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6 CABLES AND SMALL WIRING

6.1 GENERAL

6.1.1 Scope

- 1 This Part specifies the general requirements for power cables and small wiring systems. It shall be read in conjunction with other parts of the Project Documentation.
- 2 This particular requirement is to be read in conjunction with Specification for Underground Cables in PVC-u Ducts, plus Section 21 Part 30 Duct Bank and Manholes refers (but not limited to).
- 3 Related Parts and Sections are as follows:

This Section

Part 1..... General Provisions for Electrical Installations
Part 7..... Conduits
Part 8..... Trunking
Part 9..... Cable Trays
Part 10..... Wiring Accessories and General Power
Part 23..... Testing

6.1.2 References

- 1 Cables and wires shall comply with the following standards or updated/revised amended versions as appropriate:

BS 1442Galvanized mild steel wire for armouring cables (EN 10257-1)
BS 2484Straight concrete clay ware covers
BS 2897Aluminium strip armour for cables
BS 3506Unplasticised PVC pipe for industrial purposes (ISO15493)
BS 4066Tests on electric cables under fire conditions(IEC60332)
BS 4660Unplasticised polyvinyl chloride (PVC-u) pipes and plastic fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage
BS 5308Instrumentation cables.(EN 50288-7)
BS 5467(IEC 502) Cables with thermosetting Insulation for electricity supply for voltages of up to and including 600/1000 V and 19000/30000 V
BS 6004(IEC 227) PVC insulated cables (non-armoured) for electrical power
BS 6007Rubber insulated cables for electric power and lighting
BS 6207(IEC 245) Mineral insulated cables.
BS 6234Polythene insulation and sheath for cables.
BS 6346PVC insulated cables for electrical supply.
BS 6360(IEC 228) Copper conductors for cables.
BS 6500(IEC 227) Insulated flexible cords.
BS 6622(IEC 502) Cables with extruded cross linked polyethylene Insulation, for rated voltage 3800/6000 V up to 19000/30000 V
BS 6746PVC Insulation and sheath of electric cables
BS 6746CColour chart for insulation and sheath of electric cables
BS 6899Rubber insulation and sheath of electric cables

BS 7671Requirements for electrical installations

QGWECCLatest regulation

EN 29453Soft solder alloys-chemical composition and forms

ISO 9000Quality management and assurance standards

Cable terminations shall comply with the following specifications:

BS 1858Bitumen based compounds for electrical purposes

BS 4579Performance of mechanical and compression Joints in electric cable and wire connectors

BS 6121Mechanical cable glands for elastomer and plastic Insulated cables

BS 6910Cold pour resin compound and heat shrink cable joints in the voltage range up to 1000 V AC and 1500 V DC

IEC 60364 Low voltage electrical installations

6.1.3 Quality Assurance

- 1 The Contractor shall determine the correct size of cables to be used for the equipment selected, based on current rating and voltage drop, as relevant, after taking into consideration:
 - (a) type of cable and wire
 - (b) ambient conditions
 - (c) method of installation
 - (d) the disposition of each cable relative to other cables
 - (e) fault power level
 - (f) protective device ratings
 - (g) motor circuit voltage drop during starting.
- 2 Voltage drop and current ratings shall be calculated according to QGEWC Regulations or BS 7671 , IEC 60364 and IEE regulation, whichever is more stringent.
- 3 All cables and wires shall be suitable for installation and continuous service in the ambient conditions described in Part 1, and shall be manufactured to ISO 9000 or equivalent.
- 4 Approximate cable route lengths and equipment power ratings indicated on the Project Drawings shall be for calculating cable sizes for tendering purposes. The Contractor shall determine exact cable lengths from site measurements and calculate cable size from the power ratings of the actual equipment being proposed. The Contractor shall be responsible for any increase in costs or design work associated with proposed equipment which has different electrical characteristics than the equipment on which the design was based.
- 5 Cables from manufacturer whose product have been in satisfactory use in similar services in the state of Qatar for not less than 5 years shall be used only. Certificate of origin shall be submitted with the offer.

6.1.4 Submissions

- 1 Shop Drawings and Product Data:

- (a) submit full technical details including cable sizing calculations (Cable loading, voltage drop, thermal limit verification of cable under fault condition, overloading capability, protective devices ratings, motor voltage drop during starting, as a minimum) for each method of installation used on site, performed with an approved professional international recognized licensed software (Subject of Engineer's approval), and catalogue information of each type of cable or wire proposed for the Engineer's approval before ordering
- (b) submit copy of test certificates from the manufacturer or an independent testing authority confirming that cables comply with the Specifications.
- (c) submit exact route of the cable runs and relevant Sections in the shop drawings, including fixing details, termination details etc.

6.1.5 Products Delivery, Storage and Handling

- 1 Reference Part 1.
- 2 Each drum length of cable shall be allotted a distinct and separate reference number. This number shall appear on the test certificates covering the respective length of cable and shall also be clearly marked on the cable drum.
- 3 The Contractor shall advise the Engineer upon delivery to site of each drum length, quoting the reference number. The test certificates shall be handed to the Engineer for examination and approval.
- 4 All cables shall be delivered to site with the manufacturer's seals, labels, or other proof of origin intact. These labels and seals shall not be removed until the cable is required for use and shall be retained for inspection by the Engineer.
- 5 The Contractor shall be responsible for the off-loading and handling of the cables on site and shall ensure that cables are delivered to site on drums and properly protected against mechanical damage. Where lengths are cut from cables, the open cable ends shall be sealed.

