	Standard	Asset Management
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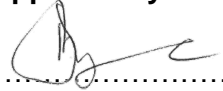
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CONTENTS

	Page
1. INTRODUCTION	4
2. SUPPORTING CLAUSES	4
2.1 SCOPE	4
2.1.1 Purpose	4
2.1.2 Applicability	4
2.2 NORMATIVE/INFORMATIVE REFERENCES	5
2.2.1 Normative	5
2.2.2 Informative	8
2.3 DEFINITIONS	8
2.3.1 Disclosure Classification	9
2.4 ABBREVIATIONS	9
2.5 ROLES AND RESPONSIBILITIES	10
2.6 PROCESS FOR MONITORING	11
2.7 RELATED/SUPPORTING DOCUMENTS	11
3. LIGHTING AND SMALL POWER INSTALLATION FOR NEW AND EXISTING ESKOM POWER STATIONS	11
3.1 GENERAL REQUIREMENTS	11
3.1.1 Cables	11
3.1.2 Safety	11
3.1.3 Change Management	11
3.1.4 Drawings	11
3.1.5 Service Conditions	12
3.1.6 Hazardous Locations	12
3.1.7 Tests	12
3.2 DESIGN PHILOSOPHY	12
3.2.1 Boiler House and Basement	12
3.2.2 Turbine House and Basement	13
3.2.3 Auxiliary Bay, Offices, Switchgear Rooms or Substations and Workshops	13
3.2.4 Heating Ventilation and Air Conditioning (HVAC)	14
3.2.5 Control Room	14
3.2.6 Cable Tunnels, Substation Basement and Conveyor Walkways	14
3.2.7 Outside Arrears and Terrace Lighting	14
3.2.8 Smoke Stack Lighting	14
3.2.9 Coal Stock Yard (CSY)	15
3.2.10 Security Fence	15
3.2.11 Schedule	15
3.2.12 Quality of Materials	16
3.2.13 Conduit and Accessories	16
3.2.14 Conduit in Roof Spaces	16
3.2.15 Surface Mounted Conduit	17
3.2.16 Conduit in Concrete Slabs	17
3.2.17 Flexible Connections for Appliances	18
3.2.18 Wiring	18
3.2.18.1 Conduit	18
3.2.18.2 Power Trunking	18
3.2.19 Switches and Socket Outlets	19
3.2.20 Distribution Boards	19
3.2.21 Workmanship and Staff	19
3.2.22 Certificate of Compliance	20
3.2.23 Earthing Installation	20
3.2.24 Mounting and Positioning of Luminaires	20
3.3 INSTALLATION DETAILS	20
3.3.1 Cable Sleeve Pipes	21

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3.3.2 Photoelectric control units for lighting (Photocells)	21
3.3.3 Earthing and Bonding	21
3.3.4 Supply and Connection	21
3.3.5 Cables	22
3.3.6 Distribution Boards	22
3.3.6.1 Construction of Flush Mounted Distribution Boards.....	23
3.3.6.2 Construction of Surface Mounted Distribution Boards	23
3.3.6.3 Construction of Floor Standing Distribution Boards	23
3.3.6.4 Busbars in Distribution Boards	24
3.3.6.5 Distribution Board Wiring	24
3.3.7 Lamps and Luminaires	24
3.3.8 Energy Efficient Lamps or Luminaires	24
3.3.8.1 Illumination Design Factors.....	24
3.3.9 Fluorescent or Linear LED Luminaires	25
3.3.10 Bulkhead Luminaires	25
3.3.11 Floodlight Luminaires	26
3.3.12 High-bay Luminaires	26
3.3.13 Emergency Lighting.....	27
3.3.14 Socket Outlets, Switches and Welding Plugs	27
3.3.14.1 Socket Outlets	27
3.3.14.2 Switches	27
3.3.14.3 Switch and Socket Outlet Boxes	28
3.3.14.4 Welding plugs.....	28
3.3.15 Streetlight luminaires	28
3.3.16 Aircraft Warning Lights	28
3.4 MAINTENANCE AND TESTING REQUIREMENTS	28
3.4.1 Legal Requirements (OHS ACT).....	28
3.4.2 Breakdown Maintenance	29
3.4.3 Illumination Measurements	29
3.4.4 Hazardous Locations Luminaires	29
3.4.5 Lamp Replacement	29
3.4.6 Fluorescent or LED Linear/Panel Luminaires	30
3.4.7 HID Bulkhead or LED Bulkhead Luminaires	30
3.4.8 HID Floodlight or LED Floodlight Luminaires	31
3.4.9 HID High-bay and Low-bay or LED High-bay and Low-bay Luminaires	31
3.4.10 Essential Luminaires	31
3.4.11 Emergency Luminaires.....	32
4. AUTHORISATION	33
5. REVISIONS	34
6. DEVELOPMENT TEAM	34
7. ACKNOWLEDGEMENTS	34
APPENDIX A : TYPICAL LED LUMINAIRE TECHNICAL REQUIREMENTS.....	35
APPENDIX B : LED LUMINAIRE TECHNICAL SCHEDULES A AND B	38
APPENDIX C : GUIDELINES ON TECHNICAL EVALUATION SCORING MATRIX.....	40

TABLES

Table 1: Room reflection factors.....	24
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1. INTRODUCTION

This standard serves to detail the design philosophy, minimum material, and maintenance criteria for the lighting and small power installations at Eskom coal fired power stations.

The lighting installation and associated work shall be designed and executed in accordance with Eskom Safety and site management standards, SANS codes of practice, Occupational Health and Safety Act No. 85 of 1993 and the equipment manufacturers' recommendations. In the absence of such information the design may be based on this standard to the extent that the conditions of installation correspond to those described herein. The final contract for the works shall take precedence over this standard.

The areas included in this standard are:

- Hazardous locations
- Boiler house
- Turbine house
- Auxiliary bay, offices, switchgear rooms or substations and workshops
- Control room
- Cable tunnels, substation basements and conveyor walkways
- Outside areas and terrace lighting
- Smoke stack lighting
- Coal stock yard (CSY)
- Security fence

2. SUPPORTING CLAUSES

2.1 SCOPE

This standard sets out Eskom's requirements for the supply, delivery and installation of Lighting and small power for use on all Eskom Power stations, when proper lighting design protocols are used a broader application is possible.

2.1.1 Purpose

The purpose of providing lighting is to create a lighted environment, which will contribute to the safe and comfortable movement of people and vehicles during the hours of darkness.

This standard is a technical document that specifies functional, performance and other requirements that equipment and materials should meet to satisfy the need for high quality Eskom Generation Power Station Lighting and Small Power Installation.

The content of this standard shall be brought to the attention of all Eskom employees who require the information for the safe and effective execution of their duties.

This document specifies the design and technical requirements for the installation and maintenance of lighting at all Eskom Power stations and will be used for technical enquiry and evaluation purposes.

2.1.2 Applicability

This document shall apply throughout Eskom Generation Power Stations.

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2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

Prospective suppliers are responsible for obtaining the latest copies of the South African National Standards (SANS) and international standards referred to in this document. Copies of the latest revision of Eskom documents will be supplied by the purchaser and will form part of the enquiry documentation.

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems.
- [2] SANS 121 Hot dip galvanized coatings on fabricated iron and steel articles Specifications and test methods.
- [3] SANS 164-1 & 2 Plug and socket-outlet systems for household and similar purposes for use in South Africa.
- [4] SANS 475 Luminaires for interior lighting, street lighting and floodlighting Performance requirements
- [5] SANS 556 Low-voltage switchgear: Circuit-breakers.
- [6] SANS 767-1 Earth leakage protection units: Fixed earth leakage protection circuit-breakers.
- [7] SANS 1007 Reciprocated internal combustion engine driven alternating current low power generating sets.
- [8] SANS 1041 Tubular fluorescent lamps for general service.
- [9] SANS 1085 Wall outlet boxes for the enclosure of electrical accessories.
- [10] SANS 1088 Luminaire entries and spigots.
- [11] SANS 1091 National colour standard.
- [12] SANS 1186-3 Symbolic safety signs Part 3: Internally illuminated signs.
- [13] SANS 1195 Busbars.
- [14] SANS 1274 Coatings applied by the powder-coating process.
- [15] SANS 1507-1 to 6 Electric cables with extruded solid dielectric insulation for fixed installations.
- [16] SANS 1574 Electric flexible cores, cords, and cables with solid extruded dielectric insulation.
- [17] SANS 1777 Photoelectric Control Units for lighting (PECUs).
- [18] SANS 1973 Low-voltage switchgear and control gear Assemblies.
- [19] SANS 10098-1 Public lighting – Part 1: The lighting of public thoroughfares.
- [20] SANS 10098-2 Public lighting – Part 2: The lighting of certain specific areas of streets and highways.
- [21] SANS 10108 The classification of hazardous locations and the selection of apparatus for use in such locations.
- [22] SANS 10114-1 Interior lighting Part 1 Artificial lighting of interiors.
- [23] SANS 10114-2 Interior lighting Part 2 Emergency lighting.
- [24] SANS 10140 Identification colour marking Part 1: General.

