

IMPLEMENTATION SPECIFICATION FOR ROAD WORKS

SERIES IM/1400 (IMPLEMENTATION) ELECTRICAL WORK FOR ROAD LIGHTING AND SIGNS



*This Specification Series implements the requirements in
Subsidiary Legislation 499.57, Part II (New Roads and Road
Works Regulations) in accordance with the Agency for
Infrastructure Malta ACT XXVIII, CAP. 588, Part I*

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1400 ELECTRICAL WORK FOR ROAD LIGHTING AND TRAFFIC SIGNS

1401 General

1 Materials equipment and workmanship required under the Contract shall comply with BS 7671 Regulations for Electrical Installations (IEE Wiring Regulations) and the rules and regulations of the electricity supplier who provides the supply. The installation and maintenance of electrical apparatus and cabling for road lighting and traffic signs shall comply with the quality management scheme detailed in Appendix A. The Contractor shall take into account Engineering Recommendation G.39/1 'Model Code of Practice covering Electrical Safety in the Planning Installation, Commissioning and Maintenance of Public Lighting and Other Street Furniture'. Other relevant requirements are contained in the Electricity at Work Regulations, 1989.

The Contractor shall employ only competent personnel each of whom holds a "Competent Persons Authorisation Certificate" in accordance with the model form in Appendix B of the above document G.39/1, but modified as specified below, which has been duly completed by the Contractor and authorised by a designated responsible person in the Authority or company as defined in Clause 2 of G.39/1, all in accordance with Clause 10 of G.39/1. The form of certificate as specified above shall be modified on page B2 of G.39/1 by insertion of the following after the space for 'Name and Address of Employer':

"Name of Authority or Company....."

In addition to the requirements of sub-Clauses 10.2 and 10.3 of G.39/1, each Competent Person as defined in G.39/1, Clause 2, shall be provided by the Contractor with not less than one copy of the above certificate, duly completed and signed as Approved, and such certificate(s) shall be retained and be available at all times for inspection on the Works on request by the Overseeing Organisation. A suitable Work Allocation Record shall be kept by the Contractor to enable works to be identified with the operatives and supervisors responsible for those works.

2 The following definitions shall apply:

- a) Road Lighting Units shall consist of the following: column, bracket, wall mounting, Electrical Equipment as defined in (d) below and wiring excluding electrical supply cable.
- b) Lit Sign Units shall consist of a traffic sign, refuge beacon, Belisha beacon, illuminated centre island post, illuminated permanent bollard, illuminated guard post, school crossing warning lights and river navigation lights requiring an electricity supply and Electrical Equipment and wiring as in sub-Clause 2(a) above.
- c) The term Lighting Unit applies to both Road Lighting Units and Lit Sign Units.
- d) Electrical Equipment for Lighting Units shall consist of the following: luminaires, photo-electric control units (PECUs), Central Management System (CMS) Control Devices,

shorting plugs, lamps, time switches, ballasts, ignitors, starters, capacitors, cut-outs, fuses, fuse holders, flasher units, lamp holders and miniature circuit breakers (MCBs). The network is the electrical distribution system installed by the Contractor from the electricity supplier's interface to the Lighting Units.

- 3 Each network shall operate on a single phase 230V -6% to +10% or three phase 400V - 6% to +10%.
- 4 The *Contractor* shall provide facilities for the electricity supplier for service connections and commissioning of the network.
- 5 A dedicated feeder pillar shall be provided for the *Overseeing Organisation's* network. Supplies provided to electrical equipment and lighting units for third parties shall not be connected to the *Overseeing Organisation's* network. Where required, and described in Appendix 14/2, electrical isolation pillars shall be provided on the network at the maintenance boundaries between the *Overseeing Organisation* and third parties, with the prior agreement of the *Overseeing Organisation*.

