GOVERNMENT ICT STANDARDS

Fiber Optic-Backbone, Metro and Last Mile Infrastructure Standard

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REVISION OF ICT STANDARDS

In order to keep abreast of progress in industry, ICT Standards will be reviewed annually. Suggestions for improvements to published standards, addressed to the Chief Executive Officer, ICT Authority, are welcome. The Standard Review Board will consider the requests during their quarterly meetings and if appropriate recommend them to be incorporated during annual review of the Standard.

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FOREWORD

The ICT Authority has the mandate to set and enforce ICT standards and guidelines across all aspects of information and communication technology including Systems, Infrastructure, Processes, Human Resources and Technology for the public service. The overall purpose of this mandate is to ensure coherent and unified approach to acquisition, deployment, management and operation of ICTs across the public service in order to achieve secure, efficient, flexible, integrated and cost effective deployment and use of ICTs.

To achieve this mandate, the Authority established a standards committee to identify the relevant standard domains and oversee the standards development process. The committee consulted and researched broadly among subject matter experts to ensure conformity to acceptable international and national industry best practices as well as relevance to the Kenyan public service. The committee eventually adopted the Kenya Bureau of Standards (KEBS) format and procedure for standards development. In an engagement founded on a memorandum of understanding KEBS, participated in the development of these Standards and gave invaluable advice and guidance.

For example, the Fiber-Optic Backbone, Metro and Last Mile Infrastructure Standard, which falls under the overall Government Enterprise Architecture (GEA), has therefore been prepared in accordance with KEBS standards development guidelines which are, in turn, based on the international best practices by standards development organizations including ISO.

The Authority's Directorate of Programmes and Standards has the oversight role and responsibility for management, enforcement and review of this standard. The Directorate shall carry out quarterly audits in all the Ministries, Counties, and Agencies (MCA) and private entities to determine compliance to this Standard.

The Authority shall issue a certificate for compliance to entities upon inspection and assessment of the level of compliance to the standard. For non-compliant entities, a report detailing the extent of the deviation and the prevailing circumstances shall be tabled before the Standards Review Board who shall advise and make recommendations to remedy the shortfall.

The ICT Authority management, conscious of the central and core role that standards play in public service integration, fostering shared services and increasing value in ICT investments, shall prioritize the adoption of this standard by Government and private entities. The Authority therefore encourages adherence to this standard in order to obtain value from ICT investments.

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Ag. Chief Executive Officer

ICT Authority

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1.0 INTRODUCTION

The National ICT Infrastructure Master-plan 2019 identifies lack of standards to guide the design, development and implementation of both backbone and last mile fiber optic infrastructure. This has affected deployment, design and integration of both roads and ICT infrastructure across the country. This Standard is intended to address these gaps to ensure sustainable fiber infrastructure deployment.

2.0 SCOPE

This Standard sets out minimum requirements for the planning, design, deployment, operation, maintenance and management of back- bone, metro and last mile fiber optic cable.

3.0 APPLICATION

This Standard applies to entities planning, designing, developing and operating fiber optic infrastructure within the boundaries of the Republic of Kenya.

4.0 NORMATIVE REFERENCES

The following Standards contain provisions which, through reference in this text, constitute provisions of this Standard. All Standards are subject to revision and, since any reference to a Standard is deemed to be a reference to the latest edition of that Standard, parties to agreements based on this Standard are encouraged to take steps to ensure the use of the most recent editions of the Standards indicated below. Information on currently valid National and International Standards can be obtained from the Kenya Bureau of Standards.

- Communications Authority - The Kenya Information and Communications (Importation, Type Approval and Distribution of Communications Equipment) Regulations, 2010
- GoK Information Security Standard
- ICT Authority End-User Equipment Standard, ICTA-2.002:2019
- ICT Authority Information Security Standard Second Edition 2019 ICTA.3.002:2019
- IEC 60794-4-20 Part 4-20: Sectional specification – Aerial optical cables along electrical power lines – Family specification for ADSS (all dielectric self-supported) optical cables
- ISO/IEC 27002:2013 Information technology — Security techniques — Code of practice for information security controls
- ITU - T L.10 Optical fiber cables for duct, tunnel, aerial and buried application
- Kenya Standard KS 516:2008 Wood poles for power and Telecommunication lines
- KS 1933:2018 Concrete poles for telephone, power and lighting Purposes-Specification.
- KPLC Specification for treated wooden poles KP1/3CB/TSP/03/001-1

- KS 1933:2018 Kenya Standard — Concrete poles for telephone, power and lighting purposes — Specification, Second Edition
- KS 2611:2016 Kenya Standard — HDPE ducts — Main, mini and micro
- NEMA E-waste guidelines
- Other procurement guidelines are released by the Public Procurement Oversight Authority, from time to time.
- Public Procurement and Disposal Act & Regulations
- Roads Act 2019
- Water Act 2016

5.0 DEFINITIONS

a. Authentication

This is the process of verifying the claimed identity of a session requestor. The confidential authenticator that provides the verification can be based on a password, Personal Identification Number (PIN), token, smart card, biometrics, exchange of keys, etc.

b. Duct

This is a medium which underground cabling is housed to protect the fiber cable from any damage or interference.

c. Hand hole

These are holes constructed under the ground to access telecom cables/components by inserting our hands. During installations, these hand holes serve as space to assist the cable pass through ducts smoothly.

d. Identification

This is the process whereby the network equipment recognizes a user's unique and auditable identity such as the User-ID.

e. Infrastructure owner

One responsible for construction of the shared infrastructure

f. Maintenance chambers

They are access chambers designed for underground conduit systems; they enable access to pipes during pulling, connecting and maintaining telecommunication cables, fiber-optic cables and tele-technical ones.

g. Micro duct

These are mini ducts bundled together to form one large duct which micro cables are housed in.

h. The per link subscriber to subscriber availability: -

This is defined as the availability between any two data or equipment users between Remote Terminal Unit to reporting Control Centre and between control centers.

i. The calculated availability

This is defined as the theoretical availability determined by a statistical calculation based on the mean-**time-between-failure (MTBF) and the mea-time-to-repair (MTTR) of the components and subsystems comprising the FOTS.**

j. User-ID

This is the name by which a valid user is recognized by the Network equipment. This item of information is generally not considered confidential.

