

SECTION - VI

PARTICULAR TECHNICAL SPECIFICATIONS
Cables

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4.1.5 Particular technical specifications – 66, 33 AND 11 kV Cables

4.1.5.1 Cables

4.1.5.1.1 General

All cables accessories and materials shall be in accordance with the latest editions (including all amendments) of IEC and ISO recommendations.

4.1.5.1.2 Conductors

All conductors shall be stranded copper or aluminium. The conductor shall be clean, uniform in size, shape and quality, smooth and free from scale, splits, sharp edges and other harmful defects. The conductor shall be in accordance with IEC 60228. The conductor shall be filled with swelling powder to stop axial ingress of moisture.

4.1.5.1.3 Cable

The conductor shall be covered with:

- An extruded semi-conducting layer
- A layer of dry vulcanised cross-linked polyethylene (XLPE) insulation
- An extruded strippable semi-conducting layer
- A water tight copper or aluminium seal
- A layer of swelling tape to prevent axial ingress of water along the screen
- A layer of earthing screen of stranded aluminium or copper
- An outer LDPE (low density polyethylene) sheath for water tightness and mechanical protection.

4.1.5.1.3.1 Manufacturer's Identification

The manufacturer's identification shall be provided throughout the length of the cables by means of a tape under the sheath printed with the manufacturer's name and ``Property of KPLC''. Alternatively the identification may be embossed on the outer PVC sheet together with identification and voltage markings

4.1.5.1.3.2 Armour

All cables shall be armoured according to approved manner

4.1.5.1.4 Testing

Notwithstanding that cables are manufactured to approved standards all cables, accessories and materials shall be subjected to and withstand satisfactorily the test requirements detailed in this specification. All materials shall withstand such routine tests as are customary in the manufacture of the cables and accessories included in the Contract. The manufacturer shall have established a quality control system based on

regularly accelerated test of production samples according to CENELEC HD605. This system shall be described in the Bid.

4.1.5.1.5 Sealing and drumming

The cable shall be wound on strong metallic drums arranged to take a round spindle of a section adequate to support the loaded cable drum during installation and handling. The drums shall be lagged with closely fitting battens that shall be securely fixed to prevent damage to the cable.. Each drum shall be clearly marked including indication of direction of rolling.

The ends of the cables shall be suitable sealed to prevent ingress of moisture. The end of the cable left projecting from the drum shall be securely protected against damage by mishandling during transport and storage.

4.1.5.1.6 Current carrying Capacity and Design Parameters

The maximum continuous current carrying capacity and maximum permissible continuous conductor temperature, and the factors for determining such rating and temperature shall be based on recommendations found in IEC 60287, subsequent amendments and all conditions prevailing on the Site

4.1.5.1.7 Terminations

Detailed drawings showing the types of cable sealing ends, terminal arrangements shall be submitted to the Project Manager for approval. Stress cones or other approved means shall be provided for grading the voltage stress on the core insulation of the cables.

The terminations for the cables shall be of an appropriate heat shrink design incorporating a suitable arrangement for stress control, and rain sheds for outdoor use.

Termination kits shall include suitable heat shrink tubing to effectively shroud, seal and insulate the exposed cable conductor and shall include a heat shrink glove to effectively seal the crutch of the cable to prevent ingress of moisture into the interstices of the cable. Suitable arrangements shall be provided to earth the cable screens and armour

Terminations into cable boxes shall include brass compression glands and back nuts of the correct size, which shall secure the cable outer sheath and ensure effective continuity between the cable armouring wires and the metal enclosures on which the cables are terminated. At all rising terminations the cable inner sheath shall pass through the gland to terminate not less than 6 mm above the gland

4.1.5.1.8 Heat Shrink Materials

Heat shrinking tubing and moulded parts shall be flexible, flame retardant, polyofin-based material of electrical insulating quality, and shall be obtained from an approved manufacturer. They shall be suitable for use indoors or outdoors in the conditions prevailing on site

The material shall reduce to predetermined size and shape when heated above 120 °C. The components shall also be provided with an internal coating of hot melt adhesive compound that shall not flow or exude at temperature below 85 °C. All parts and materials shall be tested to a program of tests to be agreed with the manufacturer.

Each part shall bear the manufacturer's mark, part number and any other necessary marking to ensure correct identification for use on the correct size and type of cable. Each set of parts shall be packed as one unit with full and complete installation instruction and clearly marked to show the application.

4.1.5.2 **Installation**

This extract from KPLC's "Medium Voltage Underground Distribution Handbook determines the minimum acceptable conditions for installation of medium voltage cables."

4.1.5.2.1 **General**

The cables will be laid in trenches that will be as straight as possible avoiding sharp bends.

The areas where trenches are to be excavated will be marked clearly on the ground. If the location of other services is known, they will be marked in order to take necessary precautions.

Before construction commences trial pits will be made in order to confirm the soil strata of the planned trenches and to confirm the location of other services.

Safety precautions such as covering the trench, fencing and warning signs will have to be provided for during the period of work.

When designing the plan for the trench layout, the minimum radius will be as in the following table.

TABLE 3.1: BENDING RADII

Bending radii	Single core	3-core
Recommended	17xD	15xD
Minimum	15xD	12xD
At sealing ends	12xD	10xD

D = cable diameter

4.1.5.2.2 **Cable Marker**

Cable markers shall be installed at the beginning and end of the cable run on the surface all along the route, at all changes of direction, and above all joints, above cable duct entries and exits and at an interval not exceeding 50m along the cable route. This information as well as details about the joint (i.e. joint location) will be also recorded on a map.

4.1.5.3 **Excavation of Trenches**

The trench will be dug vertically to a minimum depth of 1200mm or more as required.

All precautions must be made so as not to cover any services e.g. fire hydrants with soil that may be encountered in the path of the trench. The cable shall at all times run under any services encountered and well protected at these crossings.

During construction on public roads passage and access of motorists and pedestrians to commercial areas must be maintained. All safety measures must be put in place.

