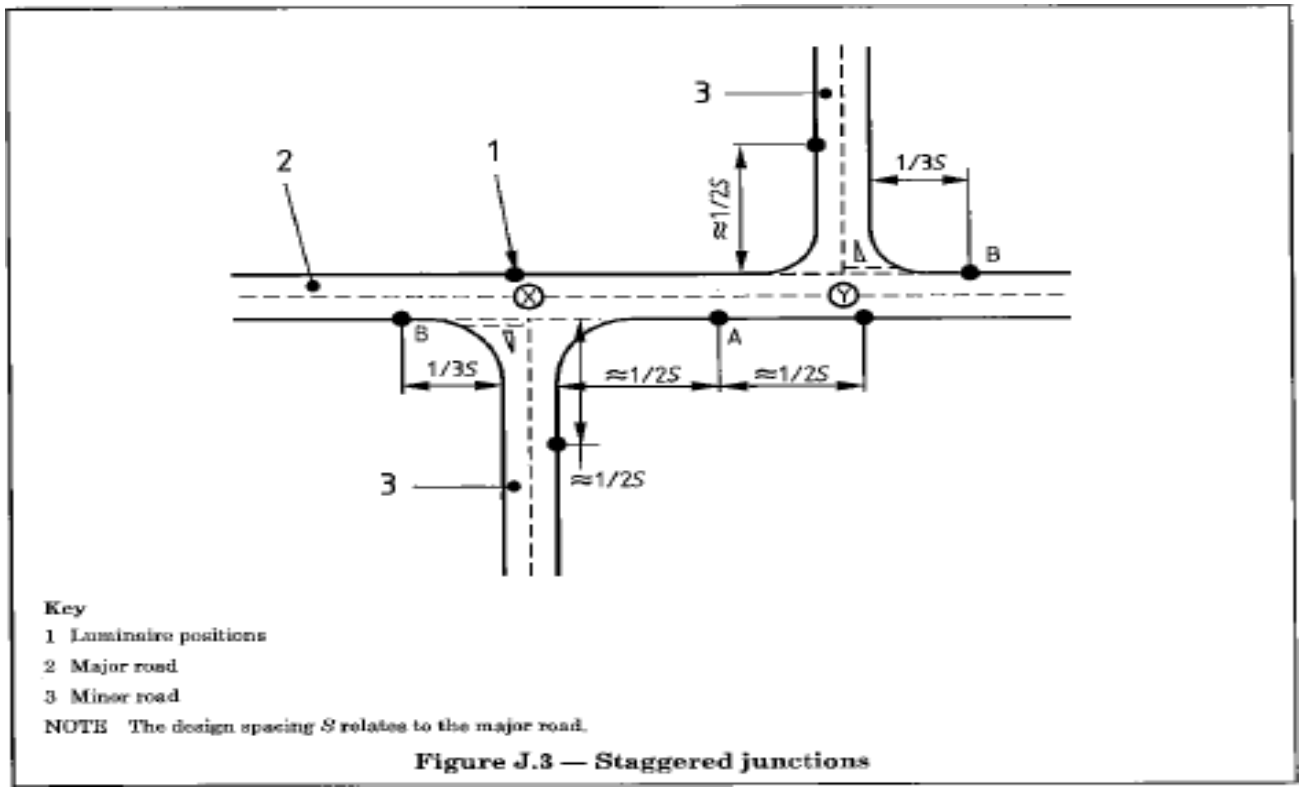
3 Minor road

NOTE The design spacing *S* relates to the major road.

Figure J.2 — T-junctions on bends

Fig–5: T-Junction on Bend

3.10.3.1.3. Staggered Junctions

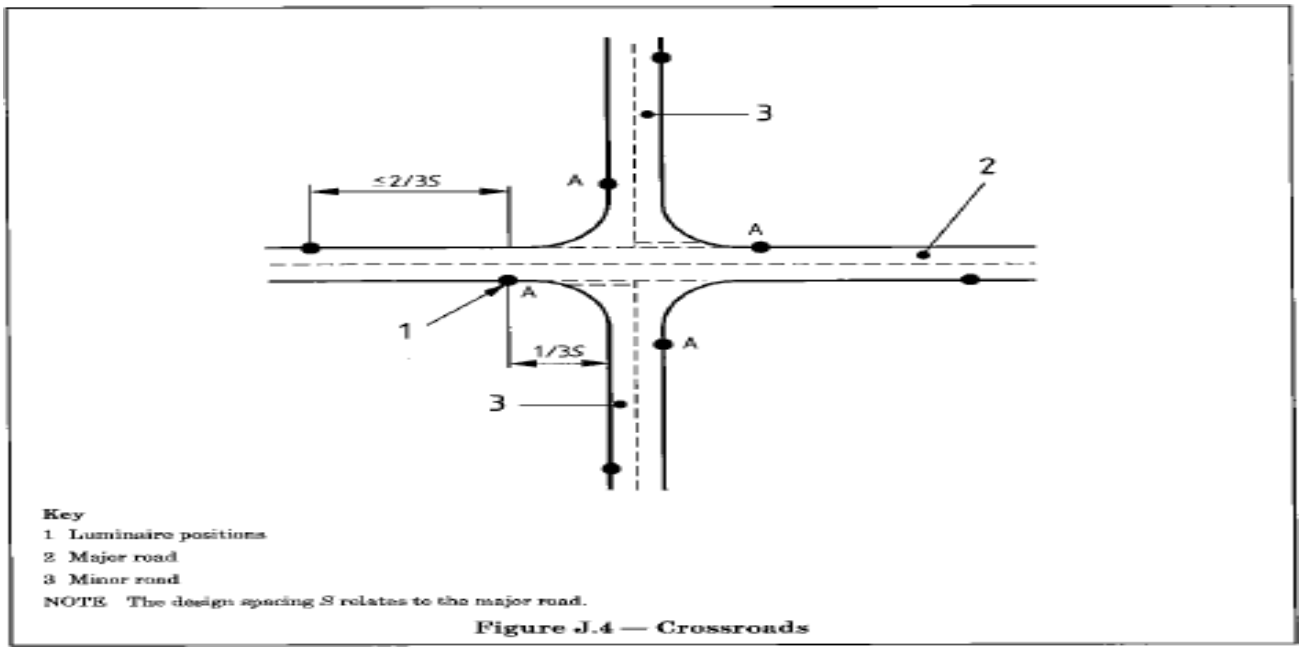


Key
1 Luminaire positions
2 Major road
3 Minor road
NOTE The design spacing S relates to the major road.

