Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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Telecom
Sector
Skill
Council

Participant Handbook

Sector
Telecom

Sub-Sector
Passive Infrastructure

Occupation
Operations and Maintenance – Passive Infrastructure

Reference ID: **TEL/Q6400, Version 4.0**
NSQF level 3

Optical Fiber Splicer

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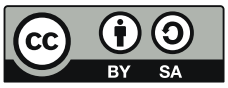

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> Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi
Prime Minister of India

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TELECOM SECTOR SKILL COUNCIL OF INDIA

for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: **'Optical Fiber Splicer'** QP No. **'TEL/Q6400, NSQF Level 3'**

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The preparation of this handbook would not have been possible without the Telecom Industry's support. Industry feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gaps existing today in the industry.

This participant handbook is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this book

India is currently the world's second-largest telecommunications market with a subscriber base of 1.20 billion and has registered strong growth in the last decade and a half. The Industry has grown over twenty times in just ten years. Telecommunication has supported the socioeconomic development of India and has played a significant role in narrowing down the rural-urban digital divide to some extent. The exponential growth witnessed by the telecom sector in the past decade has led to the development of telecom equipment manufacturing and other supporting industries.

Over the years, the telecom industry has created millions of jobs in India. The sector contributes around 6.5% to the country's GDP and has given employment to more than four million jobs, of which approximately 2.2 million direct and 1.8 million are indirect employees. The overall employment opportunities in the telecom sector are expected to grow by 20% in the country, implying additional jobs in the upcoming years.

This Participant handbook is designed to impart theoretical and practical skill training to students for becoming Optical Fiber Splicer in the Telecom Sector.

Optical Fiber Splicer is responsible for ensuring efficient splicing of the optical fiber cables and test effectiveness and record the test results.

This Participant Handbook is based on Optical Fiber Splicer Qualification Pack (TEL/Q6400) and includes the following National Occupational Standards (NOSs):

1. TEL/N6400 – Splice Optical Fiber
2. TEL/N6401 – Test Effectiveness and Record Test Results
3. TEL/N9101 – Organize Work and Resources as Per Health and Safety Standard
4. TEL/N9102 – Interact effectively with Team Members and Customers

The Key Learning Outcomes and the skills gained by the participant are defined in their respective units.

Post this training, the participant will be able to manage the counter, promote and sell the products and respond to queries on products and services.

We hope this Participant Handbook will provide sound learning support to our young friends to build an attractive careers in the telecom industry.

Symbols Used


Key Learning Outcomes


Unit Objectives


Exercise


Tips


Notes


Activity


Summary

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1. Role and Responsibilities of an Optical Fiber Splicer

Telecom Sector Skill Council

Unit 1.1 - Objectives of the Program

Unit 1.2 - Telecom Sector in India

Unit 1.3 - Telecom Basics

Key Learning Outcomes

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

1. Outline the course objectives and outcomes
2. Discuss the size and scope of the Telecom industry and Passive Infrastructure sub-sector
3. Identify the roles and responsibilities of an Optical Fibre Splicer
4. Discuss the career progression of an Optical Fibre Splicer in the Telecom industry

UNIT 1.1: Objectives of the Program

Unit Objectives

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

1. Explain the overview of the program
2. Discuss the essential skills on which the participant will be trained in this program

1.1.1 Overview of the Program

This program will facilitate an overview of:

- Telecom Industry
- Roles and responsibilities of an Optical Fibre Splicer
- Optical fibre splicing technique
- Behavioural, professional, technical and language skills required for performing your job effectively
- Techniques for managing the retail counter
- Methods for sales and promotion of handsets
- Ways to maintain, create and update daily reports
- Interview skills

Basic Skills

The skills that this program trains you on are:

- Communication skills
- Language Skills
- Grooming Skills
- Art of Influencing
- Time Management
- Customer Centricity

Main Activities

As an optical fibre Splicer, you have to perform these main activities:

- Optical fibre splicing
- Fibre cable repair
- Operate cleaver, OTDR, & fibre identifier, etc.
- Handel tools skilfully
- Maintain daily work records

Fig. 1.1.1: Optical Fibre Cable Jointing Splicing Machine

1.1.2 Ground Rules

All participants must follow certain ground rules to facilitate an efficient learning environment. These rules are:

- Arrive and start on time.
- All participants are expected to participate in all phases of the workshop.
- Mobile phones of the participants should be switched off or in silent mode.
- Participants must adhere to the timelines. If the break given to the participants is of 15 minutes, then everybody has to be in the training room within those 15 minutes.
- All the doubts should be raised to the facilitator. They should not talk among themselves.
- Listen actively - respect others when they are talking.
- Learn and ask questions if you don't understand.

UNIT 1.2: Telecom Sector in India

Unit Objectives

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

1. Outline the size and scope of the Telecom industry in India
2. Outline the growth and opportunities in the broadband industry
3. Discuss about optical fibres technology
4. List the roles and responsibilities of the Optical Fibre Splicer
5. Illustrate the career progression of an Optical Fibre Splicer

1.2.1 Introduction to Telecom Industry

The Indian telecom industry has been one of the fastest growing industries in the country, and this sector strives to tap almost every potential customer to render its services. Having a mobile has become the need of every person, and nowadays, everybody wants to enjoy these services.

Due to recent growth in the Information Technology (IT) industry, there has been a boom in the Indian telecom sector, leading to an increase in market size. Since there has been a high dependency of the Indian population on this sector, as several companies are operating in India and overseas, there have been frequent problems in the smooth functioning of this sector as customers' needs and desires are increasing daily. This study will provide insight into the telecom sector and the steps they take to improve its customer relationship.

With privatisation, liberalisation and globalisation after 1991, so many companies are operating in India; hence the market is quite competitive. With so much competition prevailing, companies are interested to know the customer's perception towards various mobile services to work on it and capture the market.

India is the world's second-largest telecommunications market. The total subscriber base, wireless subscriptions, and wired broadband subscriptions have grown consistently. Tele-density stood at 85.91%, as of December 2021, total broadband subscriptions grew to 792.1 million until December 2021, and the total subscriber base stood at 1.18 billion in December 2021.

India's telephone subscriber base expanded rapidly during the last few years. Due to rigid competition, some industry has witnessed some major mergers in recent times as telecom companies are in the process of optimising and rationalising their operations.

