REPUBLIC OF LEBANON

TELECOMMUNICATIONS REGULATORY AUTHORITY

Document for Public Consultation

OPTICAL FIBER DEPLOYMENT GUIDELINES

Issue date: August 12th, 2026
Closing date: September 9th, 2026
Responses to be sent to: Fiber_guidelines@tra.gov.lb
Version: 1.0

Republic of Lebanon
Telecommunications
Regulatory Authority

OPTICAL FIBER DEPLOYMENT GUIDELINES

Optical Fiber Deployment Guidelines for Access Networks (Central Office to Building Segment)

(Consistent with ITU-T and other internationally recognized standards and recommendations)

Contents

1 Executive Summary

1.1 Purpose

These Guidelines establish harmonized technical, operational, and procedural requirements for the deployment of optical fiber infrastructure from Central Offices (COs) to buildings, covering the outside plant portion of the Optical Distribution Network (ODN) and associated passive infrastructure. They are intended to support consistent, safe, efficient, and future-ready deployment practices across multiple operators and deployment environments.

These Guidelines support:

- Seamless interoperability, coordination, and collaboration among operators, infrastructure providers, contractors, and equipment vendors.
- Safe, standardized, and high-quality civil works, installation, maintenance, and restoration practices.
- Efficient use, protection, and sharing of public and private infrastructure, including Rights of Way and passive network assets.
- Continuity of deployment, operation, and maintenance activities, including the orderly transfer, handover, or continuation of works where required.

Unless otherwise explicitly stated, these Guidelines apply to all optical fiber cable types, passive infrastructure components, and deployment methods within their scope, including feeder, distribution, and drop network segments, irrespective of the underlying access network architecture or technology employed.

1.2 Scope

- **Physical scope**: These Guidelines apply to Outside Plant (OSP) infrastructure extending from the Central Office (CO), Optical Line Terminal (OLT), or equivalent network node to the building property line, building access point, or building entry point, as applicable to the deployed FTTC, FTTB, FTTH, or similar access network architecture.
- **Technical scope:** These Guidelines cover optical fibers, cables, ducts, microducts, manholes, handholes, closures, splitters, cabinets, Optical Distribution Frames (ODFs), Fiber Distribution Hubs (FDHs), splicing, testing, asset identification, Infrastructure documentation (e.g., GIS records), and associated passive infrastructure.

- **Process scope:** These Guidelines address planning, permitting, Right of Way (RoW) management, design, construction, testing, commissioning, maintenance, restoration, monitoring, safety, and related coordination activities.
- **Customer premises and In-Building Infrastructure:** Unless otherwise explicitly stated, the primary scope of these Guidelines ends at the building entry point or building access point. In-building telecommunications infrastructure, including riser cables, floor distribution systems, and customer wiring, is addressed separately in Appendix (4), which provides complementary guidance for installations within buildings and customer premises.

1.3 Target Stakeholders

- Licensed telecommunications operators and service providers authorized to deploy FTTx networks;
- Owners and operators of passive telecommunications infrastructure, including ducts, poles, chambers, manholes, handholes, towers, and fiber networks;
- Government Departments, public authorities, municipalities, unions of municipalities, public institutions, and any other public entities responsible for granting, managing, controlling, or supervising access to Covered Public Property and Rights of Way;
- Accredited engineering consultants, civil works contractors, telecommunications contractors, and project management entities;

1.4 Key Outcomes

- **Seamless interoperability:** Standardized fiber types, connectors, closures, documentation, and testing methodologies to ensure compatibility between operators, vendors, and infrastructure owners.
- **Continuity:** Mandatory documentation and handover packages enabling efficient maintenance, and project continuity in the event of operator withdrawal, default, or project transfer.
- **Transparency:** Shared Infrastructure maps and capacity disclosure.
- **Collaboration:** Regulated co-deployment and coordinated civil works to minimize duplication, reduce costs, and limit disruption to public property.
- **Safety and environmental protection:** Deployment practices that protect public safety, preserve infrastructure assets, minimize environmental impact, and ensure proper restoration of affected areas.

2 Regulatory & Rights of Way (RoW) Management

2.1 Legal Framework

Deployments shall comply with all applicable laws, regulations, decrees, permits, and technical requirements governing telecommunications infrastructure deployment in Lebanon, including but not limited to:

- Law No. 431/2002 (Telecommunications Law) and any amendments thereto;
- Applicable telecommunications licenses, authorizations, and regulatory decisions issued by the Ministry of Telecommunications and/or the Telecommunications Regulatory Authority (TRA);
- The Rights of Way (RoW) Decree and all related implementation procedures, decisions, and instructions;
- Municipal laws, regulations, permits, excavation requirements, and road restoration obligations issued by competent municipalities and public authorities;
- Requirements of the Ministry of Public Works and Transport (MoPWT) relating to roads, highways, bridges, tunnels, ports, airports, and other public infrastructure under its jurisdiction;
- Requirements of public authorities and public institutions responsible for the management of Covered Public Property and public infrastructure;
- Applicable environmental protection legislation and regulations, including environmental impact assessment requirements where applicable;
- Applicable cultural heritage and archaeological protection laws and regulations;
- Occupational health, safety, and public safety laws, regulations, and standards applicable to civil works and telecommunications infrastructure deployment;
- Applicable utility coordination requirements, including those relating to electricity, water, wastewater, transport, and other infrastructure networks;
- Any other applicable Lebanese laws, decrees, regulations, standards, or decisions governing the deployment, operation, maintenance, sharing, or protection of telecommunications infrastructure.

2.2 Relation to RoW Decree

All applications for the use of public rights of way and Covered Public Property shall be submitted, processed, and approved in accordance with the procedures, requirements, and timelines set out in the Rights of Way Decree (in particular Articles 11 to 19 thereof). The relevant Government Department shall provide a written response within one month of receiving a formal request, in accordance with Article 19. Any refusal, failure to respond within the prescribed period, or approval subject to terms and conditions that are not acceptable to the requesting Service Provider shall be subject to the mediation and escalation procedures set out in Article 33 of the Rights of Way Decree.

This includes particularly:

- submission of the required technical, engineering, administrative, and project documentation;
- coordination with relevant Government Departments, public authorities, municipalities, utility operators, and infrastructure owners, as applicable;
- assessment of technical feasibility, public safety, environmental and restoration considerations;
- evaluation of the availability and suitability of existing infrastructure and opportunities for co-deployment;
- issuance of approvals, conditional approvals, or justified refusals within the prescribed timelines; and
- compliance with any conditions, inspections, reporting obligations, and restoration requirements associated with the granted approval.

