Standards and Guidelines for Airfield Ground Lighting

AREA OF APPLICABILITY
ALL AIRPORTS

Division
Capital Infrastructure & Asset Management
(Infrastructure Asset Management)

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Public

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1. Purpose

The standard and guidelines for Airfield Ground Lighting (AGL) document has been prepared to provide guidance on the minimum requirements for the design, supply, installation, commissioning and maintenance of the Airfield Ground Lighting (AGL) at Airports Company South Africa SOC Limited.

These standards and guidelines are to be used in conjunction with other requirements and recommendations set forth in the applicable codes, applicable regulations, industry standards and approach tailored to the specific project. It is important to note that any omissions in the Company manual does not rule out the need to comply to the above-mentioned requirements.

The management and development of Airfield Ground Lighting and associated systems is highly regulated and prescribed by International Civil Aviation Organization (ICAO) and South African Civil Aviation Authority (SACAA). The function of these systems is primarily to ensure safe touchdown and safe guidance to an appropriate taxiways and apron in all weather conditions all year round. It is a recommendation of the standard that all airports ensure uniform application for each system as per its category of operation.

The standards and guidelines manual for Airfield Ground Lighting (AGL) is intended to provide a suitable and uniform approach to Airfield Ground Lighting (AGL) throughout the Organisation. It also seeks to ensure to that the certain level of Airfield Ground Lighting (AGL) standardisation throughout the Company airports

1.1 Scope of the Standard

These minimum standards and guidelines apply to the AGL and associated systems at the airports owned by Airports Company South Africa.

2. Definitions and Abbreviations

2.1 Definitions

SACAA
The South African Civil Aviation Authority is mandated to promote, regulate and enforce civil aviation safety and security in South Africa.

IAM
The Infrastructure Asset Management department of shall be responsible for the maintenance related activities.

“hotspots”
Hazardous locations on runways and/or taxiways where incursion incidents have occurred, sometimes frequently.

3. Abbreviations

Abbreviation	Description
AGL	Airfield Ground Lighting
A-SMGCS	Advanced Surface Movement Guidance and Control Systems
ATM	Air-traffic Movements
FAA	Federal Aviation Administration (of the United States of America)
ICAO	International Civil Aviation Organisation
PAPI	Precision Approach Slope Indicator
PLC	Programmable Logic Controller
RCL	Runway Centre Line Lights
LRST	Local Runway Safety Team
SACAA	South African Civil Aviation Authority
SCADA	Supervisory Control and Data Acquisition
TCL	Taxiway Centre Line Lights
TEA	Techno-Economic Analysis
TDZ	Touch Down Zone Lights
VFR	Visual Flight Rules

4. Design Basis, Professionals & Considerations

4.1 Design Basis

- Use of and reliance upon visual aids and visual cues in approaching, landing, and operating on the airport surfaces
- Primarily to ensure safe touchdown and safe guidance to an appropriate taxiways and apron in all weather conditions all year round
- Safe and efficient aircraft taxiing and ground movement at the aerodromes.
- Compliance with Aerodrome Licence Requirements
- SACAA Regulatory Requirements
- ICAO Doc 9157 Part 4 and Part 5
- ICAO Annex 14

4.2 Design Professionals

In line with the Engineering Profession Act 46 of 2000 and the Identification of engineering works regulations, the designs, installation, and commissioning shall be conducted and signed-off by an ECSA registered professional engineer or technologist in the Electrical Engineering discipline.

The method of installation for secondary cables on different types of pavements shall also be reviewed and approved by a professional civil engineer or technologist competent in pavements.

4.3 Design Considerations

4.3.1 Stakeholder Engagement

The Airfield Ground Lighting design, upgrade and modifications shall be aligned and coordinated with the existing and future airport plans with regards to the category of operation as advised by the Operations Management as part of stakeholder engagements.

The recommendations of the Local Runway Safety Team (LRST) shall be considered and implemented on a regular and practicable basis as and when the need arises. Specific references are made towards the mitigation of “hotspots.”

4.3.2 Relevant Regulations and Standards

The SACAA fully subscribes to the ICAO Annex 14 with the associated appendices. Other ICAO documents such as Doc 9157 Part 4 and Part 5 contain guidelines and important considerations when designing an AGL system. Table 1 below provided the minimum relevant standards and regulations applicable to AGL.

Table 1: Minimum Standards

Description	Document Number
Advanced Surface Movement Guidance and Control Systems (A-SMGCS)	ICAO Doc 9830:
Aerodrome Design Manual, Part 5 Electrical Systems	ICAO Doc 9157: Part 5
Aerodrome Design Manual, Part 4 Visual Aids	ICAO Doc 9157: Part 4
Aerodrome Design and Operations, Volume 1: • Chapter 5: Visual aids for navigation • Chapter 8: electrical systems • Appendix 1: Colours for aeronautical ground lights, markings, signs and panel • Appendix 2: Aeronautical ground light characteristics	ICAO Annexure 14: Aerodromes, Volume I - Aerodrome Design and Operations
SACATS 139	SACATS 139.01.32: SURFACE MOVEMENT GUIDANCE AND CONTROL SYSTEM
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations.

Table 1: Minimum Standards

4.3.3 Federal Aviation Administration (FAA) Advisory Circulars

The advisory circulars from the FAA are also a valuable source to reference appurtenant elements of the total AGL system. It is important that these circulars, as amended, be updated at the same time as these "Standards" are updated as the reference numbers do change. These standards shall be interpreted in a rational manner and be moderated where required so as to ensure that local circumstances and resources remains applicable. The following technical and circulars shall be considered as per Table 2:

Description	Document Number
Specification of Airport Light Bases, Transformer Housings, Junction Boxes and Accessories	150/5345-42J
Design and Installation Details for Airport Visual Aids	150/5340-30J
Specification for Constant Current Regulators and Regulator Monitors	150/5345-10H
Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits	150/5345-7F
Specification for Series-to-Series Isolation Transformers for Airport Lighting Systems	150/5345-47C
FAA Specification for L-823 Plug and Receptacle Cable Connectors	150/5345-26D
SPECIFICATION FOR RUNWAY AND TAXIWAY LIGHT FIXTURES	150/5345-46E
Specification for low-impact resistant (LIR) structures used in supporting approach lighting systems (ALS) and other airport equipment.	AC 150/5345-45C

Table 2: FAA Advisory Circulars

4.3.4 New Technologies

The adoption of any new AGL technology at the Company shall be based on the outcome of the techno-economic assessment/analysis (TEA). TEA is a process or methodology of analysing the technical and economic performance of an asset or technology by estimating its total cost of ownership (capital and operation costs) and benchmarking against other existing technologies.