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- [25] SANS 10142-1 The wiring of premises Part1: Low-voltage installations.
- [26] SANS 10389-1 to 3 Exterior lighting.
- [27] SANS 10400 The application of the National Building Regulations.
- [28] SANS 14713 Protection against corrosion of iron and steel in structures – Zinc and Aluminium coatings – Guidelines.
- [29] SANS 60079 Explosive atmospheres.
- [30] SANS 60188 High-pressure mercury vapour lamps.
- [31] SANS 60400 Lamp holders for tubular fluorescent lamps and starter holders
- [32] SANS 61439 Low-voltage switchgear and control gear assemblies – Part 1: General rules.
- [33] SANS 61439-3 Low-voltage switchgear and control gear assemblies – Part 3: Distribution boards intended to be operated by ordinary persons (DBO).
- [34] SANS 60529 Degree of protection provided by enclosures (IP Code).
- [35] SANS 60598-1 Luminaires Part 1: General requirements and tests.
- [36] SANS 60662 High-pressure sodium vapour lamps.
- [37] SANS 60669-1 Switches for household and similar fixed-electrical installations Part 1: General requirements.
- [38] SANS 60923 Auxiliaries for lamps - Ballasts for discharge lamps (excluding tubular fluorescent lamps) - Performance requirements.
- [39] SANS 60927 Auxiliaries for lamps - Starting devices (other than glow starters) Performance requirements.
- [40] SANS 60947 Low-voltage switchgear and control gear. All Parts.
- [41] SANS 61048 Capacitors for use with fluorescent and other discharge lamp ballasts.
- [42] SANS 61084 Cable trunking and ducting systems for electrical installations.
- [43] IEC 61347-1 Lamp control gear. Part 1: General and safety requirements.
- [44] SANS 61386-21 Conduit systems for cable management Part 21: Particular requirements Rigid conduit systems.
- [45] SANS 61386-23 Conduit systems for cable management Part 23: Particular requirements Flexible conduit systems.
- [46] SANS 61643 Low-voltage surge protective devices Part 1: Surge protective devices connected to low voltage power distribution systems requirements and tests
- [47] SANS 62031 LED modules for general lighting – safety specifications.
- [48] SANS 62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
- [49] SANS 62384 DC or AC supplied electronic control gear for LED modules – Performance requirements.
- [50] SANS 62504 General lighting – Light emitting diode (LED) products and related equipment – Terms and Definitions.
- [51] SANS 62560 Self-ballasted LED-lamps for general lighting services by voltage > 50 V – Safety specification.

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- [52] SANS 62612 Self-ballasted LED lamps for general lighting services with supply voltages > 50 V - Performance requirements.
- [53] EN 55015 Limits and methods of measurement of radio disturbance of electrical lighting or equipment.
- [54] SANS VC 8039 Glow starters for fluorescent lamps.
- [55] SANS VC 9091 Single-capped fluorescent lamps.
- [56] EN 61000-3-2 Electromagnetic compatibility (EMC) Limits for harmonic current emissions.
- [57] EN 61000-3-3 Electromagnetic compatibility (EMC) - Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems.
- [58] EN 61547 Equipment for general lighting purposes: EMC immunity requirements.
- [59] IEC 61167 Metal Halide lamps.
- [60] IEC-EN 62471 Photo biological Safety of Lamps and Lamp Systems for LED's.
- [61] IES LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- [62] IES LM80 Approved Method: Measuring lumen maintenance of LED light sources.
- [63] Electromagnetic Compatibility (EMC) Directive (2014/30/EU).
- [64] ARP 035 Guideline for installation and maintenance of street lighting.
- [65] 240-139282493 Security Lighting for Eskom Applications.
- [66] 240-126210656 LED Street Lighting for Eskom Properties.
- [67] 240-78980848 Standard for non-lethal energized perimeter detection system (NLEPDS) Electrical Components.
- [68] 240-150642762 Generation Plant Safety Regulations.
- [69] 240-56227443 Generation Requirements for Control and Power Cables for Power Stations Standard.
- [70] 240-103031952 Application of Certificate of Compliance (CoC) and Safety Clearance Certificate on Electrical installations in Generating power plant Work Instruction.
- [71] 0.54/393 Eskom Earthing Standard.
- [72] 240-56536505 Management of Hazardous Locations Standard.
- [73] 240-86973501 Engineering Drawing Standard - common requirements.
- [74] 240-56356396 Earthing and Lightning Protection Standard.

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2.2.2 Informative

[75] IEC 62493 Assessment of lighting equipment related to human exposure to electromagnetic fields.

2.3 DEFINITIONS

Definition	Description
Approved by	The accountability of the Approver of the document is equivalent to the specified role of Functional Responsible/Owner as identified in 240-53114186 and 32-6 for Documents and Records Management.
Essential luminaires	Luminaires supplied from the essential boards with a diesel generator back-up or another external power source.
Harmonic distortion	The ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.
Horizontal illuminance	The measure of brightness from a light source, usually measured in lux, which is taken through a light meter's sensor at a horizontal position on a horizontal surface.
IK rating	The extent (or level) of protection of the equipment provided by an enclosure against harmful mechanical impacts and verified by standardised test methods.
Illuminance	(usually "E" in formulas) is the total amount of visible light illuminating (incident upon) a point on a surface from all directions above the surface. This "surface" can be a physical surface or an imaginary plane. Therefore, illuminance is equivalent to irradiance weighted with the response curve of the human eye. Standard unit for illuminance is Lux (lx), which is lumen per square meter (lm/m ²).
IP rating	System to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water and to give additional information in connection with such protection.
.IES / .LTD files	Electronic lighting design simulation file
Label	An inscription on equipment or on a sub-unit, either integral therewith or on a separate piece of material affixed thereto.
Light output ratio	The percentage of light emitted from the light source that makes it out of the luminaire. An LOR of 70 means 30 per cent of the light from lamp or luminaire is lost inside the reflector and luminaire. The optically efficient of LED luminaires will demonstrate an 'efficiency' - of 100 per cent.
Luminaire	Apparatus which distributes, filters or transforms the light transmitted from one or more lamps or LED modules and which includes all the parts necessary for supporting, fixing and protecting the lamps or LED modules, and where necessary circuit auxiliaries, together with the means for connecting them to the supply.
Luminous efficacy	Ratio of luminous flux of a lamp (in lumens) to the total electric power consumed (in watts)

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Definition	Description
Luminous flux	Quantity of the energy of the light emitted per second in all directions. The unit of luminous flux is lumen (lm).
Maintenance factor	The minimum light level (luminous intensity) to be safeguarded, independently from the installation's number of burning hours and service life. This is a reduction factor based on the as new luminous intensity.
Off-grid locations	For any area that is a distance away from an electricity grid, it is more cost effective to install solar road lighting than to extend the grid.
Off-terrace area	The area that is outside the boundaries of the turbine, boiler and auxiliarybay area.
Power factor	The ratio between the useful (or true) power (W) to the total (or apparent) power (VA) consumed by AC electrical equipment or a complete electrical installation.
Qualitative	Concerned with or depending on quality rather than on quantity.
Reliability	The ability to consistently function as specified under stated conditions for a stated time period.
Solar powered LED luminaires	An LED streetlight powered by a solar system and is not connected to electricity grid. Solar LED streetlights provide 100% energy savings over conventional streetlights, and hence higher savings on the energy bill.
Terminal	A metallic device for connecting electrical conductors.
Uniformity ratio	Describes the uniformity of light levels across an area. This may be expressed as a ratio of average to minimum or it may be expressed as a ratio of maximum to minimum level of illuminance for a given area.
Upward light output ratio	An indication of what percentage of light shines up. (To be read in conjunction with the definition for "Light output ratio".)

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
CG	Care group
CRI	Colour Rendering Index
DLOR	Downward light output ratio
DoC	Declaration of Conformity

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Abbreviation	Description
EMC	Electromagnetic Compatibility
EU	European Union
HPS	High pressure sodium
HV	High Voltage
HVAC	Heating Ventilation and Air Conditioning
Hz	Hertz
IES	An electronic photometric data file in the IES format using the IES LM-63-1991 standard
IK	Impact Protection rating
IP	Ingress Protection rating
K	Kelvin
LED	Light-emitting diode
lm	Lumen
Lm/W	Lumens per Watt
LOR	Light output ratio
LTD	An electronic photometric data file in the EULUMDAT photometric data format
LV	Low Voltage
LVD	Low Voltage Disconnect
mA	milli-Ampere
mm	millimetre
PCU	Photocell control unit
PV	Photo Voltaic
PWM	Pulse Width Modulation
RT&D	Research, Testing and Development
SC	Study Committee
ULOR	Upward light output ratio
USC	Uniformity of semi-cylindrical illuminance
UV	Ultraviolet
V	Volt
W	Watt

2.5 ROLES AND RESPONSIBILITIES

All engineering practitioners that specify and technically evaluate lamps, luminaires and small power components for Eskom applications shall adhere to the requirements stipulated in this standard.

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Procurement officials must refer to this standard in their purchasing documents and require that equipment and material offered for purchase, meet the requirements of this standard.

2.6 PROCESS FOR MONITORING

Not applicable.

2.7 RELATED/SUPPORTING DOCUMENTS

Not applicable.

3. LIGHTING AND SMALL POWER INSTALLATION FOR NEW AND EXISTING ESKOM POWER STATIONS

3.1 GENERAL REQUIREMENTS

3.1.1 Cables

All power supply cabling from the 400V switchgear boards to the main distribution boards shall be in accordance with 240-56227443 standard.

3.1.2 Safety

All electrical installations on site shall comply with the relevant power station safety requirements. The contract shall state the requirements and carry out safety induction training and monitoring.

In all areas the lighting shall be designed with personnel safety as the first criteria. The completed installation shall provide adequate lighting to allow Eskom employees and other personnel to do their work safely and efficiently and comply with the OHS Act's illumination levels at all times.