2.2.1 Access to Public Infrastructure

Access to and use of Covered Public Property, including ducts, poles, manholes, tunnels, and other infrastructure, shall be governed by the Rights of Way Decree, including principles of non-discrimination, capacity-based allocation, and mandatory sharing.

Without prejudice to these legal provisions, operators shall, as a technical and planning principle:

1. where reasonably practicable, assess the availability and suitability of existing telecommunications passive infrastructure, including ducts, microducts, poles, chambers, manholes, and other relevant infrastructure, in order to maximize infrastructure sharing and minimize unnecessary excavation. Such assessment shall take into consideration information available from infrastructure owners, relevant public

authorities, existing infrastructure records, and any infrastructure information repository established by the TRA.

2. justify the construction of new infrastructure based on lack of capacity, technical infeasibility, or safety constraints; and
3. design deployments in a manner that facilitates future sharing and efficient use of public assets.
4. The TRA may define standardized data fields, formats, geospatial referencing requirements, and electronic exchange mechanisms for information submitted to or made available through its infrastructure repository, with the objective of facilitating infrastructure planning, sharing, and coordination among authorized stakeholders.

3 Network Architecture & Planning Guidelines

3.1 FTTx / ODN Architecture

Architectures shall follow the ODN concepts used in ITU-T PON standards and the ITU manual (International Telecommunication Union (ITU), ITU-T, *Optical Fibres, Cables and Systems*, ITU-T Manual, Geneva, latest edition.):

- **ODN:** Physical fiber network connecting the OLT in the CO to ONUs/ONTs.
- **OLT:** Optical Line Termination in the CO.
- **ONU/ONT:** Termination at the building (FTTB/FTTC) or at the customer premises (FTTH).

Permitted architectures:

- **The passive Optical Distribution Network (ODN) shall be designed and deployed to support current-generation PON technologies, including GPON, XGS-PON and NG-PON2, and to facilitate migration to higher-capacity PON technologies, including 50G-PON, where technically and economically feasible, taking into account expected demand, network utilization, investment viability, deployment costs, and the characteristics of the served area, including urban, suburban, and rural environments. The ODN design should take into consideration the optical loss budget, splitter architecture and splitting ratios, fiber capacity and spare fiber requirements, connector and splice performance, and other passive infrastructure characteristics that may affect future technology migration, with the objective of enabling network evolution without substantial reconstruction or replacement of the passive infrastructure.Point-to-point Ethernet** – for business/high-capacity customers.
- **Hybrid** – PON for residential, P2P for key enterprise or mobile backhaul.

3.2 Fiber Types & High-Level Design

Fiber types shall conform to ITU-T Recommendations:

- **ITU-T G.651.1: Characteristics of a 50/125 µm multimode graded index optical fibre cable for the optical access network** (see Appendix 3) only where required for legacy intra-building systems.
- **ITU-T G.652: Characteristics of a single-mode optical fibre and cable** (see Appendix 3): Standard single-mode, recommended for feeder routes.
- **ITU-T G.657: Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network** (see Appendix 3): Bend-insensitive fibers for access / distribution and tight bends in urban environments.

Network design shall use:

- Feeder cables from CO to distribution/FDH cabinets
- Distribution cables from FDH to building access point

Fiber types used in network deployments shall conform to applicable ITU-T Recommendations and be selected according to the intended application, installation environment, and network architecture as detailed below

Recommended fiber types include:

- ITU-T G.651.1 (see Appendix 3) – Multimode optical fiber intended primarily for specific short-distance applications and legacy installations. Its use in access networks should generally be limited to existing intra-building systems or other specialized cases where justified.
- ITU-T G.652.D (see Appendix 3) – Standard single-mode optical fiber suitable for long-distance transmission and feeder network segments. G.652.D is generally recommended for feeder routes connecting Central Offices (COs), aggregation points, and distribution nodes.
- ITU-T G.657.A1/A2 (see Appendix 3) – Bend-insensitive single-mode optical fiber designed for access networks and installations involving tighter bend radii. G.657 fibers are generally recommended for distribution networks, building entry segments, and other locations where space constraints or routing conditions may increase bending risks.

Fiber selection, cable sizing, spare capacity, and route design should take into account projected demand growth, maintenance requirements, resilience objectives, and future technology upgrades.

3.3 Passive Infrastructure Placement & Design

- Manholes / Handholes: Shall be designed and installed in accordance with applicable EN 124 load classifications and relevant ITU-T L-series Recommendations (see Appendix 3). They shall provide adequate space for cable routing, splice closures, slack storage, maintenance activities, future branching, and network expansion. Designs should also consider accessibility, drainage, environmental protection, asset identification, and safe working conditions for installation and maintenance personnel.
- FDH / Street Cabinets: Shall be designed as environmentally protected enclosures capable of supporting multi-operator deployments where required by applicable regulations. Cabinets shall provide structured fiber management, bend-radius control, cable segregation, physical security, asset identification, and sufficient capacity for maintenance and future expansion, in accordance with relevant ITU-T L-series Recommendations (including L.10, L.50, L.51 and L.87) and the ITU-T Optical Fibres, Cables and Systems Manual (see Appendix 3).
- Optical Distribution Frames (ODFs) in Central Offices: ODFs shall provide structured fiber management and clear segregation between feeder, distribution, and interconnection functions. Where multiple operators are accommodated within the same facility, ODF arrangements shall support operational independence, clear asset ownership identification, controlled access, efficient interconnection, fault isolation, and future capacity expansion.

4 Technical Standards

4.1 Fiber & Cable Attributes

Consistent with the ITU-T framework, optical transmission characteristics are considered at three levels: fiber attributes (individual fiber characteristics), cable attributes (characteristics of the cable assembly), and link attributes (end-to-end characteristics of the installed optical path). The requirements in this section are intended to ensure interoperability, performance, and long-term maintainability of deployed optical infrastructure.