4.4 Performance Requirements

The performance requirements for AGL are as follows:

- Availability: 99.5%

- The useful lives for the AGL components as per the Company Asset Data Dictionary are provided below:

Sub-system / Components	Months	Years
Airfield Lights	60	5
Taxiway Lights	60	5
Runway Edge Lights	60	5
Aeronautical Ground Lighting	60	5
Approach Light Elevated	60	5
Approach Light Inset	60	5
Side Row Barrette Inset Light	60	5
Light fitting	60	5
Lighting element	60	5
Base	60	5
Precision Approach Pathway Indicator (PAPI)	60	5
Runway Guard Light	60	5
Programmable Logic Unit	60	5
Stop Bar Elevated Light	60	5
Stop Bar Inset Light	60	5
Constant Current Regulator (CCR)	180	15
AGL Secondary Transformer	60	5
Cabling (AFL, AGL)	240	20
Control Unit (AFL, AGL)	60	5
Illuminated Signage	180	15
SCADA	120	10

Table 3: AGL equipment useful lives

5. Guidelines for Design Trade-offs

The design trade-offs shall take the following into consideration:

- Capital and operational costs
- Acceptable control measures to manage risk

6. Deliverable Design Information or Minimum Design Outputs

The following information shall be deliverable at the end of ECSA Stage 3 and 4:

- Point-to-point statement of compliance with this specification. (Also, to be provided at tendering stage)
- Detailed Design & Operating philosophy.
- Proposed Method of Installation.
- Minimum spare holding requirements

- Exact number of spares required for the life span of the equipment based on their other installations.
- Maintenance schedule for equipment
- Operating guidelines for equipment
- Electrical drawings
- Civil engineering designs and drawings where applicable.

7. Equipment Specifications

7.1 Airfield Ground Lighting System Requirements

7.1.1 General

The lighting fixtures and supporting structures installations on operational areas shall be in accordance with the Aerodrome Design Manual (Doc 9157), Part 6, for guidance on frangibility of light fixtures and supporting structures.

The elevated approach lights and their supporting structures shall be frangible in accordance with the latest ICAO Annex 14, Volume 1. The elevated runway, stopway and taxiway lighting shall be frangible, and their height shall be sufficiently low to preserve clearance against aircrafts.

The surface lights fixtures inset in the surface of runways, stopways, taxiways and aprons shall be fitted as to withstand being run over by the wheel of an aircraft without damage either to the aircraft or the lights themselves.

The intensity of runway lighting shall be adequate for the minimum conditions of visibility and ambient light in which use of the runway is intended, and compatible with that of the nearest section of the approach lighting system when provided.

The intensity controls shall be provided where high-intensity lighting system is required or provided to ensure that the following systems when installed can be operated at compatible intensities:

- approach lighting system
- runway edge lights
- runway end lights
- runway centre line lights
- runway touchdown zone lights
- taxiway centre line lights.

Table *4* provides the AGL specifications in accordance with the ICAO Annex 14 and the SACATS 139.

Airfield Ground Lighting +B3:L10B3:L11B3:LB3:L18	Colour	Standard Candelas (Minimum Average)	Intensity Requirements	Spacing (CATS 139.01.32 - Part 1 & ICAO Annex 14 - Chapter 1)				Serviceability Mininum Threshold (CATS 139.02.23 - Part 14 & ICAO Annex 14 - Chapter 10)		
				Non Instrument	CAT I	CAT II	CAT III	CAT I	CAT II	CAT III
Inner 450 m Approach Lighting System	White & Red	White: 20 000 cd Red: 5 000 cd	High	60m apart	30m apart	15m apart	15m apart	85%	95%	95%
Beyond 450m Approach Lighting System	White & Red	White: 20 000 cd Red: 5 000 cd	High	60m apart	30m apart	15m apart	15m apart	85%	85%	85%
Runway Edge Lights (Omni-directional)	White & Yellow	White: 10 000 cd Yellow: 4 000 cd	High	100m apart	60m apart	60m apart	60m apart	85%	95%	95%
Runway Threshold Lights	Green	10 000 cd		at least 6	3m apart (uniformly spaced)	>=3m apart (uniformly spaced)	>=3m apart (uniformly spaced)	85%	95%	95%
Runway End Lights (Uni-directional)	Red	2 500 cd	High	at least 6 equally spaced			>=6m apart	85%	75%	75%
Runway centre line lights (Bi-directional)	White & Red	**White:** White: 5 000 cd (with 30m longitudinal spacing) White: 5000 cd (for CAT III with 15m longitudinal spacing) white : 2500 cd (for CAT I & CAT II with 15m longitudinal spacing) **Red:** 750 cd (with 30m longitudinal spacing) 750 cd (for CAT III with 15m longitudinal spacing) 375 cd (for CAT I & CAT II with 15m longitudinal spacing)	High		30m apart	30m apart	15m apart		95%	95%
Runway touchdown zone lights	White	5 000 cd	High			30m apart	30m apart		90%	90%
Taxiway centre line lights	Green	200 cd (15m spacing - RVR <350m) 100cd (7.5m spacing - RVR <350m) 20cd (30m & 60m spacing - RVR >=350) 20cd (7.5m, 15m, & 30m spacing - RVR >=350) 1800 cd (15m longitudinal spacings - High-intensity taxiway centre line intended for use in an advace surface movement guidance and control system) 400 cd (7.5 m spacings on curve sections- High-intensity taxiway centre line intended for use in an advace surface movement guidance and control system)	High			=7.5 m apart (curves up to 400m) =15m apart (curves of 401m to 899m) =30m apart (curves of 900m or greater	<=15m apart (Longitudinal spacing) <=15m apart (curve) <=7.5m apart (curve less than 400m radius)			
Taxiway Edge Lights	Blue			<=60m apart (Longitudinal spacing) <60m apart (curve)	<=60m apart (Longitudinal spacing) <60m apart (curve)	<=60m apart (Longitudinal spacing) <60m apart (curve)	<=60m apart (Longitudinal spacing) <60m apart (curve)			
Rapid exit taxiway indicator lights (Unidirectional)	Yellow	**Yellow:** 1 400 cd (with 30m longitudinal spacing) 1 400 cd (for CAT III with 15m longitudinal spacing) 1 000 cd (for CAT I & CAT II with 15m longitudinal spacing)			<=15m apart (Longitudinal spacing)	<=15m apart (Longitudinal spacing)	<=15m apart (Longitudinal spacing)			
Stop Bars	Red	200 cd(straight sections - RVR <350m) 100 cd (curved sections - RVR <350m) 20 cd (straight sections - RVR >=350 1800 cd (straight sections intended for use in an advanced surface movement guidance and control system where higher intensities are required) 400 cd (curved sections intended for use in an advanced surface movement guidance and control system where higher intensities are required)		<3m apart (uniform intervals)	<3m apart (uniform intervals)	<3m apart (uniform intervals)	<3m apart (uniform intervals)			
PAPI	White & Red	**Red:** 15 000 cd **White:**30 000 cd								
High-Intensity runway guard lights		1 000 cd								
Low-Intensity runway guard lights		300 cd								