6.2 PRODUCTS

6.2.1 Performance Requirements for Environmental Conditions

- 1 The Contractor shall be aware of the need to supply and install all wire and cables for this Contract which are most suitable for the special environmental conditions prevailing in Qatar.
- 2 All conductors shall have good fatigue resistance and not be subject to breaks due to nicks or cuts when terminating.

6.2.2 Cables

- 1 Unless otherwise specified, cables and wires of the following specified voltage ratings shall be used as indicated.
 - (a) 6350/11000 V rated cables : 11kV ring and radial circuit
 - (b) 600/1000 V rated cables : Main and sub-main distribution panels, motor control centres, circuits serving process equipment
 - (c) 450/750 V rated cables : Final sub-circuit supplies for lighting, socket outlets, etc.
 - (d) 300/500 V rated cables : Instrumentation

- (e) 250 V rated cables : Extra low voltage wiring, communication circuits where the maximum voltage is 50 V.
 - (f) Special screened and : Music/paging systems, Cable and TV system cable twisted pair conductors circuits
- 2 General:
- (a) conductors shall be high conductivity copper, to BS 6360 (IEC 228) unless otherwise indicated.
 - (b) copper conductors shall be stranded.
 - (c) signal control cables shall have solid conductors
 - (d) flexible cords shall have fine stranded conductors.
 - (e) conductor sizes shall be metric. Conductors with cross sectional areas smaller than those specified will not be accepted
 - (f) insulation for each conductor shall be colour coded or otherwise identified as required by the Regulations. Colour coding shall be maintained throughout the installation
 - (g) the current carrying capacity of conductors has been determined in accordance with the specified Regulations, the specified type of insulation and the expected conditions of installation
 - (h) all cables shall be as far as practicable, of one manufacturer only. All cables shall comply with the relevant IEC/BS.
- 3 600/1000 V rated PVC Insulated armoured cables.
- (a) PVC/SWA/PVC cable: 600/1000 V Grade, to BS 6346
 - (b) conductor: Annealed high conductivity copper, stranded, shaped and laid in an approved manner
 - (c) armour: Single layer of galvanised steel wires for multicore cables
 - (d) insulation: Colour coded to BS 6746C
 - (e) PVC for sheath and insulation to BS 6746
 - (f) cables shall be terminated with compression glands as specified below, giving adequate mechanical support by locking on the armour and ensuring a high earth continuity.
- 4 PVC Insulated PVC Sheathed (PVC/PVC) Cable.
- (a) to BS 6346, 600/1000V Grade, or to BS 6004, 300/500 V Grade
 - (b) flat twin and three core cable shall be to BS 6004 and incorporate an earth conductor placed between the red and black cores for two core cable and between the yellow and blue cores for three core cable
 - (c) conductor: annealed high conductivity copper, stranded, shaped and laid in an approved manner
 - (d) insulation: Colour coded to BS 6746C
 - (e) PVC for sheath and insulation : to BS 6746
- 5 Single core PVC Insulated Wires:
- (a) (cable shall be to BS 6004, rated 450/750 V, with high conductivity copper conductors and PVC compound insulation. Colour coding shall be in accordance with table 51 A of BS 7671

- (b) wires shall be continuous from outlet to outlet and no splice shall be made except within outlet and junction boxes. A separate neutral wire shall be provided for each circuit. Wires shall be left sufficiently long enough (minimum 150 mm) to permit making final connections.
- 6 Mineral Insulated Cable:
- (a) to EN 60702: Part 1, rated 600/1000 V
- (b) cable shall comprise of a pressure packed magnesium oxide insulation contained within a continuous soft ductile copper sheath and copper conductors embedded in the dielectric in standard formation
- (c) cable termination kit shall comprise of conductor insulation of neoprene sleeving retained by cone shaped beads beneath a fibre sealing disc. Each conductor shall be identified with regard to phase etc., by means of sleeving placed over the neoprene insulation
- (d) cable seals shall comprise of screw-in-pot type seals, with brass ring glands designed to accommodate the pot seal.
- 7 Terminals:
- (a) for cable up to 6 mm²: two screw pinching type
- (b) for cable over 6 mm²: grip lug type cable sockets
- (c) brass saddles: purpose made, two fixing screw type.
- 8 Heat Resistant and High Temperature cable:
- (a) to BS 6500, or BS 6004 300/500 V grade, designated EPR (ethylene polypropylene rubber) insulated HOFR sheathed, 85 °C or EPR insulated OFR sheathed, 60 °C. Conductor(s) shall be flexible class 5 tinned copper to BS 6360. Insulation shall be type GP.1 to BS 6899. Outer sheath shall be HOFR (heat, oil, fume resistant) or OFR (oil and fume resistant) sheath type RS3 to BS 6899 and flame retardant to BS 4066 Part 1, temperature rating 60 ° or 85 °C
- (b) high temperature cable shall be to BS 6500 or BS 6007, designated 300/500 V grade silicone insulated glass braided, 180 °C. Conductors shall be flexible class 5 tinned copper to BS 6360. Insulation shall be silicone rubber type EI 2 to BS 6899. Outer sheath shall be treated glass fibre braid, temperature rating 180 °C.
- 9 Flexible Cable:
- (a) to BS 6007, or BS 6500, rated in accordance with manufacturer's tables
- (b) flexible cables subject to excessive heat shall be insulated as (8) above, (a) or (b) as per the Project Documentation requirement.
- 10 600/1000V rated XLPE Insulated Cable
- (a) to BS 5467, 600/1000V grade, designated XLPE/SWA/PVC for armoured multicore cable, and XPLE/PVC for unarmoured cable
- (b) conductors : plain annealed copper to BS 6360
- (c) cable shall comprise of plain copper, stranded circular conductors insulated with an adequate thickness of extruded cross linked polyethylene (XLPE)
- (d) conductors shall be laid up together and warmed circular with suitable performed fillers and warnings, bound with polythene terephthalate (PTP) tape and covered with an extruded PVC sheath, minimum 1.4 mm thick for multicore cable

