26 05 19 - CONDUCTORS AND CABLES

1.0 GENERAL

1.1 Reference

Conform to General Requirements for Electrical Services of Division 26.

1.2 Description of Work

Supply and Installation of all power system conductors and cables.

1.3 Quality Control/Assurance

Design, manufacture, testing and method of installation of all apparatus and materials furnished under requirement of these specification shall conform to latest publications or standard rules of the following:

a) Abu Dhabi Distribution Company(ADDC) regulations for electrical installation works
b) Regulations for Electrical equipment of building IEE, BS London
c) British Standards.

The Quality Control/Quality Control/Assurance duties shall be performed by the Contractor. The system of quality control verification shall be in accordance with ISO 9000 standards of Quality Control/Assurance.

1.4 Codes and Standards

1.4.1 The cables design, material and performance shall conform except where otherwise specified, with the latest issues and amendments of the following codes and standards.

a)	IEC 227	Power and Lighting PVC insulated cable.
b)	IEC 228	Conductors of insulated cables
c)	IEC 502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV.
d)	IEC 331	Fire resisting characteristics of electrical cables (where specified)
e)	IEC 332	Tests on electric cables under fire conditions.
f)	IEC 811	Common test methods for insulating and sheathing of electrical cable.
g)	IEC 287	Calculation of the continuous current rating of cables.
h)	BS 4066	Test on electric cables under fire conditions.

i) BS 6346 PVC insulated cables for electricity supply.

j) BS 6004 PVC insulated cables (non armoured) for electric power and lighting.

k) BS 801 Composition of lead and lead alloy sheaths of electric cables.

l) EEMUA 133 Underground cable protected against solvent penetration and corrosive attack.

m) BS 5467 XLPE insulated armoured cables for electrical supply

n) BS 6724 XLPE insulated armoured LSF sheathed cables

o) BS 7211 LSF Insulated non armoured cables / wires.

1.4.2 Where conflicts exist between the requirements of this specification and other drawings, standards, codes and specifications, the most stringent shall be applied.

1.5 Submittals

1.5.1 The CONTRACTOR shall submit the following drawings and documents related with each electrical system for ENGINEER's approval.

a) Original catalogues for various proposed components.

b) Schedule of Accessories and Fittings.

c) Test Certificates.

d) Related work shop drawings and schematic diagrams.

2.0 PRODUCTS

2.1 Service and Installation Conditions

a) The cable shall be suitable for continuous operation in desert locations under high ambient temperatures and humidity. The atmosphere is to be considered saliferous, sulphurous, dusty and with high concentrations of windburn sand as commonly encountered in petrochemical installations in the Middle East. The possibility of condensation, as experienced during large temperature fluctuations in humid atmosphere, shall be taken into account.

Cables shall be installed as stated below:

⇒ Directly buried in the ground or in formed concrete trenches with backfill.

⇒ Fastened to cable ladder rack or tray in the open air exposed to direct sunlight or within buildings.
⇒ In underground ducts.

b) Unless specified otherwise the following site conditions shall apply:

⇒ Design temperature (Outdoor)	+ 50° C
⇒ Surface temperature due to solar radiation	+ 85° C
⇒ Maximum ambient air temperature – shade	+ 55° C
⇒ Minimum ambient air temperature	+ 5° C
⇒ Altitude not exceeding	1000m AMSL
⇒ Maximum relative humidity at 43°C	95%
⇒ Ground temperature	+ 35° C
⇒ Soil thermal resistively	2.5° C m/w

2.2 System Particulars

2.2.1 Cables covered in this specification will be used on 400 V 3 phase, 4 wire 50 Hz neutral solidly earthed systems.

2.2.2 Cable Construction

a) High voltage, XLPE insulated, PVC inner sheath, double layer galvanized steel tape armoured PVC outer sheathed power cables.

Voltage grade Uo/U	:	6.35/22KV for 22KV system
Um	:	12 KV
Conductors	:	Stranded annealed copper. Circular or shaped section. Minimum size shall be 25mm^2.
Conductors screen	:	Extruded semi conductive compound
Insulation	:	Cross linked polyethylene.
Core Identification	:	Colored red, yellow, blue
Insulation Screen	:	Extruded semi conductive compound, bedding of semi conductive tape and earth screen of copper tape. Copper tape screen shall be designed to carry the earth fault current of the system for a period of one second without exceeding the permissible temperature rise. Additional copper wire for 25ka/0.5sec current capacity without steel tape armour.
Conductor Lay	:	Cores laid up with extruded PVC fillers to form a circular cable.