6.0 ABBREVIATIONS

ADSS	All-Dielectric Self-Supporting
CFOT	Certified Fiber Optic Technician ()
CFOT	Certified Fiber Optic Technician
EIA	Environmental impact assessment
EOL	End of life
EOM	End of manufacture
EOS	End of support
FOTS	Fiber-Optic Transmission System
GIS	Geographic Information System
GoK	Government of Kenya
GRP	Glass Reinforced Polymer
GSM	Global System for Mobile Communications
GSM	The Global System for Mobile Communications
HDPE	High-density polyethylene
ICTA	ICT Authority
IEC	International Electro Technical Commission
ISO	International Organization for Standardization
ITU	International telecommunications union
KEBS	Kenya bureau of standards
KeNHA	Kenya National Highways Authority
KeRRA	Kenya Rural Roads Authority
KMZ	Keyhole Markup Language
KPC	Kenya Pipeline Corporation
KPLC	Kenya power and lighting company
KRC	Kenya Railways Corporation
KS	Kenya standard
KURA	Kenya Urban Roads Authority
Mbps	Megabytes per second
Mbps	megabits per second
MTBF	Mean-Time-Between-Failure
MTTR	Mean-Time-To-Repair
NE	Network element
NE	Network Equipment
NOFBI	National optic Fiber Backbone Infrastructure
OFC	Optical fiber cable
OLTE	Optical Line Termination Equipment
OTDR	Optical Time Domain Reflectometer
SLA	Service level agreement
SMC	Sheet Molded Compound
UTM	Universal Transverse Mercator

UV	Ultraviolet
V/UHF	Very high/Ultra High Frequency

7.0 SUBDOMAINS

The sub- domains of this standard are:

a. Ducts
b. Maintenance Chambers
c. Hand Holes
d. Way Leaves
e. Poles
f. Fiber Cables
g. Markings
h. Equipment
i. Security
j. Aerial Cable

8.0 REQUIREMENTS

8.1 Ducts

8.1.1 OFC Duct Physical Requirements

a) The physical requirement of the ducts shall meet the minimum specifications as defined on Annex 1.

8.1.2 OFC Duct Technical Requirements

a) OFC ducts shall meet the minimum technical requirements as specified in Annex 2.

8.1.3 Duct installation

8.1.3.1 Trenching of all soil types shall be done as guided by the Roads Authority and shall be as per the minimum requirements in Annex 3.

8.1.3.2 Concrete envelop shall be used in all the areas where the soil is not stable and the installation shall meet the following minimum requirements:

a. Concrete mixture used shall be Class A: 1:2:4 (Cement-Sand-Gravel) ratio by weight or volume, ratio by weight will be used: x1 50kg bag of cement that is accredited by Kenya Bureau of Standards.
b. The following minimum specifications shall be adhered to for proper concrete mixture:

i. Cement shall be fresh (not expired) and without damage from humidity or from water splash.
ii. The river Sand shall be clean and without foreign particles like soil, wood, plastics, etc.
iii. The Aggregate can be collected locally or brought in from ballast stone crusher plant. However, it shall be clean and contain particles that are within 15mm to 20mm in diameter.
iv. Clean Water shall be added and mixed to a thick but fluid mix that pours freely and is easily workable. Water–cement ratios of 0.45:1 to 0.60:1 by weight are more typically used.
v. A Concrete Mixing machine shall be used to attain a clean homogenous mix.
vi. A Concrete Vibrator machine shall be used to attain a perfect concrete consolidation; free from air bubbles and homogenous across the covered area—helps to avoid cracks from weaker areas.
vii. Concrete Curing shall be undertaken for a minimum of seven (7) days. In hot areas, water is poured on the curing concrete early in the morning and late in the evening when the temperatures are low to avoid immediate evaporation. The curing concrete should be covered in guinea bags and covered with a two (2) inch layer of sand; to help retain the water longer over the curing concrete.

8.1.3.3 Gabions shall be employed mainly at river/lagga crossings, where installed optic fiber cables can be damaged by flood waters. Gabions' trenching and construction shall meet the following minimum specifications:

a. Gabion mesh-wire shall be of minimum 2.8mm galvanized wire with double twist. The Wire shall be Hot Deep Galvanized class 1 at 366g/m2 of zinc coating.
b. Gabion rocks shall be of a minimum of 100mm diameter and maximum of 150mm diameter and be of natural solid non-porous hard-rock.
c. Inside the gabion, the ducts shall be GI 50mm OD galvanized steel pipe and must protrude 1m on both ends of the gabion to interface with the regular HDPE duct.
d. The minimum trenching requirements for Gabion that is covered with a soil erosion protection treatment—soil stabilization over gabion shall be as specified in appendix 10.

8.1.3.4 Road crossing shall be done using directional drilling or thrust boring and shall meet the following minimum requirements:

a. Bores shall be at a depth of 1.8m across spur subsidiary roads and 2m across the carriage way from the tarmac level.
b. Bores shall exit at a depth of 1.8m; same level as the trench.
c. Bores shall typically span to lengths of 15m-20m but could span to a maximum of 30m if need be.
d. The equipment used shall drill bores spanning to a maximum of up to 30m long:
e. The drilling head shall accommodate rock drilling bits: for rocky ground.
f. After making a bore across the road, two (X2) 102 mm diameter galvanized pipes or two 110mm HDPE plastic pipes (one to act as spare for future use) shall be inserted through the bore.
g. Bores shall be well marked on both ends with marked reinforced concrete pillars.

i. The operation pits shall be backfilled, unless there is need to install a Hand-hole on the pit location.

8.1.3.5 Railway crossings shall be done using directional drilling or thrust boring. Any drilling or thrust boring on railway crossings shall be done in accordance with the existing government regulations. Construction of bores for Railway crossings shall meet the following minimum requirements:

a. Bores shall be at a depth of 1.5m across spur subsidiary roads and 2m across the railway track from the ground level.
b. Bores shall exit at a depth of 1.5m; same level as the trench.
c. Bores shall typically span to lengths of 20m.
d. The equipment used shall be able to drill bores spanning to a maximum of up to 30m long.
e. The drilling head shall be able to accommodate rock drilling bits: for rocky ground.
f. After making a bore across the road, two (X2) 102 mm diameter galvanized pipes or two 110mm HDPE plastic pipes (one to act as spare for future use) shall be inserted through the bore.
g. Bores shall be well marked on both ends with marked reinforced concrete pillars.
h. Conduits inside a bore shall be equipped with draw-wires.
i. The operation pits shall be backfilled, unless there is need to install a Hand-hole on the pit location.

8.1.3.6 River/swamp/laggas crossing shall be done using directional drilling or thrust boring, trenching, bridge attachment. Any drilling or thrust boring on river crossings shall be done in accordance with the existing government regulations. Construction of bores for river crossings shall meet the following minimum requirements:

a. Depth shall be at a depth of 1.8m from river bed across and across the whole river.
b. Drilling bore shall start and exit at riparian land.
c. Gabions Stone pitching shall be used at the river slopes.
d. A concrete envelop of C15 shall be installed.
e. Drill bores should span to a maximum of up to 30m long.
f. The drilling head shall be able to accommodate rock drilling bits: for rocky ground.
g. After making a bore across the road, two (X2) 102 mm diameter galvanized pipes or two 110mm HDPE plastic pipes (one to act as spare for future use) shall be inserted through the bore.
h. Bores shall be well marked on both ends with marked reinforced concrete pillars.
i. Conduits inside a bore shall be equipped with draw-wires.
j. The operation pits shall be backfilled, unless there is need to install a Hand-hole on the pit location.

