



Hellenic Gas Transmission System Operator S.A.
357-359 Messogion Av., GR 152 31 Halandri
Tel.: 213 088 4000
Fax: 210 674 9504
Email: desfa@desfa.gr

TECHNICAL SPECIFICATION

Doc No: DSF-SPC-ELE-013

Rev. 1

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HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

OUTDOOR LIGHTING (ROADWAYS BOUNDARY FENCES AND GENERAL AREAS)

JUNE 2021

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1	Second Issue	30-06-2021	PP	KM	TPI
0	First Issue	05-04-2011	PQ DPT.		V.G.
REV	DESCRIPTION	DATE	PRPD	CHKD	APVD



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1 INTRODUCTION

2 SCOPE AND OBJECTIVES

This Specification covers the minimum requirements for the design, supply and installation for outdoor lighting installations of roadways, boundary fences, general open yards and parking spaces for the stations and pipelines of the natural gas transmission system.

3 REFERENCES

3.1 Reference Documents

3.2 Reference Codes and Standards

2014/34/EU	Equipment Explosive Atmospheres Directive
2014/35/EU	Low Voltage Directive
2014/30/EU	Electromagnetic Compatibility Directive
MINISTERIAL DECISION	
50/12081/642/2006 F A –	
GG B / 1222/5.9.2006	Security Home Electrical Installations (E.I.E.). Introduction of a Differential Current Installation of Construction and Fundamental Grounding
ELOT EN 1594 E3	Gas Supply Systems. Pipelines for Maximum Operating Pressure over 16 bar. Functional Requirements
ELOT EN 14161+A1	Petroleum and Natural Gas Industries. Pipeline Transportation Systems
BS EN 62561-1:2017	Lightning protection system components (LPSC). Requirements for connection components
BS EN 62561-2:2012	Lightning Protection System Components (LPSC). Requirements for conductors and earth electrodes



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BS EN 62561-3:2017	Lightning protection system components (LPSC). Requirements for isolating spark gaps (ISG)
BS EN 62561-4:2017	Lightning protection system components (LPSC). Requirements for conductor fasteners
BS EN 62561-5:2017	Lightning protection system components (LPSC). Requirements for earth electrode inspection housings and earth electrode seals
BS EN IEC 62561-6:2018	Lightning protection system components (LPSC). Requirements for lightning strike counters (LSC)
BS EN IEC 62561-7:2018	Lightning protection system components (LPSC). Requirements for earthing enhancing compounds
ELOT EN IEC 60079-0 E5	Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements
ELOT EN 60079-7 E3	Electrical Apparatus for Explosive Gas Atmospheres - Part 7: Increased safety e
ELOT EN 60079-10-1 E2	Electrical Apparatus for Explosive Gas Atmospheres – Part 10: Classification of Hazardous Areas
ELOT EN 60099-4 E3	Surge Arresters - Metal Oxide Surge Arresters without Gaps for A.C. Systems
ELOT EN IEC 60099-5 E3	Surge Arresters - Selection & Application Recommendations
ELOT EN 62305-1 E2	Protection against Lightning, Part 1: General Principles
ELOT EN 62305-2 E2	Protection against Lightning, Part 2: Risk Management
ELOT EN 62305-3 E3	Protection against Lightning, Physical Damage to Structures and Life Hazard
ELOT EN 62305-4 E4	Protection against Lightning, Part 4: Electrical and Electronic Systems within Structures
ELOT EN ISO 9001 E4	Quality Management Systems
ELOT EN ISO/IEC 17025 E3	General Requirements for the Competence of Testing and Calibration Laboratories
ELOT HD 384	Requirements for Electrical Installations