Bedding	:	Extruded polyvinyl chloride.
Armouring	:	Double layer galvanized steel tape armoured single core cables shall have aluminium wire armouring.
Outer Sheath	:	The outer sheath of cable shall be an extruded layer of polyvinyl chloride intrinsically flame retardant and anti termite protected and cables shall meet the requirements of BS 4066 Part 1, and IEC 332-1.

Color of outer sheath – Red RAL 2002

b) Low voltage XLPE insulated, PVC inner sheath, SWA, PVC outer sheathed power and control cables.

Voltage grades	0.6/1kV
Conductors	Stranded annealed copper. Circular or shaped section.
Insulation	Cross linked polyethylene.
Core Identification	Up to four cores colored (Red, Yellow, Blue, Black). All control cables shall be colored white with black numbers along the length of cores at 150mm intervals. Core numbering shall be of the non-fading type. 3 core cables used for lighting shall have (Red, Black, Green, Yellow colors for the cores).
Conductor lay	Cores laid up with extruded PVC filler for up to 5 cores. For 6 cores or more wrapping of polyester tape.
Inner sheath/bedding	Low Smoke Zero Halogen (LSF)
Armouring	Galvanized steel wire. Single core cables shall have aluminium wire armouring.
Outer Sheath	The outer sheath of cable shall be low smoke zero hologen (LSF) intrinsically flame retardant and cables shall meet the requirements of BS 6724:1997 (2007).

Power cables installed outside the building shall be of XLPE/SWA/PVC with extruded polyvinyl chloride outer and inner sheeth, anti-termite protected and shall meet with the requirements of BS6004:2000 (2006).

c) PVC insulated single core cable (wire) for use in conduit

Voltage grades	450/750V (IEC)
Conductor	Stranded annealed copper.
Insulation	Low smoke and fume thermosetting (color red, yellow, blue, black etc, as required) shall meet with BS 7211:1998 (2005).

d) Earthing Cable

Voltage grades	450/750V
Conductor	Stranded annealed copper.
Insulation	Low smoke and fume thermosetting (colour green, yellow)

e) General

Cables shall be drummed in maximum continuous lengths on non returnable cable drums.

Cables ends shall be sealed and fixed to the drum. Cable drums shall be fitted with battens, fixed around the entire periphery of the drum.

All cable drums shall have their identification reference clearly stenciled on the outside of both flanges.

Drum identification labels shall be attached on the outside and inside of the drum flange. Labels shall be robust and non fading and give the following information:

⇒ Drum identification number
⇒ Voltage grade
⇒ Cable construction (i.e. XLPE, PVC, SWA, and PVC).
⇒ Number of cores and cross sectional area.
⇒ Cable length.
⇒ Purchase order number and item number
⇒ Manufacturer's name
⇒ Drum weight.

In addition to the information required by the specified standards, the following information shall be embossed every one meter along the entire cable length on the external surface of the outer sheath.

⇒ Number of Cores
⇒ Size of Conductor
⇒ Voltage rating
⇒ Manufacturer's name
⇒ Remaining cable length
Example: 4 Core 25 Sq.mm 1 kV grade. (XYZ Company).

2.2.3 Data to be furnished by the manufacturer

The following data shall be furbished by the manufacturers:

a) Insulation thickness

b) Diameter under armour

c) Diameter over armour

d) Overall diameter

e) Current rating in air and ground for the ambient conditions specified.

f) Resistance, reactance per KM.

g) Maximum continuous drum length for each size of cable.

h) Maximum pulling tension.

i) Minimum recommended Bending Radius.

2.2.4 Application

a) Wire and cable installed in conduits shall be of the LSF type single core to BS 7211.

b) All power cables shall be XLPE insulated, armoured type, PVC sheathed, or LSF as specified copper conductor cables of 600/1000V grade (for size of cable 4 mm^2 and above sizes) as per BS 5467.

c) All lighting distribution wiring shall be LSF insulated wiring cables non-armoured to BS7211 enclosed in trunking/conduit.

d) All control cables shall be XLPE insulated, armoured, PVC sheathed, 2.5 mm^2 copper conductor cables of 600/1000V grade as per BS 5467.

e) Fire resistant FP200 cables shall be used for emergency services.

f) No cables smaller than 1.5 mm^2 shall be used and cables of 2.5 mm^2 and above shall be multi-strand.

g) All earth cables shall be of similar size to the phase conductor.

h) Home runs exceeding 25m in length to distribution boards shall be minimum 6 mm^2 unless otherwise stated.

j) Color code phase conductors as follows:

- 3 phase	- Red, yellow, blue
- 1 phase	- Red,
- Control wiring	- White with black numbers along the length of cores at 150mm interval with cable marker to match the diagrams at each point of connection and termination.