- **Fiber attributes:** Optical fibers shall conform to the characteristics specified in the applicable ITU-T Recommendations (including G.652 and G.657 (see Appendix 3)), such as mode field diameter (MFD), cladding diameter (e.g. 125 µm), cut-off wavelength, attenuation, macrobending performance, and chromatic dispersion.
- **Cable attributes:** Optical cables shall comply with the attenuation coefficient (e.g. ≤ 0.35 dB/km at 1310 nm and ≤ 0.22 dB/km at 1550 nm), polarization mode dispersion (e.g., PMD ≤ 0.2 ps/√km), environmental, and mechanical performance requirements specified in the applicable ITU-T and IEC standards, including ITU-T G.652, ITU-T G.657, IEC 60794, and relevant ITU-T L-series Recommendations (see Appendix 3)**.**
- **Link attributes:** Installed optical links shall be designed and maintained such that total attenuation, dispersion, differential group delay (DGD), polarization mode dispersion (PMD), and other transmission characteristics remain within the optical budget and performance limits of the applicable transmission system standards (e.g. ITU-T G.984, G.9807.1 and successor Recommendations (see Appendix 3)).

Operators shall specify, procure, install, and maintain optical fibers and cables in a manner that ensures compliance with the applicable standards and network performance objectives.

- Typical splice losses should not exceed 0.1 dB under normal installation conditions.
- Compliance with fiber, cable, and link performance requirements shall be verified through appropriate testing and commissioning activities, including OTDR and insertion loss testing, in accordance with applicable ITU-T Recommendations and recognized industry practices.

4.2 Cable Construction

General recommendation:

- Cables for aerial, sewer, buried, duct and FTTH riser applications shall be selected and deployed in accordance with relevant ITU-T L-series Recommendations (including L.12, L.26, L.50, L.72 and L.87 (see Appendix 3)), ensuring suitability for the specific installation environment. Cable construction, environmental performance and mechanical characteristics shall comply with the IEC 60794 series standards or equivalent internationally recognized standards (see Appendix 3).

Non-Aerial (e.g., Underground or buried) Cables

- Cable design shall follow the principles and requirements set out in relevant ITU-T Recommendations (including ITU-T L.12, L.26 and L.87) and the ITU-T Optical Fibres, Cables and Systems Manual (see Appendix 3), including guidance on optical fiber protection, moisture protection, strength members, sheathing systems, cable identification, and environmental protection.
- Cable construction, mechanical performance, and environmental characteristics shall comply with the IEC 60794 series standards (see Appendix 3) or equivalent internationally recognized standards.
- Optical fibers shall incorporate appropriate primary and secondary protection systems to ensure long-term mechanical and environmental performance in accordance with applicable ITU-T and IEC standards (see Appendix 3).
- Appropriate water-blocking measures, such as gels, tapes, swellable yarns, or equivalent technologies, shall be used where required to prevent longitudinal water ingress and maintain cable integrity.
- Strength members shall be designed and dimensioned to ensure that fiber strain and mechanical loading remain within the limits specified by the applicable standards during installation, operation, maintenance, and throughout the expected service life of the cable.
- Cable sheaths shall be permanently marked at regular intervals with information sufficient to identify the operator, cable designation or identification number, and year of manufacture or installation.

Aerial Optical Fiber Cables

- Aerial deployment shall be used only where underground installation is not feasible or not permitted, subject to approval by the relevant Government Departments and asset owners (The escalation procedures shall be in accordance with the provisions of the Rights of Way Decree). Aerial deployment may be considered in cases such as "hard-to-reach" or rural areas where trenching in rocky terrain is prohibitively expensive.

- Design, installation and operation of aerial optical fiber cables shall comply with applicable national regulations (including **electrical safety** and pole infrastructure rules) and relevant ITU-T L-series Recommendations (including L.26, L.12 and L.87 (see Appendix 3)), ensuring adequate clearances, mechanical loading, and environmental resilience.

- Aerial optical fiber cables shall be specifically designed and rated for outdoor overhead deployment. Such cables shall be selected based on the mechanical, environmental, and

operational conditions of the installation route, taking into account span lengths, wind loading, temperature variations, ultraviolet (UV) exposure, vibration, ice loading (where applicable), and long-term aging effects.

- Aerial cables may be self-supporting (e.g., ADSS), messenger-supported, or otherwise designed for installation on poles and supporting structures. The cable construction, tensile strength, maximum allowable sag, minimum bending radius, and attachment hardware shall be appropriate for the intended installation environment and shall comply with applicable national safety requirements and the relevant ITU-T Recommendations referenced in Appendix 3.

- Where aerial deployment is used, the selected cable and support system shall provide adequate protection against environmental exposure, mechanical stresses, and accidental damage, while ensuring reliable long-term operation and ease of maintenance. The planning, permitting, and installation of aerial infrastructure shall be coordinated with the relevant public authorities, electricity utilities, transport authorities, municipalities, and other affected infrastructure owners, as applicable, to ensure compliance with safety, operational, and right-of-way requirements. Aerial installations shall maintain the required separation distances from **electrical power networks and other utilities**, comply with applicable safety regulations particularly those relating to electrical safety clearances, work at height, induced voltages, and proximity to power infrastructure. Such installations shall be designed for the expected wind, temperature, corrosion, and loading conditions. Adequate clearances from roads, buildings, vegetation, and other infrastructure shall be maintained to ensure public safety, network reliability, and safe maintenance access.

4.3 Connectors, Closures & Passive Nodes

Underground and Building Installation

Connectors, closures, splitters, cabinets, Optical Distribution Frames (ODFs), and other passive network elements used in underground, duct, direct-buried, sewer, tunnel, and building environments shall be designed, selected, and installed to provide adequate mechanical protection, environmental sealing, fiber management, and accessibility for operation and maintenance. Connector interfaces shall comply with the applicable IEC 61754 series standards, with SC/APC connectors generally recommended for passive optical access networks and LC-type connectors permitted where justified by equipment density or application requirements. Connector end-faces shall be cleaned as necessary, prior to

connection and acceptance, in accordance with IEC 61300-3-35 or other applicable standards. Connector insertion loss and reflectance/return loss shall comply with the applicable component and system standards and shall remain within the optical loss budget and performance requirements of the deployed network.

Splice closures and passive network components shall provide protection against moisture, dust, corrosion, temperature variations, and other environmental conditions relevant to the installation environment and shall comply with applicable ITU-T, IEC, and manufacturer requirements.

Cabinets, ODFs, and passive nodes shall provide adequate cable routing, bend-radius control, slack storage, labeling, asset identification, and safe access for maintenance, testing, fault localization, and future expansion. Outdoor and underground equipment shall be suitable for the intended operating environment and provide an appropriate level of protection against environmental and accidental damage.