1402 Site Records

- 1 In accordance with the requirements of the Electricity at Work Regulations the *Contractor* shall, on the completion of the electrical work, provide a set of as-installed drawings or transparencies showing as a minimum the position and identification mark (including luminaire type, modification status, lamp setting, lamp type and serial numbers) of equipment requiring electrical connections, ducts, underground cables and joints and the type and depth of cables. The *Contractor* shall also supply test certificates and Operation and Maintenance manuals. Any additional requirements for records shall be as described in Appendix 14/1.
- 2 Locational measurements shall be taken of the underground equipment to the nearest 100 mm from the nearest edge of the carriageway or fence line. Offsets to cables and ducts shall be recorded at 20 m intervals along their line. Offsets shall be defined longitudinally by distance from a permanent highway feature, a marker post or other suitable point.
- 3 The *Contractor* shall keep a daily record of the work in sufficient detail, including the type and drum number of underground cables, to enable site records to be completed. A copy of the daily record shall be provided by the Contractor on the next working day for retention and use by the *Overseeing Organisation*.
- 4 The *Contractor* shall supply to the *Overseeing Organisation* one master and two prints of the 'as-built' drawings of power supply arrangements for road lighting and traffic signal installations immediately upon completion of the installation work.

1403 Location of Lighting Units and Feeder Pillars

- 1 The position of Lighting Units and feeder pillars is described in Appendix 14/2. The exact location will be agreed on site before commencement of any associated ground work. The Contractor shall be responsible for recording the actual location.
- 2 In cases where the location of an item has been determined as indicated above and it is impossible because of underground obstruction to install the item then any excavation shall be backfilled and reinstated to its original condition.

1404 Change of Lighting Arrangements

- 1 No Lighting Unit shall be switched on or off, dismantled, resited, replaced or removed without prior approval of the Overseeing Organisation.

1405 Temporary Lighting

- 1 The standard of temporary Lighting Units shall conform to the Clauses in this Series and Appendix 14/3.
- 2 The *Contractor* shall ensure that any temporary lighting he provides does not cause glare to traffic using any highway nor annoyance to occupants of surrounding property.

1406 Radio Interference

- 1 Electrical equipment shall be installed so that levels of radio interference given in MSA EN 55014-1 are not exceeded.

1407 Luminaires

- 1 The General Requirements of a Luminaire are as stated below:
 - a) The supplier shall guarantee the luminaire and its internal components including the LED driver for at least 10 years.
 - b) The luminaire shall have an Elexon charge code.
- 2 Luminaires for road lighting shall:
 - a) comply with MSA EN 60598-2-3;
 - b) be fitted in accordance with manufacturers' instructions with no gap between the luminaire and the shoulder of any bracket arm;
 - c) for the luminaire optical system (lamp housing), have a degree of protection rating IP 66 to MSA EN 60529;
 - d) for the luminaire control gear housing, have a degree of protection rating IP 66 to MSA EN 60529

- e) not have the IP rating compromised due to cable connections. The *Contractor* shall provide glands to maintain the IP rating of the fitting during installation. This shall include glands for both single and multicore cables;
 - f) have an IK08 rating to MSA EN 62262;
 - g) be fitted with a 7 pin NEMA socket located in the canopy;
 - h) have a modular design so that components are replaceable upon failure, when life expired or redundant. For example, as below:
 - i) Drivers
 - ii) Lamp (LED or otherwise) panel/module
 - iii) Diffuser
 - iv) Reflectors/Refractors
 - v) Surge Protection
 - i) be designed to maintain the International Protection (IP) rating throughout their lifecycle and not degrade due to maintenance and periodic testing;
 - j) have adaptable mounting options side-entry or post top adjustable in 5°C increments between + 10°C and -10°C;
 - k) have terminals that are large enough to accommodate two conductors of 4 mm² cross-sectional area;
 - l) have a suitable control device with a switching of 35/18 Lux;
 - m) have provision for additional fixings through the use of chains or lanyards where lids are removable;
 - n) have captive fittings for diffusers and lids; and
 - o) be in Black (RAL9005) or Signal Grey (RAL 7004) or Galvanised.
- 3 Luminares for Traffic Signs shall comply with MSA EN 12899-1, Appendix 12/1, and the following:
- a) External lighting luminaires shall be correctly positioned to meet the luminance requirements of the sign and;
 - b) Mean sign luminance shall be as required in the Maltese National Annex to MSA EN 12899- 1 unless otherwise stated in Appendix 12/1.
- 4 The Electrical Requirements Luminaires are as follows:
- a) The primary nominal supply voltage (U_o) shall be 230 V AC. The Contractor shall state the range in voltage that the luminaire can operate under;
 - b) Leakage currents must comply with MSA EN 60598-1 Section 10;
 - c) The power factor shall be greater than or equal to 0.9;
 - d) The supplier shall state the total power consumption in watts;
 - e) Must employ a Constant Light Output (CLO) driver;
 - f) The luminaire and all associated internal components shall be protected from electrical faults and surges without causing disruption to other luminaries on the same circuit;