- (e) armoured multicore cable shall have steel wire armouring and extruded sheath of black PVC
- (f) armoured single core cable shall have aluminium wire armouring and extruded sheath of black PVC
- (g) outer sheath of single core cables shall be at least 2.5 mm thick
- (h) conductor screen : non-metallic comprising either semi-conducting tape or a layer of extruded semi-conducting material
- (i) prevent void formation in insulation by careful control of its passage through temperature graded water baths
- (j) cable shall be terminated with compression glands as specified below, giving adequate mechanical support by locking on the armour and ensuring high earth continuity.

11 6350/11000V Cable

- (a) cable shall be armoured type, rated 6350/11000 Volts, and shall comply with BS 6622. Single core cable shall be designated 11 kV XLPE/AWA/PVC. Multi-core cable shall be designated 11 kV XLPE/SWA/PVC
- (b) conductors shall be stranded copper complying with BS 6360, covered with a semi-conducting screen extruded on to the conductors
- (c) insulation shall be extruded cross linked polyethylene suitable for continuous operation at 90 °C, able to accept a final temperature of 250 °C in the event of a short circuit, and covered with a screen consisting of an extruded semi-conducting layer and a copper tape layer
- (d) armoured cables shall have a secure bedding, over the core or core assembly, for the armour. For single core cable, the bedding shall consist of a PVC sheath. For multi-core cable, the bedding shall consist of non-hygroscopic fillers
- (e) single core cable shall have aluminium wire armour. Multi-core cables shall have galvanised steel wire armour. Cable shall be covered with a red coloured PVC sheath
- (f) electrical design stress at any point in the insulation shall not exceed 3 kV per mm

12 Instrumentation Cables - Analogue Signals:

- (a) to BS 5308 part 2 (EN 50288-7), type 2,300-500 V
- (b) Single /Multi stranded copper conductor 1/0.8 mm.
- (c) polyethylene insulation
- (d) individual screen of aluminium backed polyester tape with tinned copper stranded drain wire
- (e) collective screen of aluminium backed polyester tape with tinned copper stranded drain wire
- (f) extruded PVC bedding
- (g) galvanised steel wire armour
- (h) PVC outer sheath, gray/black
- (i) core identification as BS 5308 Part 2-(EN 50288-7)

13 Instrumentation Cables - Digital Signals:

- (a) to BS 5308 part 2 (EN 50288-7), type 2 300-500 V
- (b) Single/Multi stranded copper conductor 1/0.8 mm

- (c) polyethylene insulation
- (d) collective screen of aluminium backed polyester tape with tinned copper stranded drain wire
- (e) extruded PVC bedding
- (f) galvanised steel wire armour
- (g) PVC outer sheath, Gray/black
- (h) Core identification as BS 5308 Part 2 (EN 50288-7)

14 Pilot cables shall comply with following requirements:

- (a) Pilot cables shall be PVC insulated multi core cables to be used for:
 - (i) Standard pilot wires protection schemes
 - (ii) Telecommunication purpose.
- (b) Conductors shall be stranded copper, plain annealed and in accordance with BS 6360.
- (c) Core insulation shall be PVC complying with requirements of BS 6746. It shall be applied by an extrusion process and shall form a compact, homogenous body of uniform thickness. Insulation thickness shall be in compliance with BS 6346.
- (d) Core identification shall be by one of the following:
 - (i) Number printed on the core insulation
 - (ii) Colour, 4mm cores having colours Red, Blue and Black.
- (e) Bedding shall be compliance with BS 6346.
- (f) The cables shall have a single layer of galvanised steel wire armour of diameter 1.6mm in accordance with BS 6346.
- (g) The oversheath shall be of black PVC in compliance with BS 6746 Type 1 compound. It shall have a minimum thickness of 1.7mm and shall be in general compliance with BS 6346.

15 Source Tests on Cables

- (a) Provide test certificates against each drum and /or cable length. These shall include:-
 - (i) high voltage D.C. insulation pressure test, between cores, each core to earth, metallic sheath or armour as applicable.
 - (ii) insulation resistance test.
 - (iii) core continuity and identification.
 - (iv) conductor resistance test.