Aerial Installation

Connectors, splice closures, splitters, distribution points, and other passive network elements used in aerial deployments shall be specifically designed for outdoor overhead environments and shall provide adequate protection against ultraviolet (UV) radiation, wind, rain, humidity, temperature variations, corrosion, vibration, and other environmental factors. Aerial closures and passive nodes shall be securely mounted to supporting structures, maintain the mechanical integrity of the network, and permit safe access for installation, inspection, maintenance, and restoration activities. Fiber management systems shall ensure compliance with the manufacturer's specified bend-radius requirements and facilitate future network expansion and infrastructure sharing where applicable.

4.4 Splicing & Testing

Splicing Requirements

- Optical fibers shall be joined using fusion splicing as the preferred method, utilizing automated alignment and controlled arc-fusion equipment, in accordance with recognized industry practices and the installation guidance provided in relevant ITU-T Recommendations (including ITU-T L.12 and ITU-T L.87) and the ITU-T Optical Fibres, Cables and Systems Manual (see Appendix 3).

- Splicing shall be carried out by qualified personnel using procedures and equipment suitable for the fiber type and application.
- Splice protectors and splice trays shall be installed to prevent mechanical stress and ensure long-term reliability.
- Typical splice loss should not exceed 0.1 dB and shall remain within the limits defined by the applicable network design and acceptance criteria.

Testing and Acceptance

The following tests shall be performed following installation, repair, network extension, or completion of each construction phase:

- Optical Time Domain Reflectometer (OTDR) measurements performed bi-directionally at appropriate wavelengths in accordance with ITU-T G.650.x, typically 1310 nm and 1550 nm for single-mode fiber (see Appendix 3);
- Insertion Loss (IL) measurements;
- Optical Return Loss (ORL) / Reflectance measurements;
- Continuity and fiber identification verification, where applicable.

Test methods, acceptance criteria, and reporting requirements shall be consistent with ITU-T G.650.x (see Appendix 3), applicable PON ODN Recommendations, and the network operator's approved engineering specifications.

Acceptance criteria shall include compliance with the maximum end-to-end optical loss budget applicable to the deployed PON technology, ODN class, splitter architecture, and approved network design. Individual splice, connector, and other reflective-event losses and reflectance values shall remain within the applicable component, system, and operator acceptance limits. Operators shall retain complete testing records, including native OTDR trace files in an industry-standard format, such as (.sor), together with insertion-loss, ORL/reflectance, continuity, and fiber-identification results, as part of the network’s technical and as-built documentation.

4.5 Documentation & Infrastructure Records

- Comprehensive as-built documentation shall be maintained and updated throughout the project lifecycle. As-built records shall include route drawings, fiber routing, cable identifiers, splice locations, closures, splitters, cabinets, ODFs, handholes, manholes, ducts, and any other relevant passive infrastructure elements.
- As-built drawings shall accurately reflect the final installed network and shall include sufficient detail to support operation, maintenance, fault localization, future expansion, and project handover or takeover activities.

- An infrastructure database shall be maintained containing georeferenced information on fiber routes, cable identifiers, duct occupancy, coordinates of manholes, handholes, cabinets, passive nodes, and available spare capacity, together with any other information required by the TRA or applicable regulations.
- Infrastructure records shall be maintained with an appropriate level of positional accuracy and geospatial referencing suitable for network planning, operation, maintenance, infrastructure sharing, and regulatory purposes. The TRA may define standardized data fields, coordinate reference systems, accuracy requirements, machine-readable exchange formats, and submission procedures applicable to information provided to the TRA infrastructure repository.

- Network records shall include fiber and link characteristics, cable specifications, splice records, test results, and other technical parameters necessary to support network planning, link budget calculations, dispersion analysis, maintenance, and troubleshooting activities.
- Documentation, infrastructure records (including GIS-based records where used) and associated test reports shall be retained and kept up to date throughout the operational life of the network and shall be made available to the relevant authorities in accordance with applicable laws, regulations, licenses, and the Rights of Way Decree.

5 Civil Works & Deployment Procedures

5.1 General Principles

- Civil works shall be planned, designed, and executed in accordance with the applicable ITU-T L-series Recommendations, national engineering standards, road authority requirements, municipal regulations, occupational health and safety requirements, and any other applicable legal or regulatory obligations.
- Prior to commencing any excavation, trenching, drilling, or installation activity, the operator shall undertake an appropriate site assessment and investigation to identify existing infrastructure, utilities, environmental constraints, and site-specific risks. Such investigations shall include, where appropriate, the review of available utility records, as-built drawings, infrastructure data (e.g., GIS records), cartographic records, site surveys, utility coordination activities, and, where necessary, the use of ground-penetrating radar or other suitable detection methods.

- Operators and contractors shall take all reasonable measures to prevent damage to existing infrastructure, utilities, public property, private property, roads, pavements, landscaping, and other assets during the execution of the works.
- Civil works shall be designed and executed in a manner that minimizes disruption to traffic, pedestrians, residents, businesses, public services, and the surrounding environment.
- Upon completion of the works, all affected areas, including roads, pavements, sidewalks, landscaping, public spaces, and other infrastructure, shall be restored to at least their original condition, or to any higher standard required by the relevant authority.
- The operator shall remain fully responsible for the quality and integrity of the civil works performed on its behalf, including works carried out by contractors or subcontractors.
- Any defects, settlement, subsidence, pavement deterioration, damage, safety hazards, restoration deficiencies, or other deficiencies attributable to the civil works shall be remedied by the operator at its own cost and within the timeframe specified by the relevant authority. The relevant authority may require corrective actions, re-excavation, re-restoration, or other remedial measures where the completed works do not meet the required standards.
- The operator shall remain responsible for latent defects arising from the civil works for the period specified under applicable laws, permits, contracts, or regulatory requirements, without prejudice to any additional rights or remedies available to the relevant authority.