3.1.3 Change Management

All lighting and small power design changes shall be verified and approved as per the project design change management process as stated in the site's contract.

In an existing installation the minimum change management is that before any equipment is added to distribution boards (DB's) or any circuits, the designer shall check the DB designed loads and installed capacity and then re-calculate the DB's load with the new additions. Only after the new additions have been confirmed by the site engineer shall the changes be implemented according to the new set of approved drawings.

3.1.4 Drawings

The contract shall list all drawings issued for the project.

It is the Contractor's responsibility to liaise with the Employer for the acceptance and approval of preliminary design drawings. Drawings in hard copies shall be A2 in Eskom format and standard. Existing and new preliminary design drawings are marked up in red and yellow as per the Employer's requirement.

All drawings shall be in Microstation DGN format. The changes made during execution shall be reflected on the drawings and ultimately submitted as "As Built" drawings.

The drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed. The position of power points, switches and

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light points that may be influenced by built-in furniture must be established on site, prior to these items being built in.

3.1.5 Service Conditions

All plant shall be designed for the climatic conditions appertaining to the service(s) at the site and these shall be listed in the contract.

3.1.6 Hazardous Locations

A hazardous location in terms of SANS 10108 and 240-56536505 of the plant, is an area where there might be a significant risk of igniting gas, dust or vapour. There are special requirements for apparatus used in such areas.

The power station approved hazardous location procedure shall be applicable for the lighting and small power installation (and other Plant). The lighting and small power installation shall conform to the authorised power station hazardous location classification document.

When an area is classified (e.g. the battery rooms) the luminaires used in that area shall be approved by the required authority to be suitable for that area e.g. if an area is classified as Zone 2, only luminaires with an Explosion Rating of "Ex ia" shall be used. The certification from an accredited laboratory is required.

Dust ignition protected (DIP) with an ingress protection rating of IP 65 luminaires shall be used in areas where dust is likely to be a problem e.g. coal incline conveyors, coal bunkers and coal reclaim areas (Zone 20 to 22). The luminaire must comply with SANS 10108 and the applicable standard for the type of apparatus i.e. increased safety apparatus shall comply with the relevant parts of SANS 60079.

3.1.7 Tests

On completion of the works, a full testing shall be carried out on the installation during the commissioning to ensure compliance to all relevant standards.

The Contractor shall provide all instruments and equipment required for commissioning and testing of the installations at completion.

On completion of the installation, an Electrical Certificate of Compliance (CoC) shall be issued for the installation in terms of the Occupational Health and Safety Act, (OHS Act 85 of 1993).

The competent person shall perform illumination measurements as recommended in SANS 10114 - 1. Illumination measurement reports shall be produced and submitted to the Employer. Measurements shall be performed once the installation has been completed.

3.2 DESIGN PHILOSOPHY

3.2.1 Boiler House and Basement

The boiler house and basement area are extremely dusty and hence the design maintenance factor shall be 0.8 (i.e. a 20% loss of light due to dust/dirt collection on the luminaire, before cleaning). In areas around the coal mills, the design maintenance factor shall be 0.5. Note that these design maintenance factors exclude the lamp lumen depreciation factor. The boiler areas are cleaned by washing the area down hence the luminaires shall be hose proof type luminaires, IP 65.

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The lamp shall be energy efficient. The types of luminaires used shall be a broad beam low wattage floodlight and/or a low glare, low wattage bulkhead.

Special care shall be taken in the design of the lighting in the boiler to minimise glare and harsh shadows.

All bulkhead luminaires shall be mounted at a preferred height of 2.2 meters above a walkway or on near a fixed structure for ease of maintenance. For walkways and platforms, to prevent damage and to give head clearance, the minimum height shall be 1.9 meters and the luminaires should be mounted off the centre line. The maximum and minimum heights stipulated refer to the underside of the luminaire.

The emergency shutdown lighting in this area shall provide at least 20% of the light in the working area to enable continued safe operation or shut down of the plant.

3.2.2 Turbine House and Basement

The turbine house and basement design maintenance factor shall be 0.85 (i.e. a 15% loss of light due to dust/dirt collection on the luminaire, before cleaning). Maintenance factor shall be 0.85 if there is wall dividing boiler and turbine houses and 0.8 if there is no wall. Note that these design maintenance factors exclude the lamp lumen depreciation factor.

The lamp shall be energy efficient. Where possible the luminaire types used shall be the same as for the boiler area.

For the turbine hall lighting it is recommended to use high bay type luminaires mounted above the crane which would be used to provide the installation and maintenance platform. The lamps and luminaires shall be energy efficient. The design should consider the availability of the crane and access for maintenance. The light distribution from the luminaires should overlap at floor level and the number of lamps and luminaires shall be optimised.

The emergency shutdown lighting in this area shall provide at least 20% of the light in the working area to enable continued safe operation or shut down of the plant.

3.2.3 Auxiliary Bay, Offices, Switchgear Rooms or Substations and Workshops

The auxiliary bay encompasses many different types of areas (e.g. offices, switchgear rooms, workshops). In an office type environment, a design maintenance factor of 0.9 shall be used. In all other areas not considered to be office type environment and not air conditioned, a design maintenance factor of 0.85 shall be used.

The SANS average lumen method shall be used for the design of the lighting installation. This yield both the quantities required and the spacing of the luminaires. It is recommended that occupancy sensors are used to switch lights off at least 80% of the lights when areas are unoccupied.

The applicable reflection factor for the room shall be used. Lamps and luminaires shall be those applicable to the environmental conditions and functionality of the particular room. Special care shall be required to choose the correct luminaire.

Recessed or surface mounted low glare or low brightness fluorescent luminaires (T5 and T8 lamps) with electronic control gear shall be used in offices and areas of similar environment. Generally, fluorescent battens of 1.5 m length shall be used in all other areas where there are no ceilings or where the luminaires can be surface mounted. It is recommended that occupancy sensors are used to switch luminaires off when the areas are unoccupied.

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The emergency evacuation lighting in these areas shall provide at least 20% of the light in the working area to enable continued safe operation or shut down of the plant.

3.2.4 Heating Ventilation and Air Conditioning (HVAC)

Air conditioners in the plant areas shall be supplied direct from the specific switchgear board. In the office areas, the air conditioners may be incorporated in the building lighting and small power distribution boards.

3.2.5 Control Room

All luminaires in the control room shall be supplied from the essential power supply of which 80% shall be AC essential supply and 20% on DC essential supply.

Direct current luminaires shall be positioned at the doors, over key control equipment and provide the emergency shutdown lighting for these areas supplied from the nearest unit 220V DC essential board shall provide the essential lighting in the control room for “black out” situations that can last for longer than one hour. The DC luminaires shall be marked clearly as DC emergency lighting.

The luminaires shall be of the tubular fluorescent or compact fluorescent (CFL) or Light Emitting Diode (LED) type. These luminaires shall be continuously in service.

3.2.6 Cable Tunnels, Substation Basement and Conveyor Walkways

The design maintenance factor shall be 0.8 for the cable tunnels, substation basements and conveyor walkways. A low glare, bulkhead luminaires shall be used for the cable tunnels and conveyor walkways. The luminaires shall be an energy efficient lamp or luminaire. It is recommended that occupancy sensors are used to switch lights off at least 80% of the lights when areas are unoccupied. The lights remaining on shall be at the exits and on the evacuation route from these areas.

The emergency shutdown lighting in these areas shall provide at least 20% of the light in the working area to enable continued safe operation or shut down of the plant.

3.2.7 Outside Arrears and Terrace Lighting

The outside areas and terrace lighting design maintenance factor shall be 0.85. The lamp lumen depreciation factor shall be included in the calculation for lighting levels.

Large areas that require lighting such as the terrace, 15 to 40 metre high masts with high lumen output energy efficient lamps and floodlights shall be used.

The lighting shall be controlled by a photo electric cell and a contactor and shall have a manual override switch.

3.2.8 Smoke Stack Lighting

The smoke stack is the highest structure at the power station and aircraft warning lights shall be installed as per the requirements of the Aviation Act. Aircraft Warning Lights (AWL) shall be installed on three levels. There shall be three double fittings on each level equally spaced (every 120°) around the outside.

An alarm to the station control room shall be installed to indicate lamp failure. The AWL's shall be controlled with a daylight switch and a bypass switch for maintenance will be installed for each level. These lights shall be supplied from the AC essential power system with diesel generator back-up.

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HID or LED luminaires may be used with the provision of statutory compliance. Approval certificates by the manufacture shall be supplied with these luminaires. The luminaire manufacturer shall state the lamp replacement interval for their design to comply with the requirements of the Aviation Act.

The smoke stack internal lighting design maintenance factor shall be 0.85. The staircase lights shall be fluorescent or LED luminaires and the light level on the stairs shall be 100 lux. The chimney shall be a restricted area and access to this area shall be controlled by the operating department. The normal transport medium in the chimney shall be the personnel hoist and therefore the staircase shall be used only for emergencies. The staircase luminaires shall have an emergency two-way switch on each platform one at the top and the second at the lower level, only to be switched on during an emergency. The staircase lights shall be fed from the essential supply distribution board that has a diesel generator back-up.

The light level on the internal platforms shall be 160 lux. Energy efficient luminaires and robust construction shall be installed on the platforms and at ground level.

Two lockable bypass switches clearly labelled "Aircraft Warning Lights" and "Stair lights", shall be installed at ground level for luminaire and lamp maintenance purposes.

