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DRAFT TANZANIA STANDARD

(Draft for comments only)

Optical fiber cable installation requirements

TANZANIA BUREAU OF STANDARDS

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LIST OF ABBREVIATIONS

ADSS	All-dielectric Self-Supporting
ANSI	American National Standards Institute
APC	Angle Physical Connector
COD	Corrugated Optical Duct
dB	decibel
GR	Generic Requirements
HDPE	High-Density Polyethylene
ICEA	Indoor-Outdoor Optical Fiber Cable
ITU	International Telecommunication Union
LC	Lucent Connector
LED	Light Emitting Diode
LGA	Local Government Authority
NOC	Network Operations Center
OFC	Optical Fiber Cable
PC	Physical Connector
PoP	Point of Presence
QoS	Quality of Service
SC	Square Connector
SLA	Service Level Agreement
SP	Service Provider
TCRA	Tanzania Communications Regulatory Authority

1. INTRODUCTION

Fiber optic communication is revolutionizing the communications industry. With fiber optic cables, communication links are deployed over longer distances with much lower level of signal losses. Fiber optic communications systems are widely employed for transmitting voice, data as well as cable television signals. As a result of its advantages, fiber optic networks play a key role in increasing internet broadband penetration.

Fiber optic networks are categorized into three groups, namely core, backbone, and access/last mile fiber optic networks. The core fiber optic network is the undersea fiber optic connecting international internet traffic via submarine cable landing stations, whereas the backbone fiber optic network refers to the national fiber to service providers across various regions. The access/last mile fiber network is the fiber optic connecting the base stations and the end users including fiber to home, office or buildings.

Depending on the environment, application and business needs, fiber optic is installed in three major ways; underground, aerial/overhead and submarine. Each type of installation comes with its own requirements.

Considering that fiber optic networks are the primary infrastructures for current and emerging communication technologies, well-defined processes and best practices must be followed when deploying and maintaining the fiber optic networks to avoid substandard installations as well as damage to existing infrastructures.

2. SCOPE

This standard provides requirements for the deployment and maintenance of fiber optic cables. The standard aims to provide guidance on the deployment of fiber optic networks in order to ensure that optimal network performance and reliability of services are met as provided by regulator

The standard shall not change any obligations imposed by other relevant authorities to the service providers.

3. NORMATIVE REFERENCES

TZS 686:2022 *Wood poles and blocks for power and telecommunication lines – Specification*

TZS 2725-1-1: 2022 *Optical fibre cables - Part 1-1: Generic specification – General*

TZS 2725-3-12: 2022 *Optical fibre cables - Part 3-12: Outdoor cables - Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling*

4. TERMS AND DEFINITIONS

Attenuation means a gradual loss in intensity of light through the fiber-optic medium specified in decibel (dB) for light at a specific wave-length.

Environmental Monitoring System means a system that monitors temperature, airflow, humidity and other related parameters in the station or container housing communication equipment.

Fiber link means concatenation of fiber spans to allow end-to-end connection between two sites

Fiber span means contiguous fiber between two repeater stations or between a repeater station and a link endpoint

Handhole means the jointing chambers in which specified equipment is to be used with dimensions 1850height x 1120width x 1650 Length x 150 wall thickness. The average spacing between handholes is 2km for direct buried cable and 500m for ducted cable.

Manhole means the jointing chambers in which specified equipment is to be used with dimensions 2290height x 1800width x 2400 Length x 230 wall thickness. The design of the jointing chambers and the frames covers shall be such that an adjustment to modified surface level is facilitated. The average spacing between manholes is 4km

Point of Presence means a physical location where fiber optic connections come together

Repeater/Regenerator site means a facility for the co-location of amplification and/or regeneration equipment between fiber spans

Right-of-Way means a permit or authorization granted by the land owner that gives rights to deploy fiber optic infrastructure

Scheduled Maintenance means planned network changes carried out to install new infrastructure, optimize existing network resources or upgrade the fiber optic network

Service Provider means a licensed optic fiber network service provider

5. REQUIREMENTS

5.1 GENERAL OFC REQUIREMENTS

The following requirements shall be considered during deployment of Optical Fiber Cables

