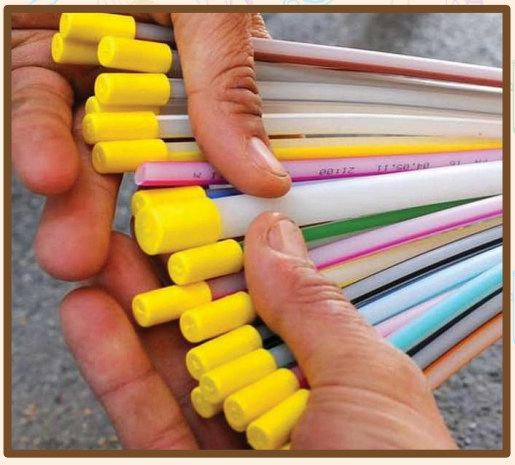
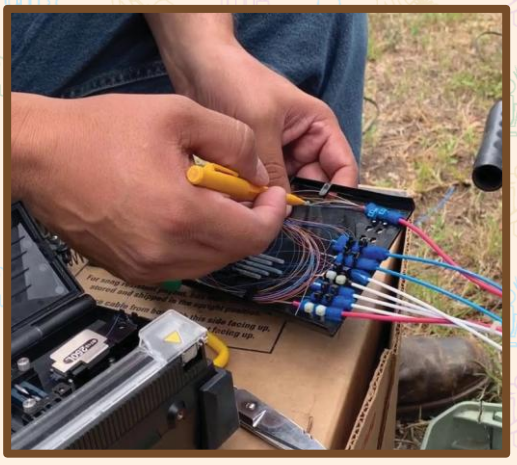
Telecom Sector Skill Council

Facilitator Guide


Sector

Telecom

Sub-Sector

Passive Infrastructure

Occupation

Customer Service - Passive Infrastructure

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NSQF Level **4**

Fiber Installation, Testing and Commissioning Technician

This book is sponsored by
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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

Acknowledgements

Telecom Sector Skill Council (TSSC) would like to thank all the individuals and institutions who contributed in various ways towards the preparation of this facilitator guide. The facilitator guide could not have been completed without their active contribution. Special gratitude is extended to those who collaborated during the preparation of the different modules in the facilitator guide. Wholehearted appreciation is also extended to all who provided peer review for these modules.

The preparation of this guide would not have been possible without the Telecom Industry's support. Industry feedback has been extremely beneficial since inception to conclusion and it is with their guidance that we have tried to bridge the existing skill gaps in the industry. This facilitator guide is dedicated to the aspiring youth, who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this Guide

The Facilitator Guide (FG) for Fiber Installation, Testing and Commissioning Technician is primarily designed to facilitate skill development and training of people, who want to become professional Fiber Installation, Testing and Commissioning Technicians in the industry. The Facilitator Guide is aligned to the Qualification Pack (QP) and the National Occupational Standards (NOS) as drafted by the Telecom Sector Skill Council of India (TSSCI) and ratified by National Skill Development Corporation (NSDC).

It includes the following National Occupational Standards (NOSs):

1. TEL/N4126: Fiber Construction, Performance and Selection Criteria
2. TEL/N4127: Fiber connectorisation, splicing and first level checks
3. TEL/N4128: Cable Installation Procedures and Practices
4. TEL/N4129: Preparing Cables for Termination and Splicing
5. TEL/N4130: Fiber Testing and Troubleshooting
6. TEL/N4131: Work Safety Practices with Fiber Optics
7. TEL/N9111: Follow sustainability practices in telecom cabling operations
8. DGT/VSQ/N0102: Employability Skills (60 Hours)

Post this training, the participants will be able to perform tasks as professional Fiber Installation, Testing and Commissioning Technician. We hope that this Facilitator Guide provides a sound learning support to our young friends to build a lucrative career in the telecom industry.

Symbols Used

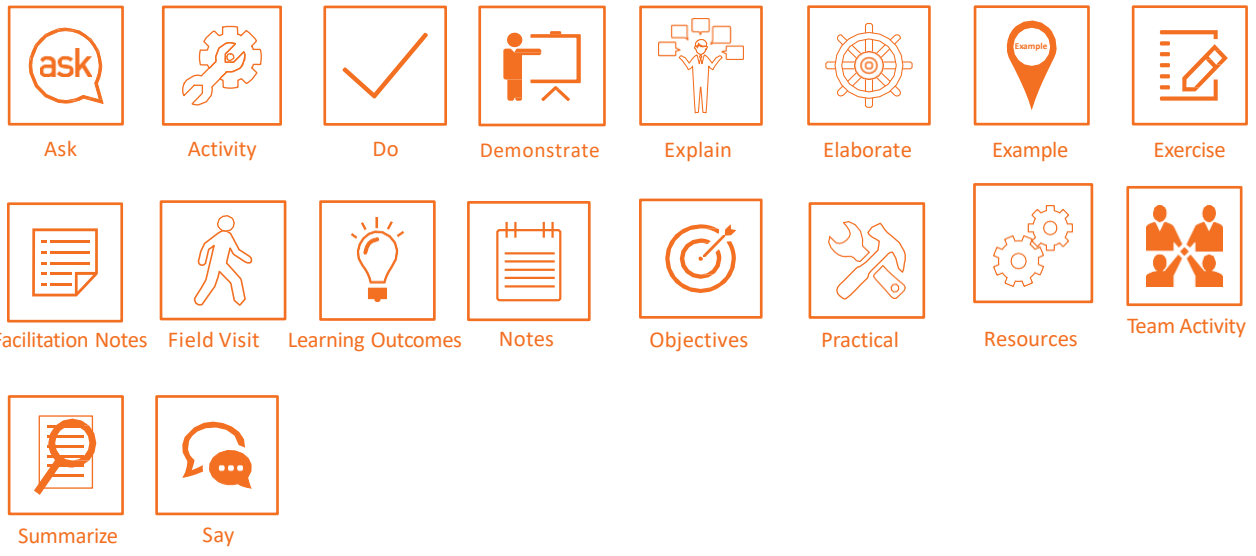


Table of Contents

It is recommended that all trainings include the appropriate Employability skills Module. Content for the same is available here: **https://www.skillindiadigital.gov.in/content/list**

1. Introduction to the sector & the job role of a Fiber Installation, Testing and Commissioning Technician

Telecom Sector Skill Council

Unit 1.1 – Telecom Sector in India

Unit 1.2 – Roles and Responsibilities of Fiber Installation, Testing and Commissioning Technician

TEL/N4126

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the significance of the telecom sector in modern communication and economic development.
2. Elucidate the key skills and technical expertise required for a Fiber Installation, Testing and Commissioning Technician.
3. Describe the challenges faced in the installation and maintenance of FTTH/X networks.
4. Determine the impact of fiber optic technology on internet speed and connectivity.
5. Discuss the role and responsibilities of a Fiber Installation, Testing and Commissioning Technician.

UNIT 1.1: Telecom Sector in India

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Outline the growth of the Telecom Sector in India.
2. Describe the size and scope of the Telecom industry and its sub-sectors.

Resources to be Used

Participant handbook, whiteboard, markers, projector, internet-enabled laptop, charts showing telecom growth statistics, videos on telecom evolution in India.

Note

This unit helps trainees understand how India's telecom sector evolved, its current scale, and the different sub-sectors that contribute to this vast industry.

Say

Good morning everyone!

Before we explore the technical aspects of broadband and passive infrastructure, it is important to understand the industry we are a part of. Today, we will look at how the telecom sector in India has grown and how large and diverse this sector really is.

Ask

Ask the participants:

- Do you know when mobile services first started in India?
- How many telecom users do you think India has today?
- Can you name a few major telecom sub-sectors?

Write their answers on the whiteboard or flipchart.

Use their responses to transition into the lesson.

Elaborate

In this session, we will discuss the following point:

- Growth of the Telecom Sector in India
- Size and Scope of the Telecom Industry
- Telecom Service Providers (TSPs)
- Active Network Providers
- Fiber and Broadband Networks
- Mobile Devices and Accessories
- Cybersecurity and IoT solutions

Say

Now let's participate in a quick activity to understand the depth and diversity of India's telecom landscape.

Activity

- **Duration**: 25 minutes
- **Resources**: Chart paper, markers, projector.
- **Steps**:
  1. Divide the class into small groups.
  2. Assign each group one sub-sector—Mobile services, Broadband, Infrastructure, IoT, or Data centers.
  3. Ask each group to identify:
     - Major companies
     - Key services
     - How their sub-sector supports digital connectivity
  4. Groups present their findings.
  5. Summarize how all sub-sectors work together to form the telecom ecosystem.

Do

- Help groups categorize telecom sub-sectors correctly.
- Add additional points where required.
- Encourage trainees to relate this knowledge to the Broadband Technician role.
- Summarize key facts on the board.

Notes for Facilitation

- Encourage questions about the job roles.
- Allow trainees to answer each other to promote peer learning.
- Suggest reading the introductory chapter in the participant handbook.

Notes

Unit 1.2: Roles and Responsibilities of Fiber Installation, Testing and Commissioning Technician

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Elucidate the key skills and technical expertise required for a Fiber Installation, Testing and Commissioning Technician.
2. Describe the challenges faced in the installation and maintenance of FTTH/X networks.
3. Explain the impact of fiber optic technology on internet speed and connectivity.
4. Discuss the key responsibilities of a Fiber Installation, Testing and Commissioning Technician.

Resources to be Used

Participant handbook, fiber cables, connectors, splicing machine, OTDR, visual fault locator (VFL), safety gloves, fiber cleaver, projector, whiteboard, markers, fiber network diagrams.

Note

In this unit, trainees will gain a clear understanding of what a fiber technician does, the skills required, and how fiber technology enables high-speed internet.

Say

Good morning everyone!

Today we will explore one of the most important roles in modern broadband networks—the Fiber Installation, Testing & Commissioning Technician. With India rapidly shifting toward fiber-based internet, understanding this role is essential for anyone entering the telecom field.

Ask

Ask the participants:

- Have you seen fiber cables being laid or spliced?
- Why do you think fiber is preferred over copper today?
- What challenges might a technician face while installing fiber at customer sites?

Write their answers on the whiteboard or flipchart.

Use their responses to transition into the lesson.

Elaborate

In this session, we will discuss the following point:

- Key Skills and Technical Expertise Required
- Challenges in FTTH/FTTX Installation and Maintenance
- Impact of Fiber Optic Technology on Speed and Connectivity
- Key Responsibilities of a Fiber Installation, Testing & Commissioning Technician

Say

Let's now apply this learning with a hands-on activity.

Activity

- **Duration**: 45 minutes
- **Resources**: Fiber cable, splicer, ONT, OTDR, connectors, VFL.
- **Steps**:
  1. Divide trainees into small groups.
  2. Show a live demonstration of::
     - Fiber stripping and cleaning
     - Splicing
     - Connectorization
  3. Ask each group to perform:
     - A mock FTTH installation layout
     - A basic OTDR test
  4. Each group presents what challenges they faced during the process.

Do

- Offer hands-on guidance during fiber preparation and splicing.
- Correct posture, alignment, and handling techniques.
- Demonstrate proper cleaning practices to avoid contamination.
- Encourage trainees to share their difficulties and learning points.

Notes for Facilitation

- Reinforce safety measures consistently.
- Highlight that accuracy and cleanliness are essential in fiber work.
- Encourage trainees to refer to diagrams and equipment manuals.
- Close the session by summarizing the importance of fiber technology in India's digital growth.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. The telecom sector enables digital communication, supports connectivity through voice, data, and internet services, and forms the backbone of modern communication systems and economic activities.
2. Essential expertise includes fiber splicing, OTDR and power meter testing, cable routing, connectorization, fusion splicing, and understanding network topologies and safety standards.
3. Common challenges include handling fragile fibers, managing tight spaces or ducts, ensuring proper routing, dealing with right-of-way issues, and avoiding bends or physical damage during installation.
4. Fiber optic technology provides high bandwidth, low latency, and minimal signal loss, resulting in faster, more reliable connectivity and improved network performance for end users.
5. Responsibilities include installing fiber cables, performing splicing, testing links using OTDR/OLTS, troubleshooting faults, ensuring proper commissioning, maintaining documentation, and following safety protocols.

B. Multiple Choice Questions (MCQs):

1. b) Enables digital communication infrastructure
2. b) Fiber splicing and OTDR testing
3. b) Handling fragile fiber cables
4. c) High bandwidth and low signal loss
5. b) Performing fiber link testing

C. Fill in the Blanks:

1. Modern
2. Splicing
3. Fragile
4. Bandwidth
5. testing

Notes

2. Fiber Construction, Performance and Selection Criteria

Unit 2.1 – Optical Fiber Construction, Transmission Checks, and Performance Evaluation

Unit 2.2 – Fiber Type Identification and Cable Selection Criteria

TEL/N4126

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the process for conducting fiber construction and transmission checks.
2. Describe key parameters used to evaluate fiber performance.
3. Explain methods for identifying and selecting appropriate fiber types and identifiers.
4. Describe key criteria for selecting optical fiber cables based on application and environment.

Unit 2.1 – Optical Fiber Construction, Transmission Checks, and Performance Evaluation

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the structural features and construction elements of different fiber types including multi-core, single-mode, multimode, and ribbon fibers.
2. Describe key transmission characteristics such as attenuation, dispersion, and modal properties and their effect on performance.
3. Illustrate how bending radius, tensile strength, environmental exposure, and mechanical stress affect fiber longevity and efficiency.
4. Explain specifications and functions of passive optical components like splices, connectors, splitters, pigtails, and joint enclosures.
5. Explain differences between speed and bandwidth in fiber transmission with reference to multi-core and conventional fibers.
6. Illustrate the interpretation of characteristic fiber performance charts to assess parameters like loss margins, return loss, and bandwidth.
7. Distinguish between wavelength-dependent attenuation and dispersion effects across fiber types.
8. Explain the significance of bend-sensitive fiber design in minimizing microbend/macrobend losses in high-density environments.
9. Describe the classification of fiber types based on construction and deployment conditions such as armored, direct burial, aerial, and micro-duct.
10. Illustrate the analysis of performance data to identify losses due to scattering, absorption, bends, or improper handling.

Resources to be Used

Participant handbook, fiber structure diagrams, sample fiber cables (SM, MM, ribbon, armored, aerial), laser pointer, projector, whiteboard, markers, pigtails, connectors, splitters, splice tray samples, fiber performance charts, OTDR sample screenshots, gloves, fiber cutaways.

Note

In this unit, trainees explore how optical fibers are built, how they carry light, and how different conditions impact performance—something every broadband technician must master.

Say

Good Morning everyone!
Today we dive into the heart of broadband communication—optical fiber. Understanding fiber structure and its transmission behavior helps technicians work confidently in the field and ensures high-quality service delivery. Let's explore how fibers are constructed, what affects their performance, and how to interpret fiber performance data like a professional.

Ask

Ask the participants the following questions:

- Have you ever seen a fiber cable from the inside?
- What do you think causes signal loss in optical fibers?
- Can bending a fiber affect data transmission? Why?

Write down their answers on the whiteboard or flipchart.

Use their responses as your starting point for the lesson.

Elaborate

In this session, we will discuss the following point:

- Structural Features of Fiber Types
- Key Transmission Characteristics
- Impact of Bending, Stress, and Environment
- Passive Optical Components
- Speed vs. Bandwidth in Fibers
- Classification Based on Deployment Conditions
- Performance Data Analysis

Say

Let's now move into an activity to strengthen your understanding of fiber types and behavior.