- g) The luminaire shall conform to Class B requirements for Conducted and Radiated Emissions in compliance with MSA EN 55011;
 - h) The luminaire shall be resilient to fast transient bursts with the following characteristics and in accordance with MSA EN 61000-4-4:
 - i) Peak Voltage ± 4 kV
 - ii) Rise time 5 ns
 - iii) Pulse width 50 ns
 - i) The luminaire shall be resilient to electrical surges with the following characteristics and in accordance with MSA EN 61000-4-5:
 - i) ± 4 kV Common Mode
 - ii) ± 2 kV Differential Mode
 - iii) Rise time 1.2 μ s
 - iv) Pulse width 50 μ s
 - j) The luminaire shall be resilient to electrostatic discharges with the following characteristics and in accordance with MSA EN 61000-4-2:
 - i) ± 6 kV Contact Discharge
 - ii) ± 8 kV Air Discharge
 - k) Surge Protection shall be 8 kV Common. Mode and 6 kV Differential. Mode to IEC 61000-4-5; 10 kV Single Pulse.
- 5 The Luminaire's declaration of performance shall include:
- a) Luminaire manufacturer;
 - b) Model type/reference;
 - c) Housing material;
 - d) Fixing type (e.g. post-top or side-entry);
 - e) Fixing angle of inclination;
 - f) Optic type;
 - g) Optic distribution setting/matrix reference;
 - h) Diffuser type (e.g. full cut-off flat glass polycarbonate bowl);
 - i) Control gear type (e.g. electronic);
 - j) Control gear housing (e.g. integral or remote);
 - k) Control gear compartment IP (Ingress Protection) rating;
 - l) Lamp compartment IP (Ingress Protection) rating;
 - m) Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK) rating;
 - n) Luminaire weight;
 - o) Luminaire windage area; and
 - p) Lighting control fitting (e.g. photocell NEMA socket mini-photo cell CMS node).

1408 Lamps

- 1 Lamps shall be compatible with the luminaires used.
- 2 The initial luminous flux of a lamp multiplied by the lamp flux maintenance factor for the projected lamp life shall be taken as its light output for road lighting design.
- 3 Lamps shall be specified in Scheme-Specific Appendix 14/4.

Lamps for Road Lighting

- 4 Low pressure and high-pressure sodium vapour lamps shall comply with MSA EN 62035.
- 5 LED lamps shall comply with MSA EN 62504.

Photometry of LED Lamps

- 6 LED Lamps must be suitable for achieving the requirements set in MSA EN 13201-2 and the design and instruction by the *Client*.
- 7 The light output shall have a minimum Colour Rendering Index (CRI) of 70.
- 8 The colour temperature range shall be between 3000 K and 4000 K.
- 9 The initial and maintained chromaticity coordinate values shall not exceed a 3-step MacAdam ellipse.
- 10 The *Contractor* shall use Type C Goniophotometer measurement to provide IES/LDT files for lighting design.
- 11 The *Contractor* shall be able to provide luminaire data (IES/LDT) files for importing into lighting design software packages such as, but not limited to Lighting Reality, DIALux and RELUX used by the *Client*.
- 12 The S/P ratio shall not be less than 1.
- 13 The Luminaire's luminous intensity class (glare rating) must be a G6 in accordance with Annex A of MSA EN 13201-2. So preferably the luminaire shall be classified as being of the 'Full Cut-off' type (as defined by the Illuminating Engineering Society of North America (IESNA)).

Performance of LED Lamps

- 14 The luminous output shall be calculated by taking the total amount of light emitted from the whole unit including any optical components.
- 15 The electrical power of the luminaire shall be taken as power consumption of the entire luminaire including the control unit.
- 16 The minimum luminous efficacy shall be no less than 120 lumens per circuit watt using the definitions of lumens and electrical power stipulated in sub-Clauses 14 and 15 above.
- 17 The luminaire shall have a light output ratio greater than or equal to 0.9 over the life of the product.