In order to reduce the cost of reinstatement on roads and pavements the digging shall be done at intervals of 2-3 m and a gallery or tunnel dug underneath. All road crossings shall be through micro-tunnelling and as approved by highway authorities.

If trenches are constructed in soggy or inconsistent soil, the cables will be laid inside a concrete duct as a protective measure and precautions taken to prevent the entry of water at the ends or joints of the ducts

The bottom of the trench must be made of firm material in order to prevent collapse of the base that may subject the cable to mechanical stress.

When several cables of different voltages are laid in the same trench they will be placed at different depths. The cables of the higher voltage will be placed deepest.

Where the trench is too deep as to cause instability to the walls of the trench shoring will be placed to provide lateral support to the trench walls.

The separation between two groups of cables will be a minimum of 450mm. If this separation cannot be attained they will be laid in ducts or will be separated by a layer of bricks.

4.1.5.3.1 **Backfilling of Trenches**

Once the cable has been laid the trenches must be back filled to an adequate compaction level. Care must be taken to ensure that the first layer covering the cables will be free of rocks or any sharp mechanical objects.

The back fill will be laid in layers of 150mm, which should be compressed and watered if necessary in order to make the soil sufficiently compact.

4.1.5.4 **Pavement Reinstating**

The pavement shall be reinstated back to the standard of the original pavement. New materials will generally be used in accordance with Municipal regulations.

4.1.5.5 **Ducts**

Road crossings when necessary will be done with ducts in the following manner

- they will be installed in a level position and concreted where possible to provide mechanical protection through out its length, they will have a depth of 1.2m.
- future expansion will be provided for by providing one or several spare ducts depending on the location of the crossing.
- at all times the cables should be adequately protected.
- road and railway crossings must be planned in full detail.
- drainage of the trenches must be provided for during and after construction.

In crossings with other normal underground services, a prudent distance will be maintained in view of future excavations, and when there is a possibility of service interference, as is the case of other electric cables, waste water sewers e.t.c.

The ducts will be fabricated from PVC or concrete with a smooth interior surface and an interior diameter of not less than 2 times the diameter of the cable to be housed inside it, and in no case will this diameter be less than 150 mm.

The joints of ducts will be sealed with cement, in which case the bottom of the trench must be carefully levelled after setting down a layer of fine sand or red soil in order to permit continuous joints.

The ducts will be laid in such a manner that there is no abrasion between the insulation of the cable and the surface of the duct.

In the cases of single core cables the cable will have to be anchored to prevent movement due to magnetic effects by concreting the ducts at the ends of the joints. This shall not apply to three core cables.

When constructing a duct a length of wire will be left inside to facilitate the fitting of cleaning elements as well as the cables themselves.

The cleaning will consist of passing inside a cylinder in order to remove concrete that will pass through the joints and later passing a broom or a rag to remove the residue.

4.1.5.6 **Direct Burial**

For armoured cables the following criteria for burial will be met:

- the trench must have a 150mm layer of fine sand upon which the cable shall be laid to protect the cable from mechanical damage due to sharp objects. On top of the cable another 150mm of fine sand will be laid. Both layers will cover the entire width of the trench.
- the sand should be well graded
- any materials used for back filling the trench must meet the approval of the KPLC Construction Supervisor in charge.
- the cables must be buried at a depth of not less than 600mm. Exceptions could be made for rocky areas where the minimum depth can not be attained in this case the cable will be laid in a duct.

Cables must be protected with a layer of protecting slabs, which will also indicate their presence.

For armoured cables the excavated materials without mechanically sharp objects will be adequate enough to backfill the trench.

Cables shall not be buried in areas within the substation boundaries. Necessary cable trenches shall be prepared instead to the satisfaction of the client's project Manager.

4.1.5.7 **Galleries**

When the number of cables justify the use they shall be laid in galleries.

The cables will be fixed to the cable trays by means of brackets or clamps.

All metallic elements will be earthed with independent connectors if there are circuits of different voltages.

Electric cables will not be installed where there are inflammable materials.

4.1.5.8 **Parallel Separation**

4.1.5.8.1 **Low Voltage Cables**

Medium Voltage cables may be laid parallel to Low voltage cables as long as there is always a minimum distance of 250 mm between them. When this distance cannot be attained, a solid brick wall shall separate them or they will be placed in ducts.

4.1.5.8.2 **Medium Voltage Cables**

The distance to be maintained in the case of parallel situations of underground Medium Voltage lines is 250mm. If this distance cannot be achieved a protective brick wall will be installed between them, or one of them will be installed within ducts.

4.1.5.8.3 **Telecommunication Cables**

In the case of parallel laying of subterranean electric cables and telecommunications wires, they must be as far as possible from each other. As long as the cables both electric and telecommunications are buried, a minimum separation of 2 meters must be maintained at all times. This distance could be reduced further to 250mm between ducts.

The clearances must be in accordance with agreements between KPLC and respective Authorities.

4.1.5.8.4 **Water Steam etc.**

In parallel layouts between power cables and buried water pipes a minimum distance of 0.5m will be maintained in a horizontal projection. If these clearances cannot be maintained the cables will be laid in ducts.

4.1.5.8.5 **Oil Pipe Lines**

The minimum distance between the cables and the oil pipelines will be 0.5 m. The cable will be protected from any gas leaks.

4.1.5.8.6 Sewers

In parallel layouts of electric cables with sewerage conduits, a minimum distance of 0.5 m will be maintained, the cables will be adequately protected if this distance cannot be maintained.

4.1.5.8.7 Fuel Storage Tanks

There will be a minimum distance of 1.20 meters between cables and fuel storage tanks, apart from providing adequate protection for the electric cables.

4.1.5.8.8 Foundations of Other Services

When there are structural supports for public transport, suspended telecommunication wires, street lighting, the electric cables will be laid at a distance of at least 500mm from the outer extremities of the supports or foundations of the structures. This minimum distance shall further be increased to 1.5m if the support or foundation is subject to continuous stress towards the curb sides.