Activity

- **Duration**: 45 minutes
- **Resources**: Fiber cable samples, connectors, performance charts, OTDR screenshots.
- **Steps**:
  1. Split trainees into small groups.
  2. Give each group different fiber samples (SMF, MMF, ribbon, armored).
  3. Ask them to identify structural features.
  4. Show OTDR traces and performance charts.
  5. Ask each group to interpret loss points, bends, and anomalies.
  6. Have groups present their findings.

Do

- Demonstrate the cross-section of different fiber types using diagrams.
- Show real examples of excessive bending and explain its effect.
- Guide trainees in interpreting performance charts step-by-step.
- Encourage sharing observations from field experiences.

Notes for Facilitation

- Reinforce that handling fiber carefully is as important as understanding theory.
- Use real-world scenarios to explain how improper installation leads to customer issues.
- Encourage trainees to ask questions related to fiber types, performance, and installation environments.
- Link this unit to future units on OTDR testing, splicing, and troubleshooting.

Notes

UNIT 2.2: Fiber Type Identification and Cable Selection Criteria

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the classification of fiber types based on construction such as zip cord, distribution, loose tube, breakout, and ribbon cables.
2. Describe fiber categories by deployment suitability, including armored, aerial, direct burial, underwater, and bend-sensitive variants.
3. Discuss the structural characteristics, applications, and limitations of single-mode and multi-mode fibers, including the enhanced data-carrying capabilities of multi-core fibers.
4. Elucidate the role and significance of wavelength cut-off in selecting the appropriate fiber type for different network applications.
5. Explain the electrical hazards and safety risks involved in fiber installations near or within high-voltage environments.
6. Discuss the fundamental principles of optical transmission, including reflection, scattering, dispersion, and loss mechanisms.
7. Describe the standard procedures for testing fiber continuity, measuring insertion loss and return loss, and interpreting related results.
8. Discuss health, safety, and environmental compliance requirements in fiber network installations, including those involving multi-fiber assemblies and microduct deployments.
9. Demonstrate the selection and deployment of appropriate fiber types considering installation environment, application needs, and ease of installation.
10. Show how to identify and apply standardized fiber color codes for accurate fiber identification and documentation.
11. Demonstrate how to verify compatibility between selected fiber types and passive optical components for seamless integration.
12. Show the selection of fiber cables based on parameters such as tensile strength, water and rodent resistance, and suitability for multi-fiber and microduct installations.
13. Demonstrate grounding and bonding techniques for armored fiber cables to ensure installation safety and long-term durability.
14. Show how to ensure compliance with environmental guidelines and industry standards when selecting cables for different deployment scenarios.

Resources to be Used

Participant handbook, fiber splicing toolkit, safety gloves, notepad, markers, whiteboard, projector, fiber stripper, cleaver, cutter, visual fault locator (VFL), power meter, cable drum (demo or image).

Note

In this unit, we will learn about the essential tools used in fiber installations and how to maintain a complete, well-organized toolkit.

Say

Good Morning everyone!
Today we'll explore the tools that every fiber technician must carry. Whether you're installing, testing, or maintaining fiber networks, having the right tools—and keeping them organized—can make your work smoother, faster, and safer.

Ask

Ask the participants the following questions:

- What tools do you think are essential for fiber installation?
- Have you ever worked with any fiber splicing tools before?

Write down their answers on the whiteboard or flipchart.

Use their responses as your starting point for the lesson.

Elaborate

In this session, we will discuss the following point:

- Types of basic and advanced fiber optic tools
- Importance of tool maintenance and readiness
- Arranging tools and spare parts for installation work
- Cable drum placement at site: safety and alignment
- Optical continuity testing on the drum (using VFL, power meter, etc.)
- Preventing tool damage and avoiding loss of critical items

Say

Let's move into an activity to understand Fiber Tool Kit Preparation Drill.

Activity

- **Duration**: 25 minutes
- **Resources**: Demo tool kit, fiber tools (stripper, cleaver, cutter), VFL, power meter, spare connectors, labels, cable drum (or picture).
- **Steps**:
  1. Divide the class into small groups.
  2. Provide each group with a mixed set of tools, spares, and unused items.
  3. Ask trainees to plan:
     - Identify the essential fiber tools
     - Arrange the tools in proper order (testing tools together, splicing tools together, etc.)
     - Label the compartments of the toolkits
  4. Show a cable drum setup (real or picture) and ask trainees to explain the correct placement.
  5. Each group briefly demonstrates how they would test the cable on the drum for continuity using a VFL or power meter.
  6. Conclude by showing the ideal toolkit layout and correct cable drum testing procedure.

Do

- Ask a trainee to write down the essential tools identified by the groups on the board.
- Highlight mistakes and guide them toward proper toolkit organization.
- Share field tips on tool safety and avoiding tool loss at work sites.

Notes for Facilitation

- Invite trainees to ask questions about tool functions and handling.
- Encourage peer learning—let trainees explain tool uses to each other.
- Refer them to the tool list in the participant manual for reinforcement.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. Structural differences:
   - Single-mode fiber: Very small core (~9 µm), supports only one light mode, used for long-distance transmission.
   - Multimode fiber: Larger core (50/62.5 µm), supports multiple modes, used for short-distance links.
   - Ribbon fiber: Contains 8–24 or more fibers arranged in a flat ribbon for high-density splicing and installations.
   - Multi-core fiber: Contains multiple independent cores within a single cladding to increase capacity in the same cable.

2. Effect of attenuation & dispersion:
   - Attenuation reduces signal strength over distance, affecting how far a signal can travel before regeneration.
   - Dispersion causes pulse spreading, which limits bandwidth and increases bit-error rates. Single-mode fibers have lower dispersion than multimode fibers.

3. Impact of bending & mechanical stress:
   - Exceeding the minimum bending radius causes microbend and macrobend losses, weakening the signal.
   - Mechanical stress such as pulling, crushing, and tension can damage the fiber structure, reducing lifespan and increasing failure rates.

4. Role of passive optical components:
   - Splices permanently join fibers with minimal loss.
   - Connectors provide detachable connections for linking equipment and patching.
   - Splitters divide optical signals into multiple outputs in PON/FTTH networks.

   These components ensure proper routing and distribution of optical signals.

5. Safety concerns near high-voltage areas:
   - Risks include electrical induction, arcing, and grounding hazards.
   - Workers must avoid contact with live conductors, maintain safe clearance, follow earthing procedures, and use insulated tools and PPE.

B. Multiple Choice Questions (MCQs):

1. b) Core diameter
2. b) Microbend and macrobend losses
3. a) Signal strength after passing through a component
4. b) Direct burial or rodent-prone environments
5. b) Which wavelengths propagate efficiently in a given fiber

C. Fill in the Blanks:

1. Attenuation and dispersion
2. ribbon-like (flat)
3. bending radius
4. Passive
5. return

Notes

3. Fiber Connectorisation, Splicing and First Level Checks

Unit 3.1 – Fiber Connectorization and Splicing Techniques

Unit 3.2 – Performance Checks and Documentation

TEL/N4127

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the modern applications of fiber optics such as smart cities, 5G, telemedicine, and high-bandwidth entertainment.
2. Demonstrate installation of fiber networks across FTTx variations including FTTN, FTTC, FTTB, and FTTD.
3. Elucidate the advances in high-capacity networks, AI-driven optimization, sustainable deployment, and cybersecurity in fiber networks.
4. Show how to deploy and configure pre-connectorized optical cables, micro-ducts, and micro-trenching solutions for dense urban applications.
5. Describe the principles of FTTx architectures (FTTN, FTTC, FTTB, FTTH, FTTD) and their impact on deployment planning.
6. Demonstrate how to integrate network components like ONTs, OLTs, splitters, routers, and IoT devices in home and enterprise networks.
7. Discuss network planning and design principles, including selection of architecture (PON / GPON / XGS-PON) and cabling layout.
8. Show how to apply network planning and design principles to select the right FTTx architecture based on site and customer requirements.
9. Explain the use of GIS tools for mapping fiber routes, infrastructure documentation, and asset tracking.
10. Show how to determine infrastructure requirements such as conduit paths, fiber types, distribution points, and access nodes.
11. Discuss tools and technologies for testing cables, real-time fault detection, and predictive maintenance in fiber networks.
12. Show how to ensure seamless splicing and terminations using precision splicing tools and low-loss connector practices.
13. Elucidate the role of automation and smart diagnostic tools in network testing and troubleshooting.
14. Demonstrate how to ensure alignment with regulatory and compliance requirements during FTTx network installation.
15. Describe how ONTs, OLTs, splitters, and IoT devices integrate within FTTx access networks.
16. Show how to select equipment and materials for scalability and future upgrades (e.g., migration to XGS-PON / 10G PON).
17. Discuss industry standards and guidelines issued by TRAI, Broadband Forum, and ITU-T related to fiber network deployment.
18. Demonstrate accurate documentation, reporting, and compliance verification for audit and certification.

UNIT 3.1: Fiber Connectorization and Splicing Techniques

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain standard procedures for fiber optic splicing, connectorization, and first-level performance testing.
2. Elucidate the risks associated with deviations from standard protocols, including their impact on quality assurance and network performance.
3. Discuss the escalation protocols for addressing unresolved technical issues, faulty splices, or safety non-compliance.
4. Describe the types, specifications, and use cases of fiber connectors including legacy and emerging standards like MPO/MTP.
5. Discuss the key factors contributing to attenuation, insertion loss, and return loss in fiber optic systems.
6. Explain industry-approved methods for minimizing optical loss through precise alignment, cleanliness, and fiber handling techniques.
7. Elucidate the functions, operation, and maintenance of essential tools such as fiber strippers, cleavers, fusion splicers, and inspection scopes.
8. Discuss common splicing faults including white line, offset, misalignment, and their corrective actions based on test results. Demonstrate how to identify and differentiate fiber connectors using TIA-568 color coding, fiber type (SM/MM), and application-specific types (ST, SC, FC/PC, MT, LC, MPO/MTP).
9. Show how to assess the impact of different polish types (Flat, PC, UPC, APC) on insertion loss and return loss during testing.
10. Demonstrate end-face inspection, cleaning, and proper connector termination in field conditions, including handling contamination and physical damage.
11. Show how to incorporate pre-terminated connectors and MPO/MTP solutions to improve installation speed in high-density environments.
12. Demonstrate fiber preparation for splicing, including jacket stripping, buffer tube management, coating removal, and fiber cleaning using approved solvents.
13. Show how to perform accurate fiber cleaving using precision cleavers for both single and ribbon fiber types.
14. Demonstrate mechanical splicing using elastomeric or other advanced splicing techniques, and verify splice alignment and quality.
15. Show how to operate fusion splicing machines, select appropriate programs, perform arc calibration, and achieve low-loss splices.
16. Demonstrate how to validate fusion splice quality using automated loss estimation tools and apply protection methods like heat-shrink sleeves.
17. Show how to prepare ribbon fibers, align and cleave them using specialized ribbon cleavers, and execute precise ribbon splicing with performance validation.
18. Demonstrate the application of advanced fusion splicers and pre-terminated fiber solutions to reduce installation time and increase accuracy in large-scale deployments.

Resources to be Used

Participant handbook, OTDR, power meter, light source, fiber cables, notepad, markers, projector, whiteboard, spare fiber components, fiber cleaning tools.

Note

In this unit, we will learn how to test optical fibers effectively and ensure that the network meets the required performance standards.

Say

Good Morning everyone!
Today we're going to explore one of the most crucial parts of fiber optic work — testing the fiber. Testing tells us whether the fiber installation is good, whether the signal can travel efficiently, and whether any faults need correction.

Ask

Ask the participants the following questions:

- Have you ever seen or used a Fiber Connectors?
- What do you think happens if a fiber link is installed but never tested?

Write down their answers on the whiteboard.

Elaborate

In this session, we will discuss the following point:

- Types, Specifications, Identification, and Use Cases of Fiber Connectors
- Factors Affecting System Performance
- Minimizing Optical Loss
- Impact of Connector Polish Types
- Standard Procedures for Fiber Optic Splicing, Connectorization, and First-Level Testing
- Fiber End-Face Inspection, Cleaning, and Connector Termination
- Fiber Preparation for Splicing
- Precision Fiber Cleaving for Single Fiber and Ribbon Fiber

Say

Let's now take part in an activity to understand fiber testing more practically.

Activity

- **Duration**: 30 minutes
- **Resources**: OTDR, power meter, light source, fiber patch cords, fiber spool, projector, whiteboard..
- **Steps**:

1. Divide the class into small groups.
2. Provide each group with a fiber patch cord and ask them to connect the power meter and light source.
3. Ask them to:
   - Measure the power loss
   - Record the reading
   - Compare their results with acceptable industry values
4. Then demonstrate an OTDR trace on the projector.
5. Ask each group to identify: a. Event points, b.Splice points, c. Loss values, d. Any abnormal spikes
6. Each group shares their findings and explains the probable cause of any loss.

Do

- Ask a student to note the readings from each group on the whiteboard.
- Guide the participants if they misinterpret an OTDR trace.
- Share additional examples from real-world installations.
- Encourage trainees to hold the tools and try the measurement steps themselves.
- Ask one participant to summarize the key readings and learning points.

Notes for Facilitation

- Ask if trainees have questions about OTDR functions or test parameters.
- Let participants respond to each other to encourage peer learning.
- Remind trainees to read the detailed tool specifications in their participant manual.
- Reinforce that accurate fiber testing prevents future failures and service downtime.

Notes

Unit 3.2 – Performance Checks and Documentation

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Describe the industry standards and acceptable thresholds for insertion loss, return loss, and continuity testing in fiber optic networks.
2. Discuss the occupational health, safety, and environmental compliance guidelines relevant to fiber splicing and connectorization activities.
3. Explain the operational and cost-efficiency benefits of using pre-terminated fiber solutions in field deployments.
4. Elucidate the application of MPO/MTP connectors in data centers, FTTH, and high-density backhaul environments.
5. Discuss recent advancements in fusion splicing machines, including auto-alignment features and integrated loss estimation systems, and their impact on precision and productivity.
6. Describe the relevance of ribbon fiber splicing for high-capacity, large-scale network rollouts and its benefits in reducing splicing time and complexity.
7. Explain the importance of documenting test results, splice loss values, cable drum serial numbers, and exact splice locations in field logs.
8. Describe how to prepare, validate, and submit performance reports and fiber test records to project authorities or supervisors for inspection and compliance trackin
9. Demonstrate how to perform immediate post-splicing performance checks using a Visual Fault Locator (VFL) and OTDR to detect potential splice or connector faults.
10. Show how to evaluate completed splices for common defects including white line, misalignment, diameter mismatch, bubbles, and bulging using inspection scopes and test tools.
11. Demonstrate how to analyze and identify root causes of splicing defects and implement appropriate corrective actions to meet quality benchmarks.
12. Show how to verify optical loss parameters and ensure they are within acceptable limits as per industry standards and client specifications.
13. 1Demonstrate the correct usage of standard data recording formats to capture splicing activity, measured losses, fault corrections, and validation steps systematically for quality audits.

Resources to be Used

Participant handbook, whiteboard, flipchart, markers, projector, laptop, optical connectors (SC, LC, FC, ST), advanced protection sleeves, fiber cleaver, mechanical splicing kit, fusion splicer (multi-joiner, if available), fiber stripper, cable blowing machine demo/video, joint closure samples, route marker samples, documentation templates.

Note

In this unit, we will understand how to test, document, and maintain optical fiber networks using both traditional and advanced tools.

Say

Good Morning everyone!
Today's session will focus on how to properly test optical fiber networks, maintain installation quality, and ensure accurate documentation. This forms the backbone of predictive maintenance and long-term network reliability.