SPECIFICATIONS OF OFC

i. Optic Fiber Cables (OFC) must meet specifications outlined in relevant ITU-T recommendations as follows: -
   a) ITU-T G.652D for dispersion unshifted standard single mode optical fiber used in metro and long-distance optical networks
   b) ITU-T G.654D for cut-off shifted single-mode optical fiber used in long-haul submarine optical networks
   c) ITU-T G.654E for cut-off shifted single-mode optical fiber used in high-speed long-haul terrestrial optical networks
   d) ITU-T G.655 for non-zero dispersion shifted single-mode optical fiber for long-haul and backbone applications
   e) ITU-T G.657 for bending loss insensitive single-mode optical fiber for use in distribution networks and customer premises
   f) ITU-T G.651 for multimode optical fiber
ii. OFC shall meet all requirement specified at operational wavelengths, including but not limited to attenuation, chromatic dispersion and polarization mode dispersion.
iii. Each OFC must be distinguishable from other OFC in the same duct by means of color-coding ink or non-removable label visible throughout the life of the cable
iv. Each OFC shall have traceability back to the original fiber manufacturers serialized fiber number and measured fiber parameters
v. The OFC must be circular in cross-section and free from pinholes, joints, repairs and other defects
vi. The OFC shall be properly marked and labeled at each manhole and at all entry and end points of the OFCs.
vii. The OFC shall be able to withstand temperatures between -50°C and 70°C to support storage, transportation, installation and operation.

5.2 GENERAL DEPLOYMENT REQUIREMENT

The following shall be taken into consideration during deployment of OFC;

i. The OFC network shall be deployed to meet future requirements and the deployed network will be shared among service providers under specific guidelines from respective authority to minimize deployment costs

ii. The existing OFC infrastructure shall be used whenever possible under specific guidelines from respective authority.

iii. The minimum capacity for the OFC backbone network shall be 48 cores

iv. The minimum capacity of the OFC Metro network shall be 96 cores

v. The cable length between splices shall not exceed 6 km for access networks

vi. The distance between poles for short span shall be between 50 to 60m for both Urban and Suburban areas and not more than 80m for rural areas.

5.3 SPLICING

Splices are critical points in the OFC network, as they affect the quality of the links, as well as the lifetime of the links. Splices shall have low splice loss and tensile strength near that of the fiber proof-test level. Further, the splices shall be stable over the design life of the optical fiber link under its expected environmental conditions. Service providers shall ensure that the splice losses shall be between 0.01 dB to 0.5 dB for fusion splicing and 0.3 dB to 0.75 dB for mechanical splicing.

5.4 FIBER OPTIC CONNECTORS

The single mode connectors furnished on optical patch cords and pigtails shall be SC/APC connectors (IEC 61754-4), LC/APC connectors (IEC 61754-20) or any other standard connectors. All optical connectors supplied will be factory installed on patch cords or pigtails. No field installation of connectors shall be permitted.

5.5 PIGTAILS

The optical pigtails shall be comprised of a section of OFC, jacketed cable of sufficient length, equipped with a factory-installed connector at one end. The other end can be stripped and prepared for fusion splicing. Pigtails are to be fusion spliced to the main cable, have an appropriate splice protector applied and installed in splice trays to the manufacturer's specifications.

5.6 FIBER OPTIC SPLICE ENCLOSURES

All splices shall be contained within a suitable splice enclosure as specified in ITU-T Recommendation L.201. The enclosure must be watertight and weatherproof and must cater for the full number of fiber cores in a fiber that it is being spliced.

5.7 REPEATER/ REGENERATOR STATION

For long-distance OFC links, optical repeaters or regenerators shall be deployed at certain distances along the link, depending on design factors such as the capacity of the link and transmit power. The following shall be considered;

i. The repeater/regenerator shall be housed in a either proper container, Building, Outdoor Direct Burried, Overhead or Submarine with controlled access.

ii. All regenerator/repeater sites shall be equipped with an environmental monitoring system.