The emergency evacuation lighting shall provide by portable lights, for example rechargeable handheld torches.

3.2.9 Coal Stock Yard (CSY)

The CSY shall be lit by floodlight luminaires mounted on 15 to 40 metre high masts. The floodlight luminaires. Care shall be taken during the installation and commissioning of the CSY high mast luminaires that the environmental pollution requirements for lighting shall be adhered to. The peak light of the floodlights shall not be aimed above 75° from the downward vertical. The design maintenance factor shall be 0.9 for the floodlights.

The bulkheads and floodlights in the transfer houses and reclaim tunnels shall be broad beam luminaires. An ingress protection rating of IP65 and Zone 20 to 22 bulkhead and floodlight luminaires shall be used these areas.

The lighting shall be controlled by a photo electric cell and a contactor and have a manual override switch.

The emergency evacuation lighting shall provide by portable luminaires for example rechargeable handheld torches.

3.2.10 Security Fence

Refer to the standard for perimeter security lighting 240-139282493 Security Lighting for Eskom Applications.

3.2.11 Schedule

In all instances where schedule of lamps, luminaires, socket outlet and power points are attached to or included on the design drawings, these schedules shall be regarded as forming part of this standard.

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3.2.12 Quality of Materials

Wherever applicable the material shall comply with the relevant South African National of Standards, Specifications and to IEC Standard Specifications, where no SANS Specifications exist.

3.2.13 Conduit and Accessories

The conduit and conduit accessories shall comply with the applicable SANS specifications as set out below and the conduit shall bear the mark of approval of the South African National Standards. Conduit and accessories shall be in accordance with the SANS 950.

All conduits shall be manufactured of mild steel with a minimum thickness of 1,2mm for plain-end conduit and 1,6mm in respect of screwed conduit and galvanised. All conduit and accessories used shall be galvanised to SANS 121.

All conduit fittings except couplings shall be of the inspection type. Where cast metal conduit accessories are used, these shall be of malleable iron. Zinc base fittings shall not be allowed.

Bushes used for conduit shall be brass and shall be provided in addition to locknuts at all points where the conduit terminates at distribution boards, switch-boxes, draw-boxes, etc.

Draw-boxes are to be provided in accordance with the SANS 10142-1 and wherever necessary to facilitate ease of wiring.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm.

Only one manufactured type of conduit and conduit accessories shall be allowed throughout the installation.

Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

Under no circumstances shall conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.

Bending and setting of conduits must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied, as indicated by the Employer shall be completely removed and rectified and any wiring already drawn into such damaged conduits shall be completely renewed.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaires as well as all load bearing conduit shall in all instances be of the metallic screwed type.

3.2.14 Conduit in Roof Spaces

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5m by means of saddles screwed to the roof timbers.

Under flat roofs, in false ceilings or where there is less than 0,9m of clearance, or should the ceilings be insulated with glass wool or other insulating material, the conduit shall be installed in such a manner as to allow for all wiring to be executed from below the ceilings.

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Conduit runs from distribution boards shall, where possible be terminated in fabricated sheet steel trays installed directly above or in close proximity to the distribution boards.

3.2.15 Surface Mounted Conduit

Wherever possible, the conduit installation shall be concealed in the building work. Conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

The use of inspection bends is to be avoided and instead the conduit shall be set uniformly, and inspection coupling used where necessary.

No threads will be permitted to show when the conduit installation is complete, except where running couplings have been employed.

Running couplings are only to be used where unavoidable and shall be fitted with sliced couplings as a lock nut.

Conduit is to be run on approved spaced saddles mechanically secured to the walls.

Alternatively, fittings, tees, boxes, couplings etc., are to be cut into the surface to allow the conduit to fit flush against the surface. Conduit shall be bedded into any wall irregularities to avoid gaps between the surface and the conduit.

Crossing of conduits is to be avoided; however, should it be necessary purpose-made metal boxes are to be provided at the junction. The finish of the boxes and positioning shall be in keeping with the general layout.

Where several conduits are installed side by side, they shall be evenly spaced and grouped under one saddle.

Distribution boards, industrial switches and socket outlets etc., shall be neatly recessed into the surface to avoid double sets.

In situations where there are no ceilings, the conduits shall be run along the wall plates and the beams. Painting of surface conduit shall match the colour of the adjacent wall finishes.

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etc., and round-head screws shall be used for fixing saddles, switches, socket outlets, etc., to walls. The use of wood plugs and the plugging in joints in brick walls shall not be allowed.

3.2.16 Conduit in Concrete Slabs

So as not to delay building operations the Contractor must ensure that all conduits and other electrical equipment which are to be cast in the concrete columns and slabs are installed in good time.

The Contractor shall have a representative in attendance at all times when the casting of concrete takes place.

Draw-boxes, expansion joint boxes and round conduit boxes are to be provided where necessary. Sharp bends of any nature will not be allowed in concrete slabs.

All boxes shall be securely fixed to the shuttering to prevent displacement when concrete is cast. The conduit shall be supported and secured at regular intervals and installed as close as possible to the

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neutral axis of concrete slabs and/or beams. A draw wire, 1.5mm galvanised steel wire shall be installed in all conduits cast in concrete.

Before any concrete slabs are cast, all conduit droppers to distribution boards shall be neatly spaced and rigidly fixed. After cast of the concrete and access allowed, the Contractor shall check that all conduits are clear and are continuous.

3.2.17 Flexible Connections for Appliances

Flexible tubing connections shall be of galvanised steel construction, and in damp situations of the plastic sheathed galvanised steel construction

Connectors for coupling onto the flexible tubing shall be of the gland or screw-in types, manufactured of either brass or cadmium or zinc plated mild steel, and the connectors after having been fixed onto the tubing, shall be durable and mechanically sound.

Aluminium and zinc alloy connectors shall not be allowed.

3.2.18 Wiring

3.2.18.1 Conduit

Wiring shall be carried out in conduit and electrical trunking.

No wiring shall be drawn into conduit until the conduit installation has been completed and all conduit ends provided with bushes. All conduits shall be clear of moisture and debris before any wiring is commenced.

The wiring of the installation shall be carried out in accordance with the SANS 10142-1. Further to the requirements concerning the installation of earth conductors to certain light points as set out in the SANS 10142-1, it is a specific requirement of this document that where plain-end metallic conduit has been used, earth conductors must be provided and drawn into the conduit with the main conductors to all points, including all luminaires and switches throughout the installation.

Engineering practitioner shall calculate sizing of wires or cables for voltage drop compliance using the equipment starting currents. The maximum voltage drop of 5% shall be used from the distribution board to the furthers luminaire on the circuit. The minimum size of wire for the lighting circuits shall be 2.5 mm². The minimum size of wire for the socket outlet circuits shall be 4.0 mm². The maximum number of luminaires and socket outlets allowed shall not exceed the load capacity of the conductors. In certain instances, due to the long runs, the sizes of the aforementioned conductors may be increased for specified circuits. Sizes of conductors to be drawn into conduit in all other instances, such as feeders to distribution boards, power points etc., shall be as specified elsewhere in this specification or indicated on the drawings. Sizes of conductors not specified must be determined in accordance with the SANS 10142-1.

The loop-in system shall be followed throughout, joints of any description shall not be allowed. The wiring shall be done in PVC insulated 600/1000V grade cable to SANS 1574-2.

Where cable ends connect onto switches, luminaires etc., the end strands must be neatly and tightly twisted together and firmly secured. Cutting away of wire strands of any cable shall not be allowed.

3.2.18.2 Power Trunking

The power trunking shall comply with SANS 61084-1.

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3.2.19 Switches and Socket Outlets

All switches and switch-socket outlet combination units shall conform to the relevant SANS standards.

Only 16A three pin sockets shall be used, unless other special purpose types are distinctly specified or shown on the design drawings.

3.2.20 Distribution Boards

All boards shall be in accordance with the types as specified, be constructed according to the detail or type drawings and must be approved by the Employer before installation.

Any construction or standard type of a distribution board proposed, as an alternative to that specified must have the prior approval of the Employer.

All incomer breakers on three phase distribution boards shall be rated a minimum of 32A with a minimum fault current level of 10kA.

The distribution boards shall be constructed in such a way that it will be capable of withstanding all the mechanical, electrical and thermal stresses as well as the effects of dust ingress and humidity which will be encountered during normal operation. The minimum thickness for the plate steel shall be 1.6mm. Cubicle doors shall be positively drawn closed onto seals by means of padlock-lockable lever operated catches. Perforated foam type seals shall not be provided. The distribution board shall be provided with an internal equipment cover plate in accordance with SANS 10142-1. The cover plates shall not be used to keep components in position. The cover plates shall be provided with hinges for opening/closing and shall be provided with a square key lock.

Finishing colour shall be in accordance with SANS 1091 "Light Orange" and "Signal Red" for a normal and essential 230/400V distribution boards respectively.

The distribution boards utilised outdoors shall be IP65 rated and for indoor IP55 rated. Distribution boards for Hazardous Locations of the plant shall be installed in Safe Location and where not practical shall conform to the requirements of SANS 10108. The distribution board circuit design shall be such that the load distribution between the phases is even (within 10%). This requirement shall also be considered when additional luminaires are installed.

All busbars, wiring, terminals, etc., are to be adequately insulated and supported for fault current forces. All wiring is to enter the distribution board from the bottom or top of the board. The circuit breakers shall be mounted within the distribution boards to give a flush front panel. Cable and boxes and other ancillary equipment must be provided as shown on the drawing.