If this separation cannot be maintained a resistant mechanical safety measure must be used throughout the length of the support and its foundation, extending to a length of 500mm, on both sides of outer extremes.

4.1.5.9 Crossing of Roads and Railroad Tracks

4.1.5.9.1 Public Roads

When crossing streets and roads cables must be laid at depths of at least 1.2m. The ducts must be durable and mechanically strong, and must have a minimum diameter of 150mm in order to permit the easy passage of the cables within the tubes. Conditions specified in the Electric Power Act must be observed at all times. Spare ducts must be provided where necessary.

4.1.5.9.2 Railroad tracks

Crossing railroad tracks must be done with reinforced concrete or heavy duty PVC reinforced by concrete 150mm thick surround laid perpendicular to the tracks at a minimum depth of 1.6 m. This depth must be measured from the bottom side of the track's crossbars. It is recommended that the crossing takes place at the narrower points of railroad areas. Conditions specified by municipalities and the Railroad companies shall take precedence.

4.1.5.10 Crossing Other Services

4.1.5.10.1 Low Voltage Cables

When medium voltage cables cross low voltage cables, a minimum distance of 250mm must be kept between them. If this cannot be achieved, medium voltage and low voltage cables must be separated by pipes, conduits, or solid brick divisor walls.

4.1.5.10.2 Medium Voltage Cables

When crossing other medium voltage cables, the minimum distance to be observed between them is 250mm. If this distance cannot be maintained solid bricks must be laid between them.

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ANNEX A: Guaranteed Technical Particulars *(to be filled and signed by the Manufacturer and submitted together with copies of manufacturer's catalogues, brochures, drawings, technical data, sales records and copies of complete type test certificates and complete type test reports for tender evaluation)*

FOREWORD

The manufacturer shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

This specification is for single core XLPE insulated copper cables and their accessories for operation at 50Hz ac voltages of 38.1kV between any conductor and sheath or earth, 66kV between phase conductors and maximum sustained power frequency voltage between phase conductors of 72.5kV.

The specification also covers inspection and test of the cables and their accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

The specification stipulates the minimum requirements for 66kV single core XLPE insulated copper cables and their accessories acceptable for use in the company and it shall be the responsibility of the Manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the cables for KPLC.

The specification does not purport to include all the necessary provisions of a contract.

2. STANDARDS

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

4.1.5

4.1.5 IEC 60840: Power cables with extruded insulation and their accessories for rated voltages above 30kV ($U_m = 36kV$) up to 150kV ($U_m = 170kV$) – Test methods and requirements.

IEC 60228: Conductors of insulated cables.

3. TERMS AND DEFINITIONS

For the purpose of this specification the definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1 SERVICE AND SYSTEM CONDITIONS

4.1.1 Cable Application

- a) The cable shall be a subtransmission cable for use in outdoors installations and tropical conditions (temperature range of $-1^{\circ}C$ to $+40^{\circ}C$, humidity of upto 90%).
- b) The cable shall be suitable for laying in cable ducts and directly in the ground in switching stations and between stations.
- c) The cable shall also be suitable for laying on slopes.
- d) Permissible continuous loading operating temperature shall be $90^{\circ}C$.
- e) Permissible emergency loading temperature shall be $130^{\circ}C$ for at least 8 hours.

- f) Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5s as per IEC 60840).

4.1.2 The cables shall be connected to underground system operating at a nominal voltage of 66kV, 50Hz and maximum system voltage of 72.5kV and are solidly earthed at the transformer neutrals.

4.2. MATERIALS AND CONSTRUCTION

4.2.1. Design

4.2.1.1 The cable shall be designed and manufactured to IEC 60840, IEC 60228 and the requirements of this specification.

4.2.1.2 All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).

4.2.2. Conductor

The cable shall be made from stranded circular plain copper conductors that conform to IEC 60228.

4.2.3. Conductor Screen

4.2.3.1 A conductor screen consisting of an extruded layer of cross-linkable semi-conducting compound shall be applied over the conductor and cover the surface of the conductor completely.

4.2.3.2 The extruded conductor screen shall be applied in the same operation as the insulation and be fully bonded to the insulation.

4.2.4. Insulation

4.2.4.1 The insulation shall be cross-linked polyethylene (XLPE) conforming to the requirements of IEC 60840.

4.2.4.2 The insulation shall be applied by extrusion and cross-linked to form a compact and homogeneous layer.

4.2.4.3 The colour of the insulation shall be such that it is easily distinguishable from the screening materials.

4.2.5. Insulation Screen

4.2.5.1 There shall be an insulation screen consisting of a cross-linked extruded semi-conducting layer in combination with a metallic layer.

4.2.5.2 The extruded semi-conducting layer shall consist of a strippable semi-conducting compound capable of removal for jointing and terminating. It shall be applied in the same operation as the insulation, directly over the insulation and shall cover the surface of the core completely.

4.2.5.3 A metallic screen shall be applied around the core. The screen shall consist of helically applied overlapped copper tape.

4.2.6. Water Barriers

Water barriers shall be provided to prevent water penetration between and along the various layers in the cable. A water impermeable barrier around the cable and longitudinal water barriers are required.

4.2.7. Metallic Sheath

There shall be a seamless metallic sheath consisting of corrugated aluminium.

The metallic sheath shall be impervious to water and shall be capable of carrying the earth fault current without exceeding 250°C.

The grain size of the sheath shall be uniform and the sheath shall exhibit no marked change after application, installation or in-service, particularly under extended periods of operation at elevated temperatures or under repeated cyclic variations of load.