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ELOT HD 60364	Electrical Installations of Buildings
EN 61000	Electromagnetic compatibility (EMC)
EN 61643-11	Low Voltage Surge Protective Devices – Part 11: SPDs Connected to Low Voltage Power Distribution Systems – Performance Requirements and Testing Methods
EN 61643-21	Low Voltage Surge Protective Devices – Part 22: SPDs Connected to Telecommunication and Signaling Networks – Performance Requirements and Testing Methods
IEC 60664	Insulation Coordination for Equipment within Low-Voltage Systems
IEC 61643-12	Low Voltage Surge Protective Devices – Part 12: SPDs Connected to Low Voltage Power Distribution Systems – Selection and Application Principles
IEC 61643-22	Low Voltage Surge Protective Devices – Part 22: SPDs Connected to Telecommunication and Signaling Networks – Selection and Application Principles
IEC 62548	Design Requirements for Photovoltaic (PV) Arrays
IEC 62561-1	Lightning Protection Components (LPC), Part 1: Requirements for Connection Components
IEC 62561-2	Lightning Protection Components (LPC), Part 2: Requirements for Conductors and Earth Electrodes
IEC 62561-3	Lightning Protection Components (LPC), Part 3: Requirements for Isolating Spark Gaps
IEC 62561-4	Lightning Protection Components (LPC), Part 4: Requirements for Conductor Fasteners
IEC 62561-5	Lightning Protection Components (LPC), Part 5: Requirements for Earth Electrode Inspection Housings and Earth Electrode Seals
IEC 62561-6	Lightning Protection Components (LPC), Part 6: Requirements for Lightning Strike Counters



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IEC 62561-7

Lightning Protection Components (LPC), Part 7:
Requirements for Earthing Enhancing Compounds

ELOT EN 60071-1

Insulation Coordination – Definitions, Principles & Rules

ELOT EN 60071-2

Insulation Coordination – Application Guide

EN 60664-1

Insulation Coordination for equipment within Low Voltage
Systems

IEC 61643-11

Low-voltage surge protective devices - Part 11: Surge
protective devices connected to low-voltage power
distribution systems - Requirements and tests

4 ACRONYMS

AC	Alternating Current
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ATEX	ATmosphères EXplosibles (Explosive Atmospheres)
ATS	Automatic Transfer System
BMS	Building Management System
BVS	Block Valve Station
BCC	Back-up Control Centre at Nea Messimvria
CCTV	Closed Circuit Television System
CPR	Construction Products Regulation
CP	Cathodic Protection
CPU	Central Processor Unit
CS	Compressor Station
DB	Distribution Board
DC	Direct current
DCS	Distributed Control System
DEG	Detailed Engineering
DIN	Deutsches Institut für Normung (German Institute of Standardization)
DVA	Digital Voice Announcer



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DVD	Digital Video Disc
EDG	Emergency Diesel Generator
ELOT	Hellenic Organization for Standardization
ELV	Extra Low Voltage (nominal voltage not exceeding 50 V AC or 120 V DC (ripple-free) between conductors or to earth, as defined by the Standard EN 61558)
EN	European Norms
EPC	Engineering, Procurement and Construction
EU	European Union
ESD	Emergency Shut Down
F&G	Fire and Gas
FACP	Fire Alarm Central Control Panel
FARP	Fire Alarm Repeater Control Panel
FAT	Factory Acceptance Test
FEG	Field Engineering
FC	Floe Computer
FOC	Fibre Optic Cable
GCC	Gas Control Centre at Patima
HEDNO	Hellenic Electricity Distribution Network Operator
HDPE	High Density Polyethylene
HMI	Human Machine Interface
HVAC	Heating Ventilation Air Conditioning
I/O	Input / Output
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
LAN	Local Area Network
LCS	Local Control System
LED	Light Emitting Diode
LFEP	Local Fire Detection & Fire Extinguishing Panel
LV	Low Voltage



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LSP	Load Share Panel
MSC/MCS/SMC	Main Station Controller
MV	Medium Voltage
MPS	Master Project Schedule
MPR	Monthly Progress Report
NFPA	National Fire Protection Association
NNGTS	National Natural Gas Transmission System
NTSC	National Television System Committee
O&M	Operation and Maintenance
PID	Piping and Instrumentation Diagram
PA/GA	Public Address / General Alarm
PCS	Process Control System
PED	Pressure Equipment Directive
PEP	Project Execution Plan
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PMS	Power Management System
POC	Project Organization Chart
PAL	Phase Alternate Line
PPC	Public Power Corporation
PTZ	Pan, Tilt, Zoom
PVC	Poly Vinyl Chloride
QA	Quality Assurance
RCC	Remote Communications and Controls
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detectors
RTU	Remote terminal Unit
S/S	Scraper Station
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition (including Telemetry)
SCS	Station Control System



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SFP	Small Form-factor Pluggable
SPD	Surge Protection Device
SPL	Sound Pressure Level
UDP	User Datagram Protocol
UPS	Uninterruptible Power Supply
UV	Ultraviolet
VGA	Video Graphics Array
VMS	Video Management Software

5 LIGHTING DESIGN

Lighting design shall be according to the Hellenic Legislation Ministerial Decree for “Improvement of Energy Performance in Public Buildings” (Υ.Α. Δ6/Β/14826/17.06.2008 (ΦΕΚ 1122 Β/ 2008) «Μέτρα για τη βελτίωση της ενεργειακής απόδοσης και την εξοικονόμηση ενέργειας στο δημόσιο και ευρύτερο δημόσιο τομέα».