Elaborate

In this session, we will discuss the following point:

- Industry Standards and Acceptable Thresholds for Insertion Loss, Return Loss, and Continuity Testing
- Occupational Health, Safety, and Environmental Compliance in Fiber Splicing and Connectorization
- Operational and Cost-Efficiency Benefits of Pre-Terminated Fiber Solutions
- Application of MPO/MTP Connectors in High-Density Environments
- Advancements in Fusion Splicing Machines and Their Impact
- Relevance of Ribbon Fiber Splicing in High-Capacity Network Rollouts
- Importance of Documenting Test Results and Field Records

Say

Let's now take part in an activity to understand Connector Identification and Compatibility Mapping.

Activity

- **Duration**: 30 minutes
- **Resources**: SC, LC, FC, ST connectors, protection sleeve samples, compatibility chart, projector.
- **Steps**:

1. Divide the class into small groups.
2. Provide each group with a set of connectors and protection sleeves.
3. Ask them to identify:
   - The connector type
   - The equipment it is compatible with
   - The correct sleeve required for termination
4. Groups will map compatibility on chart paper.
5. Each group presents their findings.

Do

- Ask a trainee to list connector compatibility tables on the board.
- Correct any mismatches and explain industry-standard pairings.
- Share insights from real deployments where incorrect connectors caused major issues.
- Encourage each group to handle the connectors physically for better understanding.

Notes for Facilitation

- Ask if trainees have questions.
- Encourage peer-to-peer explanation to build collaborative understanding.
- Remind participants to practice connector identification and splicing techniques using the handbook diagrams.
- Reinforce that neat documentation and clean installation practices are part of quality assurance.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. Standard fiber splicing steps include: cable preparation, stripping the fiber, cleaning, cleaving, aligning fibers (mechanical or fusion), performing the splice, protecting the splice with heat-shrink sleeves, connectorization (if required), and final testing/inspection.
2. Risks include: high splice loss, network outages, signal degradation, compromised reliability, increased maintenance costs, and possible fiber damage.
3. Cleavers ensure perfect flat fiber end-faces; fusion splicers align and fuse fibers with minimal loss; strippers remove protective coatings without damaging the glass; inspection scopes check end-face cleanliness and connector quality.
4. MPO/MTP connectors enable efficient, high-density, multi-fiber connectivity, making them essential for data centers, parallel optics, and high-capacity backbone networks.
5. Proper documentation ensures traceability, validates performance against standards, supports troubleshooting, and acts as proof of compliance for project acceptance.

B. Multiple Choice Questions (MCQs):

1. b) White line
2. b) Misalignment and poor connector cleanliness
3. b) High-density data centers and FTTH splitters
4. c) Precision arc fusion alignment
5. b) The amount of reflected optical power

C. Fill in the Blanks:

1. signal quality
2. Cleaving
3. splicing time
4. Industry
5. operational

Notes

4. Cable Installation Procedures and Practices

Unit 4.1 – Cable Installation Procedures and Practices

TEL/N4128

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the structure, types, and materials of optical fibers, including core, cladding, and jacket properties, as well as the optical properties like attenuation, dispersion, and wavelength.
2. Discuss the basic physics of light transmission in optical fibers and how it relates to signal performance.
3. Elucidate the different splicing techniques (mechanical, fusion, twist, etc.), their applications, and best practices for minimizing splice loss and ensuring joint durability.
4. Describe the tools and equipment used for splicing, including fusion splicers, inspection tools, smart cleavers, and safety equipment, along with the proper handling of splicing consumables.
5. Explain the advanced characteristics of optical fibers and the features and functions of advanced splicing machines and testing equipment.
6. Discuss the techniques for splicing in challenging environments like outdoor, submarine, or underground networks, and how to mitigate environmental effects on fiber and splice joints.
7. Describe the use of fiber pigtails, connectorized fiber, routing inside junction boxes, and the various fiber jointing techniques.
8. Demonstrate how to check the availability and functionality of advanced optical testing tools such as OTDR, power meter, OSA, CD analyzer, and PMD analyzer.
9. Show how to check for availability and manage advanced splicing tools, including automated splicers, robotic arms, cleavers, and inspection tools.
10. Demonstrate how to manage splicing consumables like joint kits, connectors, heat shrink sleeves, and fiber optic enclosures.
11. Show how to ensure that splicing machines and testing equipment are calibrated and updated to meet precision standards, and coordinate repair or replacement of faulty tools.
12. Demonstrate how to locate and identify fibers for splicing using automated mapping tools and network plans, while checking for physical damage with advanced inspection tools.
13. Show how to prepare optical fibers for splicing by removing jackets, cleaning cores with automated systems, and securing cables within bend radius and stress limits.
14. Demonstrate how to install joint closures, splitters, and pigtails with weatherproofing, route connectorized fibers, and document compliance with network plans.
15. Explain the role of AI-powered tools for fault detection, predictive maintenance, and optimization in fiber networks.
16. Discuss the integration of splicing tasks with IoT-enabled smart network management systems and the principles of cloud-based systems for remote monitoring, reporting, and troubleshooting.
17. Describe the regulatory compliance practices for optical fiber installation and maintenance, and how they affect network planning and design.
18. Elucidate the advanced fusion splicing process, including fiber preparation, splicing machine operation, and ribbon fiber splicing techniques.
19. Discuss the proper use of splice closures (heat shrink vs. cold shrink) and sealing techniques for weatherproofing in various environments.
20. Explain the techniques and applications of crimp splicing, particularly in hybrid networks.
21. Describe the basics of AI-driven predictive maintenance tools used to monitor and optimize fiber networks.
22. Show how to identify fiber faults using OTDR, robotic arms, OFIs, and smart cleavers for maintenance in challenging environments.

23. Demonstrate how to coordinate with NOC for outage windows, perform fault inspections for microbends and environmental wear, clean fibers, replace damaged sections, re-splice fibers, and ensure proper weatherproofing of cables.
24. Demonstrate how to operate fusion splicing machines with automation to minimize errors, and perform various splicing methods (mechanical, fusion, ribbon, etc.) for different applications.
25. Show how to ensure splice quality using real-time diagnostics, precision cleavers, and advanced imaging tools, while sealing splices with heat-shrink or cold-shrink closures for protection.
26. Demonstrate how to perform micro and nano fiber splicing using specialized tools and document splicing details digitally.
27. Show how to use AI-enabled OTDR for fault detection and accurate loss measurement, and test signal quality with tools like OSA, CD analyzer, and PMD analyzer.
28. Demonstrate how to verify performance KPIs, generate automated reports for monitoring and compliance, and maintain documentation for network optimization.

UNIT 4.1: Cable Installation Procedures and Practices

Unit Objectives

After the completion of this module, the participant will be able to:

1. Explain the structure, types, and materials of optical fibers, including core, cladding, and jacket properties, as well as the optical properties like attenuation, dispersion, and wavelength.
2. Discuss the basic physics of light transmission in optical fibers and how it relates to signal performance.
3. Elucidate the different splicing techniques (mechanical, fusion, twist, etc.), their applications, and best practices for minimizing splice loss and ensuring joint durability.
4. Describe the tools and equipment used for splicing, including fusion splicers, inspection tools, smart cleavers, and safety equipment, along with the proper handling of splicing consumables.
5. Explain the advanced characteristics of optical fibers and the features and functions of advanced splicing machines and testing equipment.
6. Discuss the techniques for splicing in challenging environments like outdoor, submarine, or underground networks, and how to mitigate environmental effects on fiber and splice joints.
7. Describe the use of fiber pigtails, connectorized fiber, routing inside junction boxes, and the various fiber jointing techniques.
8. Demonstrate how to check the availability and functionality of advanced optical testing tools such as OTDR, power meter, OSA, CD analyzer, and PMD analyzer.
9. Show how to check for availability and manage advanced splicing tools, including automated splicers, robotic arms, cleavers, and inspection tools.
10. Demonstrate how to manage splicing consumables like joint kits, connectors, heat shrink sleeves, and fiber optic enclosures.
11. Show how to ensure that splicing machines and testing equipment are calibrated and updated to meet precision standards, and coordinate repair or replacement of faulty tools.
12. Demonstrate how to locate and identify fibers for splicing using automated mapping tools and network plans, while checking for physical damage with advanced inspection tools.
13. Show how to prepare optical fibers for splicing by removing jackets, cleaning cores with automated systems, and securing cables within bend radius and stress limits.
14. Demonstrate how to install joint closures, splitters, and pigtails with weatherproofing, route connectorized fibers, and document compliance with network plans.
15. Explain the role of AI-powered tools for fault detection, predictive maintenance, and optimization in fiber networks.
16. Discuss the integration of splicing tasks with IoT-enabled smart network management systems and the principles of cloud-based systems for remote monitoring, reporting, and troubleshooting.
17. Describe the regulatory compliance practices for optical fiber installation and maintenance, and how they affect network planning and design.
18. Elucidate the advanced fusion splicing process, including fiber preparation, splicing machine operation, and ribbon fiber splicing techniques.
19. Discuss the proper use of splice closures (heat shrink vs. cold shrink) and sealing techniques for weatherproofing in various environments.
20. Explain the techniques and applications of crimp splicing, particularly in hybrid networks.
21. Describe the basics of AI-driven predictive maintenance tools used to monitor and optimize fiber networks.
22. Show how to identify fiber faults using OTDR, robotic arms, OFIs, and smart cleavers for maintenance in challenging environments.

23. Demonstrate how to coordinate with NOC for outage windows, perform fault inspections for microbends and environmental wear, clean fibers, replace damaged sections, re-splice fibers, and ensure proper weatherproofing of cables.
24. Demonstrate how to operate fusion splicing machines with automation to minimize errors, and perform various splicing methods (mechanical, fusion, ribbon, etc.) for different applications.
25. Show how to ensure splice quality using real-time diagnostics, precision cleavers, and advanced imaging tools, while sealing splices with heat-shrink or cold-shrink closures for protection.
26. Demonstrate how to perform micro and nano fiber splicing using specialized tools and document splicing details digitally.
27. Show how to use AI-enabled OTDR for fault detection and accurate loss measurement, and test signal quality with tools like OSA, CD analyzer, and PMD analyzer.
28. Demonstrate how to verify performance KPIs, generate automated reports for monitoring and compliance, and maintain documentation for network optimization.

Resources to be Used

Participant handbook, OTDR device, cable reels, duct rods, tension meters, pulling grips, micro ducts, aerial hardware, trenching equipment visuals, safety gear (PPE), sample documentation templates, projector, whiteboard, markers, fiber blowers, breakaway swivels, and sample installation checklists.

Note

This unit covers the entire lifecycle of fiber installation—from planning to deployment—using real field principles. Trainers should encourage trainees to connect theory with practical field challenges.

Say

Good Morning everyone!
Today, we are going to learn about the complete workflow of fiber installation—planning, trenching, ducting, micro-trenching, duct preparation, cable pulling, aerial installations, grounding, and final documentation.

Ask

Ask the participants the following questions:

- What happens if a fiber cable is pulled with excessive tension?
- Why do we perform pre-construction surveys?

Write their responses on the whiteboard.

Elaborate

In this session, we will discuss the following point:

- Project Management Principles in Fiber Installation
- Planning, Supervision, and Validation of Pre-Construction Surveys
- Compliance, Standards & Regulatory Requirements
- Cable Types, Suitability & Handling Standards
- Infrastructure Requirements and Installation Methodologies
- Regulatory, Safety, and Environmental Standards
- Pre-Installation Checks and Quality Assurance
- Oversight of Aerial Cable Installations: Compliance with Wind Load, Sag, Pole-Clearance & Safety Norms
- Deployment of Messenger Strands & Securing Cables Using Lashing, Clamps, or Self-Supporting Methods

Say

Now we will perform activities to help you think, act, and supervise like a real field technician.

Activity

- **Duration**: 30 minutes
- **Resources**: Planning worksheets, sample layouts, markers, projector..
- **Steps**:
  1. Divide trainees into small groups.
  2. Provide each group with a sample fiber installation route map.
  3. Ask them to:
     - Estimate time for each task.
     - Identify task sequence.
     - Allocate resources (manpower, equipment).Identify risks if standard steps are skipped.
  4. Each group presents its plan.

Do

- Guide trainees in analyzing the route map and creating a realistic plan.
- Point out where delays commonly occur in real field projects.
- Encourage discussion on how proper planning improves workflow.
- Share practical examples of faults caused by deviations from SOPs.
- Reinforce the link between good planning and high-quality service.

Notes for Facilitation

- Encourage peer-to-peer learning by asking trainees to compare their plans.
- Remind trainees that project management is a skill they will use daily as technicians.
- Ask trainees to complete related questions in the participant handbook.
- Take time to clarify doubts about sequencing, time estimation, or SOP requirements.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. They ensure accurate planning, avoid delays, optimize manpower/equipment use, and maintain smooth workflow in fiber installation.
2. It leads to high signal loss, cable damage, safety hazards, and increased chances of network failure or outages.
3. Work permits, route maps, trenching permissions, utility NOCs, safety clearances, and installation/commissioning documentation.
4. Proper handling prevents microbends, avoids stress on fibers, and ensures long-term signal performance.
5. OTDR analysis helps detect faults, verify cable quality, and confirm the route is fit before deployment.

B. Multiple Choice Questions (MCQs):

1. b) Signal loss and service outages
2. b) Minimizes surface disruption and reduces deployment cost
3. b) Duct rodder
4. b) Improve electrical safety and system longevity
5. b) Support and secure aerial fiber cables

C. Fill in the Blanks:

1. Damage
2. Tension
3. Excavation
4. Twisting
5. performance

Notes

5. Preparing Cables for Termination and Splicing

Unit 5.1 – Preparing Cables for Termination and Splicing

TEL/N4129

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain Passive Optical Networks (PONs) like GPON, EPON, and Next-Gen PON.
2. Demonstrate how to identify and assess passive components, including PLC and FBT splitters, for different deployment environments.
3. Describe the fundamentals of GPON technology, including architecture, components, and benefits.
4. Show how to install wall-mount and rack-mount splitters (1x8, 1x16, 1x32) using precision tools.
5. Discuss the roles of ONTs, OLTs, and splitters in GPON networks.
6. Demonstrate how to ensure compatibility of splitters with GPON, XG-PON, and NG-PON2 technologies.
7. Elucidate Outside Plant (OSP) considerations including routing and environmental protection.
8. Show how to check installation sites for optimal placement, minimizing loss and complying with building standards.
9. Explain advanced transmission mechanisms like WDM and TDMA.
10. Demonstrate how to configure splitters for WDM and TDMA technologies.
11. Discuss Wavelength Division Multiplexing (WDM) and high-speed transmission.
12. Show how to validate and configure advanced WDM/TDMA mechanisms for optimized bandwidth.
13. Determine loss budget concepts and best design practices.
14. Demonstrate how to analyze and calculate loss budgets considering WDM/TDMA.
15. Analyze the impact of components on loss budgets and optimize designs.
16. Describe power testing techniques including insertion loss, reflection, and validation.
17. Show how to conduct insertion loss and reflection testing using OLTS/OTDR.
18. Show how to measure power output at distribution ports using precision power meters.
19. Show how to validate network performance parameters for GPON and NG-PON2 compliance.
20. Discuss fiber management practices (slack, connectors, scalability).
21. Show how to identify and organize feeder and distribution fiber routing.
22. Demonstrate fiber management techniques for secure and scalable deployment.
23. Demonstrate using advanced connectors (SC, LC, APC).
24. Demonstrate final connector polishing to reduce insertion loss.
25. Explain emerging diagnostic tools like AI-enabled OTDR & advanced OLTS.
26. Show how to use AI-enabled diagnostic tools for real-time fault detection and troubleshooting.
27. Describe safety protocols for optical fiber handling and PPE usage.
28. Explain best practices for documentation, loss budgets, testing results, and troubleshooting records.
29. Show how to install and configure passive components compatible with GPON and NG-PON2 networks.
30. Demonstrate splitter configuration for broadcast-based GPON deployments.

