CONSULTATION PAPER ON OUTSIDE PLANT CODE & IN-BUILDING CABLING

PAKISTAN TELECOMMUNICATION AUTHORITY
www.pta.gov.pk

1. Background

The rapid evolution of telecommunications and data networks necessitates the development of robust standards for both **Outside Plant (OSP)** and **In-Building Cabling** systems. OSP refers to the infrastructure that connects telecommunication networks from central facilities to end-user premises, encompassing components such as underground conduits, aerial cables, and fiber optics. Meanwhile, In-Building Cabling ensures seamless connectivity within buildings through structured cabling systems that support voice, data, and video communications.

The increasing reliance on high-speed internet, smart buildings, and IoT devices has highlighted the critical role of these systems in modern infrastructure. The growing complexity of networks, coupled with the need for sustainability, scalability, and compliance with safety regulations, calls for updated and comprehensive guidelines that integrate both OSP and In-Building Cabling.

This consultation paper aims to address these challenges by fostering stakeholder engagement to develop a unified framework that ensures compatibility, reliability, and future-proofing of telecommunication infrastructure.

2. Objectives

The objectives of this consultation process, which includes Outside Plant Code and In-Building Cabling Standards, are as under:

- Develop unified guidelines for installing and maintaining OSP and In-Building Cabling systems and streamlining installation processes
- Align with international standards to ensure global compatibility.
- Address safety concerns for Outside Plant and in-building cabling
- Ensure environmental protection in OSP installations by adopting eco-friendly practices.
- Ensure scalability to accommodate future advancements in telecommunications and design flexible systems that can adapt to evolving network demands without significant overhauls.
- Optimize cable management within buildings through structured cabling practices like clear labeling, documentation, and adherence to bending radius limits, etc.
- Involve key stakeholders such as telecommunication providers, architects, engineers, contractors, and end-users in shaping the standards.

3. Legal Provisions

The Pakistan Telecommunication Authority (PTA), established under the Pakistan Telecommunication (Re-Organization) Act, 1996, is mandated to regulate telecommunication systems and services in Pakistan. Under Section 8 of the Act, the Federal Government may issue policies to support telecommunication sector development. Recognizing the critical role of telecommunications in economic growth, connectivity, and digitalization, the Government of Pakistan introduced the Telecommunication Policy 2015 (TP 2015)

In line with Clause 7.2 of the TP 2015, PTA has developed an advisory Outside Plant Code (OPC) for local authorities to ensure ducts and associated access points are provided in **new or rebuilt roads, footpaths, and railway tracks**. Additionally, Clause 7.3 of TP 2015 mandates PTA to identify standards for **in-building** telecommunications cabling for new, existing, and refurbished buildings.

To fulfill these requirements:

i. PTA has prepared a draft OPC outlining the standards and specifications for telecommunications ducts and related infrastructure. The draft OPC is attached as **Annex-A**.

ii. M/s Nayatel and M/s PTCL (PTA's licensees) submitted a document titled *Digital Connectivity Infrastructure* (DCI) to the Pakistan Engineering Council (PEC) in 2024. This document includes standards for **in-building** telecommunications cabling and has been reviewed by PTA for compliance with Clause 7.3 of TP 2015. The updated/reviewed In-Building Cabling Standards is attached as **Annex-B**.

The Pakistan Engineering Council (PEC), established under the Pakistan Engineering Council Act, 1975 (V of 1976), regulates engineering practices across Pakistan. As per Clause (xxv) of Section 2 of the PEC Act, PEC is mandated to oversee **professional engineering work** including but not limited to transport infrastructure (such as **railways**, aerodromes, bridges, tunnels, and **roads**) as well as **residential and non-residential buildings.** PEC may incorporate these codes into its relevant regulatory instruments for implementation, as per procedure in vogue. Other key stakeholders such as local government (TMA, CDA, LDA, etc.), regulatory bodies (NHA, DHA, CAA, Cantonment Board, etc.) may also incorporate these standards in the respective Byelaws.

4. Scope of Outside Plant Code

The Outside Plant Code (OPC-2025) standards apply to all OSP installations in new developments, including new roads, footpaths, railway tracks, and their reconstruction. These Standards do not change any obligations imposed by other administrative authorities. Installations along roads, highways and railway tracks shall strictly observe the requirements set by the relevant authorities having jurisdiction. Therefore, all installations must align with the provisions and guidelines established by these concerned authorities.OPC-2025 serves as an essential reference for developers, operators, local authorities, and regulatory bodies, ensuring a standardized approach that promotes sustainable development in the telecommunications sector.

The OPC-2025 includes guidelines for the design, planning, and integration of OSP infrastructure, covering cables, ducts, manholes/handholes, street cabinets, and equipment chambers. It establishes standards for installation practices such as trenching, cable placement, underground installation, testing, and quality control. The code also outlines safety protocols for installation and maintenance, along with environmental protections for OSP infrastructure. Additionally, it provides guidelines for infrastructure sharing, promoting multi-stakeholder collaboration and efficient resource utilization.

5. Scope of In building Cabling Standards

The In-Building standards apply to the design, operation, and maintenance of buildings and building clusters with a construction area of 1,500 square meters or more, covering existing, new, and modified installations. These standards shall be adopted by the owners of such buildings, both public and private.

The code defines technical standards for in-building physical infrastructure, guiding consultants, developers, contractors, and building owners in designing and installing telecommunications networks. It ensures compliance with global best practices, particularly for fiber broadband and cellular services, fostering resilient and future-ready infrastructure in new developments.

6. Invitation for Stakeholder Input

PTA invites all telecom licensees (Integrated, CMO, LDI, LL, TIP, Class Licenses), industry experts, policymakers, regulatory bodies, local government, concerned ministries and the general public to provide feedback on Outside Plant Code and In-Building Cabling Standards, attached as **Annex-A** and **Annex-B**, respectively.

7. Submission Guidelines

The stakeholders are requested to submit requisite comments, preferably through email, latest by **May 12, 2025**. Email ID: consultationsnd@pta.gov.pk

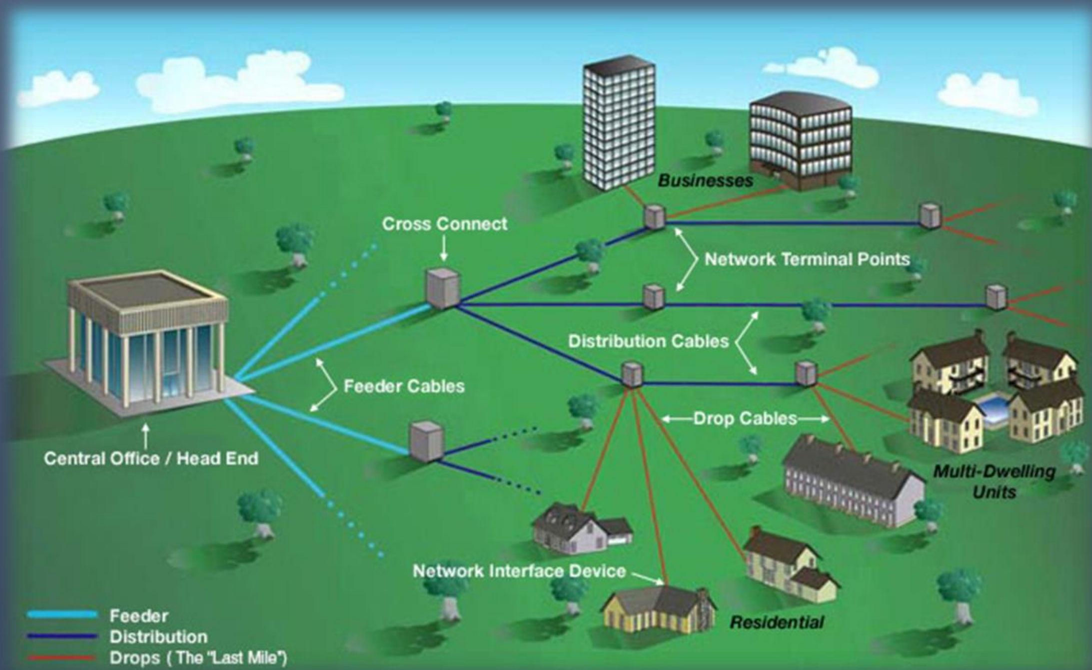
Comments /input / opinions may be addressed to Director S&D, S&D Division, PTA HQ, F-5/1 Islamabad Fax. 051-2878133.

Consultation paper is also available at PTA's website:
https://www.pta.gov.pk/category/consultation-papers-1237411963-2023-05-30

Annex-A

2025

Outside Plant Code



Pakistan Telecommunication Authority | F-5/1, Islamabad

Foreword

Pakistan Telecommunication Authority (PTA), established under Pakistan Telecommunication (Re-Organization) Act, 1996 (Act), is mandated to regulate telecommunication systems and provision of telecommunication services in Pakistan. As per section 8 of the Act, The Federal Government may issue policy for telecommunication sector development. Recognizing the pivotal role of telecommunication in economic growth through connectivity and digitalization, the Government of Pakistan, issued Telecommunication Policy 2015. As per section 7.2 of the Telecom Policy 2015 PTA was tasked to work with the appropriate authorities to develop outside plant code, which states that "an advisory code for local authorities will be developed to ensure that ducts and associated access points are provided in **new roads, footpaths and railway tracks,** and those that are being rebuilt". Further, Clause 7.3 of the Telecom Policy 2015, mandates PTA to "review and identify standards for in-building telecommunications cabling for new, existing and re-furbished buildings."

Pakistan Engineering Council (PEC), a Statutory Regulatory Body established under the Pakistan Engineering Council Act, 1975 (V of 1976), is mandated to regulate the **engineering profession,** including education and practice, across Pakistan. As per Clause (xxv) of Section 2 of the PEC Act, PEC is mandated to oversee **professional engineering work**, which encompasses providing professional advice and opinions, conducting measurements and layouts, preparing reports, computations, designs, drawings, and specifications, as well as supervising and inspecting engineering works. This applies to diverse domains, including but not limited to transport infrastructure (such as **railways**, aerodromes, bridges, tunnels, and **roads**), various engineering disciplines (electrical, mechanical, hydraulic, **communication**, aeronautical, power, geological, and mining), **residential and non-residential buildings**, structures accessory to engineering works and intended to house them.

Pursuant to Clause 7.2 of the Telecommunication Policy, 2015, PTA has developed a draft Outside Plant Code (OPC), identifying standards/specifications for telecommunications ducts and related infrastructure, ensuring designated voids and spaces for the installation of buried or surface-mounted equipment chambers. The code also defines terms and conditions for providing ducts and voids/spaces to telecommunication license holders, fostering infrastructure expansion under a transparent regulatory framework.

This Code will serve as a fundamental guideline for engineers, telecom operators, builders, civil contractors, relevant authorities, and regulators, ensuring the development of a resilient and future-ready telecommunications infrastructure in Pakistan. Its implementation and enforcement will be carried out through a statutory notification by the Government of Pakistan. All relevant local authorities with jurisdiction shall ensure compliance with this Code through necessary regulations, orders, and directives. All OSP providers must comply to this Code by adopting or amending their respective bylaws or rules for implementation. The Code may be reviewed and updated after five (05) years of implementation or as needed, based on data and feedback received from relevant local authorities, by the committee constituted by the Pakistan Engineering Council (PEC).

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- ANSI – American National Standards Institute
- BICSI – Building Industry Consulting Service International
- CGA – Common Ground Alliance
- CITC – Communications and Information Technology Commission
- DCP – Dynamic Cone Penetrometer
- FBP – Fiber Backbone Path's
- FDFs – Fiber Distribution Frames
- FOA – Fiber Optic Association
- FOC – Fiber Optic Cable
- GPR – Ground Penetrating Radar
- HDPE – High-Density Polyethylene
- HH – Handhole
- IEC – International Electrotechnical Commission
- IEEE – Institute of Electrical and Electronics Engineers
- ISO – International Organization for Standardization
- ITU – International Telecommunication Union
- MH – Manhole
- MoITT – Ministry of Information Technology & Telecommunication
- NECA – National Electrical Contractors Association
- ODB – Optical Distribution Box
- OLTS – Optical Loss Test Set
- OSP – Outside Plant
- OTDR – Optical Time Domain Reflectometer
- PEC – Pakistan Engineering Council
- PETSAC – Pakistan Electric and Telecommunication Safety Code
- PTA – Pakistan Telecommunication Authority
- ROW – Right of Way
- SC – Street Cabinets
- SDS – Safety Data Sheets

- SDU – Single Dwelling Unit
- TIA – Telecommunications Industry Association
- UTOPIA – Utah Telecommunication Open Infrastructure Agency
- UPVC – Ultra-High-Density Polyvinyl Chloride

1 INTRODUCTION

Outside Plant refers to the physical infrastructure needed for the installation, maintenance, and management of telecommunications networks. It includes components like cables, conduits, cabinets, manholes, and other associated infrastructure, forming the backbone that connects network elements such as cell towers, data centers, and Central Office to deliver services to end-users. OSP networks vary based on factors like topography, climate, cabling choice, economics considerations, **local codes** requirement, and network functionality, both current and future types of supported equipment and customer requirements. Compliance with local codes is crucial for ensuring reliability, durability, and minimal environmental impact.

Typical layout of OSP is shown in **Figure 1**, where the diagram illustrates an optical fiber distribution network, detailing the structured flow of fiber connections from the Central Office to end-user buildings. It begins with the Central Office, linking to the Central Distribution Point, the primary data source. Feeder Cables from Central Distribution Point extends to Street Cabinet, an intermediate node for further distribution. Distribution Cables, spreading from street cabinets pass through underground Manholes, enabling maintenance and expansion of network. The system reaches Access Points, where individual connections are established before the final Lead-In directs fiber into buildings. This distinguishes Outside plant (underground infrastructure) from In-Building Cabling (end-user fiber delivery) for scalability and reliability.

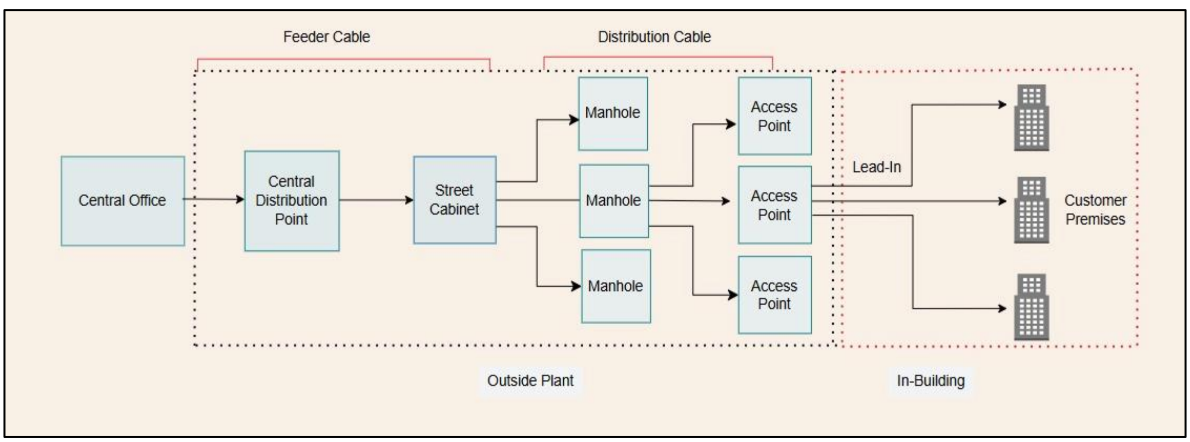

Figure 1: Typical layout of Outside Plant (OSP)

The "**Dig Once"** policy**,** published by the World Economic Forum**,** helps install multiple utilities at the same time during a single excavation. This reduces costs, limits disruptions, and speeds up network expansion, especially for telecommunications, to meet the increasing need for fast internet.

Recognizing the pivotal role of telecommunication in economic growth through connectivity and digitalization, the Government of Pakistan, issued Telecommunication Policy 2015 (TP 2015). As per section 7.2 of TP 2015, PTA was tasked to develop outside plant code, which states that "an advisory code for local authorities will be developed to ensure that ducts and associated access points are provided in new roads, footpaths and railway tracks, and those that are being rebuilt"

This document outlines the Outside Plant Code (OPC) developed by PTA, which sets standards and specifications for telecommunications ducts and related infrastructure. It ensures the allocation of designated voids and spaces at critical locations for buried or surface-mounted equipment chambers. Additionally, the code establishes terms and conditions for providing ducts and voids/spaces to telecommunication license holders, promoting infrastructure expansion within a transparent regulatory framework.