16 Field Tests on Cables

- (a) inform the Engineer prior to the testing of the cables and be responsible for liaising with any other contractor to whose equipment the cables may be terminated to ensure that all parties concerned are aware of the impending tests, to guarantee the safety of personnel and that the isolation of any equipment has been completed. Any special isolation or preparation required to be carried out before cable testing can be completed, shall be carried out by the Contractor responsible for that equipment. All tests shall be carried out by the Contractor and supervised by the Engineer.

- (b) All cables shall be tested in accordance with the latest QGEWC requirements and the relevant BS and IEE regulations for the class of cable. QGEWC shall be given the opportunity to witness the testing of high voltage cables and these shall be tested in accordance with their specific requirements.
- (c) demonstrate correct phasing of cores in all cables throughout the works and test the insulation of all cables, both between the cores and between the cores and earth, during installation with a 500-volt insulation tester.

6.2.3 Sundries

1 Cable Jointing and Termination:

- (a) joints in wires and cable shall be avoided wherever possible. Joints in flexible cables and cords are not permitted
- (b) joints and terminations of all power cables shall be made by skilled cable jointers approved by the Engineer
- (c) no reduction in the number of strands of a cable core shall be allowed at a cable joint or termination
- (d) ferrules, compression connectors and bare portions of cable core resulting from a jointing or terminating process shall be insulated with an approved type of insulating tape or heat shrinkable tubing after completion of process. Such insulating tape or heat shrinkable tubing shall have equal or better electrical and mechanical properties than those of the original insulation removed, and shall be adhered to the cores etc. securely and permanently. The final thickness shall be in smooth contour throughout the whole length
- (e) every compression joint shall be of a type which has been the subject of a test certificate as described in BS 4579. When a compression joint is made, the appropriate tools specified by the manufacturer of the joint connectors shall be used.
- (f) a circuit protective conductor having adequate cross sectional area and of same material as the phase conductors shall be installed and connected to maintain the effectiveness of the earth continuity across every cable joint
- (g) all cable jointing and termination shall be witnessed by the Engineer
- (h) sufficient spare cable shall be allowed to remake the joint or termination
- (i) above ground cable joints and terminations shall be accessible
- (j) cable cores shall pass through glands or termination boxes directly to equipment terminals, without crosses if practicable.

2 Joints

- (a) straight through joints for copper conductors: Where permitted by the Engineer, conductors shall be joined by approved type compression connectors using the appropriate tools and connectors.
- (b) joints shall be made core-to-core.

3 Joints Boxes and Termination Boxes

- (a) malleable cast iron boxes for joints in all power cables shall be compound filled and of adequate size. The boxes shall be fitted with suitable armouring clamps and glands. The armouring of the cables shall be terminated at the armouring clamps and the inner sheath shall pass through the gland. Self amalgamating tapes shall be applied to give fully screening insulation reinstatement where the insulation is screened

- (b) the box and compound shall be at the correct temperature before the compound is poured to allow total adhesion between the compound and the box. The compound shall then be allowed to cool and topped up before the box is closed. No air locks shall be formed within the box
 - (c) with the consent of the Engineer, plastic shells fitted with suitably sized armour bond and filled with an approved type of cold pouring encapsulating compound to BS 6910 may be used as an alternative to the compound filled cast iron joint boxes for jointing PVC-insulated power cables. In such cases, the complete jointing kit, including plastic shell, compound, insulating tape etc. shall be from the same proprietary manufacturer who is specialised in manufacturing products for this purpose. The jointing methods and procedures, as laid down by the manufacturer, shall be followed in strict accordance
 - (d) MICC mains cable: joints shall be suitably sized galvanised malleable iron adaptable box with glands and fixed base mechanical clamping connectors of approved design. For external use the jointing box shall be enclosed in a second galvanised box with glands, filled with encapsulating compound
- 4 Cable Glands
- (a) cable glands shall be used for terminating cables to switch gear, switch boards, motor control centres, motors and other equipment
 - (b) they shall be brass compression glands and comply with the relevant part of BS 6121, except for MICC cables, which shall comply with BS 6207 Part 2.
 - (c) glands for armoured or screened cables shall have suitable clamps
 - (d) external compression glands shall have close fitting PVC shrouds
 - (e) earthing for armouring and metallic sheaths: suitable brass or copper clamps, and copper strip conductor in accordance with QGEWC requirements, and not less than 2.5 sq. mm
 - (f) cables forming part of a LAN or structured cable system shall be terminated to floor plates or wall sockets compatible with the media interface connector specified for the particular network being used.
- 5 Cable Sockets:
- (a) shall be correct size for type of cable
 - (b) shall be sweating type, or an approved crimping type used with an approved crimping tool
 - (c) sweating sockets for conductors 70 sq. mm. and over shall be machined cast brass.
- 6 Fire Barriers:
- (a) shall be purpose made, comprising a rigid fixed frame with adjustable seals and a suitable clamping device
 - (b) in fire compartment separation walls and floors shall be same standard of fire resistance as wall or floor.
- 7 Cable Covers: shall be to BS 2484 and concrete covers exceeding 300 mm wide shall be reinforced.
- 8 Pipe Ducts : shall be PVC or as indicated.
- 9 Solder: an alloy of lead and tin to EN 29453 grade F or H, unless otherwise recommended by cable manufacturer.