5.2 Standard Trenching

- Except for mini-trenching and micro-trenching techniques, trench depth shall be determined based on road authority requirements, soil and pavement conditions, utility separation requirements, infrastructure protection needs and applicable permit conditions. Where minimum depth requirements are specified, the measurement shall be clearly defined, preferably as the minimum cover measured vertically from the finished surface level to the top (crown) of the installed duct or conduit. In urban environments, typical installation depths are generally in the range of 60–90 cm, unless otherwise required by the relevant authority.
- Adequate horizontal and vertical separation shall be maintained between telecommunications infrastructure and existing utilities, including electricity, water, gas, sewerage, and other infrastructure. The applicable separation distances and protection measures shall comply with the requirements of the relevant public authorities and utility owners and shall take into account safety, accessibility, maintenance, and

prevention of interference or accidental damage. Where the required separation cannot be achieved, appropriate protection measures shall be agreed with the concerned authority or utility owner prior to installation.

- Suitable bedding and backfill materials (e.g., sand or fine soil free of sharp objects and debris) shall be provided around ducts and cables to protect them from mechanical damage during installation and throughout their operational life.
- A continuous telecommunications warning or marker tape shall be installed above the duct route at an appropriate depth, typically approximately 20–30 cm below the final surface level, to provide advance warning of the presence of underground telecommunications infrastructure. Where required by the relevant authority, additional route identification measures, such as tracer wires, electronic markers, or surface markers, may also be used.

5.3 Trenchless Techniques

- Only For crossings of roads, highways, railways, utility corridors, watercourses, environmentally sensitive areas, heritage sites, and other locations (where open-cut excavation would result in significant disruption, risk, or restoration requirements), the trenchless techniques (including horizontal directional drilling (HDD), boring, pipe jacking, and other suitable methods) shall be preferred where technically and economically feasible. Such techniques shall be designed and executed in accordance with the relevant ITU-T L-series Recommendations (including ITU-T L.12 and ITU-T L.87 (see Appendix 3)), applicable civil engineering standards, and the requirements of the relevant authorities.

5.4 Mini-Trench

Mini-trenching techniques may be used, subject to approval by the relevant public authorities, road authorities, and utility owners, where applicable, and in accordance with applicable standards, permit conditions, and site-specific engineering assessments.

- Typical trench widths may range from approximately 7–15 cm, with depths typically in the range of 30–40 cm. The required depth shall be determined by the relevant public authority taking into account pavement structure, anticipated road maintenance activities (including milling and resurfacing), traffic loading, existing underground infrastructure, and local engineering conditions. In all cases, the installed duct or cable

shall be located below the anticipated milling depth with sufficient cover to protect the telecommunications infrastructure throughout the pavement life cycle.

- Reinstatement materials and techniques shall ensure durable bonding with the surrounding pavement structure and provide long-term mechanical performance equivalent to the adjacent pavement, minimizing the risk of cracking, settlement, water ingress, or premature deterioration, in accordance with the requirements of the relevant road authority.
- Mini-trenching shall be applied only where ground and pavement conditions are suitable. Its use should be carefully evaluated in unstable, sandy, cobbly, heavily cracked, or otherwise unsuitable subgrades unless appropriate engineering mitigation measures are implemented.
- Prior to excavation, operators shall identify and locate existing utilities and infrastructure using available records, surveys, and detection methods as appropriate. Route planning shall minimize conflicts with existing utilities, reduce crossing points, and avoid excessive bends or other conditions that may affect installation quality or future maintenance.
- Appropriate separation distances shall be maintained from existing utilities and infrastructure in accordance with applicable regulations, utility requirements, and engineering best practices.
- Backfilling and reinstatement materials, including high-fluidity concrete, grout, or equivalent materials, shall be selected to ensure mechanical performance compatible with the surrounding pavement, subgrade, and expected traffic loads, while minimizing long-term settlement, cracking, or surface deterioration.
- Traffic management, pedestrian protection, and work-zone safety measures shall be implemented throughout construction in accordance with applicable safety requirements and permit conditions.

5.5 Micro-Trench

Micro-trenching techniques for shallow installations in asphalt or similar pavement structures may be used, subject to approval by the relevant public authorities, road authorities, and utility owners, where applicable, and in accordance with applicable standards, permit conditions, and site-specific engineering assessments.

- Narrow slots, typically in the range of approximately 1–5 cm wide and depths in the range of 10–30 cm, may be used for the installation of microducts or optical cables. The dimensions and depth of the micro-trench shall be determined based on pavement structure, traffic conditions, installed infrastructure, and the requirements of the relevant authority.

- Prior to cutting activities, operators shall identify and locate existing utilities and infrastructure using available records, surveys, and detection methods as appropriate. Route selection shall minimize conflicts with existing infrastructure and facilitate future maintenance and restoration activities.
- Dedicated cutting and installation equipment shall be used to ensure accurate slot dimensions, proper cable placement, compliance with minimum bend-radius requirements, and avoidance of damage to surrounding infrastructure.
- Restoration shall be carried out using high-performance materials and methods designed to withstand anticipated traffic loads, environmental conditions, thermal expansion, water ingress, and long-term pavement deterioration, in accordance with applicable road authority standards.
- Traffic management, pedestrian protection, and work-zone safety measures shall be implemented throughout construction in accordance with applicable safety requirements and permit conditions.
- Accurate records of micro-trench locations, depths, installed infrastructure, and restoration details shall be incorporated into the operator's Infrastructure database and submitted to the TRA repository, where applicable, following completion of the works.

5.6 Duct, Sewer and Tunnel Deployment

- Duct installation (including cable pulling and blowing techniques) shall comply with relevant ITU-T L-series Recommendations (including L.12 and L.87 (see Appendix 3)), ensuring that maximum pulling tension, sidewall pressure, minimum bend radius, and other installation limits are respected. Appropriate lubrication, cable handling procedures, and installation practices shall be employed to prevent damage to cables and ducts. Duct systems should be designed and utilized in a manner that facilitates future maintenance, network expansion, and, where applicable, infrastructure sharing.

- Sewer and tunnel installations shall utilize mounting systems, supports, and cable protection methods specifically designed for such environments and shall comply with relevant ITU-T Recommendations (including L.72 for sewer systems and L.87 for access network deployment (see Appendix 3)). Installations shall be designed to withstand moisture, chemicals, temperature variations, biological agents, and mechanical stresses associated with the operating environment.

- Operators shall coordinate installation and maintenance activities with the relevant sewer, tunnel, transport, utility, or infrastructure authorities, as applicable, and shall

ensure that the deployment does not adversely affect the operation, maintenance, safety, or structural integrity of the host infrastructure.