1.1 Title

This Code shall be known as the **O**utside **P**lant **C**ode (2025), herein after referred to as **OPC-2025.**

1.2 Purpose

The purpose of OPC-2025 is to:

- Establish technical standards and guidelines for local authorities ensuring compliance with OSP code pertaining to OSP Infrastructure in new public and private developments, roads, footpaths, and railway tracks, and those that are being rebuilt.
- Provide specification for ducts carrying telecommunications and related power cabling, along with spaces for buried or surface-mounted equipment chambers.
- Ensure that telecommunications networks are designed and installed according to international best practices across residential, commercial, industrial, governmental, and other facilities.
- Facilitate efficient and cost-effective installation of OSP infrastructure, supporting the rapid evolution and increasing demand for modern telecommunication services in residential, commercial, and industrial sectors.
- Promote infrastructure sharing among stakeholders, fosters competition, and enables the deployment of advanced telecommunications technologies as essential components of sustainable ICT sector growth.

1.3 Scope

The OPC-2025 standards apply to all OSP installations in new developments, including new roads, footpaths, railway tracks, and their reconstruction. These Standards do not change any obligations imposed by other administrative authorities. Installations along roads, highways and railway tracks shall strictly observe the requirements set by the relevant authorities having jurisdiction. Therefore, all installations must align with the provisions and guidelines established by these concerned authorities.OPC-2025 serves as an essential reference for developers, operators, local authorities, and regulatory bodies, ensuring a standardized approach that promotes sustainable development in the telecommunications sector.

The OPC-2025 includes guidelines for the design, planning, and integration of OSP infrastructure, covering cables, ducts, manholes/handholes, street cabinets, and equipment chambers. It establishes standards for installation practices such as trenching, cable placement, underground installation, testing, and quality control. The code also outlines safety protocols for installation and maintenance, along with environmental protections for OSP infrastructure. Additionally, it provides guidelines for infrastructure sharing, promoting multi-stakeholder collaboration and efficient resource utilization.

1.4 SOURCE DOCUMENTS

Technical Standards of OPC-2025 have been developed based on recommendations from the Fiber Optic Association (FOA), American National Standards Institute (ANSI), Telecommunications Industry Association (TIA), International Telecommunication Union (ITU), Building Industry Consulting Service International (BICSI), National Electrical Contractors Association (NECA), and Utah Telecommunication Open Infrastructure Agency (UTOPIA) Fiber. Additionally, these standards have been referenced in OPC-2025 to ensure alignment with industry best practices and adherence to technical specifications. In case reference is made to international specifications (ITU-T, ISO/IEC, etc.), the latest version shall apply, ensuring the infrastructure supports current and future telecommunications needs effectively and sustainably.

1.5 ADMINISTRATION AND ENFORCEMENT

The administration and enforcement of the Outside Plant Code (OPC-2025) is essential to ensure its effective implementation across all OSP-related infrastructure projects. The following sections outline the compliance and administrative requirements for stakeholders involved in OSP installations and maintenance, as well as the process for review and updates.

1.6 COMPLIANCE REQUIREMENTS

- All installations and maintenance of equipment and infrastructure related to OSP shall be in accordance with OPC-2025

- These provisions shall be applicable to all new installations, extensions and replacement of OSP infrastructure new public and private developments, roads, footpaths, and railway tracks
- In case of existing installations, whether maintenance or replacement, such installation is required to be in compliance with this Code.
- All OSP providers shall comply with this Code**.**

1.7 Administrative Requirements

- The implementation and enforcement of this Code shall be through a statutory notification by the Government of Pakistan
- All relevant local authorities having jurisdiction shall ensure compliance and implementations of this Code through necessary regulations, orders and directives.
- All OSP providers shall comply with this Code by adopting or amending their relevant byelaws or rules for implementation.

1.8 Supplementary Information

This Code may be reviewed and updated, after five (05) years of implementation or as and when required based on data and feedback received from the concerned local authorities, by the committee as constituted by Pakistan Engineering Council (PEC).

2 DEFINITIONS

3.1. **Access Area:** The physical location containing the lead-in ducts and cabling from the telecommunications access point to the telecommunications space / room.

3.2. **Access point:** The physical spot outside a building that houses the Optical Distribution Box (ODB) and establishes a connection between the Outside Plant and the In-building Physical Infrastructure is known as an Access Point. It acts as the line separating outdoor and indoor infrastructure.

3.3. **Backfill:** Materials like sand, crushed stone, or soil used to fill an excavation. It helps provide support, stability, and protection for underground utilities.

3.4. **Barricade:** A temporary barrier, such as a rope or fence, set up to restrict public access to a protected area.

3.5. **Central Office:** Centralized location for transmission, reception, and switching handling large volume of data.

3.6. **Conduits:** Protective enclosures for routing telecommunication cables, made of metal or plastic.

3.7. **Distribution Cable:** A distribution cable in OSP connects the street cabinets (distribution points) to the access points (splitter port), ensuring high-capacity signal transmission to end users. It is typically routed through street cabinets, manholes, and access points for efficient distribution.

3.8. **Ducts:** Underground pathways, typically made up of Poly Vinyl Chloride (PVC) or High Density Polyethylene (HDPE), for housing and protecting Outside plant cables, allowing easy installation and maintenance.

3.9. **Facilities Backbone Provider (FBP):** The primary high-capacity route for data transmission, connecting access points, network nodes, and core infrastructure to the internet and other communication networks.

3.10. **Feeder Cable:** A high-capacity cable that carries signals or power from the central point (like a hub or main source) to distribution points.

3.11. **Fiber or Fiber Optic:** The technology used to transmit data as light pulses via a strand of glass or plastic (fiber).

3.12. **Fiber Optic Cable (FOC):** A cable made up of one or more strands of glass consisting of a central core and outer cladding (optical fibers), strength members, and an outer jacket.

3.13. **Grounding:** Process of connecting electrical equipment or a telecommunications system to the earth to prevent electrical shock hazards and protect against electrical surges. This connection allows excess electrical charge to safely dissipate into the ground.

3.14. **Handhole:** An access opening in equipment or a subsurface enclosure for underground cables, allowing personnel to reach in but not enter, to install, operate, or maintain equipment or cables.

3.15. **Manhole:** A manhole is an underground chamber with a top aperture where someone can enter to install equipment or cables, make connections, or carry out maintenance and operations on the outside plant cables.

3.16. **Multi-dwelling Unit (MDU):** Multi-dwelling Unit (MDU) refers to two or more units which can be joined through a common wall or belongings boundary. Examples of MDUs consist of apartments, workplace, commercial premises, shops and public buildings. An MDU might also encompass a couple of towers which might be a part of a common most important building.

3.17. **New Development:** Encompass real estate projects involving land planning, site preparation, and the construction of structures for residential, commercial, industrial, governmental, or other uses, carried out by developers

3.18. **Outside Plant (OSP):** Outside Plant (OSP) refers to the infrastructure and network components installed outside of a building or facility, primarily for telecommunication and data transmission. It includes cables, ducts, conduits, manholes, handhole, street cabinet and all other equipment installed on, along, over or under streets, alleys, highways, or on private rights-of-way. OSP connects Central Office to customer locations or links multiple Central Offices.

3.19. **Pathway:** A facility for the placement of telecommunications cable.

3.20. **Point to point:** Direct connection between two locations or devices, enabling communication or data transfer without intermediate nodes.

3.21. **Right of Way "(RoW)"** means a right belonging to any person or public authority to pass over land or property of other person to provide telecom license services.

3.22. **Single –dwelling Unit (SDU):** A single dwelling unit (SDU) is a building that houses just one unit, such as an office, residential, or commercial space.

3.23. **Slump Test:** A Method for determining the consistency of fresh concrete before it sets. It is used to verify that the correct amount of water has been added to the mix

3.24. **Splice Closures:** Splice closures are used to protect and connect individual fibers within a fiber optic cable. They are weatherproof and provide protection against moisture, dust, and other environmental elements.

3 OSP SITE PREPARATION

This section presents a systematic approach for conducting preliminary investigations, field surveys, and utility assessments to ensure safe and efficient Outside Plant (OSP) infrastructure deployment.

3.1 PRELIMINARY INVESTIGATIONS

OSP designers must conduct thorough preliminary investigations to gather critical information for selecting optimal pathways, mitigating safety hazards, and ensuring compliance with regulations. Prior to construction, designers should:

- **Review Existing Records**
  - Examine available utility maps, infrastructure layouts, and prior survey data.
  - Identify locations of power, fuel, water, and telecommunications facilities.
  - Pay special attention to natural gas and oil pipelines due to fire risks.
- **Coordinate with Utility Providers & Agencies**
  - Engage with relevant authorities to locate existing and planned facilities.
  - Verify the presence of underground utilities to prevent potential conflicts.
- **Verify Field Conditions**
  - Compare existing records with actual field conditions.
  - If discrepancies exist, seek confirmation from utility providers or conduct test holes.
- **Identify Unrecorded Structures**
  - Determine ownership of any unidentified lines or structures not recorded in existing documents.
  - Notify relevant authorities for proper documentation.
- **Consider Key Route Planning Factors**
  - Safety, location, topography, existing infrastructure, costs, local restrictions, and future developments should be taken into account.

3.2 SITE SURVEYS

Site surveys are essential to assess environmental and infrastructural conditions necessary for optimal OSP design and implementation. This proactive approach ensures optimal OSP implementation while saving time and resources. The following procedure must be followed for site surveys:

- **Survey Preparation & Equipment**

  Before starting the site survey, ensure the availability of the following tools:

  - Digital camera (with spare batteries)
  - GPS with tracking function (with spare batteries)
  - Dynamic Cone Penetrometer (DCP) tester
  - Measuring tools (tape measure, measuring wheel)
  - Clipboard, notebook, and stationery
  - Route drawings from the client
  - Reflector jacket and personal identification

- **Review Pre-Build Drawings & Physical Site Inspection**
  - Validate the marked route by comparing pre-build drawings with actual site conditions.

- **Evaluate Site & Infrastructure Conditions**
  - Gather data on existing OSP infrastructure.
  - Conduct field visits to assess potential conflicts with other utilities.

- **Verify Soil Classification**
  - Conduct one visual and one manual test per 1 km.
  - If soil conditions differ from contract specifications, consult the relevant authority immediately.

- **Check Utility Locations**
  - Identify and verify above- and below-ground utilities.
  - Record any road or rail crossings and service intersections.

- **Assess Facility Placement**
  - Determine whether new infrastructure will be aerial, direct-buried, or underground.
  - Document field conditions for future reference.

- **Observe & Document Route Changes**
  - Identify changes in gradient or direction.
  - Capture photographs of significant landmarks and obstacles.

- **Verify Handhole (HH) & Manhole (MH) Positions**
  - Confirm locations and document nearby structures.

- **Balance Service Life with Technological Advances**
  - Consider future technological requirements when designing infrastructure:
    - Aerial plant (poles, cables): ~30 years lifespan.
    - Direct-buried plant: Similar or shorter lifespan due to limited external protection.
    - Underground plant: More expensive but lasts over 50 years.
- **Consider Alternative Routes**
  - If the proposed route faces challenges such as heavy traffic, costly pavement repairs, unsuitable soil, high installation costs, or right-of-way (RoW) restrictions, evaluate alternative routing options.
- **Final Verification & Approval**
  - Double-check all recorded details on the return journey.
  - Submit findings for approval before initiating construction.
  - By following this structured approach, OSP designers can ensure an efficient, cost-effective, and sustainable network deployment.

3.3 IDENTIFYING AND MARKING UTILITIES

Designers must identify and mark the existing utilities before excavation to prevent damage and safety hazards. Further, the markings must be verified before the excavation begins. The color codes mentioned in Table 1, as suggested in Common Ground Alliance (CGA) Best Practices Guide, should be used for identification for different utilities. Best Practices Guide

Color	Identified Utility
White	Proposed excavation
Pink	Temporary survey markings
Red	Electric power lines, cables, conduit, and lighting cables
Yellow	Gas, oil, steam, petroleum or gaseous materials
Orange	Communications lines, alarm or signal lines, cables, or conduit
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
Green	Sewers and drain lines

Table 1: Standard Utility Color Codes for Identification and Marking of Utilities

3.4 Test Holes

OSP designers may have to drill exploratory holes to assess soil conditions and identify potential underground obstacles. The following procedure to be followed:

- **Determine Test Hole Locations**
  - Drill test holes above or beside the assumed position of an obstacle.
  - Utilize non-invasive methods as per CGA's Best Practices Guide.
- **Excavation Tolerance Zone**
  - The excavator observes a tolerance zone that is comprised of the width of the facility plus 18 in. on either side of the outside edge of the underground facility on a horizontal plane. This practice is not intended to preempt any existing state/provincial requirements that currently specify a tolerance zone of more than 18 in

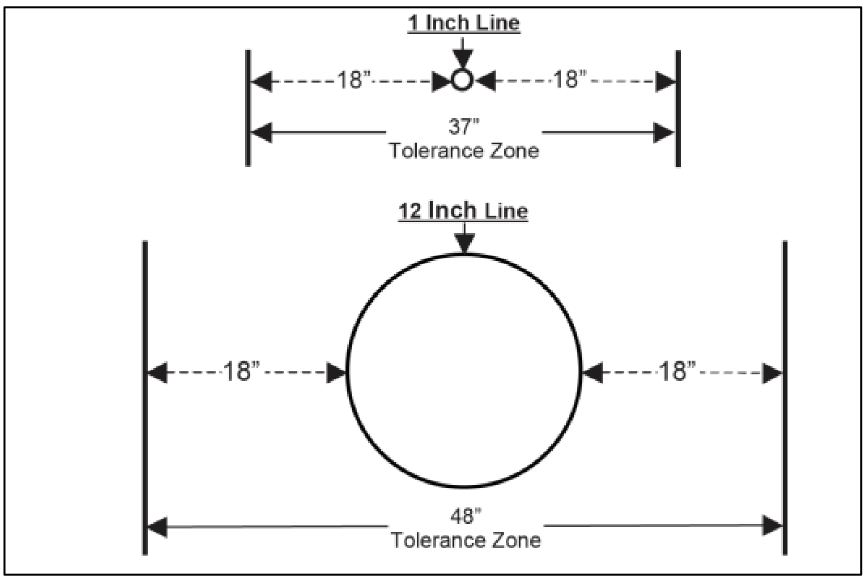

Figure 2: Tolerance Zone
Source: CGA

- **Document Findings**
  - Maintain a plan and profile drawing for accurate route plotting.

3.5 Pathways

OSP providers must design and implement OSP pathways that provide reliable and scalable infrastructure for telecommunications networks. The procedure to be followed is as under:

- **Select Appropriate Pathway Type**
  - Aerial, direct-buried, or underground pathways based on project requirements.
  - Underground pathways preferred for security, maintenance ease, and future scalability.
- **Design Compliance**
  - Ensure compliance with **ANSI/TIA-569-B** standards.
  - Consider environmental conditions, safety, and right-of-way (RoW) constraints.
- **Pathway Planning Considerations**
  - Evaluate soil conditions, waterways, utilities, and cost constraints.
  - Conduct thorough site surveys to identify challenges and alternative routes.
- **Underground Infrastructure Requirements**
  - May include conduits, manholes (MHs), handholes (HHs), utility tunnels, vaults, pedestals, and cabinets.
  - Number of ducts should accommodate current cable needs and future expansions.
- **Utility Coordination & Damage Prevention**
  - Coordinate with public utility damage prevention systems to avoid accidental damage.
- **Manhole & Conduit Design**
  - Manhole location should minimize directional changes in conduit routes.
  - Ensure proper water runoff in manhole placements.
  - Maintain correct geometry for conduit bends to facilitate cable installation.

4 TRENCHING

This section outlines the procedures and best practices for trenching activities, ensuring safety, efficiency, and regulatory compliance. It covers trenching procedures, pilot holes, barricading, and trenching near roadside structures, as well as road, bridge, railway, stream, and river crossings, along with considerations for working near other utilities. All trenching operations must comply with the Pakistan Electric and Telecommunication Safety Code (PETSAC) wherever applicable, ensuring adherence to national safety and engineering standards.