- 18 Testing of efficacy, minimum light output power factor and standby power must be conducted on the complete product (e.g. solid-state LED device(s) luminaire and associated electronic control gear) and under normal operating conditions.

Environmental Performance of LED Lamps

- 19 The luminaire shall be designed to operate at ambient temperatures of -10°C to 50°C.
20 Provide optical thermal management between optics and control gear.

Reliability of LED Lamps

- 21 The Abrupt Failure Value (AFV) of the luminaire at 50000 hours shall be less than or equal to 10%.
- 22 All components including the driver shall have a minimum rated life of 100000 hours.
- 23 A failure fraction B30 or 70% shall be used for all lumen maintenance values reported.
- 24 All lumen maintenance values shall be given in respect to L90.
- 25 The luminaire shall provide a minimum of 100000 hours of L90 performance verified by demonstrating to a 90% level of confidence that the 100000-hour success probability is 0.5 or 50% when subjected to a maximum operating temperature of 50°C and mean operating current.

Programmable Control Gear LED Luminaires

- 26 The LED control driver must be programmable and dimmable.
27 The LED driver circuits shall be thermally separated from the LED modules.

1409 Photo-electric Control Units (PECUs)

- 1 Photo-electric control units (PECUs) shall comply with BS 5972. They shall have differential switch on - switch off levels as described in Appendix 14/4. They shall be designed where possible so that in the event of a fault occurring in the unit they cause the load to be switched 'on'.
- 2 PECUs shall:
- a) be secured as appropriate to the:
 - i) road lighting luminaire canopy;
 - ii) top of pole located close to feeder pillar;
 - iii) top of sign post;
 - iv) internally illuminated sign housing; or
 - v) luminaire of externally illuminated sign;
 - b) include a delay device to prevent the lamp being switched in response to transient changes in light conditions;

- c) be indelibly marked with the (a) manufacturer's identification mark (b) model number and (c) switch on level;
 - d) be provided with a gasket or grommet to maintain the IP protection rating of the luminaire;
 - e) be installed to the manufacturer's instructions.
- 3 Where luminaires are a pair mounted on twin arm brackets, unless otherwise specified in Appendix 14/4, one luminaire shall be fitted with a PECU to control both luminaires and the other luminaire shall be fitted with a shorting plug. The luminaire to be fitted with the shorting plug shall be as described in Appendix 14/4.
- 4 Where described in Appendix 14/4, circuits shall be group switched as specified therein.

1410 Shorting Plugs (Dummy PECUs)

- 1 Shorting plugs shall:
- a) be interchangeable with PECUs;
 - b) have the line and load terminals permanently connected internally; and
 - c) be clearly distinguishable from PECUs.

1411 Time Switches

- 1 Time switches shall:
- a) be electrically or electronically driven;
 - b) have an electrically wound spring or battery reserve of not less than 12 hours unless otherwise described in Appendix 14/4;
 - c) be equipped with a solar dial suitable for the geographic location or equivalent means of setting and seasonal adjustment;
 - d) have 2 switched on/off periods per 24 hours;
 - e) be capable of switching a 10 A inductive load current at the specified operating voltage of the network.

1412 Ballasts

- 1 Unless otherwise specified in Appendix 14/4 ballasts shall comply with
- 2 MSA EN 61347-1, MSA EN 61347-2-1, MSA EN 61347-2-8, MSA EN 61347-2-9 and MSA EN 60921 or MSA EN 60923 as appropriate and be tap selected to the specified operating voltage of the network.
- 3 The terminals shall be indelibly marked to indicate all wiring connections and operating voltages.

1413 Ignitors for Discharge Lamps

- 1 Unless otherwise specified in Appendix 14/4, ignitors shall not be incorporated in the lamps.
- 2 Ignitor, lamp and ballast shall be mutually compatible.

1414 Starters for Fluorescent Lamps

- 1 Starters shall comply with MSA EN 60155 and shall be incorporated in the electrical equipment where applicable.