UNIT 5.1: Preparing Cables for Termination and Splicing

Unit Objectives

After the completion of this module, the participant will be able to:

1. Explain standard protocols and procedures for handling, preparing, terminating, and splicing fiber optic cables.
2. Discuss the risks, quality issues, and long-term impacts of non-compliance with defined preparation and handling procedures.
3. Elucidate the applicable industry standards and regulatory requirements for safe and compliant cable preparation and installation.
4. Describe health, safety, and environmental regulations related to manual and mechanical cable handling in varied installation environments.
5. Explain the correct use, storage, and maintenance of cable preparation tools such as strippers, cleavers, cutters, and cleaning supplies.
6. Determine how improper cable laying and handling practices affect signal attenuation, cable lifespan, and network performance.
7. Discuss industry-recommended practices for transporting, storing, and securing fiber optic cables to avoid mechanical or environmental damage.
8. Explain essential cable characteristics such as minimum bend radius, tensile load, and crush resistance in relation to preparation practices.
9. Describe the role of documentation in ensuring traceability, quality control, and future maintenance support.
10. Explain fiber cable quality assurance steps including pre-handling inspection and conformance to specification.
11. Elucidate proper techniques for jacket removal and coating stripping to preserve fiber core integrity.
12. Discuss the critical role of accurate cleaving, cleaning, and alignment in ensuring low-loss, high-quality splicing outcomes.
13. Describe how precision tools contribute to effective cable preparation and reliable splicing operations.
14. Explain the significance of correct wrapping, mechanical protection, and enclosure sealing in maintaining cable integrity over time.
15. Demonstrate how to remove the cable jacket using precision stripping tools while preserving the underlying fibers.
16. Show how to use the rip-cord effectively to expose the inner cable layers without damaging the core.
17. Demonstrate how to identify, prepare, and secure the strength member to enable robust and durable terminations.
18. Show how to use Kellum's grip for strain relief and mechanical support during installations.
19. Demonstrate the safe cutting of armored cables using industry-compliant cutters while minimizing fiber stress.
20. Show how to inspect and verify cable specifications such as bend radius, diameter, and markings before preparation.
21. Demonstrate accurate cleaving techniques and fiber cleaning methods using approved solvents and lint-free tools.
22. Show how to wrap, seal, and protect prepared cable ends to ensure mechanical and environmental protection.

23. Demonstrate the correct manual and mechanical methods for lifting, rolling, unwinding, and positioning cable drums.
24. Show how to unload, and store fiber cable drums as per manufacturer guidelines to prevent deformation or breakage.
25. Simulate inspection of fiber cables before and after handling to identify abrasions, cracks, or other physical defects.
26. Show how to operate high-quality splicing preparation tools for clean, durable, and low-loss fiber joins.
27. Demonstrate how to calculate required slack length considering installation layout, future maintenance, and expansion.
28. Show how to organize and secure slack using appropriate enclosures, brackets, or loops to prevent obstruction or signal degradation.
29. Demonstrate effective slack management to maintain accessibility and avoid strain during future splicing or rerouting.
30. Show how to accurately document cable preparation and slack management activities, including material used, slack length provided, and enclosure references for future maintenance and troubleshooting.

Resources to be Used

Fiber optic cables (sample), strippers, cleavers, fiber microscope, alcohol wipes, lint-free tissues, cutters, fusion splicer, mechanical splice kit, protective gloves, safety glasses, cleaning solutions, ODF/Splice tray samples, participant handbook, projector, whiteboard, markers.

Note

In this unit, we will explore industry-approved methods to prepare, handle, and splice fiber optic cables safely and efficiently. These practices are crucial for achieving high network reliability and reducing long-term maintenance issues.

Say

Good Morning everyone!
Today's session is extremely important because fiber optic cables are sensitive and precise components of the broadband network. A small mistake in handling can cause major signal issues, repeated faults, and even permanent damage. Let's learn how to prepare and splice fiber correctly—just like professionals in the field.

Ask

Ask the participants the following questions:

- Have you ever seen a fiber cable being stripped or spliced?
- What do you think happens if a fiber is bent too sharply?
- Write their responses on the whiteboard.

Elaborate

In this session, we will discuss the following point:

- Standards, Compliance & Safety Requirements
- Cable Characteristics, Quality Assurance & Documentation
- Tools: Usage, Storage & Calibration
- Cable Preparation Techniques
- Fiber Cleaving, Cleaning & Splicing Readiness
- Cable Handling, Drum Management & Mechanical Support

Say

Let's do a hands-on activity Fiber Preparation and Splicing Demonstration to reinforce what we've discussed.

Activity

- **Duration**: 60 minutes
- **Resources**: Fiber cable, cleaver, stripper, microscope, splicing machine, splice tray, wipes.
- **Steps**:
  1. Show trainees how to strip the jacket and coating correctly.
  2. Demonstrate proper cleaving and inspection under a fiber scope.
  3. Conduct a live splicing demonstration (fusion or mechanical).Allow trainees to practice tool handling in groups.
  4. Inspect their work and provide feedback on technique.

Do

- Assist trainees in using tools safely and confidently
- .Reinforce correct tool angles, pressure, and cleaning methods
- Observe trainees and correct common mistakes—such as excessive stripping force or fiber contamination.
- Highlight best practices throughout the hands-on session.

Notes for Facilitation

- Ensure all trainees wear eye protection during fiber work.
- Remind them to properly dispose of fiber scraps in a designated container.
- Encourage peer learning—ask trainees to observe and correct each other.
- Ask trainees to complete the related exercises in the participant handbook.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. Standard protocols include: cleaning and preparing the fiber, maintaining bend-radius limits, using proper stripping tools, performing clean cleaving, aligning cores accurately, and using controlled fusion splicing to preserve core integrity.
2. Long-term impacts include: increased attenuation, higher failure rates due to microbends/microcracks, and frequent service disruptions from premature cable degradation.
3. Key standards include: ITU-T (G.652/G.657), IEC/ISO fiber installation standards, TIA/EIA-568 guidelines, and national safety regulations for telecom works.
4. Proper techniques: use calibrated tools, strip the jacket gently in stages, avoid excessive pressure, clean the fiber thoroughly, and cleave with a precision cleaver to avoid end-face chips or cracks.
5. Documentation is critical because: it ensures traceability, supports fault-location during repairs, and helps in future maintenance planning and audits.

B. Multiple Choice Questions (MCQs):

1. b) Signal attenuation and microbend loss
2. b) Precision cleaver
3. b) Poor cleave quality and contamination of fiber end faces
4. c) Follow manufacturer guidelines to prevent deformation and moisture ingress
5. b) Inspecting cable for abrasions, diameter markings, and bend-radius compliance

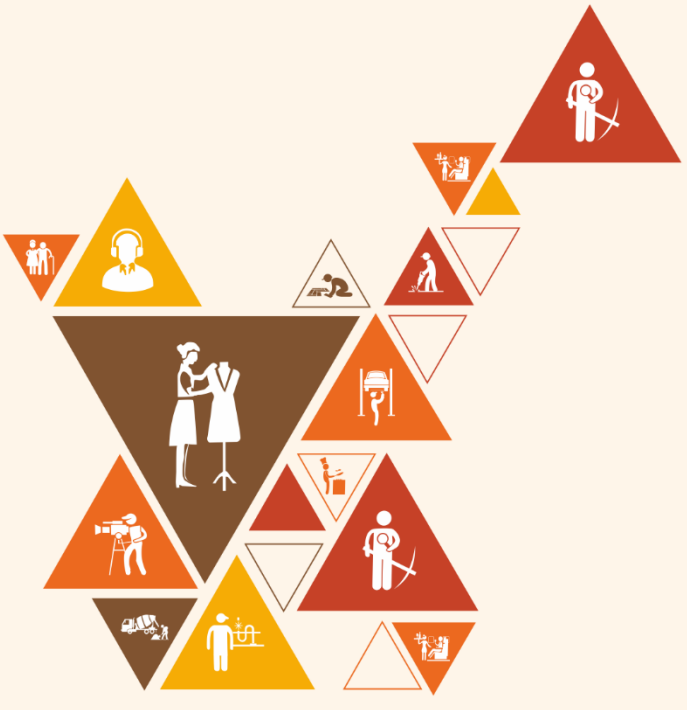
C. Fill in the Blanks:

1. bend-radius, strength
2. Cleaving
3. Strain
4. loss, lifespan
5. OTDR

Notes

6. Fiber Testing and Troubleshooting

Unit 6.1 - Fiber Testing
Unit 6.2 - Fiber Troubleshooting
Unit 6.3 - Testing Installed Network



TEL/N4130

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Explain the types and characteristics of fiber optic cables, including bend radius, tensile strength, and fusion splicing techniques.
2. Discuss the tools for fiber installation (e.g., fish tape, splicing machines, OTDR, VFL) and the techniques to measure signal loss and maintain network performance.
3. Discuss the role of fiber networks in supporting cloud gaming, ultra-low latency applications like High-Frequency Trading (HFT), and Industry 4.0 applications such as automation, robotics, and real-time data monitoring in smart manufacturing.
4. Elucidate the IoT and IoE device types, their connectivity requirements, and network configurations, and the role of FTTH in IoE.
5. Show how to validate ONT connectivity to IoT devices and smart home systems, ensuring proper data throughput.
6. Describe the key FTTH GPON components, their functions, and GPON technology including splitters, ONT configuration, and VLAN management.
7. Demonstrate how to check and prepare customer premises for installing Customer Premises Equipment (CPE), follow GPON installation procedures ensuring correct splitter connections and fiber termination, and conduct comprehensive tests for connectivity and data speeds at the customer's end using tools like OTDR and fiber testers.
8. Explain the basics of network security, including encryption protocols, firewalls, access control mechanisms, and cybersecurity considerations in FTTH networks.
9. Show how to identify potential cybersecurity vulnerabilities in FTTH installations and mitigate risks using secure installation practices, configure ONTs with secure settings including password protection, encryption protocols, and firewalls, and conduct penetration tests to identify potential security risks and validate network integrity.
10. Describe Safety, Health, and Environmental (SHE) and occupational health and safety (OHS) regulations for fiber installations.
11. Show how to ensure proper sealing of conduits to avoid dust, moisture, or pest intrusion.
12. Elucidate the documentation requirements for installation, testing, and cybersecurity compliance.
13. Demonstrate how to provide customers with guidelines for maintaining network security, including password updates and device firmware updates.
14. Explain the role of AI-driven network management and automation tools for monitoring fiber performance and diagnosing faults remotely.
15. Show how to troubleshoot network issues related to CPE, resolve common complaints related to fiber connectivity, signal loss, and ONT/router configurations, and provide basic troubleshooting training to customers, explaining technical details in easy terms and addressing their concerns.
16. Demonstrate how to check the site as per the building layout plan, identify the cabling path from the outdoor fiber landing point to the ONT installation point, and determine horizontal and vertical cable lengths, considering slack for maintenance and future upgrades.
17. Show how to check load compliance of cable trays, ensure compatibility with existing services like power and data cables, and lay fiber along tray tracks using proper pulling techniques, ensuring no damage to the cable jacket or core.
18. Demonstrate how to secure fibers in the trays, maintaining proper slack and tension to avoid over-tensioning in vertical runs and ensure proper grounding of metallic trays in line with safety standards.
19. Demonstrate how to pull fiber through conduits using appropriate tools, secure excess fiber (minimum of 3 meters) at termination points for maintenance purposes and inspect conduit integrity to prevent electromagnetic interference or mechanical damage.
20. Describe the Triple-Play service requirements (internet, voice, video) and their impact on network infrastructure, and how to optimize Quality of Service (QoS) parameters, such as latency, jitter, and throughput.

21. Show how to determine the infrastructure requirements for Triple-Play services, configure ONT settings to enable these services, and test High-Speed Internet, VoIP, and IPTV services for Quality of Service (QoS) parameters like latency, jitter, and packet loss.
22. Discuss future trends in IoE, innovations in smart home technologies, and the impact of these developments on triple-play services.
23. Demonstrate how to optimize FTTH installations for emerging IoE applications, ensuring minimal latency and maximum reliability.
24. Demonstrate how to install cables through false ceilings using the figure-8 method to prevent tangling or cable stress, secure cables in conduits above false ceilings to prevent dislodgement and ensure slack management.
25. Show how to ensure accessibility for future maintenance by marking cable routes clearly.
26. Demonstrate how to terminate and connectorize fiber at the ONT, ensuring signal integrity and minimal loss, power up and configure the ONT for operational readiness, and conduct live fiber testing using tools like Visual Fault Locator (VFL) and power meters to confirm signal integrity.
27. Demonstrate how to determine IoT device connectivity requirements such as bandwidth and latency, install network elements or CPEs for IoT devices, and configure ONTs to support IoT devices like smart thermostats, cameras, and voice assistants.
28. Show how to test IoT device compatibility with installed FTTH networks to ensure seamless integration and coordinate with customers for specific IoT device setups and provide technical guidance.
29. Demonstrate how to coordinate with service providers to address issues with VoIP call quality, IPTV buffering, or internet speeds.
30. Show how to identify the scope of IoE and its impact on FTTH network design and installation, integrate IoE-compatible devices into the FTTH network ensuring seamless communication between devices, and follow future trends in IoE while identifying scalable network solutions for customers.

UNIT 6.1: Fiber Testing

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the industry standards and best practices for outside plant fiber testing using tools such as LSPM, OTDR, VFL, OLTS, and optical fiber microscopes.
2. Discuss the importance of adhering to standardized testing protocols, integrating remote monitoring tools for proactive issue identification.
3. Elucidate occupational health and safety regulations for fiber testing operations, including laser safety and handling of high-performance connectors.
4. Explain the significance of units like dB, dBm, and mW in fiber measurement, including conversion and relevance across different testing scenarios.
5. Explain the principles of optical power measurement, including attenuation, reflection, insertion loss, and return loss, while highlighting the role of remote diagnostics.
6. Describe the performance characteristics of different fiber types under varying environmental conditions, ensuring accurate diagnostics in diverse network configurations.
7. Demonstrate how to measure optical parameters including optical power, insertion loss, attenuation, and reflection using LSPM, OTDR, VFL, OLTS, and fiber microscopes.
8. Show how to perform power-loss measurements on single-mode and multimode fibers using single-ended and double-ended testing.
9. Demonstrate continuity and polarity testing using tracers and light sources as part of preventive maintenance protocols.
10. Demonstrate accurate use of an Optical Power Meter and light source to assess link performance and insertion loss.
11. Demonstrate Optical Loss Test Set (OLTS) procedures for validating link conformance and certifying installation quality.
12. Show how to inspect and clean fiber end faces and connector interfaces using fiber scopes and approved cleaning methods.
13. Show how to calibrate and maintain fiber testing instruments according to manufacturer guidelines to ensure measurement accuracy.

Resources to be Used

Participant handbook, Fiber optic cables (different types and characteristics), fiber handling tools (e.g., cable cutters, strippers, splicers), visual aids (diagrams, charts, images), fiber cable components samples (strength members, cable sheath, core, cladding), vlf (very low frequency) testing equipment

Say

- Hello, everyone! Welcome to today's session on the Basics of Fiber Optics.
- In this session, we will explore the fundamental aspects of fiber optics, including cable types, fiber handling practices, cable components, and the VLF principle and testing features.
- Understanding these basics is crucial for anyone working with fiber optic networks.
- By grasping the concepts, you'll be able to identify different cable types, handle fiber properly, comprehend cable components, and apply VLF testing for reliable network performance."