Table 4: AGL Specifications

7.1.2 Emergency Lighting

The Emergency lighting shall be implemented in accordance with the latest ICAO Annex 14, Volume 1.

7.1.3 Aeronautical Beacons

The Aeronautical Beacons shall be implemented in accordance with the latest ICAO Annex 14, Volume 1. Aerodrome Beacon:

Parameter	Specification
Frequency of total flashes	20-30 flashes/minute
Coloured flashes – Land Aerodromes	Green flashes alternating with white flashes or white only
Intensity of flashes	≥2000 cd

Identification beacon:

Parameter	Specification
Coloured flashes – Land Aerodromes	Green flashes
Intensity of flashes	≥2000 cd

7.1.4 Approach Lighting Systems

The approach lighting system shall be implemented in accordance with the standards and recommended practices of the latest ICAO Annex 14, Volume 1 for the applicable category of runway approaches.

7.1.5 Visual Approach Slope Indicator Systems

The Visual Approach Slope Indicator lighting system shall be implemented in accordance with ICAO Annex 14, Volume 1, applicable standards, and recommendations. The Visual Approach Slope Indicator lighting system shall be implemented in accordance with the guidelines in the application of ICAO Annex 14, Volume 1, chapter 5, sub-section 5.3.5 contained and ICAO Doc 9157, Part 4, chapter 8.

The FAA AC 150/5345-28 which contains the specifications for the Precision Approach Path Indicator (PAPI) Systems also provide guidelines for the environmental requirements for the PAPI. The environmental requirements from the document states that, the PAPI equipment shall be designed for outdoor installation and continuous operation in harsh environmental conditions as provided in the table below:

Parameter	Value
Temperature Range	Up to +55°
Relative Humidity	up to 100%
Wind	Up to 161 km/hr

It is the responsibility of the designer or contractor to conduct due diligence of the environmental conditions at the site which the equipment shall be located or operated.

7.1.6 Runway and Taxiway Lighting Systems

The Runway and Taxiway lighting shall be in accordance with ICAO Annex 14, Volume 1, Chapter 3, and specifications 5.3 as indicated in the table below:

Taxiway Lighting System	ICAO Annex 14 Specifications	ICAO Doc 9157, Part 4	SA CATS 139
Emergency lighting	5.3.2		
Aeronautical beacons	5.3.3		
Runway lead-in lighting systems	5.3.7	Chapter 6	139.01.31
Runway threshold identification lights	5.3.8		
Runway edge lights	5.3.9		
Runway threshold and wing bar lights	5.3.10		
Runway end lights	5.3.11		
Runway Centreline Lights (RCL)	5.3.12	Chapter 9	
Touchdown Zone (TDZ) lighting	5.3.13 & 5.3.14		
Rapid exit taxiway indicator lights	5.3.15		
Stopway lights	5.3.16		
Taxiway Centreline Lights	5.3.17	Chapter 9	139.01.32
Taxiway Edge Lights	5.3.18	Chapter 9	139.01.32
Runway turn pad lights	5.3.19		
Stop Bars	5.3.20		139.01.32
Intermediate holding position lights	5.3.21		139.01.32
De-icing/anti-icing facility exit lights	5.3.22		
Runway Guards Lights (RGL)	5.3.23		139.01.32
Apron Floodlighting	5.3.24		
Visual Docking Guidance System	5.3.25		
Advanced visual docking guidance system	5.3.26		

Aircraft stand manoeuvring guidance lights	5.3.27		
Road-holding position light	5.3.28		
No-entry bar	5.3.29		
Runway status lights	5.3.30		

The design of the electrical systems for the stop bar shall be in accordance with Aerodrome Design Manual (Doc 9157), Part 5 and shall ensure that all the lights of a stop bar shall not fail at the same time.

The purpose of the runway guard lights (RGL) is to provide a warning to the pilots and the drivers of vehicles when they are operating on taxiways that they are about to enter a runway. The RGL shall be provided as part of the runway incursion prevention measures at each taxiway and runway intersection where runway incursion hot spots have been identified and shall be used under all weather conditions during day and night.

The ICAO Aerodrome Design Manual Doc 9157, Part 4 provide guidance on the application of taxiway and runway lighting systems.