4.1 Trenching Procedure

The following standard trenching practices, as specified in *OSP Fiber Optics Civil Works Guide* by the Fiber Optic Association (FOA), must be followed to ensure proper duct installation, protection, and durability.

- **Bedding Material Preparation**
    - Bedding creates a smooth, stable trench base for duct placement.
    - Must consist of granular, non-cohesive material with particle sizes between **0.6 mm** and **19 mm**.
    - Both bedding and padding should be passed through a sieve for uniformity.

Figure 3: Bedding & Padding Material Preparation
Source: FOA

- **Padding and Side Support**
    - Padding must be **manually compacted** using a hand tamper.

- Inadequate side support increases the risk of **duct buckling**.

- **Backfilling Process**
  - Once padding is compacted, proceed with backfilling using excavated material, ensuring it is **free from stones (>150 mm),** debris, or organic matter that may damage ducts.
  - Apply backfill in **layers no thicker than 300 mm** compacting each layer before adding the next.

- **Warning/Marking Tape Placement**
  - After compacting the first backfill layer, place a colored plastic warning tape **(minimum 0.1 mm thick, 300 mm wide).**
  - Tape must be positioned **300 mm** below ground level, running continuously along the duct structure.
  - Warnings must be clearly printed in **Urdu** and **English**, stating **"CAUTION!!! TELECOM CABLE"** along with a contact number.
  - Ensure the tape remains in place throughout the backfilling process.

Figure 4: Placement of Marking Tape
Source: FOA

- **Concrete Placement and Testing**
  - Conduct a **slump test** to verify concrete consistency.
  - Carefully tamper concrete to avoid damaging ducts and eliminate cavities.

- Allow concrete to cure until it hardens sufficiently.

Figure 5: Concrete Encasing
Source: FOA

- **Compaction and Layering**
  - Poor compaction can lead to high air voids, increasing the risk of damage (e.g., veld fires).
  - Manual compaction must be performed until ducts are covered with:
    - **150 mm (½ feet)** of padding
    - **300 mm (1 feet)** of backfill
  - After these layers, use a vibratory plate compactor for further compaction.
  - The final backfill layer must be compacted with a compaction machine to achieve a density equal to or greater than the surrounding undisturbed soil.

Figure 6: Trench Compacting
Source: FOA

- **Dynamic Cone Penetrometer (DCP) Testing:**
  - Conduct **DCP tests** to ensure compaction quality:
    - **Every 15m** in standard trenches.
    - **Every 5m** in road reserves or under footpaths.
  - Testing frequency can be reduced with consistent satisfactory results and approval from the relevant authority.
  - Standard penetration benchmarks:
    - **<100mm penetration**
    - **2 blows for verges**
    - **3 blows for footpaths**
    - **5 blows for roadways** (or as per client specifications).

Figure 7: *DCP Test*
Source: Spectest

4.2 PILOT HOLE

Once the trench has been marked, pilot holes should be dug at intervals of **30-50 meters**, especially at locations where the new trench intersects with existing utilities. These pilot holes should be at least **150mm (½ feet)** deeper and wider than the planned trench.

Pilot holes as shown in Figure 8, are highly effective for both locating underground utilities and determining the precise position of the trench in relation to other services.

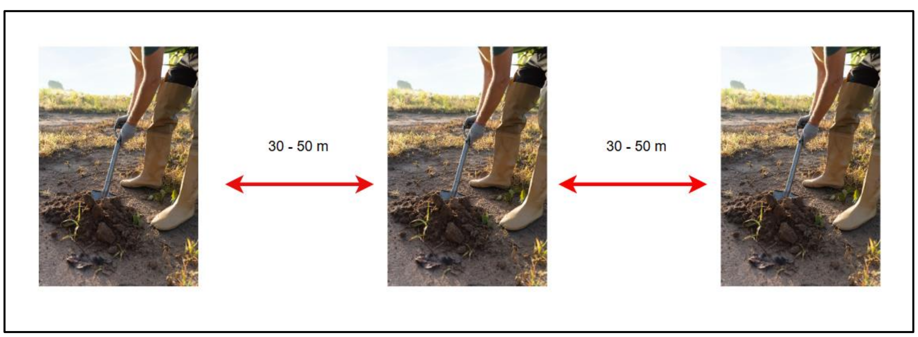

Figure 8: Pilot Hole Placement for Trench Excavation

4.3 BARRICADING

- Provide clear warnings and guidance to ensure the safety of motorists, pedestrians, cyclists, and workers from hazards, including setting up fences or barriers at least **1.2 meters** high close to excavation area in high traffic areas**.**

- Use bright boundary indicators for visibility at night or in low-light conditions, and ensure workers wear high-visibility vests and hard hats when near roads or working at night.
- During excavation near the road, place warning signs before and after the work area. A flagman with a red flag should stand at least **40 meters** before the **"Work In Progress"** sign, to ensure the safety of team members working in dangerous positions.
- Approved road cones should be placed regularly along the entire trenching area.
- Backfill the excavation as soon as possible.

4.4 Trenching Near Roadside Structures

- When excavating beneath kerbs, gutters, or driveways etc., ensure proper support is provided for these structures until tunneling and backfilling are complete. If tunneling isn't feasible, cut existing concrete paving with an angle grinder to create smooth edges.
- Carefully remove existing paving blocks to lay ducts underneath and reuse the blocks. After installation, re-lay the paving blocks on a sand bedding, restoring the area to its original state or better.

4.5 Road Crossings

- Inform the relevant road authority 48 hours before work starts and the contractor shall ensure compliance with traffic, safety, traffic signs, and barricading laws.
- As per PETSAC, conduits to be placed along the length of a roads should be installed in the **shoulder**; if not, place them **within one traffic lane** to reduce disruptions, minimize road closures.
- Directional boring is the preferred method to crossroads, highways, railway lines, rivers and all other services that may prove to be too dangerous or costly to cross using conventional methods and the angle of the crossing should be as near a right angle to the road centerline as possible.
- The hole for road crossings the covering should be at least three times its diameter and **1.5 meters deep**, while for river crossings the distance between the bottom of the water and the drilling hole should be **10 times the diameter of the pipe** and not less than 3m., ensuring proper protection and security.
- Use rigid **steel conduits** when crossing under tunnels or roadways.
- If accuracy isn't specified, the drill must stay within **40mm (1½ Inches)** of the planned path, and the location of underground services must be known to avoid obstacles.
- Hammerhead Moles offer a cost-effective alternative to horizontal drilling by simultaneously boring and installing a duct. To use them, entrance and exit trenches

must be dug at the designated positions, then the mole is inserted to begin boring, with a duct-pulling attachment installing the duct as the bore is made.

- The top of the trench must be cut using asphalt/concrete cutters to deliver smooth, uniform edges, ensuring services are buried at a minimum depth of **800 mm (2½ feet)** under the road, with ducts extending at least **0.5 meters** beyond the road edge.
- Place and mark excavated materials and equipment in a way to avoid obstructing traffic, and do not off-load potentially damaging materials onto public roads that may damage the surface.
- Ducts in a road crossing shall be locatable either by using permanent markings on the curb on both sides of the road or by recording coordinates of the survey points.

4.6 Bridge Crossings

- Firstly, thoroughly explore the possibility of using existing ducts or service culverts within bridges. Ducts installed on the underside of bridges must not impact its load-bearing capacity, reduce clearance, or create any other problems.
- The conduit system should be positioned to minimize damage from traffic and ensure safe inspection and maintenance of both the structure and the conduit.
- Bridge structures may have different installation configurations, requiring tailored procedures. The most common method involves using a hydraulically operated crane with a safety basket positioned near the bridge balustrade. Workers, wearing safety harnesses, are hoisted over the balustrade and lowered into position as needed.
- Mark the bracket positions on the bridge as per the design, then drill holes, insert anchors, attach the brackets, and secure them.
- Position and firmly secure the steel or Ultra High-Density Polyvinyl Chloride (UHD-PVC) base carrier duct, then pull the micro ducts through newly mounted base carrier. Use a continuous length of duct (no joints permitted).
- Where specified in the design instructions, both the approach and departure ends may need to be enclosed in concrete as they pass through the bridge abutments and enter the ground. The final result should be safe and visually appealing.

4.7 Railway Crossings

- The top of the conduit system must be placed at a minimum depth of**:**
  - **900 mm (36 inches)** below the top of the rails for street railways.
  - **1.27 m (50 inches)** below the top of the rails for railroads.
- If existing installations or unusual conditions create conflicts, a greater depth may be required.

- If maintaining the specified depth is impractical, the required separation may be reduced through mutual agreement between the parties involved. However, under no circumstances should the top of the conduit or any protective structure be positioned higher than the bottom of the ballast section that undergoes cleaning or maintenance.
- Manholes, handholes, and vaults should not be placed in the roadbed under railroads whenever possible.

4.8 Stream and River Crossings

- A **100mm (~ 4 Inches)** galvanized steel duct is used to accommodate sub-ducts when crossing streams or rivers.
- Cement blocks must be cast at both ends of the steel duct to secure it and prevent wash-away, and the duct must be sealed at both ends to keep out water and dirt.
- Underwater crossings should be placed to avoid erosion from tides or currents and kept away from ship anchorage areas.

4.9 Trenching Near Other Utilities

- Where no physical barrier exists, no duct or cable shall be laid within **600mm (2 feet) horizontally** nor cross within **300mm (1 feet) vertically** of any high voltage power cable. If this separation is compromised, use concrete slabs for protection. The standard protection slab measures **900mm x 300mm x 75mm** thick, reinforced with **3.55mm** high tensile wires.
- Minimum distance that should be maintained between the communication cables and existing utilities, as per **ANSI/TIA-758-B-2012** is given in Table 2

Type of Structure	Minimum Separation Required
Electric power, or other conduits	▪ 75 mm (3 inches) of concrete ▪ 100 mm (4 inches) of masonry ▪ 300 mm (12 inches) of earth
Other utilities (gas, water, oil etc.)	▪ 300 mm (12 inches) from transmission pipelines ▪ 150 mm (6 inches) from local distribution pipelines

Table 2: Minimum separations from other utilities

- The minimum distance specified in Table 2 must be adhered to Unless greater separations are required by local authority having jurisdiction

4.10 Trench Depth

The following standard trench depth requirements and protective measures for duct installations in various soil conditions, as suggested in OSP *Fiber Optics Civil Works Guide* by the Fiber Optic Association (FOA), should be followed:

- **Standard Trench Depth Requirements**
  - Minimum trench depth must be **800mm (~ 2 ½ feet)** to cover the duct crown in all soil conditions, except hard rock.
  - If achieving this depth is not feasible, the relevant authority must be notified.
- **Hard Rock Conditions**
  - When excavation in hard rock limits depth, a minimum backfill cover of **300mm (~1 feet)** over the uppermost duct is acceptable.
  - The duct must be protected with a concrete slab (precast or cast on-site) placed over padding material before backfilling.
  - Concrete slab specifications:
    - Strength: **20 MPa**, reinforced with high-tensile wires.
    - Dimensions: **75mm (~3 inches) thick, 300mm (~1 feet) wide, and 900mm (~3 feet) long**.
  - Refer to **Figure 9** for trench depth and layer specifications in duct installations.

Figure 9: Trench depth and Layer specifications for Duct Installations
Source: FOA

- **Concrete Encasing Considerations**
  - Concrete encasing may turn a flexible duct into a rigid beam, increasing fracture risks due to ground movement.

- Before pouring concrete, conduct a **slump test** to ensure proper consistency:
  - **Dry mix: 25-50mm (~1 – 2 inches)**
  - **Wet mix: 150-175mm (~6 – 7 inches)**
- Photographic documentation of the process is required for compliance.

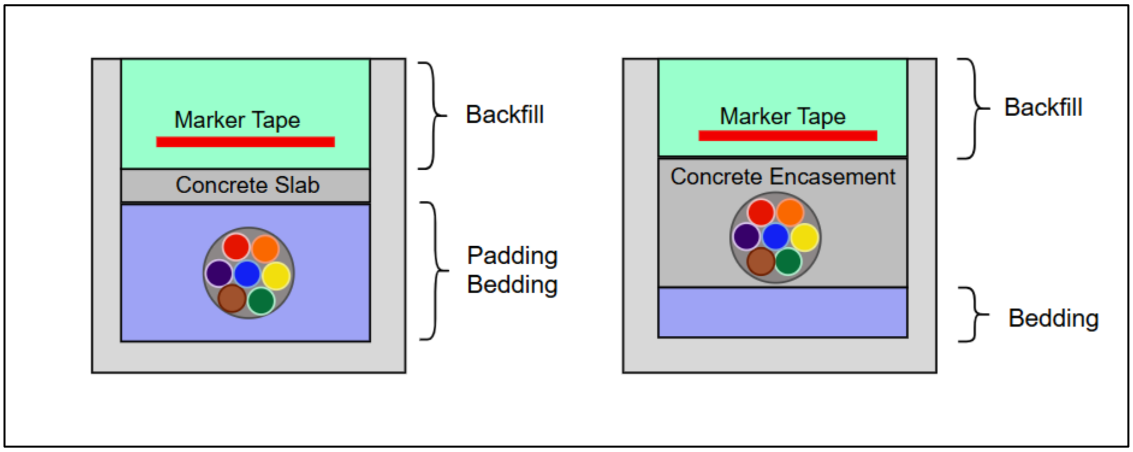

Figure 10: Duct Installation: Concrete Slab and Encased Configurations
Source: FOA

4.11 Trench Width

Trench width is crucial as it depends upon the size of the duct being installed (Figure 11). Trenches that are too narrow or too wide can lead to inefficient installation and increased costs. If no specific width is provided, consider examples shown in Figure 11. If single cable of 100 mm (4 inches) is to be installed, then trench width should be 300 mm i.e. 100 mm on each side of the cable. In case multiple cables are to be installed inter cable distance of minimum 50 mm to be added.

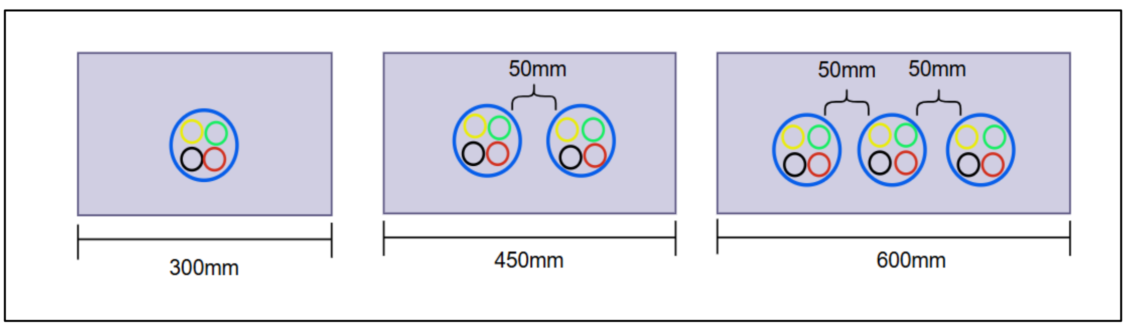

Figure 11: Trench Width for Duct Installation
Source: FOA

5 MANHOLES/HANDHOLES

Manholes (MHs) and Handholes (HHs) are essential components of the underground duct system, facilitating cable installation, maintenance, and management. Manholes provide personnel access for complex tasks such as splicing and repairs, whereas handholes serve as smaller access points for cable handling and inspections. This section outlines the requirements for the location, entry, cable protection, and safety measures associated with MHs and HHs. All manhole/handhole specifications and requirements must comply with the Pakistan Electric and Telecommunication Safety Code (PETSAC), ensuring adherence to national safety and engineering standards.

5.1 GENERAL REQUIREMENTS

The placement of MHs and HHs must be planned carefully to ensure accessibility, safety, and efficient network deployment. The following factors must be considered when determining the location of a manhole or handhole:

- Ground topography
- Soil conditions
- Proximity to surrounding structures
- Accessibility for personnel
- Potential difficulties in using the handhole for cable placement
- Loading scheme and spacing
- Available lengths of cable on reels
- Safety considerations

5.2 LOCATION & PLACEMENT REQUIREMENTS

- Manholes and handholes shall be capable of shared access for more than one public telecommunications network.
- The first manhole shall be installed at the beginning of a new development, with another at the end of a route where a significant delay is expected between project stages.
- Handholes made from concrete, polyethylene, or composite materials must be traffic-rated if placed in vehicular areas. In underground installations, HHs shall function as pull-through points, not splice locations.
- A manhole shall be installed within **5 meters** of any duct change direction exceeding **90 degrees**.