Clearly engraved labels shall be mounted on or below every device. The wording of the labels in English, is as directed by the Employer's representative and must be confirmed on site. Flush mounted boards shall be installed with the top of the board 2,0m above the finished floor level.

The symbols to identify the distribution board on the design drawings shall be according to the latest revision of Eskom Lighting Schedule Standard, as shown on documents 0.90/3928, 0.90/3929 and 0.90/3930.

3.2.21 Workmanship and Staff

An accredited person shall exercise general control over all electrical installation work being carried out.

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The workmanship shall be of the highest grade, comply with the contract and to the satisfaction of the Employer's inspecting officers.

All inferior work as indicated by the Employer's inspecting officers shall immediately be removed and rectified by and at the expense of the Contractor in terms of the contract.

3.2.22 Certificate of Compliance

On completion of the installation, an Electrical Certificate of Compliance (CoC) shall be issued to the Employer in terms of the Occupational Health and Safety Act, (OHS Act 85 of 1993).

The competent person shall perform illumination measurements as recommended in SANS 10114 - 1. Illumination measurement reports shall be produced and submitted to the Employer. Measurements shall be performed once the installation has been completed.

Areas shall be re-checked periodically depending on the type of area and the type of lamps used (one year for fluorescent type lamps and two years for discharge type lamps and LED type luminaires).

3.2.23 Earthing Installation

Lighting and small power installations shall be effectively earthed in accordance with the SANS 10142-1, Eskom Earthing Standard 0.54/393 and 240-56356396.

3.2.24 Mounting and Positioning of Luminaires

The Contractor is to note that in the case of board and acoustic tile ceilings, i.e. as opposed to concrete slabs, close co-operation with the building contractor is necessary to ensure that as far as possible the luminaires are symmetrically positioned with regard to the ceiling pattern.

The layout of the luminaires as indicated on the design drawings must be adhered to as far as possible and must be confirmed with the Employer's representative.

Fluorescent luminaires installed against concrete ceilings shall be screwed to the outlet boxes and in addition, 2 x 6mm expansion or other approved type fixing bolts are to be provided. The bolts shall be placed three-fourth of the length of the luminaires apart.

Fluorescent luminaires to be mounted on board ceilings shall be secured by means of two 40mm x No. 10 round head screws and washers. The luminaires shall also be bonded to the circuit conduit by means of locknuts and brass bushes. The fixing screws shall be placed three-fourths of the length of the fitting apart.

Earth conductors must be drawn in with the circuit wiring and connected to the earthing terminal of all fluorescent luminaires as well as other luminaires exposed to the weather in accordance with the SANS 10142-1.

Manufacturer's installation guides should be followed as far as possible

3.3 INSTALLATION DETAILS

During the construction phase the Contractor shall provide access and general area lighting to ensure that the Contractor's personnel can reach their place of employment/work safely. Once the construction reaches such a phase that the permanent luminaires can be installed, the access and general area lighting shall be provided by the Employer.

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Each contractor shall provide his own construction lighting with lighting levels in accordance with the OHS Act. The luminaire installation and lighting level measurements shall be part of the routine safety inspections.

Wherever possible the permanent luminaires and wiring shall be installed, supplied, if necessary, from a temporary supply. The installation and removal of temporary lighting are a costly exercise that shall be avoided as far as possible.

3.3.1 Cable Sleeve Pipes

Where cables cross under roadways, other services and where cables enter buildings, the cables shall be installed in fibre reinforced-cement pipes, earthenware, or high-density polyethylene pipes. A draw wire, 1.5 mm galvanised steel wires shall be installed in all conduits cast in concrete.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables.

3.3.2 Photoelectric control units for lighting (Photocells)

The photoelectric control unit for lighting shall be in accordance with SANS 1777.

The Photocells shall be used for the control of outside areas lighting and shall be provided with switch contacts able to carry at least 5A inductive and capacitive loads. The current during no-load conditions shall not exceed 50 mA.

The Photocells shall be suitable for 240V + 6%, 50Hz. single-phase alternating current.

The Photocells shall be weather and vibration resistant as they are to be mounted on top of building, poles, high mast luminaires and streetlight luminaires. The design shall be of such a nature that the Photocells will be able to withstand both hail damage and damage by vandalism.

The socket shall have a bracket for mounting on a pole.

All components shall be treated to be corrosion resistant.

The Photocells shall be suitable for operating under dusty conditions between temperatures of -5°C and 55°C.

Photocells shall switch on when the light intensity drops to 15 lux + 20% and shall switch off when the light intensity reaches 40 lux + 20%.

When the unit is in the "on" position there must be a delay of not less than one minute if it were to switch off in the case of a sudden increase in the light intensity.

3.3.3 Earthing and Bonding

All earthing and bonding of the building and installation shall be done in accordance with SANS 10142-1, 0.54/393 and 240-56356396.

3.3.4 Supply and Connection

The power supply shall be 400 Volt and 230Volt 50Hz.

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3.3.5 Cables

All wiring cables as indicated on the design drawings in accordance with SANS 1574 and SANS 1507.

3.3.6 Distribution Boards

This section covers the manufacturing and testing of flush mounted, surface mounted and floor standing distribution boards for general installations in normal environmental conditions and for system voltages up to 1 kV.

All distribution boards shall be of ample size to accommodate the specified circuit breakers and provide space for future circuit breaker.

All three-phase lighting distribution boards that supplies single-phase lighting circuits (that are connected between a phase conductor and the neutral conductor) shall have a double-pole circuit breaker installed in the lighting distribution board. This installation must be in accordance with SANS 10142-1 clauses 6.1.2 & 6.14.1.3.

The maximum allowable height of free-standing distribution boards is 2,2m. Cubicle type boards may be up to 2,4m high if they can be fully dismantled into individual cubicles. Where, due to space restrictions, a board exceeds 2,4m in height, equipment not normally requiring access, shall be installed in the top section, enabling equipment normally requiring access to be installed lower down in the board. All other specified external dimensions for distribution boards shall be strictly adhered to.

All distribution boards shall be rendered moisture proof and vermin proof and shall be adequately ventilated.

The load shall be balanced as equally as possible across multiphase supplies. The circuit breakers shall comply with SANS 556-1.

Where specified, the circuit breaker shall be capable of accommodating factory fitted shunt trip or auxiliary contact units or similar equipment.

The operating handle shall provide clear indication of "ON", "OFF" and "TRIP" positions.

The mechanism shall be of the TRIP-FREE type preventing the unit from being held in the ON position under overload conditions.

All moulded case circuit breakers in a particular installation shall as far as is practical be supplied by a single manufacturer.

The incoming terminals of single pole miniature circuit breakers shall be suitable for connection to a common busbar.

The circuit breaker shall have a rating plate indicating the current rating, voltage rating and breaking capacity.

Extension type operating handles shall be provided for units of 600A rating and above.

Earth leakage relays shall be single equipment with sensitivity of 30mA with associated circuit breaker or on-load switch for use on 220/250V single phase, 50 Hz, supplies.

The units shall be suitable for installation in distribution boards in clip-in trays or bolted to the chassis.

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The earth leakage relay shall function on the current balance principle and shall comply with SANS 767 as amended. Integral test facilities shall be incorporated in the unit.

Circuit breakers with trip coils used integrally with earth leakage equipment shall comply with SANS 556-1. On-load switches used integrally with earth leakage equipment shall comply with SANS 60947-3.

The fault current rating of the unit shall be 2,5kA or 5kA as required, when tested in accordance with SANS 556-1.

Surge arrestors shall comply with the requirements of the relevant part of SANS 61643.

Surge arrestors shall be suitable for installation at altitudes of up to 1800m above sea level.

The unit shall be contained within a thermoplastic or cast resin housing and all internal components shall be fully sealed in.

The unit shall be supplied complete with a galvanised steel mounting bracket for convenient mounting onto the clip-tray of a distribution board.

Alternatively, the surge arrestors shall be of the type which can be mounted into the clip-tray of a distribution board.

Surge arrestors shall be provided in all cases where a distribution board is supplied directly from an overhead line.

The colour of normal distribution boards and equipment enclosures shall be "Light Orange", colour B26 of SANS 1091 as recommended in SANS 10140, Part II unless specified to the contrary.

The standby power section of emergency or essential distribution boards shall be coloured "SIGNAL RED", colour of SANS 1091.

A three-phase four-wire circuit that supplies only single-phase luminaires (that are connected between a phase conductor and the neutral conductor) may supply any number of points if the circuit is protected by a multipole circuit-breaker, or single-phase protective devices with a multipole switch-disconnector on the supply side. (SANS 10142-1(2017) clause 6.1.2)

Circuit breakers locking-out mechanisms shall be installed in all DB's. It must not be possible to lock-out a circuit breaker in an ON position, but only when in OFF position, and the number of lock-out mechanisms that should be adequate to lock-out and entire row of circuit breakers.

3.3.6.1 Construction of Flush Mounted Distribution Boards

Flush mounted distribution boards shall comply fully with the relevant parts of SANS 1973.

3.3.6.2 Construction of Surface Mounted Distribution Boards

Surface mounted distribution boards shall comply with the relevant parts of SANS 1973.

3.3.6.3 Construction of Floor Standing Distribution Boards

Floor standing distribution boards shall comply with the relevant parts of SANS 1973.

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3.3.6.4 Busbars in Distribution Boards

Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with the relevant parts of SANS 1973, where applicable.