Over the last seven years, the Telecom Tower industry in India has grown significantly by 65%. The number of mobile towers increased from 400,000 in 2014 to 660,000 in 2021. This has resulted in the rapid growth of Mobile Base Transceiver Stations by 187% and increased from 800,000 in 2014 to 2.3 mn in 2021.

The Department of Telecom (DoT), GOI targets a combination of 100% broadband connectivity in the villages, 55% fibreization of mobile towers, average broadband speeds of 25 Mbps and 30 lakh km of optic fibre rollouts by December 2022. By December 2024, it looks at 70% fibreisation of towers, average broadband speeds of 50 Mbps and 50 lakh km of optic fibre rollouts at a pan-India level. It is also projected that 5G technology will contribute approximately $450 bn to the Indian Economy in the period 2023-2040.

Source: https://www.investindia.gov.in/sector/telecom

1.2.2 Various Sub-Sectors of the Telecom Industry

Telecommunication is a multi-dimensional industry. It is divided into the following subsectors:

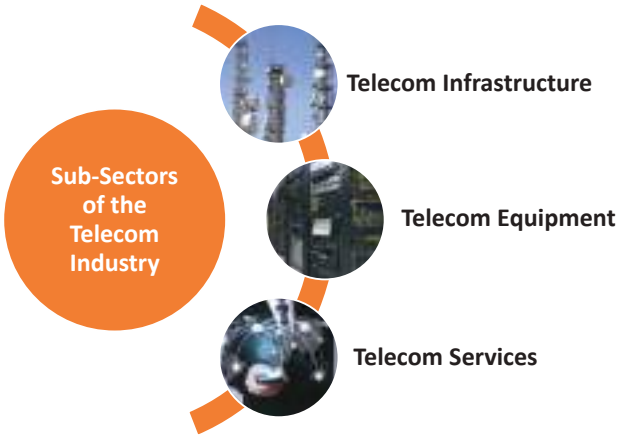


Fig. 1.1.1: Telecom Sub-Sectors

- **Telecom Infrastructure -** It is a physical medium through which all the data flows. This includes telephone wires, cables, microwaves, satellites, and mobile technology such as fifth-generation (5G) mobile networks.
- **Telecom Equipment -** It includes a wide range of communication technologies, from transmission lines and communication satellites to radios and answering machines. Examples of telecommunications equipment include switches, routers, voice-over-internet protocol (VoIP), and smartphones.
- **Telecom Services –** A service provided by a telecommunications provider or a specified set of user-information transfer capabilities provided to a group of users by a telecommunications system. It includes voice, data and other hosts of services.

The major segments within these sub-sectors include the following:

- Wireless communications
- Communications equipment
- Processing systems and products
- Long-distance carriers
- Domestic telecom services
- Foreign telecom services
- Diversified communication services

1.2.3 Broad Band Industry

Telecommunication plays a major role in economic and social development and has got the scope in all technical fields. It integrates all the tele-related services in India.

Improving internet and mobile technology has significantly impacted economic growth in India. This point has been taken into government consideration, and they are involved in developing the telecom industry. India has got second place in the telecom industry, after China.

In India, broadband connection power is less compared to China. So, improving broadband connectivity can play a major role in digitalisation.

India is also trying to enhance network connectivity in rural areas. The main aim of the Government of India is to provide broadband connectivity to all the people in India. As the first step for this, they have started giving 100 Mbs network connection to the villages at a low cost. Panchayat unions are working on the same project. By March 2019, the Government of India is planning to implement a 100 Mb broadband connection to all the villages in India. These operations can make India move to first place in the telecom industry in the world. The Government of India is looking for foreign investment in the telecom sector. These kinds of steps improve employment in the telecom industry.

1.2.4 Optical Fibre Technology

Fibre optics is a technology used to transmit light using glass or plastic. These are used in communications, lighting and sensors. It works by sending signals through the fibre strands. This concept started 40 years ago in research labs in Chica go, USA. The fibres were replaced with the microwave and signals in the late 1980s.

In the 2000s, these were used to provide internet connection at home. In older days, these fibres were used in phone communication to transmit signals from senders to receivers. Later, these communications were taken over by mobile and wireless Internet systems. Most wireless products are dominant in today's market, and LANs utilise fibres to transmit signals and data.

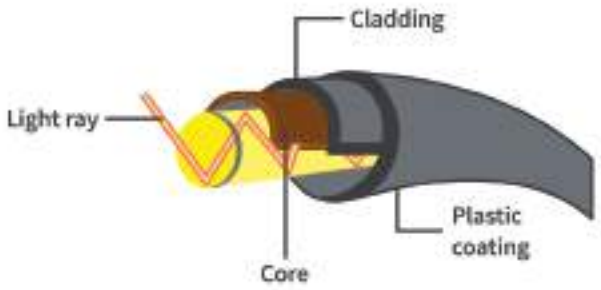


Fig. 1.2.1: Light travels through optical fibre

Applications:

- Mobile
- Network connections in the plane and other aircraft
- Network connections in ship and automobile industries
- Used in schools and traffic light controls
- Business use

Advantage:

- Reduced cost
- Efficiency

Significance of Optical Fibre:

- Flexibility
- Used in long-distance telecommunications
- Light transmission is due to internal reflection, which reduces the external signals

- Clear and error-free
- Allows twists and turns
- Can be used to transmit any wavelength.
- Can be used for single or bidirectional communication
- Use different transmission modes
- Cost-effective
- Have greater efficiency in transmitting the signals
- Low loss of signals
- Excellent linearity

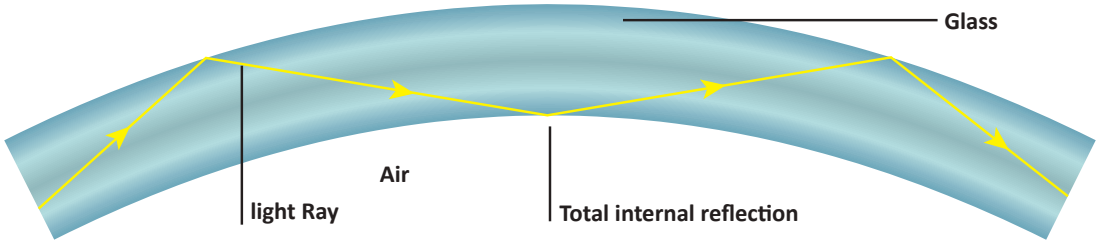


Fig. 1.2.2: Total Internal Reflection in Optical Fibre

Elements of Optical Fibre

There are mainly three elements present in optical fibre technology.