5.1 Illumination Levels

The average horizontal illumination level on the pavement, when the illuminating source is at its lowest output and when the luminary is at its dirtiest condition, shall be according to ELOT EN 12464-2 E2, and shall not be less than:

Classification of area	Illuminati level-
Main road	20
Secondary road	10
Boundary fence and patrol road	50
Parking area	10
General open yard, storage of bulk material, area for future expansions and alike	20
Main administration building surround	20
Approach road	20
Prominent faces of buildings	>100 (*)



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(*) Value referred to vertical surface. On the basis of architecture effects desired, this value shall be adjusted by taking into account also the reflectance of surface materials.

Generally, the lowest illumination value at any point on the pavement shall never be less than one-third of the average value; for boundary fence and patrol road a lower uniformity may be accepted.

Intersecting converging and diverging roadway areas shall require higher illumination level than that above recommended.

The illumination at these areas shall be at least equal to the sum of the illumination values provided at roadways intersection.

5.2 Lighting Calculation

Lighting intensity calculation shall take into account the causes of light loss:

- lamp output depreciation,
- aging of luminaire finish and material
- luminaire dirt depreciation.

The maintenance factor (product of lamp luminous flux depreciation factor multiplied by luminaire dirt depreciation factor) to be applied shall not be higher than 70%.

It shall be responsibility of Contractor to determine actual reduction factors, when the said factor of 70% should not be suitable for the particular application. The following conditions shall be considered:

- cleaning frequency of luminaires at intervals of 24 months
- relamping 50% frequency at intervals of 24 months

5.3 Luminaire Light Distribution

5.3.1 General

Proper distribution of the light flux from luminaires is one of the essential factors in efficient and uniform external lighting.



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A sound design compromise from technical and economical point of view becomes necessary in selecting the installation parameters, in order to achieve balanced performance; pavement luminance generally increases with higher vertical angle of light flux emission, but correspondingly disability and discomfort glare increases.

- a. For roadway and fence lighting the factors to be considered are the following:
 - luminaire lateral and vertical distribution curves and relevant control of light intensity distribution above maximum light intensity point,
 - luminaire mounting height,
 - luminaire spacing.
- b. For parking areas, general open yards and alike, flood lighting shall be preferred; the appropriate factors shall be considered (i.e. the beam spread instead of vertical and lateral distribution curves).

5.3.2 Glare

The glare phenomenon shall be kept within limitation degree G5 or higher, corresponding to tolerable value.

It is important to notice that, for the same illumination level, the pavement luminance and the source output intensity within visual angle of an observer, such as pedestrian or driver, can affect largely annoyance, discomfort or loss of visual performance and visibility in different degree, starting from fully discomfortable (G1) up to perceivable-non-glare (G9).

Therefore, the above-mentioned method shall be taken into account in solving successfully the glare effects and in selecting the luminaires, considering also the type of pavement, beyond all other factors.

For glare evaluating Contractor shall prepare a particular study, showing clearly all provisions adopted in achieving the specified G5 degree of glare.

A field measurement of calculated luminance shall be carried out only in case of doubt on the recommended solutions and luminance measurement shall be agreed with all parties concerned.

5.3.3 Interferences with On-site and Off-site Areas and with Public Roads

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The external lighting, as covered by this specification, shall be designed so that it does not affect:

- safety and operability of on-site and off-site plant areas,
- safety of traffic on adjacent public roads

Care shall be taken to prevent glare effect to plant's operators and to drivers running on public roads.

6 POWER DISTRIBUTION DESIGN

6.1 Power Sources and Distribution Circuits

The power requested to supply lighting circuits of various areas shall be drawn from main lighting distribution switch-boards, to be installed in the nearest electrical substations.