Figure J.3 — Staggered junctions

Fig–6: Staggered Junctions

3.10.3.1.4. Crossroads

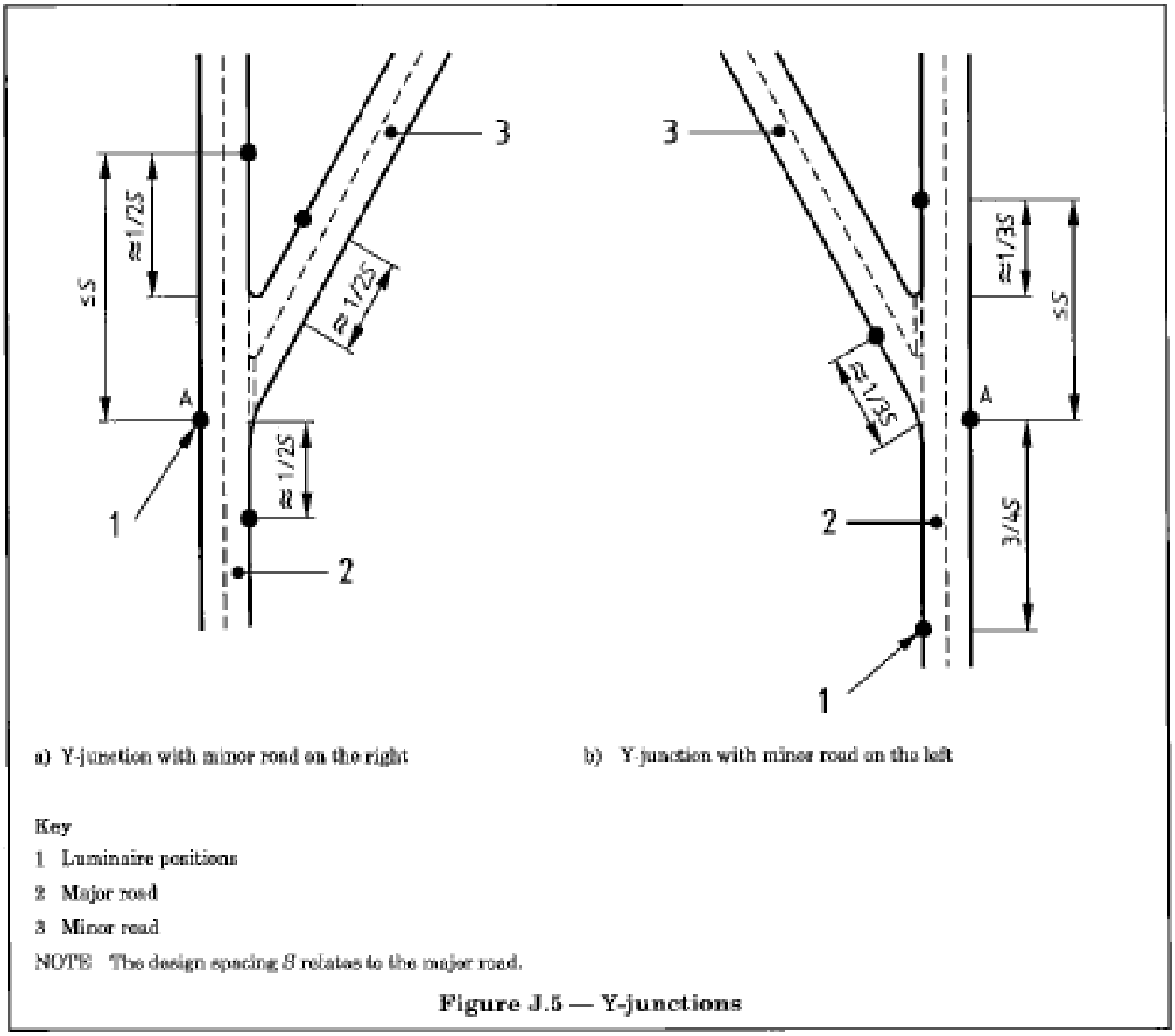


Key
1 Luminaire positions
2 Major road
3 Minor road
NOTE The design spacing S relates to the major road.

Figure J.4 — Crossroads

Fig–7: Crossroads

The next instances capture unique junctions between Major Road and Minor roads in thefollowing



a) Y-junction with minor road on the right

b) Y-junction with minor road on the left

Key

1 Luminaire positions

2 Major road

3 Minor road

NOTE The design spacing S relates to the major road.