8.2 Maintenance Chambers

8.2.1

The maintenance chambers shall meet the following minimum requirements.

a. Size of the chambers shall be: 1600mm [L]*1300mm [W]*1600mm [D].
b. The cover shall be mechanically lockable with special key and fully water and weather proof and shall have digital locking solution.
c. Upon leasing of the infrastructure, access to the manhole shall be the responsibility of the infrastructure owner and authorized agents.
d. Chamber materials shall be of high strength with reinforced concrete or polymer composite.
e. Cover materials shall be of high strength; made of a Glass Reinforced Polymer (GRP) such as Sheet Molded Compound (SMC).
f. The chamber cover shall have a load rating of at least 135KN.
g. The manhole shall have a slack management bracket inside the chamber, position to secure the splicing boxes and at least 8 x 50mm split cable entry holes.
h. The chamber shall be equipped with a knock out drain at the bottom.
i. Maintenance chambers (with polymer hardened cover) shall be used (With owner Logo) 100mm below the top.
j. The maintenance chamber shall have digital locking solution that can be monitored in the NOC.

8.2.2

The maintenance chamber installation shall meet the following minimum requirements:

a. Maintenance chamber pit shall be dug to fit the maintenance chamber installation with minim 1600mm [L]*1300mm [W]*1600mm [D].
b. Labeling shall be done using Stencil on both cover, body and inner side of the wall after installation, the serial number shall follow approved design.
c. After the installation of the maintenance hole the soil shall be backfilled and compacted
d. Concrete grade shall meet a minimum ofC25.
e. The maintenance hole shall have all its accessories including brackets etc.
f. The maintenance hole shall have provision of a drain hole at the bottom of every chamber to drain water.
g. Maintenance hole shall be located in interceptions, road crossings, Building /Home entrances and intervals of 1000m along main roads.
h. There shall be provision of slack bracket to manage the cables and closures in the manhole.

8.3 Hand Holes

8.3.1

The hand hole chambers shall meet the following minimum requirements.

a. Chamber and cover materials shall be of high strength; made of a Glass Reinforced Polymer (GRP) such as Sheet Molded Compound (SMC).
b. Chambers shall be cylindrical in shape.
c. Sizes of the two chambers shall be: - 1000mm deep and 900mm
d. The cover shall be mechanically lockable with special key and fully water and weather proof.
e. The chamber cover shall have a load rating of at least 40KN.
f. Slack management brackets shall be placed inside the chamber, position to secure the splicing boxes and at least 8 x 50mm split cable entry holes.
g. The chamber shall be equipped with a knock out drain at the bottom.
h. The chamber shall have digital locking system that will be monitored at the NOC.

8.3.2

Installation of the hand hole shall meet the following minimum requirements:

a. Hand-holes shall be covered by a flat watertight lid.
b. Hand-hole lids shall be labeled with the provisioning owners name.
c. Hand-holes shall be located outside of sidewalks and side [1] roadways.
d. Hand-holes shall be located a minimum of 2 meters off the edge of pedestrian way, and 3m from the off of the side-roadways.
e. Hand-holes shall not be located in the ditch line or in an erosion [1] prone location.
f. All Underground OFC Joint splicing shall be housed inside the 900/1000mm Hand-hole.
g. All Access Point splicing shall be housed in the 600/600mm Hand [1] holes.
h. The pulling of the cable shall be hand assisted at each Manhole or Hand hole. Sufficient slack shall be left at each end of the cable to allow proper cable termination and enough spare cable (50 meters at the Joint Hand-hole and 50 meters at the Access Hand-hole) to facilitate repair of damaged OFC sections.
i. Slack coils shall be stored without violating the minimum recommended slack coil diameter; as specified in the cable specs depending on the size. Typically, D>=20x Cable OD 326. The cable shall be marked and labeled at each Manhole and Hand-hole and at all entry and termination points of the fiber optic cables.
j. The soil around the Hand-hole shall be compacted and stabilized and in line with the provided drawings on the Hand-hole chamber installation.
k. Upon final acceptance of the conduit system, all Hand-holes shall be free of debris.

8.4 Way leaves

8.4.1 All fiber ducts shall run along and across the Road, Rail way and pipeline corridors respectively where the corridors width allows.

8.4.2 Way leaves shall be categorized under the respective jurisdictions as described below:

a. KeNHA – These are way leaves that are along the trunk roads
b. KURA – These are way leaves along KURA Road reserves.
c. KeRRA – These are way leaves along KeRRA Road Reserves.
d. County way leave – These are way leaves along County Road Reserves.
e. KRC- These are way leaves that are along and across railways.
f. KPC- These are way leaves that are along the pipeline.
g. Way leaves along Private properties.

8.4.3 All roads' designs shall incorporate provision for optic fiber infrastructure as per the standards defined herein.

8.4.4 Way leaves unit of measure shall be expressed in Meters.

8.4.5 Where the road corridor permits, way leave shall be located on the right side of the road - considering the west most point on a road to be the start point and, 0.5 to 1 meter from the extreme end of the corridor.

8.4.6 Installed fiber way leave shall be geo-mapped as well as marked with visible marker post.

8.4.7 The fees and charges for way leaves permits shall be standardized across jurisdiction. The fees and charges shall encompass the cost of processing applications and inspection of the installed fiber ducts.

8.5 Poles

8.5.1 Transportation of poles

8.5.1.1 Poles shall not exceed the 0.5m vehicle over hang and shall have a red flag secured on the overhang.

8.5.1.2 Poles that are loaded onto a pole carrier shall be secured to ensure that the cargo does not move while on transit.

8.5.2 Wooden Poles

8.5.2.1 A wooden pole shall not be less than 20 ft tall

8.5.2.2 It shall be of a minimum circumference of 34.6 at the bottom and 21.6 at the top.

8.5.2.3 Entities shall ensure the pole is fitted with end plates and strapping at both ends.

8.5.3 Concrete poles

8.5.3.1 The concrete poles shall be used to support the Aerial Optic Fiber cable in areas where the use of Underground OFC cable is not feasible due to the difficulty of the terrain in question or due to lack of space to trench for the Underground cable.

8.5.3.2 The manufacture of concrete poles shall conform to KS 1933:2018.

8.5.4 Pole Holes

8.5.4.1 All excavations for pole holes shall be such that the survey peg indicates the center line.

8.5.4.2 Holes for the poles shall be 1000mm deep and 200mm wider.

8.5.4.3 Where a hole is dug on the sloping ground, the depth of the hole shall be measured from the lowest point on the ground surface.

8.5.4.4 In extreme rocky conditions where holes cannot be excavated to the specified depth, an arrangement between contractor and client can be reached for poles to be set in concrete.

8.5.5 Pole Set in Concrete

8.5.5.1 Where poles are planted in soil that is difficult to compact, such as sand and swampy areas and in extreme rocky conditions, the poles shall be cast in concrete.

a. Only new wooden poles shall be set in concrete.

b. The hole shall be circular in shape. The hole diameter shall be kept.

8.5.6 Pole Spacing

8.5.6.1 A uniform span length shall be maintained and only depart from this when it is rendered necessary by conditions such as;

a. Uneven ground

b. Sharp bends

This may necessitate the planting of additional poles or omitting of poles.