- 10 Cable Sealing Compounds: shall be tropical grade to BS 1858 or BS 6910 and approved by cable manufacturer, of an oil-resisting compound where the difference in level between cable ends exceeds 6 m.
- 11 Cleats: shall be an approved claw type cast aluminium, gunmetal, plastic or brass of approved type, two bolt fixing for cables greater than 50 mm diameter.
- 12 Cable Markers:
 - (a) shall be precast concrete, minimum size 300 x 300 mm x 100 mm deep
 - (b) the markers shall be engraved "HV CABLE", "ELECTRIC CABLE", "ELV CABLE", "EARTH PIT" or "CABLE JOINT", as applicable
 - (c) cable marker construction details and engravings shall be approved by QGEWC.
- 13 Cable Transits
 - (a) cable transits shall have a stainless steel frame which shall be cast into or bolted to the structural concrete.
 - (b) the insert blocks shall be proofed against fire, explosion, water, rodents and gas.
 - (c) the design shall be such that at a later date cables can be added or removed with minimal disturbance to the remaining cables.
 - (d) the whole cable transit assembly shall be of an approved proprietary modular system which shall be certified by a recognised International Testing Authority.
 - (e) full details of proposed cable transits shall be submitted for the approval of the Engineer.

6.2.4 Jointing 11 kV, L.V. and Pilot Cables

- 1 General
 - (a) All jointing shall be carried out to instructions of QGEWC and the Engineer and only by approved Jointers. All jointing shall be carried out in accordance with the QGEWC Safety Rules.
 - (b) All connections to lead sheaths shall be plumbed.
- 2 11 kV Cables
 - (a) Terminations - These shall generally be of the heat shrinkable type using compression connectors although occasionally compound filled terminations shall be required. Generally crossed cores shall be avoided.
 - (b) Straight Joints - Intermediate joints shall be joined in the easiest way avoiding crossed cores.
 - (c) Phasing joints - Phasing shall be in accordance with the instructions of QGEWC and the Engineer to obtain correct phasing. The joints shall be of the bituminous filled type using sweated ferrules.
- 3 Pilot Cables - These shall be jointed in accordance with instructions of QGEWC and the Engineer. The joints shall be resin filled type using compression connectors for straight joints and mechanical glands for terminations.
- 4 600/1000 Volt Cables
 - (a) All jointing shall be on a colour basis such that:
 - (i) Core 1: Red phase
 - (ii) Core 2: Yellow phase
 - (iii) Core 3: Blue phase
 - (iv) Core 4: Neutral

- (b) For terminations heat shrinkable techniques and compression connectors shall be used.
- (c) For straight joints heat shrinkable techniques of joints using bituminous compound or resin shall be used at the discretion of QGEWC and the Engineer.
- (d) For tee or branch joints bituminous compound or resin shall be at the discretion of QGEWC and Engineer. Mechanical or sweated connectors shall be used as decided by QGEWC and the Engineer.

6.3 INSTALLATION

6.3.1 General

1 Installing cables:

- (a) pull cable into position by hand, where possible using an adequate number of operative roller guides suitably positioned along cable length
- (b) obtain approval of pulling cables by winch or similar appliance
- (c) when pulling by winch or the like, fit a suitable tension gauge into the haulage line between winch and cable. Pulling tension shall not exceed the limit recommended by the cable manufacturer
- (d) do not allow cable to twist or rotate about its longitudinal axis
- (e) lay 3 phase groups of single core cables in trefoil formation. If this is not possible obtain instructions
- (f) install cables to allow any one cable to be subsequently removed without disturbing the remainder
- (g) underground cable horizontal separation shall be a minimum of 150 mm
- (h) damaged cables shall be removed, unless the Engineer agrees to a repair.
- (i) all cables shall be neatly run in all situations. Where two or more cables are to be installed, cable tray must be provided.
- (j) where power cables are surface run on the external faces of structures or above ground level they shall be installed on cable tray. They shall be protected from radiation of the sun by means of purpose made sunshades, which shall be of an approved design, securely fixed and fully ventilated.
- (k) mechanical protection by cable tray covers shall be provided for all cable trays above ground/floor level to a height of 1000mm.
- (l) when more than one cable is to be terminated at particular items of equipment special care should be taken to ensure that all cables to that equipment are routed from a common direction and each is terminated in an orderly and symmetrical fashion. Each and every cable shall be permanently identified at each end by its cable number as noted within the schedules. The identification label shall be of adequate size and style to a pattern approved by the Engineer and shall be securely fixed to its relative cable.
- (m) identification labels shall also be fixed on cables at each and every entry and exit point of buried ducts, exits and entry to any structure and in such other positions as are necessary to identify and trace the route of any site cable. The use of punch type adhesive labels (Dymo-tape) will not be permitted.