Figure J.5 — Y-junctions

Y – Junctions, Fig–8: Y – Junctions

3.10.3.1.5. Fork Junctions

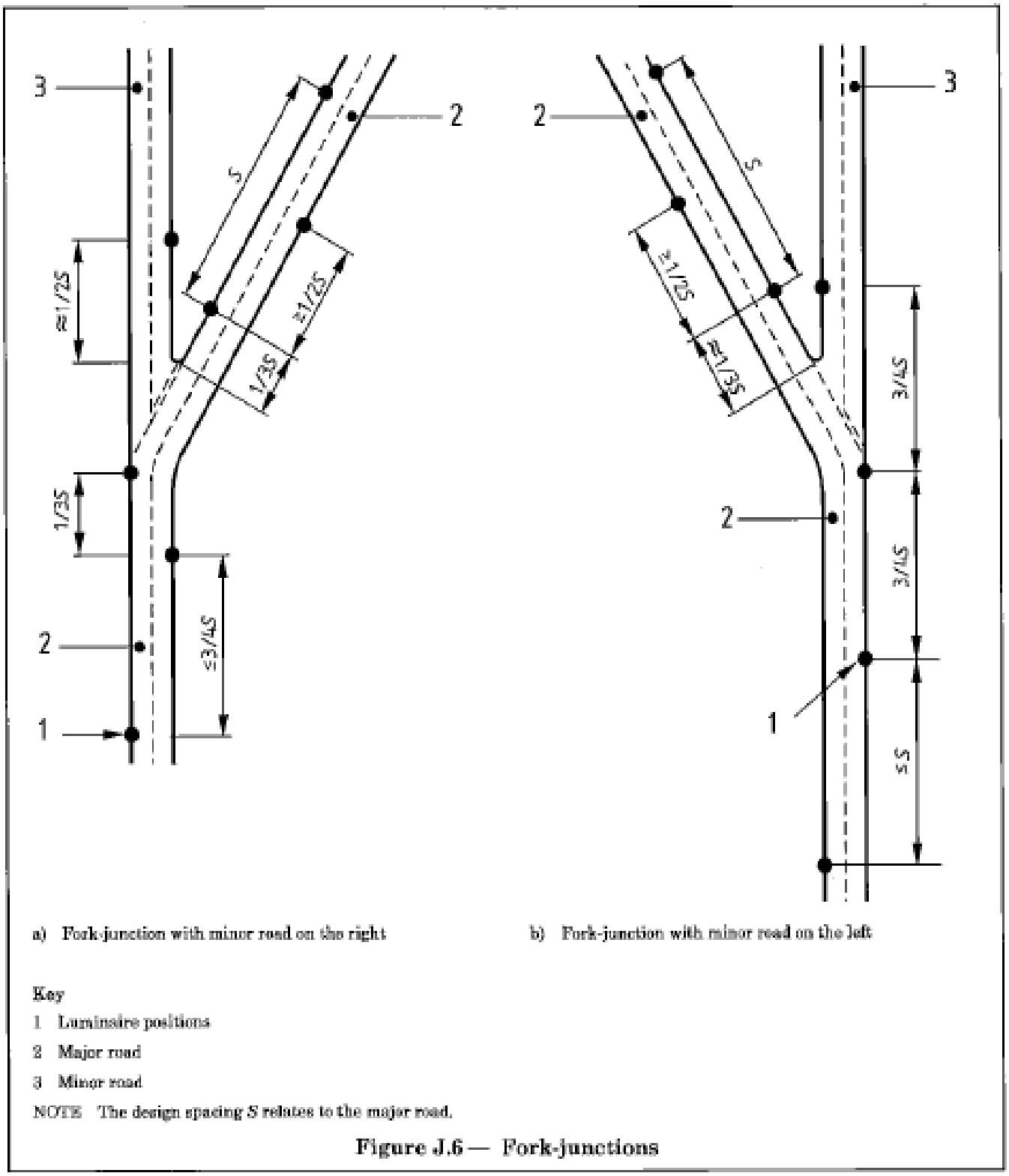
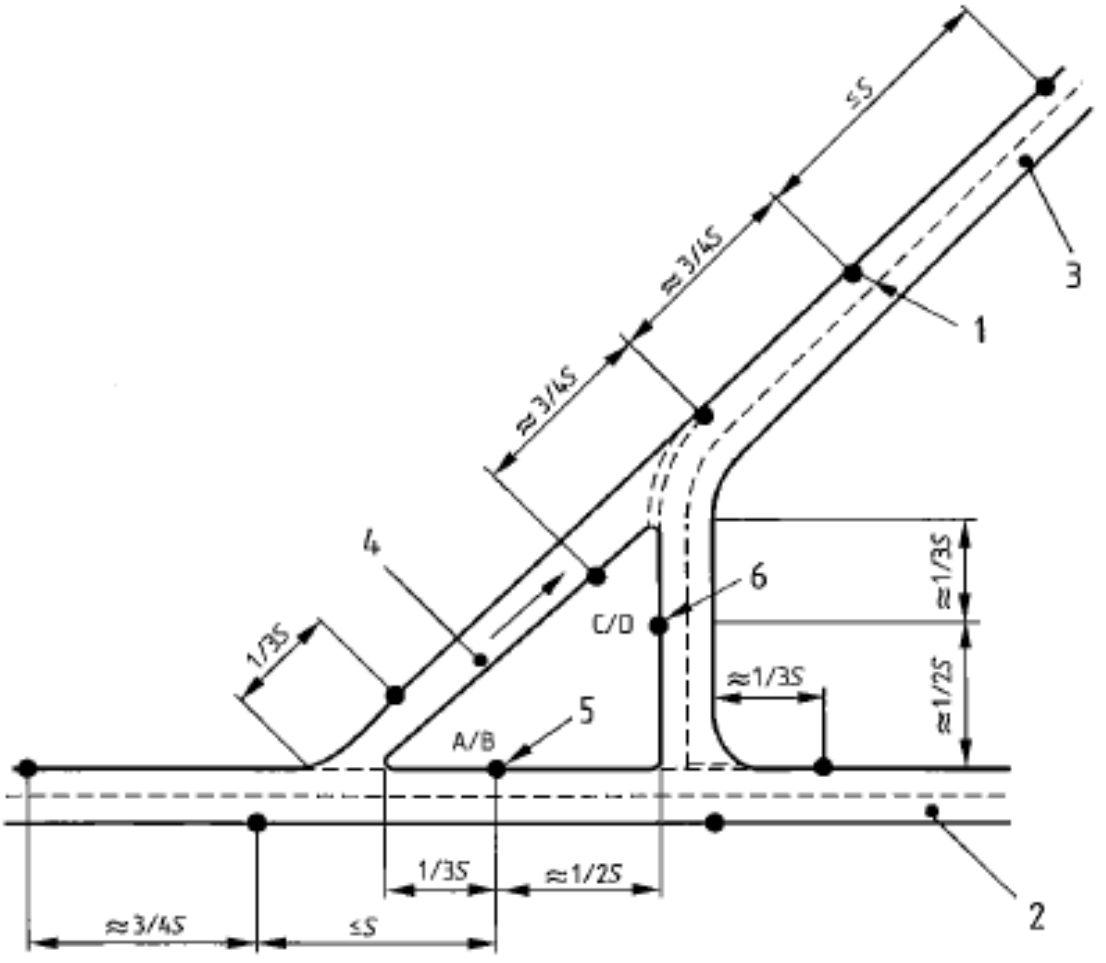


Figure J.6 — Fork-junctions

Fig–9: Fork – Junctions

Triangular Islands (Minor Road at obtuse angle



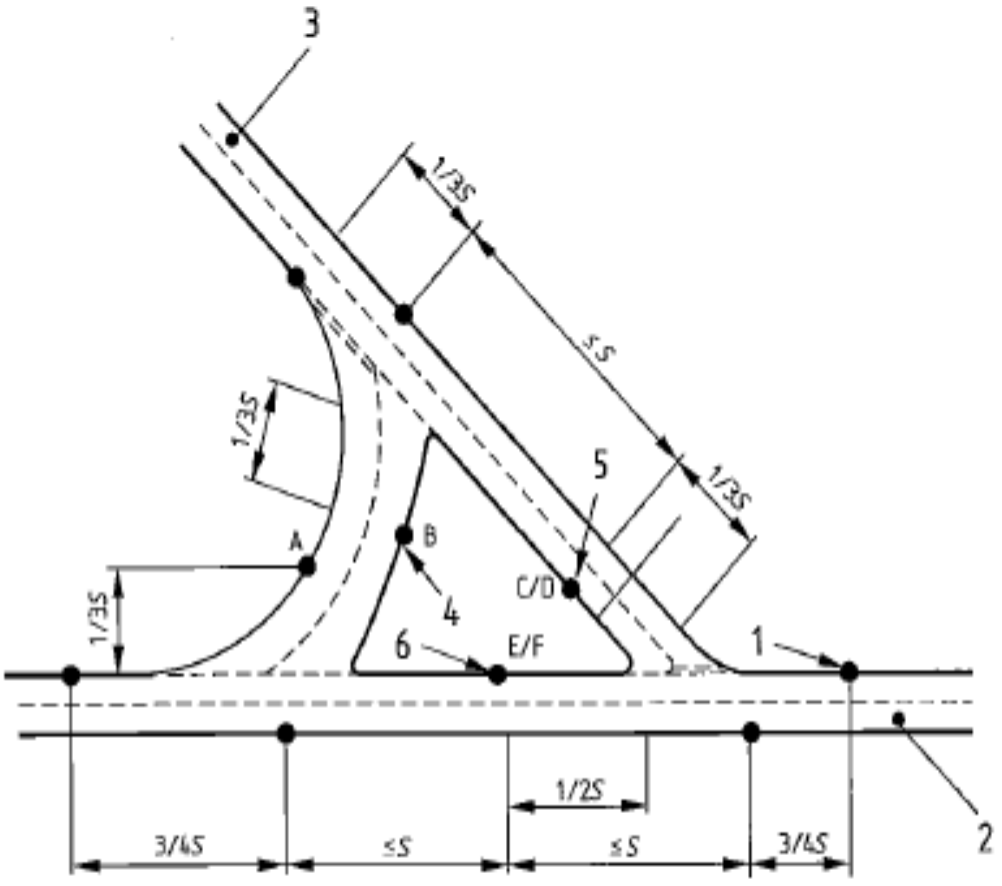
Key

1 Luminaire positions
2 Major road
3 Minor road
4 One-way link road
5 A and B can be separate or combined positions, depending on the size of the island
6 C and D can be separate or combined positions, depending on the size of the island

NOTE The design spacing *S* relates to the major road.