Generally separated circuits shall be provided for:

- main and secondary roads,
- general areas,
- main administration building surround and service area,
- gate house surround and entries.

Circuits shall be single phase or three phases depending on economics and phase balance. Circuit design shall limit maximum distances from supply sources available in the substations.

Solar panels to be considered for outdoor lighting poles.

6.2 Sizing and Installation of Distribution Circuits

6.2.1 Sizing of Conductors

General requirements for conductor selection and sizing shall comply with Specification "General Electrical Works".



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Voltage drop on sub-distribution circuits at the most distant luminaire, calculated from lighting circuit origin (secondary lighting distribution switch board), shall not, exceed 3%; voltage drops not higher than 1% shall be considered on the main lighting feeder from lighting main distribution switchboard to secondary lighting distribution switchboard (or lighting panel), if any.

In any case the total voltage drop shall not exceed 4% and the Joule losses 6%.

6.2.1 Installation of Lighting Circuits

Lighting cables shall be generally laid directly buried and shall comply with requirements of Specification "General Electrical Works". The grounding cable shall be laid in the same trench, close to the lighting cables.

7 EQUIPMENT AND MATERIAL

7.1 Luminaires

7.1.1 General

Luminaires (lighting fixtures) shall be suitable for outdoor installation with gasketed glass cover, to protect reflector and light source from atmospheric agents.

The mechanical protection degree shall not be less than IP 65.

7.1.2 Luminaires

High Intensity Discharge (H.I.D.) LED type lamp luminaires shall be equipped with integral high power-factor ballast, suitable to improve power factor to at least 0,9 and shall be of the type cut-off or semi-cut-off to keep the glare effects within tolerable limits.

7.1.3 Floodlights

High Intensity Discharge (H.I.D.) LED type lamp shall be provided for floodlighting.

Fixtures shall be suitable for outdoor use with integral high-power factor ballast 0.9 or better.

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7.2 Type of Lamps

Lamps shall be LED, with energy performance according to the requirements of the Ministerial Decree for “energy efficiency requirements for ballasts for fluorescent lighting harmonization measures to the European Directive 2000/55/EC of the European Parliament and of the Council of 18 September 2000 on energy efficiency requirements for ballasts for fluorescent lighting” (Υ.Α. Δ6/Β/17682/16.10.2001 (ΦΕΚ 1407 Β/ 2001) «Απαιτήσεις ενεργειακής απόδοσης για τα στραγγαλιστικά πηνία που προορίζονται για λαμπτήρες φθορισμού, σε συμμόρφωση προς την Οδηγία του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου της 18ης Σεπτεμβρίου 2000»).

7.3 Lighting Towers and Poles

7.3.1 Lighting Towers

Towers shall be made in hot dip galvanized metal pipe. Relamps and maintenance operations may be:

- with access to the upper platform, by means of ladders, fitted with safety cages and with intermediate platforms at regular intervals, each equal or less than 9 m; the platforms shall have hand-rails and safety toe plate;
- with provisions to move up and down the upper platform, on which floodlights and relevant features are installed, by means of a manually operated lifting device, so to allow operations at grade level.

7.3.1 Lighting Poles

The luminaire shall be mounted at suitable height on poles made of hot-dip galvanized metal.

Each pole shall be fitted with one junction box (handhole) complete with suitable terminals.

Lighting poles shall be high hinged or basculant type in order to be easily accessible during maintenance.

LED type street lighting fixtures shall also be installed on shelter/skid and building's exterior sides, powered by buildings' switchboards and controlled by photocell.

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All outdoor lighting fixtures, terminal boxes and accessories included inside classified areas shall be explosion proof, proper for zone 1 IIB T3 hazardous area.

7.4 Junction Boxes

Junction boxes with two cable entries, equipped with suitable cable glands, shall be provided the above ground level base of each lighting tower or lighting pole.

Enclosures shall have mechanical protection degree not less than IP 65. Terminals in the junction box shall be of the composite type, fixed on standard profile ELOT EN 50022, ELOT EN 50035 and ELOT EN 50045.

Two earthing terminals shall be provided, one internal and one external of the junction box. Junction box shall be preferably made of insulating resin; in this case the earthing terminal shall be of the pass-through type.

8 INSTALLATION OF LIGHTING POLES AND TOWERS

8.1 Location of Supports

Generally lighting poles shall be installed along routes on the walk way, at a distance 1m to 1,50 m from the road edge; lighting towers shall be installed in points where they do not disturb the traffic or material movements.