- Light source – It is placed at one end of the device. It receives signals and converts the
- electric signals to optic signals
- Fibre – It is connected from the origin to the destination to transmit light.
- The light detector – It is placed at the opposite end of the light source. It detects the signal and converts it into an electric signal. This leads to electric input.

1.2.5 Types of Optical Fibre

Optical fibre technology is associated with data transmission using light pulses travelling along with a long fibre which is typically made of glass or plastic. These facilitate the propagation of light along with the optical fibre depending on the requirement of power and distance of transmission.

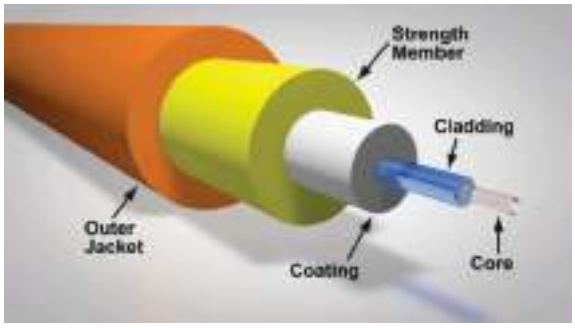


Fig. 1.2.4: Fibre Optics

Multi-mode fibre is used for shorter distances, while single-mode fibre is used for long-distance transmission.

Classification based on the refractive index:

- **Step Index Fibres -** It consists of a core surrounded by the cladding, which has a single uniform index of refraction
- **Graded Index Fibres -** The refractive index of the optical fibre decreases as the radial distance from the fibre axis increases

Classification based on the materials used:

- **Plastic Optical Fibres** - Polymethylmethacrylate is used as a core material for the transmission of light
- **Glass Fibres -** It consists of extremely fine glass fibres

Classification based on the mode of propagation of light:

- **Single-Mode Fibres -** Used for long-distance signal transmission
- **Multi-mode Fibres -** Used for short-distance signal transmission

The mode of propagation and refractive index of the core is used to form 4 combination types of optic fibres as follows:

- Step index-single mode fibres
- Graded index-Single mode fibres
- Step index-Multimode fibres
- Graded index-Multimode fibres

1.2.6 Optical Fibre Splicer

The Telecom industry requires diverse professionals for its growth. Major demand is for optical fibre splicers and engineers. The scope for employment in these sectors is going to increase vastly. An estimation says that the telecom industry is going to make 40lakh direct and indirect job openings in the next five years.

Personal attributes: Teamwork is very important in the telecom industry. As the telecom industry deals with many challenges which may occur at any time, it requires every individual effort to overcome the problems with appropriate solutions. The person should be able to deal with the pressure and problems that can occur to improve productivity in the telecom industry.

They must be able to complete the task that is assigned to them at a fixed timeline. Telecom sector professionals must know the local language in which they work because a problem in broadband connection might need to be addressed in the local language by the people in the village.

Fig. 1.2.1: Optical Fibre Splicer at work

1.2.7 Need for Splicing of Optical Fibres

To overcome the drawbacks of optical fibre connectors, the splicing of optical fibres is used to maintain permanent connections between the two optical fibre cables. Splicing essentially provides permanent or semi-permanent joints.

Fig. 1.2.2: Fibre Optics Joints Closure

Optical fibres of various lengths, like more than 5kms, 10kms, etc., are not capable of a permanent connection and can't run longer, and are also not suitable for repeated connections and disconnection of cables.

Hence, it is necessary to splice the fibre optic cables of two lengths to join them together, providing a sufficient permanent connection for a longer run.

Fig. 1.2.3: Splicing of Optical Fibre

Splicing Techniques

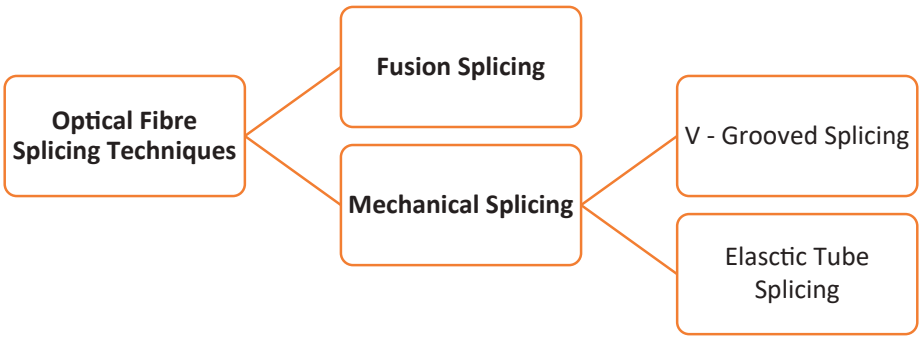


Fig 1.2.4 Splicing Techniques

Advantages and Disadvantages of fibre splicing

Advantages:

- Allows long-distance signal transmission
- Reduced reflection at the time of signal transmission
- Provides almost permanent connection of the fibres

Disadvantages:

- Fibre losses are higher than the acceptable limits
- Increase in the overall cost of the optical fibre communication system

1.2.8 Job Role of Fibre Optic Splicer

A Fibre Optical Splicer utilises modern telecom technology to splice together fibre optical cable. Combining science and telecom, Fibre Splicers splice thin strands of flexible glass that allow the transmission of light from one location to the next.

The Splicing Technician specialises in terminating fibre optic cables to expand telecom networks into new areas or replace existing ones. They also perform troubleshooting and maintenance to resolve signal issues.

A fibre splicer technician installs, repairs, and maintains fibre optic wires that are used in high-speed communications. A professional uses a number of specialised tools and techniques to cut, connect, and test wires.

Fibre optic splicing technicians are also known as telecommunications line installers and repairers. They can specialise in fibre optic cables used in phone, television and data networks.

Fibre optic cables, which are usually made of glass and transmit signals using light, are utilised by the telecommunications industry to carry phone, television and Internet data and are handled by line installers and repairers.