Figure J.7 — Junctions with triangular islands (minor road at obtuse angle)

Triangular Islands (Minor Road at acute angle



Key

1 Luminaire positions

2 Major road

3 Minor road

4 A and B can be alternative positions, but B is preferred

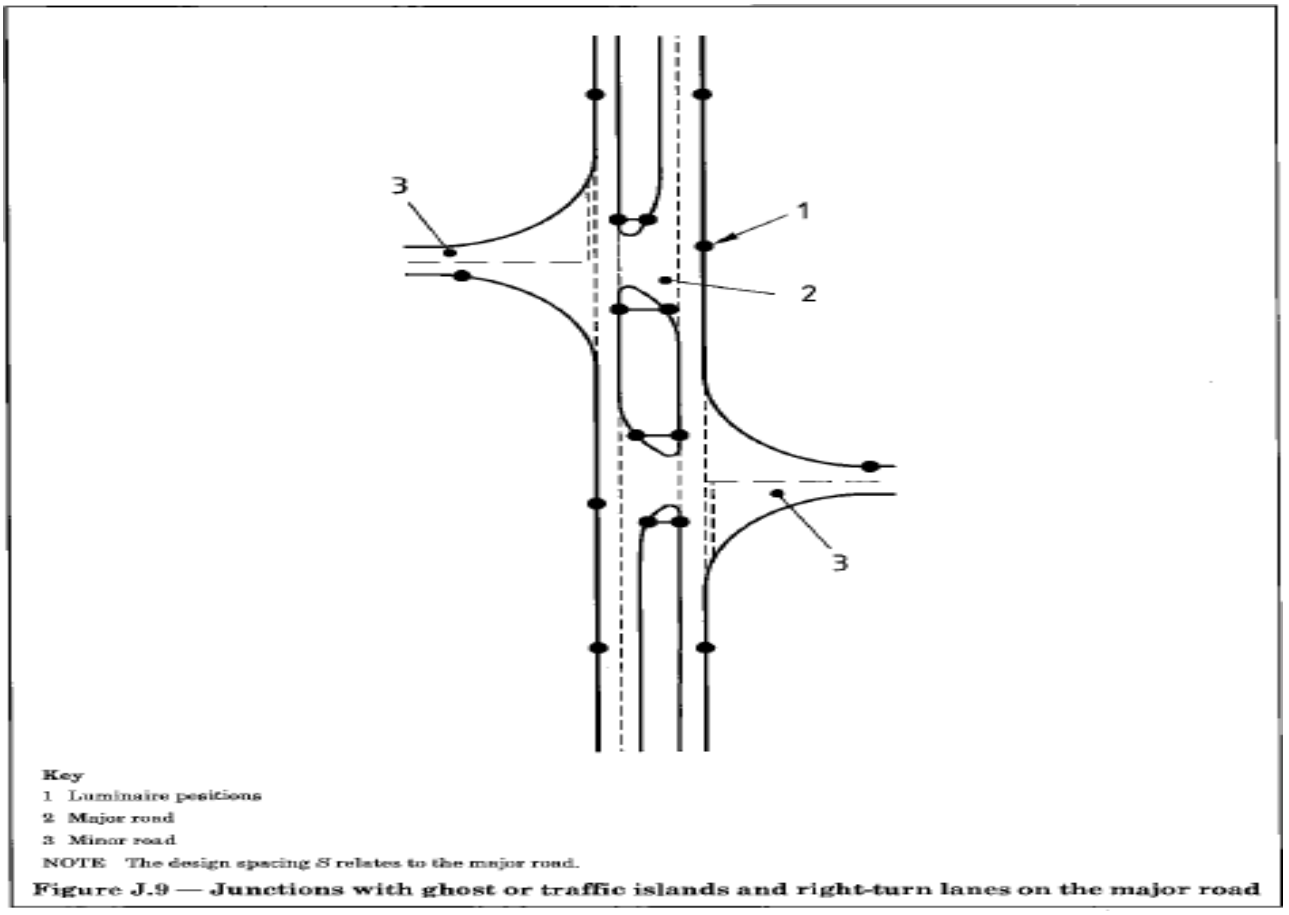
5 C and D can be separate or combined positions, depending on the size of the island

6 E and F can be separate or combined positions, depending on the size of the island

NOTE The design spacing *S* relates to the major road.

Figure J.8 — Junctions with triangular islands (minor road at acute angle)

3.10.3.1.6. Junctions with traffic islands & left turn lanes on the Major Road



Fig–12: Junctions with Islands & Left angle turns

3.10.3.2. Structure Unique to Roundabouts

The following additional structure restrictions shall apply:

LOCATION OF MASTS/ POLES FOR ROUNDABOUTS			
PARAMETER	**HEIGHT (meters)**	**EQUIPMENT**	**LOCATION**
High Mast	>15 - 30	Steel Structures	◦ Centre of Roundabout; ◦ Inner Circle of Roundabout; Perimeter of Roundabout
Standard Mast	10 – 15	Steel Structures;Concrete; Wooden	◦ Centre of Roundabout; ◦ Along approaches to roundabouts

Table–7: Roundabout Specific MAST/POLE Location

3.10.3.2.1. Roundabouts

3.10.3.2.1.1. Principle [i]

Best practice approaches placement of streetlights at roundabouts for as follows:

(a) Good illumination should be provided: -

- on the approach nose of splitter islands,
- at all conflict areas where traffic is entering the circulation stream, and
- at all places where the traffic streams separate to exit the roundabout.

(b) Illumination of the roundabout needs to be from the outside in towards the centre to improve:

- visibility of the central island, and
- Visibility of circulating vehicles to vehicles approaching the roundabout. (ref: 1, May 2010).

To further enhance illumination, it is proposed to:

1. Introduce High Mast Lighting at the centre of the roundabout
2. Multiple High Mast Lighting on the perimeter of the centre island, and
3. In cases of Small roundabouts, to utilise the centre High Mast Lighting alone.