- (n) where cables enter or leave structures or panel plinths, the ducts including spare ducts shall be sealed at the points of entry or exit. Caulking shall be carried out with an approved asbestos compound and followed by not less than 40mm of epoxy resin two-mix cold waterproof compound or a weak sand/cement mixture as directed by the Engineer. The Contractor shall be responsible for temporarily sealing all cable ducts into structures during the installation stage to prevent accidental flooding of structures.
 - (o) during caulking care should be taken to ensure that the serving and/or armouring of any cable is not damaged. Any damaged cables shall be replaced entirely.
 - (p) all cables entering or leaving hazardous areas (e.g. wet well), air conditioned areas or areas protected by a fixed fire fighting installation shall do so via approved proprietary manufactured cable transits. Cables entering or leaving structures or passing between rooms of the same classification may be sealed by alternative means subject to the agreement of the Engineer.
 - (q) cables shall be free from kinks and the whole installation shall present a neat appearance.
 - (r) ties of PVC, nylon, plastic or similar material will not be permitted under any circumstances.
 - (s) protection of cables against possible mechanical damage shall be provided wherever seen to be necessary by the Engineer. All cables are to be run with particular regard to neatness. Multiple runs are to be arranged so that cables entering or leaving the run do so in a logical order.
 - (t) all power cables shall be terminated with palm type compression terminals of the correct type and size.
 - (u) special terminals shall be provided where necessary. Standard terminals which have palms/holes which are oversized for the application will not be acceptable. Standard terminals which are drilled out to a larger size, reducing the area of the palm will not be acceptable.
 - (v) removal of strands or shaving of conductors to enable them to be terminated at terminals which are not designed for the size of cable necessary will not be permitted at any point.
 - (w) pneumatic crimping machines shall be employed with correctly sized dies. Hand crimping shall not be used.
- 2 Bending Radius: as large as possible and cable shall not to bend to a radius less than that specified in the relevant British Standard, QGEWC regulations or manufacturer's recommendation, whichever is largest.
- 3 Underground Cables in PVC-u Ducts:
- (a) cables shall be installed in ducts where there is hard standing or vehicular passage. Ducts where there is vehicular passage or landscaped area shall be concrete encased
 - (b) cable duct size shall be as specified in the Drawings, to BS 3506 Class B or BS 4660.
 - (c) However the minimum duct wall thickness shall be as per the following:

DUCT SIZE (mm)	DUCT WALL THICKNESS (mm)
75	3.2
100	3.4
150	3.6
200	4.2

- (d) run cables at least 300 mm clear of other services, whether the latter run parallel or transversely to cable trench. use pulling compound, or lubricant to avoid excessive stress on the cable, if required
- (e) run cables below intersecting piped services, unless the cable would be at a depth exceeding 2 m, in which case seek instructions
- (f) ducts shall not be filled with cables to more than 60 % of their capacity
- (g) nylon draw cords shall always be left in ducts
- (h) cable duct pits shall be provided at each change in direction and in any case at distances not exceeding 30 m
- (i) ducts shall be suitably sealed with polyurethane foam or proprietary cable sealing arrangements if specified
- (j) empty ducts shall be plugged with removable plugs
- (k) ducts shall have a minimum diameter of 100 mm.

4 Direct Buried Cables:

- (a) the excavation and backfilling of cable trench work shall be carried out by the Contractor.
- (b) excavated spoil shall be removed from the route of the trench. There shall be no loose stones or other debris on either side of the trench for a distance of 1000mm.
- (c) the Contractor shall supply and lay the sand bedding, cables, sand blinding, cable cover tiles and marking tape. He shall also supply and lay cable route marker posts after the backfilling and top soiling has been carried out.
- (d) the sanding and laying of all cables shall satisfy the following requirements:
 - (i) cable depths shall be measured from the finished ground level unless otherwise directed by the Engineer.
 - (ii) H.V. cables shall be laid at a depth of 1 meter.
 - (iii) L.V. cables shall be laid at a depth of 0.6 meter.
 - (iv) H.V. and L.V. cables may be run in the same trench but should be staggered. however where necessary to pass through ductwork, cables shall be laid vertically on top each other with the H.V. cables at the lowest level with a good sand blinding forming the sand bedding for the L.V. cables.
 - (v) before laying in cables the Contractor shall inspect the trench work to ensure that the trench bottom is of a smooth and firm contour and free from any sharp materials or obstructions.
 - (vi) cable bedding within the trenches shall be formed by a 200-mm sand layer.
 - (vii) cables shall be laid with adequate separation and shall be "snaked" to avoid tension during backfilling operations and subsequent settlement.
 - (viii) before sanding and backfilling, all laid cables shall be inspected by the Engineer, and a further inspection following sanding and tiling shall be made by the Engineer before backfilling.
 - (ix) after cables have been laid, they shall be covered by a further 200-mm of sand, which shall be well tamped around the cables. Mechanical punners shall not be used for this work.
 - (x) after sanding cable cover tiles shall be placed in position to overlap the cables by a minimum of 50 mm either side of the cables as per Clause 6.3.5 of this Section.

- (xi) the Contractor shall carry out backfilling and shall ensure that cable cover tiles are undisturbed and that large rocks, stones and the like (more than 20mm diameter) are eliminated from backfill spoil.
- (xii) after backfilling the Contractor shall reinstate to finished ground level. The Contractor shall lay in position the necessary cable route markers at a maximum of 10 meters apart and at entries to buildings and any change in direction.
- (xiii) cables are to be spaced in accordance with QGEWC requirements i.e. M.V./M.V. – 700mm, M.V./H.V. – 1000mm and H.V./H.V. – 1000mm.
- (xiv) the Contractor shall provide cable route markers to the approval of the Engineer and engraved “Electricity Cables”, or other suitable legend, with the appropriate voltage.