8.5.6.2 ADSS span lengths based on fiber cable route type shall be considered

Type of the route	(m)
Short span	50
Medium span	80
Long span	120

- Road crossing poles should have a minimum length of 12 meters
- Route length poles should have a minimum of 9 -10 meters

8.5.7 Pole Planting Process

8.5.7.1 All holes necessary for pole dressing shall be drilled before the pole erection.

8.5.7.2 A pole should be erected by laying it on the ground in such a position that by raising the top section the base should slide into the hole.

8.5.7.3 Poles shall be erected vertically and in straight lines, one to the other, as much as possible, except where the road curves.

8.5.7.4 Backfilling and ramming shall take place in 300mm intervals.

8.5. 7.5 Where stones are available they should be used to stiffen the holding.

8.5.7.6 Pole Plumpness shall be maintained during the backfill and ramming process.

8.5.7.7 Poles shall be erected vertically and in straight lines, one to the other, as much as possible, except where the road curves.

8.6 Fiber cables

8.6.1 Color and labeling of the cable

8.6.1.1 Color coding shall be determined by the organization
8.6.1.2 Black shall be the standard color for the backbone
8.6.1.3 The cable shall be labeled with the following characteristic
a. Organization logo or organization initials or abbreviations
b. Year of manufacture
c. Owner of the cable
d. Number of cores
8.6.1.4 The labeling shall be done at every 1-meter interval

8.6.2 Design considerations

8.6.2.1 The design of any cable infrastructure should be alive to the service intended to be offered.
8.6.2.2 The cable chosen shall conform to the ITU -T specifications for the required service as detailed on Annex 4.

8.6.3 Pre-Installation Cable Drum Inspection

8.6.3.1 The client shall conduct an onsite pre-installation inspection of cable drum. See Annex 5 for the checklist

8.6.4 Placement conditions for underground cables as per the duct depth

8.6.4.1 The highest point of optic fiber cable duct shall be: -

Backbone

a. Not less than 1.5m below the current centerline level of the carriageway
b. Not less than 1.5m below the surface of the road reserve or side drain or verge at any point along the cable alignment.

Spur connectivity

a. Not less than 1.5m below the current centerline level of the carriageway
b. Not less than 1.5m below the surface of the road reserve or side drain or verge at any point along the cable alignment.

Metro

a. Not less than 1.5m below the current centerline level of the carriageway
b. Not less than 1.5m below the surface of the road reserve or side drain or verge at any point along the cable alignment.

Last Mile

a. Not less than 1.5 m below the current centerline level of the carriageway
b. Not less than 1m below the surface of the road reserve or side drain or verge at any point along the cable alignment.

8.6.5 Fiber Cables categorization.

8.6.5.1 The fibers shall be categorized as follows: -

a. Backbone management – minimum of 96 core – should have 2 (96 cores) running parallel
   i. Cable 1 is actual backbone (Express)
   ii. Cable 2 is the access cable
b. Spur Cable Installation
   i. Minimum of Metro 48 core
   ii. Minimum of Access 48 core
c. Metro Cable Installation
   i. Minimum of Metro 144 core
   ii. Minimum of Access 48 core
d. Last mile
   Minimum of 2 – 24 core

8.6.5.2 Cables running parallel to the road reserve shall be placed not more than two (2) meters from the edge of the road reserve as provided.

8.5.6.3 The method for placing cables across the carriageway shall be strictly through micro tunneling.

8.5.6.4 Where ducts and sleeves have been provided by the Authority, they shall be used for crossing the carriageway.

8.5.6.5 The level of workmanship shall be to the highest standards. Supervision shall be provided by an Engineer.

8.5.7 OTDR Pre-Test

8.5.7.1 The client shall conduct a minimum OTDR Pre-Test. See Annex 6 for the checklist

8.5.8 Cable Installation along Roadways

8.5.8.1 Cable installation along Roadways shall strictly observe the following requirements:

8.5.8.2 The cables shall be laid in ducts buried to depths of not less than 1500mm.

8.5.8.3 The cables shall be laid 1.5m to 2m from the edge of the Road Right of Way on Class A roads and 0.5m to 1.0m on Class B roads and other roads. Any deviation to this rule, due to technical or practical reasons will be documented and authority to do so given by the road Authority. All designs will be signed by the road authority before implementation.

8.5.8.4 Horizontal distance of 1 meter between the existing underground utilities will be reserved and the new OFC cable, and if not possible, an appropriate duct protection and document and affected local authorities informed and network providers of the change possibly five days before the intended excavation.

8.5.8.5 Barriers will be placed and road signs required by current laws during excavation works.

8.5.9 Cable Installation

8.5.9.1 When pulling optical cables into conduits, cable trays, or raceways, the strength member(s) of the cable shall bear all or nearly all of the pulling force.

8.5.9.2 Cable able jackets shall not be directly pulled unless designed for the purpose or unless the run is very short and requires a minimal pulling force. Pulling of cables will only be allowed where blowing is not possible.

8.5.9.3 Optical cables shall not be pulled into place by applying tension directly to the fibers (pulling the fibers).

8.5.9.4 Install junction boxes between the full length of an optic fiber cable (in the middle of the span) to allow pulling the cable into two equal opposite directions.

8.5.9.5 Optical cables shall be attached to a pulling line only by methods recommended by the manufacturer of the cable.

8.5.9.6 Unless stated otherwise by the cable manufacturer, the maximum pulling tensions used for optical cables shall be 273 kg for outdoor cable. The pulling force shall be uniform and consistent; cables shall not be jerked.

8.5.9.7 Cable pulling shall be done by hand, except when tension meters, tension-controlled, or breakaway swivels are employed.

8.5.9.8 When powered pulling equipment is used to install optical cable, tension monitoring equipment or breakaway swivels shall be used. Swivels shall be used when pulling optical cables into conduits. Exceptions shall be made to this requirement only for very short runs, which require a minimum pulling force.

8.5.9.9 If Pull Boxes are to be used with optical cables, they shall be designed for the purpose, and shall be equipped with cable supports and shall be sized so that no cables in the box shall be tightly bent.

8.5.9.10 A length of free cable shall be provided at each end of a cable pull. Loops of cable (commonly called service loops) shall be provided at all intermediate pulling points or at Pull Boxes. The cables' minimum bending radii shall not be violated.

8.5.9.11 When pulls are accomplished in two or more stages, and spare unreeled, it shall be configured in large figure-eight on a safe, flat surface, such as the ground or a clean floor.

8.5.9.12 The entry of outside plant cables into a structure may require special fire safety considerations.

8.5.10 Splicing and Termination

8.5.10.1 All fiber terminations and jointing shall be done by fusion splicing methods such that the signal attenuation at each connector and joint is less than 0.06 dB and 0.03 dB, respectively, at 1310 nm and less than 0.07dB and 0.04 dB at 1550 nm.

8.5.10.2 The average loss for all joints in any one fiber link (from one Core substation to another Core substation or one OFC repeater to another) shall not exceed 0.12 dB.