5.8 FIBER OPTIC TERMINATION PANEL

All OFCs must be terminated onto a fiber optic termination panel at the endpoints as well as at the regeneration or repeater sites. Provisions must be made to allow for specific fiber cores to be spliced all the way through to the terminal equipment, if needed. The following requirements must be adhered to: -

i. All terminated fiber spans must be clearly and accurately labelled

ii. Fiber slack must be provided at all points where the fiber connects to a patch panel. All slack must be neatly coiled and secured in a manner that does not exceed the minimum bend radius of the pigtail

iii. Any unused ports on the panel must be covered with suitable plugs or protective covers.

6. UNDERGROUND OFC INSTALLATION

Underground installations of OFC are necessary and unavoidable in some areas for various reasons including nature and heritage conservation, natural obstacles, aesthetics, space, and safety. Placing cables underground has additional benefits of reducing transmission losses from extreme weather. Underground cables can be installed by burying them directly in the ground or by placing the fiber optic inside a duct buried underground. The basic requirement for the installation of fiber-optic cable underground includes the following: -

6.1 REQUIREMENT FOR CIVIL WORKS

6.1.1 PRE-CONSTRUCTION ROUTE SURVEY

A survey of the cable route shall be conducted for all types of installations before the commencement of excavation works. The route shall be clear of any obstacles and shall

be marked with fliers at distances of 50m to 100m for urban areas and 100m to 200m for other areas. If a change in route is required for any practical reasons, prior approval shall be obtained from relevant authorities.

6.1.2 TRENCHING

Excavation of trenches to lay OFC shall be as follows: -

i. Digging and trenching works shall be as per requirements in the Manual for Control Utilities within Road Reserves, 2012 issued by the Ministry responsible for Roads.

ii. Trenches shall have a minimum depth of 150 cm below ground level for ducts and direct buried OFC, and between 40-100 cm depth below ground level for Rocky soils.

iii. Where the cable crosses the roads, ducting shall be of PVC pipes class 'D' buried at a minimum depth of 150 cm for protection from vehicular and pedestrian traffic stresses. Similar materials galvanized steel pipe ducts shall be used at bridge attachments.

iv. At least a horizontal distance of 0.5 meter between the existing utilities and the new cable shall be reserved, and if not possible, there shall be appropriate protection and the existing utility provider shall be informed accordingly two weeks (14 days) before the commencement of the work

v. Trenches must be guarded by barricades, warning tapes or covers

vi. Backfilling and reinstatement of the surface shall comply with all guidelines, and provisions established by relevant authorities.

6.1.3 TRENCHLESS TECHNIQUES

Trenchless also called no-dig techniques, involve creating a horizontal bore below the ground in which the underground ducts, pipes or direct buried cables can be placed. Trenchless techniques reduce environmental damage and provide an economic alternative to open-trench methods. Horizontal directional drilling is the preferred method to cross roads, highways, railway lines and rivers. Other situations in which trenchless techniques are recommended to be used are described under ITU-T Recommendation L.38. The following shall be observed when installing OFC through trenchless techniques: -

i. The depth of any hole drilled for installation of a new cable must be at least 1.5 m below the surface

ii. The depth of cover must not be less than three times the final diameter of the drilled hole and at a minimum of 1.5 m.

iii. At river crossings, the distance between the bottom of the water and the drilled hole shall be 10-times the diameter of the pipe and not less than 3 m

iv. OFCs can also be installed inside sewer ducts according to the procedure described in ITU-T Recommendation L.77 after approval from relevant authorities

v. Micro-trenching may also be used in accordance with ITU-T Recommendation L.49.

6.2 DUCTING

Deployed ducts shall be shared to reduce costs and damage of existing infrastructure. Ducting offers a more economically sensible option for underground OFC installation. The following shall be considered during ducting: -

i. Conventional ducts or COD shall be made from material comprising of High-Density Polyethylene (HDPE)

ii. Sub-ducts shall be made of PVC (Polyvinyl chloride) or PE (Polyethylene)

iii. Different colors shall be used to identify each sub-duct installed (typically by pulling) in a primary duct

iv. The cables and ducts shall be marked and labeled at each manhole and at all entry and endpoints

v. At least 2 ducts with a minimum of 12 cores shall be installed for access fiber networks and at least 5 ducts with a minimum of 96 cores for the backbone

vi. Where a new fiber route with micro-ducts is deployed, 7-way micro-ducts shall be used.

vii. Manholes or handhole shall be used as network splice and flexibility points.

viii. Consideration shall be given to the storage of excess cable in boxes or manholes.