5 Cables above Ground:

- (a) protection shall be provided where mechanical damage is possible
- (b) unarmoured cables shall be protected by conduit, ducting or trunking
- (c) cables shall be protected from direct sunlight
- (d) cable spacings and layouts shall be as table 4A of BS 7671
- (e) cables shall be run at least 150 mm from other services.

6 Underground Cables in trenches

- (a) in areas of hard standing cables may also be installed in concrete or brick cable trenches with removable covers
- (b) cables may be laid in a single layer on the trench floor, otherwise they shall be supported on the sides of the trench on cable tray by cleats or ladders
- (c) cable spacings and layouts in the trenches shall be as table 4A of BS 7671
- (d) other services shall not be run in cable trenches.

7 Cable Supports:

- (a) cables shall be supported in accordance with the methods described in table 4A of BS 7671. Other methods shall be approved by the Engineer
- (b) cables shall be supported at regular intervals and at spacings a maximum of 400 mm for cleats for horizontal runs and 550 mm for vertical runs
- (c) vertical cable runs exceeding 100 m shall incorporate tension releasing sections
- (d) structured cable management systems or ladders shall be of G.R.P or galvanised steel cable supports shall be provided at 300 mm intervals
- (e) MICC Cables:
 - (i) run on surface of walls ceilings. Where embedded, run in a PVC trough or conduit
 - (ii) run cables in square symmetrical lines. Where single core cables are run in groups, bend the sheaths at maximum 50 mm centres
 - (iii) fix surface run cables with saddles at maximum 300 mm centres.

8 Heat Resistant Cables:

- (a) in areas where a constant ambient temperature exceeding 55°C will occur, run all final sub-circuits and distribution circuits in heat resistant cable

- (b) make conversion from PVC cable to heat resistant cable with a fixed block connector housed and fixed into a conduit box or equal, except where the conversion of cable types emanate from a switch, ceiling rose or similar fixed connector accessory.
- 9 Flexible Cables:
 - (a) flexible cable shall be kept to a minimum and concealed if possible
 - (b) mechanical retainment shall not depend on electrical connections.
- 10 Sealing Cables:
 - (a) seal both ends of cables immediately after tests
 - (b) seal MICC cables immediately after cutting to prevent hygroscopic action by the dielectric. All cables shall give an infinity test when tested on a 1000 volt Megger immediately, and 48 hours after sealing
 - (c) seal aluminium sheathed cables with a metal cap plumbed to the sheath
 - (d) seal plastic sheathed cables with a plastic cap embracing the wires and outer sheath
 - (e) mark cable ends in accordance with the relevant BS.
- 11 QGEWC will require to carry out inspections at the following stages:
 - (a) Completion of excavations
 - (b) Completion of bedding of trench prior to cable installation.
 - (c) Cable installation
 - (d) Completion of surround over cables and installation of cable tiles etc.
 - (e) Upon completion of reinstatement.
- 12 The Contractor must not progress from one stage to the next of the above without the approval of QGEWC and the Engineer. The Contractor shall be responsible for arranging inspections by QGEWC to suit his programme of Works.
- 13 Cable Segregation
 - (a) Only conductors carrying signals of the same instrumentation signal category shall be contained within any one multi-core cable.
 - (b) In each instrumentation signal category, a further segregation is required to ensure that conductors forming part of an intrinsically safe circuit are contained within multi-core cables reserved solely for such circuits.
 - (c) High integrity signals such as data transmission or critical shut down signals shall be contained in separate cables.
 - (d) ICA/Telemetry cables sharing a cable tray, duct or route with power cables shall be avoided. Power cables are defined as a.c. cables above 50 volts with a 10-amp rating. Where this is not practicable, a minimum maintained separation between cables should be provided in accordance with Table 6.1.
 - (e) Where the maximum current exceeds 100 amps or the voltage exceeds 650 volts, the minimum segregation shall be in accordance to Clause 6.3.3 of this Section.
 - (f) Where the length of an enforced parallel run between power and ICA/Telemetry cables is greater than 500 meters, a progressive “pro-rata” increase in the segregation distance shall apply.
 - (g) The segregation distances shall be maintained by positive means and shall apply to both above ground and below ground installations.