The **SA CATS 139.01.31** shall be complied with in the design and implementation of the following lighting system:

- The Runway lead-in lights,
- Taxiway Centreline Lights,
- Taxiway Edge Lights,
- Stop Bars,
- Intermediate holding position lights, and
- Runway Guards Lights (RGL)

7.2 Interspersion of Light Source Technologies

The mixing of light source technologies is not recommended as it may present a difference in perceived colour or/and brightness between different technologies. These differences have the potential to the visual presentation to the pilot. The FAA AC 150/5340-30J & ICAO Doc 9157 Part 5 (specifications 12.12.3) recommends that the LED Technology shall not be mixed for the following runway lighting:

- Runway Guard Lights (RGLs): each pair of elevated RGLs shall be the same technology.
- For in-pavement RGL: LED shall not be mixed with incandescent fixtures in the same bar. For individual installations, all the lights shall be of the same technology.

- Touchdown Zone Lights: For individual installations, all the lights shall be of the same technology.
- Runway Edge Lights: For each individual installation, all the lights of a runway edge lighting system including the yellow portion within the end of the runway caution zone shall be of the same technology.
- Runway Threshold, End, and Stopway lighting: For each individual installation, all the lights of the runway threshold, runway end and stopway shall be of the same technology.
- Signs per location: The LED signs shall not be collocated with the incandescent signs. Example: runway holding position signs on both sides of a taxiway, holding position signs on both sides of a runway, separate signs that form a sign array.
- Taxiway Centreline and Edge lighting: Taxiway lighting per "segment" shall be of the same technology.
- Approach Light Systems: Per runway end, the white steady burning lights of an approach lighting system shall be of the same technology.
- Stop Bars: For individual installations all the lights of an in-pavement stop bar system shall be of the same technology.
- Runway Centreline Lights (RCL): For individual installations all the lights of an in-pavement stop bar system shall be of the same technology.
- Lead-on and Lead-off lights
- Precision Approach Path Indicator (PAPI): Per runway end, the light units of PAPI shall be of the same technology. This includes where PAPI are installed on both sides of a runway.

The interspersion of lighting shall not be allowed at allowed for new installations and in replacement projects.

7.3 Signs Requirements

The signs shall be in accordance with ICAO Annex 14, Volume 1, Chapter 5, and specifications 5.4. The provision of the system of sign at the aerodromes is key in achieving the safe and efficient taxiing and ground movement at the aerodrome for the pilots and the vehicle drivers in the movement area.

The sign also enables the pilots and drivers to identify their position in manoeuvring area and to be able to report their position to the ATC. The mandatory signs shall be provided at an aerodrome to identify a location beyond which a vehicle or taxing aircraft shall not proceed unless authorized by the air traffic control.
The mandatory instruction signs shall always be located on each side of the runway or taxiway to enable the pilots to have an interrupted view of the signs at all times. The mandatory instruction signs include designation signs, Category I, II, III holding position signs, runway-holding position signs, road-holding position signs, and NO ENTRY signs.

The information signs shall be provided at an aerodrome where there is an operational need to indicate by a sign a specific location, routing information, as well as to provided other information relevant to the safe and efficient movement of the aircraft and vehicles. The colours used in any information sign shall conform to the specifications given in the latest Annex 14, volume 1, Appendix 1, Figures 1.2 to 1.4.

Category	Colours
Mandatory Signs	Red and white
Information Signs	Yellow and Black

The guidance on the signs is contained in the Aerodrome Design Manual (Doc 9157), Part 4.
The design requirements (i.e., fonts, dimensions, luminance) for the guidance signs are specified in the ICAO Annex 14, Volume 1, Appendix 4.

Prior to the installation of a sign, it shall be demonstrated that the sign conforms to the sign design requirements in Annex 14, Volume 1, Appendix 4. Tests shall be carried out to demonstrate compliance that a sign fully represents the size, colour, inscription layout and lighting that shall be used in service.

7.4 Electrical Systems Requirements

7.4.1 General

The electrical circuits of the AGL shall conform to the requirements of SANS 10142-1.

The electrical power supply systems for the AGL and associated systems shall be in accordance with ICAO Annex 14, Chapter 8: Electrical Systems.
The design and installation of the Electrical System for the aerodrome lighting shall be in accordance with the guidelines provided in the ICAO Doc 9157, Aerodrome Design Manual, Part 5 – Electrical Systems.

It shall be the responsibility of contractor to ensure and confirm that the electrical power tap-off point is adequate for the functioning of AGL and that it also includes the secondary power supply meeting the switch-over times as outlined in ICAO Annex 14, Chapter 8: Electrical Systems, Table 8-1.

The sources of electrical power shall be analysed for availability, capacity, reliability, and practicality for the proposed lighting design and installation.
The design and installation of the electrical system shall consider the factors that may lead to the malfunction of the system such as electromagnetic disturbances, line losses, power quality. The AGL circuits and system shall be considered to be continuous load. Continuous Load are loads that operate continuously for a period

three hours and more. The feeder circuit conductors supplying the CCRs, or parallel circuit shall be sized to carry 125% of the actual full load current imposed on the circuit.

The power distribution system components shall be specified within their fault current withstand and interrupting ratings.
The short circuit analysis shall be conducted to enhance the reliability and safety of the power distribution system. The CCRs shall be connected in such way the load on the 3 phase distribution systems is balanced.

7.4.2 Constant Current Regulators

The options available on the extra-over features of the CCRs shall coincide with the overall configuration design of the AGL in the field. This shall include as aspects such as multiple circuits with the associated circuit selectors, addressable light systems, earth fault and lamp fault indicators, etc.

The primary circuit design shall determine the number of CCRs to be deployed and the cost benefit analyses, including the risk associated, shall be considered. Herewith some broad guidelines that can be followed:

- The lesser the number of CCRs the less complex and less expensive the system can be.
- For smaller airports, it can be considered to use one set of CCRs to energized the
- PAPIS of both approaches.
- For VFR only airports the approach lights for both approached can be from the same CCR.
- Addressable lights can be considered to switch several low power systems such as TCL and stop bars using the same CCR(s).
- Multiple circuits can be fed from the same CCR in specifically instances where there are no interdependencies.