Busbars shall be supplied for the following applications:

- Distribution of supply voltage.
- Connection bars for neutral conductors.
- Earth busbars.
- Connections to miniature circuit-breakers.

3.3.6.5 Distribution Board Wiring

All distribution board wiring shall comply with the relevant parts of SANS 1973.

3.3.7 Lamps and Luminaires

To achieve standardisation, lamps of similar luminaire type shall be interchangeable.

Luminaires offered shall comply with SANS 475. Technical information on luminaires shall be provided and a sample of luminaires shall be provided on request for evaluation and approval by the Employer during tendering period.

Luminaires, associated equipment and control gear shall be new and unused and shall be supplied complete with lamps, control gear, diffusers, mounting brackets, etc. and shall be delivered to site in a protective covering.

The luminaires shall be suitable for connection to a single-phase electricity supply with a nominal voltage of 230V /400V $\pm 10\%$ at 50Hz. The actual voltage shall be specified in the project specification.

3.3.8 Energy Efficient Lamps or Luminaires

An energy efficient lamp is required to be a lamp that produces at least the light output for the type and wattage that is installed in the surrounding area and has the same or better colour rendering index, depreciation factor and efficacy

3.3.8.1 Illumination Design Factors

For illumination calculation, the following room reflection factors shall be used.

Table 1: Room reflection factors.

Descriptions	Reflection Factors		
	Floor	Ceiling	Walls
Turbine House and Basements	0.1	0.3	0.3
Boiler House and Basements	0.1	0.3	0.3
Mill Area	0.1	0.3	0.1
Precipitator Area, Smoke Stack Stairs and Platform, Cable Tunnels	0.1	0.3	0.3
Coal Conveyors and Transfer House	0.1	0.3	0.3

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Ash Plant	0.1	0.3	0.3
Auxiliary Bays, Substation, Switchgear Room, Battery Room, Workshop, Pump Houses, Stores	0.1	0.5	0.5
Control Rooms, Offices, Ablution Room, Passages,	0.1	0.7	0.5

The lamp (LF) and ballast (BF) factors of 0.98 shall be used. The lamp temperature (TF) factor of 1.0 shall be used.

3.3.9 Fluorescent or Linear LED Luminaires

The majority of the fluorescent or linear luminaires are used in offices, electrical and C&I equipment rooms and workshops etc.

Fluorescent lamps are available in a variety of sizes, types and wattages. The number of different types of fluorescent luminaires has been limited to keep spares to a minimum, ease of maintenance and standardisation. At the power station the size, type and wattage shall be limited to as few as possible and generally the 1.2 m and 1.5 m lamps are used. The lamp depreciation factor of 0.9 for tri-phosphor and 0.85 for halo-phosphor lamps shall be used. It is recommended that tri-phosphor lamps are used.

All fluorescent luminaires shall have electronic control gear of the warm start type that will not adversely affect the life of the lamp when used with sensor switching. Zone rated luminaires are excluded if there is no suitable approved electronic control gear luminaire. The housing of the luminaires must be manufactured from not less than 0.7 mm mild steel and powder coated white. The lamp holders shall be of the bi-pin rotor-lock type suitable for the T5 or T8 lamp as applicable. The electrical incoming terminals must be able to take 2 solid 2.5mm² conductors. Industrial type luminaires shall consist of a basic channel luminaire fitted with detachable side reflectors. The reflectors shall be manufactured of cold rolled steel, not less than 0.7mm thick. The reflectors shall be designed to improve the downward light output ratio and decrease the upward light output ratio to a value of less than 2%.

The information which the manufacturer / supplier must provide refer to Annexure A and B Typical Luminaire Technical Requirements.

Details of the construction of Zone luminaires must be stated and the same technical information with regard to their performance as above required for metal fluorescent luminaires.

3.3.10 Bulkhead Luminaires

Bulkhead luminaires with an ingress protection rating at least IP65 and with suitable zone rating shall be used. Bulkhead luminaires shall be a low glare luminaire with an even light distribution. The Bulkhead luminaire shall be used in the precipitator plant, conveyors, transfer houses, boiler and turbine areas.

The low glare and even light distribution make it suitable for low mounting heights.

All bulkhead luminaires must have high pressure cast aluminium bodies with injection moulded high impact acrylic diffusers. The bodies must be labelled with the power rating and type of the control gear. The labels shall have white letters/numbers not less than 40 mm high and 8 mm thick strokes on the coloured background as follows: Orange for high pressure sodium; Blue for mercury vapour; Green for metal halide. The diffusers shall be naturally resistant or be treated not to yellow with age

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due to the high ultraviolet radiation and temperatures. The bulkhead luminaires shall have an IP rating of not less than IP65 unless they are Zone 1 or Zone 2 luminaires and then the Zone requirements must be met. The electrical incoming terminals must be able to take two solid 4mm² conductors.

The information which the manufacturer / supplier must provide refer to Annexure A and B Typical Luminaire Technical Requirements.

Details of the construction of Zone luminaires must be stated and the same technical information with regard to their performance as above is required for these luminaires.

3.3.11 Floodlight Luminaires

Floodlight luminaires with an ingress protection rating at least IP65 shall be used.

The floodlights shall be available with at least three types of symmetrical light distribution characteristics. These shall be:

- Wide beam
- Medium beam
- Narrow beam

The terms narrow, medium and wide beam are industry loosely used terms and are to be defined by the designer when selecting the low-bay, high-bay, bulkhead or floodlight. This should include the peak intensity required, the peak axially and transverse angles, the 50% peak angles, the 10% peak angles and the cut-off angle above the peak to reduce light glare and pollution.

As floodlights are powerful projectors of light, careful positioning and angling of the luminaire is required, especially the azimuth angle. A reasonable amount of light overlap is required to avoid harsh shadows.

All Floodlight luminaires shall have high pressure cast aluminium bodies with polished bright anodised aluminium reflectors. The floodlight shall be enclosed type, with glass lensed. The floodlight luminaire shall have the lens clipped close by stainless steel clips or captive stainless screws to facilitate lamp replacement or the lamp may be removed from the side of the luminaire so that the aiming angles are not changed during lamp replacement. The bodies shall be labelled with the power rating and type of the control gear. The labels shall have white letters / numbers not less than 40 mm high and 8 mm thick strokes on the coloured background as follows: Orange for high pressure sodium; Blue for mercury vapour; Green for metal halide. The inverse of the above colour scheme is acceptable. The floodlight luminaire's control gear compartment shall have an IP rating of not less than IP65 unless they are Zone 1 or Zone 2 luminaires and then the Zone requirements must be met. The electrical incoming terminals shall be able to take 2 solid 4 mm² conductors.

The information which the manufacturer / supplier must provide refer to Annexure A and B Typical Luminaire Technical Requirements.

3.3.12 High-bay Luminaires

The High-bay luminaires shall be the self-cleaning type. Although these luminaires are self-cleaning, they still require cleaning at least every two years.

The High-bay luminaires shall be extensively used to illuminate the turbine hall and pump house.

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All High bay luminaires shall have a high pressure cast aluminium bodies with polished bright anodised aluminium reflectors. The high bay luminaire reflector shall have ventilation slots to allow convection air movement to “self-clean” the lamp and reflector. The bodies shall be labelled with the power rating and type of the control gear. The labels shall have white letters / numbers not less than 40 mm high and 8 mm thick strokes on the coloured background as follows: Orange for high pressure sodium; Blue for mercury vapour; Green for metal halide. The high bay luminaires control gear compartment shall have an IP rating of not less than IP54 unless they are Zone 1 or Zone 2 luminaires and then the Zone requirements must be met. The electrical incoming terminals shall be able to take 2 solid 4 mm² conductors.

The information which the manufacturer / supplier must provide refer to Annexure A and B Typical Luminaire Technical Requirements.

All the details of the luminaires shall be stated and the luminaires technical information with regard to their performance as above is required for these luminaires.

3.3.13 Emergency Lighting

The following standards shall be applicable on the emergency lighting installation which forms part of this standard: SANS 10114-2, SANS 1186-3, SANS 1464-22, SANS 10114-1, SANS 10400, SANS 10142-1 and OHS Act 85 of 1993.

Emergency lighting that provides illumination for the safety of people who are leaving a location on the premises or who are attempting to terminate a hazardous process before leaving the location.

Emergency lighting shall be provided to enable people to exit safely from an area by providing visual information on the direction and exit points and safety equipment.

High risk task area lighting is provided stand by lighting to enable people to safely shut down potentially dangerous equipment or processes during a failure of the main power supply.

3.3.14 Socket Outlets, Switches and Welding Plugs

This section covers the requirements for switches, socket outlets and welding plugs for use in general installations under normal environmental conditions.

In classified hazardous locations the switches, socket outlets, welding plugs and associated circuitry shall be provided in accordance with the respective zone classification.

3.3.14.1 Socket Outlets

All socket-outlets shall be suitable for mounting in 100 x 100 x 50mm or 100 x 50 x 50mm boxes, shall comply with SANS 164-1.

3.3.14.2 Switches

All switches shall be suitable for mounting in 100 x 50 x 50mm boxes shall comply with SANS 60669-1 and shall bear the SABS mark.

Switches shall be SANS approved rated at 16A, 220/250V.

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3.3.14.3 Switch and Socket Outlet Boxes

All switch boxes and socket outlet boxes shall be manufactured of pressed galvanised steel of at least 1mm thickness. All boxes shall be fitted with the necessary lugs to suit standard flush mounted switches and socket outlets manufactured in accordance with SANS 1085.