6.3 DIRECT-BURIED INSTALLATION

This method involves digging a trench, installing the cable and reinstating the surface. Although the method is simple and cost-effective, it renders the fiber more susceptible to damage and also more difficult to access and repair. The following shall be taken into consideration: -

i. Armored cable must be deployed to cater for both crush and rodent protection as required under ITU-T Rec. L.3

ii. The splice cases shall be directly buried or protected by an optical closure or a prefabricated box

iii. The length between splices shall not exceed 6000 m for the last mile networks

6.4 MANHOLE/HANDHOLE REQUIREMENT

Deployment of manholes and handholes shall consider the followings: -

i. Manholes/Handholes shall be positioned outside sidewalks and roadways

ii. The distance between manhole and handhole shall not exceed 1 km

iii. Handholes must be strategically placed between manholes and the maximum distance between two consecutive handholes must not exceed 500 m

iv. The maximum distance between manholes must not exceed 4 km

v. Each manhole needs to cater for about 30 m of total fiber slack (15 m from either direction) which must be neatly stored on slack management trays

vi. Each handhole must cater for at least 10 m of total fiber slack

vii. The splice enclosures must be firmly mounted to the manhole

viii. All manholes and handholes must be tightly sealed to avoid water entrance.

ix. Access to manholes and handholes must be controlled using either a mechanical lock or a smart lock

x. A location marker is required at each handhole and manhole and must be clearly documented

xi. Manholes/Handholes shall not be located in the ditch line

xii. Manholes/Handholes shall be labeled with the name of the service provider

xiii. Manhole/Handhole covers must be watertight

xiv. All duct entries and exits at the handholes must be sealed properly to prevent water ingress

xv. GPS coordinates of all manholes and handholes must be taken and documented to form part of the as-built documents

6.5 REINSTATEMENT

Reinstatement work must be done by the service provider in accordance with standards provided by responsible authorities.

6.6 OVERHEAD/AERIAL OFC INSTALLATION

Deploying fiber above the ground removes the need for digging and is particularly useful when the ground is undulating or rocky. The reasons for choosing aerial installations may include: -

i. Aerial fibers are typically much faster and cheaper to deploy than buried fibers

ii. The planned route may be undulating, rocky or both, making digging less appealing

iii. All-Dielectric Self Supporting (ADSS) cables shall be erected in close proximity to power transmission lines. This allows for pole sharing, which reduces installation costs and speeds-up deployment

6.7 OVERHEAD CABLE REQUIREMENT

i. The cables used shall conform to environmental and mechanical properties as described in ITU-T Recommendation L.26

ii. The OFC jacket/sheath shall be made of polyethylene or other materials suitable for the relevant environmental and mechanical conditions associated with installation and operation

iii. In high voltage environment where Optical Power Ground Wire (OPGW) is not available, OFC shall be installed in a position of minimum field strength. A special cable sheath material (IEEE 1222) shall be used depending on the level of the electric field.

6.8 INSTALLATION REQUIREMENT

i. Poles shall be made of treated wood, concrete or galvanized steel

ii. Poles must be at least 8 m high

iii. Poles must be buried to a depth of 1/6 of the length of the pole.

iv. ADSS deployment shall not exceed 80 meters for short span and shall not exceed 600 meters for long span.

v. Uniform pole spacing must be maintained except at river crossings and sharp bends

vi. Consideration must be given to continual tension from the cable weight and wind loads

vii. The cables shall be lashed to or twisted around a support cable/wire (messenger) or otherwise a self-supporting cable should be used

viii. The cables shall be suspended on all poles, however at special positions, for example;