7.4.3 Categories of CCRs

The CCRs are categorized into two (2) classed based on the output currents, and are also categorized into two (2) classes based on the brightness steps as provided below (AC 150/5345-10H):

- **2-Classes:**
    - Class 1: 6.6 Amperes output current
    - Class 2: 20 Amperes output current

- **Style:**
    - Style 1: 3-brightness steps
    - Style 2: 5-Brightness steps

7.4.4 Environmental Requirements

The CCRs shall be designed for continuous operation under the following conditions: (ICAO Doc 9157, Part 5, Chapter 7, Sub-section 7.2)

Parameter	Value
Temperature Range	-40° to +55°
Relative Humidity	10% to 100%
Altitude	0 to 2 000m

It is responsibility of the designer or contractor to conduct due diligence of the environmental condition at which the equipment shall be located or operated.

7.4.5 Functional Performance Requirements

The CCR shall maintain the output currents provided on the table below while powering any load from short circuit to 100 %. The CCR shall regulate the output currents within the allowable range over a full range of the specified environmental conditions (ICAO Doc 9157, Part 5, Chapter 7, Table 7-1):

Class	Style	Step	Nominal Output Current (A)	Allowable Range (A)
1	1	3	6.6	6.5 – 6.7
		2	5.5	5.4 – 5.6
		1	4.8	4.7 – 4.9
1	2	5	6.6	6.50 – 6.70
		4	5.2	5.10 – 5.30
		3	4.1	4.00 – 4.20
		2	3.4	3.30 – 3.50
		1	2.8	2.70 – 2.90
2	2	5	20.0	19.70 – 20.30
		4	15.8	15.50 – 16.10
		3	12.4	12.10 – 12.70
		2	10.3	10.00 – 10.60
		1	8.5	8.20 – 8.80

The CCR shall have voltage taps from which the correct supply voltage shall be selected. The CCR shall be able take the input voltage as per the table below:

Parameter	Specification
Input Voltage	240 VAC 1-Ø
Frequency	50 Hz

The CCRs shall be equipped with open circuit and over-current protection. Below are the required Operating Characteristics of the CCRs as per ICAO Doc 9157 Part 5 (7.2):

- Maintain a constant current output within ±2 per cent for any load from one-half to full load with up to 30 per cent of isolating transformers having open circuit secondaries.
- Indicate a grounding fault on the circuit while permitting the circuit to operate normally when a single ground fault prevails.
- Have a high degree of reliability.
- Incorporate an open circuit device which locks the primary voltage within two seconds and requires resetting of the regulator.
- Respond to circuit changes within fifteen cycles.
- Incorporate a security device that sets the regulator out-of-service or assures a reduction of the current in case of over-current.
- Provide the required number of intensity settings or a continuously variable control as required.
- Regulator shall be designed so that the intensity setting can be changed without de-energizing the regulator.
- Electrically isolate the primary power circuit from the secondary lighting circuit.
- Dynamic characteristics which enable quick restart in case of voltage failure in accordance with the switch over time requirements of Annex 14, Volume I, Table 8-1.
- Operate continuously at full load in ambient temperatures between –40°C and +55°C and relative humidity between 10 and 100 per cent and at altitudes up to 2 000 m.

7.4.6 AGL Series Transformers

The AGL Series Transformers shall conform with the guidelines provided in the ICAO Doc 9157, Aerodrome Design Manual, Part 5 – Electrical Systems, chapter 9.

Parameter	Specification
Operating Temperature	-55 °C to 65 °C
Primary Leads size	≥ 10 mm^2
Primary Leads Insulation	≥ 5 kV
Primary Leads Length	≥ 50 cm
Secondary Leads size	≥ 4 mm^2
Secondary Leads Insulation	≥ 600 V

The FAA Advisory Circular AC No. 150/5345-47C also contains the Specification for Series to Serios Isolation Transformers for Airport Lighting.

7.4.7 Underground Electrical Systems

The ICAO Doc 9157 Part 5 Electrical System provide guidelines and practices for underground electrical systems for AGL. It also encourages compliance with the local practices. The design, installation and construction of the underground electrical systems shall be in accordance with ICAO Doc 9157 Part 5 Electrical System and applicable SANS standards.

The contractor shall provide evidence of how the ICAO Doc 9157 is complied with and how the manufactures recommendations are taken into consideration at design and installation stages. The typical underground installation for AGL shall include primary cable, AGL transformer, secondary wiring, ground equipment, lightning protection system, and light unit mounting.

The underground cables for AGL shall be shielded for Electromagnetic Compatibility (EMC) purposes. The shied shall be continuous throughout the loop and earthed at the ends of the primary series circuit. The bonding shall be made continuous by bonding the AGL outgoing and incoming cables.
It is preferrable that the installation of the primary cables between the CCR and the lights be made through a placement of a conduit over the direct burial method. It is recommended that the existing conduits are used as much as possible. The secondary may be installed directly in saw cuts or using conduits. Preferably using conduits.

The grounding system for AGL shall have an earth resistance of the values range between 6Ω to 25Ω. The underground electrical system for AGL shall

have lightning protection either through the lighting protection system (LPS) or counterpoise system to provide a low resistance path the lighting discharge through earth and to safely dissipate without causing damage to equipment.
The underground cables, cable route, and lighting stations shall have marked and have identification numbers for ease of identification.

7.5 Methods of Installation

The methods of installation for secondary cables on different types of pavements shall be agreed upon between the contractor and the site Civil Maintenance representative, site Electrical Maintenance representative, Chief Civil Engineer, Chief Electrical engineer. Alternatively, the method of installation for secondary cables on different types of pavements shall be reviewed and approved by a professional civil engineer or technologist competent in pavements.

The method of Installation for light bases shall ensure minimisation of the entrance of surface water and other liquids into the lighting bases.
The choice of sealants and adhesives shall be compatible with the type of material used on pavements.
The methods of installation for primary and secondary cables shall take into considerations the site-specific environmental conditions and the conditions of the pavement.
The methods of installation for primary cables shall be agreed upon between the contractor and the site Civil Maintenance representative, site Electrical Maintenance representative, Chief Civil Engineer, Chief Electrical engineer.
The methods of installation shall ensure that the manholes are watertight.
The methods of installation shall ensure that both primary and secondary cables are protected against water and sand damage.
The methods of installation shall ensure that there is adequate clearance between the runways/taxiways and the cable installations to enable maintenance activities on the taxiways and runways.