Do

- Begin the session with an overview of the topics to be covered, setting the context for participants.
- Use visual aids and real-life examples to enhance understanding and engagement.
- Encourage active participation by asking questions, facilitating discussions, and inviting participants to share their experiences or insights.
- Explain the VLF principle and demonstrate the testing features using appropriate equipment.

Ask

- Can you name any type of fiber optic cables used in in-building deployments?
- Why is it important to follow appropriate fiber handling practices?
- Can you name some essential components of a fiber optic cable and describe their functions?

Elaborate

- Fiber optic cable types and characteristics for in-building deployments:
  - Differentiate between single-mode and multimode cables.
  - Understand the characteristics and applications of each type.
- Fiber handling practices:
  - Explain the importance of cleanliness and avoiding bending or twisting the fiber.
  - Showcase proper techniques for cutting, stripping, and splicing fiber cables.
- Fiber cable components (strength members, cable sheath, core, cladding, etc.):
  - Identify the different parts of a fiber optic cable and their roles.
  - Discuss the characteristics and materials used in each component.
- VLF principle and testing features:
  - Explain the concept of Very Low Frequency (VLF) testing and its benefits.
  - Outline the testing procedure and the equipment used for VLF testing.

Demonstrate

Demonstrate proper fiber handling practices, including cable cutting, stripping, and splicing, using the appropriate tools and techniques.

Activity

- **Activity name:** Fiber Cable Identification
- **Objective:** To practice identifying fiber optic cable types and their characteristics.
- **Type of activity:** Group
- **Resources:** Samples of different fiber optic cables (single-mode and multimode), Visual aids with cable type characteristics
- **Time Duration:** 30 minutes
- **Instructions:**
  - Divide participants into groups of 3-4.
  - Provide each group with samples of different fiber optic cables.
  - Instruct groups to examine the cables closely and identify the cable types (single-mode or multimode).
  - Ask groups to discuss and list the characteristics or features that differentiate each cable type.
  - Allow time for each group to present their findings and discuss any variations or similarities.
  - Facilitate a group discussion to reinforce understanding and address any questions or misconceptions.
- **Outcome:** Participants will enhance their ability to distinguish fiber optic cable types and understand their respective characteristics.

Notes for Facilitation

- Create a positive and inclusive learning environment.
- Encourage active participation and respect diverse perspectives.
- Use clear and concise language to explain technical concepts.
- Foster collaboration and teamwork during group activities.
- Emphasize the importance of cleanliness and careful handling to maintain fiber integrity.
- Highlight the significance of cable component identification for troubleshooting and installation purposes.

UNIT 6.2: Installation of Optical Fibers

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Discuss the tools for fiber installation (e.g., fish tape, splicing machines, OTDR, VFL) and the techniques to measure signal loss and maintain network performance.
2. Demonstrate how to check and prepare customer premises for installing Customer Premises Equipment (CPE), follow GPON installation procedures ensuring correct splitter connections and fiber termination, and conduct comprehensive tests for connectivity and data speeds at the customer's end using tools like OTDR and fiber testers.
3. Show how to ensure proper sealing of conduits to avoid dust, moisture, or pest intrusion.
4. Demonstrate how to check the site as per the building layout plan, identify the cabling path from the outdoor fiber landing point to the ONT installation point, and determine horizontal and vertical cable lengths, considering slack for maintenance and future upgrades.
5. Show how to check load compliance of cable trays, ensure compatibility with existing services like power and data cables, and lay fiber along tray tracks using proper pulling techniques, ensuring no damage to the cable jacket or core.
6. Demonstrate how to secure fibers in the trays, maintaining proper slack and tension to avoid over-tensioning in vertical runs and ensure proper grounding of metallic trays in line with safety standards.
7. Demonstrate how to pull fiber through conduits using appropriate tools, secure excess fiber (minimum of 3 meters) at termination points for maintenance purposes and inspect conduit integrity to prevent electromagnetic interference or mechanical damage.
8. Demonstrate how to install cables through false ceilings using the figure-8 method to prevent tangling or cable stress, secure cables in conduits above false ceilings to prevent dislodgement and ensure slack management.
9. Show how to ensure accessibility for future maintenance by marking cable routes clearly.
10. Demonstrate how to terminate and connectorize fiber at the ONT, ensuring signal integrity and minimal loss, power up and configure the ONT for operational readiness, and conduct live fiber testing using tools like Visual Fault Locator (VFL) and power meters to confirm signal integrity.
11. Demonstrate how to determine IoT device connectivity requirements such as bandwidth and latency, install network elements or CPEs for IoT devices, and configure ONTs to support IoT devices like smart thermostats, cameras, and voice assistants.
12. Demonstrate how to optimize FTTH installations for emerging IoE applications, ensuring minimal latency and maximum reliability.

Resources to be Used

Participant handbook, Fiber fusion splicer, inspection tools (e.g., site plans, measuring tape), cable management materials (cable ties, trays, slack storage), load compliance measurement tools, conduit installation materials (conduits, false ceiling samples), fiber pulling tools (fish tape, strength member, fiber termination materials (connectors, termination boxes)

Say

- Hello, everyone! Welcome to today's session on the Installation of Optical Fibers.
- In this session, we will cover various aspects of fiber optic cable installation, including fusion splicing, site inspection, cable slack management, cable length calculation, cable tray load compliance, conduit installation, fiber pulling, and securing excess fiber.
- Understanding these installation techniques and best practices is essential for ensuring proper fiber optic network connectivity, performance, and reliability.
- By mastering these skills, you'll be able to install optical fibers efficiently and effectively.

Do

- Begin the session by providing an overview of the topics to be covered, setting the context for participants.
- Use visual aids, diagrams, and real-life examples to enhance understanding and engagement.
- Encourage active participation by asking questions, facilitating discussions, and inviting participants to share their experiences or insights.

Ask

- What is fusion splicing, and why is it important in fiber optic cable installation?
- Why is it necessary to inspect the site before installation?

Elaborate

- Fusion splicing:
  - Explain the concept and benefits of fusion splicing.
  - Highlight the importance of achieving low splice losses and maintaining fiber alignment.
- Inspection of the sites to identify the cabling path:
  - Explain the purpose and process of site inspection.
  - Provide guidelines for identifying the optimal cabling path from the outdoor fiber landing point to the ONT installation point.
  - Discuss potential obstacles or considerations during the inspection.
- Explain the importance and relevance of managing cable slack and cable management:
  - Discuss the impact of cable slack on installation, maintenance, and future upgrades.
  - Explain different cable management techniques and materials.
  - Emphasize the importance of proper cable organization, routing, and securing.
- Calculate the horizontal and vertical cable length to manage cable slack:
  - Explain how to calculate the cable length needed for horizontal and vertical runs.
  - Discuss factors influencing cable length calculations, such as bends, slack storage, and service loops.
- Measure the pre-existing load and post-installation load compliance of the cable trays:
  - Explain the importance of load compliance in cable tray installation.
  - Demonstrate the process of measuring load compliance using appropriate tools.
  - Discuss the significance of load compliance for cable protection and network performance.

  - Demonstrate the process of measuring load compliance using appropriate tools.
  - Discuss the significance of load compliance for cable protection and network performance.
- Cable installation through conduits on false ceiling:
  Explain the process of conduit installation on a false ceiling.
  - Highlight considerations for maintaining cable integrity during the installation process.
- Fiber pulling through conduits using appropriate tools (like fish tape) and technique (strength member):
  - Explain the purpose and steps involved in fiber pulling through conduits.
  - Demonstrate the use of tools such as fish tape and strength members.
  - Highlight best practices for minimizing tension and protecting the fiber during pulling.
- Secure excess fiber at the termination point:
  - Explain the importance of securing excess fiber and managing termination points.

Demonstrate

Demonstrate the process of fusion splicing using a fusion splicer.

Activity

- Activity name: Cable Slack Management
- Objective: To practice calculating and managing cable slack in a simulated installation scenario.
- Type of activity: Group
- Resources: Simulated cable lengths, cable ties, cable trays, measuring tape, scissors.
- Time Duration: 20-30 minutes
- Instructions:
  - Divide participants into groups of 3-4.
  - Provide each group with simulated cable lengths and cable management materials.
  - Instruct participants to calculate the required cable length and manage the cable slack using cable ties, cable trays, or other appropriate techniques.
  - Encourage participants to discuss their approaches, collaborate, and troubleshoot any challenges.
  - Allocate time for each group to present their cable slack management solutions to the rest of the class.
- Outcome: Participants will gain hands-on experience in calculating and managing cable slack, as well as insights into different cable management techniques.

Notes for Facilitation

- Encourage active participation and create a supportive learning environment.
- Provide clear instructions and demonstrate techniques whenever possible.
- Foster collaboration and group discussions to enhance learning and knowledge sharing.
- Address questions and concerns promptly, promoting a two-way communication flow.
- Emphasize the significance of fusion splicing for achieving low loss and reliable fiber connections.

UNIT 6.3: Testing Installed Network

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to validate ONT connectivity to IoT devices and smart home systems, ensuring proper data throughput.
2. Show how to identify potential cybersecurity vulnerabilities in FTTH installations and mitigate risks using secure installation practices, configure ONTs with secure settings including password protection, encryption protocols, and firewalls, and conduct penetration tests to identify potential security risks and validate network integrity.
3. Elucidate the documentation requirements for installation, testing, and cybersecurity compliance.
4. Demonstrate how to provide customers with guidelines for maintaining network security, including password updates and device firmware updates.
5. Show how to troubleshoot network issues related to CPE, resolve common complaints related to fiber connectivity, signal loss, and ONT/router configurations, and provide basic troubleshooting training to customers, explaining technical details in easy terms and addressing their concerns.
6. Show how to determine the infrastructure requirements for Triple-Play services, configure ONT settings to enable these services, and test High-Speed Internet, VoIP, and IPTV services for Quality of Service (QoS) parameters like latency, jitter, and packet loss.
7. Show how to test IoT device compatibility with installed FTTH networks to ensure seamless integration and coordinate with customers for specific IoT device setups and provide technical guidance.
8. Demonstrate how to coordinate with service providers to address issues with VoIP call quality, IPTV buffering, or internet speeds.

Resources to be Used

Participant handbook, Optical Network Terminal (ONT), Telecommunication Outlet (TO), IP network for ONT configuration and testing, Visual Fault Locator (VFL), Fiber detection meter, Test record sheets

Say

- Good day, everyone! Welcome to today's session on Testing Installed Network.
- In this session, we will cover the essential steps and tools involved in testing an installed fiber optic network.
- We will learn how to terminate fibers at the Optical Network Terminal (ONT) and Telecommunication Outlet (TO), configure the ONT, conduct network tests using an IP network, operate a Visual Fault Locator (VFL), test live fibers using a fiber detection meter, and record test values.
- Understanding these testing procedures is crucial for verifying the quality and performance of an installed network.
- By mastering these techniques, you'll be able to ensure proper network connectivity, troubleshoot issues effectively, and maintain reliable fiber optic connections.

Do

- Begin the session by providing an overview of the topics to be covered, setting the context for participants.
- Use visual aids, diagrams, and real-life examples to enhance understanding and engagement.
- Encourage active participation by asking questions, facilitating discussions, and inviting participants to share their experiences or insights.

Ask

- What is the purpose of fiber termination at the ONT and TO?
- How can we configure an ONT after providing the power supply?
- Why is it necessary to conduct network tests using an IP network?

Elaborate

- Fiber termination at the ONT and TO:
  - Explain the process of fiber termination at the ONT and TO.
  - Highlight the importance of accurate and reliable fiber connections for network performance.
- Configure the ONT after providing the power supply:
  - Explain the steps involved in ONT configuration, such as accessing the configuration interface and setting up network parameters.
  - Discuss common configuration settings and considerations.
- ONT test using an IP network:
  - Explain the purpose of ONT testing using an IP network.
  - Discuss the interpretation of test results and troubleshooting techniques.
- Operate Visual Fault Locator (VFL) for the installed fiber run:
  - Explain the purpose and operation of a Visual Fault Locator.
  - Discuss safety precautions and best practices for using a VFL effectively.
- Test the live fiber using a fiber detection meter:
  - Explain the purpose of live fiber testing and the role of a fiber detection meter.
  - Discuss the significance of accurate live fiber testing for network performance and troubleshooting.

Demonstrate

Demonstrate the process of fiber termination at the ONT and TO, showcasing the proper techniques for stripping, cleaning, and securing the fibers.

Activity

- **Activity name:** Test Value Recording
- **Objective:** To practice recording test values accurately and systematically.
- **Type of activity:** Individual
- **Resources:** Test record sheets, pens/pencils.
- **Time Duration:** 20-30 minutes
- **Instructions:a**
  - Distribute test record sheets to each participant.
  - Provide sample test scenarios or results.
    - Instruct participants to record the test values systematically, including details such as date, time, location, test parameters, and measurements.
    - Encourage participants to review their recorded values and ensure clarity and consistency.
    - Allocate time for participants to share their test record sheets and discuss any observations or challenges faced.
- **Outcome:** Participants will enhance their skills in accurately recording test values, ensuring traceability and facilitating future troubleshooting or maintenance activities.

Notes for Facilitation

- Maintain a positive and engaging learning environment.
- Encourage active participation, questions, and discussions.
- Provide clear instructions and demonstrations.
- Foster collaboration and peer learning opportunities.
- Emphasize the importance of proper fiber termination for reliable network performance.
- Highlight the significance of accurate ONT configuration for seamless network connectivity.

Exercise

Answers to exercises for PHB

Answers to exercises for PHB

A. Short Answer Questions:

1. LSPM, OTDR, VFL, OLTS, and fiber microscopes are used to measure loss, detect faults, inspect connector cleanliness, and verify link performance. Together they ensure the fiber meets required transmission standards before activation.
2. Standardized testing protocols ensure accurate measurements, consistent documentation, and early detection of defects. This prevents future outages and supports long-term network stability.
3. Key safety regulations include: wearing PPE, following laser safety rules (Class 1M/3B precautions), avoiding direct eye exposure, using lockout/tag-out procedures, and ensuring safe handling of fiber scraps and chemicals.
4. OTDR trace interpretation involves analyzing reflection peaks, splice loss values, and sudden drops in power to identify breaks, high-loss joints, dirty connectors, and bending issues.
5. Proper calibration and maintenance ensure measurement accuracy, prevent false readings, and extend instrument life, ensuring reliable field test results.