8.5.10.3 OFC fibers shall be arranged in the termination and splicing boxes with loops contained within trays in an orderly and consistent identifiable pattern with sufficient slack to allow re-jointing without resorting to extra optical fiber cable.

8.5.10.4 All splicing boxes shall be sealed such that they are watertight. Materials used for securing the fiber cable and the splicing boxes shall be durable to give the required maintenance free design life of 50 years.

8.5.11 Post installation Testing:

8.5.11.1 The attenuation of all fibers shall be checked with an OTDR after installation and splicing of all the fibers.

8.5.12 Slack Installation

8.5.12.1 The slack recommended is 1% of the backbone and 2% of the Metro & Last fibre of the distance between the two neighboring manholes.

8.5.12.2 The maximum slack in the manholes shall not exceed 30% of the manhole size.

8.5.13 Earthling, Bonding and Surge protection

8.5.13.1 The armoring of optical fiber cables shall be lugged and bonded to an earth bar using soft multi-stranded 6mm2 green/yellow insulated bonding cables.

8.5.13.2 Bonding cables shall be kept as short as practically possible and shall contain no sharp bends.

8.5.14 Work safety

8.5.14.1 Optic Fiber Cable workers along the roadway shall strictly observe the following requirements:

8.5.14.2 Workers shall wear gloves, hard-hats, steel-toe work boots and brightly colored reflective worker's garments (Clearly marked with a label of implementing authority).

8.5.14.3 Aerial cable installers shall use body harnesses or appropriate rigging gear at all times; when climbing and while aloft. Any operation at height will be carried out by technicians certified to work at heights.

8.5.14.4 A ladder shall be secured at the base by one person during climb and by a safety rope before work on the pole commences.

8.5.14.5 During optic fiber splicing, workers shall wear protective goggles (safety glasses) to protect them from fiber splinters.

8.5.14.6 All cut fiber pieces shall be put in a safe place and away from ingestion and from the public, especially the local community.

8.5.14.7 A vehicle will be available to within short distance/time (20Km or 20 minutes away, whichever is less) from the workers in case of an emergency.

8.5.14.8 Where there is no GSM coverage, team leaders shall have V/UHF radio communication with the nearest vehicle

8.5.14.9 Each working team shall be equipped with a complete First Aid kit and shall have at least one member who is First Aid certified.

8.5.14.10 Where personal security is at risk due to banditry, local Administration Police Reservist (APR) personnel shall be engaged to secure the workers.

8.5.14.11 Unskilled labor should as much as possible be sought from local residents. This will enhance security for the whole team and avert confrontation between foreign workers and local job seekers.

8.5.14.12 The work team shall place barriers along the trench area, to warn people of "Dangerous Trench" as required by current laws, during excavation works.

8.5.14.13 The work team shall place large and visible WARNING signs to warn road users and pedestrians of "Excavation Works" along the cable route.

8.5.14.14 All open concrete pole holes will be guarded with red/white barrier tape to warn the local community of possible hazards.

8.5.14.15 Trenches shall be backfilled as soon as possible and to the original state.

8.5.14.16 No environmental pollution or degradation shall be allowed as a result of OFC cable works in any area.

8.5.14.17 If the excavation shall remain open or the road will be otherwise obstructed during the night or under low-visibility conditions, reflective road signs shall be complemented by lighting devices of the color, shape and size stipulated by the Kenyan traffic code.

8.5.14.18 The OFC cables shall be laid as stipulated in the plan but any deviation to this rule, due to technical or practical reasons, shall be documented and authority to do so given by Implementing Authority. This is to avoid disputes or fights with the local community—to avoid injury or damage to the cables and equipment.

8.5.14.19 Trench excavation within a market center or a township shall only be done after verifying that all utility lines (water pipes, electric cables, and sewer lines) in the area are marked and known.

8.5.14.20 All reasonable steps necessary shall be taken and special consideration given to water, electricity and sewer systems within the area that cannot be located accurately.

8.5.15 Sharing

8.5.15.1 To limit duplication, gear investments towards underserved areas, encourage product innovation, improve customer service experience, reduce entrance and development costs, facilitate the use of existing infrastructure and minimize the need for frequent excavations and environmental impacts that go with this, utility providers should share infrastructure as much as possible. In this regard telecommunication cables can be installed in sewer ducts as per ITU-T Recommendation L.77 while joint use of tunnels by pipeline and telecommunication cables shall be as provided by ITU-T Recommendation L.11.

8.5.15.2 The backbone fiber and Metro fiber should be shared by all Telcos.

8.5.15.3 All Cross connect and landing station should be shared by all the Telcos.

8.5.15.4 Peering and meet me point should be shared by all the Telcos.

8.5.15.5 The planner of network shall consider the future expansion as they carry out the fiber expansion program.

8.5.15.6 The telco should be encouraged to do data sharing.

8.5.16 Environmental Management

8.5.16.1 The project owner shall conduct or contract for an initial environmental impact assessment and prepare a report which should include a mitigation plan.

8.5.16.2 The contractor or subcontractor shall adhere to the mitigation plan and submit report regularly.

8.5.16.3 The project owner shall conduct periodic reviews to establish effectiveness of the mitigation plan.

8.5.16.4 The project owner/ contractor shall develop procedures and operational controls of onsite storage of project materials.

8.5.16.5 E-waste resulting from ICT infrastructure deployment, maintenance or upgrade shall be disposed in accordance to National Environment Management Authority (NEMA) guidelines on e-waste management.

Fiber Optic Cable Maintenance

8.5.17.1 The responsibility for maintenance shall be borne by cable owners and shall adhere to the below guidelines.

a. Maintenance procedure: - A maintenance procedure shall guide all aspects of maintenance work and shall include authorization for the works, documentation and signoffs by technician/Engineer carrying out the works.

b. Network Operations Centre: -Cable owners/operators shall establish and operate a Network Operations Center.

c. Incident /Fault reporting: - All incidents shall be reported, categorized and recorded. At a minimum, the fault report shall include description of incident, contact details of reporting entity, location of the incident, time of occurrence, a fault ticket and the responsible entity for the resolution.

d. Fault Categorization: - Each incident shall be categorized as either a Critical Fault when total loss of service is experienced, Severe if significant degradation of services occurs or a Minor Fault if only minor service degradation occurs.

e. As built diagram: - Updating of the as built diagram whenever there is a change.

f. Preventive Maintenance: - Quarterly testing shall be done for all fiber installations to detect performance deterioration and apply corrective measures to within agreeable parameters (Annex 7).

g. Unscheduled Maintenance: - Unscheduled or emergency maintenance activities shall require issuance of a notice to service subscribers within the hour of the emergency occurrence.

h. Planned Maintenance: - Where the Owner requires conducting a planned maintenance activity the Owner shall issue a Change Request Notice to subscribers ten (10) days in advance.

i. Personnel

i. Installation & Maintenance personnel shall have certification issued by relevant body.

ii. Installation & Maintenance shall have a valid Certified Fiber Optic Technician (CFOT) certificate or its equivalent.