- Duct runs should not exceed **250 meters** without transitioning through a handhole. The span length may be extended based on the installation method (e.g., air-blown fiber) and determined during the project design phase.
- In proximity to street intersections, a manhole should be placed on the side connecting to the Fiber Backbone Path (FBP), avoiding future street widening conflicts. A clearance of **30 meters** from intersections is recommended.
- Manholes and handholes should be positioned as far away as possible from road junctions.
- Handholes should be installed in grassy or decorative areas whenever possible. Placement on sidewalks or pedestrian travel areas should be avoided unless space is limited.
- Handholes must not be exposed to vehicular traffic.
- The distance between maintenance holes must not exceed 200 meters.
- Handholes must include drainage features such as drain holes, open bottoms, or sump holes.
- Key locations for handhole placement include:
    - **2 feet** from the sidewalk within the public utility area or Right of Way (RoW).
    - Property edges where cables connect to residences.
    - Railroad track bores if no handhole exists within **1500 feet**.
    - Both sides of river or lake crossings.
    - Points where cables transition from underground to overhead installations.
    - All underground splice locations for aerial builds.
    - Tunnel entrances and exits.
    - Near network equipment such as cabinets or huts.
    - At distribution cable connection points (within **10 feet** of a cabinet or hut if the distance exceeds **500 feet**).

5.3 SPECIFICATIONS

Manhole and Handhole specification mentioned in Pakistan Electric and Telecommunication Safety Code (PETSAC) must be complied, the following specifications of manhole and handholes may be considered as reference:

5.3.1 General Specifications

- All manholes shall have **galvanized pulling eyes** installed opposite each duct entry, positioned **300 mm** above and below the duct entry line.
- Pre-cast manholes and handholes must be sourced from an approved supplier and labeled with serial numbers for identification.
- Manhole covers shall be installed flush with the asphalt surface.
- Manhole lids and structures must support a **minimum load of 40 tons** or comply with project-specific road classifications.
- Handhole covers must match the nominal handhole size and meet relevant safety codes.

5.3.2 Pre-Casted Manhole Specifications

- Minimum height: **1200 mm (4 feet)**
- Minimum width and length: **1200 mm (4 feet)**
- Access shaft opening: **600 × 600 mm or 600 mm (2 feet) diameter**

5.3.3 Pre-casted Handhole Specifications

- Minimum height: **800 mm (2.62 feet)**
- Minimum width and length: **600 mm (2 feet)**
- Access shaft opening: **600 × 600 mm**

5.3.4 Brick-made Manholes/Handholes Specifications

Where bricks are used to construct handholes (HHs)/Manholes(MHs), specific guidelines must be followed to ensure safety, durability, and compliance with project standards. The following points outline the essential criteria for brick construction in handholes/Manholes:

- Written permission from the client is required to ensure compliance with project specifications and mutual agreement on construction methods.
- Only baked clay bricks from an approved manufacturer should be used to guarantee the structural integrity and longevity of the handhole/Manhole.
- Reinforcing every third layer of bricks enhances the wall's strength and durability, minimizing the risk of cracking.
- The wall must be at least double brick thick to provide adequate insulation and resistance to external pressures.
- The outer wall must be waterproofed to prevent water infiltration, protecting the structure from potential damage over time.

- An approved footway-type or roadway-type frame and cover must be used for safety and to facilitate easy access for maintenance.

5.4 Manhole Access

Proper installation and maintenance of duct systems within manholes and handholes are critical to ensuring operational efficiency and infrastructure safety. The provisions of Pakistan Electric and Telecommunication Safety Code (PETSAC) must be complied. Additionally, the following duct entry and access requirements must be adhered to:

- Duct entry points must be drilled with care to prevent damage to the surrounding structure.
- Ducts shall enter and exit in alignment with the route direction, maintaining a continuous conduit without abrupt transitions.
- Ducts must not enter and exit from the same wall.
- Ducts shall enter through the narrowest face of the MH/HH at right angles to the wall.

5.5 Identification and Security

- Manholes and handholes must be externally labeled on the coping (not the lid).
- Manhole and handhole covers should have an identifying mark that will indicate ownership or type of utility.
- GPS coordinates of all MHs and HHs must be recorded for accurate tracking
- All covers shall have locks with unique security keys.

5.6 Cable Protection Requirements

Cable protection measures in MHs and HHs are critical for ensuring service continuity, preventing damage, and minimizing interference.

5.6.1 General Protection Measures

- All duct entry cuts must be made with care to avoid damaging existing cables.
- Cables must be uniformly supported along their entire length.
- Cables, joints, and associated equipment must **not** be used for purposes such as climbing, standing, or supporting objects.

5.6.2 Environmental Protection

- Sufficient pumping equipment shall be available to prevent water accumulation in manholes.

- Cables must be shielded appropriately to prevent mechanical damage.

5.6.3 Grounding

- The provisions of Pakistan Electric and Telecommunication Safety Code (PETSAC) must be complied.

5.7 Safety Procedures

Manholes and handholes are confined spaces that pose potential hazards. The following safety protocols must be strictly followed to ensure worker protection:

5.7.1 Pre-Entry Safety Measures

- Obtain prior authorization for manhole/handhole entry.
- Ensure **at least two personnel** are present when entering a manhole.
- Park vehicles safely and set up barricades and cones around the work area.
- Pour water around the manhole lid to prevent sparks before opening.
- Remove manhole covers using proper lifting techniques and place them **at least 2 meters away** from the opening.

5.7.2 Confined Space Entry Procedures

- Conduct gas testing at three levels (**bottom, middle, top**) for a minimum of **60 seconds** each, checking for oxygen levels and hazardous gases (e.g., hydrogen sulfide).
- Maintain continuous ventilation inside the manhole while work is in progress.
- Use an **aluminum ladder** for entry, and tools must be raised or lowered using ropes or buckets—**never placed at the edge of the manhole.**
- Fusion splicing shall **not** be conducted within confined spaces.

6 DUCTS

Ducts are essential components of outside plant infrastructure, designed to route and protect cables or fiber optics. Typically made from materials like Poly Vinyl Chloride (PVC) or High density Polyethylene (HDPE_, they provide a durable, organized pathway for long-distance or high-capacity installations, shielding cables from environmental factors and physical damage. Their rigid structure makes them ideal for underground installations or areas requiring high load-bearing capacity.

6.1 Duct Architecture

Outside Plant (OSP) architecture is crucial for providing reliable and high-speed telecommunications services. It involves designing and implementing the physical infrastructure, such as ducts, conduits, manholes etc., that connect central offices to end-users. The following duct architectures shall be used:

6.1.1 Single Side of Street

Single-side street duct architecture, as shown in Figure 12, involves installation of ducts only on one side of the street, with road crossings used to reach buildings on the other side of the street. It offers a cost-effective and simpler installation. This design is ideal for areas with limited space or where road conditions make dual installations impractical. However, this approach can limit redundancy and network resilience compared to dual-side installations, as there are fewer routing options available in case of a fault or disruption. Careful planning is crucial to ensure all connections are maintained, even with a single-side layout.

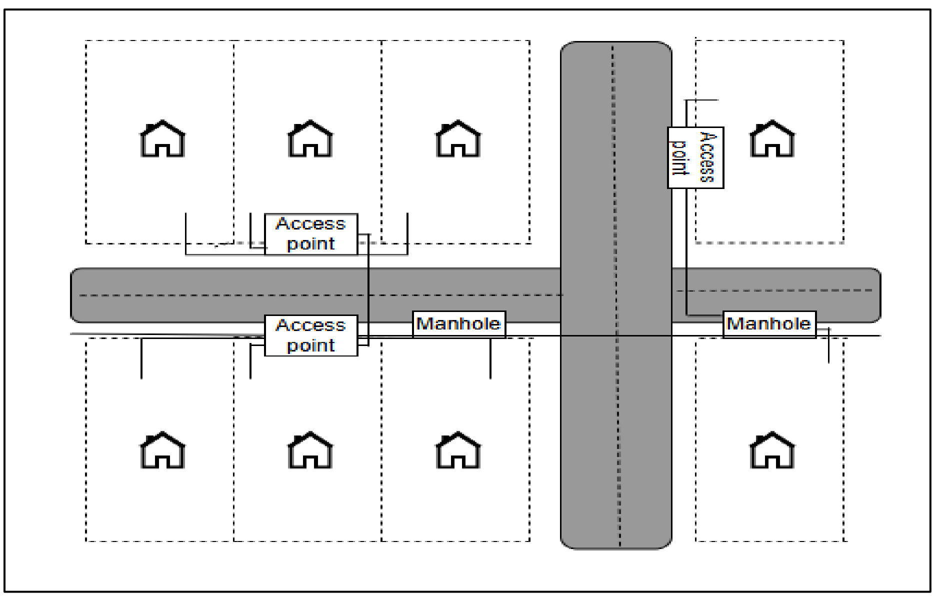

Figure 12: Single-Side Street Architecture
Source: CITC

6.1.2 Dual Side of Street

Dual-side street duct architecture, as shown in Figure 13, involves placing ducts on both sides of a street, offering increased flexibility, redundancy and reliability as it provides alternative routing options for fiber cables. It facilitates better network management and maintenance by enabling easy access to infrastructure on either side, which can minimize disruption during repairs or upgrades. It also supports higher capacity and scalability, accommodating future growth and expansion.

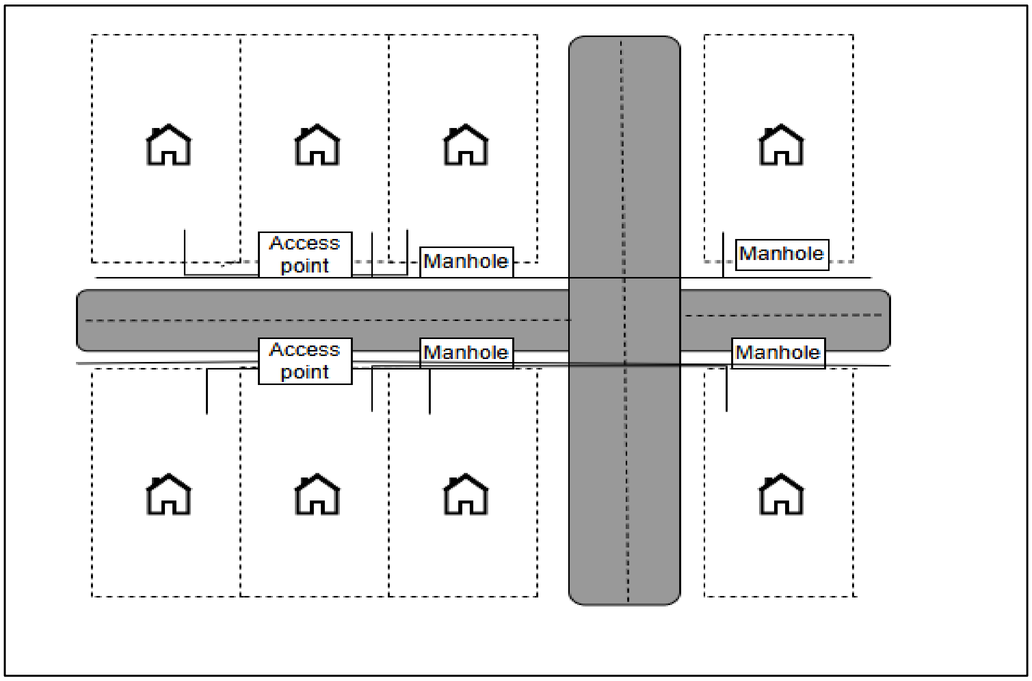

Figure 13: Dual-Side Street OSP Architecture
Source: CITC

6.1.3 Duct Architecture Considerations

The following considerations should be taken into account when designing the duct architecture:

- **Single-side ducts** should be used where space is limited on both sides of the street, making dual-side installations impractical. This approach is also more cost-effective in cases where budget constraints exist.
- **Dual-side ducts** are recommended when there is sufficient space on both sides of the street. They offer better scalability, improved network redundancy, and easier maintenance access, enhancing overall reliability.
- **Hybrid configurations** that combine both single- and dual-side duct layouts may be adopted to allow greater design flexibility.

- **Feeder duct redundancy** should be ensured by implementing at least two alternative duct routes connecting the distribution network.
- **Access Point connectivity** should follow a structured approach:
    - A single Access Point typically connects 4 to 10 buildings.
    - Up to 10 Access Points should be connected to a manhole.
    - Approximately 5 manholes should be connected to a street cabinet
- **Street cabinets** must be connected to feeder ducts with a 50 mm (~2 inches) diameter to ensure adequate capacity.
- **Optical Distribution Frames (ODF) and associated manholes** should be placed at the boundary of new developments for efficient network integration.
- **Road crossings** should include sufficient extra reserve capacity to maintain network reliability and accommodate future expansions.
- **Feeder duct layout for new business, industrial, or governmental developments** should be designed in a **ring configuration** rather than a simple branch layout. This ensures coverage for all potential buildings and premises, improving network resilience and expansion capabilities.

6.2 Duct Identification and Color Schemes

- Ducts, sub ducts and bends shall be made from material consisting of HDPE conforming to international standards. Both ducts and sub ducts shall be ribbed inside.
- Mark access points like manholes and place markers at the start and end of ducts for identification.
- Label ducts and bends with the duct number at intervals of **1 meter or less**.
- Number main ducts from the top left corner, moving right and then row by row.
- Number sub-ducts within each main duct, start from the bottom of the main duct and move upwards.
- Use one airtight duct size coupler per duct span to join ducts and a test for air tightness shall be conducted.
- Table 2 provides details on minimum sizes and tolerances to ensure ducts are adequately sized and durable for cable protection and routing.

Duct Type	Minimum Inner Diameter	Wall Thickness Tolerance
Feeder Duct	50mm	±3.25 mm

Distribution Duct (to Access point)	20mm	±2.00 mm

Table 3: Minimum Specifications for Ducts in New Installations
Source: CITC

- Underground ducts shall be laid in straight line in parallel to the roads center line. If curves are required, the bending radius should be at least 20 times the outer diameter or as per the manufacturer's specifications.
- Cables in a duct should be arranged from bottom to top within the manhole. Always use the lower joints location first.
- Duct arrangement between manholes must be maintained, with bundles, flat liners, or sub-ducts to organize ducts and optimize space.
- Sub-ducts should have a Stripped pattern to differentiate them from the main duct.
- A standardized color scheme for sub-ducts aids in identification and organization. Sub-ducts or pre-formed duct bundles shall follow a uniform color code as given in Table 4. Placement of sub-ducts is shown in Figure 14.

Duct	Color	Duct	Color
1	Red	7	Brown
2	Green	8	Violet
3	Blue	9	Turquoise
4	Yellow	10	Black
5	White	11	Orange
6	Grey	12	Pink

Table 4: Sub-ducts Color Coding
Source: CITC

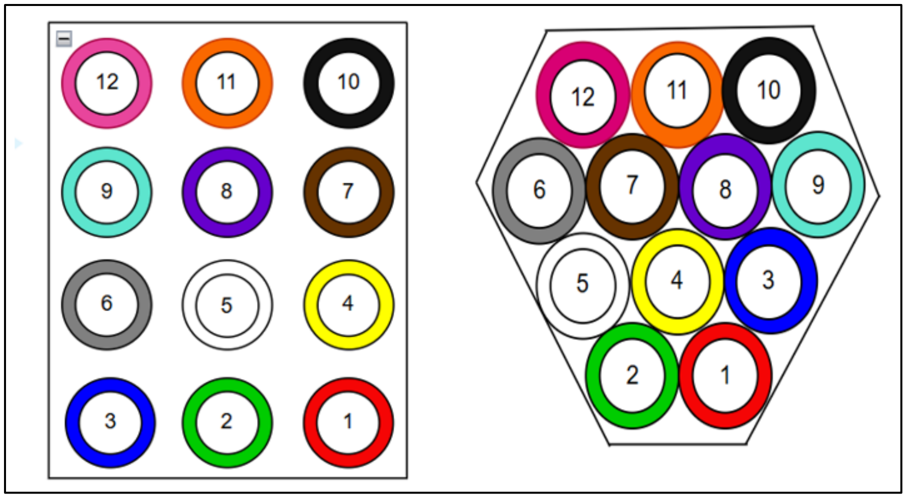

Figure 14: Numbering and Placement of sub-ducts
Source: CITC

6.3 Duct Installation Practices

Fiber optic cable installations for outside plant (OSP) usually involve point-to-point connections, with the terminations located inside buildings where the communication equipment is housed. Intermediate connections are made in sealed enclosures. OSP cables can be buried underground, pulled through ducts or conduits, mounted on poles or laid underwater across rivers or lakes.