7.6 Control and Monitoring System Requirements

7.6.1 General

The principles for the control system design shall take cognisance of the specific airport's complexity, operating minima, and movements. For example, the system of an airport with a single runway with a single link taxiway to the apron with only VFR operations and limited to 11 movements per hour shall have a very simple control systems whilst an AGL system required to support multiple runways, very low operating minima and a high ATM frequency traffic shall be more complex.

For the more complex system, the high-level configuration shall consist of a network of PLC; the latter located at the various CCR rooms, a SCADA system with touch screen displays in the Tower Cabin and the maintenance complex and IMC monitoring room, the associated dual server and a redundant network. The size and quantity of the displays shall be depended on the amount of information to be displayed and the number of lighting systems to be controlled.
For simple systems, a single bespoke PLC control unit using status indication on a mimic display that directly controls the various CCRs shall suffice.

The communication network of the control system needs to be installed in a manner that shall guarantee its integrity. Cables installed on the airfield can be prone to rogue trench digging activities. The control and monitoring system for the AGL shall conform to the ICAO Annex 14: Chapter 8 - Electrical Systems, and Sub-section 8.3 – Monitoring. The control and monitoring system for the AGL shall be implemented in accordance with ICAO Doc 9157, Part 5: Chapter 10: Control and Monitoring of Aerodrome Lighting Systems. The FAA AC 150/5345-56B specification document shall be taken into consideration as it covers the requirements and recommendations for an Airfield Lighting Control and Monitoring System (ALCMS).

7.6.2 Requirements as per ICAO Annex 14, Chapter 8 (Sub-section 8.3 Monitoring)

It is recommended that a system of monitoring is employed to indicate the operational status of the lighting systems. The lighting system used for aircraft control purposes shall be automatically monitored to provide an indication of any fault which may affect the control functions and the information needs to be automatically relayed to the ATC.

A change in the operational status of lights shall be relayed and indicated at ATC within two (2) seconds for a stop bar at a runway-holding position and within five (5) seconds for all other types of visual aids. The lighting systems detailed shall be monitored automatically to provide an indication when the serviceability level of any element falls below the minimum serviceability level specified in ICAO Annex 14. This information shall be automatically relayed to the maintenance crew to trigger the relevant maintenance activities.

7.6.3 Requirements as per ICAO Doc 9157, Part 5: Chapter 10: Control and Monitoring of Aerodrome Lighting Systems

Remote Control: The remote control shall be provided at the ATC tower to enable remote control of the lighting system remote from the respective substations. The additional remote stations may be provided at other remote locations if required by the aerodrome.

Local control: The local control in the respective substation shall be provided as an alternative control to the remote control at ATC during emergencies. The local control shall be a replica of the remote control at ATC tower.

Interlocking control stations: To avoid conflicting operation of the controls and for safety purposes only one control station shall operate at the time.

Communication Link: The preferred communication link for the Control and Monitoring system between the substations and the Air Traffic Control tower is fibre optic link as it is not limited by distance, voltage drops, and electromagnetic interference.

Response Time for Aerodrome Lighting Computer System (ALCS): The response time for the monitoring system in a case where a change of operational status occurs an indication is provided within two (2) seconds for stop bards and within five (5) seconds for all other types of visual lighting.
Lighting circuits monitoring: Paragraph 8.3 of Annex 14, Volume 1, states that the system of monitoring shall be employed to indicate the operational status of the lighting system. The lighting systems shall be monitored for the following fault conditions as per Paragraph 10.10.4, ICAO Doc 9157, Part 5:

- Loss of AC input power to the constant current regulator.
- Shutdown of the regulator due to operation of protective circuits
- A 10 % or more drop in the volt-amperes (VA) delivered to the series circuit.
- Failure of the regulator to deliver the output current that corresponds to the brightness step selected.
- Failure of a pre-set number of lamps in the series circuit.

The fault conditions that pertain to total circuit failure such as loss of the lighting to the pilot shall be reported to the ATC. The fault conditions that are related to maintenance criteria, such as failure of a pre-set number of lamps shall be reported to the operation centre (IMC) and to the maintenance centre (Maintenance Workshop).

Insulation Resistance Monitoring System: The constant current regulators shall be provided with an insulation resistance monitoring system which enables real time monitoring of the circuits as well as to generate statistical reports.

7.6.4 Control Philosophy Requirements

The control philosophy shall be remote, radio and local, the function shall offer the following:

- A graphical user interface showing geographical layout of site (runways, taxiways and aprons)
- Fibre data transfer for status monitoring
- Ability to monitor a 10km range reliability and efficiently.
- Latest windows operating system full compatibility
- Ability of multiple views (Fast Reaction Panel (FRP) and Touch Screen Input Devices)
    - Remote control of all lights by the ATC
    - Local control by Maintenance team
    - Monitoring view for Maintenance team
    - Monitoring for IMC
- Pre-defined Runway Lighting Selection
- Selectable Uni-directional or bi-directional taxiway lighting as required.
- Single Lamp Failure Monitoring and notification alerts
- Maintenance management (IMC and Electrical Maintenance):
    - Serviceability levels as compared to ICAO Serviceability Requirements
    - Real time monitoring and reporting System and Element Failures
    - Direct Individual Unique Identification of Failed Equipment or Element
    - Loss of power to the Current regulator
    - ±10% power drop delivered to the entire circuit.
    - Insulation resistance monitoring on each circuit
    - Generator predefined parameters
    - UPS predefined parameters
- Record keeping with timestamp for at least 3 years.

7.7 Surface Movement Guidance and Control Systems (SMGCS)

A surface movement guidance and control system (SMGCS) shall be provided at the aerodrome in accordance with the latest Annex 14, volume 1. The guidelines on surface movement and control systems are contained in the Manual of Surface Movement and Control Systems (SMGCS) ICAO Doc 7476. An SMGCS shall be

designed in such a manner that it assists with the prevention of the following incidents on any part of the movement area:

- Inadvertent incursions of aircrafts and vehicles onto an active runway
- Collisions between aircrafts, and between aircrafts and vehicles or objects

7.8 Advanced-Surface Movement Guidance Control Systems (A-SMGCS)

The ICAO Doc 9830 Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual shall be consulted and complied with for the implementation of the A-SMGC at the Company Airports.