Documentation

8.5.18.1 Upon completion of the construction, the "as-built" drawings of the cable and all other facilities, shall be prepared and submitted to the Authority. The drawings will consist of a properly geo-referenced location map and longitudinal profile of the power line (UTM Map projection on Arc 1960 datum), on A3 Size paper, indicating the exact locations of all installed underground fiber cable line placements along or across the roads. A copy of the map should also be forwarded in digital (AUTOCAD) format. The map should be clearly labelled and should also show the plots abutting the road. Coordinates (X, Y) list for all the utility line bends and road crossings should also be included in the map.

8.5.18.2 As built, at minimum shall be provided in standard formats:

i. Auto- Cad drawings (In soft copy).
ii. KMZ files.
iii. Hard copy drawings (At least 2 copies).

8.5.18.3 Such documentation shall contain the following information:

i. Photos taken of every procedure as proof of existence.
ii. Position of the completed trenches.
iii. Position and location of installed Gabions and Bores and their lengths.
iv. Position of the installed conduits and cables.
v. Position and location of installed Hand-holes.
vi. Position and location and span length of installed poles.
vii. Soil Stabilization accomplished; position and length of stabilized area.
viii. Network loss link budget.
ix. Equipment Shelter and Power Connectivity.

8.5.19 Quality Assurance

8.5.19.1 Inspections shall be conducted for installation in progress. It is the responsibility of the Contractor to schedule regular and milestone inspection times. It is incumbent upon the Contractor to verify that the installation and material used has been inspected before it is enclosed within building features, buried, or otherwise hidden from view.

8.5.19.2 The Contractor shall provide electronic test results and a 20-year manufacturer's warranty with a copy of the warranty to be submitted to the owner at the completion of work.

8.5.19.3 All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions.

All conductors and fibers of each installed cable shall be verified usable prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed-through couplers, patch panels, and connector blocks shall be repaired or replaced at the provider's expense in order to ensure 100% usable conductors in all installed cables.

8.6 Markings

8.6.1 Polymer makers shall be used.
8.6.2 These markers shall have a length of not less than 1.8M and a diameter of not less than 100mm.
8.6.3 Markers shall be planted 600mm deep opposite a Maintenance chamber and well compacted.
8.6.4 Distance - Intervals shall be not more than 500 meters marking.
8.6.5 A standard equipment shall be used for GIS coordinates.
8.6.6 Text should be black – manhole number, Handhold Number, Joint and Joint Number, whether is Backbone or access, Operator/Owner.
8.6.7 Electromagnetic markers shall be built in a hand holes and also be place at the undercover of the manholes.

8.8 Equipment

8.8.1 Availability

8.8.1.1 The availability of fiber optic link and equipment (E2 to E2) shall be at least 99.95%.
8.8.1.2 The average per link subscriber to subscriber availability shall be at least 99.97%. The down time of available standard fiber optic cable shall also be considered in the aforesaid availability calculations.
8.8.1.3 The calculated failure rates of the units and the calculated availability of the equipment being offered shall be provided. The analysis shall be based on an availability block diagram and shall include the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of all of the components on the link.
8.8.1.4 An MTTR of at least 4 hours shall be provided.

8.8.2 Built in Testing

All active equipment shall provide a built in mechanism for testing installed modules and its subsystem components. Equipment specifications as per accompanying data sheets and white papers shall conform as specified and testable. The datasheet and all testing criteria shall be available for audit.

Equipment life time

8.8.3.1 End of Manufacture - The Supplied Fiber transmission equipment end of manufacture date shall be no more than three (3) years from the manufacture start date
8.8.3.2 End of Support - The supplied optical transmission equipment shall provide guaranteed eight (8) years equipment support.
8.8.3.3 End of Life - The supplied optical transmission equipment shall provide guaranteed twelve (12) years End of life Specification.

8.8.4 Interoperability considerations

A multi manufacturer environment shall be encouraged.

8.9 Security

Information Security & Cybersecurity measures will be adhered to and ensure protective security considerations are inbuilt to all equipment and Accessories to determine their suitability for use in National Fiber Optic Infrastructure (NOFBI) Government facilities.

8.9.1 Security controls shall be implemented in line with the GoK information security standards

8.9.2 Identification: All authorized users of the NE shall be uniquely identified to support individual accountability.

The requirements for Identification are:

8.9.2.1 Within a specific NE, the NE shall enforce unambiguous User-IDs to identify its users.

8.9.2.2 All NE interfaces and ports that accept user command inputs shall require unambiguous User-IDs before performing any actions.

8.9.2.3 The NE shall internally maintain the identity of all current active users.

8.9.2.4 The NE shall restrict a User-ID to only one active session.

8.9.2.5 All operations-related processes running on the NE shall be associated with the User-ID of the invoking user.

8.9.2.6 If a user-ID has not been used for a period of 3 months, the NE shall be capable of disabling that User-ID.

8.9.2.7 In addition, the security administrator shall have a choice of automatic or manual disabling of these User-IDs.

8.9.2.8 The NE shall log all activities carried out by the user during each session. All logs must include timestamps and activity or system accessed.

8.9.3 All building sites and equipment (and all information and software contained therein) shall be protected from theft, vandalism, natural disaster, man-made catastrophes, and accidental damage (e.g., from electrical surges, extreme temperatures, and spilled coffee).

8.9.4 The fiber network shall be appropriately segmented to ensure security and performance. The segmentation shall allow for the main backbone network running from point to point and the access network, typically used for last mile connections.

8.10 Aerial Cable

8.10.1 All aerial cables shall conform to the requirements IEC 60794-4-20

8.10.2 Aerial cable in arid and semi arid shall be designed to withstand temperatures above 80 degrees.

ANNEXES

ANNEX 1: STANDARD PHYSICAL REQUIREMENT OF THE DUCTS
(1) BACKBONE NETWORK PHYSICAL STANDARDS

Description	Spec
Conduit Type	HDPE
Inner Layer	Silicone with cream inner side
Color	Owner
Labeling	Owner- yyyy= mm/yyyy (Month & Year of manufacture) =Spacing of the labeling will be 1.0m. The year will be changed to the right year of manufacture)
Outside diameter (mm)	40
Inside diameter (mm)	33
Standard straight length (m)	n/a
Standard length coils (m)	Min 50
Min. bending radius (mm) 6m length	n/a
Material used	Must be anti-rodent material
Minimum number of ducts to be installed	6
Min. bending radius (mm) coils	150

(2) Metro Network Physical Standards

Description	Spec
Conduit Type	Micro ducts 7 way minimum
Inner Layer	Silicone with cream inner side
Color	Owners Color
Labeling	Owner- yyyy= mm/yyyy (Month & Year of manufacture) =Spacing of the labeling will be 1.0m. The year will be changed to the right year of manufacture)
Outside	
diameter (mm)	14
Inside	
diameter (mm)	10
Standard	
straight length (m)	n/a
Standard length coils (m)	Min 50
Min. bending radius (mm) 6m length	n/a
Min number to be installed once	2
Material used	Must be anti-rodent material
Min. bending radius (mm) coils	150

(3) Last Mile Network Physical Standards

Last mile network shall be characterized into:

- Fiber to the Building (FTTB) – Minimum 7 Way from the manhole to the building and structured cable
- Fiber to the Homes (FTTH) – Minimum 7Way
- Fiber to the Site - Minimum 4 Way

All last mile network shall use micro ducts in the implementation of the network with below physical characteristics:

Description	Specification
Conduit Type	Micro ducts 7 way minimum
Inner Layer	Silicone with cream inner side
Color	Owners Color
Labeling	Owner- yyyy= mm/yyyy (Month & Year of manufacture) =Spacing of the labeling will be 1.0m. The year will be changed to the right year of manufacture)
Outside diameter (mm)	14
Inside diameter (mm)	10
Standard straight length (m)	n/a
Standard length coils (m)	Min 50
Min. bending radius (mm) 6m length	n/a
Min number of ducts to be installed	2
Material used	Must be anti-rodent material
Min. bending radius (mm) coils	150

4) Road crossing Physical Standards

Road crossing for all the new roads shall be constructed during road building using Concrete service ducts at intervals of 500m. The road crossing for existing ducts shall use below physical characteristics:

Description	Spec
Conduit Type	HDPE
Inner Layer	Silicone with cream inner side
Color	Owners Color
Labeling	Owner- yyyy= mm/yyyy (Month & Year of manufacture) =Spacing of the labeling will be 1.0m. The year will be changed to the right year of manufacture)
Outside diameter (mm)	Class A road- 160mm
Class B, C, D roads- 110	
Inside diameter (mm)	Class A road –147mm
Class B, C, D -100mm	
Standard straight length (m)	n/a
Standard length coils (m)	Min 50
Min. bending radius (mm) 6m length	n/a
Material used	Must be anti-rodent material
Minimum Number for any road crossing	2
Min. bending radius (mm) coils	150

Annex 2: OFC Duct Technical Requirements

Item	Description	Spec	Units	Method	
1.		Density	0.95	g/cm3	DIN 53 479
2.		Tensile strength at break	23 – 30	N/mm2	DIN 53 455
3.		Ball indentation hardness	30 – 65	N/mm2	DIN 53 456
4.		Notched bar impact strength	> 5	mJ/mm2	DIN 53 453
5.		Thermal conductivity	0.40 – 0.46	W/m K	DIN 52 612
6.		Coefficient of elongation	1.5–2.0 x 10-4	K-1	DIN 52 328
7.		Dielectric strength	800 – 900	kV/cm	DIN 53 481
8.		Specific insulation resistance	1016	Ohm. cm	DIN 53 482

Annex 3: Trenching of all soil types

Item	Description	Spec
1	Trenching Depth for all the soil type	1500mm
2	Minimum trench width at 1500mm (bottom)	300mm
3	Minimum trench width at 0 depth (Top)	400mm
4	Compacted treated Bedding at bottom of trench	150mm
5	Warning Tape depth	750mm
6	Depth of compacted treated backfill at top of trench	300mm

Annex 4: Optical Fiber Characteristics

No	ITEM
1	**Introduction** Optical fiber cables are categorized into six main types based on their characteristics as defined by the International Telecommunications Union standards ITU-T G. series (ITU-T G.652 - G.657). The classification and standards define the various cable types to reflect their properties as here below summarized and the ideal applications for each.
	1) G.652 - Characteristics of a single-mode optical fiber cable. 2) G.653 - Characteristics of a dispersion-shifted, single-mode optical fiber cable. 3) G.654 - Characteristics of a cut-off shifted, single-mode optical fiber cable. 4) G.655 - Characteristics of a non-zero dispersion-shifted single-mode optical fiber cable. 5) G.656 - Characteristics of a fiber and cable with non-zero dispersion for wideband optical transport. 6) G.657 - Characteristics of a bending-loss insensitive single-mode optical fiber and cable for the access network.
2	**Backbone deployments** • Optical fiber used in the cable manufacturing fully comply with ITU-T-Rec G 652 D. For detailed characteristics. • More specific for general fiber installations • Optical fiber used in the cable manufacturing fully comply with ITU-T-Rec G 655 D. For detailed characteristics. • More specific for backbone and high capacity long haul links with DWDM equipment • Optical fiber used in the cable manufacturing fully comply with ITU-T-Rec G 656 D. For detailed characteristics. • More specific for backbone and high capacity long haul links with DWDM equipment • Optical fiber used in the cable manufacturing fully comply with ITU-T-Rec G 657 D. For detailed characteristics. • More specific for last mile installations with limited bending areas and thus small bending radius appropriate

Annex 5: Pre Installation for cable Drum

No	Item	
1	Check that the cable specified, has been procured	
2	The cable drum shall be inspected for signs of excessive weathering and/or damage	
3	Drums shall be transported or stored with their battens intact	
4	Never accept delivery of a cable should the drum is damaged	
5	Plastic foil wrap shall remain in place until cable placement	
6	To remove plastic foil wrap on a cable, do not use sharp tools	
7	Ensure that all cable drum bolts are all tightened	
8	Verify that nails, bolts or screws on the inside surface of drum flanges are counter-sunk to avoid damage to the cable during placement.	
9	Place the cable drum in line with the intended direction of deployment, to prevent reel flange-cable rubbing	
10	Cable end shall always be sealed – using pre-formed or heat shrinkable end caps	
11	Using tape for sealing cable ends is considered unsuitable	
12	Always roll the drum following the direction of the arrow	
13	Drums shall be chocked to prevent them from moving	

14	Branding
	The branding of the cables, ducts, poles, and any other accessories should meet the following minimum requirements. • All the text shall be electronically printed • The printed text on the fiber cables shall have the organization name, logo, year of manufacture, number of cores and the physical location of the route reading From..... To..... • The printed text on the ducts shall have the organization name, logo, year of manufacture and the physical location of the route reading From..... To..... • The text shall be printed in intervals of 1meter spacing for the cables and ducts • The printed text shall be legible, which typically means they should be printed on a high quality to ensure the text is easy to read • The text should be consistent • The text should be able to last for a long period of time, therefore durability is key as the ducts, cables and other accessories last for many years. • The text shall be permanently placed on the products.
15	Label
	a. Plastic cable labels shall be mechanically printed and shall be attached to all fiber optic cables using black UV rated cable ties or stainless-steel cable ties within six inches of the splice closure and 6 "from all ducts and sleeves. b. Provide electronically printed, waterproof, self-adhesive, laminated labels installable on the external surface of the outside panel of all FDU's and closures.

Annex 6: OTDR Pre- test

No	Item
1	All fiber should be tested before installation begins by use of a minimum OTDR or Scalable OTDR based in the technology.
2	Testing shall be done on all fibers in one direction at 1550nm or 1310nm, using a pulse of 30ns
3	Traces will be stored and soft/electronic copy submitted to the client
4	Should a cable be installed without OTDR pre-test – a supplier can claim that the installer assumed liability upon installation.