Duct installation is an essential part of building reliable telecommunication Infrastructure. To ensure compliance with international best practices, duct installation must adhere to the following standards:

- Underground installation of ducts/conduits shall be achieved by trenching, boring or plowing.
- HDPE ducts are usually supplied on cable drums, with a connector or socket at one end to connect the duct lengths. Each duct has a socket at one end designed to fit the barrel of the next duct.
- Ducts should be placed in the center of the trench, laid straight, and properly aligned. Ducts can be installed as a single duct or arranged in a multi-duct formation, with multi-ducts organized in a rectangular layout. In multi-duct formations within a trench, the largest ducts should be positioned at the bottom.
- Measure duct lengths accurately on-site and cut accordingly between manholes. When installing sub-ducts, choose the lowest available primary duct on the outer edge. Extend the sub-ducts 10 cm beyond the primary duct into the manhole.

- Install ducts to the property boundary on undeveloped lots and mark them. When the lot is developed, extend ducts to the building, with the developer coordinating duct placement with the landowner.

6.4 Pre-formed Duct Bends

Preformed duct bends are crucial Outside Plant (OSP) duct installations. They provide smooth, pre-curved sections that help guide cables around corners smoothly ensuring that cables maintain proper bend radii, minimizing the risk of damage and optimizing the integrity of the duct system. There are some standards one shall keep in mind when working with installation of Pre-formed duct bends:

- All bends must be made of the same material as the duct or duct bundles they connect to.
- Pre-formed bends are required for short run ducts with bends limited to less than **10 degrees**. They should only be used at the ends of ducts for building or manhole entries and house lead-ins, or for routes between manholes.
- A maximum of two 90-degree bends (or equivalent) may be installed in the duct between any two manholes.
- Minimum bend radii for ducts between two manholes are mentioned in Table 5.

Duct Diameter	Bend Radius Long Run(>100m)	Bend Radius Short Run(<100m)
100 mm (4 Inches)	5000 mm (16½ feet)	800 mm (2½ feet)
50 mm (2 Inches)	800 mm (2½ feet)	300 mm (1 foot)
25 mm (1 Inch)	Not applicable	300 mm (1 foot)

Table 5: Minimum Bend Radii for Ducts between Manholes
Source: CITC

- Preferably, use combination of bends with angles of either 30° or 45° with a 5000 mm radius for direction change of a 100 mm (4 Inches) duct over a long run (>100m).

6.5 Protection and Sealing of Ducts

Proper protection and sealing of ducts are vital to maintaining the integrity of telecommunication infrastructure by preventing the ingress of water, gas, dirt, debris, and vermin. All ducts, including sub-ducts and duct bundles, should be securely sealed at manholes, handholes, and building entry points using appropriate methods such as gas-tight and watertight seals, end caps, plugs, or expanding foams. Ducts shall be sealed at both ends—inside the manhole and at the building's entry—while empty ducts, especially those ending in street cabinets, should be plugged. The plug should be easy to remove later when it's time to install cables or sub-ducts. The choice of sealing method should account for environmental conditions and maintenance needs, with combined approaches offering greater reliability in challenging settings.

6.6 Duct Cleaning and Testing

Ensuring clean ducts is essential to prevent blockages, ensure smooth installation of cables, maintain system performance, avoid cable damage, prevent corrosion, and meet industry standards. Clean ducts ensure optimal functioning and longevity. The following procedure should be followed for duct cleaning:

6.6.1 Duct Cleaning

A cylindrical brush or a close-fitting mandrel to one end of the installed pull rope and pulling it through the duct to clean out any debris and check for blockages. The mandrel shall have at least 80% of the duct's internal diameter.

6.6.2 Testing for Blockage

If the brush or mandrel cannot pass through the duct after cleaning, seek advice from the appropriate authority on if there is a need to switch to a different duct or repair the existing one. If any defects or blockages are found, they need to be repaired immediately.

6.6.3 Duct Integrity Testing (DIT)

Duct cleaning and testing are initial steps to ensure ducts are clear of debris and obstructions. Duct Integrity Testing (DIT) follows to confirm the overall performance and condition of the cleaned ducts. In case test reveals any issue, consult relevant authority, to decide whether to fix the duct or opt for a different one. Key methods include:

- **Air Testing:** Check duct by measuring airflow at the end.
- **Foam Sponge Testing:** Cleans the duct and identifies any excess water or dirt.
- **Shuttle Blowing:** Identify bends, twists, or obstructions in the duct.

- **Pressure Test:** Monitoring pressure stability assesses for coupler leaks or punctures.

6.7 Draw Ropes

- The use of draw ropes is optional for future installation of fiber optic cables (FOC) or sub-ducts.
- If used, draw ropes must be threaded through each duct (bore) and left with extra length for future cabling or sub-ducting operations.
- Ropes can be joined together to achieve the necessary length between jointing chambers or manholes.
- For lead-in ducts, the rope must be securely attached to the duct seal’s rope anchor or the plug’s pressure anchor eye.
- A rope must not pass through the duct seal, as it may compromise the seal’s function.
- Draw rope used in any duct must be rated to support a minimum weight of **550 Kg**.
- Fiber optic cables have special strength members (typically aramid yarn) that must be used for pulling force.
- Applying force on other parts of the cable can cause stress and damage to the fibers.
- To prevent cable twisting during the pull, swivel pulling eyes should be used to securely attach the pulling rope or tape to the cable.

6.8 Pulled Joints

- Pulled joints are used to connect duct sections when a continuous duct run is not feasible during fiber optic cable installations.
- These joints are typically made from HDPE material or compatible methods such as adhesives, connectors, or welding to ensure a secure, sealed connection.
- The primary purpose of pulled joints is to prevent water ingress, dirt accumulation, and mechanical stress.
- If a duct joint separates, short duct segments can be inserted for temporary restoration, but proper sealing methods must be used for long-term reliability.
- Post-installation testing is required to verify the joint’s integrity and ensure durability under environmental conditions.
- Inspection and testing are conducted after installation to confirm the joint's structural stability.

7 FIBER OPTIC CABLE (FOC)

The following guidelines helps with the proper installation and maintenance of Fiber Optic Cable (FOC) reducing service interruptions and ensuring everything runs smoothly.

7.1 FOC Installation Requirements

- Handle fiber optic equipment carefully to prevent damage, following manufacturer guidelines, and inspect all components upon arrival for damage, testing for continuity or loss if any issues are suspected.
- Verify that all components match the order in quantity and specifications (e.g., type and length of fiber), noting any discrepancies or damage for replacement, and ensure that equipment is stored in a clean, dry location, shielded from harsh environmental conditions.
- Handle fiber optic cable reels carefully**,** ensuring both ends are accessible for testing. Use a fiber tracer or visual fault locator for checking continuity and perform OTDR testing on fibers if damage is suspected. Move small, lightweight fiber optic spools by hand and larger reels using lifting equipment or multiple skilled installers.
- For large reels, use matched set of slings or chokers attached to a suitable pipe in the center of the reel, avoiding attachments around the spooled area of the reel. Cable reels should be moved carefully to prevent damage to the cable.
- Install support structures for fiber optic cables before installation, ensuring compliance with relevant building codes and standards, such as **Building Code of Pakistan, TIA-569** and **NECA/BICSI-568**.
- Consider future growth in cable quantity and size when determining size of the pathway bend radius requirements.
- Feeder cables should have no fewer than 48 fibers, while distribution cables must include at least 12 fibers. Redundancy should be ensured in both feeder and distribution networks to support future expansions.
- Ground any metallic hardware (e.g., termination boxes, racks, patch panels) and bond conductive cables (e.g., metallic-armored or composite cables) according to electrical codes, **PETSAC-2014, IEEE C2, IEEE 1100, TIA-607 and TIA-758** standards, manufacturers' specifications and company or client site-specific standards.

7.2 FOC Installation Guidelines

Fiber optic cables can be installed indoors or outdoors using various methods. Outdoor cables may be directly buried, pulled or blown into conduits or subducts, or installed aerially. Indoor cables can be placed in raceways, cable trays, hangers, or conduits, or blown through special ducts using compressed gas. The installation method depends on the specific requirements and cable type. While fiber cables can withstand greater pulling forces than copper cables, excessive stress can damage the fibers.

- Adhere to the specific installation recommendations provided by the fiber optic cable manufacturer. Fiber optic cable is often custom designed for installation and the manufacturer may have specific instructions on its installation.
- Ensure the cable is long enough for the installation run to avoid splicing and provide special protection for the splices.
- Assess the route beforehand to identify installation methods and obstacles, aiming to complete the installation in a single pull.
- Avoid mixing fiber optic and copper cables in one tray as copper cables are heavier and can crush fiber. If necessary, attach fiber ducts to the side of copper trays and pull the fiber into the duct.
- Fiber optic cables should only be pulled using their special strength members (usually aramid yarn) to prevent stress on the fibers.
- Use swivel pulling eyes to attach pulling ropes or tapes to the cable to avoid twisting the cable during pulls.
- Avoid pulling cables by the jacket unless specifically approved by the manufacturer and only do so with an approved cable grip if this method is used.
- Do not exceed the maximum pulling tension rating; consult manufacturers (cable manufacturer and suppliers of conduit, sub duct, and cable lubricants) for guidelines on tension ratings and lubricant use.
- For long cable runs in a conduit, lubricants may be needed. Ensure the lubricant is compatible with the cable jacket material. If possible, use an automated puller with tension control or a breakaway pulling eye for better safety and ease.
- Each Fiber Optic Cable (FOC) must be identifiable within a duct using color coding ink or non-removable labeling. FOCs shall be marked and labeled at each manhole, as well as at all entry and endpoint locations of FOC.
- Conduct a thorough route assessment to identify potential obstacles and determine the best installation method. Opt for single-pull cable installations to minimize splicing and ensure efficiency.
- Outdoor cable shall have a minimum pull strength of **2670 N (600 lbf)** and support specific bend radius requirements during installation.
    - **Without tension**: Bend radius 10 times the cable’s outer diameter.
    - **Under tension**: Bend radius 20 times the cable’s outer diameter.

- When installing long optical fiber cables, if a single pull is not possible due to load limitations, the load can be distributed along the cable using either static or dynamic methods.
- A common Static method is known as "**figure-of-eight system**”, shown in Figure 15. It involves placing the cable drum at an intermediate point, pulling the cable in one direction, laying the remaining cable in a figure-of-eight pattern, and then using a winch to pull it in the opposite direction, requiring sufficient space at the figure-of-eight point. This prevents cable twisting during pulling.
- Dynamic load sharing is more complex and requires additional equipment and setup. However, it allows the cable to be installed in one direction directly from the drum. This method uses special winches at intermediate points, with the cable's load depending on the distance between these points.
- It's important to note that with intermediate winching, all the forces are transferred through the cable sheath, so the cable's design must account for this.
- Distributed winching systems need careful coordination, synchronization, and communication between the points. Capstan-type winches may cause extra twisting of the cable.

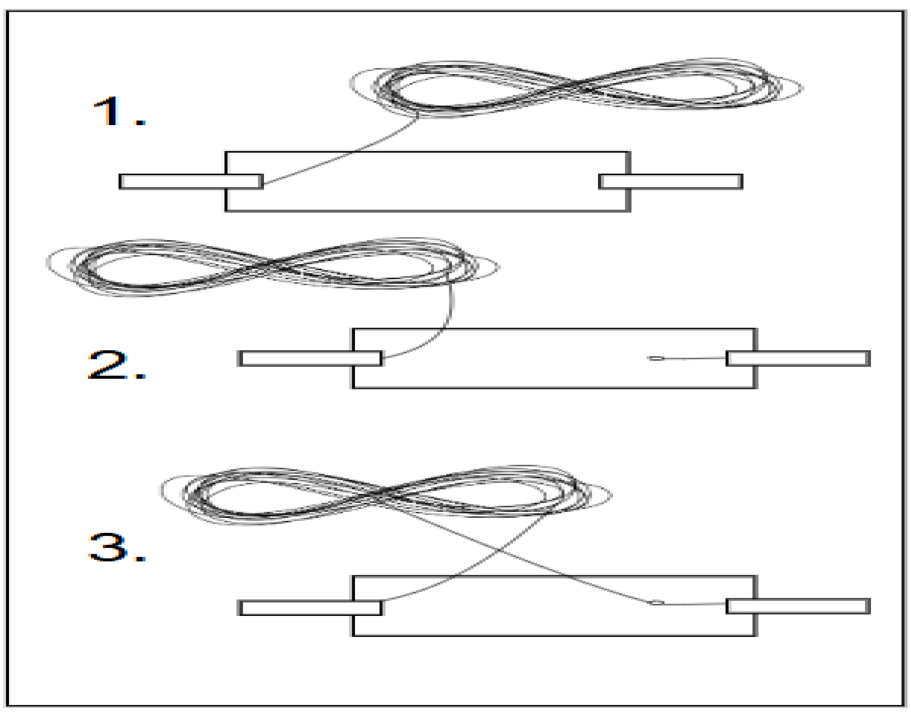

Figure 15: Figure-of-Eight System
Source: NECA

- Do not exceed the cable bend radius, as fibers can break if bent too tightly, especially during pulling. If no specific recommendations are provided from cable manufacture, the cable should not be pulled over a bend radius smaller than **twenty (20) times** the cable diameter. After completion of the pull, the cable should not have any bend radius smaller than **ten (10) times** the cable diameter.
- Avoid twisting the cable, as it can stress the fibers. Tension on the cable and pulling ropes can cause twisting.
- Roll the cable off the spool, as shown in Figure 16, instead of spinning it off the spool end to prevent putting a twist in the cable for every turn on the spool.

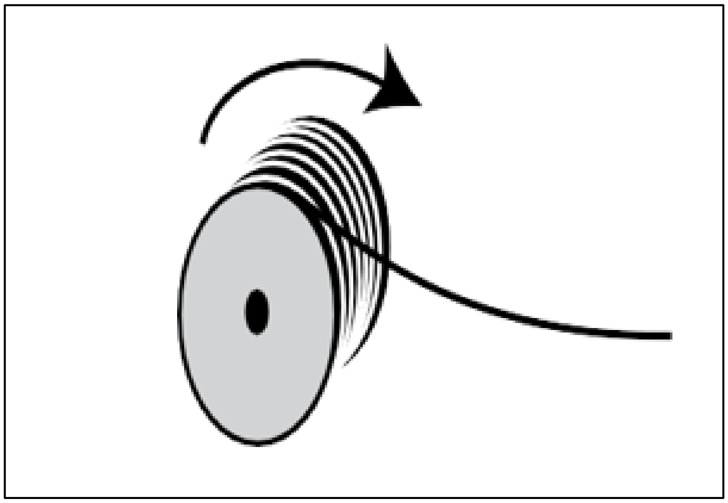

Figure 16: Rolling Cable
Source: NECA

7.3 FOC Installation Technique

Cable installation traditionally involves manual or mechanical hauling, which can be challenging for long distances or heavy cables. Modern air-assisted methods, such as **jetting and blowing**, use compressed air to reduce friction and float the cable through the duct, allowing for longer, stress-free installations. These techniques are preferred for their ability to cover greater distances and exert less strain on the cable. While air-assisted methods are preferred, traditional hauling may still be required in some scenarios, particularly for long-distance installations where heavy-duty ducts are recommended to withstand the tough conditions of cable hauling.

Jetting uses a missile (rotating rollers or belts) to gently push the cable at the front to create a pulling force simultaneously, high-pressure air is blown into the duct, while **blowing** relies on air flowing along the cable for distributed pulling**.** For cables up to **15mm**, a pneumatic blowing machine is preferred, while cables **14-32mm** work best with a hydraulic machine, as hydraulics provide stronger force. Key factors include blowing distance **(typically 1000-2000m)** and speed **(40-50 meters per minute at 10 bars).**

Smaller, lighter cables can be blown over longer distances, and larger duct diameters reduce the push force, limiting blowing range. Jetting and blowing are shown in Figure 17.