Neutrals shall be color coded black.
Earth wires shall be color-coded green/yellow striped.

k) All conductors shall have the color impregnated into the insulation at the time of manufacture.

l) Painting of conductor insulation will not be accepted.

m) Type and size of Cables shall be as indicated in the electrical schematic diagrams, electrical load schedules and other related drawings.

n) Unless otherwise indicated, the following final sub-circuit connection and wiring details shall apply throughout the works :

i) Lighting Circuits up to 1000 Watts:

10 amp breaker protection Wired with 3 x 2.5mm2 LSF wires.

ii) Lighting Circuits 1000 to 1800 watts:

15 amp breaker protection Wired with 3 x 2.5mm2 LSF wires.

iii) High integrity earthed 13 amp socket outlets:

32 amp breaker protection on ring main basis wired with 4 x 4mm2 and 2 x 2.5mm2. LSF wires.

Clean earth 13amp socket outlets

32 amp breaker protection on rinmain basis wired with 4x4mm2 and 4x2.5mm2 LSF wire

iv) Unit water heaters up to 3 KW rating:
20 amp breaker protection Wired with 2x4 mm^2 and 1x2.5 mm^2 LSF wires.

v) Domestic cooker control unit:

45/32 amp breaker protection Wired with 3 x 6mm2 LSF wires.

vi) Fan coil units each :

15 amp breaker protection wired with 2 x 4mm2 and 1 x 2.5mm2 LSF wires.

vii) Electric Hand dryers.

20 amp breaker with 10 mA earth leakage sensitivity protection Wired with 2 x 4mm^2 + 1 x 2.5 mm^2 (2Kw rating) LSF wires.

The above details for connections shall apply throughout the Works, except where the IEE Regulations would be contravened in respect of permissible voltage drop. In such cases the contractor shall utilize a larger conductor size as appropriate.

o) Cable specification and manufacture must be consistent throughout each wired system. All cable utilized must be continuously run from source to termination, without any through jointing included.

p) Cable must be adequately stored and protected from damage pending installation and also during installation until permanent protection is effected.

q) Cable reels must be supported on purpose formed support frames and under no circumstance shall cable be drawn from reels laid on the ground. This shall be strictly enforced as the Engineer's condemnation of any cable that is considered to have been abused will involve total replacement at cost to the Contractor.

r) The cross sectional area of every cable shall be suitable for carrying the maximum sustained load current under normal conditions and shall be selected in accordance with IEE Regulations. The cross sectional area of the neutral conductor for 3-phase circuits shall be equal to the cross sectional area of the phase conductors. The cables shall be selected such that the drop in voltage from the origin of the installation to any point in the installation does not exceed 4% of the nominal voltage when the conductors are carrying the full load current, but disregarding starting conditions. Voltage drop calculation shall be submitted for approval and the cross sectional area of the cable shall be increased accordingly if required to meet the above mentioned requirement without any extra cost.

s) The cables connected in parallel shall be of the same type, cross sectional area, length and disposition and be arranged so as to carry substantially equal load currents.

t) Where cables are to be connected to bus bars, breakers etc. The insulation and/or sheath shall be removed for a distance of 150mm from the connection and replaced by suitable heat-resisting insulation.

u) The wire armour of single core cables in the same circuit shall be bounded together at both ends.

2.3 Temporary Wiring

2.3.1 No part of the new installations shall be connected temporarily to the Supply Authority's mains without the approval of the Engineer and the Authority.

2.3.2 All temporary lighting and electric wiring which the Contractor may require, must be provided by the Contractor who will be responsible for all charges for electricity consumed as stated in the Contract conditions.

2.3.3 Temporary wiring and connections executed by the contractor to the instructions of the Engineer shall be arranged in accordance with the IEE Regulations. Where the ambient air temperature is in excess of 50ºC. heat resisting silicon rubber cables shall be used for temporary connection. Where such cables may be subject to mechanical damage they shall be protected by conduit:

3.0 EXECUTION

3.1 Installation

3.1.1 All wiring of multi-point circuits shall be carried out in a 'looping-in' system and joints and connections other than those required for the connection of switches, fuses, socket outlets, motors, etc, shall not be allowed.

3.1.2 PVC cables shall not be in direct contact with any form of polystyrene used in the building.

3.1.3 PVC cables shall not enter any luminaire or heat-producing equipment. In the case of tungsten luminaries, heat-resisting cables shall be installed from the luminaries to the lighting switches or equivalent. In the case of fluorescent luminaries high temperature PVC cables shall be installed from the lighting switch or equivalent. In the case of recessed tungsten and fluorescent luminaries and heat producing/emitting equipment having final connections effected using flexible cables, final connections shall be made using heat-resistant flexible cables.