4.2.8. Oversheath

4.2.8.1 There shall be an extruded oversheath of suitable material for intended service conditions in 4.1.1.

4.2.8.2 The cable shall be embossed with the following information throughout the length of the oversheath.

- (i) 66000 VOLTS XLPE POWER CABLE PROPERTY OF KPLC;
- (ii) Name of manufacturer;
- (iii) Year of manufacture;
- (iv) The number of cores, type and nominal area of conductors;

Letters and figures shall be raised and consist of upright block characters. Minimum size of characters shall be not less than 15% of average overall cable diameter and the distance between one set of markings and the next shall not exceed 500mm. All markings shall be clear and permanent. An indelible marking shall also be given at every one meter interval to assist field personal in cutting required length.

4.3. STANDARD SIZES AND CHARACTERISTICS

The standard sizes and characteristics of the cables shall be as follows:

Conductor nominal cross-sectional area		1 8 5	3 0 0	4 0 0
Voltage Designation U _o /U (Um)		38.1/66(72.5)		
Conductor shape		stranded, compacted round		
Impulse withstand voltage & power frequency withstand voltage for cable		1.2/50µs dry: 325kV peak 50Hz wet (60s): 140kV rms		

Impulse withstand voltage & frequency withstand voltage for terminations			1.2/50µs dry: 380kV peak 50Hz wet (60s): 150kV rms		
Maximum resistance of conductor at 20°C		0. 0 9 9 1	0. 0 6 0 1	0. 0 4 7 0	

Note: The thickness of insulation, thickness of metallic sheath, thickness of oversheath and the current carrying capacity of the cable underground and in air shall be stated by the manufacturer in the Guaranteed Technical Particulars as per Annex A. The declared values shall be verified during factory testing as per IEC.

4.1.5.1

4.4. QUALITY MANAGEMENT SYSTEM

4.4.1 The bidder shall submit a quality assurance programme (QAP) that will be used to ensure that the cable design, material, workmanship, tests, service capability, maintenance and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.

4.4.2 The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001:2008 certificate shall be submitted with the tender for evaluation.

4.4.3 The bidder shall indicate the delivery time of the cables, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of cables sold in the last five years shall be submitted with the tender for evaluation.

4.5. CABLE ACCESSORIES

Jointing and terminating accessories for the single core cables covered by this specification shall satisfy the requirements of IEC 60840 and the following:

4.5.1 Cable straight through joints

4.5.1.1 Straight through joints shall be suitable for the cable specified and shall contain all materials required to:

- a) mechanically connect the type and size of conductor specified;
- b) electrically connect the conductor specified;
- c) provide the necessary level of insulation and stress control within the joint;
- d) restore the integrity of the core screen ;
- e) restore the integrity of the aluminium sheath with regard to water imperviousness and current carrying capabilities;
- f) provide an insulated outer housing that is completely filled and that meet the insulation requirements specified in IEC 60840.

4.5.1.2 Straight through joints shall be of cold or heat shrinkable material suitable for use in terminating XLPE cables with conductors of stranded copper.

4.5.1.3 The jointing material shall have an internal insulating tubing and compression connector component, which shall provide adequate insulation and connection over the conductor at the cable joint.

4.5.1.4 The jointing material shall have a stress control-tubing component, which shall provide proper electrical stress control at the operating voltage over the insulated cable cores at the joint.

4.5.1.5 The jointing material shall have anti-tracking tubing, which shall provide resistance to tracking and erosion of the material.

The joints shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the service conditions specified.

The complete components and materials shall be free from defects, which would be likely to cause them to be unsatisfactory in service.

The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

4.5.1.6 Specialized tools that are required during the jointing process shall be stated and the costs shall be quoted for separately.

4.5.2 Outdoor cable terminations

- a) shall be of heat shrinkable silicon rubber based and suitable for use in terminating XLPE cables with conductors of stranded copper.
- b) shall have a stress control tubing component which shall provide proper electrical stress control at the operating voltage over the insulated cable cores at the termination.
- c) shall have an anti-tracking tubing which shall provide resistance to tracking and erosion of the material.
- d) shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the specified service conditions.
- e) the complete components and materials shall be free from defects which would be likely to cause them to be unsatisfactory in service.
- f) the components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.
- g) Outdoor terminations shall be of specific creepage distance of 31mm/kV and shall be provided with sheds for creepage extension.

Specialized tools that are required during the terminating process shall be stated and the costs shall be quoted separately.

The supplier shall provide the installation procedures and instructions for the straight through joints and termination kits to be used as accessories of the cable specified.

5. TESTS AND INSPECTION

- 5.1 The cable shall be inspected and tested in accordance with the requirements of this specification, IEC 60228 and IEC 60840. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.
- 5.2 Copies of previous type test reports and type test certificates by the relevant International or National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 accredited independent laboratory) shall be submitted with the offer for evaluation. A copy of accreditation certificate for the laboratory shall also be submitted (all in English Language).
- 5.3 Test reports to IEC 60840 for the cables and accessories to be supplied shall be submitted to KPLC for approval before shipment of the goods. KPLC Engineers (2) will witness the following tests at the factory before shipment:
- a) Conductor examination
 - b) Measurement of electrical resistance of conductor
 - c) Measurement of thickness of insulation and oversheath
 - d) Measurement of thickness of metallic sheath
 - e) Measurement of diameters
 - f) Hot set test for XLPE
 - g) Measurement of capacitance
 - h) Partial discharge test
 - i) Voltage test
 - j) Bending test followed by partial discharge test
 - k) Tan delta measurement
 - l) Heating cycle voltage test followed by partial discharge measurement
 - m) Impulse withstand test followed by a power frequency voltage test
 - n) Tests on accessories.

The above tests shall be carried out in accordance with IEC 60840 and this specification.

As per IEC 60840, if the sample from any length selected for the tests fails in any of the tests above, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this specification. If either fail, this batch of cables shall be regarded as having failed to comply and shall be rejected.

During acceptance testing, the manufacturer shall demonstrate that the accessories are mechanically and electrically fit for the cable offered.