3.10.3.2.1.2 Concepts[ii]

The paper proposes the adoption of four basic concepts applied as follows:

1. Single Centre High Mast LED Lighting with approach lighting for ***smallroundabouts***

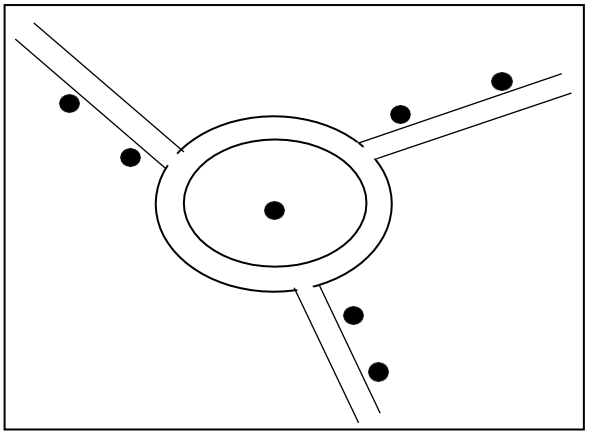
2. Perimeter Lighting with approach lighting for ***standard roundabout***

3. Central High Mast LED Lighting in combination with Perimeter lighting withapproach Lighting for ***Large Roundabouts***

4. Multiple Central High Mast LED Lighting with approach lighting for ***Large Roundabouts*** (ref: 1, May 2010; 2,).

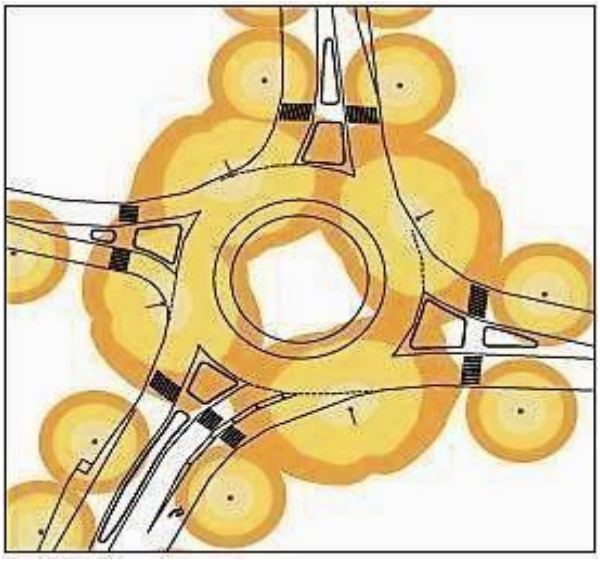
Illustrations:

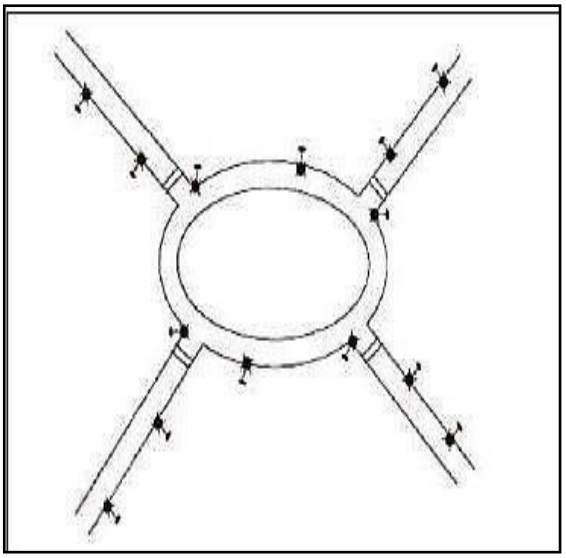
Concept – 1: Single Centre High Mast LED Lighting



Fig–13: Concept 1

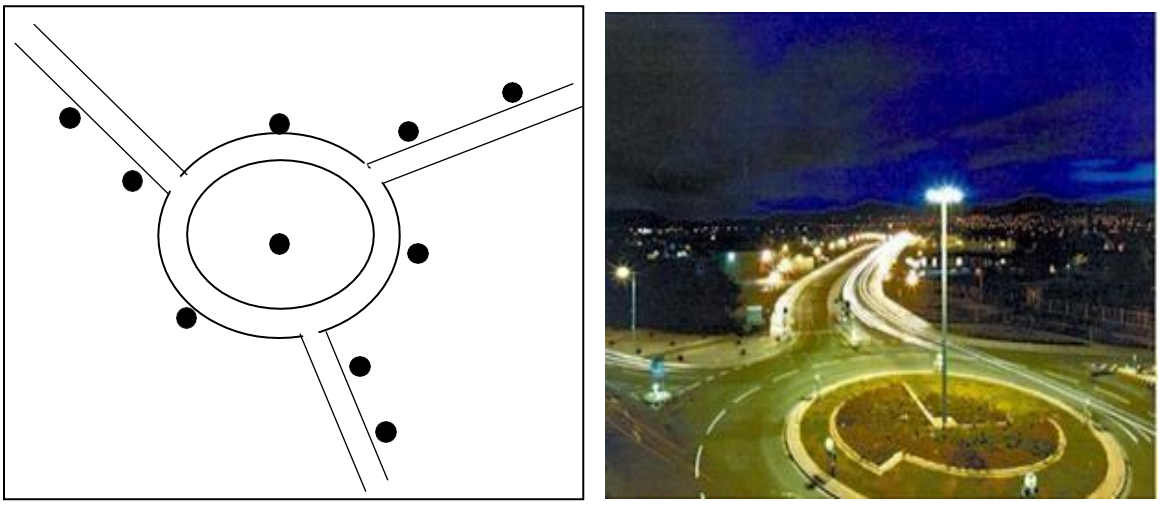
Concept – 2: Perimeter Lighting





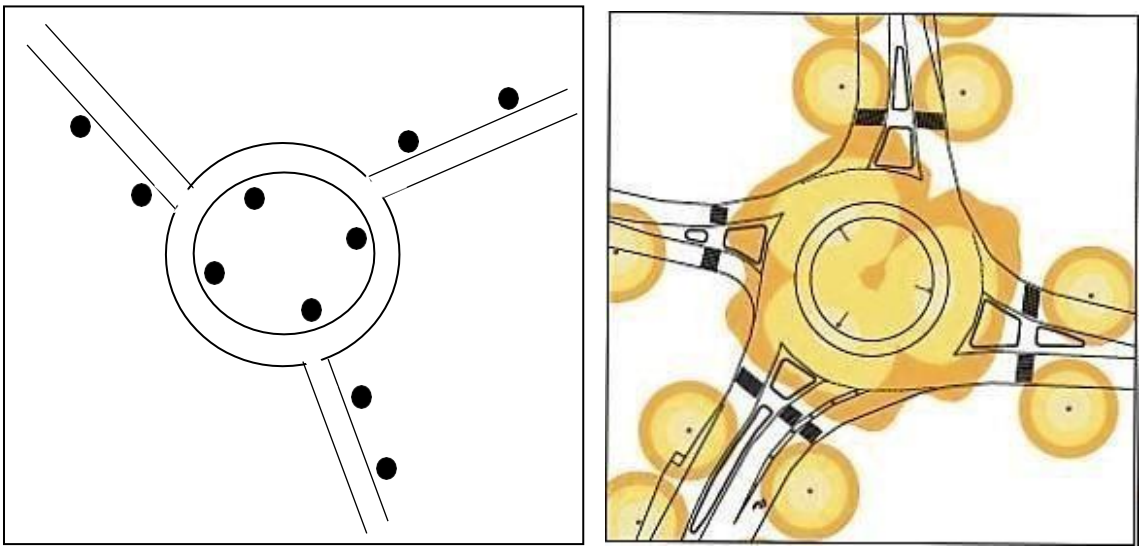
Fig–14: Concept 2

Concept – 3: Central High Mast LED Lighting in combination with Perimeter lighting



Fig–15: Concept 3

Concept – 4: Multiple Central High Mast LED Lighting



Fig–16: Concept 4

3.10.3.2.1.3 Roundabout Classification

For proper application of the concepts above in location of Masts / Poles for illumination of roundabouts the following Categorisation shall apply:

Roundabout Classification

NO	ROUNDABOUT CLASS	LIGHTING CONCEPT	RANGE(A – B) *(mts)*
1	SMALL	Single Centre High Mast LED Lighting	10 – 15
2	STANDARD	Perimeter Lighting	>16 – <30
3	LARGE	Central High Mast LED Lightingin combination with Perimeter lighting	> 30
4	LARGE	Multiple Central High Mast LED Lighting	> 30

Table–8: Roundabout Classification

The size of roundabouts is determined by the radius from the centre to the perimeter asindicated in the diagram and table below:

Fig–16: Roundabout Classification

3.10.3.2.1.4. Other Roundabout Related Considerations:

A combination of the above concepts may be utilized as the situation demands to cater for:

(a) Angle of approach (corner, slope, etc.)