- (h) Where a crossover between power and ICA/Telemetry cables is unavoidable the cable shall be arranged to cross at right angles. The number of crossovers shall be kept to a minimum.
- (i) Where cable installations are of a restrictive nature such as entries into buildings, panels' etc. relaxation of the minimum segregation distance requirement from a power cable(s) is acceptable. The minimum segregation distance shall then be the distance, determined by the length of the parallelism at the restrictive section of the installation.
- (j) Where a manufacturer's installation specification requires greater segregation than detailed in Table 6.1 such as for data highway cables etc. the Contractor shall comply with the manufacturer's segregation specification.
- (k) Cables of different categories shall not be installed in the same duct
- (l) Public Telephone service (Telecom Provider) cables shall be installed in separate ducts

Table 6.1
Minimum Segregation Distance for Cables

Distance over which parallelism exists between signal and power cables in metres Power cable		Minimum Segregation Distance Requirement in mm	
		Instrumentation Signal Classification Category to BS 6739 or equivalent	
		Cat. 2	Cat. 3
Maximum current 10 amps at any phase voltage up to 250 volts a.c. or d.c.	0 - <3	50	50
	3 - <10	100	100
	10 - <25	100	150
	25 - <100	150	200
	100 - <250	200	250
	250 - < 500	250	300
Maximum current 50 amps at any phase voltage up to 650 volts a.c.	0 - <3	100	150
	3 - <10	150	200
	10 - <100	200	250
	100 - <250	275	350
	250 - < 500	350	450
Maximum current 100 amps at any phase voltage up to 650 volts a.c.	0 - <3	175	250
	3 - <10	200	300
	10 - <100	250	450
	100 - <250	350	525
	250 - < 500	500	650

6.3.2 Cable Trays

1 Generally:

- (a) install cables on trays in a single layer, unless otherwise specified
- (b) use purpose made straps or saddles to maintain cables in a neat regular disposition
- (c) secure cables with load bearing cleats securely fixed to the tray, where trays do not directly support the cables
- (d) space cleats, saddles and straps at maximum centres recommended in QGEWC Regulations, as above, or by cable manufacturer
- (e) cable trays and installation shall be in accordance with Part 9 of this section, QGEWC regulations and BS 7671.

6.3.3 Spacing Between Cables

- 1 High Voltage Cables
 - (a) 11,000 volt cables shall be laid with a horizontal spacing of 750mm between centres and a minimum distance of 150mm from trench wall.
 - (b) Pilot cables shall be laid with a horizontal spacing of 140mm from the associated main cable in case of multiple cables trenches pilot cables shall be laid between the power cables.
- 2 Low Voltage Cables - 1000 volt main cables shall be laid with a horizontal spacing of 600mm between centres and with a minimum distance of 150mm from trench wall.
- 3 High Voltage and Low Voltage Cables in same trench - Where 11,000 volt and 1000 volt cables are laid in the same trench the spacing between the 11,000 volt and 1,000 volt shall be 750mm.
- 4 Reduction of Spacing - Any reduction from above spacing can only be permissible for lengths of 10 m or less.

6.3.4 Trench Depth

- 1 High Voltage - For 11,000 volt cables the trench shall be 950mm deep.
- 2 Low Voltage
 - (a) For 1,000 V main cables the trench shall be 850 mm deep
 - (b) For 1,000 V service cables the trench shall be 650mm deep.
- 3 Arrangements for Trenches with High Voltage and Low Voltage Cables - Where 11,000 volt and 1,000 volt cables are to be laid along the same route a stepped trench shall be dug with the 1,000 volt cables laid inside i.e away from the road.

6.3.5 Cable tiles

- 1 The Contractor shall provide and install:
 - (a) Concrete cable tiles over all 66 kV cables. The cable tiles shall be of the size and form shown on the drawings. Samples must be provided for approval by QGEWC and the Engineer and satisfy a test of impact strength in accordance with BS 2484: 1985.
 - (b) Cable tiles over all 11,000 volt cables and MV/LV instrumentation /Control Cables manufactured from recycled polyethylene indicating cable voltage levels or similar complying with the following requirements:

Minimum thickness	:	12 mm
Length	:	1m
Width	:	24mm
Tensile	:	8.40 N/mm ²

(B S2782 Method 20C)
 - (c) The tiles shall be marked as specified. The cable tiles must be supplied complete with any pins, pegs or other devices for jointing tiles together. Samples must be supplied to QGEWC and the Engineer for approval prior to use.

6.3.6 Removal of Existing Cables

- 1 The Contractor shall liaise directly with QGEWC regarding the removal of existing cables and shall not, under any circumstances, commence removal of cables until QGEWC have verified such apparatus as being redundant. Removal of cables shall only be carried out in the presence of a QGEWC Engineer.

- 2 The Contractor shall arrange uplift of empty cable drums from QGEWC Stores and shall return all recovered cables neatly coiled on the drums provided.

6.3.7 Ducts

- 1 Ducts are to be supplied by the Contractor. They shall be of the following type:

Material	- High impact resistance PVC
Internal Diameter	- 150 mm or 100 mm as specified
Minimum wall thickness	- 3.6 mm (for 150 mm ducts) or 2.4 mm (for 100 mm ducts)

- 2 Samples shall be provided for approval by the Engineer prior to use.

6.3.8 Quarry Scalping

- 1 Shall comprise of quarried limestone materials having particle sizes varying from 5 mm down to dust with a homogenous mixture of all particle sizes.
- 2 The materials shall have specific mechanical and thermal resistive qualities as defined below:
- (a) Thermal Resistivity - The material shall be subject to a 90 % compaction, using an amount of water equal to optimum moisture content. After subsequent drying, such that the water content does not exceed 2% of the weight of the sample, the thermal resistivity of the material shall not exceed 2.0 C M/Watt
 - (b) Mechanical Qualities - The scalping material shall have mechanical qualities that meet the requirements of the QCS Roadworks Section.

END OF PART