Fence lighting shall be provided with supporting arms clipped to fence wall or with self-supporting poles distanced at least 1,5 m from the fence wall.

8.2 Foundations

Steel armoured concrete prefabricated foundations or foundations directly poured in field, shall be sized by taking into account the wind velocity soil bearing pressure, total pole weight and the requirements specified by local regulations and manufacturer recommendations in written forms.

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9 GROUNDING

In general requirements set forth in Specification “General Electrical Works”.

The following particular requirements shall be considered.

9.1 Grounding of Lighting Towers, Poles and Luminaries

9.1.1 Lighting Towers

Lighting towers shall be connected from the main grounding cable through a copper conductor of 50 mm² cross sectional area and shall be provided with an individual lightning vertical rod, because the towers shall be considered as exposed to lightning.

9.1.2 Lighting Poles and Supports

- a) Metallic lighting poles and supports shall be connected with the main grounding cable via a bare copper conductor with a cross sectional area not less than 16 mm².

The pole grounding terminal shall be welded to the metal body of the pole at the height of about 200 mm above grade level; the junction box shall be connected to the grounding terminal via a protective conductor, having the same cross-sectional area as the grounding conductor.

At the upper part of the pole or support a suitable grounding terminal, welded to the body, shall be provided for the protective grounding of the luminaire metallic parts; connection shall be via protective conductor with a minimum cross-sectional area of 6 mm² copper. The metallic body of the pole or support shall be considered as a part of the protective conductor.

- b) Steel reinforced concrete poles shall have the two above mentioned grounding terminals welded to the same steel reinforcing rod, which shall be considered as a part of the protective conductor. Remaining requirements as per point a herein above).

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9.2 Protective Grounding for Lighting Installations

Two characteristic situations shall be considered for the design of the grounding system for lighting installations.

Lighting installations within the area protected by the main grounding cable.

The main grounding cable shall be common through-out the plant. Generally, the buried wire grounding cable shall be installed along the run of the lighting supply cable; it shall have a cross sectional area not less than 50 mm² (supply cable shall not be less than 2,5 mm²).

Lighting installations within the area not covered by the main grounding cable.

This situation may generally exist for boundary fence and for roads within future expansion areas, which may run completely outside the area presently covered by the main grounding cable.

Because of the problem of dangerous gradient (touch and step voltages) outside the limits of the main grounding cable, unity ratio isolating transformers shall be used for the supply of those circuits, which shall be connected only to luminaires installed away the main grounding cable. Such towers or poles might be affected by dangerous touch voltages in case of earth fault on the high voltage supply system, if no separated earthing would be adopted.

The unity ratio isolating transformers shall be installed in the supply substations.

The exposed conductive parts of them shall be connected to the substations grounding; the isolation of the secondary winding versus primary winding, core and exposed conductive parts shall be for 3,6 kV rated voltage (8 kV test voltage).

The neutral or intermediate point of the secondary winding of the isolating transformer shall not be connected to the main grounding cable.

One point of the secondary winding (neutral or intermediate point) of the isolating transformer shall be connected to a grounding cable which shall be separated and independent from the main one (one grounding cable is independent versus another one if it doesn't reach a voltage higher than 50 V during the operation of the first one).

This separated grounding cable may be that of the tower or of that of the poles.

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Grounding cable and supply cable between substation and circuit grounding point shall have the same isolation level to ground as the secondary winding; a multicore cable may be used, having an external sheath with the said isolation.

An earth fault sensing device shall trip- off the primary of the isolation transformer in case of fault on the lighting circuit.

10 AUTOMATIC LIGHTING CONTROL

In each substation supplying lighting circuits a common photoelectric cell-operated relay shall be provided, to control lighting.

The outdoor lighting fixtures shall be controlled by photoelectric cell system, with automatic, manual and OFF modes. The control of the normal and of the emergency outdoor lighting fixtures shall be carried out by selector switches in the front side of the main distribution board, enabling the selection between manual and auto operation. Auto operation shall be possible from photocell and from timer switch.

11 MEASUREMENT OF LIGHT

11.1 Preparation for the Survey

In roadway and floodlight installations the light is projected in a direction forming a large angle of incidence with the surface to be lighted, therefore each luminaire shall be adjusted carefully to permit the best utilization, before carrying out the field measurement of illumination.