- 5.4 During delivery of the cables and their accessories, KPLC will inspect them and may perform or have performed any of the relevant tests in order to verify compliance

with the specification. The manufacturer shall replace/rectify without charge to KPLC, cables/accessories which upon examination, test or use fail to meet any or all of the requirements in the specification.

6. MARKING, LABELLING AND PACKING

- 6.1 The finished cable shall be wound on wooden drum such as to prevent damage during transportation and handling. The drums shall be made from treated timber resistant to termite attack.
- 6.2 The actual length of cable shall not be less than the length indicated on the drum.
- 6.3 Both ends of every drum length of cable shall have been sealed to prevent the ingress of water during transportation, storage, handling and installation. Both ends shall be secured to the drum to prevent mechanical damage.
- 6.4 The following information shall be marked legibly and in a permanent manner on the flange of the drum:
 - a) The manufacturer's name;
 - b) The type and rating of cable;
 - c) The conductor cross-sectional area in mm²;
 - d) The length of the cable, in metres;
 - e) The year of manufacture;
 - f) The gross mass and net mass, in kilogram;
 - g) The instructions for handling and use (in English Language);
 - h) The words "**PROPERTY OF KENYA POWER & LIGHTING CO.**"

Note: The cable itself shall have been marked in accordance with clause 4.2.8.2

ANNEX A: Guaranteed Technical Particulars (to be filled and signed by the Manufacturer for all clauses and submitted together with copies of manufacturer's catalogues, brochures, drawings, technical data, sales records and type test reports for tender evaluation)

Tender No.....

		Bidder's offer
4.1.5.1.1	Description	
	Manufacturer	
	Country of manufacture	
	Service Conditions & application	
	Applicable Standard(s)	
	Type and design	
	Conductor	
	1.1.3.1.1.1.1.1 Conductor screen	
	1.1.3.1.1.1.1.2 Insulation	
	1.1.3.1.1.1.1.3 Insulation screen	
	1.1.3.1.1.1.1.4 Water barriers	
	1.1.3.1.1.1.1.5 Metallic sheath	
	Oversheath	Material Marking
	RATINGS/CHARACTERISTICS	
	Conductor nominal cross-sectional area	
	Voltage designation U ₀ /U(U _m)	
	Conductor shape	
	Thickness of insulation	
	Thickness of metallic sheath	
	Thickness of oversheath	
	Maximum conductor resistance at 20°C	
	Current carrying capacity	underground In air
	Power frequency withstand voltage	
	Impulse withstand voltage and power frequency withstand voltage for cable	
	Impulse withstand voltage and power frequency withstand voltage for terminations	
	Cable accessories (type & design)	
	Quality Assurance Program	

	Copy of ISO 9001:2008 submitted	
	List of Type Test Reports submitted (indicate Test Report Numbers)	
	List of Tests to be witnessed by KPLC Engineers at the factory before shipment	
	Marking on cable & drum (parameters to be indicated and method of marking)	
	Packing	
	Installation and technical manuals to be provided during delivery	
	List of catalogues, brochures, drawings, technical data and customer sales records submitted to support the offer.	
	Statement of compliance and or deviations from Tender Specifications	
	Inspection/test by KPLC during delivery before acceptance to stores/site	

.....
Manufacturer's Name, Signature, Stamp and Date

4.1.5.1.2 Telecommunication Wires

When crossing telecommunication wires, the electric cables must be situated within conduits of appropriate mechanical resistance, maintaining a minimum distance of at least 250mm, between the outer sides.

The electric cable must be protected in PVC or concrete duct and in such a way that it guarantees that the distance between the cables is greater than the minimum established for parallel layouts.

The crossing must be at least 1m from a junction box for telecommunications wires and joints for electric cables will not be installed next to crossings of telecommunications cables.

4.1.5.1.3 Water Steam etc.

There should never be a water pipe joint over the cable. A water pipe joint must be at least 2.0 m from a crossing.

4.1.5.1.4 Gas

The minimum distance in crossings with gas pipelines shall be of 250mm. The crossing shall not be made over gas pipelines joints.

4.1.5.1.5 Sewers

In crossing sewage pipes it is recommended that the electric cable should be below the sewer line where possible.

4.1.5.1.6 Fuel Depots

Electric cable crossings over fuel deposits will be avoided at all times, the electric cables must be laid bordering the fuel tanks, maintaining a minimum distance of 1.2 metres.

4.1.5.2 Transporting Cable Drums

Loading and unloading from trucks or appropriate trailers will always be made through an adequate bar that passes through the centre of the cable drum.

The cable drums will always be transported upright and never on its side.

When several cable drums are transported together they must be aligned back to back and have stopping blocks to prevent movement.

The stoppers should be uniform so that they do not pierce the cable insulation. The stoppers should span the whole length of the cable drum.

An alternative to stoppers may be to have wooden pieces nailed to the platform supporting cable drums. The stoppers will be placed at the reels of the cable drums.

The cable drum must not be tied down with ropes, cables or chains. Upon off loading the cable drum the roll must not drop down from the truck or trailer, a provisional ramp with an inclination of not more than 1/4 will instead be constructed in the case where there are no pulleys for lifting the drum. The roll can be rolled of the ramp by means of guide ropes. Sand can be placed at the bottom of the ramp to act as shock absorber and brake for the cable drum.

When rolling the drum on the ground the rotational direction must be observed so that the cable does not come loose.

When the drum is rolled care must be taken to ensure that the drum is not rolled on rough ground. Care must also be taken to ensure the reel is not broken because the splinters can puncture the cable.

Where possible the cable drums should not be exposed to the elements.

4.1.5.3 Laying of the Cable

The cable drum will be installed on the site in such a way that the cable is reeled out of the top part of the drum and is not forced when the cable is laid.

During cable laying the drum will always be supported by means of a mechanical jack and a bar of the appropriate strength.

The base of the jacks will be sufficiently large as to ensure stability during operation.

When taking off the wood stoppers care must be ensured that the material used in nailing them does no damage to the cable.