1415 Capacitors

- 1 Capacitors shall comply with MSA EN 61048 and MSA EN 61049 and be supplied complete with fixing clips, discharge resistors, and either sealed-in cable tails or shrouded terminals.
- 2 Capacitors shall correct the lamp circuit power factor to not less than 0.85 lagging.

1416 Cut-outs, Fuse Holders, Fuses and Miniature Circuit Breakers (MCBs)

- 1 Cut-outs, fuse holders and MCBs shall have moulded drip-proof housings to IP 31 or above.
- 2 Cut-outs shall be double pole and comply with BS 7654.
- 3 Terminals shall be sufficient for the conductors as described in Appendix 14/4. They shall be clearly labelled to differentiate circuits and phases.
- 4 When fuse holders are intended to be used as isolating devices, special tools or protective measures shall not be necessary to extract them.
- 5 Fuse links shall comply with the requirements of either MSA EN 60269-1, MSA EN 60269-2, BS 646/BS 2950, or BS 1361. They shall be of high breaking capacity type and be of a value specified in Appendix 14/4 to protect the circuit.
- 6 Miniature circuit breakers shall be in accordance with MSA EN 60898 and MSA EN 60947-2 for use on the specified operating voltage of the network at single or three phase as appropriate. Their short circuit current rating and type shall be as described in Appendix 14/4. Thermal or magnetic excess current tripping devices shall be provided with a mechanism to ensure that the contact cannot be held closed against a fault.
- 7 Where MCBs are intended to be used as isolating devices, a 'lock off' facility shall be provided.

1417 Base Compartment Fixing Arrangements

- 1 Electrical equipment described in Clauses 1411 to 1416 installed within the base compartment of columns or posts shall be positioned as described in Appendix 14/4 and Appendix 14/5 and fixed in accordance with manufacturers' instructions with corrosion resistant fixing screws.

1418 Feeder Pillars

- 1 Feeder pillars shall be constructed in the materials described in Appendix 14/4. They shall comply with IP 34 of MSA EN 60529. They shall include a full-size back board of varnished marine plywood at least 15 mm thick or other suitable non-hygroscopic material. Alternatively, a purpose-designed equipment mounting system may be used. The entry for cables shall be via the roof.
- 2 The distribution MCBs or fuse boards shall have sufficient spare capacity to accommodate at least one extra circuit. (One three phase spare way on a three-phase distribution unit and one single phase spare way on a single phase distribution unit). There shall be at least 25% usable spare space on the back board.
- 3 The feeder pillar shall be fitted with a suitably rated 1 to 3-phase and neutral switch fuse to MSA EN 60947-3 as appropriate for the supply cable.
- 4 The pillar doors shall be fitted with tamper-proof locks, all locks being identical in pattern and two sets of keys shall be provided. All hinges and locks shall be of stainless steel unless otherwise stated in Appendix 14/4.
- 5 Distribution boards shall be provided with an external earth, phase barriered and colour coded. They shall be fitted with the same number of live and neutral bus bar terminals as there are outgoing circuits plus at least one spare way.
- 6 Circuit details and labelling shall be provided in each feeder pillar as described in Appendix 14/4.
- 7 The main earthing terminal in each feeder pillar shall be connected to earth as described in Appendix 14/4.
- 8 Unless otherwise stated in Appendix 14/4, feeder pillars shall be mounted on a 150 mm thick foundation of ST2 concrete in compliance with Clause 2602. After completion of the cabling the feeder pillar base shall be filled to 25 mm below the door with rounded coarse aggregate conforming with Table 2 of MSA EN 12620, 4/14 aggregate with a grading category of GC90/15.
- 9 A durable warning sign indicating 'Danger 415 Volts' or 'Danger 240 Volts' as appropriate, shall be fixed to the front of the pillar where applicable.