(b) Terrain OR topography (hilly)

(c) Vegetation (trees, hedges, etc.)

4. Technical Characteristics of Street Lighting Structures

Structure Category / Types & Dimensions

The structures shall meet the following technical specification and exceptions shall begiven atthe road junctions and roundabouts.

Metallic Masts					
Type	**Height [mt]** *(with cross arm)*	**Base Plate [cm]**		**Avg diameter [cm]** *(Top/Bottom)*	**Other equipment**
		Length *Square X-sec*	*Diameter* *Circular X-sec*		
Regular Mast	11	42 x 42	47.5	12/30	Underground oroverhead line
	12	44 x 44	50.0	15/30	
	15	55 x 55	62.5	20/42	
High Mast	20	57.5 x 57.5	65.0	20/45	
	30	62 x 62	70.0	20/52	

Table–9: Metallic Mast Dimensions

Note: All Steel used to confirm to the following standard or equivalent: IS 2062, EN 10025

Concrete poles			
Type	**Height [m]** *(without cross arm)*	**Avg diameter[cm]** *(Top/Bottom)*	**Other equipment**
Concrete	10	15/26	Cross arms, overhead line
	12	17.5/ 30	
Pre-stressed concrete	10	15/26	Cross arms, overhead line
	12	17.5/ 30	

Table–10: Concrete Pole Dimensions

4.1. Installation of Solar Street Light System

- The solar street lighting installation shall not damage aesthetic of the existing city or street plan; rather it shall add beauty to the existing roadway.
- The battery box shall be mounted on the light pole (in case of stand-alone solar street lighting systems)
- Sensors such as Ultrasonic sensors, IR Sensors and LDR sensors are used to control the LED lamp functionalities in order to achieve a more energy efficient system. In this case the street light must have auto on and off and must have at least two state of dimming function to save energy, from dusk to dawn.
- The warranty against any manufacturing/ design/ installation defects shall be a minimum period of 3 years from the date of installation.

PART TWO: STREETLIGHTS MAINTENANCE STANDARDS

5. General maintenance requirements

5.1. Maintenance programs

Ownership of the road lighting installation is to be confirmed before any maintenance is undertaken.
There are two road lighting maintenance ownerships:

- Street Lighting supplied, installed, owned and maintained by the Electricity Entity REG, located along the high roads.
- Street Lighting supplied by REG but, installed, owned and maintained by the District with Private Companies. These roads generally are the secondary feeder roads, urban centers and districts towns.

5.2. Applicable standards

All work is to be carried out in accordance with REG distribution Reticulation standards, National standards, Street light reticulations standards, Technical Specifications, RURA Regulations and Codes of Practice. This document does not detail all activities that must be undertaken to comply with the requirements of the Standards and Regulations; however, all works, processes and procedures used in maintenance activities associated with the electrical works described herein is be in accordance with the Standards and regulations. Maintenance is not to be carried out live except as permitted under the standard.

5.3. Installation drawings

Installation drawings are required for the safe maintenance of electrical and lighting installations. REGand Districts shall work closely with the maintenance provider to ensure that electrical installation drawings are current and reflect the actual state of the installation. Where drawings are incorrectand/or non-existent, REG and Districts are to arrange for accurate drawings to be followed as produced. These include complete single line diagram with distances between light poles.
Drawings are to conform to the requirements of the current Technical Specifications of REG. Final 'AsBuilt' drawings need to be readily available for the department's road lighting maintenance reference.

5.4. Maintenance planned equipment

Due to the height of road lighting installations, Elevated Work Platform (EWP) vehicles such as Cranes, hoists and winches are to be used. Every operator is to possess a valid EWP, the relevant driver' shall have an appropriate level of experience in EWP operation.

5.5. Maintenance waste disposal

Disposal of lamps after they are removed from service is to be undertaken in an environmentally safe manner. Breakage of lamps before disposal is to be avoided. Other maintenance waste is to be disposed of appropriately. Disposal records shall be kept in accordance with record keeping requirements and asset disposal information updated accordingly.

5.6. Replacement parts

All replacement parts are to comply with standards and Technical Specifications. The current rating and characteristics of electrical circuit protection devices shall be no greater than those specified on the Standard Drawings. Installations that do not comply with the requirements are to be rectified. The electrical characteristics of replacement luminaires are to be such that the lighting and electrical integrity of the installation are not compromised. Where identical luminaires are not available, design verification for compliance with the standards shall be carried out by an appropriately qualified and experienced Electrical Engineer.

5.7. Traffic management

Signalization to show that road lights are in maintenance must be used. Where road lighting is expected to be non-operational for more than three days from when the fault is identified, the temporary sign '**STREET LIGHTING UNDER REPAIR'** is to be displayed

5.8. Record keeping

All road lighting maintenance activities are to be logged in order to monitor road lighting performance and to trend failure and outage rates.

Data to be collected is defined in Appendices A and B. Minimum details required to be logged and reported include:

- Name of road and/or road number,
- item maintained – pole, pit, switchboard, lamp, luminaire, re-openable junction box, ducting, and so on
- Identification number of pole
- identification number of switchboard
- date installed
- date maintained
- date last electrically verified
- type of maintenance service – damage / fault, bulk lamp replacement, routine spot, and so on
- name of maintenance service provider (Contractor company name and maintenance personnel)
- light source replacement date.

Asset and site information pertaining to the road light and maintenance activities are to be stored electronically in the REG or the District depending on who is managing that infrastructure

5.9. Scheduled inspections and maintenance

5.9.1. Electrical

Inspections and tests shall be carried out every six years. Where the risk of degradation of the installation due to environmental or other factors is considered high, more frequent inspections shallbe carried out. Check audits on parts of high-risk installations shall be carried out at a maximum of 12-month intervals. Immediate electrical risks (including exposed live conductors, unearthed equipment and incorrect polarity) require immediate action.

5.9.1.1.Point of supply maintenance

The road lighting installation power supply is distributed by REG from

- overhead pole mounted transformer with fuse
- pillar boxes
- street lighting column connection.

5.9.1.2.Electrical switchboard Verification-Quarterly

The switchboard is the point where lighting circuits originate and are controlled. Its maintenance shallbe carried out to ensure the electrical integrity and Good condition. Inspection include but limited to:

- mounting or support for the switchboard enclosure
- Correct enclosure labelling and nameplates.