The major responsibilities of an Optical Fibre Splicer include:

- Cable installation, maintenance and repair
- Perform splicing activity
- Locate cables faults and repair to maintain the existing cable network without causing signal interruptions
- Test end-to-end service provisioning for the cable network
- Confirm accurate cable terminations on cross-connect, hubs, patch panels and routers
- Conduct site surveys to prepare condition discrepancy reports, design drawings, and technical manuals for cable installation feasibility
- Maintain project tracking information such as production sheets, time sheets, and customer-required paperwork
- Maintain a safe and secure work environment by complying with legal regulations as per the Government standards

1.2.9 Physical Requirements of Optical Fibre Splicer

- Must have adequate physical strength, hand-eye coordination, and stamina to complete jobs in various areas
- Must be able to clearly see and identify colours
- Must be able to lift and carry up to 20 Kgs and push and pull 30-40 Kgs loads at a time
- Must be able to stand and walk up to eight hours daily and climb multiple stairs while carrying materials weighing 10-20 Kgs
- Must be able to ride a vehicle for up to four hours to travel to and from job sites
- Must be able to work in varying temperatures and weather conditions
- Exposure to characteristic construction site dangers
- Must have the vision to allow differences in colours, shades and brightness
- Must have flexibility in scheduling to meet the needs of the business

1.2.10 Career progression of an Optical Fibre Splicer

A fibre optic splicer can determine their career goals through career progression. For example, they could start with a role such as a technician, progress to a title such as a team leader, and eventually end up with the title area manager.

A fibre optic splicer can work just about anywhere from big cities to rural areas, indoors or outdoors in big or small offices, buildings. He/she might work for a telephone company, an Internet service provider, a CATV company, an independent contractor, or even the military.

The typical career progression of an Optical Fibre Splicer is shown below:

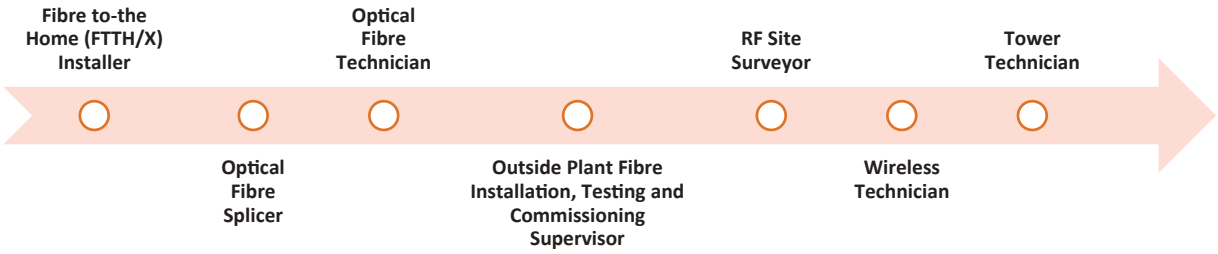


Fig. 1.2.5: Career Path of an Optical Fibre Splicer

UNIT 1.3: Telecom Basics

Unit Objectives

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

1. Explain and outline the functioning of the public switched telephone network
2. Identify and describe various media of transmission
3. List important telecom terminologies

1.3.1 Basics of Telecom

Any telecommunication system has three basic units:

- Transmitter - It takes information and converts it to a signal
- Transmission medium - Also called the "physical channel" that carries the signal
- Receiver - It takes the signal from the channel and converts it back into usable information

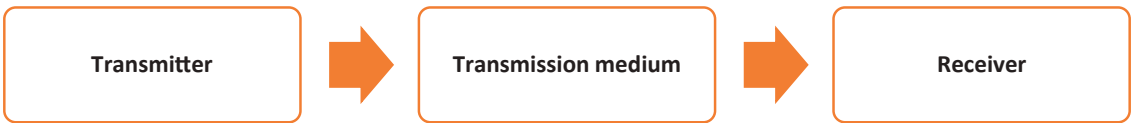


Fig. 1.3.1: Signal Transmission

Telecommunication over telephone lines is called:

- **Point-to-point communication** - Between one transmitter and one receiver
- **Broadcast communication** - Between one powerful transmitter and numerous low-power but sensitive receivers

Types of telecommunication networks

- Computer networks, ARPANET, Ethernet, Internet, Wireless networks
- Public switched telephone networks (PSTN)
- Packet-switched networks
- Radio network

1.3.2 Public Switched Telephone Network (PSTN)

- It is a standard telephone service. Some of the examples are BSNL, Airtel and MTNL.
- Public Switched Telephone Network, operated through "SWITCH" devices to open or close circuits, or it can break the electronic or certain path.
- This integrates the world circuit of telephone networks that are performed by na
- It consists of the fibre optic cable, telephonic lines, communication waves, networks, satellites and telephonic cables. These are interconnected with each other to communicate with anyone around the world.
- The telephone system network consists of mobile and telephones around the world.

- The process of PSTN – Dialling a person with whom we want to connect. The receiver gets the signal, picks the call, and exchanges the information. The circuit completes when they talk to each other

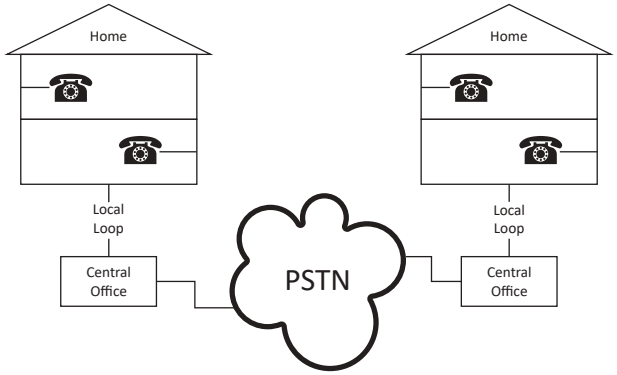


Fig. 1.3.2: A typical PSTN Network

1.3.3 Traditional Forms of Retailing in India

In telecom terminology, a transmission medium is a physical path between the transmitter and receiver, i.e., the channel through which data is exchanged from one place to another. Transmission Media can be broadly classified into the following types:

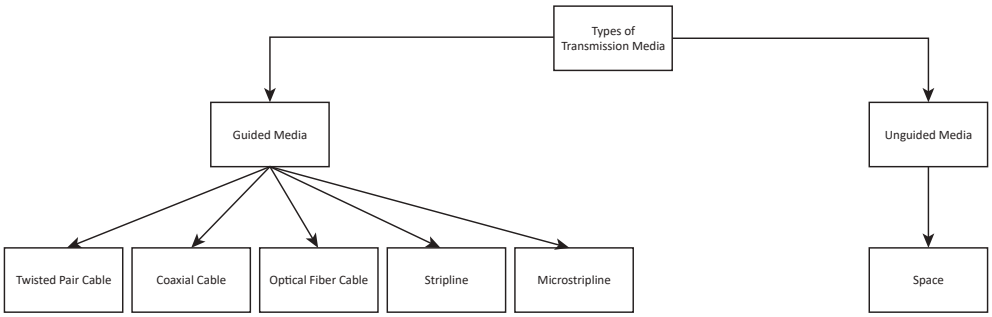


Fig. 1.3.2: Types of Transmission Media

Twisted pair cabling refers to wiring type. This consist of two conductors in a single circuit in which the conductors are twisted to cancel the electromagnetic induction from external sources.