- ✓ splice poles;
- ✓ end of the route;
- ✓ river or road crossing;
- ✓ every given number of poles,

the cable should be anchored (fixed to the pole) in order to transfer the main load from the cable onto the pole

ix. Splices shall be done in manholes on the ground or in suitable optical enclosures supported on the pole. Where splicing is done on the ground, galvanized caping steel shall be deployed on the pole to a height of at least three (3) meters above ground level for the protection of the fiber cable.

x. A length of cable for cable splicing purposes shall be stored at splicing positions

7. DAMAGE TO EXISTING UTILITY

The service provider shall be responsible for damages to existing utilities during the installation and maintenance of OFC networks. Relevant authorities who are custodians of the damaged utilities shall determine the proper course of action on a case-to-case basis.

8. FIBER TESTING

8.1 PRE-INSTALLATION TESTS

Service providers shall follow requirement for testing OFC prior to installation to ensure that losses due to laying/blowing the fiber are within accepted tolerances.

8.2 POST-INSTALLATION TESTS

Service providers shall: -

i. Perform bi-directional tests for all installed fiber cores between Points of Presence
ii. Conduct tests for Attenuation, Chromatic dispersion and Polarization mode dispersion
iii. Document each specific test procedure including details of the test equipment used.

9 MARKERS

i. Underground routes must be marked with identifiable markers
ii. The markers shall have a height of at least 1000 mm and top a width of at least 140x140 mm, base a width of at least 200x200 mm and shall indicate the service provider as well as the cable depth.
iii. The markings shall be placed at intervals of between100m for urban areas and 200m for other areas.
iv. A colored plastic tape measuring a minimum of 0.5 mm thickness and a minimum width of 100mm shall be laid along the geometrical center of the cable route above each duct structure at a depth of 1000mm below ground level.

10 AS-BUILT DOCUMENTS

Upon completion of the installation works, the service provider shall submit to the relevant authorities, the as-built documentation. The drawings shall accurately indicate the location of all installed fiber assets, civil works, cable types and labeling. The documentation shall include fiber optic cable test results in appropriate formats and shall be required to be updated from time to time to facilitate operations and maintenance activities.

11 MAINTENANCE REQUIREMENT

11.1 PREVENTATIVE MAINTENANCE

The service provider shall: -

i. Monitor the OFC networks continuously, to detect faults and take appropriate actions
ii. Perform preventive maintenance without interfering with the normal operation of the OFC network and the existing infrastructures.

11.2 CORRECTIVE MAINTENANCE

The service providers in accordance to the regulations of relevant authorities shall: -

i. Observe requirement for restoration times.

ii. Facilitate rerouting of affected routes to alternate routes where possible

iii. Carry out all repairs in accordance with set standards and applicable regulatory frameworks

iv. Carry out tests to confirm the integrity of the repairs

v. Document all details for fault resolution including root cause, impact and remedial measures.

11.3 CRITICAL OUTAGES

Critical outage refers to faults causing service interruption which persisting for more than 30 Minutes. The service provider shall follow the procedure below in handling critical outages: -

11.3.1 CRITICAL OUTAGES FROM SCHEDULED MAINTENANCE

i. Issue advance notice to their customers at least 72 hours before carrying out the activity

ii. Notify TCRA at least 96 hours before executing the planned service affecting maintenance

iii. Issue notices that are clear on affected services, service areas, impact and expected restoration times.

11.3.2 UNPLANNED CRITICAL OUTAGES

i. Notify TCRA and their customers within one (1) hour of the outage, stating the affected services, area, impact and expected time for restoration

ii. Continue to provide updates to TCRA after every hour providing details of progress in resolving the faults

iii. Submit to TCRA within twenty-four (24) hours a formal report on the service interruption, the impact caused and the actions taken to restore the services.

12 OCCUPATIONAL HEALTH AND SAFETY REQUIREMENT

In carrying out installations and maintenance works for OFC networks, the service provider shall comply with all applicable occupational health and safety requirements, standards, laws and regulations in the United Republic of Tanzania.

13 ENVIRONMENTAL MANAGEMENT REQUIREMENT

All OFC installations and maintenance works shall be performed in accordance with the requirement of the environmental management laws and regulations in the United Republic of Tanzania.