The cables must always be unrolled and laid with the greatest care to avoid torsion or kinks and always maintaining the correct bending radius of the cables (ref: 3.1)

When the cables are being laid the workers must be distributed uniformly along the trench.

The cables should also be laid using cable rollers.

4.1.5.4 **Mechanical Protection**

Underground electric lines must be protected against possible breakdowns caused by landslides, contact with hard bodies, and clashing of metal tools. For this purpose, a protective layer of hatari slabs of class 15 concrete will be placed.

4.1.5.5 **Warning Signs**

All cables must have a protection slab placed over the cables buried at least 200 mm above the cable layer. When the cables or groups of cables of different voltages are placed in vertical layers the protection slab must be placed over each layer.

4.1.5.5.1 **Identification**

The cables must bear marks indicating the year of manufacture, manufacturers name, and cable characteristics (size and voltage level).

4.1.5.6 **Fibre Optic Cable**

4.1.5.6.1 **General Specifications**

a. The equipment to be supplied shall conform in all respects to this specification. Unless another standard is specifically mentioned in this specification, all material and practices employed in the works must be in accordance with such other authorised standard appropriate to the country of manufacture, which in the opinion of this company shall ensure an equivalent or higher quality.

Alternative solutions, which deviate from the specifications required, may be submitted separately in addition to this tender. Such alternatives should be fully detailed and the price indicated, they may be considered for adoption after the comparison of quotation submitted in accordance with this specification.

b. All material used under this Contract shall be new, of the highest quality and of the class most suitable for working under the conditions specified, shall withstand the variations of temperature and atmospheric condition arising under working conditions

without distortion or deterioration or setting up of undue stresses on, or impairing the effectiveness of any part.

- c. The cable shall be an all dielectric, Single Mode, 24 fibres, Optical Fibre cable Specifically manufactured for underground Installation. The cable is to be laid in the same trench as 11kV 300sq mm s/c XLPE copper power cables. A written confirmation must be obtained from the cable manufacturer giving an assurance that the cable so offered is suitable for underground installation along side the 66kV Power cables and that it will give a reliable communication link suitable for Protection of the 66KV cable, Speech and Data Transmission.
- d. The Manufacturer shall also submit a list showing Locations where similar cables have been laid underground along side single core Power cables rated 66kV or above and the duration over which the cables have been in Operation.

4.1.5.6.2 Standards

The optical cables herein specified must be in accordance with the following standards.

- IEC 60793 – 1 , Optical Fibres-Part 1 : Generic Specifications.
- IEC 60793 – 2 , Optical Fibres – Part II : Product Specifications.

All cables must conform to ITU G652 and G655

4.1.5.6.3 Geometrical characteristics

The fibre cables specified herein will fulfil the following geometrical specifications.

The cable should have	24fibres
Core diameter	9-10 microns
Cladding diameter	125.0 ±2.0 microns
Mode field concentricity error	≤ 1.0 micron
Cladding non-circularity	≤ 2.0 %
Coating diameter	245 ± 8 microns
Mode field diameter	9 ± 1 Micron

4.1.5.6.4 Optical characteristics

The single-mode fibre cable specified herein must fulfil the following optical specifications

Attenuation coefficient:

At 1310 nm.	≤0.35 dB/ Km.
At 1550 nm.	≤0.22 dB/ Km.

Total chromatic dispersion

For 1280 nm ≤ λ ≤ 1340 nm	≤ 2.9 ps/(nm*Km)
At 1550 nm.	≤ 18 ps/(nm*Km)

Cable cut-off wavelength: $\lambda \leq 1250 \text{ nm}$.

4.1.5.6.5 Conditions of operation

All the optical fibres shall be able to work without significantly degradation in its characteristics in the temperature range -20 C to 70 C . The shipping and storage temperature range of the cable shall be -50 C to 70 C .

The installation temperature range of the cable shall be -5 C to 70 C .

NOTE: The cable will be for underground installation alongside 3 No. 11KV Medium voltage Voltage single core cables. It should have the pre-requisite Mechanical Protection to prevent damage during installation and due to other Human activities such as excavation. The cable should also be Rodent resistant. The cable must be specifically manufactured for underground installation and must be all dielectric, hence unaffected by Electromagnetic induction from the 66KV Cables. This must be specifically stated in the Tender Offer.

4.1.5.6.6 Additional Requirements

The cables shall additionally meet the following standards. Tenderers shall give technical documents on whether they meet these standards.

Standards summary

Test carried on cables

	Cable Test Type	Applicable Standard	
1	Water Ingress Test	IEEE 1138	
2	Seepage of Flooding Compound	IEEE 1138	
3	Short Circuit Test	IEEE 1138	
4	Aeolian Vibration Test	IEEE 1138	
5	Galloping Test	IEEE 1138	
6	Sheave Test	IEEE 1138	
7	Crush Test	IEEE 1138	
8	Impact Test	IEEE 1138	
9	Creep Test	IEEE 1138	
10	Fibre Strain Test	IEEE 1138	
11	Strain Margin Test	IEEE 1138	
12	Stress Strain Test	IEEE 1138	
13	Cable Cut-Off Wavelength	IEEE 1138	
14	Temperature Cycle Test	IEEE Std 563	
15	Cable Self Damping	IEEE Std 4	
16	Lightning Test	EIA/TIA-455-16A	
17	Salt Spray Corrosion	MCIT 048-200 6508	
18	Temperature Water Immersion	MCIT 048 200 6508	Cycling/Ageing/
19	Tension Cycle Sustained Loading	MCIT 048 200 6508	
20	Gas Tube Tightness Test	MCIT 048 200 6508	

21	Twist Test	MCIT 048 200 6508
22	Bend Test	IEC 794
23	DC Resistance	
24	Generic fibre specifications	IEC 60793, IEC 60794
25	Ageing Test	EN187000

4.1.5.6.7 Colour code

The colour coding of fibres and tubes shall be in accordance with table below.