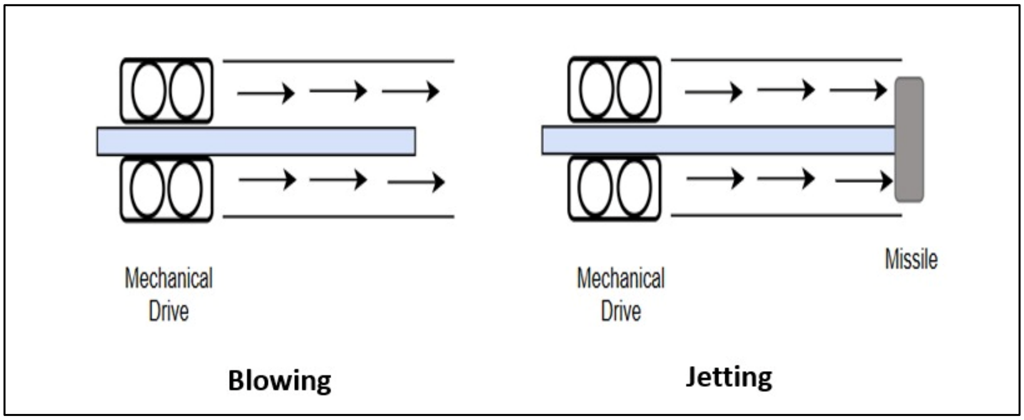

Figure 17: Jetting and Blowing Techniques
Source: FAO

As per ITU-T manual on Optical fibers, cables and systems, there are two primary variations of the blowing technique:

- **Single-Pass Blowing**: In this system, stiffer fiber cables are blown directly into small pipes or ducts. Depending on the cable and duct characteristics, installation units are placed every 500 to 1,000 meters. Lubricating both the ducts and cables can increase the distance covered by each installation unit.
- **Two-Pass Blowing**: small tubes (micro-ducts) are installed first, then blow fiber bundles or larger cables through them using compressed air. This minimize strain on the fibers and enables long cable routes of up to 10 km without requiring splices.

7.4 SPLICING AND TERMINATION

- Fiber optic termination processes differ based on the fiber type and connector style. Termination methods include:
  - **Connectors**: Create temporary joints to connect fibers or to network equipment.
  - **Splices**: Form permanent joints between two fibers.
- The choice between connectors and splices depends on the application. Some considerations to keep in mind during terminations are as follow:
- Whichever process is used for termination follow the manufacturer's instructions for termination processes.
- Use only manufacturer-approved adhesives and employ adhesive curing times in accordance with the manufacturer's instructions.

- Special tools must be used according to the manufacturer's guidelines.
- After installation, cover connectors with fiber dust caps and store them safely until testing or connection to network equipment.

7.5 Testing of Installed FOC

After installation, test each fiber in the fiber optic cables to verify installation performance and ensure compliance with applicable standards. Conduct the following tests:

- Perform **continuity testing** to ensure correct fiber routing, polarization, and proper documentation.
- Measure end-to-end **insertion loss** with an **Optical Loss Test Set (OLTS)** power meter and source, using **TIA-526-14**/**TIA-526-7**, as per type of fiber. Total loss must be below the maximum allowable loss specified in the loss budget, based on relevant standards or customer specifications.
- Optionally, conduct **Optical Time Domain Reflectometer (OTDR)** testing to verify installation, assess splice performance, and troubleshoot issues.
- If the design documentation does not include cable plant length, and this is not recorded during installation, test the length of the fiber using the length feature available on an OTDR or some OLTSs. If testing shows variances from expected losses troubleshoot the problems and correct them.

7.6 Safety and Cautions for FOC

Fiber optic installation safety includes common cable installation precautions such as safe ladder use and hazard awareness. Specific concerns involve avoiding exposure to light radiation in fibers, proper disposal of fiber scraps and safe handling of hazardous chemicals used in termination, splicing or cleaning as per manufacturer and company or client site-specific standards. Although fiber optic cables are dielectric and carry no electrical power, care should be taken to avoid or disconnect nearby electrical cables during installation. For guidance on safety protocols, adhere to the standards set by **NECA/FOA 301-2016** as some are listed below:

- Wear safety glasses, wash hands after handling fiber, and never look directly into fiber ends as they can transmit very strong light signals, which may cause serious eye damage. Use an optical power meter to check for light.
- Dispose of scraps in marked containers, clean work areas thoroughly, and avoid eating or drinking nearby. After work, inspect clothing for sharp fiber remnants, as they may pose safety hazards.
- Work in well-ventilated areas and request Safety Data Sheets (SDS) for chemicals.
- Do not use fusion splicers in confined spaces with flammable materials.

- Maintain cleanliness by working in clean areas, keeping dust caps on connectors, avoiding contact with ends of connectors, and using approved cleaning tools. Test equipment fiber inputs/outputs and test cables should be cleaned from time to time.

7.7 Slack Management

Slack refers to extra cable length left during installation for future adjustments, repairs, or expansions. It allows for easier repairs with fewer splices, saving labor, hardware costs, and reducing signal loss. Common location for slacks are manholes/handholes in outside plant (OSP) cable installations. Some things shall be kept in mind during slack management:

- Always wear protective clothing, gloves, and safety boots when handling cables.
- For manholes/handholes with splicing enclosures allocate 15 meters of slack for future maintenance and 2 meters for splicing. Ensure HHs/MHs are accessible to splicing vehicles.
- Install slack brackets on the walls of handholes (HH)/manholes (MH) to secure cables, tying slack together with tie wraps or PVC tape at 1m intervals, and coil fiber cable slack in a clockwise direction ensuring it remains slightly loose without excessive tension.
- Make sure the slack from one splice closure does not get tangled with the slack from other splice closures in the HH/MH.
- Bundle cables together by relevance and route them in a way that ensures they do not block ducts, maintaining organization and accessibility.
- Drop cables should have 7 meters of extra length in manholes and at both ends inside buildings to allow for future adjustments or maintenance.
- The final length of the slack will depend on local conditions and the specific project design, which will ensure there is adequate slack.

8 STREET CABINETS (SC)

A street cabinet is a small, weatherproof box or enclosure located on the street that houses telecommunications equipment. From Street cabinets drop cables are laid to the Access Points in front of a building. Typical Street Cabinet is shown in Figure 18.

Figure 18: Typical Street Cabinet

Typical street cabinet has at least two compartments: One for incoming cables from the last manhole and Another for patching (fiber termination and cross-connection). The design of the street cabinet (SC) shall adhere to the following criteria:

- The SC should support multiple public telecommunications networks.
- It must include spare capacity for the Outside Plant (OSP).
- The maximum cable distance from the SC to the farthest customer building shall be within **500 meters**, extendable in rural areas to best meet the project design.
- Each SC can accommodate up to **1,728** building terminations, which may be reduced to **864** based on project requirements.
- Customer buildings can typically connect to the SC without needing alternative routes.
- Protection posts may be installed in accordance with local or municipal regulations
- Protection posts may be installed according to local/municipal standards. When choosing telecom outdoor cabinets, there are several key considerations to keep in mind. Here are some important factors to consider:
    - Waterproofing

- Security
- Cooling and ventilation
- Cable management
- Power and backup
- Size and capacity
- Material and construction
- Ease of installation and maintenance
- Compliance and standards

9 ACCESS POINTS

Access points are physical locations in the outside plant (OSP) where telecommunications networks connect to in-building physical infrastructure (IPI). These points, accessible by public telecommunications networks, host the Optical Distribution Box (ODB) and serve as the demarcation point between OSP and IPI. Access points, as shown in Figure 19, enable service distribution within buildings, ensuring efficient connectivity and protection from environmental factors.

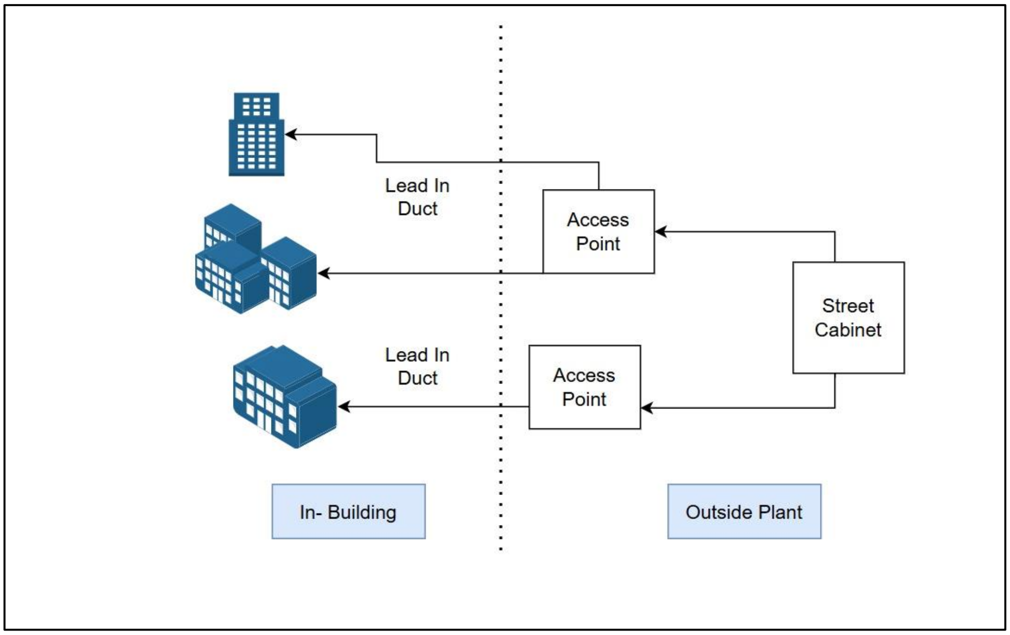

Figure 19: Access Point in OSP

9.1 Responsibilities

- **Service Provider**: Responsible for providing the Optical Distribution Box (ODB) at the access point.
- **Building Developer**: Responsible for access point space allocation and lead-in ducts.
- **Coordination**: Due to different construction timelines, coordination between OSP and IPI entities is necessary.

9.2 Construction Scenarios

9.2.1 OSP Built Before the Building

- The OSP developer must mark the termination at each property to facilitate joining lead-in ducts during building construction.

- The OSP and building developers should coordinate the access point location in alignment with other utility constructions.

9.2.2 Building Completed Before OSP Availability

- The access point location should be clearly marked and coordinated between the building and OSP developers.
- A temporary terminal for the lead-in ducts should be installed for future integration with the access point when the OSP becomes available.

9.3 Access Point Requirements

9.3.1 General Requirements

- The Access Point demarcates the OSP from the IPI.
- The building owner must provide space for the Access Point.
- It must be easily accessible for telecommunications and protected from damage, ideally with a lockable cover.
- The service provider's Optical Distribution Box (ODB) must be hosted at the Access Point, accommodating at least four fibers per unit.

9.3.2 Location Specifications

- For **Single-Dwelling Units (SDUs)**: The Access Point should be mounted on the building wall.
- For **Multi-Dwelling Units (MDUs)**: The Access Point may be located underground or on a wall.
- Each plot requires one exclusive Access Point.
- The Access Point location must align with external network connections and be coordinated with the property owner.
- The size and type of the Access Point depend on the number of entry ducts to the building.
- It must be located within **1 meter of the property boundary**.
- The maximum distance from the Access Point to the customer's premises should not exceed **200 meters**.

9.4 Electrical Safety

- An **earth rod** shall be provided at the Access Point where necessary.
- The earth resistance must not exceed **5 Ohms**, ensuring that any excess electrical energy is safely directed into the ground to prevent electrical hazards.

9.5 Shared Infrastructure Guidelines

- Public Telecommunications Networks shall share the entry into buildings, including:
    - Manholes
    - Handholes
    - Street cabinets
    - Access points
    - Lead-ins
    - Telecommunications Room/Space

10 MISCELLANEOUS

10.1 Infrastructure Sharing

Infrastructure sharing is strongly encouraged, and to facilitate this, PTA has already established the Telecom Infrastructure Sharing Framework. The terms of infrastructure sharing will be governed by a commercial agreement between the lessor (the party providing the infrastructure) and the lessee (the party utilizing it). The lessor is required to offer the infrastructure in a transparent, fair, and non-discriminatory manner, ensuring that all parties have equal access.

The OSP provider is expected to offer services on a "first come, first served" basis while ensuring that access remains non-exclusive to any single party. Furthermore, the tariffs for utilizing ducts, voids/spaces will be determined in manner equivalent to that for rights of way. The Right of Way policy issued by the government, along with any related directives or decisions made by the government or the relevant authority, will apply in this context, ensuring consistency and compliance with existing regime.

10.2 Budget Allocation

For Outside Plant (OSP), the expenses associated with constructing ducts, spaces, and voids necessary for telecommunications infrastructure will be allocated within the overall budget for the respective road, footpath, or railway project. These costs will be fully covered by the designated budget holder responsible for the primary infrastructure.

10.3 As-Built Documentation

The OSP provider must keep accurate records for the as-built work. Any modifications made during construction must be reflected in the original "to-build" plan, with drawings precisely indicating the location of installations, cable types, and labeling. The updated as-built plan will serve as the foundation for comprehensive network documentation. Furthermore, the as-built documentation must include details about the original design and any deviations, containing essential information for each section and cable. As-built documentation needs to be kept up to date to support operations and maintenance activities. Europeans' standards reference guide provides the minimum required information and required linkages requirements for documentation. The same are reproduced in Table 6.

Documentation Requirement			
	Record	**Required Information**	**Required Linkages**
Pathways and Spaces	Pathway	Pathway identification # Pathway type Pathway fill Pathway load	Cable records Space records Pathway records Grounding records
	Space	Space identification # Space type Grounding records	Pathway records Cable records
Wiring	Cable	Cable identification # Cable type Unterminated Strands Damaged Strands Available Strands	Termination records Splice records Pathway records Grounding records
	Termination Hardware	Termination hardware #s Termination hardware type Damaged position #s	Termination position records Space records Grounding records
	Termination Position	Termination position # Termination position type User code Fiber Condition Information	Cable records Other termination records Termination hardware- records Space records
	Splice	Splice identification # Splice type	Cable records Space records
Grounding	TMGB(Telecommunications Main Grounding Busbar)	TMGB identification # Bus bar type Grounding conductor #s Resistance to earth Date of measurement	Bonding Conductor- records Space Records
	Bonding Conductor	Bonding conductor ID# Conductor type bus bar identification #	Grounding bus bar records Pathway records

	TGB	bus bar identification # Bus bar type	Bonding conductor records Space records

Table 6: As-Built Documentation Requirements
Source: ANIXTER

10.4 Safety of Outside Plant (OSP) Works

During construction, it is essential to avoid any accidents, incidents, or hazards property by complying with international safety standards for OSP works, as It's better to prevent accidents from happening than to deal with them after they occur. To ensure safety, a suitable number of expert personnel must be employed, along with adequate equipment and construction materials. This approach focuses on the safety of employees before work begins and throughout its progress, as well as the protection of public and private property. Additionally, ensuring the availability of appropriate tools and equipment at the work area is crucial for maintaining a safe working environment. Key safety measures as per FOA are as under:

- Management must ensure all team members and supervisors are trained with applicable safe work practices and take prompt action if these safe work practices are not followed.
- All employees, management personnel, and visitors must complete induction training conducted by the Site Manager or a designated deputy before their first visit to the site. Induction records will be maintained on site for the project's duration.
- Supervisors must ensure team members wear required Personal Protective Equipment (PPE) and secure the work area with necessary signs, cones, lights, traffic control personnel etc. PPE includes items like protective clothing, hard hats, safety glasses or other equipment/garment designed to protect the wearer's body from injury.
- A qualified person must conduct a pre-construction risk assessment, documented in the health and safety plan to mitigate risks, covering:
    - Identification of activity-specific hazards and risks.
    - Evaluation and ranking of each risk as high, medium, or low.
    - Primary goal to eliminate hazards, or if not feasible, minimize them.
- Keep public areas clear of debris and hazards, that may constitute slipping, tripping, or any other hazard.
- Adhere to all health and safety management plan procedures.
- Develop and approve a Traffic Management Plan (TMP).
- Report and record all site accidents, incidents, and property damage.
- Set safe airspace requirements before using lifting and construction equipment.