1419 Wiring

- 1 All wiring and installation of components within the column, post or Lit Sign Unit shall be as described in Appendix 14/4 and Appendix 14/5.
- 2 Wiring between the terminal block in the luminaire and the components in the base of the column or sign unit shall be PVC or XLPE insulated and sheathed single, multi-core or composite cable to BS 6004 of 300/500 volt grade. Phase and neutral copper conductors shall be not less than 2.5 mm² in cross-sectional area except that where the vertical unsupported length does not exceed 6 metres their cross-sectional area may be reduced to 1.5 mm². Cable

- types and sizes shall be selected to ensure that the operation of the lighting systems shall not be adversely affected.
- 3 Where electronic ignitors are used with remote control gear, single core cable shall be used.
 - 4 The final connection between equipment mounted in the base compartment and the cut out shall be made using PVC or XLPE insulated and sheathed single core cable of a minimum cross-sectional area of 2.5 mm².
 - 5 All cables shall be correctly colour coded throughout their length and labelled appropriately at the feeder pillar and the cut-out.
 - 6 Unsupported lengths of cable shall be kept to a minimum and shall not be allowed to come into contact with components by their freedom of movement. Where there is more than one cable they shall be secured together at one metre intervals throughout the unsupported length. Vertical cables within posts or columns shall be adequately supported along their length at the top of the cable run.
 - 7 On double bracket columns the wiring shall connect PECU sockets in series, unless otherwise specified in Appendix 14/4.
 - 8 Wiring shall wherever possible be housed inside columns, wall brackets and posts or stiffening members. Where it is external it shall be as described in Appendix 14/4. Connections between conduit and sign housings, switchboxes and other components shall be waterproof and be smooth internally.
 - 9 All unused cores in cables shall be cut to a minimum length, long enough to connect to the furthest working-off point within the unit and shall be cut to equal length. The ends of the cores shall be tied together and sealed with self-amalgamating waterproof jointing tape. The unused cores shall be coiled and strapped in a suitable unobtrusive position.

1420 Earthing

- 1 Circuit protective and equipotential conductors shall be installed as shown on the Drawings and shall be green/yellow PVC or XLPE insulated or sleeved. Where bolted connections are required, these conductors shall be terminated in accordance with manufacturers' instructions in correctly sized purpose made lugs. Such connections shall be made with non-ferrous nuts, bolts and washers.
- 2 A circuit protective conductor shall connect the earth terminal on each luminaire to the main earth terminal associated with the service cut-out unit.
- 3 A separate circuit protective conductor of not less than 2.5 mm² cross-sectional area shall connect all metal enclosures of all electrical components to the main earth terminal.
- 4 All extraneous conductive parts, as described in BS 7671, and including doors to feeder pillars, lighting columns and lit sign units, shall be bonded to the main earth terminal using an equipotential bonding conductor of 6 mm² cross-sectional area when the lighting unit is directly serviced by a TN-C-S supply. Earth electrodes shall be installed where necessary.

- 5 All street lighting and other electrically supplied street furniture shall be earthed and bonded in compliance with BS 7430.

1421 Underground and Ducted Cable

- 1 Cables shall have XLPE insulation and sheathing material coloured in accordance with National Joint Utilities Group publication “Guidelines on the positioning and colour coding of utilities’ apparatus”. The identification of the conductors by colour shall be as per Table 51 of BS 7671 and every core shall be identifiable by colour throughout its length. The sheathing material shall be appropriate to the ground conditions in which it will be laid. In ground that is liable at any time to become waterlogged, then the sheathing material shall have an ASTM F1249-1 tested maximum permeability of 2.0 g.d-1-2, 90% R.H, 1mm. The cables shall be 600/1000 V grade with steel wire or aluminium strip armouring to BS 6346 or
- 2 BS 5467 and all conductors shall be of equal cross-sectional area. The Contractor shall provide to the Overseeing Organisation evidence that each cable length delivered to Site has been tested at the place of manufacture and complies with the testing requirements of BS 6346 or BS 5467 according to the cable used.
- 3 Service ducts shall be self-coloured in accordance with National Joint Utilities Group publication “Guidelines on the positioning and colour coding of utilities’ apparatus” and shall comply with Series 500 and Appendix 5/2.
- 4 Cable covers for protection of underground cables shall comply with BS 2484 and shall be installed as described in Appendix 14/4. When cable covers are installed, marker tapes are not required. Cable trenches shall be excavated to the lines described in Appendix 14/4 and in accordance with Clause 602. The depth of excavation shall be such that cables laid under verges, footways or open ground shall have a minimum cover of 500 mm and under carriageways of 750 mm or 300 mm below formation whichever is the greater depth.
- 5 Cables shall be laid without sharp bends and kinks and in accordance with any particular requirements in Appendix 14/4. If required, additional protection and support shall be provided as described in Appendix 14/4.
- 6 Where cables are laid across or within 500 mm of filter drains, they shall be contained within a duct. The duct shall be surrounded with 50 mm of ST2 concrete in compliance with Clause 2602.
- 7 Cables following the same route shall unless otherwise described in Appendix 14/4 occupy the same trench with a clearance of 50 mm between the outer sheath of the cables.
- 8 Power supply cables, other than those associated solely with the communications system, shall not be installed within 500 mm of signal or communication cables, within 300 mm of telecommunication cables or within 300 mm of HV cables, unless otherwise described in Appendix 14/4.