B. Multiple Choice Questions (MCQs):

1. c) dBm
2. b) Identifying visible faults like sharp bends or breaks in short-distance fibers
3. b) Validate consistency of loss measurements in both directions
4. b) Continuity and polarity testing using tracers and light sources
5. b) Accurate and consistent measurement results across testing scenarios

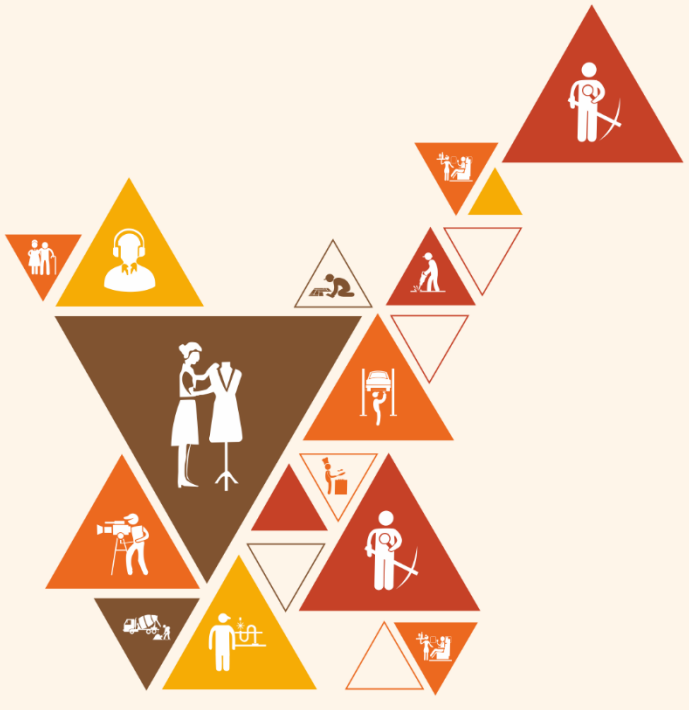
C. Fill in the Blanks:

1. OLTS (Optical Loss Test Set)
2. poor / high-loss
3. insertion loss
4. dBm
5. OTDR (or “measurement”) data

Notes

7. Work Safety Practices with Fiber Optics

Unit 7.1 - Safety Regulations, Roles, and Worksite Hazard Awareness
Unit 7.2 - Site Safety, Infrastructure Awareness, Fire/Electrical Safety & Hazard Control



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Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Explain the construction of fiber optics and methods for protecting fibers from environmental damage.
2. Describe required PPE for fiber optic installations, including safety glasses and cut-resistant gloves.
3. Elucidate the benefits of PPE in terms of safety, injury prevention, and regulatory compliance.
4. Discuss safety features, limitations, and maintenance of protective equipment.
5. Explain laser safety guidelines and risk levels of various laser classes used in fiber optics.
6. Describe hazards such as micro-shards and laser exposure, along with safe disposal practices for fiber scraps.
7. Demonstrate appropriate eye-safety measures when working with laser-emitting devices like ONTs and splicing equipment.
8. Show how to safely handle bare fiber, broken ends, and scraps, ensuring proper disposal.
9. Demonstrate safe handling of Class 1M and higher laser devices following laser safety rules.
10. Show how to use and maintain safety gear such as gloves, boots, and protective eyewear.
11. Explain the construction of fiber optics and methods for protecting fibers from environmental damage.
12. Describe required PPE for fiber optic installations, including safety glasses and cut-resistant gloves.
13. Elucidate the benefits of PPE in terms of safety, injury prevention, and regulatory compliance.
14. Discuss safety features, limitations, and maintenance of protective equipment.
15. Explain laser safety guidelines and risk levels of various laser classes used in fiber optics.
16. Describe hazards such as micro-shards and laser exposure, along with safe disposal practices for fiber scraps.
17. Demonstrate appropriate eye-safety measures when working with laser-emitting devices like ONTs and splicing equipment.
18. Show how to safely handle bare fiber, broken ends, and scraps, ensuring proper disposal.
19. Demonstrate safe handling of Class 1M and higher laser devices following laser safety rules.
20. Show how to use and maintain safety gear such as gloves, boots, and protective eyewear.
21. Discuss layout of associated services such as gas pipelines and electrical cables and how to avoid consequential damage.
22. Demonstrate fire safety practices when using high-voltage arc fusion splicers and heating tools.
23. Show how to adhere to electrical safety norms when working alongside electrical cables and active power sources.
24. Demonstrate how to identify and mitigate hazards like confined spaces, sharp edges, and high temperatures.
25. Show how to safely handle pre-terminated fiber assemblies and connectors to prevent contamination or damage.
26. Describe procedures for handling emergency situations, including accidental fiber cuts and high-voltage exposure.
27. Identify different health and safety hazards at FTTH installation sites and define limits of personal responsibility.
28. Discuss roles and responsibilities related to legislative and organizational safety procedures.
29. Discuss the importance of maintaining high standards of safety and implications of non-compliance.
30. Demonstrate safe cable routing techniques to avoid damage to existing infrastructure (gas, electrical, water pipelines).

UNIT 7.1: Safety Regulations, Roles, and Worksite Hazard Awareness

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Identify different health and safety hazards at FTTH installation sites and define limits of personal responsibility.
2. Discuss roles and responsibilities related to legislative and organizational safety procedures.
3. Discuss the importance of maintaining high standards of safety and implications of non-compliance.
4. Discuss layout of associated services such as gas pipelines and electrical cables and how to avoid consequential damage.
5. Show how to adhere to electrical safety norms when working alongside electrical cables and active power sources.
6. Demonstrate how to identify and mitigate hazards like confined spaces, sharp edges, and high temperatures.
7. Demonstrate fire safety practices when using high-voltage fusion splicers and heating tools.
8. Describe the implications that any non-compliance with health, safety and security may have on individuals and the organization.

Resources to be Used

Participant handbook, Legislative requirements and organizational procedures for health, safety, and security, hazard identification and reporting tools (e.g., checklist, incident report form), examples or case studies illustrating non-compliance consequences, visual aids (e.g., powerpoint slides, videos) for explanation and illustration purposes

Say

- Hello, everyone! Welcome to today's session on Safety Rules in Work Maintenance.
- In this session, we will cover important topics related to health, safety, and security in the workplace.
- We will understand legislative requirements and organizational procedures, learn about different types of hazards, explore the process of reporting hazards, discuss the limits of responsibility for dealing with hazards, and understand the significance of maintaining high standards of health, safety, and security.
- Understanding these safety rules is crucial to ensure the well-being of individuals, prevent accidents, and maintain a safe working environment.
- By adhering to these rules, we can protect ourselves, our colleagues, and the organization as a whole.

Do

- Start by providing an overview of the topics to be covered, setting the context for participants.
- Use visual aids, examples, and case studies to enhance understanding and engagement.
- Facilitate discussions and encourage participants to share their experiences, concerns, or insights related to workplace safety.
- Highlight the importance of compliance with legislative requirements and organizational procedures.
- Emphasize the role and responsibilities of individuals in maintaining a safe work environment.

Elaborate

- Legislative requirements and organizational procedures for health, safety, and security and role and responsibilities:
  - Explain the importance of complying with laws and regulations pertaining to health, safety, and security.
  - Discuss the role of organizations in implementing policies, procedures, and training programs to ensure a safe work environment.
  - Highlight the responsibilities of individuals in following safety rules and promoting a culture of safety.
- Hazards:
  - Define hazards and their significance in the context of workplace safety.
  - Discuss various types of hazards, such as physical, chemical, biological, ergonomic, and psychosocial hazards.
  - Provide examples and scenarios to illustrate each type of hazard.
- Preparing to report hazards:
  - Explain the importance of promptly reporting hazards to prevent accidents or injuries.
  - Discuss the steps involved in identifying, documenting, and reporting hazards.
  - Provide guidance on using reporting tools, such as checklists or incident report forms.
- Dealing with hazards:
  - Clarify the boundaries and limitations of individual responsibility in addressing hazards.
  - Discuss the role of supervisors, managers, and safety professionals in hazard management.
  - Highlight the importance of effective communication and collaboration in addressing hazards.
- Maintaining high standards of health, safety, and security:
  - Discuss the benefits of maintaining a safe work environment, including improved productivity, morale, and reputation.
  - Emphasize the role of individuals in adhering to safety rules, implementing best practices, and promoting a safety culture.
- Non-compliance with health, safety, and security:
  - Discuss the potential consequences of non-compliance, such as accidents, injuries, legal issues, reputational damage, and financial losses.
  - Highlight the importance of understanding and adhering to safety regulations to protect oneself and others.

Demonstrate

Conduct a hazard identification and reporting demonstration, showcasing how to identify potential hazards in the workplace, document them using a reporting tool, and report them to the appropriate authority.

Activity

- **Activity name:** Hazard Identification and Reporting
- **Objective:** To practice identifying hazards and reporting them effectively.
- **Type of activity:** Group
- **Resources:** Hazard identification checklist, incident report forms, pens/pencils.
- **Time Duration:** 25-30 minutes
- **Instructions:**
  - Divide participants into small groups.
  - Distribute hazard identification checklists and incident report forms to each group.
  - Instruct groups to identify potential hazards in a given workplace scenario using the checklist.
  - Ask groups to document the identified hazards on the incident report forms, including necessary details and recommended actions.
  - Allocate time for groups to discuss their findings and share their reports with the rest of the participants.
  - Facilitate a group discussion to analyze the identified hazards, review the reporting process, and discuss any challenges or insights.
- **Outcome:** Participants will enhance their skills in identifying hazards, documenting them, and understanding the importance of reporting for effective hazard management.

Notes for Facilitation

- Create a safe and inclusive learning environment.
- Encourage active participation and open discussion.
- Provide clear explanations and examples to facilitate understanding.
- Foster a sense of responsibility and ownership for workplace safety.
- Be sensitive to participants' concerns and experiences related to safety issues.
- Emphasize the significance of understanding legislative requirements and organizational procedures for maintaining a safe work environment.
- Encourage participants to actively participate in hazard identification and reporting activities.
- Encourage participants to share best practices and practical tips for ensuring safety in the workplace.

UNIT 7.2: Site Safety, Infrastructure Awareness, Fire/Electrical Safety & Hazard Control

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Describe required PPE for fiber optic installations, including safety glasses and cut-resistant gloves.
2. Elucidate the benefits of PPE in terms of safety, injury prevention, and regulatory compliance.
3. Discuss safety features, limitations, and maintenance of protective equipment.
4. Explain laser safety guidelines and risk levels of various laser classes used in fiber optics.
5. Describe hazards such as micro-shards & laser exposure, along with safe disposal practices for fiber scraps.
6. Demonstrate eye-safety measures when working with laser-emitting devices like ONTs and splicing.
7. Show how to safely handle bare fiber, broken ends, and scraps, ensuring proper disposal.
8. Demonstrate safe handling of Class 1M and higher laser devices following laser safety rules.
9. Show how to use and maintain safety gear such as gloves, boots, and protective eyewear.
10. Describe hazards such as micro-shards & laser exposure, along with safe disposal practices for fiber scraps.
11. Demonstrate fire safety practices when using high-voltage arc fusion splicers and heating tools.
12. Show how to adhere to electrical safety norms when working alongside electrical cables and active power sources.
13. Explain the importance of maintaining high standards of health, safety and security.

Resources to be Used

Participant handbook, Safety guidelines and procedures for fiber optic installations, eye protection equipment (safety goggles), tools for handling bare fiber (fiber scrap container, fiber cleaning supplies), manufacturer supplied material safety data sheets (MSDS), fire safety guidelines for using electric arc fusion splicers, visual aids (e.g., PowerPoint slides, videos) to illustrate fiber construction and safety features of protective equipment and gears

Say

- Hello, everyone! Welcome to today's session on Work Safety Practices in Optical Fiber Installation.
- In this session, we will focus on ensuring safety during fiber optic installations.
- We will learn about performing fiber work safely, wearing proper eye protection, handling bare fiber safely, comparing material safety data sheets, following fire safety practices, understanding fiber construction, and identifying safety features of protective equipment and gears.
- Understanding and practicing work safety in fiber optic installations is essential to protect ourselves from potential hazards and ensure the integrity of the optical fiber network.
- By adhering to these safety practices, we can prevent injuries, damage to equipment, and maintain the quality of installations.

Do

- Start by providing an overview of the topics to be covered, setting the context for participants.
- Use visual aids, diagrams, and videos to enhance understanding and engagement.
- Explain safety guidelines and procedures step by step, emphasizing the importance of each practice.
- Encourage participants to ask questions and share their experiences related to work safety in fiber optic installations.

Ask

- Why is it important to wear proper eye protection during fiber optic installations?
- How can we handle bare fiber safely to prevent injuries and equipment damage?
- What are some fire safety practices to follow while using electric arc fusion splicers?

Elaborate

- Fiber work safely in fiber optic installations:
  - Explain the importance of following safety guidelines and procedures throughout the installation process.
  - Discuss practices such as proper cable management, avoiding excessive pulling tension, and securing cables to prevent tripping hazards.
- Eye-safety to protect cornea or lens during work:
  - Highlight the potential risks to the eyes during fiber optic installations.
  - Explain the importance of wearing safety goggles or eye protection to prevent injuries from fiber shards or other debris.
- Bare fiber from broken ends of fibers and scraps of fibers during termination and splicing:
  - Discuss safe handling techniques for bare fiber, including using designated containers for fiber scraps and avoiding direct contact with broken fiber ends.
  - Emphasize the importance of using appropriate tools and fiber cleaning supplies to maintain cleanliness and prevent contamination.
- Manufacturer supplied material safety data sheet (MSDS) with on-ground materials:
  - Explain the purpose of material safety data sheets (MSDS) and their relevance to safety in fiber optic installations.
  - Discuss how to compare MSDS provided by manufacturers with the actual materials being used on-site to identify any potential hazards or precautions.
- Fire safety practices while using electric arc to make fusion splicers:
  - Explain the fire risks associated with electric arc fusion splicers.
  - Discuss fire safety guidelines, such as keeping flammable materials away, ensuring proper ventilation, and having fire extinguishing equipment readily available.
- Construct of fiber and the damage the fiber constituent material can cause:
  - Explain the composition and structure of optical fibers.
  - Discuss how damage to the fiber's constituent materials can affect its performance and safety.
- Safety features of protective equipment and gears:
  - Identify and discuss the different safety features present in protective equipment and gears used in fiber optic installations, such as gloves, helmets, and high-visibility vests.

Field Visit

Conduct a field visit showcasing the correct use of safety goggles and proper handling techniques for bare fiber, emphasizing the importance of adherence to safety practices.

Activity

- **Activity name:** Fiber Safety Equipment Inspection
- **Objective:** To identify and understand the safety features of protective equipment and gears used in fiber optic installations.
- **Type of activity:** Group
- **Resources:** Sample safety equipment (safety goggles, gloves, helmets, high-visibility vests), inspection checklist.
- **Time Duration:** 30 minutes
- **Instructions:**
  - Divide participants into small groups.
  - Provide each group with a set of safety equipment.
  - Instruct groups to inspect the safety equipment and identify the safety features present.
  - Ask groups to discuss and record their findings on the inspection checklist.
  - Allocate time for groups to present their findings and discuss the importance of each safety feature.
  - Facilitate a group discussion to share insights and address any questions or concerns.
- **Outcome:** Participants will enhance their knowledge of safety features in protective equipment and gears used in fiber optic installations.

Notes for Facilitation

- Create a safe and inclusive learning environment.
- Encourage active participation and open discussion.
- Demonstrate safety practices and reinforce their importance.
- Highlight the potential risks and hazards associated with incorrect safety practices.
- Encourage participants to actively engage in the safety equipment inspection activity and discuss the significance of safety features.
- Discuss the role of personal responsibility and vigilance in promoting work safety practices.