- All personnel must wear the following PPE:
    - Protective overalls at all times.
    - Steel-toed safety boots as a general rule at all times.
    - Hard hat and safety glasses when required.
    - Work gloves to prevent cuts and bruises.
    - High-visibility vests when working near streets, highways, or when working at night.
- The contractor must use guards, protective structures, warning signs, barriers, and fences to protect workers and direct pedestrians and traffic safely around the work area. Open trenches must be secured with adequate warning signs.
- A first aid box will be provided to a trained, certified first aider. All site injuries must be treated and recorded. If professional medical treatment is needed, the supervising officer must complete an accident report. Ensure the first aid kit is accessible, properly stocked, and that a register is maintained for used or missing items.
- Safety glasses with side shields and protective gloves must be worn during fiber optic cable installations, treating fiber optic splinters as glass splinters. All fiber pieces should be disposed of in a properly marked container, and the work area must be thoroughly cleaned upon completion.
- Unannounced inspections and evaluation of safety precautions and procedures will be conducted periodically to ensure adherence to safety rules and procedures.

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In-Building Cabling Standards

Building Code of Pakistan

Digital Connectivity Infrastructure - DCI

(1) The Provisions of Building Code of Pakistan (Digital Connectivity Infrastructure) provide rules for installation of digital connectivity infrastructure by licensed telecommunication service providers to install, operate and maintain modern telecommunication and broadband facilities. These rules shall be adopted by the owners of such buildings, both public and private.

(2) The Provisions shall apply for engineering design, operations and maintenance of the building and building clusters with construction area of 1,500 square meters or more. The buildings include but not limited to the following residential or commercial properties,

a) Apartment complexes
b) Educational or non-educational campuses
c) Offices
d) Industrial estates / parks
e) Sea Ports
f) Airports
g) Railway stations
h) Bus stations
i) Metro stations
j) High rise buildings
k) Shopping malls
l) Medical Hospitals
m) Museums
n) Commercial office buildings, etc.

(3) This Code shall be effective after three months of necessary notification.

(4) All relevant regulators shall ensure compliance and implementations of this Code.

(5) The provisions of this Code shall also be applicable to existing, new and modified installations. Construction and operations of buildings in violation of Building Code shall be considered as violation of professional engineering work as specified under clause xxv of section 2 of Pakistan Engineering Council Act, 1975 (V of 1976).

(6) This Code shall be reviewed and updated after two (2) years of implementation and thereafter every (5) five years or earlier on the basis of data and feedback received from the concerned regulators, by the Committee as constituted by Pakistan Engineering Council.

CHAIRMAN
PEC

1. Scope

Given the rapidly evolving technology and Data transportation options, it is imperative to consider a comprehensive approach that can accommodate various future service needs when designing building infrastructures. A well-planned building with accessible features.

This document defines the technical standards for In-building physical Infrastructure for buildings to standardize and direct all consultants, developers, contractors, building owners and management to design and install telecommunications network infrastructure in public and private buildings.

This Code is established with the intention of making sure that any in-constructing bodily infrastructure in new traits is built in accordance with global first-rate exercise specifically for fiber broadband and cellular services.

In view of the above and for the purpose of these code, Digital Connectivity Infrastructure (DCI) consists of passive and active elements which include any component, apparatus, appliance, instrument, equipment, and system. All infrastructure required for establishing Wireless or Wireline Access Networks such as Radio Access Networks (RAN) and Wi-Fi systems, and Transmission Links Interface, Duct Space, Optical Fiber, Poles, Towers, Feeder cable, Antenna, Base Station, In-Building Solutions (IBS), Distributed Antenna System (DAS), or any other equipment to be used for the provision of digital connectivity, will be part of DCI.

For making digital connectivity an essential part of a Building, the development of DCI is required to be made an integral part of the building construction and approval process, similar to water, electricity, gas, and fire protection, and safety, etc.

2. Definitions

2.1. Passive Network Components: Passive network components are elements within a network that do not require a power source to operate and typically do not contain active electronic components like transistors or integrated circuits. Instead, they serve to facilitate the transmission of data signals and to manage the physical and electrical characteristics of the network. Some common passive network components include:

1. **Access Distribution Terminal (ADT) / Access Termination Box (ATB):** The **ADT / ATB** is a network interface point within a building's fiber infrastructure, connecting vertical riser cabling to horizontal cabling that extends to individual units.

2. **Antennas:** In wireless networks, passive antennas are used to transmit and receive radio frequency signals.

3. **Attenuators:** Attenuators are used to reduce the power of optical signals to prevent overloading sensitive components in a fiber optic network.

4. **Cables and Connectors:** These are used to physically connect network devices and transmit data. Examples include fiber optic cables, as well as connectors such as SC or LC connectors for fiber optic networks.

5. **Conduits and Ducts:** Conduits and ducts are used to protect and route OSP cables underground or overhead. They provide a protective pathway for the cables and allow for easy access for maintenance and upgrades.

6. **Fiber Distribution Hub (FDH) / Fiber Distribution Terminal (FDT):** These Distribution cabinets are outdoor enclosures that house networking equipment and cable terminations. They provide a centralized location for managing and distributing OSP signals.

7. **Filters:** Filters are used to allow specific frequencies to pass through while blocking others, helping to control the flow of signals in the network.

8. **Optical Distribution Frame (ODF):** ODFs are used for the organization and termination of cables, allowing for easy management and reconfiguration of network connections.

9. **Splice Closures:** Splice closures are used to protect and connect individual fibers within a fiber optic cable. They are weatherproof and provide protection against moisture, dust, and other environmental elements.

10. **Splitters and Couplers:** These components are used in optical fiber networks to divide or combine optical signals to route data to multiple destinations.

11. **Wall Outlets and Faceplates / Fiber Terminal Box (FTB):** These provide the interface for connecting end-user devices to the network and are often used for terminating network cabling within Customer's premises.

Overall, passive network components are essential for the physical infrastructure of a network and play a crucial role in ensuring the efficient and reliable transmission of data.

2.2. Outside Plant (OSP): OSP stands for Outside Plant, and OSP infrastructure refers to the physical components and systems that are installed outdoors to support the transmission of telecommunications signals. OSP infrastructure is an essential part of a telecommunications network and is responsible for connecting buildings, campuses, neighbourhoods, and cities to the broader telecommunications network.

Components of OSP infrastructure includes all the Passive components defined previously.

OSP infrastructure is crucial for establishing reliable and efficient telecommunications networks that can meet the growing demand for high-speed data transmission and connectivity. Proper design, installation, and maintenance of OSP infrastructure are essential to ensure the performance and longevity of a telecommunications network.

2.3. Telecommunications Access Point: It is a manhole, built outdoor the building reachable via public / private telecommunications networks, hosting the Optical Distribution box (ODB), via which a connection among the outdoor plant and the in-building physical infrastructure is made. It is the demarcation factor among outside plant and in-building infrastructure.

2.4. Access Area: means the physical location containing the lead-in ducts and cabling from the telecommunications access point to the telecommunications space / room.

2.5. In-building Physical Infrastructure (IPI): In-building physical infrastructure refers to the components and systems that are installed inside a building to support the transmission of data and communication signals within the building itself. This infrastructure is crucial for providing connectivity and access to network services for occupants, employees, and visitors within the building. In-building physical infrastructure may include:

a) **Structured Cabling Systems:** This includes copper and fiber optic cabling that is installed throughout the building to connect network devices such as computers, telephones, printers, and other equipment. The cabling is typically organized and managed within structured cabling systems to ensure efficiency and ease of maintenance.

b) **Building Distribution Frame (BDF) or Intermediate Distribution Frames (IDFs):** It is a distribution detail among the outside plant and the in-building infrastructure (internal plant). The BDF / IDF lets in connection of the lead-in cables from the telecommunications access point (outdoor the premises) to each unit across indoor fiber distribution network.

c) **Telecommunication Rooms (TRs)**: These are an enclosed architectural space and designated areas within the building to incorporate telecommunications system where networking equipment, such as routers, switches, and BDF / IDF for cables terminations, are housed. TRs or IDFs serve as central points for connecting various parts of the building to the wider (OST) network infrastructure.

d) **Power Distribution Units (PDUs):** PDUs are used to distribute power to networking, testing & commissioning equipment.

e) **Cable Trays, Conduits, and Raceways:** These components are used to support and protect cabling within the building, helping to organize and manage cables while reducing the risk of damage or interference.

f) **Riser Area:** means the physical pathways / routes containing the vertical ducts and distribution cabling that connects each floor with the BDF / IDF.

g) **Floor Distributor (FD):** means a sub-dividing element between the BDF / IDF and the Fiber Terminal Box (FTB) / Optical Network Termination (ONT) Points located nearby or in the riser area which allows the transition from the vertical to the horizontal indoor cable. Also referred as ADT / ATB

In-building physical infrastructure plays a vital role in maintaining connectivity, efficiency, and reliability within a building's network environment. Designing and implementing a robust in-building physical infrastructure is essential for meeting the communication needs of occupants and facilitating the integration of modern technologies within the building space.

2.6. Optical Network Terminal (ONT): is the active device at which the in-building physical infrastructure (IPI) of a building unit terminates. A building unit may have multiple ONTs.

2.7. High-speed-ready: means that the Outside Plant (OSP) and the in-building physical infrastructure (IPI), hosting all necessary passive network elements to enable data delivery at a minimum speed of 100 Mbps.

2.8. Unit: defined in this document as the customer's premises which can be a room, apartment or space where Optical Network Terminal (ONT) is installed

2.9. Multi-dwelling Unit (MDU): Multi-dwelling Unit (MDU) refers to two or more units which can be joined through a not unusual wall or belongings boundary. Examples of MDUs consist of apartments, workplace, commercial premises, shops and public buildings. An MDU might also encompass a couple of towers which might be a part of a common most important building.

3. Configuration for MDU

MDUs should be equipped with facilities to incorporate a high-speed-equipped broadband infrastructure at cost effective rates. The installations of such infrastructure must be finished in three areas: (i) access place, (ii) riser location and (iii) the office/housing region. For an easy implementation, the following infrastructure factors should be taken into account:

- ✓ Telecommunications Access Point
- ✓ Access Area
- ✓ Telecommunications Room
- ✓ Riser Area
- ✓ Floor Distributor
- ✓ Unit Access
- ✓ Appropriate Placement / Location of ONT

Mechanism of Pre-Cabling inside the Building

The preferable method for bigger buildings takes a staged approach, bringing fiber into the building, then each floor, then into each Apartment / Office / Shop etc.

3.1. Building Access (Reference Configuration)

To get fiber into a building premises, a cable has to be routed from the OSP (the Outside Distribution Box / *Access Point*, in this instance) into the building through the *Wall / Access Area* **(Figure 1(a))**, and plugged into a further *Building Distribution Frame (BDF / IDF)* **(Figure 1(b))** in the *Telecomm Room (TR)* for internal fiber distribution.

Benefits of fiber distribution point inside a building area,

- ✓ First of all, it extends the network lifecycle by increasing its protection
- ✓ The fiber terminals and other passive equipment are no longer at risk of being damaged by harsh weather, Negligence or Vandalism.
- ✓ It speeds up the whole process of installation.
- ✓ As we shall see later in this document, it is common practice for network operators to route fiber cable from the basement of an apartment or office block up to floor boxes on each landing. This allows operators to break out fiber quickly and cost effectively when a resident demands it.

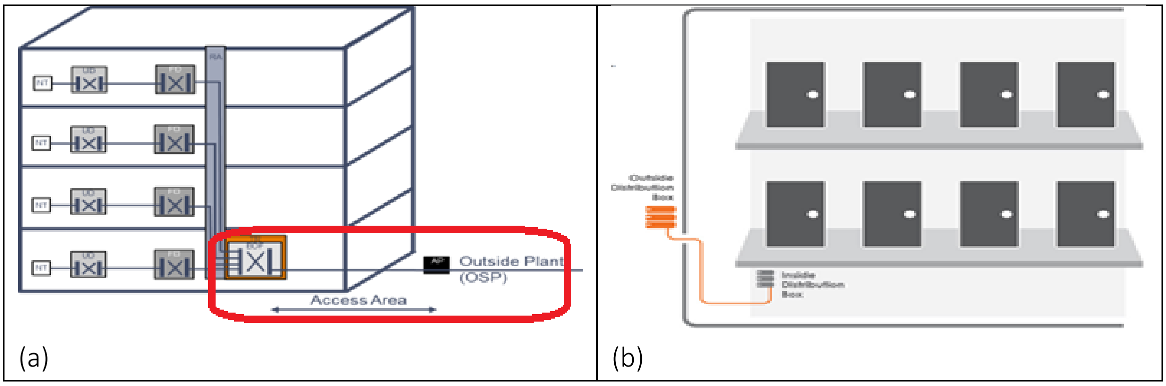

Figure 1(a): Fiber cable entry point—OSP (Outside Distribution Box / Access Point) connection through the Wall / Access Area into the building.

Figure 1(b): Internal fiber distribution—Fiber connection from the entry point to the Building Distribution Frame (BDF / IDF) in the Telecommunications Room (TR).

- ✓ There should be at least one telecommunications access point developed for an MDU. Telecommunications access points should be reachable to public / private Telecommunications Networks. Telecommunications access points are the demarcation factor among outside Plant and In-building physical Infrastructure. These are linked to the telecommunications room (TR) through two or more lead-in duct(s).

- ✓ Every MDU should be ready with a telecommunications room (TR) depending on the number of units of MDU. This room includes the BDF / IDF, in which - via the access area and the lead in ducts / cables – the outside and inside cabling is hooked up. In addition, the telecommunications room serves as collocation place for broadband operators' equipment. This device is likewise related to the BDF. The BDF permits connections among cabling coming from out of doors of the building with the inside cabling and collocated gadget.

- ✓ In MDUs a vertical riser location should be provided among BDF and each floor. Each floor may additionally comprise a floor distributor to attach among vertical and horizontal cabling. Every unit is geared up with one or greater optical network terminations, coupled with Fiber distribution box. The FTB is then linked to the floor distributor.

Cabling Type / Material

The Fiber Cable that should be UV resistant and outdoor rated will be laid from AP to BDF.

Choosing cable connectors irrespective of whether the network architecture is PON, P2P, or some other configuration, once the fibers have been brought onto the building distribution frame (or, for small scale MDUs, the Floor distribution box), they will then need to be connectorized.

The most popular connectors used here are SC with angled end faces (APC), however with larger buildings the scope for and LC with angled end faces (APC) connectors becomes more suitable / scalable - particularly in multi-floor scenarios where each floor level box connects up to 8 or more subscribers.

3.2. Floor Access & Distribution (Reference Configuration)

Floor access distribution design / methods vary for different building types according to the placement of risers and floor layouts.

Whether the cable is routed through an existing conduit or not, it will invariably terminate at a *<u>Floor Distribution Box (FDB)</u>* on each floor **(Figure 2)**.

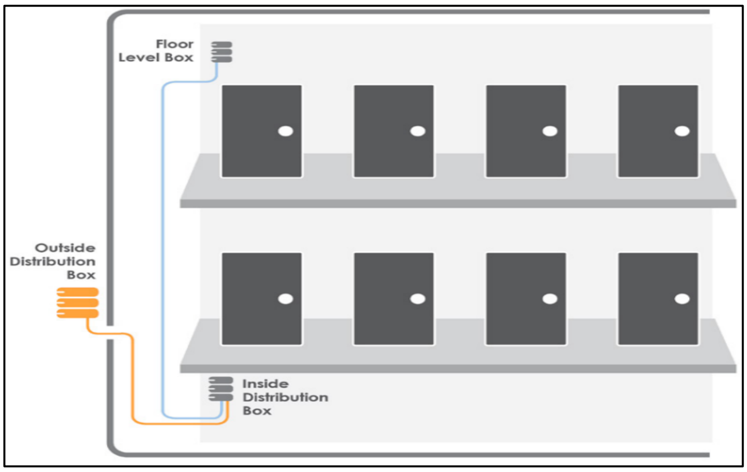

Figure 2 Cable entry into building

There may be 2 types of ways through which cables are distributed on floor

Option 1 – Floor distributor topology (Duel Level Distribution) configuration for In-building Physical Infrastructure

- ✓ This topology should be applicable for MDUs having 9 or more units. It is considered the preferred solution due to its efficient cable utilization, accounting shorter length of fiber optical cable.
- ✓ Building distribution frame, placed in the telecommunications room should be connected to floor distributor on each unit. The floor distributors are in turn connected with fiber terminal box and eventually ONTs **(Figure 3)**.