Number	Primary	Secondary
1	Natural	Red
2	Red	Natural
3	Blue	Natural
4	Yellow	Natural
5	Black	Natural
6	Violet	Blue
7	Brown	
8	Green	

E.t.c. for the 48 fibres.

All colour codes must be able to distinguish each fibre strand from all other fibre in the same cable.

Supplementary Information

5 INSTALLATION OF VARIOUS 33KV AND 66 KV CABLES

COMPETENCE OF PERSONNEL

It is a requirement that the contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for laying jointing and terminating cables. The cable jointer must be certified by the cable manufacturer to carry out such works.

The contractor shall have adequate resources to carry out the work satisfactorily.

TRENCHING

General

The contractor shall be responsible for all trenching and excavation work. The contractor shall, before trenching commence, familiarize himself with the routes and sites conditions and the procedure and order of doing the work shall be planned in conjunction with the general construction programme for other services and building requirements.

The contractor shall acquaint himself with the position of all the existing services such as storm water pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose he shall approach this company's representative, the local municipal authority and any other authority which may be involved, in writing.

The contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.

The contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

The contractor shall ensure that the excavation will not endanger existing structures, roads, railways, other site construction or other property.

Mechanical excavators

Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other plant, services or other installations likely to be damaged by the use of such machinery.

The use of power driven mechanical excavators shall be subject to the approval of the Project manager.

Blasting

No guarantee is given or implied that blasting will not be required

Should blasting be necessary and approved by the Project manager, the contractor shall obtain the necessary authority from the relevant government authorities. The contractor shall take full responsibility and observe all conditions and regulations set for the by the above authorities.

Routes

Trenches shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by the Project manager beforehand.

The Project manager reserves the right to alter any cable route or portion thereof in advance of cable laying.

The removal of obstructions along the cable routes shall be subject to the approval of the Project manager

Shoring and Water logging

The contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to water logging or other ground conditions.

The strength of shoring must be adequate for site conditions prevailing and the shoring must be braced across the trench.

The contractor shall provide all pumps and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed off without any nuisance or hazard.

Excavation Works

Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of the company.

Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification.

The bottom of the trench shall be of smooth contour, and shall have no sharp dips or rises, which may cause tensile forces in the cable during backfilling.

The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for backfilling on completion of cable laying.

Surplus material shall be removed from site and disposed of at the cost of the contractor.

Trenches across roads, access ways or footpaths shall not be left open. If cables cannot to laid immediately the contractor shall install temporary 'bridges' or cover plates of sufficient strength to accommodate the traffic concerned.

In the event of damage to other services or structures during trenching operations the contractor shall immediately notify the project manager and institute repairs.

Prior to cable laying the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after laying shall be removed

Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, the company shall be notified before installing the cables. The company will advise on the course of action to be taken.

Dimensions of trenches

Cable trenches shall not be less 600mm wide for a single circuit . This dimension shall be valid for the total trench depth.

The width shall be increased where prior approval has been obtained.

Where trenches change direction or where cable slack is to be accommodated, the contractor shall ensure that the requirements of the relevant specification regarding the bending radii of cables are met when determining trench widths.

Trench depths shall be a minimum of 1000mm. This dimension may vary when crossing roads and other services.

Joint Boxes

Where cable joints are required to be made in the course of a cable run, a joint box shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded. The joint box shall be made of reinforced concrete and vandal proof. Earthing of the cables at all joint boxes is mandatory. The joint hole shall measure minimum 1500mm wide and 4500mm long.

BEDDING

The bottom of the trench shall be filled across the full width with a 50mm layer of suitable soil sifted through a mesh and leveled off.

Only sandy clay or approved sand/soil with a satisfactory thermal resistivity (not exceeding 1.5 k. m/W) may be used for this purpose. Sea , ash, chalk, peat, clinker or clayey soil shall not be used. The use of fine river sand is acceptable.

Where no suitable soil is available on site, the contractor shall import fill from elsewhere and make all the necessary arrangements to do so.

After cable laying a further layer of bedding shall be provided to extend to 100mm above the cables.

The bedding under joints shall be fully consolidated to prevent subsequent settling.

Cable Ducts

Where cables cross under roads, railway tracks, other service areas, etc. and where cables enter buildings, the cables shall be installed in suitable ducts as specified.

Ducts shall be joined in accordance with the manufacturer's instructions.

Ducts/Sleeves shall cross roads and railway tracks at right angles.

Ducts/Sleeves shall have a minimum diameter of 150mm. The Ducts will be of concrete or heavy duty PVC reinforced by concrete 150mm thick surround. They shall extend at least 2m beyond the tracks of a railway line or of the outermost tracks where there is more than one line. In the case of roads, the sleeves shall extend at least beyond the road edge or kerb on both sides of the road.

The ends of all ducts shall be sealed with a non-hardening watertight compound after the installation of cables. All ducts intended for future use shall likewise be sealed.

Railway and Road Crossings

The contractor shall not trench beneath any railway tracks without the Railway's administration supervision.

The contractor shall request the company(necessary authority) to arrange for the necessary supervision. The cost of such supervision will be paid for by the contractor. KPLC will arrange for the necessary wayleaves of the proposed cable routes. The contractor shall carry out the crossing installation in strict accordance with requirements and stipulations. Where these requirements are in contradiction with this specification, the project manager's guidance shall be sought. The contractor shall liaise with the various administrations well in advance regarding the intended dates, times and expected duration of the crossing operations and obtain their approval of the programme and method of operation before commencing with the work.

INSTALLATION OF THE CABLES

Installation Depths

Cables shall be installed at a minimum depth of 1000mm below final ground level. All cable depth measurements shall be made to the top of the cable when laid directly in ground or to the top of the duct (or sleeve) where these are provided. The above depths shall apply to the top layer where cables are installed in layers. The contractor may only deviate from the above depths provided prior authority in writing has been obtained from the project manager. In this event the cables shall be protected with a suitable concrete covering. The depth of cable pipes or ducts beneath railway lines or roads shall be not less than 1 m below the formation level.