- 9 Cables shall only be laid when the ambient temperature is above 0°C, and the cable has been stored at a temperature greater than 0°C for the previous 24 hours.
- 10 Cables shall not be bent to an internal radius of less than 12 times the external diameter of the cable or less than the radius recommended by the manufacturer, whichever is greater.
- 11 Sufficient length of cable shall be allowed for its termination. When termination does not proceed immediately following the installation of the cable, its end shall be sealed against the ingress of moisture. If such cable ends are buried, their positions shall be marked with a permanent marker block consisting of a 300 mm square x 225 mm deep precast concrete block having a mark as described in Appendix 14/4 indented into its top surface and recorded on the site records.
- 12 When duct or trough alignments differ from those of the trench the transition from one to the other shall not exceed 1:30 horizontally or vertically.
- 13 Cables laid in trench shall, unless otherwise specified in Appendix 14/4, be both bedded on and covered by a 100 mm thickness of lightly compacted graded sand or equivalent material passing a 2 mm BS sieve. Class 8 material complying with Table 6/1 and compacted to the requirements therein shall then be deposited to a thickness of 175 mm prior to further backfilling in compliance with sub-Clause 16 of this Clause.
- 14 A yellow, self-coloured PVC or polythene plastic tape for cable marking, not less than 0.1 mm thick and 150mm wide with the wording "Street Lighting Cables Below" printed in black along the full length so as to occupy not less than 75% of its available length and occurring at least at 1 m intervals, shall be laid approximately 250 mm above any power supply cable. Where several cables are laid in one trench, only one line of marker tape need be installed.
- 15 Where cables are required to be laid in ducts the Contractor shall swab through the duct prior to drawing in the cables and a further draw rope. On completion of cabling, ducts shall be left with a draw rope in place and re-sealed with split plugs, or suitable alternative material, to adequately seal the ducts against the ingress of foreign matter. Where cables are laid in troughs they shall be covered with sand, or equivalent material, passing a 2 mm BS sieve up to the level of the cover.
- 16 Backfilling to cable trenches shall comply with Clause 602 and to prevent damage by the ingress of foreign matter shall whenever practical be undertaken immediately after the specified operations preceding it have been completed. The Contractor shall backfill above the cable marking tape, duct or trough with Class 1, 2 or 3 material complying with Table 6/1 and compacted to the requirements therein, except that he shall:
- a) spread and compact the material evenly without dislodging, disturbing or damaging cables, ducts or troughs; and
 - b) not use power rammers within 300 mm of cables, ducts or troughs.
- 17 Where described in Appendix 2/2, buried cables shall be taken up and removed by the Contractor. Conductors shall be disconnected from the equipment in which they are

terminated, the terminal screws and glands retightened, and the cable withdrawn clear of the equipment.

- 18 Unused cores in cables shall be dealt with as described in sub-Clause 1419.9.
- 19 Unless ducts terminate at cabinets or mounting posts or columns, their ends shall be marked as described in Appendix 5/2, with marker blocks complying with sub-Clause 11 of this Clause and location posts so that their location can be clearly identified without exploratory excavation.

