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.

All cables shall be suitable for operation:

- on a system with direct earthing of the transformer neutral
- under maximum load (ONAF conditions) plus 10 % specified for respective transformers
- in the climatic conditions prevailing at site

No joints shall be allowed. Only dry vulcanising processes shall be used. Special precautions shall be taken to avoid ingress and spreading of moisture and development of water-treeing. The Tenderers shall documents the construction measures used to achieve these requirements.

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 Laying-up and Fillers of Three Phase Cables

The cores of three-phase cable shall be laid-up together with suitable fillers, wormed circular and binding tapes applied overall

4.1.5.1.3.2 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

4.1.5.1.3.3 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.

4.1.5.1.5 Sealing and drumming

The cable shall be wound on strong 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. Wooden drums shall be constructed of seasoned timber to prevent shrinkage of drums during shipment and subsequent storage at site. 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 600mm 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.

During construction on public roads passage and access of motorists and pedestrians to commercial areas must be maintained.

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.

If trenches are constructed in soggy or inconsistent soil, the cables will be laid inside a 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 250mm. 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 Joint Holes

Where cable joints are required to be made in the course of a cable run, a joint hole shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded.

4.1.5.3.2 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 throughout 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 with out 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 KENYA POWER and KPTC

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 conduits 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.

4.1.5.10.3 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.

4.1.5.10.4 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.

4.1.5.10.5 Gas

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

4.1.5.10.6 Sewers

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

4.1.5.10.7 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.

4.1.5.11 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.

4.1.5.12 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 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.

4.1.5.13 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.

4.1.5.14 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.

4.1.5.14.1 Identification

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

4.1.5.15 Fibre Optic Cable

4.1.5.15.1 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.

4.1.5.15.2 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

4.1.5.15.3 Geometrical characteristics

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

The cable should have	24 fibres
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

4.1.5.15.4 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 ≤ Labda ≤ 1340 nm ≤ 2.9 ps/(nm*Km)
At 1550 nm. ≤ 18 ps/(nm*Km)

Cable cut-off wavelength: Labda ≤ 1250 nm.

4.1.5.15.5 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.

4.1.5.15.6 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 Cycling/Ageing/ Water Immersion	MCIT 048 200 6508	
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	

4.1.5.15.7 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.