Cable spacing and laying

Cables installed in the same trench shall be laid parallel to each other in a flat formation with the minimum spacing of 200mm between cables. The cables will be transposed along the route using a suitable method. Cables for telephones, communication systems and other low voltage systems shall be separated from power cables by at least 1m. All control or pilot cables shall be laid at least 300mm from power cables.

Except where ducts, tunnels or pipes are provided, cables shall be laid directly in the ground. The cable shall be removed from the drum in such a manner that the cable is not subjected to twisting or tension exceeding that stipulated by the cable manufacturer.

Cable rollers shall be used as far as possible to run out cables. Rollers shall be spaced so that the length of cable in the trench will be totally suspended during the laying operation and sufficiently close to prevent undue sagging and the cable from touching the ground. Rollers shall also be placed in the trench in such a manner that they will not readily capsize.

Cable rollers shall have no sharp projecting part liable to damage the cables.

Where cables have to be drawn around corners, well-lubricated skid plates shall be used. The skid plates shall be securely fixed between rollers and shall constantly be examined during cable laying operations.

The cable minimum bending radius shall be observed (Assumed at 17d or as per cable manufacturer's specification)

Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. In the

case of oil filled cables, a cable sock may never be used. Special eyes giving access to the interior of the cable must be utilized.

The maximum allowable tension when pulling a cable will be as per manufacturer's specification. The company shall be informed timely of the intention to carry out all cable laying operations to allow an inspection of the works by the company if so required.

COVERS

Trenches in substations shall be covered using reinforced concrete covers.

Terminations

Suitable clamps (cleats), which will secure cables without damage, shall be used. Metal clamps or drilled hard wood blocks shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and terminal equipment employed.

The cable shall be solidly bonded and properly earthed.

JOINTS

Joints in cable runs will not be allowed unless specified in the detail Technical specification or authorized by the company.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions and by personnel competent in jointing the types of cables used.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. The sides of the hole shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The joint shall not impair the anti-electrolysis characteristics of the cable.

The contractor shall notify the project manager timely of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the project manager because of insufficient notice being given shall be opened for inspection and redone at the discretion of the project manager at the cost of the contractor. No cable jointing shall be done during extreme rainy weather.

Joints shall be fully water and airtight and shall be free of voids and air pockets.

Backing filling

The contractor shall not commence with the backfilling of trenches without prior notification to the project manager so that the cable installation may be inspected. Should the contractor fail to give a timely notification, the trenches shall be re-opened at the contractor's cost. Such an inspection will not be unreasonably delayed.

Warning weld mesh reinforced concrete slabs measuring 500mm x 500mm x 50mm shall be installed 500mm above the cable. The slabs shall be with the words 'HATARI 66KV CABLE'. These slabs shall not be more than 300mm apart from edge to edge.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material, is 75mm.

The contractor shall have allowed in his tender for the importation of suitable backfill material if required.

The backfill shall be compacted in layers of 150mm and sufficient allowance shall be made for final settlement. The contractor shall maintain the refilled trench at his expense for the duration of the contract. Surplus material shall be removed from site and suitably disposed off. On completion, the surface shall be made good to match the surrounding area e.g

GRASSED AREAS

Backfill trench

Top 150mm to be red soil mixed with manure

Grass to be type approved by parks superintendent

STANDING BOUGAINVILLAEA

Excavate hole, 120cm diameter x 120cm deep

Fill with red soil mixed with manure

100cm tall support pole planted next to the shrub

type of bougainvillaea to be approved by parks superintendent.

BOUGAINVILLAEA (SHRUB)

Excavate holes, 120cm diameter x 120cm deep

Fill with red soil mixed with manure

Holes to be at 300cm spacing in a triangular network (hexagon corner diagonally interlinked)

Erect 200mm diameter cedar poles midway between holes in the same format

External poles (of the hexagon) to be 600mm deep and 300mm above the ground

The pole at the middle (of the hexagon) to be 600mm deep and 300mm above the ground

Areas between holes to be filled with 150mm murrum

Fix barbed wire between the poles in the shape described as above.

Type of bougainvillaea to be approved by parks superintendent

In the case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

Cable markers shall be provided along all HV cable routes. Cable markers shall consist of concrete blocks in the shape of truncated pyramids, approx. 300mm high, 150 X 150mm the top and 250 X 250mm at the bottom.

Cable markers shall be installed on the surface along all the underground routes and shall project 100mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.

Cable markers shall be installed at the beginning and a cable run at all changes of direction, above all joints, above cable pipe entries and exits and at intervals not exceeding 50m along the cable route.

The position of cable markers shall be indicated on the 'as built' drawings.

TESTING

Each cable shall be tested after installation in accordance with the standard as well as the requirements of the company.

The contractor shall carry out the following tests but not limited to voltage test (NOT using D.C) between conductor and metal sheath/earth, Sheath testing (leakage between screen and mother earth)

The contractor shall make all arrangements and provide all equipment for these tests. The cost of testing shall have been included in the tender price.

The contractor shall notify the company timely on testing programme and procedure so that a representative of the company may witness the test.

On completion of the tests on the cables, the contractor shall without delay, submit three copies of the certified test reports to the company.

COMPLETION

The company reserves the right to inspect the installation at any stage during the course of construction. Such inspections will however not deem the portions inspected as being complete or accepted and the contractor shall remain responsible for safety and completing the installation fully in accordance with the contract documents.

The contractor shall carry out a final ‘as built’ survey of the cable routes and present to the company ‘as built’ route plans of the complete installation. The following information shall be reflected on the plans or submitted as separate schedules with the plans – overall length of cable;

Locations of all joints in relation to permanent reference points shall be given. Record of cable drum serial numbers “as laid” shall also be provided.

The works will be deemed to be incomplete until all tests have been conducted successfully and all “as built’ drawings and schedules have been handed to the company.