Light switch boxes shall be 100 x 50 x 50mm with two 20mm knockouts on the sides, one 20mm knockout on the top, bottom and back.

Socket outlet boxes shall be 100 x 100 x 50mm with two 20mm knockouts each on the top, bottom, sides and back.

Switch and socket outlet cover plates shall comply with SANS 1085.

3.3.14.4 Welding plugs

Three-phase welding switched plug outlets and plug tops shall have 5 pins, one for each phase, neutral and earth. The current rating shall be as specified in the detail terminal specification. The plug outlet shall be rated IP65 for ingress protection.

Welding socket outlets and plugs shall be suitable for operation on 63A, 380 to 400V ac, 50Hz supplies. The equipment shall be interlocked to prevent switching on if the plug top is not installed.

The equipment shall be supplied complete with a plug top.

The live terminals shall be shrouded and shall be completely safe when the plug top is removed.

3.3.15 Streetlight luminaires

Refer to the standard for street lighting 240-126210656 LED Street Lighting for Eskom Properties.

3.3.16 Aircraft Warning Lights

Aircraft warning lights shall be IP65, satisfy the Aviation Act requirements and installed at the top and at two other levels outside and at 120 degrees around the Smoke Stack or Chimney (three levels). The luminaires shall be red in colour when are on and controlled with the dark and foggy-weather sensitive day- night-switch. The luminaires shall have a warning alarm lamp or luminaire failure. See clause 3.15: Smoke stack lighting for more information.

3.4 MAINTENANCE AND TESTING REQUIREMENTS

It is important to note that when cleaning luminaires or changing lamps it should be taken into account that they are extremely hot in service and should be allowed to cool down before any work is performed. Isolations in accordance with the Generation Plant Safety Regulations (PSR) shall be implemented before work is performed.

3.4.1 Legal Requirements (OHS ACT)

The OHS Act requires the plant to be properly illuminated at all times to be able to operate the plant and enable emergency evacuation. The minimum average lumens required in every area is addressed in SANS 10114–1 Interior Lighting.

The light output from the lamp or luminaire is reduced when dirt and dust is collected on them, it shall therefore be necessary to clean all lamps or luminaires at regular periods, at least annually, to ensure

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compliance to the law. The lamp light output also reduces due to age. The lamp can still visibly look okay, but the lux level light output can decrease to a level below the required levels for the application and design.

A formalised maintenance plan is therefore required to ensure the safety of personnel and conformance to the OHS Act.

3.4.2 Breakdown Maintenance

The maintenance representative shall ensure that their area of responsibility is inspected once a month for failed lamps or luminaires. Faulty lamps or luminaires should be replaced irrespective of the bulk lamp replacement policy.

All faulty lamps or luminaires shall be recorded on the defect system and fixed as soon as possible. The records of the faults reflect the position of faults and what equipment was replaced and fixed. This also provides a fault history that can be used to establish whether there are other related problems in certain areas e.g. theft, temperature, over voltage etc. This information shall be used in the selection of the lighting equipment.

Should the fault not be corrected by replacing the lamp or luminaire, the fault shall be escalated to the electrician to repair.

Note that the Aircraft Warning Lights have a lamp or luminaires failure warning alarm and the maintenance department should be informed immediately of the failure and this shall be repaired within 24 hours.

3.4.3 Illumination Measurements

Illumination measurements shall be performed as recommended in SANS 10114-1. The competent person shall measure the illumination levels. Reports shall be produced, and records kept ensuring the illumination levels on site stay within the allowed tolerances.

Areas shall be re-checked periodically depending on the type of area and the type of lamps used (one year for fluorescent type lamps, two years for discharge type lamps and two years for LED luminaires).

Before any illumination measurements can be conducted, all luminaires need to be cleaned and new lamps need to be installed. Dirty fittings and faulty luminaires will yield unfair illumination levels.

3.4.4 Hazardous Locations Luminaires

Special care is required when maintaining explosion protected luminaires. No work shall be performed unless the circuit supplying the luminaire is isolated. When working on these luminaires such as removing the luminaire diffuser, special care must be taken to ensure that the diffuser seals are not damaged and after maintenance that it is tightened down correctly and seals correctly. The classification of the luminaires should be maintained at all times.

The luminaires shall be operated in the manner prescribed by the manufacturer. Only external cleaning is done to the luminaires. Internal cleaning is performed during lamp changes. No modifications are allowed to the luminaires without reference to and approval from the manufacturer.

3.4.5 Lamp Replacement

The lighting design criteria used are the luminaire utilization and maintenance factor and the lamp mortality and lumen depreciation factors for the respective luminaire and lamp combinations. The lamp

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depreciation factor of 0.9 allows for 10% loss of light before the lamps should be replaced. After cleaning the luminaires and an illumination measurement is performed where the required light level is still not achieving the required OHS illumination level then the lamps shall be replaced.

Fluorescent lamps and all discharge lamps at rated life are recommended to be bulk-replaced. An increase in breakdown failure percentage of between 10 to 14% per year indicates that bulk replacement is due.

Lamps must be replaced with the exact specification as per design to keep the illumination levels. If a replacement is needed with a different lamp type, the Lighting Laboratory at the Eskom Research and Innovation Centre must be consulted. A redesign for the area affected, will be necessary to confirm illumination levels.

3.4.6 Fluorescent or LED Linear/Panel Luminaires

The fluorescent lamps are recommended to have a bulk replaced (e.g. on two or three yearly basis) with breakdown maintenance in between.

The luminaires are installed in relative clean and controlled environments (offices, switchgear rooms, corridors and boardrooms). Cleaning will consist of dusting in most cases and wiping with a clean wet rag in the odd case. With fluorescent luminaires it should be taken into account that the diffusers are made of high-quality soft aluminium and cannot be damaged (by scratching) beyond repair by the rubbing action during washing/wiping. Washing/wiping should therefore be done with care. The luminaires shall be switched off at the distribution board whilst cleaning or work is in progress.

The exact period between cleaning depends upon the environment. The following is a guide to the interval of cleaning:

- Offices (air conditioned, non-opening windows) - 2 years.
- Offices (opening windows) - 1 year.
- General areas - 1 year.
- Workshops, substations etc. - 1 year.

3.4.7 HID Bulkhead or LED Bulkhead Luminaires

The maintenance philosophy for HID Bulkhead type of lamp is recommended to be bulk replacement at the rated lamp life.

The lamps need to be replaced on breakdown. Breakdown is defined as the point where the lamp starts to cycle or simply fail.

Cleaning of the luminaire (especially the diffuser) outside shall be required. The luminaires is cleaned with water and the appropriate high impact acrylic diffuses cleaning detergent where dusting is not sufficient. Always clean the luminaire inside and outside when lamps are replaced, or maintenance work is performed to a luminaire. The luminaire shall be switched off at the distribution board while cleaning is in progress.

The exact period between cleaning depends upon the environment. The following is a guide to the interval of cleaning:

- Boiler walkways, galleries etc. - 1 year.

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- Boiler mills and coal area - 6 months or less.
- Turbine general areas - 1 year.
- Tunnels, cable chambers - 1 year.
- Outside areas - 1 year.

3.4.8 HID Floodlight or LED Floodlight Luminaires

The maintenance philosophy for HID floodlight type of lamp is recommended to be bulk replacement at the rated lamp life. The lamps need to be replaced on breakdown. Breakdown is defined as the point where the lamp starts to cycle or simply fail.

Always clean the luminaire inside and outside when lamps are replaced, or maintenance work is performed to a luminaire. The luminaire shall be switched off at the distribution board while cleaning is in progress.

The period between cleaning depends upon the environment. The following is a guide to the interval of cleaning:

- Boiler walkways, galleries etc. - 1 year.
- Boiler mills and coal area - 6 months.
- Turbine general areas - 1 year.
- Tunnels, cable chambers - 1 year.
- Outside areas - 1 year.

3.4.9 HID High-bay and Low-bay or LED High-bay and Low-bay Luminaires

The lamps used in the HID High-Bay and Low-Bay applications shall consist of long life energy efficient lamps. The maintenance philosophy for this type of lamp is recommended to be bulk replacement at the rated lamp life. The lamps need to be replaced on breakdown. Breakdown is defined as the point where the lamp starts to cycle or simply fail therefore it may be found that bulk lamp changes should be considered for all high bay lamps. Always clean the luminaire inside and outside when lamps are replaced, or maintenance work is performed to a luminaire.

It should be taken into account that high bay luminaires tend to be placed in inaccessible places. The luminaire shall be switched off at the distribution board while cleaning is in progress.

Cleaning of the luminaires will consist mostly of dusting but in the more persistent cases cleaning is carried out using a clean cloth, water and detergent. The exact period of cleaning depends upon the environment, but as a guide the luminaire should be cleaned every time the lamp is changed.

3.4.10 Essential Luminaires

The essential lighting maintenance philosophy should be as described for the specified lamp type or LED luminaire. Additional care has to be exercised with the maintenance of this lighting as they are widely spaced, and a light can be easily missed when defective. These luminaires operate at all times and are part of the normal lighting system and shall follow their maintenance routine.

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Supply to these luminaires is critical and it shall be restored within 20 seconds during a total unit blackout but it can take up to 30 minutes to restore the supply due to the diesel generator starting problems.

3.4.11 Emergency Luminaires

Before installation, each emergency luminaire must undergo quality checks. The wiring needs to be inspected and the correct batteries must be used to avoid damage to the control gear.