For illumination measurements the contractor shall be ready to perform the following:

- to inspect and to record the condition of the luminaires (globes, reflectors, refractors, lamp positions, electric connections, grounding connections);
- to record the mounting height and spacing of luminaires;
- to record the location of poles by numbering them, the lamp output rating and other pertinent data,
- to check these recorded data against the recommended layout,



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- to determine and to record the hours of operating of the installed lamps (at least 100 hours of operation for high intensity discharge lamps shall elapse, before measuring are taken),
- to wait that the night atmospheric conditions are the best from visibility point of view, with all luminaires lighted, for at least one hour, to be sure that nominal operating output has been attained,
- to record the voltage at lamp sockets for a 30% of installed lamps and the voltage at the main switch, providing that allowance is made for the voltage drop to individual units (if the measured or calculated voltage drop is not exactly within the allowed voltage rating of the lamp, the lux readings obtained shall be the corrected according to lamp Manufacturer's data).

11.2 Survey Procedures

Measurements shall be made by an experienced operator with a properly calibrated visual illuminometer, corrected for colour and angle of incidence.

For the measurements it shall be necessary:

- a) To level the test plate before taking measurement at each station;
- b) To place the test plate on a firm support and to take readings at each of the test stations, located not more than 150 mm above pavement and in the center of each rectangle sized as follows:
 - For roadway, the longitudinal distance
 - Between poles (spacing) shall be divided in even number of divisions as close to 3 meters as possible and the road width divided in 3, 4 and 6 lanes for one sided, staggered or opposite luminaire arrangements respectively.
 - The rectangles shall be formed by crossing the above divisions and lanes,
 - For other locations, the same criteria,
 - Above described, can be adopted, providing that the test station be at the center of a rectangle, whose major side is no longer than 4,5 m,
 - For vertical surface it will be enough the



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357-359 Messogion Av., GR 152 31 Halandri
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Fax: 210 674 9504
Email: desfa@desfa.gr

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- Readings at accessible locations, 3 m apart from each other, and a satisfactory illumination perceivable by the eye for the remaining non-accessible locations.
Enough readings shall be taken so that the additional readings in similar locations will not change the average results significantly;
- c) To avoid casting shadow on the test plate during the reading.
The photometer shall have its calibration checked immediately before and after the test and preferably one or more times during the test.
The readings on the illuminator meter shall be checked at frequent intervals; more consistent readings are obtained if the comparison lamp operates continuously during the test.
Several readings shall be taken at each station and the average should be recorded.
The average horizontal illumination will be the quotient of the total illumination, obtained by adding together the average level of each station, divided by the corresponding number of readings.

12 ELECTRIC FIELD TESTS

Electrical field tests shall comply with requirements of Specification “General Electrical Works”.

DEFINITIONS (according to IEC 60050)

Luminaire: apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply.

Illuminance: quotient of the luminous incident on an element of the surface containing the point, by the area dA of that element.

Luminance: the luminous flux of an elementary source in one direction, divided by the apparent surface area of this source in the direction being considered

Distribution of luminous intensity (of a source): display, by means of curves or tables, of the value of the luminous intensity of the source as a function of direction in space.



Hellenic Gas Transmission System Operator S.A.
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- A vertical luminous intensity distribution curve is obtained by taking measurements at various angles of elevation in a vertical plane through the light center.
- A horizontal luminous intensity distribution curve represents measurement made at various angles of azimuth in a horizontal plane through the light center.

Beam angle: the solid angle of the cone-shaped beam of electrons emerging from the crossover point

Beam spread: In any plane, the angle between the two directions in which the luminous intensity is equal to a stated per cent (usually 10%) of the maximum luminous intensity.

Cut - off: technique used for concealing lamps and surfaces of high luminance from direct view in order to reduce glare

Semi - cut off: The luminaire category when the luminous intensity beyond the limiting transverse roadway lines does not numerically exceed 30% of the rated lumens of the light source.

Glare: condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or to extreme contrasts

UNITS AND SYMBOLS

Quantity	Unit
• Luminous flux	lumen (lm)
• Luminous intensity	candela (cd)
• Luminance	candela per square meter (cd/m ²)
• Illuminance (illumination)	lumen per square meter (lm/m ²), lux (lx)