Where cables are permitted to traverse channel-ways or similar on continuously mounted fluorescent luminaries, heat-resistant cables shall be used throughout.

3.1.4 Soldered connections or lugs shall not be permitted. All conductors requiring bolted connection shall be terminated with compression lugs using an automatic compression crimp tool which will only release after the correct crimp depth has been obtained.

All bolted connections shall have spring washers. Pinch screw terminals may not be used for conductors greater than 6.0 MM2.

3.1.5 All single strand cables shall be doubled back on themselves when terminations are made.

3.1.6 PVC cables shall not be used for final connections to any appliances containing a heating element or any appliance emitting heat. Where flexible conduit is used a final connection wiring medium, heat-resistant cables shall be used and these shall commence at the solid conduit end of the flexible conduit provided it is not in a heated area. If this is not possible, heat-resistant cables shall be run back to the first switch not in a hot area.

3.1.7 PVC cables shall not exceed the capacity of the conduit or trunking. The installations shall comply strictly with the IEE Wiring Regulations regarding capacity of conduits and trunking for 450/750 V cables, but a space factor of 40% shall not be exceededfor trunking.

3.1.8 Circuit protective conductors shall be used throughout the installation and these cables shall be the same grade and temperature rating of the live conductors of the circuit.

The conduit and/or the trunking system shall not be used exclusively as a circuit protective medium. Circuit protective conductors shall be colored green and yellow.

The cross-sectional area of protective conductors shall be in strict accordance with the requirements of the IEE Wiring Regulations.

3.1.9 Cables shall be drawn-in a careful and workmanlike manner.

Cables shall be 'combed' as drawing-in proceeds and the neutral and circuit protective conductor of each circuit shall be run with the phase cable(s) of that circuit.

Cables of one circuit shall run in the same conduit.

Cables of a circuit when run in trunking shall be 'grouped' together with approved plastic binding clips. Tape shall not be used.

3.1.10 Clip cables neatly to tray with cable separation and support spacing as recommended by the manufacturer.

3.1.11 Where more than two power cables are run together, provide a cable tray. Secure cables with cleats, saddles or ties as appropriate for location and use spacers where more than one layer is required.

3.1.12 Install cables in accordance with the manufacturer's instructions and using the manufacturer's approved terminating devices and considering the manufacturer bending radius.

3.1.13 Terminate all single conductor cables entering steel cabinets in a non-ferrous plate.

3.1.14 Where cables pass through a floor or fire barrier provide a cable transit or equivalent fire stop with openings sized for the cables.

3.1.15 Run surface cables similar to exposed conduit installations. Run cables concealed above ceilings in finished areas. Where exposed, run parallel to building lines. Avoid proximity to water.

3.1.16 All conductors requiring bolted connections shall be terminated with compression lugs using an automatic tool which will only release after correct crimp depth is obtained. Soldered connections or lugs are not permissible.

3.1.17 In surface installations, the cables shall run in a manner which shall be as inconspicuous as possible. The runs shall be truly vertical and truly horizontal and parallel with the features of the building.

3.1.18 After 'marking off' all cables shall be tested with a 1000 v 'Megger' before erection. All cables shall be tested not less than 24 hours after completion. Nothing less than an infinity reading will be acceptable between conductors or between any conductor and the cable sheath, and conductors being disconnected from the apparatus. The Contractor shall provide evidence of these tests to THE ENGINEER.

3.1.19 In all cases where cables pass through floors or walls, steel pipes shall be Inserted in the floors or walls to protect the cables as they pass through these structures. These pipes shall extend to a height of 250 mm above finished floor level or 76 mm either side of any wall. In all cases these pipes shall be so fitted as to blend into the building surfaces.

3.1.20 All cables shall be run either vertically or horizontally and where installed on the building surface. The cable is to be concealed wherever possible, being run in false ceiling spaces and as approved by THE ENGINEER.

3.2 Fire Barriers

3.2.1 Where conduit, ducting and/or trunking pass through fire-resistant structural elements such as walls and floors designated as fire barriers, the openings made shall be sealed according to the appropriate degree of fire resistance. In addition to this external fire barrier, an internal fire-resistant barrier shall also be provided to prevent the spread of fires.

3.3 Cables Installed Underground

3.3.1 Direct buried cables shall be bedded in 75mm of clean sand or riddled soil, covered with similar material, then protected by concrete slabbing or interlocking tiles. The trench shall be backfilled over a plastic identification tape laid for as detailed under cable and cable trench marking.