The ICAO Doc 9830 Manual describes A-SMGCS as a system providing routing, guidance and surveillance for the control of aircrafts and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety.

8. Commissioning, Maintenance and Handover Requirements

8.1 Acceptance Testing and Commissioning Requirements

The acceptance testing and commissioning of electrical components or equipment is a process as it ensures that the electrical systems operate safely and reliable for the intended purpose. The ICAO Doc 9157 Part 5 Electrical System provide test procedures for the acceptance testing of the new installations which shall be performed before making the system operational.

The acceptance testing and commissioning of the AGL system shall be in accordance with ICAO Doc 9157 Part 5 Electrical manual.
The commissioning and acceptance testing documentation shall be developed and provided prior to commissioning and acceptance testing phase for review and approval by Company representative engineer. The commissioning and acceptance testing documentation shall include the following:

- Test plan
- Comprehensive test procedure
- Checklist (derived from acceptance testing and commissioning documentation) and design drawings
- Test tools or equipment together with the calibration certificates as per manufacturer’s recommendations

8.1.1 Factory Acceptance Testing

It recommended that the Factory Acceptance Tests (FAT) are carried before shipment to any of the Company sites to verify that the equipment and its associated components are fit for its purpose or intended purpose and otherwise that it complies with Contract scope of work/contractor approved design/technical requirements.
The contractor shall develop an FAT plan that shall be reviewed and approved by Company representative engineer prior to the FAT taking place. Upon the completion of the FAT the contractor shall issue the test records and the FAT completion certificate for the approval of the Company's representative.

All equipment manufactured under specifications shall be pass strict Factory Acceptance Tests (FAT) before shipment and shall be visually inspected for shipping damage immediately upon receipt. The following inspections shall be conducted to ensure that no shipping damage has occurred:

- Cable, connectors, and isolating transformer inspection: To ensure that there are no minor cuts, excessive bending or any other mishandling during shipping that may lead to progressive deterioration which may lead to a complete failure after the acceptance test have been completed.
- Constant Current Regulator Inspection: To determine that there was no shipping damage on the porcelain bushings, that connections are correct, switches and relays are not blocked from operating freely.
- Light fixture and Beacon Inspection: To determine that the colour, quantity and locations of the lights are in accordance with the drawings. Also, to determine each light is operable, also that the glass is not broken or cracked, that correctly lamps are installed.
- Miscellaneous components inspections: Components such as control panels, relay cabinets, panel boards amongst others shall be visually inspected for damage, correct connections, proper fuse and circuit-breaker ratings, and confirm compliance with drawings.

8.1.2 Guarantee Period

Cable and damp or dirty cable connectors due to poor workmanship and faulty installation practices often happens several months after installation. Therefore, the guarantee period shall at least be a period of one year whereby the installation contractor is held responsible for repairing and replacing all the cables and equipment failures resulting from poor workmanship, defective materials, and equipment.

8.1.3 Visual Inspection

The most important of all inspection and test procedures are through visual inspection. The visual inspections shall be made frequently during installation, at completion of installation, and before energisation of circuits. A careful visual inspection has the potential to reveal the defects that can be corrected before acceptance testing and energisation takes place. Visual inspection shall include inspection appraisal of:

- Correctness of external connections
- Good work performance
- Cleanliness of
- Safety hazards,
- Specific requirements for individual items

8.1.4 System Operation Test

The entire system shall only be tested after comprehensive inspection of individual components upon arrival (after shipping) and after installation have been completed. Each lighting circuit shall be tested individually by ensuring that each switch of the lighting panel in the control tower is operated so that at least each switch position is reached at least twice. All the lights and vault equipment shall be observed to verify that each switch operates correctly and that it controls the corresponding circuit.

The testing of individual lighting circuits shall be repeated in the alternate control station and repeated once again using the local control switches on the regulators. Each lighting circuit shall be tested by operating it continuously for a minimum period of six (6) hours. Visual inspection shall be made at the beginning and at the end of this test to determine that the correct number of lights are operating at full intensity. It is important to note that dimming of some light in a circuit is an indication of ground faults. During these tests, the lamp-terminal voltage shall be measured on at least one light in each multiple circuit to determine that it is within ±5 % of the rated lamp voltage.

8.1.5 Electrical Tests

The electrical tests shall be conducted in accordance with the ICAO Doc 9157 Part 5 Electrical manual on series-circuit equipment, cables, constant current regulators, and as well as any other components that form part of the system.

The electrical tests shall be conducted to determine that the quality of the installation is acceptable, and that the performance thereof shall meet the operational requirements. The electrical tests shall be performed by qualified and experienced personnel who are familiar with high-voltage electrical equipment and the safety precautions which shall be observed.

8.2 Maintenance and Handover Requirements

The requirements at project close out phase for any Airfield Ground Lighting Systems related works are tabulated below.

Item No	Description of Handover requirement	Requirement Met	
		Yes	No
1	As-built drawings signed-off by a Professional Electronic Engineer or Professional Electronic Technologist.		
2	Soft copies of drawings in DWG format		
3	Installation Certificate		
4	Commissioning certificate		
5	Acceptance certificate		
6	Maintenance and Operating Manuals		
7	Datasheets of all equipment installed		
8	List of Critical Spares (with OEM names and OEM part numbers)		
9	Warranty Documentation		
10	Certificates of Compliance		
11	CMMS Data & Proof of asset loading in CMMS		
12	Training records of Operator & Maintenance Personnel		
13	PDF Datasheets of all equipment installed		
14	PDF schedule of all equipment installed		

The CMMS Data is the information required for each asset you install, as assets shall be reduced to the maintainable assets. The CMMS data format shall be as follows:

- Asset information
  - Description
  - Model
  - Manufacturer

- Serial number [if you do not have serial number, then some means to uniquely identify – if there is not, then let me know so that I can arrange the barcodes for you]
- Building [for example CTB, Western Precinct, Control Tower etc.]
- Installation location [for example ground floor, GPS location is also a good idea]

- Failure information
  - Failure description
  - Failure cause
  - Failure resolution
- Maintenance information
  - Maintenance type [for example inspection, maintenance, calibration, certification etc.]
  - Frequency [for example daily, weekly, on a Monday etc.]
  - List of tasks to perform the maintenance: for each task
    - Describe the task [for example check oil levels and top up if required]
    - Skills required [for example electrician, fitter, plumber etc.]
    - Time estimate in minutes to complete the task
    - Tool(s) required

9. Process for Monitoring

The effective implementation and monitoring of this procedure shall be done through relevant committees and reviews. Self-assessment by Maintenance Engineering (level 1) and Operational Governance (level 2) shall be conducted to determine compliance, implementation and effectiveness of this procedure. In order to ensure compliance to statutory requirements, audits on annual basis or per audit plan shall be conducted to determine compliance status.