Fig. 1.3.3: Twisted Pair Cable

Coaxial cable was invented and designed in 1880 by the English engineer named Over Heaviside. It has a conductor which is layered by a tube insulator and a shield. Most of them have an outer jacket. This term coaxial is used as the inner conductor and jacket share the same geometric axis.

Fig. 1.3.4: Co-Axial Cable

Optical fibre cable consists of one or more than one optical fibre. These are coated with plastic plates and contain protective tubes which are stable in all climatic conditions.

Fig. 1.3.5: Fibre Optics

A microwave is an electromagnetic wave. It has a wavelength in the range of 0.001 –0.3 m, or sometimes shorter than that of a normal radio wavelength. They are larger than the IR. These wavelengths are used in microwave oven and other industrial processes. These are also used to carry the telecommunications.

Fig. 1.3.6: Microwave Antena

A satellite is a system that receives signals from any part of the earth and transmits them to a receiver on earth. The main function is communicating and transmitting the signal from the sender to the receiver.

Fig. 1.3.7: Satellite used for Communication

1.3.4 Important Telecom Terminology

Terminology	Definition
Signal	Electromagnetic data presentation
Signalling	Process of sending and receiving signals using medium
Frequency	A cycle completed by electromagnetic wave in a second
Network	Communication between two or more devices to trans-mit data. It can be a computer or a mobile
Mode	Single electromagnetic field pattern
Multimode fibre	Larger core 850 and 1300 nm light source used. Applica-tions: For short distance, lower speed data networks like LANs
Single mode fibre	Smaller core-8-9 microns. Applications: For long distanc-es at very high speeds
Fibre ID	An identification of fibre using the core and size. There are international standard ID represented for fibre
Plastic optical fibres (POF)	A multimode fibre used for low speed network
Cable	A protector of fibre from climate and environmental conditions. It is commonly made up of plastics
Jacket	The outer layer of cable

Terminology	Definition
Strength members	Aramid fibres used to pull the cable. It is used to prevent kinking
Armour	Prevents the cable from rodents
Connector	A device which is used to connect fibres that can be semi-permanent or temporary
Ferrule	A fibre for alignment and part of a connector
Splice	Permanent joint which connects fibres
Hardware	Any physical equipment
Attenuation	It is calculated as dB/Km
Bandwidth	A combination of signal frequencies
Decibels (dB)	A unit to calculate the optical power transmit through the fibre.
dB	A symbol for decibel
dBm	An optical fibre in 1 milli watt
Optical Loss	Power lost while transmitting through fibre, splices, couplers, etc. expressed in "dB")
Switch	A mechanical or electronic device used to open or close the circuit
Multiplexing	A process of carrying more than one signal
Optical Power	Optical power loss while transmission, measured in dec-ibels
Scattering	Change in light direction when hitting an object
Wavelength	Colour of light that can be expressed in nm or microns
Dispersion	Pulse spreading caused by modes in multimode fibre
Public Switched Telephone Network: (PSTN)	Traditional wired phone service. It refers to the standard telephone service, e.g. BSNL
Base Transceiver Station(BTS)	A wireless service involving use of a mobile handset in mobile communication. It has an antenna mounted on a tower and at trans-receiver.
Base Station Controller(BSC)	BTS are administered by a BSC signalling
Mobile Switching Centre (MSC)	The hub of the mobile communication network. It con-nects mobile stations to PSTN
Roaming	Using mobile in a location which is outside the home service
Spectrum	Range of EM wavelength to transmit voice, data, etc.
Telephony	Transmitting voice from one place to another using the communication wavelengths
Modem	A device that both modulates and demodulates signals
NLD	National Long Distance Telephony - pertains to calls outside the local ar-ea, to any place in India

Terminology	Definition
ILD	International Long Distance Teleph-ony - outside India
SDCA	Short Distance Charging Area - There are total of 2647 SDCA in India, each having a unique STD code
LDCA	Long Distance Charging Area. A few SDCAS make a LDCA. A call beyond 50 km distance is considered as a long distance call
Service Plan	Plan selected for wireless phone service
Tariff	Service plan information kit

Fig. 1.3.8: Telecom Terminologies

Summary

- Outlining the course objectives and outcomes
- Discussing the size and scope of the Telecom industry and Passive Infrastructure sub-sector
- Identifying the roles and responsibilities of an Optical Fibre Splicer
- Discussing the career progression of an Optical Fibre Splicer in the Telecom industry

Exercise

Multiple-choice Question

1. India is the world's _____ telecommunications market.
   a) second-largest
   b) third-largest
   c) fourth-largest
   d) fifth-largest

2. _____ is a physical medium through which all the data flows.
   a) Telecom infrastructure
   b) Telecom services
   c) Telecom equipment
   d) none of the above

3. _____ is a technology used to transmit light using glass or plastic.
   a) Fibre optics
   b) Glass optics
   c) Metal optics
   d) None of the above

4. A _____ utilises modern telecom technology to splice together fibre optical cable.
   a) Fibre Optical Splicer
   b) Fibre Optical Slicer
   c) Fibre Optional Splicer
   d) none of the above

5. A _____takes information and converts it to a signal.
   a) Transmitter
   b) Transistor
   c) Receiver
   d) None of the above

Answer the following:

1. State the Physical Requirements of Optical Fibre Splicer.
2. Provide an insight to the telecom industry in India
3. Describe the elements of an optical fibre
4. What are the various sub sectors of the telecom industry?
5. Explain the career progression of an optical fibre splicer.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/Cag-bcbivtM