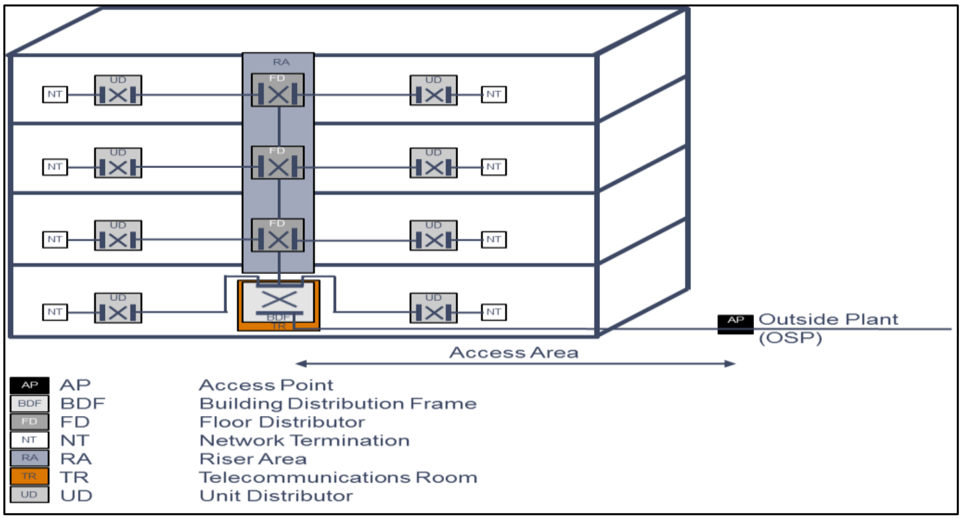

Figure 3: Floor Distribution Topology (Duel Level Distribution)

Option 2 – Star topology (Single Level Distribution) configuration for In-building Physical Infrastructure

- ✓ This topology for the In-building Infrastructure should be applicable for MDUs having up to 8 units.
- ✓ The topology is devoid of floor distributors thus resulting in lower cost of the infrastructure.
- ✓ In order to provide space for more cables, the riser area must be capable of accommodating larger conduits, sleeves, etc.
- ✓ It shall be considered the lesser preferred solution due to its increased length of fiber optical cable from building distribution frame to fiber termination box and is only feasible for smaller MDUs **(Figure 4)**.

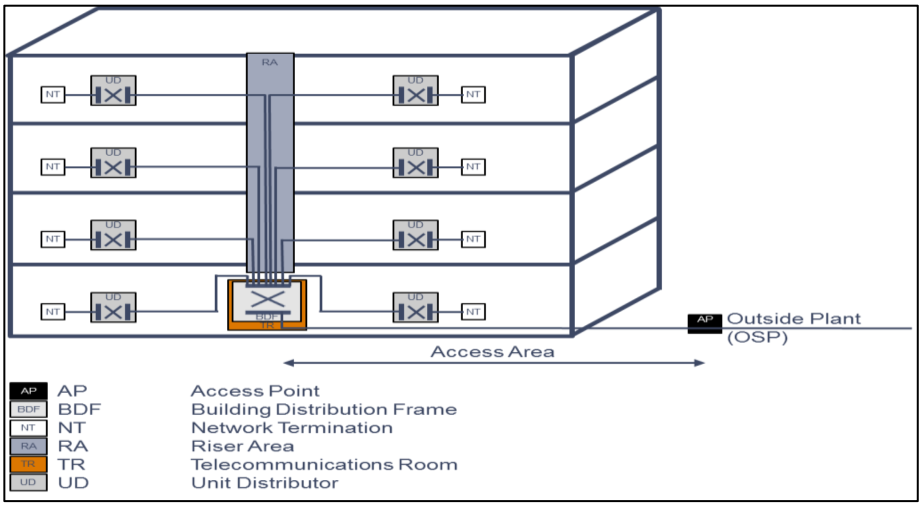

Figure 4: Star topology (Single Level Distribution) configuration

Meeting fire protection regulations:

- ✓ Whatever type of cable is used for this stage of an in-building installation it needs to meet local fire regulations.
- ✓ Therefore, the primary requirement for fiber cables is that they shouldn't propagate fire and can self-extinguish.

Note:

<u>All the above figures shows the reference configuration for In-building Physical Infrastructure (based on ISO/IEC 11 801 and ITU Rec. L.82).</u>

4. Cellular Operator Equipment

a) In-building Physical Infrastructure can also be used to facilitate cell network coverage and expansion.

b) Location and requirement of Base Transceiver System (BTS) solely lies on the mobile network operators' part. The developer may consult with them during planning phase of the MDU construction.

c) In case a fiber connection is required between the telecommunications access point and the mobile-operator end equipment, then optical network termination at the cellular operator end equipment shall be pre-deployed via redundant routes to facilitate the requirement of the mobile service provider(s).

d) To facilitate good indoor insurance for mobile network coverage, indoor antenna structures and repeaters should be set up inside the MDU. In this situation, early coordination with cell operators is mandatory to ensure provider provision. In addition, coordination with cell operators is useful to perceive the proper places for such indoor antenna structures and repeaters. In case cellular equipment is to be installed at rooftop of the building, then fiber connections should be made available from Telecommunications Room to said area.

e) A power supply preferably uninterrupted, must be provided to cellular equipment irrespective of indoor or rooftop equipment. Backup power supply will be ensured by the operator but space must be provided to accommodate equipment and its accessories.

5. Required standards for Internal Fiber Optical Cabling

Following cabling standards are required to be followed in MDU's in-building infrastructure, based on elements from the ISO/IEC 11801 Edition 2.2 Standard of Internal Cabling.

a) Fiber Optic Cable (FOC) shall be used for internal cabling. The absence of fiber optic cable would necessitate deployment of CAT6 (or preferably CAT 7) twister copper cable, where required.

b) In-building physical Infrastructure shall have capacity to provide at least two fiber connections per unit/apartment (for multiple operators) from the Telecommunications Access Point to the Telecommunications Room (TR) and from the Telecommunications Room to the Fiber Terminal Box (FTB).

c) In case of international compliances, the standards issued by ITU-T, ISO/IEC, etc. will have to be adhered.

d) Splicing of FOC should be avoided. Splice attenuation shall not exceed 0.15 dB, and be typically at 0.01 dB.

e) For FOC, SC/APC connectors (IEC 61754-4) are recommended at ONT end.

f) The dimensioning of the in-building physical infrastructure should be in line with the number of units in the building and the related quantity of connections (2 connections in line with unit) including appropriate reserve potential.

g) The in-building physical infrastructure should be designed to meet the projected providers requirements at the ground stage and shall have built-in flexibility to fulfill the developing needs of tenants.
h) Fiber optical cable (FOC) G.652 or preferably G.657 should be used for internal cabling.
i) Bending radius of the selected FOC should be calculated and implemented accordingly in the development of all linked spaces.
j) The bending radius are described in ITU-T G657 A1/A2/B2/B3. The minimal bending radius depending on the sub-kind of FOC ranges from A1 at 10 mm to B3 at 5 mm. For ITU-T G.652, bending radius is 20x the outer diameter of the fiber optical cable.

6. Prerequisites for Telecommunications Access Point

The telecommunications access point is the demarcation between outside plant and in-building physical infrastructure.

a) The telecommunications access point should be easily accessible for public telecommunications network provider and protected against potential damages. A lockable cover is desired.
b) The telecommunications access point hosts the optical distribution box (ODB) and should be capable of accommodate multiple cables that could provide at least 2 fiber connections per unit/apartment (for at least three multiple operators) within the MDU.
c) The necessary physical facilities and space for the telecommunications access point is to be furnished by way of the building developer.
d) Building developers shall provide appropriate space on or inside the wall or in the ground such that the physical facilities including the ODB can be situated.
e) If the OSP is constructed before the building, the OSP termination at every property ought to be realized with a marker. The OSP termination should be provided via the OSP developer in a way that leads-in ducts may be joined in the system of building construction. At some stage in building making plans and creation, the vicinity for the telecommunications access point should be coordinated among the building developer and service provider. The procedure will be aligned with the development of different utilities.
f) If the MDU is built before an OSP deployment, the vicinity for the telecommunications access point should be marked simply and coordinated among building developer and the OSP developer as far as viable. A temporary terminal of the lead-in ducts should be deployed with the view to be integrated into the telecommunications access point when the OSP is deployed.
g) For redundancy, two separate telecommunication access points are recommended for MDU.

7. Lead-in Duct

a) Lead-in ducts should be used between telecommunications access point and Telecommunication Room (TR) / space by developer.
b) Lead-in ducts should be laid at a depth of about 300-600 mm and protected in opposition to harm, considering any local municipal guidelines.
c) The lead-in ducts shall meet the following functional requirements:
    1. Minimum Requirement: Each MDU must have at least one (1) lead-in duct, plus one (1) reserve duct for redundancy. Duct systems with sub-ducts are recommended to improve network scalability.
    2. Duct Diameter: The outer diameter of each lead-in duct or sub-duct must be at least 40mm, and shall be defined in the project design.
    3. Duct Sizing for Large MDUs:
        i) For MDUs with fewer than 30 units → Minimum 57mm inner diameter.

ii) For MDUs with more than 30 units → Minimum 63mm inner diameter.

4. The duct's ends should be sealed at every stop.
5. The location of lead-in ducts should be in reality marked above floor for ease of finding.
6. Lead-in ducts should be assigned exclusively for telecommunications services.
7. For redundancy, two separate lead-in ducts from telecommunication access points to telecommunication room/space are recommended for MDU.

Standards: Lead-in Duct	
Parameter	**Requirement**
Minimum Dimension (inner diameter)	MDU < 30 units: 57 mm MDU > 30 units: 63 mm
Quantity	min 1 (+1 reserve)
Wall Thickness (mm)	4.20mm (for 57 mm ducts) 5.70mm (for 63 mm ducts)

d) Lead-in ducts should be planned as per the bending radius of the FOC.

e) The standard lead-in ducts should be made from High Density Polyethylene (HDPE) in accordance with internationally recognized standards.

f) Small (1.5' x 1.5' in size) pulling box should be placed at every 90degree turning and at the distance on 50M if the route length > 100M

g) The lead-in ducts shall be ribbed inside and be capable to house FOCs. A continuous and strong draw rope shall be set up in the (sub-)ducts and shall continue to be for added cable installations.

8. Telecommunications Room

a) Each MDU should be equipped with a Telecommunications Room / space preferability on ground floor.

b) The telecommunications room shall meet the subsequent requirements:

- ✓ Standard Room size,
  1. For up to 400 Units the floor space required is 4m X 4m
  2. For large numbers of Units Telecoms operator must be consulted at the planning stage
- ✓ The room should have a minimum height of 3m, have good lighting clean, dry with proper ventilation and air circulation and free from dust, could be air-conditioned in case of active equipment needs to be placed.
- ✓ The room should be far away from high voltage plant and electrical rooms.
- ✓ Room shall have an entrance lock.
- ✓ 24/7 secured access for staff of service providers of public / private telecommunications networks but must be secured from unauthorized entry.
- ✓ The room must be properly protected from the risk of flooding if provided in the basement or ground floor.
- ✓ Direct sunlight should not fall in the room.
- ✓ Power conduit and telecom cable conduit must be separate.
- ✓ Properly accessible for adding / removing / testing of equipment / component and tools.
- ✓ Master lock for the entrance door.
- ✓ Must not be beneath or subsequent to kitchens, toilet, washrooms, rubbish regions, swimming pools and other moist areas and the surrounding walls / Roof / Floor shall not have any concealed

water / drainage pipes and air-conditioning ducts passing thru. It should be a dedicated spaces not shared with other functions (such as electrical or mechanical).

- ✓ All metal parts must be earth bonded with resistance of less than 1 ohm.
- ✓ Extra space for future network equipment additions.
- ✓ Space for co-locating equipment of at least two to three providers of public / private telecommunications networks, with a minimum of two square meters for each provider of a public / private telecommunications network. The final project design shall take into account the size of the building and the number of units as well as possible enhancements.
- ✓ Power supply with at least 4-6 A/C sockets (240volt, 13 amp) with a dedicated circuit breaker.
- ✓ Anti-static flooring should be provided.
- ✓ The rooms must be provided with an emergency light, a smoke detector and a fire alarm.

9. Building Distribution Frame (BDF)

a) The building distribution frame allows arbitrary connections between in-building cabling and outside plant cabling. The BDF / IDF shall have sufficient space along with the required Accessories to accommodate 3 Operator's connections to each Floor Distributor.

b) Splitter shall be installed in BDF / IDF to function as primary fiber distribution hub.

10. Riser Area

a) A riser region should be provided for all multi-storied homes. The riser place should be capable of accommodating at the least 2 connections to every unit (FTB). 50% reserve capacity in the riser location should be maintained for cable dealing.

b) Any cables which can be installed within the riser place should be without problems replaceable in case of damage or faults. Cables should be positioned in cable risers, conduits, sleeves, tubes, etc.

c) Minimum recommendation for optical fiber in riser area is 8F per floor.

d) The following principles shall apply:

- ✓ Riser areas should be accessible at any time.
- ✓ The installations should be done using the shortest route and preferably as vertical as possible.
- ✓ Riser areas shall not be located inside units or air shafts.
- ✓ The diameter of the conduit pipes should be at minimum 40 mm.

11. Floor Distributor

a) Floor Distributors should be located close to the riser area. Floor distributors should be planned at a minimum height of 600 mm from finished floor level. The space for the floor distributor should be dry and clean.

b) Typically, floor distributor shall not require active equipment provisioning but, in case active elements are required, a power supply must be provided in floor distributor.

c) Each Unit of a floor should be connected with a 32 mm conduit pipe with the floor distributor.

d) A star topology should be used for the cabling on each floor. Cascading connections from unit to unit is not recommended.

e) If the number of units per floor exceed 8, then splitter installation will be done to function as secondary fiber distribution hub.

12. Fiber Terminal Box

a) Each unit (dwelling or office) shall have a fiber terminal box installed at a central and accessible location.

b) In case multiple ONTs are to be installed per unit, then splitters shall also be installed here to function as secondary fiber distribution hub.
c) The conduit pipes and the fiber terminal box should be able to handle all possible fiber cable.
d) In case active elements are required, a power supply should be provided.

13. Optical Network Terminal

a) Each unit shall have at least 2 connections to the BDF. For business customers a higher number of connections may be designed if demand is expected.
b) A power supply preferably uninterrupted, shall be provisioned to ONT.

14. Installation

a) Installations should be done with the aid of qualified employees. Skillset and past experience should be evaluated to verify knowledge and ability of working with fiber optical cable.
b) While putting in ICT infrastructure in parallel to different installations, all regulations concerning noise protection, health protection, or the safety of electrical installations need to be observed.
c) All materials shall be flame retardant, low smoke and zero halogen emissions.

15. Testing

a) The testing for FOC must conform to ISO/IEC TR 14763-3 and to the relevant ITU specifications.
b) The testing for balanced cabling installations (CAT6 etc.) must conform to IEC 61935-1 and to the relevant ITU specifications.

16. Documentation

a) All infrastructure components should be clearly and uniquely labeled. Labels on components must match the label in the documentation and as-built drawings.
b) The building records shall include the following:
    - ✓ Building location information (e.g. building number and way number).
    - ✓ A list of all ONT's and their locations in the building.
    - ✓ A list of all distributors and the connections.
    - ✓ Labeling of all infrastructure components.
    - ✓ Contact information.
    - ✓ As-built drawings.

c) All above documents should be kept in the telecommunications room/space.
d) All documents must be updated with any change in the record to avoid mismatch and potential outage.

17. Charges / rental for NOC / Permissions

The building owner / management will not incur any charges for the passive infrastructure that supports Telecomm services. However, telecom operators shall be responsible for covering the actual costs of installing active equipment, utilizing power supply, and obtaining NOC/permissions related to space and electricity consumption.