Annex 7: Technical details of fiber optic cable 8,24,48,72 96 & 144 fibre (g652d) dry core, multi loose tube design, single sheath, glass yarn armoured ofc suitable for duct installation

NO.	ITEM
1	**INTRODUCTION** Glass Yarn armored, Rodent protected, in full compliance with ITU-T G 652 D.
2	CABLE DESIGN:
	a. Single mode and Multimode fiber in full compliance with ITU-T G 652 D
	b. Water blocking yarns used helically over PE up coated FRP Rod[
	c. Loose buffer tubes fully filled Thixotropic Jelly
	d. Loose buffer tubes S-Z Stranded
	e. Water Blocking tape wrapping over S-Z core
	f. Glass yarn used as peripheral strength member
	g. UV Stabilized HDPE Outer sheath, black
3	**MECHANICAL CHARACTERISTICS**
	1. Temperature Range (IEC6079-1-2-F1)
	2. Operation -30° to +70°C
	3. Transport and Storage -40° to +70°C
	4. Cable Bending Radius (IEC 60794-1-2-E11)
4	**OPTICAL CHARACTERISTICS:** Optical fiber used in the cable manufacturing fully comply to ITU-T-Rec G 652 D. For detailed characteristic. i. at 1310 nm < 0.35 dB/Km ii. at 1550 nm < 0.22 dB/Km iii. at 1625 nm < 0.26 dB/Km

5	**COLOR CODING**		
	Color of Fibers in a Tube :	Blue, Orange, Green, Brown, Slate, White	
			Red, Black, Yellow, Violet, Pink & Natural/Aqua
Color of Loose Tubes:	Blue, Orange, Green, Brown, Slate, White, Red, Black		
			Yellow, Violet, Pink & Aqua
6	**Note :**		
	a. For 144 F Cable: 12 loose tubes each having 12 fibers b. For 96 F Cable: 8 loose tubes each having 12 fibers c. For 72 F Cable: 6 loose tubes each having 12 fibers d. For 48 F Cable: 4 loose tubes each having 12 fibers & 2No. Filler e. For 24 F Cable: 6 loose tubes each having 4 fibers f. For 8 F Cable: 2 loose tubes each having 8 fibers & 4No Filler		
7	**CABLE SHEATH MARKING:** Below mentioned details are generally marked on the cable sheath. Telephone Symbol, Laser Symbol, Number of Fibers, Type of Fiber (G 652 D) SM, Month & Year of Manufacturer, Manufacturer, Customer Name, Sequential Meter Marking		
8	**CABLE DRUM PACKING:**		
	Generally the cable drum flange will be marked with following:		
	a. Arrow showing the direction, the drum can be rolled. b. Country of origin. c. The manufacturer's name. d. Number of fibers. e. Nominal cable length in meters f. Net and gross weight. g. Customer's name h. Both ends of the cable shall be sealed to prevent the ingress of moisture during transportation and storage, physical damage.		

9	**GENERAL CHARACTERISTICS** a. All accompanying documentation and brochures shall be in English language b. OPTIC FIBER CABLE (G.652.D) c. STANDARDS COMPLIANCE d. The cables should be tested and proven to conform to the TIA/EIA 568B.3 and ISO/ IEC 11801:2002, IEC 60794-3-12 ,IEC 60794-3-21, IEC 60794-3-21, EN 60794-3-21:2006 requirements for optical fiber cable performance e. Should support and exceed all of the performance requirements for current and proposed applications such as 100BASE-F, 155/622 Mbps ATM Gigabit Ethernet 10 Gigabit Ethernet.	
10	**SPECIFICATIONS**	
11	a. The optical fiber cable shall comprise of [4, 6, 12, 24, 36, 48, 96, 144] fibers. b. Fiber color sequence is compiled with TIA-598. c. The filler elements are manufactured with PE to the same outside diameter as the loose tubes. d. The elements are SZ stranded around a non -metallic central strength member (FRP with coating if required) and the formation retained with polyester water blocking tapes binders. e.To prevent the ingress of water, the cable core should be jelly filled. Over this core is applied a polyester tape. f. This sheath should be black HDPE in a figure 8 formation with the upper part carrying a 7X1.2mm (for 4-72Fiber), 7X1.3mm (for 96Fiber), 7X1.6 mm (for 144Fiber) stranded zinc-coated steel strand bearer. g. The nominal radial thickness of the sheath around the cable core is 1.5mm, and around the bearer the nominal radial thickness is 1.0mm. The web dimensions are 2.0mm wide X 2.0mm high. **PERFORMANCE SPECIFICATIONS** • The Fiber Aerial Figure 8 Cable should be designed and tested in accordance with TIA-568-B.3 and ISO 11801, ITU G.652D.	
	• The Performance specifications should be measured in accordance with the Fiber Optic Test Procedures (EIA/TIA-455 documents) and the test procedures of IEC 60793-2-50,B1.3 , IEC 60794.	
	• The vendor shall provide documentary evidence/certification of prove of conformity to the above performance	
	Description	**Single Mode (1310/1550)**
	Typical Attenuation	≤ 0.36/0.36/0.23 dB/km
	Maximum Attenuation	0.4/0.4/0.4 dB/km

APPENDIX 1: TECHNICAL COMMITTEE MEMBERS

No.	Name	Organization
1	Dr. Katherine Getao	ICT Authority
2	Anthony Kyengo	Safaricom PLC
3	Samwel King'ori	Kenya Rural Roads Authority
4	Eng. Joseph Kivanguli	Kenya Urban Roads Authority
5	Jeremiah Mugambi	Kenya National Highways Authority
6	Levy Byamukama	Safaricom PLC
7	Jacob Kangogo	Telkom
8	Daniel Kituyi	Kenya Bureau of Standards
9	Benbrose Ndivo	Kenya Pipeline Company
10	Henry Ondieki	Kenya Rural Roads Authority
11	Emmanuel Kuboi	Kenya Pipeline Company
12	Carlos Escobar	EARTTDF Consultant
13	Elizabeth Wanjiru	DANCO Capital
14	Wahiru Kanake	Kenya Revenue Authority
15	Stanley Muchina	Afripipes
16	Dr. Paul Kipronoh Ronoh	ICT Authority
17	Michael Odhiambo	ICT Authority
18	Thomas Odhiambo	ICT Authority
19	Phillip Irode	ICT Authority
20	Alex Njihia	ICT Authority
21	Joshua Opondo	ICT Authority
22	Anthony Lenaiyara	ICT Authority
23	Eng. Brian Kariuki	ICT Authority
24	Angela Mugambi	ICT Authority
25	Faith Kawira	Water Resources Authority
26	Vincent Kaweru	ICT Authority
27	James Wafula	ICT Authority
28	Charles Waithiru	ICT Authority
29	Moses Kijugu	ICT Authority
30	Millah Were	ICT Authority
31	Martha Wahome	ICT Authority
32	Quty Badaso	ICT Authority
33	Kenneth Matiba	Huawei
34	Fiona Asonga	Tespok
35	Caroline Simba	Jamii Telecom
36	Sammy Njoroge	Liquid Telkom

37	James Wachira	Council of Governors
38	Charles mutuku	TESPOK

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