Introduction to Telecom Industry

https://www.youtube.com/watch?v=5SoTmES2UKM

Broad Band Industry

https://www.youtube.com/watch?v=jZOg39v73c4

Optical Fibre Technology

https://www.youtube.com/watch?v=pavBq7HIoIE

Types of Optical Fibre

https://www.youtube.com/watch?v=d-xth2HzVYU

Optical Fibre Splicer

https://www.youtube.com/watch?v=xRFe9jWY0hg

Basics of Telecom

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

2. Prepare for Splicing Operations for New Installation

Telecom Sector Skill Council

Unit 2.1 - Manage tools and spares

Unit 2.2 - Pre-Installation Procedures

Unit 2.3 - Installation of Optical Fibre

Unit 2.4 - Preparing the Cable for Splicing

TEL/N6400

Key Learning Outcomes

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

1. Discuss the characteristics of Optical Fibre
2. Identify the tools and equipment required for optical fibre splicing
3. Conduct fault analysis procedures and implement safety measures for different tools and mechanical equipment
4. Discuss the importance of calibrating the test equipment
5. Explain the colour coding of optical fibre cable
6. Demonstrate the steps to prepare the cable for splicing for new installation
7. Perform tests on OFC using an optical inspection microscope, OTDR and visual fault locator
8. Illustrate bare fibre testing

UNIT 2.1: Manage tools and spares

Unit Objectives

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

1. Explain the characteristics of Optical Fibre (like refraction, polarisation, attenuation, dispersion, etc.)
2. Identify various fibre optics tools

2.1.1 Characteristics of Optical Fibre

Total Internal Reflection

When a ray of light crosses an interface into a medium with a higher refractive index, it bends towards the normal. Conversely, light travelling across an interface from a higher refractive index medium to a lower refractive index medium bends away from the normal.

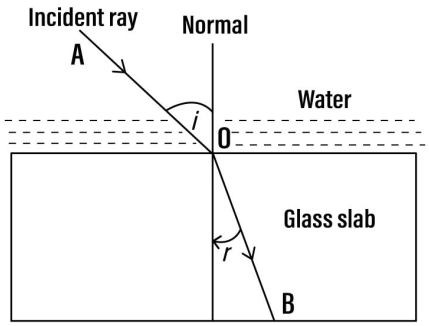


Fig. 2.1.1: Refraction of light

This has an interesting inference. At a specific angle, called the critical angle θc, the light travelling from a higher refractive index medium to a lower refractive index medium will be refracted at 90°. In other words, the light ray is refracted along the interface.

If the ray of light hits the interface at any angle larger than this critical angle, it will not pass through to the second medium. Instead, all of it will be reflected back into the first medium. This phenomenon is known as Total Internal Reflection.

Consider a ray of light passing from water into the air. The light emanating from the interface is bent towards the water. When the incident angle is increased sufficiently, the transmitted angle (in the air) reaches 90 degrees. It is at this point no light is transmitted into the air.

The critical angle θc is given by Snell's Law as:

$$n_1 \text{Sin}\theta_1 = n_2 \text{Sin}\theta_2$$

Here, n_1 and n_2 are refractive indices of the media, and θ_1 and θ_2 are angles of incidence and refraction, respectively.

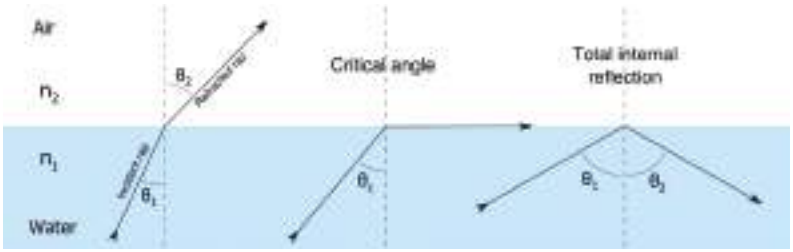


Fig. 2.1.2: Total Internal Reflection

To determine the critical angle, we find the value for θ_1 when θ_2 is equal to 90o and thus Sin θ1=1.

The resulting value of θ_1 is equal to the critical angle $\theta c = \theta_1 = \arcsin(n_1/n_2)$.

So the critical angle is only defined when n_1/n_2 is less than 1.

Optical fibres are based wholly on the principle of total internal reflection. This is explained in the following picture.

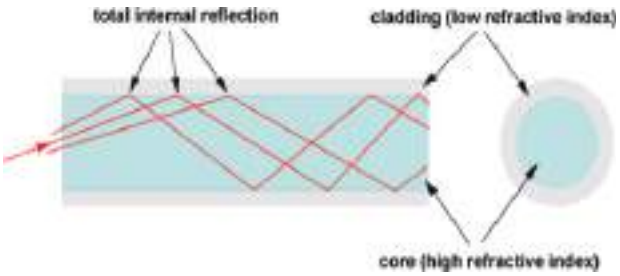


Fig 2.1.3 Refraction in optical fibre

Polarisation

A light wave that is vibrating in more than one plane is referred to as unpolarised light.

Polarised light waves are light waves in which the vibrations occur in a single plane. The process of transforming unpolarised light into polarised light is known as polarisation.

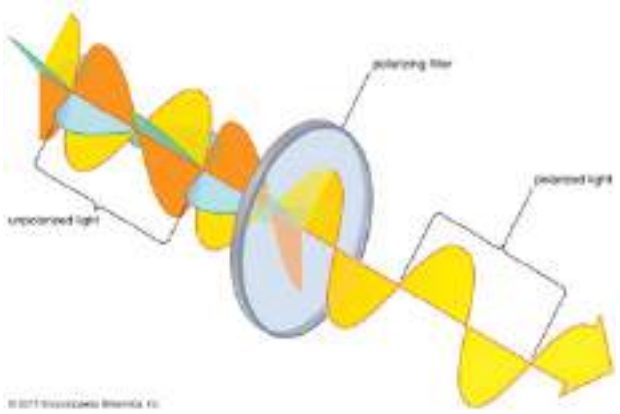


Fig. 2.1.4: Polarisation of Light

Attenuation

The attenuation of an optical fibre is the amount of light lost between input and output. Total attenuation is the sum of all losses. The attenuation of the optical fibre is a result of two factors:

- **Absorption -** The absorption is caused by the absorption of the light and conversion to heat by molecules in the glass.
- **Scattering -** Scattering occurs when light collides with individual atoms in the glass, which is anisotropic. Light scattered at angles outside the numerical aperture of the fibre will be absorbed into the cladding or transmitted back toward the source

Dispersion

Optical fibre dispersion describes the process of how an input signal broadens/spreads out as it propagates/travels down the fibre. Generally, dispersion in optical fibre cable includes modal dispersion, chromatic dispersion and polarisation mode dispersion.