1422 Cable Joints

- 1 Joints shall be made using jointing kits complying with MSA EN 50655-1 which shall be installed in compliance with BS 6910-2.
- 2 Prior to any cable laying, the Contractor shall provide evidence to the Overseeing Organisation of the jointer's competence in the use of the adopted cable joint kit. A record shall be kept to enable cable joints to be identified with the jointer responsible for the work.
- 3 Cable joints shall be made where described in Appendix 14/4. Additional joints shall not be provided on cables in duct or trough. Approval is required from the Overseeing Organisation for additional joints using other fixing methods.
- 4 Jointing shall only be carried out when all materials to be used in the jointing are free from visible signs of moisture and joints shall be left protected from the weather during the curing period.
- 5 Joints shall be adequately supported at all times. Backfilling shall not take place until the joint is fully completed in accordance with the manufacturer's instructions including curing times and is in a fit condition to withstand any stresses which may be imposed upon it.
- 6 Where described in Appendix 14/4, a cable joint marker block, as described in sub-Clause 1421.11 shall be placed over the cable joint and reference measurements taken from nearby permanent features.
- 7 All cable jointing shall be made under the protection of a specialist jointing tent.

1423 Armoured Cable Terminations

- 1 Cables shall be individually terminated and existing cables re-terminated, and secured at switches, cut-outs and other electrical apparatus by means of an armour securing clamp or an aluminium compression type gland complying with 'BS 6121-1, MSA EN 62444' and a gland plate, all as described in Appendix 14/4.
- 2 The armour securing clamp or compression gland and plate assembly shall incorporate at least one non-ferrous earthing terminal.
- 3 All glands shall be shrouded overall with PVC sleeves and the conductor shall be terminated with cable lugs.

- 4 An anti-oxidant mastic or paste protective coating shall be applied to all aluminium conductor terminals where they are exposed to the atmosphere.
- 5 Phase connections shall be clearly indicated by a suitable colour marking system.

1424 Inspection and Testing to be Carried Out by the Contractor

- 1 Every Lighting Unit and network, on completion and before being energised, shall be inspected and tested to verify that the requirements of BS 7671 have been met. The method of testing shall be such that no danger to persons or property or damage to equipment can occur even if the circuit tested is defective.
- 2 The following tests shall be carried out in the sequence indicated below and recorded on a Schedule, in an appropriate format, which shall be submitted to the Overseeing Organisation immediately after completion of all the tests, including those on Lighting Units, within each network:
 - a) For Lighting Units (ii), (iv), (vi), (vii) apply.
 - b) For networks (i), (ii), (iii), (v), (vi), (vii), (viii), (ix) apply.

Standard methods of testing are given in BS 7671.

- i) Cable sheath insulation test.
 - ii) Continuity of protective conductors including main and supplementary equipotential bonding.
 - iii) Earth electrode resistance.
 - iv) Insulation resistance at a test voltage of 500 V to be not less than 1.0 M ohm.
 - v) Insulation resistance at a test voltage of 500 V to be not less than 6 M ohm.
 - vi) Insulation of the site-built assemblies.
 - vii) Polarity, including the continuity of circuit conductors.
 - viii) Earth fault loop impedance at every cut-out.
 - ix) Operation of residual current devices.
- 3 The cable sheath insulation test shall be carried out using an insulation tester. The insulation resistance test of 1000 V, direct current, shall be applied and maintained for not less than one minute between the continuous cable armouring or earth conductor and the general mass of earth. The measured insulation resistance shall not fall below 1.0 M ohm for the full duration of the test. The cable sheath insulation test shall be carried out after the cable has been laid and the trench backfilled, but before jointing has taken place.
- 4 Voltage readings shall be taken at each feeder pillar and at the terminals of the last current-using equipment on each circuit, with all equipment energised.
- 5 The Contractor shall give not less than 7 days' notice to the Overseeing Organisation of his intention to carry out any of the tests specified and the Overseeing Organisation shall be given the opportunity to witness such tests.

- 6 The Contractor shall furnish the Overseeing Organisation with two copies of a certificate verifying compliance with BS 7671 upon satisfactory completion of the inspection and tests.
- 7 The Contractor shall ensure that all test instruments have been calibrated and adjusted in accordance with MSA EN ISO 9001 and come complete with calibration certificates to verify that MSA EN ISO 9001 has been complied with.

1425 Preparation and Finish of Metal and Other Surfaces

- 1 Electrical components and ancillary equipment shall be prepared and finished in compliance with sub-Clauses 1221.7 and 9.