- Appropriate safety procedures shall be implemented for work in confined spaces, tunnels, and similar environments, including access controls, ventilation requirements, emergency procedures, and compliance with applicable occupational health and safety regulations.
- Accurate records of duct, sewer, and tunnel installations, including route information, access points, and installed assets, shall be maintained within the operator's infrastructure database (such as GIS) and made available to the TRA in accordance with applicable reporting requirements.

5.7 Restoration & Safety

- Upon completion of the works, all affected roads, pavements, sidewalks, landscaping, public spaces, and other infrastructure shall be restored to at least their original condition, functionality, performance, and appearance, or to any higher standard required by the relevant authority.
- Restoration works shall be carried out in accordance with the requirements and specifications of the relevant road authority, municipality, infrastructure owner, or other competent authority, including any applicable reinstatement, compaction, surfacing, and finishing requirements.
- The operator shall remain responsible for the quality and integrity of all restoration works and shall, at its own cost, remedy any defects, settlement, subsidence, pavement deterioration, safety hazards, or other deficiencies attributable to the works, within the timeframe specified by the relevant authority.
- Traffic management, pedestrian safety measures, signage, barriers, lighting, and work-zone controls shall be implemented throughout the duration of the works in accordance with the requirements of the relevant authorities and applicable safety regulations.
- Operators and contractors shall implement appropriate occupational health and safety measures, including the use of personal protective equipment (PPE), confined-space procedures for manholes, chambers, and sewer installations, excavation safety measures, and safe working practices in proximity to electricity networks, railways, roads, and other hazardous infrastructure.
- All works shall be executed in a manner that minimizes risks to workers, the public, property, existing infrastructure, and the environment.

6 Project Management & Continuity Protocols

6.1 Work-Zone Management

- Prior to the commencement of any excavation, installation, maintenance, or restoration activity, the operator shall notify and coordinate with the relevant authorities, infrastructure owners, utility operators, municipalities, and security forces, as required by applicable laws, permits, and regulatory requirements.
- Each work zone shall be properly documented and registered, where required, including the location, route, scope of works, planned dates, responsible operator, contractor details, deployment method, and any traffic management or safety measures to be implemented.
- Operators shall coordinate their activities with other operators, utility providers, and infrastructure owners to avoid unnecessary duplication of works, minimize disruption to the public, and facilitate co-deployment where feasible.
- Appropriate traffic management, pedestrian protection, signage, barriers, and safety measures shall be implemented throughout the duration of the works in accordance with the requirements of the relevant authorities.
- Work-zone activities shall be planned and executed in a manner that minimizes disruption to residents, businesses, public services, emergency access routes, and existing infrastructure.
- Operators shall maintain adequate records of work-zone activities and shall make such records available to the relevant authorities upon request.

6.2 Continuity & Takeover

Operators shall maintain accurate, complete, and up-to-date handover packages throughout the project lifecycle. Such handover packages shall enable another involved operator, infrastructure owner, or the authority granting the easement, where permitted by applicable laws and regulations, to complete, operate, maintain, expand, or transfer the network and associated works if required.

The handover package shall include, at a minimum:

• As-built drawings, route maps, and Infrastructure records layers (e.g., GIS) reflecting the actual installed infrastructure;

• Detailed records of fiber routes, cable identifiers, duct occupancy, splice locations, closures, splitters, cabinets, ODFs, handholes, manholes, and other passive infrastructure elements;

• Splice records, closure records, fiber allocation schedules, and cable routing information;

• OTDR traces, insertion loss (IL) measurements, ORL/reflectance measurements, acceptance test reports, and any other relevant testing documentation;

• Inventory of installed cables, ducts, microducts, closures, cabinets, passive nodes, and associated infrastructure;

• Available spare capacity, reserved capacity and planned extensions;

• Relevant permits, approvals, easements, utility coordination records, and work completion certificates;

• Contact information for responsible personnel, contractors, and maintenance providers, where applicable;

• Any other documentation reasonably required to ensure continuity, maintenance, restoration, expansion, or transfer of the network.

The operator shall ensure that the handover package remains accurate and updated throughout the operational life of the network and shall make it available to the relevant authority or authorized party in accordance with applicable laws, licenses, permits, and the Rights of Way Decree.

6.3 Monitoring & Compliance

- The authority responsible for granting or supervising the Right of Way, the TRA, or any other competent public authority may conduct audits, site inspections, and reviews of technical documentation, including test reports, as-built records such as GIS data, safety records, and restoration compliance documentation.
- Non-compliance may result in enforcement actions by the relevant Government Departments or the TRA, including inspection findings, corrective action orders, suspension of works, removal of non-compliant infrastructure where deficiencies are not remedied within the prescribed timeframe, and the imposition of applicable penalties, in accordance with the Rights of Way Decree and other applicable laws, regulations, and permit conditions.

7 Collaboration

7.1 Co-Deployment

- Where new ducts or microducts are constructed, infrastructure shall be planned and designed to facilitate sharing and efficient use by multiple operators, in accordance with the principles set out in the Rights of Way Decree (including Articles 2, 5, 6, 19 and 22). Operators shall, where technically and economically feasible, coordinate planned civil works with other telecommunications operators and relevant public authorities to encourage co-deployment, minimize repeated excavations, and reduce disruption to the public and the environment ("Dig Once" principle). Where technically justified and economically reasonable, new infrastructure should include sufficient spare capacity, such as additional ducts, microducts, or other passive infrastructure, taking into account anticipated future demand, infrastructure-sharing opportunities, network resilience, and efficient asset utilization. The detailed requirements for coordination, information sharing, infrastructure planning, and any associated reporting procedures may be specified by the TRA or the relevant public authorities.

7.2 Duct and Pole Sharing

- Access conditions and technical rules for duct and pole sharing shall ensure efficient use of infrastructure and shall comply with relevant ITU-T L-series Recommendations (including L.12, L.26 and L.87) and applicable national regulations such as Rights of Way Decree. Such rules shall take into account mechanical constraints (e.g. loading, tension, bend radius), environmental conditions, and cable compatibility.