MONITORING CONTROLS	PURPOSE	RESPONSIBLE	FREQUENCY
COE Oversight Compliance Matrix	Oversight compliance	Group Manager: ME (as delegated)	Real Time
Internal Audits	Determine the effectiveness of the procedure and test the outcome of the manual.	Internal Audit	Annually
Operations Management Manco	Measure adequacy and implementation of the manual	Operations Management	Planned Interval

CIAM Manco	Measure adequacy and implementation of the manual	Group Executive: CIAM	Planned Interval

Note: This manual shall be reviewed in three (3) years cycle and if there is a need to review the manual before three (3) years cycle laps due to any circumstances being legal requirements, changes in the businesses, the need to reflect current practices or activities, the procedure shall be unlocked for review accordingly.

Disclaimer: In instances where document links are not accessible, directly access the documents on the Policy Management Document Store on the Airports Company South Africa SOC Limited intranet.

10. Accountabilities and Responsibilities

10.1 Accountabilities

The overall accountability for the development of this standard and guidelines lies with the Group Executive: Capital Infrastructure & Asset Management with the support of the Lead: Enterprise Asset Management. However, in the absence the designated person the acting person shall assume responsibility as per delegation of authority. The overall accountability for the effective implementation and adherence of this procedure lies with the Group Executive: Operations Management with the support of the Senior Manager: Maintenance Engineering. However, in the absence the designated person the acting person shall assume responsibility as per delegation of authority.

Authorities	Lead: Infrastructure Asset Management	Regional General Manager	Group Executive: Capital Infrastructure & Asset Management	Group Executive: Operations Management	Senior Site Manager: Maintenance Engineering	Employees (Standard role players)
Has overall accountability for development of this standard	*Responsible*	-	*Accountable*	-	*Consulted*	*Consulted*
Has overall responsibility for implementation and adherence	-	*Responsible*	-	*Accountable*	*Responsible*	*Responsible*

Authorities	Lead: Infrastructure Asset Management	Regional General Manager	Group Executive: Capital Infrastructure & Asset Management	Group Executive: Operations Management	Senior Site Manager: Maintenance Engineering	Employees (Standard role players)
of this standard						
Consulted at the time of an exception and adherence of this standard.	*Consulted*	*Consulted*	*Consulted*	*Consulted*	*Accountable*	*Responsible*
Has overall responsibility for adherence, implementation and performance of a given task.	-	-	-	-	*Accountable*	*Responsible*
Has responsibility for approval and authorisation	*Responsible*	*Informed*	*Accountable*	*Accountable*	*Informed*	-
Communicate the standard to all impacted stakeholders or employees.	*Accountable*	*Responsible*	-	-	*Responsible*	*Informed*

10.2 Roles and Responsibilities

Senior Site Manager

- Line Manager shall ensure that all works adhere to this standard

Employees

- The representative of an employee can be Company engineer, approved consultant, or design engineer.

- Ensure that all work (new design or retrofit) adhere to the minimum requirements of this standard and guidelines.
- Ensure that all works conforms to section 11 of this document before commissioning.
- Handover checklist to be signed off as per section 11.2 of this document

11. Reporting of Non-Conformance

Any deviation from this manual shall be identified and registered with corrective and preventative measures for continual improvement in accordance with Reporting of Non-Conformance Procedure Document - Z001 001M.

12. Related Policy Documents

Document Control Procedure - Z001 006M
Record Keeping Requirements Procedure - Z001 008M

13. Related Legislation and Standard

Standard/Doc Number	Description
AC 120-57	*Surface Movement Guidance and Control System*
AC 150-5340-30	*Design and Installation Details for Airport Visual Aids*
AC 150/5345-3	*Specification for L-821 Panels for Control of Airport Lighting*
AC 150/5345-5	*Circuit Selector Switch*
AC 150/5345-10	*Specification for Constant Current Regulators and Regulator Monitors*
AC 150/5345-28	*Precision Approach Path Indicator (PAPI) Systems*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*
AC 150/5370-10	*Standards for Specifying Construction of Airports*
Occupational Health and Safety Act no 85 of 1993 and Regulations	
Applicable Approving Council's Bylaws and requirements	
Engineering Profession act 46 of 2000	
Identification of Engineering Work Regulations of 2021	
Quality Management System ISO 9001	

14. Change Control and Verification Procedure

This manual shall only be verified and changed with the authorisation of the Group Executive: Capital Infrastructure & Asset Management and in accordance with Change Control and Verification Procedure – Z001 003M.

15. Records

Each Process Owner as identified is responsible for maintaining, storage and protection of their respective documents. Records shall be identifiable, easily retrievable and shall follow retention times as regulated or required by the organisation, statutory or regulatory requirements. Refer Record Keeping Requirements Procedure – Z001 008M

Record Name	Storage Location	Record Number	Responsible Person	Retention Time
FIPDM Stage 3A Deliverables	Enterprise Asset Management Department	ME – 086	Group Manager: Enterprise Asset Management	Five (5) Years

16. Revision History

Date last revised	Revision Status	Compiler	Summary of changes
11th September 2024	Version: 1	**Chief Engineer:** Electrical Engineer **Name and Surname** Tabane Montwedi	1st Issue

17. Endorsement (See Master in Policy Management Storage Room)