Compulsory inspections should be performed every three months. Every inspection is logged, and records are kept of all such inspections. The functionality of the luminaires and the capacity of the batteries should be checked. The battery capacity is checked by running the luminaire from the battery and checking whether the 60 minutes standby time is achieved providing the design light levels.

These luminaires shall be indicated by means of a red sticker on the fittings. The emergency bulkheads should be red in colour and the fluorescent or LED luminaires fitted with a battery back-up system shall be indicated by means of a red sticker.

Testing should be performed every month by switching off the normal luminaires and performing walk down inspections to determine whether all the emergency luminaires are in operation. Testing must be documented.

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5. REVISIONS

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October 2012	1	Sakhy Mnguni	Final Document for Authorisation
July 2021	1.1	Andre Blignaut	Revised considering new technology and in line with latest standards
August 2021	1.2	Andre Blignaut	First draft review by WG members
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February 2022	1.4	Andre Blignaut	Final Draft after all updated and Comments Review
February 2022	2	Andre Blignaut	Final Rev 2 Document for Authorisation and Publication

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7. ACKNOWLEDGEMENTS

- Not applicable.

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APPENDIX A: TYPICAL LED LUMINAIRE TECHNICAL REQUIREMENTS

A1 Photometric Requirements

This section contains the minimum photometric requires and must be read in conjunction with Annex A.

The light colour shall be "Neutral White" (4000K).

The colour rendering index shall be equal to or greater than 85.

The luminaire efficacy shall be equal to or greater than 110 lm/W.

The luminaire downward light output ratio (LOR) shall be equal to 100%.

The luminaire shall reach its full brightness instantaneous.

IES and/or LTD files for use with Relux must be supplied in electronic format.

A2 Electrical Requirements

This section contains the minimum electrical requirements and shall be read in conjunction with Annex A.

Luminaire input voltage shall be 230V AC $\pm 15\%$.

Luminaire operating frequency shall be 50Hz $\pm 5\%$.

Luminaire efficiency shall be equal to or greater than 90%.

Luminaire power factor shall be equal to or better than 0.95.

Luminaire total harmonic distortion shall be equal to or less than 20%.

All LED drivers shall be suitable for operation with the specified rating of the luminaire on a 230 VAC $\pm 10\%$ 50Hz single-phase electrical power supply system.

A3 Electromagnetic Requirements

Security lighting luminaires offered shall comply with the following standards: EN 55015. Proof of compliance shall be provided through standard test reports (actual measurement data for the frequency spectrum tested).

A4 Mechanical Requirements

Luminaires shall be constructed from durable lightweight materials and shall be accompanied by comprehensive test reports certifying that the luminaires have successfully passed SANS 475.

Luminaires shall be supplied complete with control gear and LED module.

Diffusers / lenses shall not have external prisms that could accumulate dirt and dust, and thus reduce the light output of the luminaires. Diffusers shall be constructed in such a manner that the wall thickness of the material is maintained at a constant thickness, hence preventing the projection of lines of patterns onto the ground level.

In case where luminaires are fitted with reflectors, the reflector shall be made of high-grade super pure deep anodized aluminium.

LED drivers shall be fully housed within or fixed onto the body of the luminaire.

The luminaire dimensions and weight shall be specified.

The number of modules and LEDs per module shall be specified.

The operating relative humidity range shall be 10% to 70%.

A5 Guarantees

Luminaire housing for a minimum period of ten (10) years.

The electrical components for 30 000 operating hours (five years).

The LED module for 30 000 operating hours (five years).

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A6 Maintenance strategy

The tenderer/s shall provide Eskom with a proposed maintenance/cleaning strategy for the luminaires offered.

This strategy must ensure that a maintenance factor of at least 0.80 will be maintained for the LED luminaires through its expected service life.

A7 Luminaire technical evaluation

The technical evaluation for the luminaires shall consist of three parts namely:

Documentation evaluation to verify all required documents and luminaire samples have been submitted. Refer to Annex A for detail. Luminaire submissions not complying with all set requirements will immediately be disqualified.

Documentation and a physical luminaire evaluation to verify all requirements as set out comply. Criteria as listed will be scored to determine compliance to set requirements. Refer to Annex B for detail. Luminaire submissions that score less than 80% will immediately be disqualified.

The remaining luminaires will undergo photometric, electrical and electromagnetic interference performance tests in the Eskom RT&D laboratories to verify compliance to the photometric, electrical and electromagnetic interference data submitted. Only luminaires with photometric, electrical and electromagnetic interference performance compliance of 95% or more compared to submit data will be considered technically acceptable for use in Eskom substations as floodlights.

All supplier submission documentation, reports and certificates shall be in English.

A8 Documentation to be submitted

The following documentation must be submitted per luminaire offered:

Proof of compliance to the SANS 60598-1 (by accredited laboratory)

Proof of compliance to the SANS 475 (by accredited laboratory)

Proof of compliance to the EN 55015 (by accredited laboratory)

Completed technical Schedule B in Appendix 1.

IES and/or LTD files supplied in electronic format.

Proposed Relux simulation (electronic .RDF file)

Photometric test reports per luminaire offered. (by reputable accredited laboratory)

Luminaire guarantee certificate.

Certificate indicating lead time for delivery from date of order

Luminaire maintenance strategy.

No luminaire will be approved or tested if these test reports are not provided.

A9 Luminaire samples to be submitted – Compulsory

One sample of all different luminaires that is proposed must accompany each submission for inspection and to undergo photometric, full electrical and electromagnetic interference performance tests in the Eskom RT&D laboratories to verify compliance to the photometric, electrical and electromagnetic interference data submitted.

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All samples not meeting the set criteria can be returned on request. Samples that met the set criteria will be retained for reference purposes for the period the luminaire will be considered acceptable (typically a period of five years).

A10 Evaluation criteria

The evaluation criteria as detailed in Appendix C will be applied in determining compliance to the set requirements.

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APPENDIX B: LED LUMINAIRE TECHNICAL SCHEDULES A AND B

Schedule A: Eskom's Particulars Requirements

Schedule B: Technical Particulars of Luminaire Offered

ITEM NO	DESCRIPTION	UNIT	SCHEDULE A	SCHEDULE B
1	Photometric Specifications			
1.1	Colour temperature	K	4000 K (Neutral White)	
1.2	LED luminous flux	lm	Specify	
1.4	Colour rendering index (CRI)		≥ 85	
1.5	Luminaire efficacy	lm/W	≥ 110	
1.5	Light output ratio (LOR)	%	Specify	
1.6	Downward light output ratio (DLOR)	%	≥ 85	
1.7	Time to full brightness	minutes	< 1	
1.8	IES and/or LTD files		Comply	
2	Electrical Specifications			
2.1	Input voltage	VAC	230 ±15%	
2.2	Frequency	Hz	50 ± 5%	
2.3	Input current (maximum)	mA	300-500	
2.4	Efficiency (total LED to total luminaire power consumption)	%	≥ 90	
2.5	Power factor (PF)		≥ 0.95	
2.7	Total Harmonic distortion	%	≤ 20	
2.8	Protection type			
3	Electromagnetic Specifications		As specified	
4	Mechanical Specifications			
4.1	Luminaire design		As specified	
4.2	Luminaire material and SANS 475 compliance		As specified	
4.3	Luminaire and accessories		As specified	
4.4	Diffuser		As specified	
4.5	Reflector material		High-grade super pure deep anodized aluminium	

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ITEM NO	DESCRIPTION	UNIT	SCHEDULE A	SCHEDULE B
4.6	LED Drivers capability		As specified	
4.7	Luminaire dimensions		As specified	
	Height	mm		
	Width	mm		
	Length	mm		
4.8	Luminaire Weight	kg		
5	General Specifications			
5.1	Number of modules			
5.2	Number of LEDs			
5.3	Arrangement (number of LEDs per module)			
5.4	Operating temperature range	°C	-10 to +60	
5.5	Operating humidity range	%RH	10% - 70%	
6	Guarantee			
6.1	Luminaire housing (minimum)	years	10	
6.2	Electrical components (minimum)	hours	30 000	
6.3	LED modules (minimum)	hours	30 000	
6.4	Luminaire replacement in case of sub-standard performance		As specified	
7	Delivery			
7.1	Lead time for delivery from time of order	Calendar days	60	
8	Maintenance strategy		Specify	

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APPENDIX C: GUIDELINES ON TECHNICAL EVALUATION SCORING MATRIX

C.1 Mandatory evaluation criteria

Mandatory criteria are not point scored. They are assessed on a Yes/No basis as to whether or not they have been satisfactorily met. An assessment of 'No' against any criterion may eliminate the tenderer from further consideration. The criteria are:

Criteria	Yes	No
Proof of compliance to the SANS 60598-1		
Proof of compliance to the SANS 475		
Proof of compliance to the EN 55015		
Completed technical schedule B per luminaire offered		
IES and/or LTD files supplied in electronic format		
Proposed Relux simulation (electronic .RDF file)		
Photometric test reports per luminaire offered		
Luminaire guarantee certificate supplied		
Lead time for delivery from date of order		
Luminaire maintenance strategy supplied		
Sample Luminaire per offering supplied		

C.2 Qualitative evaluation criteria

After a luminaire offered has met all the mandatory criteria in B1, the submission will be assessed against the following criteria (shown below with their weightings):

Criteria	% Weight
Photometric requirements	25
Electrical requirements	20
Mechanical requirements	20
Guarantees	10
Sample submitted	20
Total	100

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