- **Make-Ready Works for Shared Infrastructure:** Where access to existing poles, ducts, or other passive infrastructure requires modification, reinforcement, rearrangement, relocation, or other preparatory works to accommodate an additional operator, the infrastructure owner and the requesting operator shall coordinate the necessary make-ready works prior to deployment. The process shall include, as applicable, an assessment of available capacity and technical feasibility, structural and loading assessments, identification of required modifications, allocation of responsibilities and reasonable costs, implementation timelines, and applicable safety requirements. Make-ready works shall be carried out in a transparent and non-discriminatory manner and shall not cause undue delay to infrastructure access, subject to applicable laws, regulations, and the Rights of Way Decree

7.3 Data & Map Sharing

- All operators shall establish, maintain, and regularly update an infrastructure records inventory that accurately reflects the status of their deployed network assets, including ducts, microducts, manholes, handholes, cabinets, fiber routes, splice points, closures, and available spare capacity. Such records shall be retained as part of the operator's operational documentation and made available to the TRA upon request. Operators shall also provide the required information to the TRA's repository, once established, or through any alternative mechanism designated by the TRA, within the timeframe specified by the TRA following the completion of the relevant works and whenever material changes occur.

8 Maintenance and Safety

- Maintenance: This section is aligned with the ITU-T Optical Fibres, Cables and Systems Manual and relevant ITU-T Recommendations, including the L-series Recommendations relating to optical cable installation, operation, maintenance, protection, and restoration (such as L.12, L.72 and L.87 (see Appendix 3)). It establishes minimum requirements for maintenance practices, fault management, restoration procedures, safety measures, and environmental considerations applicable to optical fiber networks.
- Safety:
  - Optical safety: Operators shall establish procedures for the safe handling, testing, and maintenance of optical fiber infrastructure, including precautions to prevent direct eye exposure to active fibers, verification of fiber status prior to inspection or repair, and the use of appropriate testing, detection, and personal protective equipment.
  - Fire safety: Fiber infrastructure, cabinets, closures, and associated facilities shall comply with applicable fire safety requirements. Fire-resistant cables, materials, and protection measures shall be used where required, particularly in Central Offices (COs), tunnels, utility corridors, and other enclosed environments.
  - Environmental protection: Construction, maintenance, and restoration activities shall be conducted in a manner that minimizes environmental impacts. Operators shall appropriately manage waste materials, including scrap cable, ducts, closures, packaging, and construction debris, and shall consider durability, recyclability, and life-cycle impacts in the selection of materials and equipment.

- Aerial safety: Installation and maintenance of aerial infrastructure shall ensure safe working practices at height, compliance with applicable clearance requirements from roads, buildings, vegetation, and other infrastructure, and adequate separation from electrical power networks and other utilities. Appropriate personal protective equipment, fall protection measures, traffic and pedestrian safety controls, and coordination with relevant public authorities and utility operators shall be implemented to protect personnel, the public, and nearby infrastructure. Maintenance activities shall also take into account weather conditions and other environmental factors that may affect safety.

9 Appendices (Indicative Templates & References)

1. **Glossary** – aligned with ITU definitions (ODN, OLT, ONU/ONT, FDH, PON, PMD, etc.).
2. **RoW Application Template (indicative) – including route maps, method statements, safety and traffic management plan proposals, in line with the application requirements set out in the Rights of Way Decree (in particular Articles 11 to 19).**
3. **Reference Standards List** – ITU-T G.65x, G.98x; L-series (construction/installation); ITU-T Manual**;** relevant IEC and EN standards cited in the ITU manual.
4. **Requirements for New Buildings to Support Broadband Services**

Appendix 1 – Glossary

This glossary is aligned with ITU-T definitions and terminology used in the “Optical Fibres, Cables and Systems” Manual and relevant ITU-T Recommendations.

Access Network
The portion of the telecommunications network that connects end users to the core network, typically from the Central Office (CO) to customer premises.

Aerial Deployment
Installation of optical fiber cables on poles or other above-ground structures.

As-built Documentation
Final documentation reflecting the actual installed network, including routes, splices, equipment, and capacities.

Central Office (CO)
A facility housing active telecom equipment, including Optical Line Terminals (OLTs), from which access networks are operated.

Closure (Splice Closure)
An enclosure used to protect fiber splices from environmental and mechanical damage.

Duct / Microduct
A conduit system used to house and protect optical fiber cables. Microducts are smaller ducts typically used for blown fiber systems.

FDH (Fiber Distribution Hub)
A passive cabinet used to distribute feeder fibers to distribution fibers, typically containing splitters in PON networks.

FTTx (Fiber to the X)
Generic term for fiber-based access network architectures, including:

- FTTH (Home)
- FTTB (Building)
- FTTC (Cabinet/Curb)

GIS (Geographic Information System)
A digital system used to store, manage, and visualize spatial data related to network infrastructure.

Handhole / Manhole
Underground access structures used for cable routing, splicing, and maintenance.

- Handhole: smaller, typically non-entry
- Manhole: larger, human-entry structure

Insertion Loss (IL)
The loss of optical power resulting from the insertion of a component (e.g. splice, connector) in a fiber link.

IRU (Indefeasible Right of Use)
A long-term contractual right granting usage of network infrastructure (e.g. fiber, ducts) for a defined period.

ODF (Optical Distribution Frame)
A frame used in central offices to terminate, manage, and interconnect optical fibers.

ODN (Optical Distribution Network)
The passive optical network segment connecting the OLT in the CO to ONUs/ONTs at customer locations.

OLT (Optical Line Terminal)
Active equipment located in the Central Office that manages and controls the optical access network.

ONU / ONT (Optical Network Unit / Terminal)
Devices located at or near the customer premises that terminate the optical network.

ORL (Optical Return Loss)
A measure of reflected optical power in a fiber link, indicating the quality of terminations and splices.

OTDR (Optical Time Domain Reflectometer)
A test instrument used to measure fiber attenuation, locate faults, and characterize splices and connectors.

PON (Passive Optical Network)
A fiber access architecture using passive splitters to serve multiple users from a single OLT port (e.g. GPON, XGS-PON).

PMD (Polarization Mode Dispersion)
A fiber characteristic causing signal distortion due to differential propagation speeds of polarization modes.

Rights of Way (RoW)
The legal right to install, operate, and maintain telecom infrastructure on public or private land.

Splicing (Fusion Splicing)
The process of permanently joining two optical fibers using heat to create a low-loss connection.

Trenchless Techniques
Construction methods that install infrastructure without continuous surface excavation (e.g. directional drilling, boring).

Mini-trenching / Micro-trenching
Shallow and narrow trenching techniques used for fiber deployment in urban environments.

Work Zone
A defined area where construction or installation activities are taking place, requiring safety and traffic management measures.

