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TECHNICAL JOB
SPECIFICATION

740/1

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LNG PLANT

OUTDOOR LIGHTING (ROADWAYS BOUNDARY FENCES AND GENERAL AREAS)

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 2/15

QUALITY ASSURANCE PAGE

CHANGES LOG

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Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 3/15

CONTENTS

REFERENCE DOCUMENTS

- 1.0 SCOPE**
- 2.0 GENERAL**
- 3.0 CODES, STANDARDS AND REGULATIONS**
- 4.0 ENGINEERING DOCUMENTS**
- 5.0 BASIC DESIGN DATA**
- 6.0 LIGHTING DESIGN**
- 7.0 POWER DISTRIBUTION DESIGN**
- 8.0 EQUIPMENT AND MATERIAL**
- 9.0 INSTALLATION OF LIGHTING POLES AND TOWERS**
- 10.0 GROUNDING**
- 11.0 AUTOMATIC LIGHTING CONTROL**
- 12.0 MEASUREMENT OF LIGHT**
- 13.0 ELECTRICAL FIELD TESTS**

DEFINITIONS, UNITS AND SYMBOLS REFERENCES

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 4/15

REFERENCE DOCUMENTS

Job Spec. No. 700/5

EU DIRECTIVE 2006/95/EC, LVD
[Low Voltage Directive]

EU DIRECTIVE 2000/55/EC
[Energy efficiency requirements for ballasts for fluorescent lighting]

ELOT EN 12464-2
[Light and lighting - Lighting of work places - Part 2: Outdoor work places]

ELOT EN 50005
[Low Voltage Switchgear and Controlgear for Industrial Use; Terminal Marking and Distinctive Number, General Rules]

ELOT EN 50011
[Low voltage switchgear and controlgear for industrial use; Terminal marking, distinctive number and distinctive letter for particular contactor relays]

ELOT EN 50022
[Low voltage switchgear and control gear for industrial use. Mounting rails. Top hat rails, 35 mm wide, for snap-on mounting of equipment]

ELOT EN 50013
[Low voltage switchgear and controlgear for industrial use; Terminal marking and distinctive number for particular control switches]

ELOT EN 50035
[Low voltage switchgear and controlgear for industrial use. Mounting rails, G-profile for the fixing of terminal blocks]

ELOT EN 50042
[Low voltage switchgear and controlgear for industrial use. Terminal marking. Terminals for external associated electronic circuit components and contacts]

ELOT EN 50045
[Low voltage switchgear and controlgear for industrial use. Mounting rails. Top hat rail, 15 mm wide for the fixing of terminal blocks]

ELOT EN 60188
[High-pressure mercury vapour lamps - Performance specifications]

ELOT EN 60529
[Degrees of protection provided by enclosures (IP code)]

ELOT EN 60923
[Auxiliaries for lamps - Ballasts for discharge lamps (excluding tubular fluorescent lamps) - Performance requirements]

ELOT EN 61347-1
[Lamp controlgear - Part 1: General and safety requirements]

ELOT EN 61347 -2-9
[Lamp controlgear - Part 2-9: Particular requirements for ballasts for discharge lamps (excluding fluorescent lamps)]

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 5/15

IEC 60050

[International Electromechanical Vocabulary]

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»)

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»)

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 6/15

1.0 SCOPE

This specification specifies the basic design criteria for outdoor lighting installations of roadways, boundary fences, general open yards and parking spaces, in unclassified locations with respect to the hazard of explosion and fire.

The principal purpose of the outdoor lighting installations specified herein is to provide accurate and comfortable seeing at night. The pedestrian must be able to see distinctly the edges of walkways, vehicles and obstacles.

The driver must be able to see distinctly and identify with certainty and in time all significant details; notably the alignment of the road (its direction and surrounds) and any possible obstacles in or about to enter the roadway.

The watchmen (patrollers) must be able to see distinctly any movement along the boundary fence, such as the entry of non-authorized persons. When designing the lighting installations particular attention must be paid in avoiding, as far as possible, any stroboscopic effects and glare effects, which can produce a sensation of ocular discomfort.

2.0 GENERAL

This specification shall be read in conjunction with the **Job Specification No. 700/5**, as far as applicable to the particular scope of work.

3.0 EU, NATIONAL LEGISLATION AND EUROPEAN / INTERNATIONAL STANDARDS

Legislation as specified in **Job Specification No. 700/5** shall apply.

3.1 PARTICULAR EUROPEAN / INTERNATIONAL STANDARDS

Unless otherwise specified in the Material Requisition (MR), the following recommendations and standards shall be considered.