- Ingress of water and vermin.
- Deterioration of weatherproof seals and other components
- Detection of poor connections and joints
- correct earthing
- Protection against direct and indirect contact with LV terminals / surfaces
- correct operation of components
- correct internal labelling of component

5.9.1.3.Cable and connection maintenance-Quarterly

Electrical cabling and connections are to be maintained to ensure a long service life span. Consequently, scheduled visual observations and electrical tests are required.

Inspection include, but not be limited to:

- Joints, connections and terminations for corrosion
- Poor, loose, overheated or unsecured connections
- Evidence of moisture ingress to cables and/or connections
- damaged insulation
- exposed conductors
- General condition of cable
- Evidence of rodent / vermin activity.

5.9.1.4 Pits and conduit maintenance- Once per year

Pits and conduits are to be inspected visually. Pit lids are to be intact, undamaged and properly fittedto the pit... Pits shall be free draining. Maintenance of pits and conduits include but not be limited to:

- ensuring adequate drainage
- Replacement of broken or chipped pit lids
- rectifying collapsed pit side walls and other damage, and
- maintaining ground / pit surface level and pit surrounds.

5.9.2. Lighting/ _ Daily, Weekly_Monthly

Regular Inspections of lighting systems shall be carried out on daily, weekly and monthly basis.

Defected mercury vapor and sodium luminaires for Street lighting installations as the company is currently implementing an initiative to replace sodium and mercury based lamps by conventional light sources with LED technology.

Faulty LED lights shall be reported and replaced by responsible entity, contractor or owner. For conventional road lighting, periodic inspections of the lighting installation are to be undertaken to ensure the lighting is operating as designed.

To keep the harmony (harmonization) of the color of lights, the defected lamp shall be replaced by the lamp with the same color of lights. When, that lamp is not available you can use other quite similar lamp, but temporarily while waiting the availability of lamp with appropriate colour of lights.

The maximum level of luminaire outages at any one time is not to exceed 5% of the luminaire population.

Routine LED luminaire maintenance is to be carried out after five years.

Maintenance of luminaires include but not be limited to:

- cleaning of all optical surfaces of the luminaire, both internal and external
- checking of gaskets for deterioration and replacement where necessary
- replacement of damaged / weathered diffuser
- a visual check of the electrical components and wiring for signs of overheating
- checking of all accessible screws, nuts and fixings for tightness
- where undone, application of non-corrosive gel to screw fixing

LED luminaires have a **10-year** warranty. Before this period, internal repairs undertaken during the warranty period shall be reported and seriously analyzed.

5.9.3. Structural- Twice per year

Periodic visual inspections shall be undertaken to ensure their compliance with the relevant standards of:

- steel poles
- concrete poles
- other luminaire supports
- vertical distance between the pole and soil surface level, and
- tensile clamping bolt tension.

Inspections shall be carried out after the reliability period and then every six years thereafter.

5.9.3.1 Steel and concrete pole maintenance- Once per year

Generally, once steel poles have been installed and commissioned, minimal maintenance is required;however, the following aspects shall be inspected:

- testing the thickness of galvanic protection in accordance with IEC standards for Hot-dip galvanizing

Steel pole check shall include but not be limited to:

- pole vertical alignment tolerance

- surrounding area assessment.

The immediate area around the base of the pole is to be kept clear of debris and soil build up to ensure that the steel pole is not corroded.

Steel poles are to be replaced when:

- Horizontal cut(s) or slit(s) exist and exceeds 20% of the pole circumference,
- Deformation of pole due to impact exceeds 20% of the pole

diameter,concrete poles road lighting shall be replaced:

- Where the concrete has been cracked or damaged to the extent.

Welding on steel poles is only undertaken at the initial pole fabrication stage; if necessary, it may bedone under construction engineer instruction.

5.9.3.2 Environmental

5.9.3.2.1. Vegetation management_Quaterly

The growth of vegetation near luminaires has the potential to reduce significantly the effectiveness of road lighting installations.

Where vegetation or other obstructions have an impact on road lighting performance, reduce security, increase the likelihood of vermin, safe access to the sites they shall be removed after consulting environmental management.

5.10. Unscheduled maintenance

Urgent emergency repairs following damage to road lighting due to road crashes, storms, soil sliding and others incidents should be undertaken to make the installation safe for workers, road users as motorists, and pedestrians. Completion of damages repairs should be completed within one day after being reported.

Recommended maximum response time for reported lamp outages is one day where immediaterectification is not possible, details are to be reported immediately to the management.

5.11. Emergencies

Emergency: Emergency repairs/interventions following damage to road lighting due to road crashes/accident, road cracks, vandalism, storms, soil sliding and others incidents should be immediately undertaken to ensure safety for road users (motorists and pedestrians).

Emergencies include:

- ✓ a street light hanging off
- ✓ exposed live wire/cables
- ✓ street light column door off
- ✓ Conductive street light column/pole
- ✓ the lighting pole has been knocked down
- ✓ Burnt/damage of transformer

5.12. Special Maintenance of Solar powered street lights

- **Pruning/trimming the surrounding trees:** Keep a keen eye on the shrubs and tree branches that grow around your solar street light and trim them regularly so they don't hinder the power generation.

- **Cleaning of the solar PV module / panel from the dust:** Solar panels shall be regularly cleaned according to the actual situation, such as once a quarter, or once a year, depending on the rain and dust conditions of the installation site.

- Batteries or battery banks shall be inspected and maintained

- Possible damaged wires and broken connections should be checked every 3 to 6 months.

6. Annexes

Annex 1: Construction / Survey format

sn	Features	Data		Observation	
1	Feeder nearby				
2	Length of MV extension needed				
3	Length of LV extension needed				
4	Transfo.needed				
5	Road classification				
6	Piedestrian conflict				
7	Existing light infrastructre				
8	Wattage needed				
9	Illumination level				
10	Overhead/underground				
11	Size of cable				
12	Pole type and size				
13	Lampe wattage				
14	Nbr of lampe				
15	Covered distance				
16	Is the survey consistent with the existing infr.				
17	Is any project in the same bundle area				
18	Is the survey consistent with the master plan				
19	Coordination with				
20	Established by				
	Name	Fonction	date	Signature	
21	Witnessed by				
	Name	Fonction	date	Signature	

Commissioning format

sn	Features	Data		Observation	
1	Feeder				
2	Length of MV extension needed				
3	Length of LV extension needed				
4	Transfo.,circuit breaker, voltage at the Transfo LV side, unloaded	Technical characteristics		SN & date of installation	
	25 kVA				
	50 kVA				
5	Voltage at the last lamp, line loaded				
6	Road classification				
7	Piedestrian conflict				
8	Existing light infrastructre				
9	Illumination level				
10	Overhead/underground				
11	Size of cable				
12	Pole type and size				
13	Lampe wattage				
14	Nbr of lampe				
15	Covered distance				
16	Is the project consistent with the existing infr.				
17	Is any conflict with another project in the same right way				
18	Is the project consistent with the master plan				
	are any snags to be dressed during the reliability period				
	Others comments				
19	Coordination with				
20	Established by				
	Name	Fonction	date	Signature	
21	Witnessed by				
	Name	Fonction	date	Signature	