2.1.2 Various Optical Equipment

Fibre Optic Tools:

It is important to have proper tools and fibre for complete telecom communication.

Tools for Installer's Toolbox		Overview
Tubing Cutter-cuts through armoured cable		It is used to cut the cable jacket, and armour.
Rotary Cable Slitting & Ringing Tool		It is used to cut cable jacket for removal
Cable Jacket Stripper		It is used to cut 2-3mm cable jacket for removal.
Fiber Optic Stripper		Helps to remove primary Coating from fiber without nicking the optic fiber. It can also cut 2-3mm cable jacket.
Buffer Tube Stripper-to cut jacket/buffer tubes in loose tube cable		It is similar to UTP jacket cutters and prevents fiber damage

Tools for Installer's Toolbox		Overview
Crimp Tool-crimps FO connector on the cable		It is used in termination.
Kevlar Scissors - super-sharp to cut Kevlar fibres in FO cable		To cut the fibres
Scribe used to cleave fibre when terminating		Sapphire or carbide are best.
Needle Nose Pliers - use when accessing and pulling cords or ripcords		Not to be used on other things.
Tweezers		Not to be used on other things.
Polishing Plate - place under polishing pad		For polishing.
Polishing Pad-place under polishing film		Provide polish surface
Polishing Puck-insert connector into this polishing tool, lay on polishing paper		Ferrule connectors
Safety glasses		Used to prevent eyes from obstacles
Connector Curing Oven - to cure epoxy/polish connectors		Portables and easy handling

Tools for Installer's Toolbox		Overview
Lineman Scissors - heavy duty to cut through cables or other heavy materials		Used in cutting.
Flashlight Continuity Tester (MM only) or Visual Fault Locator (VFL-red laser-SM or MM) bright, visible light source for checking continuity or tracing fibers, VFL can find faults also		Testing purpose
Light source		Used for lighting
Power meter adapters		Can be used on 2.5mm ferrules
Reference Test Cables - tested and known to be low loss		To be used based on connector types
Connector Mating Adapters - with metal or ceramic alignment sleeves (NOT PLASTIC)		ST/ST, SC/SC, etc, or hybrid ST/SC
Connector inspection microscope		To protect eyes from radiation
ST Bare fiber adapter - to test bare fibers		Used in testing
Optical Time Domain Reflecto meter (OTDR)		Used in OSP cables and troubleshoot problems

Tools for Installer's Toolbox		Overview
Alcohol-saturated pads - to clean fiber and connectors during splice, termination, test		Used in cleaning purpose
Lab wipes		For cleaning purpose
Trash bin small disposable container with top to hold fi-ber scraps		1-pint deli container with lid works well.
Black work mat		Helps see the fiber scraps to clean
Dry connector cleaner		For cleaning purpose
Connector curing oven-to-cure epoxy/polish connectors		For cleaning purpose
Heat Cure, 2-Part Epoxy, 2.5 Gram		"BiPax" package has epoxy and hardener in plastic pack-age that is mixed in the package. Can be used with many connectors at one time
Cheap scissors to cut corner off epoxy package		Cheap once are available which can be used and throw.
Needle		Do not leave it open after use.

Tools for Installer's Toolbox		Overview
Anaerobic Adhesive + Accelerator (optional) works well		Used in anaerobic connector termination.
Fusion splicer		Many manufacturers options are available
Fibre cleaver		Used for mechanical splicers
Fusion splice protectors		Use the type recommended by the fusion splicer, manufacturer
Mechanical splices		Used for restoration
Wipes and reagent-grade (99%+ pure) alcohol (ethanol)		For cleaning purpose.

Table 2.1.1: Tools and equipment

UNIT 2.2: Pre-Installation Procedures

Unit Objectives

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

1. Describe fibre optic cable specification – tensile strength, bend radius, crush and impact, cable attenuation, fibre optic connectivity
2. Explain and outline factors affecting fibre optic cable – natural and man-made
3. Demonstrate the correct procedure of – unloading, unwrapping, storage, drum preparation and opening of optical fibre cable
4. Demonstrate and execute optical fibre laying pre-requisites

2.2.1 Specifications of Fibre Optic Cable

Tensile Strength

It is a protector which is applied to the cable to avoid damage. Short-term load is an initial stage of installing the cable. It gives strength to withstand the cable during installation. The installed cable is subjected to light pressure and load. This process is called operating load. The main goal of the optical fibre cable installation is to install it with less pressure and stress. So the load has to be calculated before the installation.

During the initial process, the cable can withstand the pressure and load that was given and can also resist additional pressure like pulling. The installer needs to be cautious about the force that is applied to the cables during installation. The tensile strength depends on the cable manufacturing process. This information can be found on the cable datasheet.

Bend Radius

It is a small bend which can be resisted by cable. If the cable is bent beyond this limit, it can cause significant damage.

Non-recommended bending can cause increased fibre attenuation. Straightening cable can enhance the performance of the cable.

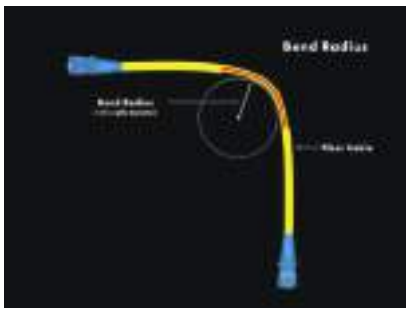


Fig. 2.2.1: Bend Radius

Two values are integrated with bend radius. Those are installation and long-term. The cable can resist some amount of pressure during installation. But they need to be calculated. Aer installation, the cable can be bent to a small bend radius. The bend radius depends on the cable size and construction.

People make mistakes in cable ben radii. A major mistake is pulling the cable through the small bend radius. The cable must be bent so that it goes through the trays between them. The cable needs to be kept away from sharp bends or corners.

Most of the optical fibre cables are constructed with flexibility in the work area. But, bending the cable over corners can cause severe damage. The cable must be tightly prevented to avoid kinks and knots.