ELOT EN and IEC (issued by the International Electrotechnical Commission) Standards. The most standards relevant to the scope of this specification are:

- ELOT EN 60188 (IEC 60188)
- ELOT EN 60529
- ELOT EN 60923 (IEC 60923)
- ELOT EN 61347 -1 and -2-9

4.0 ENGINEERING DOCUMENTS

4.1 ENGINEERING DOCUMENTS BY CONTRACTOR AND/OR BY MANUFACTURER/VENDOR

The following documentation shall consist part of the electrical engineering work and shall be furnished as a minimum, but not be limited to:

- one line diagrams,

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 7/15

- equipment specifications and material requisitions (MR),
- load data list and load computation,
- cable schedule for underground and above ground cable layouts,
- lighting layouts,
- lighting design calculations.

4.2 GENERAL REQUIREMENTS FOR ENGINEERING DOCUMENTS

Job Specification No 700/5 shall apply.

5.0 ENGINEERING DOCUMENTS

Chapter 5 of the Job Specification No. 700/5 shall apply.

6.0 LIGHTING DESIGN

Lighting design shall be according to the Hellenic Legislation Ministerial Decree for "Improvement of Energy Performance in Public Buildings" (Y.A. Δ6/B/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»

6.1 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**, and shall not be less than:

Classification of area	Illumination level-lux
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 (*)
(*) 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.

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 8/15

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.

6.2 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

6.3 LUMINAIRE LIGHT DISTRIBUTION

6.3.1 GENERAL

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

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).

6.3.2 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

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 9/15

as pedestrian or driver, can affect largely annoyance, discomfort or loss of visual performance and visibility in different degree, starting from fully uncomfortable (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.

6.3.3 INTERFERENCES WITH ON-SITE AND OFF-SITE AREAS AND WITH PUBLIC ROADS

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.

7.0 POWER DISTRIBUTION DESIGN

7.1 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 phase 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.

7.2 SIZING AND INSTALLATION OF DISTRIBUTION CIRCUITS

7.2.1 SIZING OF CONDUCTORS

General requirements for conductor selection and sizing shall comply with **chapter 22 of Job Specification No. 700/5.**

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 10/15

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%; a voltage drop 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%.

7.2.2 INSTALLATION OF LIGHTING CIRCUITS

Lighting cables shall be generally laid directly buried and shall comply with requirements of **Job Specification No. 700/5**. The grounding cable shall be laid in the same trench, close to the lighting cables (for grounding details, see **chapter 10** of this specification).

8.0 EQUIPMENT AND MATERIAL

8.1 LUMINAIRES

8.1.1 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 54.

8.1.2 LUMINAIRES

High Intensity Discharge (H.I.D.) 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.

8.1.3 FLOODLIGHTS

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

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

8.2. TYPE OF LAMPS

Lamps shall be 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»).

8.3 LIGHTING TOWERS AND POLES

8.3.1 LIGHTING TOWERS

Towers shall be made in hot dip galvanized metal pipe.

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 11/15

Relamps and maintenance operations may be:

- a) 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;
- b) 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.

8.3.2 LIGHTING POLES

The luminaire shall be mounted at suitable height on poles made of steel reinforced concrete or in hot-dip galvanized metal.

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

8.4 **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 45. 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.

9.0 INSTALLATION OF LIGHTING POLES AND TOWERS

9.1 **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.

9.2 **FOUNDATIONS**

Steel armored 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.

10.0 GROUNDING

In general requirements set forth in **chapters 24 and 25 of Job Specification No. 700/5** shall be complied with.

The following particular requirements shall be considered.

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 12/15

10.1 GROUNDING OF LIGHTING TOWERS, POLES AND LUMINARIES

10.1.1 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.

10.1.2 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).

10.2 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.

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 13/15

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 an other 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.

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.

11.0 AUTOMATIC LIGHTING CONTROL

In each substation supplying lighting circuits a common photoelectric cell-operated relay shall be provided, to control lighting. Selector Switch shall be provided for Hand-Off-Automatic selection.

12.0 MEASUREMENT OF LIGHT

12.1 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,
- 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,

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 14/15

- 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).

12.2

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 meter 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 not longer than 4,5 m,
 - For vertical surface it will be enough the
 - 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.

13.0

ELECTRIC FIELD TESTS

Chapter 29 of the **Job Specification No. 700/5** shall apply.

Job Spec. No 740/1
Revision 0
Date 29-06-2011
Page 15/15

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 flux $d\Phi_v$ 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.

- 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-cutoff: 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)