Exercise

Answers to exercises for PHB

Multiple Choice Questions:

1. a. Safety goggles
2. a. Protective equipment and gear
3. a. Emergency procedures
4. a. Laser radiation
5. a. Laser equipment

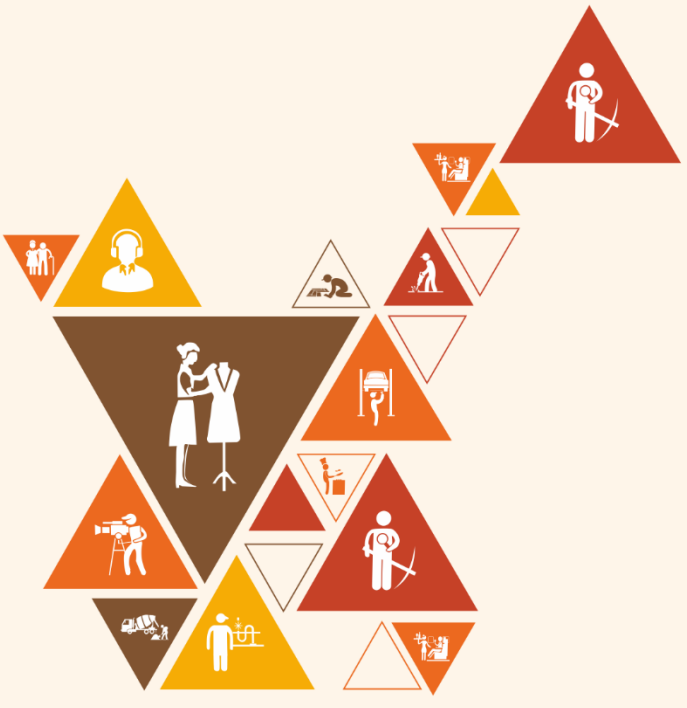
Descriptive Questions:

1. Refer to Unit 7.2 Work safety practices in optical fibre installation
   Topic 7.2.6 Laser safety norms
2. Refer to Unit 7.1 Safety rules in work maintenance
   Topic 7.1.2 Health and safety hazards in a work place
3. Refer to Unit 7.1 Safety rules in work maintenance
   Topic 7.1.4 Responsibility for dealing with hazards
4. Refer to Unit 7.2 Work safety practices in optical fibre installation
   Topic 7.2.4 Fire safety practices while using electric arc to make fusion splicers
5. Refer to Unit 7.2 Work safety practices in optical fibre installation
   Topic 7.2.8 Cause that leads to the damage the fiber constituent material

Notes

8. Follow Sustainability Practices in Telecom Cabling Operations

Unit 8.1 - Sustainability Practices in Telecom Cabling Operations



TEL/N9111

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Identify recyclable, reusable, and hazardous materials in fiber optic installations and explain how to categorize them.
2. Describe the waste management, recycling, and disposal protocols for materials used in fiber optic installations.
3. Explain how to optimize material and energy usage during cabling work in fiber optic installations.
4. Discuss the environmental and regulatory standards that must be complied with during fiber optic installations.

UNIT 8.1: Sustainability Practices in Telecom Cabling Operations

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain organizational policies on sustainability, waste reduction, and material reuse in telecom infrastructure projects.
2. Describe the procedures for recycling, hazardous waste handling, and safe disposal of telecom-related materials.
3. Discuss the importance of sustainability in long-term infrastructure planning and the environmental impact of telecom waste.
4. Elucidate the classification of materials used in optical fiber cabling, including recyclable, reusable, and hazardous components.
5. Explain standard waste management procedures for telecom operations, including segregation, labeling, and disposal methods.
6. Describe methods to reduce material wastage, such as accurate measurements, careful handling of fiber optic cables, and optimized trenching techniques.
7. Discuss the environmental hazards associated with improper disposal of optical fibers, batteries, and chemical adhesives.
8. Explain the regulations and compliance requirements for hazardous material disposal under national and international environmental laws.
9. Elucidate energy-efficient work practices, including low-power tools, optimized route planning, and reduced excavation techniques.
10. Describe the importance of proper record-keeping for disposal and recycling to ensure compliance and accountability.
11. Demonstrate how to identify, segregate, and store materials used in cabling operations, including recyclable, reusable, and hazardous materials, ensuring compliance with safety and waste management procedures.
12. Show how to follow SOPs for safe handling, disposal, and documentation of non-recyclable and hazardous materials, including fiber shards, cable sheaths, and chemical adhesives.
13. Demonstrate how to ensure proper labeling, safe storage, and disposal of hazardous waste to prevent contamination or accidents.
14. Show how to minimize waste by reducing excess material use, reusing components, and optimizing cabling work through accurate measurements and efficient layout designs.
15. Demonstrate how to maintain clean, organized work sites to prevent environmental contamination, promote safety, and comply with environmental guidelines.
16. Show how to use energy-efficient tools and machinery and ensure proper maintenance of cabling tools and equipment to reduce material consumption and unnecessary repairs.
17. Demonstrate how to coordinate and dispose of waste materials at designated collection points and report any violations or environmental hazards.
18. Show how to use and promote eco-friendly materials, such as low-impact protective coatings and biodegradable packaging.
19. Demonstrate how to follow national and local environmental regulations, workplace policies, and sustainability practices related to telecom cabling operations.
20. Show how to maintain accurate documentation of sustainability activities, including logs of disposed and recycled materials, to meet regulatory and audit requirements.
21. Demonstrate how to conduct periodic self-audits and educate team members on best practices for sustainability, waste segregation, and responsible energy consumption.
22. Show how to report violations of environmental policies, hazardous material spills, or unsafe disposal practices to the designated supervisor or regulatory body.

Resources to be Used

- Participant handbook, pen, pencil, notepad, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, PPE kit, sample cable sheaths, fiber scraps (dummy), waste bins (color-coded), eco-friendly materials, safety labels, documentation logs.

Note

In this unit, we will explore how sustainability is practiced during telecom cabling operations and how technicians can reduce waste and environmental impact during field work.

Say

- Good Morning everyone!
- Today we will discuss one of the most important aspects of modern telecom operations—working in a way that protects the environment and reduces waste. Every technician plays a key role in sustainability, from selecting materials to maintaining clean worksites.

Ask

Ask the participants the following questions:

- What types of waste have you seen during cabling or fiber installations?
- Why do you think sustainability is becoming more important in telecom projects today?

Write their responses on the whiteboard.

Elaborate

In this session, we will discuss the following point:

- Organizational sustainability policies
- Waste reduction and material reuse techniques
- Classification of cabling materials (recyclable, reusable, hazardous)Safe disposal of fiber shards, batteries, and adhesives
- National and international environmental regulations
- Eco-friendly cabling materials and biodegradable packaging
- Accurate measurement and optimized trenching for reducing waste
- Proper labeling, storage, and segregation of waste
- Maintaining records of recycling and disposal
- Energy-efficient tools and reduced excavation methods
- Clean site practices and preventing environmental contamination
- Reporting mechanisms for spills, violations, and unsafe practices
- Conducting self-audits and guiding team members

Say

Let's participate in an activity to understand material segregation and waste handling more practically.

Activity

Duration: 30 minutes

Resources: Sample materials (dummy fiber scraps, cable sheaths, packaging, adhesives), color-coded bins, labels, PPE.

Steps:

1. Divide the participants into small groups.
2. Provide each group with mixed materials used in cabling operations.
3. Ask them to segregate the materials into:
    - Recyclable
    - Reusable
    - Hazardous
    - General waste
4. Each group places the items into the correct bins and labels them.
5. The facilitator reviews and explains industry-standard segregation techniques.

Do

- Ask a trainee to note down correct vs. incorrect segregation practices.
- Highlight common mistakes (e.g., mixing adhesive tubes with general waste).
- Add real-life examples from telecom sites.
- Encourage participation from each group.
- Ask one participant to summarize the segregation logic.

Notes for Facilitation

- Ask the trainees if they have questions regarding sustainability or waste handling.
- Encourage peer learning by asking participants to answer one another's queries.
- Motivate learners to read the sustainability section in the participant handbook.
- Reinforce that clean, sustainable cabling operations reflect professionalism and compliance.

Exercise

Answers to exercises for PHB

A. Short Answer Questions:

1. Organizational policies promote reuse and recycling of telecom materials, reducing landfill waste, lowering procurement costs, and encouraging environmentally responsible practices in infrastructure projects.
2. Steps for handling hazardous waste: wear PPE, segregate waste by type, store in labeled containers, avoid mixing incompatible chemicals, transport according to regulations, and hand over to authorized disposal/recycling facilities.
3. Accurate record-keeping ensures compliance with environmental laws by documenting waste handling, disposal methods, and regulatory adherence, which supports audits and reduces legal risks.
4. Methods to reduce material wastage: precise cable measurement, pre-planning route layouts, avoiding unnecessary cable cuts, recycling scrap, and training technicians in efficient installation practices.
5. Energy-efficient tools reduce power consumption, and optimized route planning minimizes trenching and cable use, supporting sustainable, low-impact telecom infrastructure projects..

B. Multiple Choice Questions (MCQs):

1. b. To prevent contamination and ensure safe disposal
2. b. Biodegradable packaging
3. b. Waste disposal logs with hazard classification
4. b. Basel Convention
5. c. Using accurate measurements and optimized layouts

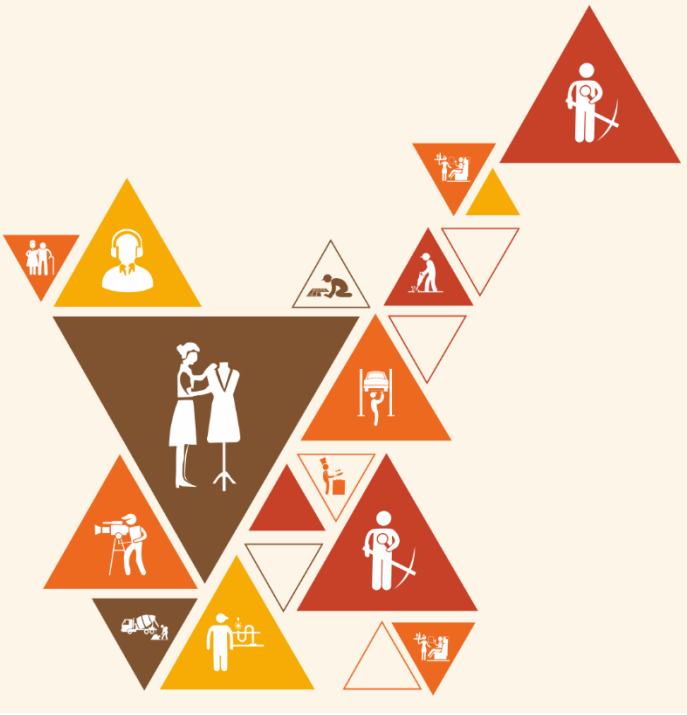
C. Fill in the Blanks:

1. designated containers
2. \record-keeping
3. Basel Convention
4. energy-efficient tools
5. documentation

Notes

9. Employability Skills (30 Hours)

It is recommended that all training include the appropriate. Employability Skills Module. Content for the same can be accessed https://www.skillindiadigital.gov.in/content/list



DGT/VSQ/N0101

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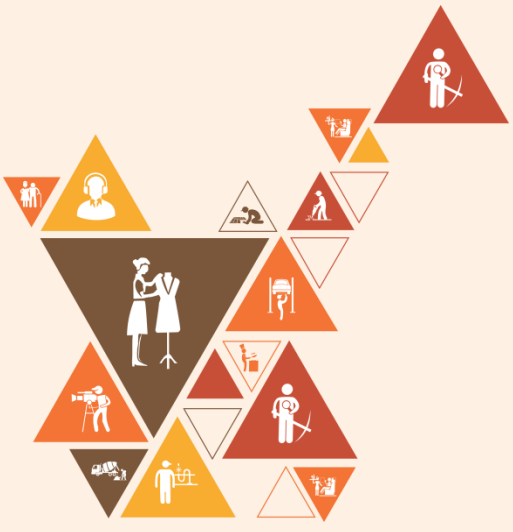
10. Annexure

Annexure I: Training Delivery Plan

Annexure II: Assessment Criteria

Annexure III: List of QR Codes used in PHB



Annexure I

Training Delivery Plan

Training Delivery Plan			
Program Name:	Fiber Installation, Testing and Commissioning Technician		
Qualification Pack Name & Ref. ID	TEL/Q4107 & NSQF Level: 4.0s		
Version No.	4.0	**Version Update Date**	08-05-2025
Pre-requisites to Training (if any)	N.A.		
Training Outcomes	**After the completion of this program, the participants will be able to:** • Explain the key factors in handling fiber constructs, performance, and selection criteria. • Elucidate the process of fiber connectorization, splicing, and conducting first-level checks. • Discuss the procedures and best practices for cable installation. • Describe the steps involved in preparing cables for termination and splicing. • Explain the testing and troubleshooting methods for fiber networks. • Discuss the essential safety practices for working with fiber optics. • Determine the best sustainability practices to follow in telecom cabling operations. • Discuss the Employability and Entrepreneurship Skills**.**		

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Method ology	Training Tools / Aids	Duration (in Hours)
1	**Introduction to the sector & the job role of a Fiber Installation, Testing and Commissioning Technician (TEL/N4126) Thery: 05:00**	Roles and Responsibilities of a Fiber Installation, Testing and Commissioning Technician	Elucidate the key skills and technical expertise required for a Fiber Installation, Testing and Commissioning Technician. Describe the challenges faced in the installation and maintenance of FTTH/X networks. Explain the impact of fiber optic technology on internet speed and connectivity. Discuss the key responsibilities of a Fiber Installation, Testing and Commissioning Technician.	Bridge Module	Facilitat or - led discussion	Laptop, book, pen, discussi on duster, Projecto r/ slides	T: 05:00. P: 00:00
2	TEL/N4126: Fiber Construction, Performance and Selection Criteria (Theory-30:00 Hours Practical-40:00 Hours)	Fiber Cable Construction & Components	Understand construction specifications of fiber cables including core, cladding, buffer, armored, ribbon & bend-sensitive fibers	PC1, KU1, KU3	Theory + Demonstration	Fiber cable samples, Construction diagrams, Cut-section models	T: 04:00. P: 04:00
		Identifying Fiber Cable Elements	Identify fibers, strength members, jackets, rip cords, multi-core fibers, and cable configurations	PC2, PC3, KU1, KU7	Demonstration + Hands-on Identification	Sample fiber cables, Cross-section charts, Identification worksheets	T: 04:00. P: 04:00
		Optical Transmission Characteristics	Understand transmission properties of single-mode, multimode, and bend-sensitive fibers	PC4, KU2, KU8	Theory + Visual Diagrams + Case Study	Fiber type charts, Transmission graphs, Laser pointer demo	T: 04:00. P: 04:00

		Installation Best Practices	Apply installation practices to minimize loss and ensure performance (microducting, multi-fiber handling)	PC5, KU6, KU7	Demonstration + Practical Handling	Microduct demos, Bend radius testers, Cable reels	T: 04:00. P: 04:00
		Fiber Performance Indicators	Understand attenuation, bandwidth, fiber size, and multi-core fiber performance impact	PC6, KU2, KU3	Theory + Chart Interpretation	Attenuation charts, Bandwidth graphs, Multi-core fiber samples	T: 04:00. P: 04:00
		Performance Evaluation & Analysis	Analyze sources of attenuation and interpret fiber performance charts for network optimization	PC7–PC10, KU8, KU9	Case Study + Hands-on Measurement	Attenuation vs wavelength graphs, OTDR screenshots	T: 03:00. P: 05:00
		Selecting Fiber Types for Deployment	Identify & select fiber types (zip cord, loose tube, armored, aerial, underwater, ribbon) for specific applications	PC11–PC13, KU1, KU3, KU5	Demonstration + Scenario-Based Learning	Fiber type catalogues, Deployment diagrams	T: 03:00. P: 05:00
		Fiber Identification & Component Compatibility	Apply color codes, identifiers, and verify compatibility with passive components	PC14–PC15, KU4	Hands-on Practice + Demonstration	Colored fiber sets, Patch cords, Splitters, Enclosures	T: 02:00. P: 05:00
		Cable Selection Criteria & Safety Compliance	Understand and apply cable selection parameters: pulling strength, rodent protection, grounding, environmental compliance	PC16–PC19, KU6, KU10	Theory + Field Simulation	Armored cable samples, Grounding kits, Standards manuals	T: 02:00. P: 05:00
3	TEL/N4127: Fiber connectorisation, splicing and first level checks (Theory-20:00 Hours Practical-20:00 Hours)	Fiber Connectors, Types & Applications	Identify connector types (SC, LC, ST, FC, MPO/MTP), color codes, polish types, and understand their impact on insertion/return loss	PC1–PC7, KU4, KU5, KU12	Theory + Demonstration + Connector Identification Activity	Connector kits (SC/LC/ST/FC/MPO), Color code charts, End-face inspection microscope	T: 04:00. P: 04:00