Annex 2/. Maintenance

Site identification format

Name/nbr of road		
Item identification maintained		
Pole nbr		
Switch nbr		
Lamp Nbr		
Date installed		
Date maintained		
Date last electically verified		
Type of of maintenance service provided		
Name of maintenance service provider		

Inspection format

Inspection Date:	
Name of center/ Village/ Sector /District:	
Line Section:	
Taping MV Pole:	
Length of MV Line:	
No of Transformer Installed:	
Taping LV Pole:	
Length of LV Line:	

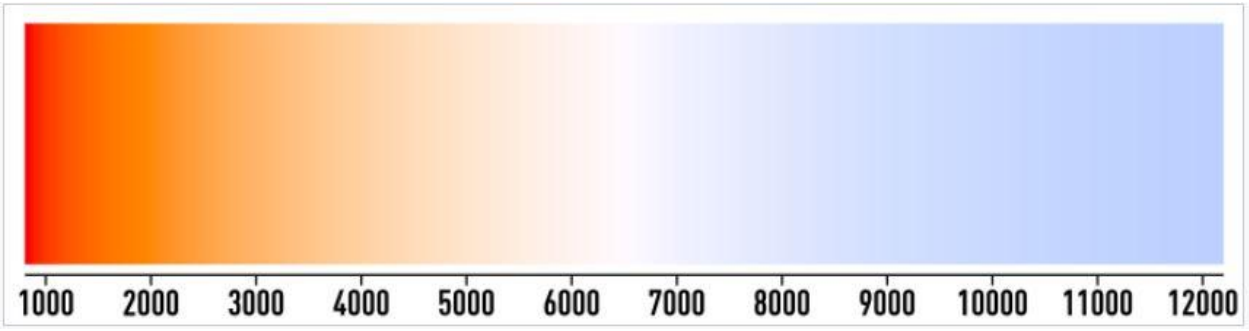
	Observ (A: Acceptable)	Comments	Observ (NA:Non acceptable)	Comments
➢ Visual inspection satisfactory (no visible signs of damaged)				
➢ MV line Correctly constructed				
➢ Transformer correctly installed				
➢ LV line Correctly constructed				
➢ Materials used match with approved standard (Pole, Luminaire, cable size)				
➢ Poles installed according to approved design				
➢ cables installed according to approved design				
➢ Luminaires connected according to approved design				
➢ Earthing system installed at each support				
➢ Pole broken				
➢ Cable cut				
➢ Cross arm supporting lamp in good position				
➢ Earthing cut				
➢ Lamp not lighting				
➢ Lamp broken				
➢ Distribution board closed				
➢ Main circuit breaker installed				
➢ Main circuit breaker well sized				
➢ Main circuit breaker in good conditions				
➢ Lighting timer in place				
➢ Lighting timer works propery				

Annex – 3: LED Specifications

characteristics	Description	Description	Description	Description	Description	Description	Description
Power	**60 W**	**80 W**	**100 W**	**120W**	**150W**	**200 W**	**250W**
Input voltage	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**	**220/240 V 50-60 Hz**
Power factor	**≥ 0,9**	**≥ 0,9**	**≥ 0,9**	**≥ 0,9**	**≥ 0,9**	**≥ 0,9**	**≥ 0,9**
Junction temperature	**120°C**	**120°C**	**120°C**	**120°C**	**120°C**	**120°C**	**120°C**
Harmonic	**NF C13-200**	**NF C13-200**	**NF C13-200**	**NF C13-200**	**NF C13-200**	**NF C13-200**	**NF C13-200**
Total Consumption	**67 W**	**87 W**	**110 W**	**135 W**	**160 W**	**214 W**	**280 W**
Number of Sources	**2 x 30W**	**2 x 40W**	**2 x 50W**	**3 x 40W**	**3 x 50W**	**4 x 50W**	**5 x 50W**
LED Output	**≥110 Lm/W**	**≥110 Lm/W**	**≥110 Lm/W**	**≥110 Lm/W**	**≥110 Lm/W**	**100 Lm/W**	**≥110 Lm/W**
Lifespan	**50 000 h**	**50 000 h**	**50 000 h**	**50 000 h**	**50 000 h**	**50 000 h**	**50 000 h**
IRC	**RA >80**	**RA >80**	**RA >80**	**RA >80**	**RA >80**	**RA >80**	**RA >80**
Collerated Colour temperature(CCT) warm white	**4000 K**	**4000 K**	**4000 K**	**4000 K**	**4000 K**	**4000 K**	**4000 K**
Luminous flux	**6,600 Lm**	**8,800Lm**	**11000 Lm**	**13200 Lm**	**16500 Lm**	**18000 Lm**	**27500 Lm**
Environment temperature	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**	**- 10.00°C /+50.00°C**
IP Protection	**IP 65**	**IP 65**	**IP 65**	**IP 65**	**IP 65**	**IP 65**	**IP 65**

characteristics	Description	Description	Description	Description	Description	Description	Description
Optic	*Tempered Shaded glass*	*Tempered Shaded glass*	*Tempered Shaded glass*	*Tempered Shaded glass*	*Tempered Shaded glass*	*Tempered Shaded glass*	*Tempered Shaded glass*
Housing	*Cast Aluminium*	*Cast Aluminium*	*Cast Aluminium*	*Cast Aluminium*	*Cast Aluminium*	*Cast Aluminium*	*Cast Aluminium*
Viewing Angle	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**	**≥ 3.5 x Mast Height**
Recommended Height	**7- 9 m**	**7 - 9 m**	**7- 9 m**	**7- 10 m**	**7- 10 m**	**11-14 m**	**7- 14 m**
IK Protection	**IK 09**	**IK 09**	**IK 09**	**IK 09**	**IK 09**	**IK 09**	**IK 09**
Protection safety class	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Wind resistance	**150 km/h**	**150 km/h**	**150 km/h**	**150 km/h**	**150 km/h**	**150 km/h**	**150 Km/h**

The preferred correlated color temperature(CCT) for the technical specifications of LED outdoor street lighting lamps is “warm white’’light ranging around 4000 K, which offers the medium and efficient road relaxing effect. A high color temperature (>4000 K) features more light in the bleu range, whereas a low color temperature (2200-3000 K) features more light in the red, orange and yellow range.



Annex –4: Illumination Table & Standard Incandescence

Illumination Condition	***(ftcd)***	***(lumens per sq meter)***
Sunlight	10,000	107,527
Full Daylight	1,000	10,752
Overcast Day	100	1,075
Very Dark Day	10	107
Twilight	1	10.8
Deep Twilight	.1	1.08
Full Moon	.01	.108
Quarter Moon	.001	.0108
Starlight	.0001	.0011
Overcast Night	.00001	.0001

The guideline recommends the adoption of illumination levels equivalent to Full Daylight, i.e.: ***10,752***lumen per square- meter and that each mast is mounted with sufficient LED lamps to attain a lumen strength equivalent to Full Daylight (10,752lumens per square meter) at ground level.