3.3.2 Prefabricated concrete troughs or preformed trenches in which cables are laid shall be filled with clean sand to provide the top layer of cables with a minimum of 75mm cover, or be completely filled with sand if this should be required by circumstances.

3.3.3 Prefabricated cable troughs, partly or wholly filled with sand shall be closed using prefabricated concrete covers. Such covers shall be provided, by the

contractor, to meet any particular load bearing requirements but shall not be less than adequate for use as a footpath.

3.3.4 Preformed trenches shall be sand filled and closed by floating over with concrete of adequate strength and thickness.

3.3.5 The use of chequer plating and other materials for closing cable troughs, trenches, etc. shall be confined to those conditions where such special treatment is fully justified technically and economically and shall be agreed by THE ENGINEER.

3.3.6 Power cables operating at voltages of 415 volts and above shall not be routed below 'jacked-up' typed unfixed flooring systems in any internal area unless unavoidable for the purpose of supplying equipment installed on the flooring system. In such cases the power cables must be totally enclosed within a steel trunking, conduit, etc., over their entire route length below the flooring system irrespective of the type of cable used.

3.3.7 Cable trench and prefabricated trough depths should not normally have less than 500mm. Direct buried cables should not normally have less than 500mm of cover from cable to finished grade level. The above shall be varied according to the requirements of actual site conditions and cable routes to provide adequate safeguard against, for example, erosion, soft ground conditions and mechanical damage, etc. The maximum thickness of any one group of cables shall not exceed 75mm unless otherwise agreed with THE ENGINEER.

3.4 Cable and Cable Trench Marker

3.4.1 All cables shall be fitted with indestructible identification bands of stainless steel at each end and then over their entire length at 30 meter intervals, at all points where they enter and leave ducts, and at changes in direction, etc.

3.4.2 Concrete or slabs covering cable trenches shall be coloured for identification purposes. Similarly where cables run under floors, markers shall be employed to clearly define the extent of the cable way over the entire route.

3.4.3 The route of underground electric cables shall be marked at 30 meter interval by permanent markers posts. They shall be reinforced concrete units fitted with 150 mm x 150 mm x 2.5 mm thick stainless steel square plate inserts bearing electrical cable trenches or HV electrical cable or similar to the present marking at site in English and Arabic. The marker post shall extend above ground level or shall be flush with the final ground level according to the site and THE ENGINEER's requirements. Two or more markers shall be visible from any point on the route and markers shall be placed at any divergence from the straight.

3.4.4 The location of all underground power cables shall be clearly identifiable throughout their route length by means of a polyethylene board laid in the ground at 300mm below actual finish ground/floor level and above each cable. The board shall be colored red and continuously marked, with black indelible

lettering of not less than 12mm high, to read the following message in both Arabic & English:

"CAUTION BURIED ELECTRIC CABLE 300mm BELOW"

3.4.5 A sample of the polyethylene board with detailed technical data shall be submitted to THE ENGINEER for approval prior to any cable laying works being carried out.

3.5 Jointing and Terminations

3.5.1 All cable conductor shall be fitted with a correctly sized cable socket or thimble and a means of identification. The cable sockets may be of the sweated or crimped compression types. If for the former the solder should have a melting point of not less than 185 Deg. C. and if for the latter they must be the appropriate tools as specified by the manufacturers of the joint connectors. The cable terminations shall be made following the positive identification of the conductors in accordance with the specified phase rotation sequence.

3.5.2 Cable lugs shall be tinned copper compression type.

3.5.3 Cable glands shall be brass double sealed compression type with earth clamping features to IP 55.

3.5.4 Cable insulation/sheath shall be removed for a distance of 150mm from the connection and replaced by suitable heat resisting insulation.

3.5.5 Joints in XLPE cable shall not be carried out without the written approval of THE ENGINEER. Low tension cable joints shall incorporate compression type ferrules with polyethylene tape insulation housed in a plastic joint box and sealed with cold pouring resin fitting.

3.5.6 Joint in HV cables shall be carried out using heat shrinkable kit.

3.5.7 All cable joints/terminations shall be strictly in accordance with cable manufacturer recommendations.

3.5.8 Termination kits shall be compatible to the cables used with and the same shall be confirmed by cable manufacturer.

3.6 Testing & Commissioning

3.6.1 All cable type shall have been subjected to Type Tests in accordance with the relevant IEC or British Standards. Type test certificates shall be furnished.

3.6.2 All cables shall be subjected to routine tests at the cable manufacturer's works in accordance with the relevant IEC or British, tests shall be subject to THE ENGINEER witness if required.

- End of Section -