		Mechanical Splicing Techniques	Understand fiber preparation steps, identify tools, and apply mechanical splicing techniques accurately	PC8–PC12, KU1, KU6, KU7, KU11	Demonstration + Hands-on Practice	Strippers, Cleavers, Mechanical splice kits, Cleaning tools, Pre-terminated samples	T: 04:00. P: 04:00
		Fusion Splicing Operations	Apply fiber preparation, operate fusion splicer, perform fusion splice, and validate splice quality	PC13–PC17, KU1, KU7, KU8, KU13	Practical Lab + Equipment Handling + Case Studies	Fusion splicer, Arc calibration guides, Heat-shrink sleeves, Cleaning kits	T: 04:00. P: 04:00
		Ribbon Fiber Splicing	Understand ribbon fiber construction, identify ribbon tools, and perform ribbon splicing for high-bandwidth networks	PC18–PC22, KU3, KU8, KU12, KU14	Demonstration + Hands-on Session	Ribbon cleavers, Ribbon holders, Ribbon splicing machine, High-bandwidth network diagrams	T: 04:00. P: 04:00
		First Level Checks, Troubleshooting & Reporting	Apply VFL/OTDR tests, assess splice defects, verify optical loss parameters, and document splicing/test results	PC23–PC30, KU2, KU5, KU6, KU9, KU10	Hands-on Testing + Troubleshooting Practice + Documentation Exercise	VFL, OTDR, Test result sheets, Splice logs, Standard reporting templates	T: 04:00. P: 04:00
4	TEL/N4128: Cable Installation Procedures and Practices (Theory - 20:00 Hours Practical- 40:00 Hours)	Pre-installation Survey & Risk Assessment	Understand how to plan and oversee pre-construction surveys, identify risks, and ensure mitigation measures	PC1–PC2, KU1–KU3	Theory + Case Study + Site Walkthrough	Survey checklists, Risk assessment forms, OTDR devices	T: 02:30. P: 05:00

		Cable Inspection & Pre-installation Checks	Identify cable faults, inspect packaging integrity, and verify parameters like pulling tension, bending radius, and splicing length	PC3–PC5, KU3, KU5	Demonstration + Hands-on Practice	OTDR, Sample cables, Measuring tools	T: 02:30. P: 05:00
		Regulatory Compliance & Documentation	Understand compliance requirements for safety and regulatory standards, and document installation readiness	PC6, KU10	Theory + Scenario Discussion	Regulatory manuals, Installation forms, Documentation templates	T: 02:30. P: 05:00
		Direct Buried Installation Techniques	Apply direct buried installation procedures including cable handling, trenching, backfilling, armor bonding, and grounding	PC7–PC13, KU4, KU5, KU7	Demonstration + Hands-on Practice	Cable reels, Armored cables, Grounding kits, Micro trenching tools	T: 02:30. P: 05:00
		Underground Duct Installation Planning	Understand duct route verification, clearance assessment, and pre-installation checks	PC14–PC15, KU3, KU5	Theory + Simulation	Duct layouts, Pulling tools, Breakaway swivels	T: 02:30. P: 05:00
		Underground Duct Cable Pulling & Blowing	Apply controlled cable pulling, 'figure-8' storage, cable blowing, and duct integration to optimize installation and minimize damage	PC16–PC19, KU5, KU7	Practical Lab + Hands-on	Cable reels, Microducts, Air-blowing machine, Pulling grips	T: 02:30. P: 05:00
		Aerial Cable Installation	Understand aerial cable selection, installation techniques, messenger strand use, lashing, and self-supporting methods	PC20–PC23, KU3, KU5, KU7	Demonstration + Hands-on Practice	Aerial cables, Clamps, Lashing tools, Self-supporting cable kits	T: 02:30. P: 05:00
		Aerial Cable Tensioning, Grounding & Documentation	Apply proper tensioning, sag monitoring, grounding, lightning protection, and maintain installation records	PC24–PC26, KU5, KU10	Practical Lab + Case Study	Tension meters, Grounding kits, Lightning protection tools, Documentation templates	T: 02:30. P: 05:00

5	TEL/N4129: Preparing Cables for Termination and Splicing (Theory-20:00 Hours Practical-20:00 Hours)	Fiber Optic Cable Preparation	Understand and apply techniques to remove outer jackets, use rip-cords, dress strength members, and cut armored cables safely	PC1–PC8, KU1, KU3, KU5, KU11, KU12, KU14	Demonstration + Hands-on Practice	Stripping tools, Rip-cords, Armored cable samples, Kellum grips	T: 04:00. P: 04:00
		Cable Drum Handling	Identify proper positioning, lifting, rolling, and unwinding techniques to prevent cable damage during installation	PC9–PC12, KU1, KU4, KU5, KU7	Demonstration + Practical Lab	Cable drums, Fork-lift/Manual handling tools, Roll guides	T: 04:00. P: 04:00
		Cable Inspection & Quality Assurance	Apply inspection procedures to detect defects or damages before and after handling; ensure use of high-quality splicing tools	PC13–PC14, KU2, KU4, KU10, KU13	Hands-on Practice + Case Study	Sample cables, Splicing tools, Inspection microscopes	T: 04:00. P: 04:00
		Cable Slack Management	Understand calculation, securing, and management of cable slack to maintain network performance and enable future maintenance	PC15–PC17, KU6, KU7, KU8	Demonstration + Hands-on Exercise	Slack brackets, Storage enclosures, Project drawings	T: 04:00. P: 04:00
		Documentation & Best Practices	Apply proper documentation, wrapping, closing, and protection techniques to ensure cable integrity and record-keeping for maintenance	PC18, KU9, KU10, KU14	Practical Lab + Scenario-Based Learning	Documentation templates, Wrapping materials, Protective covers	T: 04:00. P: 04:00

6	TEL/N4130: Fiber Testing and Troubleshooting (Theory-10:00 Hours Practical-20:00 Hours)	Fiber Test Parameters & Measurement Techniques	Understand optical parameters (optical power, attenuation, return loss, reflection), fiber continuity, polarity, and preventive maintenance practices	PC1–PC5, KU1, KU2, KU5, KU9	Theory + Demonstration + Hands-on Practice	LSPM, OTDR, VFL, Optical Fiber microscope, Sample fiber cables	T: 02:30 P: 0500
		Test Equipment Operation	Apply OTDR, Optical Power Meter, VFL, and OLTS for measuring fiber link performance, loss, and connector evaluation	PC6–PC12, KU1, KU2, KU8, KU9	Hands-on Lab + Practical Demonstration	OTDR, OPM, Light source, VFL, OLTS, Inspection scope	T: 02:30 P: 0500
		Fault Localization & Troubleshooting	Identify and isolate fiber faults using OTDR trace analysis, VFL, LSPM, and remote monitoring; understand external factors affecting fiber performance	PC13–PC18, KU3, KU6, KU9, KU10	Practical Lab + Case Study + Scenario Analysis	OTDR trace simulator, VFL, Fiber samples, Remote monitoring dashboards	T: 02:30 P: 0500
		Record Keeping & Reporting	Apply standard documentation practices, maintain accurate test records, generate reports, and ensure secure storage for audits and remote monitoring	PC19–PC22, KU2, KU3, KU4, KU7	Hands-on Exercise + Demonstration	Test report templates, Digital record systems, Sample logs	T: 02:30 P: 0500
7	TEL/N4131: Work Safety Practices with Fiber Optics (Theory-10:00 Hours Practical-20:00 Hours)	Fiber Optic Safety & PPE	Understand hazards associated with fiber optics (microshards, laser exposure, electrical risks) and identify appropriate PPE for FTTH/X installations	PC1–PC2, PC6, KU1–KU6	Theory + Demonstration + Hands-on Practice	Safety glasses, Gloves, Protective clothing, Boots, Hard hats, PPE manuals	T: 02:30 P: 0500
		Laser, Electrical & Fire Safety	Apply laser safety protocols, follow electrical safety norms, and implement fire prevention measures while working with fusion splicers and high-voltage equipment	PC3–PC5, KU5, KU6, KU15–KU17	Demonstration + Scenario-based Learning	Arc fusion splicer demo, Laser safety charts, Fire extinguisher, Electrical safety tools	T: 02:30 P: 0500

		Safe Cable Handling & Site Practices	Apply safe handling of pre-terminated assemblies, proper cable routing, hazard identification, and mitigation at installation sites	PC10–PC11, KU1, KU7, KU13, KU16	Hands-on Lab + Field Simulation	Cable assemblies, Installation site mock-up, Conduits, Warning signs	T: 02:30 P: 0500
		Industry Standards, Compliance & Documentation	Understand industry standards (TIA/EIA, ITU-T, ISO, BICSI), comply with environmental regulations and e-waste guidelines, and maintain accurate safety records	PC12–PC14, KU8–KU12, KU14–KU19	Theory + Case Study + Documentation Exercise	Standards manuals, Compliance checklists, Record templates, MSDS sheets	T: 02:30 P: 0500
5	**Follow sustainability practices in telecom cabling operations** **Theory: 10:00 Hours** **Practical: 20:00 Hours**	Sustainability Practices in Telecom Cabling Operations	•Explain organizational policies on sustainability, waste reduction, and material reuse in telecom infrastructure projects. •Describe the procedures for recycling, hazardous waste handling, and safe disposal of telecom-related materials.	TEL/N9111 PC1, PC2, PC3, PC4, PC5	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	White board/ black board marker / chalk, dust- er, comput- er or laptop attached to LCD projector, Personal Protection Equipment: safety glasses, head protection, rubber gloves, safety footwear, warning signs and tapes, fire extinguish- er and first aid kit	T: 02:30 P: 05:00
			•Elucidate the classification of materials used in optical fiber cabling, including recyclable, reusable, and hazardous components. •Explain standard waste management procedures for telecom operations, including segregation, labeling, and disposal methods.	TEL/N9111 PC6, PC7, PC8, PC9, PC10			T: 02:30 P: 05:00
			•Demonstrate how to identify, segregate, and store materials used in cabling operations, including recyclable, reusable, and hazardous materials, ensuring compliance with safety and waste management procedures.	TEL/N9111 PC11, PC12, PC13, PC14, PC15			T: 02:30 P: 05:00
			•Show how to use and promote eco-friendly materials, such as low-impact protective coatings and biodegradable packaging	TEL/N9111 PC16, PC17, PC18, PC19, PC20			T: 02:30 P: 05:00

Total Duration	Theory Duration 120:00 Practical Duration 180:00
Employability Skills (DGT/VSQ/N0102) (https://www.skillindiadigital.gov.in/content/list)	30:00
OJT	180:00
Total Duration	Theory + Practical + ES + OJT 510:00

Annexure II
Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

Assessment Criteria for	
Job Role	Fiber Installation, Testing and Commissioning Technician
Qualification Pack	TEL/Q6401
Sector Skill Council	Telecom Sector Skill Council

S. No.	Guidelines for Assessment
1	The assessment for the theory part will be based on knowledge bank of questions approved by the SSC.
2	Assessment will be conducted for all compulsory NOS, and where applicable, on the selected elective/ option NOS/ Set of NOS.
3	Individual assessment agencies will create unique question papers for theory part for each candidate at each examination/training centre (as per assessment criteria below).
4	Individual assessment agencies will create unique evaluations for skill practical for every student at each examination/training centre based on this criterion.
5	To pass the Qualifications File, every trainee should score a minimum of 50% of aggregate marks.
6	In case of unsuccessful completion, the trainee may seek reassessment on the Qualification File.

National Occupational Standards	NOS Code & Version	Theory Marks	Practical Marks	Project Marks	Viva Marks	Total Marks	Weightage
Fiber Construction, Performance and Selection Criteria	TEL/N4126, v5.0	30	50	-	20	100	15
Fiber connectorisation, splicing and first level checks	TEL/N4127, v5.0	30	50	-	20	100	15
Cable Installation Procedures and Practices	TEL/N4128, v6.0	30	50	-	20	100	15
Preparing Cables for Termination and Splicing	TEL/N4129, v4.0	30	50	-	20	100	15
Fiber Testing and Troubleshooting	TEL/N4130, v4.0	30	50	-	20	100	10
Work Safety Practices with Fiber Optics	TEL/N4131, v5.0	30	50	-	20	100	10
Follow sustainability practices in telecom cabling operations	TEL/N9111, v1.0	30	50	-	20	100	10
Employability Skills (30 Hours)	DGT/VSQ/N0101, v1.0	20	30	-	-	50	10
Total		**230**	**380**	**-**	**140**	**750**	**100**

Annexure I

QR Codes –Video Links

Module No.	Unit No.	Topic Name	Link for QR Code (s)	QR code (s)
1. Introduction to the sector & the job role of a Fiber Installation, Testing and Commissioning Technician(TEL/N4126)	Unit 1.1 - Roles and Responsibilities of a Fiber Installation, Testing and Commissioning Technician	Funda- mentals of Optical Fiber and their Appli- cations	https://www.youtube.com/watch?v=DkQjF54gy9w	Fiber to the Home explained
		Working Principle of Optical Fiber Communication System	https://www.youtube.com/watch?v=q6_q2IBm93o	Block diagram and working of fiber optic communication system
		Perfor- mances Param- eters of Optical Fiber	https://www.youtube.com/watch?v=Cwu3pbmarqM	Parameters of Optical Couplers Optical Splitting, Excess Loss, Insertion Loss & Cross Talk
2. Fiber Construction, Performance and Selection Criteria (TEL/N4126)	Unit 2.1 – Optical Fiber Construction, Transmission Checks, and Performance Evaluation	Pre-con- struction Sur- vey on the Site	https://www.youtube.com/watch?v=HOaCZqJSoSg	Fiber Construc- tion Process

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
3. Fiber connectorisation, splicing and first level checks (TEL/N4127)	Unit 3.1 – Fiber Connectorization and Splicing Techniques	Compo- nents of Optical Fiber Commu- nication (OFC) Network	105	https://www.youtube.com/watch?v=3Oi2Ku_m6dU	What are the Parts of a Fiber Optic Cable?
		Insertion Loss of Optical Splitter	105	https://www.youtube.com/watch?v=LH5lVmKSwHM	Optical Fiber - Insertion Loss And Return Loss
6. Fiber Testing and Troubleshooting (TEL/N4130)	Unit 6.1 – Fiber Testing	Bend Radius	133	https://www.youtube.com/watch?v=wGaJMVQt7qc	Bend Radius - EXFO's Animated Glossary of Fiber Optics
	Unit 6.2 – Fiber Troubleshooting	Fusion Splicing	133	https://www.youtube.com/watch?v=PFIegqsQFrs	How To Fusion Splice Fiber Optic Cable - Animated
7. Work Safety Practices with Fiber Optics (TEL/N4131)	Safety Rules in Work Maintenance	Health and Safety Hazards in a Workplace	153	https://www.youtube.com/watch?v=A3txvkETcoo	Hazard and Risk at Workplace

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MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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Telecom Sector Skill Council

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