Appendix 2: RoW Application Template (indicative)

Appendix 3: Reference Standards List

These Guidelines are based on internationally recognized standards and recommendations governing optical fiber systems, cable construction, installation practices, and testing. The following references shall be considered applicable, in their latest versions.

Unless otherwise specified, any reference in these Guidelines to a standard, recommendation, specification, code, or guideline shall be deemed a reference to the corresponding document listed in this Appendix, including its title, description, and reference source.

A. ITU-T G-Series – Optical Fiber Characteristics and Testing

ITU-T G.650.1: Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable (https://www.itu.int/rec/T-REC-G.650.1)

Provides measurement methods and acceptance criteria for attenuation, geometry, cut-off wavelength, mode field diameter, and other fundamental optical fibre characteristics.

- **ITU-T G.650.2: Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable (https://www.itu.int/rec/T-REC-G.650.2)**

Defines measurement procedures for statistical and non-linear transmission characteristics of optical fibres and cables.

- **ITU-T G.650.3: Test methods for polarization mode dispersion attributes of single-mode optical fibres and cables (https://www.itu.int/rec/T-REC-G.650.3)**

Specifies methods for measuring polarization mode dispersion (PMD), which can affect high-speed optical transmission systems.

- **ITU-T G.651.1: Characteristics of a 50/125 µm multimode graded index optical fibre cable for the optical access network (https://www.itu.int/rec/T-REC-G.651.1)**

Defines the characteristics and performance requirements of 50/125 µm multimode optical fibre used primarily in optical access networks and in-building applications.

- **ITU-T G.652: Characteristics of a single-mode optical fibre and cable (https://www.itu.int/rec/T-REC-G.652)**

Defines the geometrical, mechanical, and transmission characteristics of standard single-mode optical fibre, which constitutes the primary fibre type used in backbone, feeder, and FTTH access networks.

- **ITU-T G.657: Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network (https://www.itu.int/rec/T-REC-G.657)**

Defines bend-insensitive optical fibres specifically designed for FTTH and access network deployments where tight bends may occur within buildings, cabinets, and distribution networks.

B. ITU-T PON and Access Network Standards

- **ITU-T G.984 Series: Gigabit-capable Passive Optical Networks (GPON) (https://www.itu.int/rec/T-REC-G.984)**

Defines GPON architecture, optical budgets, transmission requirements, and interoperability specifications for broadband access networks.

- **ITU-T G.9807.1: 10-Gigabit-capable Symmetric Passive Optical Network (XGS-PON) (https://www.itu.int/rec/T-REC-G.9807.1)**

Specifies next-generation symmetrical 10 Gbps passive optical network systems for high-capacity residential and enterprise broadband services.

- **ITU-T G.989 Series: 40-Gigabit-capable Passive Optical Networks (NG-PON2) (https://www.itu.int/rec/T-REC-G.989)**

Defines wavelength division multiplexing-based PON technologies providing enhanced capacity, scalability, and service flexibility.

- **ITU-T G.9804 Series: Higher Speed Passive Optical Networks (50G-PON)**
  Defines the architecture, physical-layer requirements, optical budgets, and transmission characteristics for higher-speed passive optical networks, including 50 Gbit/s PON, supporting evolution toward higher-capacity broadband access networks.

C. ITU-T L-Series – Infrastructure, Installation and Deployment

- **ITU-T L.10: Optical fibre cable installation in ducts and tunnels (https://www.itu.int/rec/T-REC-L.10)**

Provides guidance for duct utilization, cable installation practices, and protection measures in underground infrastructure.

- **ITU-T L.12: Optical fibre cable installation methods (https://www.itu.int/rec/T-REC-L.12)**

Provides general guidance for optical fibre cable installation, handling, pulling, blowing, and construction practices.

- **ITU-T L.26: Optical fibre cable installation in access networks (https://www.itu.int/rec/T-REC-L.26)**

Defines installation requirements for optical fibre access networks, including aerial and underground deployments.

- **ITU-T L.48: Optical fibre cable installation by blowing techniques (https://www.itu.int/rec/T-REC-L.48)**

Provides requirements and engineering practices for fibre installation using air-blown deployment methods.

- **ITU-T L.50: Optical cable network infrastructure planning and installation guidance (https://www.itu.int/rec/T-REC-L.50)**

Provides guidance on optical network infrastructure deployment, planning, and management.

- **ITU-T L.51: Optical cable network infrastructure considerations (https://www.itu.int/rec/T-REC-L.51)**

Provides complementary recommendations regarding optical cable infrastructure and network implementation.

- **ITU-T L.72: Optical fibre cable installation in sewer systems (https://www.itu.int/rec/T-REC-L.72)**

Specifies technical requirements and deployment methods for installing optical fibre cables in sewer infrastructure.

- **ITU-T L.87: Optical fibre cable network design and installation for access networks (https://www.itu.int/rec/T-REC-L.87)**

Provides comprehensive guidance on planning, deployment, operation, maintenance, and management of fibre access networks.

D. IEC Standards

- **IEC 60793 Series: Optical Fibres (https://webstore.iec.ch)**

Defines classifications, performance characteristics, test procedures, and specifications for optical fibres.

- **IEC 60794 Series: Optical Fibre Cables (https://webstore.iec.ch)**

Specifies construction requirements, environmental performance, mechanical characteristics, and testing procedures for optical fibre cables.

- **IEC 61754 Series: Fibre Optic Connector Interfaces (https://webstore.iec.ch)**

Defines interface dimensions and interoperability requirements for fibre optic connectors used in telecommunications networks.

- **IEC 61300-3-35 – Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Visual inspection of fibre optic connectors and fibre-stub transceivers.**

E. European Standards

- **EN 124: Gully Tops and Manhole Tops for Vehicular and Pedestrian Areas (https://standards.iteh.ai)**

Specifies performance, loading classes, testing requirements, and safety criteria for manholes, handholes, and access chambers used in utility and telecommunications infrastructure.

F. Reference Manual

- **ITU-T Manual: Optical Fibres, Cables and Systems (https://www.itu.int/pub/T-HDB-OUT.01)**

Provides comprehensive guidance covering fibre characteristics, cable construction, installation techniques, testing methodologies, maintenance procedures, safety considerations, and optical network design principles.

Appendix 4: Requirements for New Buildings to Support Broadband Services

(A separate document)