Crush and Impact

- It aids in discovering the OPF performance and the stability to resist pressure and loads.
- In the testing procedure, cables are crushed between two plates and optical loss is measured.
- The amount of attenuation depends on the customer's needs.
- Cables are tested for breakage or damage in optical transmission characteristics.
- In the installation process, crush and impact are very important.
- Fibre cables can work in the same duct or tray as heavier power cables, and excess pressure needs to be avoided on the fibre cable.
- It is a must to avoid crossover of the cables over one another.
- Moving or shifting the installed cables can cause damage to the fibre optic cable.

Cable	Cable Structure		
Parameter	**Loose Tube**	**Tight Buffer**	**Breakout**
Bend Radius:	Larger	Smaller	Larger
Diameter:	Larger	Smaller	Larger
Tensile Strength: (Install):	Higher	Lower	Higher
Impact Resistane:	Lower	Higher	Higher
Crush Resistance:	Lower	Higher	Higher
Attentuation Change at Low Temperatures:	Lower	Higher	Higher

Fig. 2.2.2 Fibre optic specifications

Attenuation

Crush and impact aid in discovering the durability and stability of the OFC. It helps to test the stability of the OFC that is crushed between two plates and whether the optical loss has been measured. The amount of attenuation can be fixed based on the customer's request.

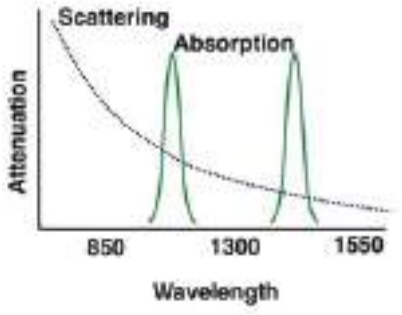


Fig. 2.2.3: Cable attenuation factors

Fibre Optic Cable Continuity

This is the calculation of the intensity passed from the light source to the other end, the receiver, to check the continuity of the OFC. This can be used to assess the damage by calculating the intensity level.

Continuity Test:

Send a light signal into the cable using a continuity tester. While you're doing this, look at the other end of the cable closely. If the light is detectable in the fibre's core, there are no breaks in the fibre, and your cable is fit for use.

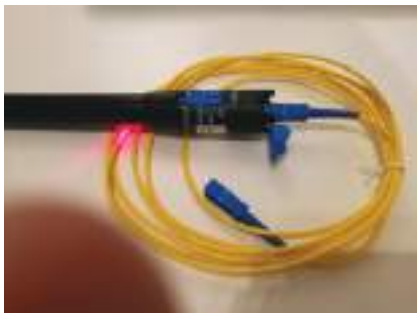


Fig. 2.2.4: Fibre Optics Continuity Tester

2.2.2 Factors Affecting OFC

There are two types of factors which affect the OFC, viz., natural and man-made.

Natural external factors		External cables					Internal cables	
		Trunk, junction and distribution					Customer premises	Central office
		Aerial	Buried	Duet	Tunnel	Under water	Building	
Temperature change	B	Cable sheath contraction with core thrusting out					–	–
	A	Increase of optical loss due to high and low temperature						
Very low temperature	B	Embrittlement of cable sheath under low temperature			–	–	–	–
	A	Crushing due to ice formation					–	–
Wind	B	Excess strain due to wind pressure	–	–	–	–	–	–
	A	Periodical excess strain due to cable dancing	–	–	–	–	–	–
Salt water	B	Corrosion of metal catenary	Corrosion of armour	–	–	Corrosion of armour	–	–
Rain and hot spring	B	Corrosion of metal catenary	Corrosion due to hot springs			–	–	–
Snow and ice	A	Sheath degradation, crushing and excess strain due to snow and ice	–	–	–	Sheath degradation and crushing due to ice	–	–
Water and moisture	A	Increase in optical loss due to water penetration. Decrease of strength of fibre					–	–
Sunshine	B	Degradation of sheath by UV rays	–	–	–	–	–	–
Lightning	B	Crushing damage due to lightning and haz-ards to personnel					–	–
Earthquakes and ship. ground subsidence and falling stones	B	Sheath deg-radation and impulsive excess strain due to falling stones	Cutting of cables due to ground movements		–	–	–	–
Condition of soil	B	–	Corrosion of armour	–	–	–	–	–
Rodents, birds and insects	B	Sheath damage due to birds, rodents and insects		–	–	–	–	–
Hydrogen	A	Increase in optical loss due to hydrogen					–	–
Water flow	B	–	–	–	–	Cable damage	–	–
Mould growth	B	–	–	Sheath damage	–	–	Sheath damage	–

A. Particular consideration for optical fibre cables.

B. Intrinsic consideration for outside plant

Fig. 2.2.5 (a): Natural Factors

Man-made factors		External cables					Internal cables	
		Trunk, junction and distribution					Customer premises	Central office
		Aerial	Buried	Duet	Tunnel	Under water	Building	
Factory smoke and air pollution	B	Corrosion of metal	–	–	–	–	–	–
	B	Chemical attack on sheath	–	–	–	–	–	–
Traffic (cars, trucks)	B	–	Damage to cable sheath and joints due to creep. Transient optical loss due to vibration of fibres		–	–	–	–
Induced voltage (AC traction systems, power lines)	B	Damage to cable and hazards to personnel			–	–	–	–
DC current	B	–	Electrolytic corrosion	–	–	–	–	–
Petroleum gas leakage	B	–	Sheath degradation due to chemical attack	–	–	–	–	–
Fire	B	Sheath (and cable core) burning	–	–	Sheath (and cable core) burning	–	Sheath (and cable core) burning	
Nuclear radiation	B	Under consideration					–	–
Hydrogen	A	Increase in optical loss due to hydrogen					–	–
Installation practices	B	Cutting or breaking of the cables					–	–
	A/B	B-Strain due pulling-in for installation			A-Strain due pulling-in for installation		–	–
		–	–	–	A-Bending at pulley for installation			
	A/B	B-Bending & pulley for installation	B-Bending and squeezing due to burying machine		A-Bending at curve in duct	–	–	–
A Particular consideration for optical fibre cables B. Intrinsic consideration for outside plant								

Fig. 2.2.5 (a): Man-made Factors

Man-made factors		External cables					Internal cables	
		Trunk, junction and distribution					Customer premises	Central office
		Aerial	Buried	Duet	Tunnel	Under water	Building	
Factory smoke and air pollution	B	Corrosion of metal	–	–	–	–	–	–
	B	Chemical attack on sheath	–	–	–	–	–	–
Traffic (cars, trucks)	B	–	Damage to cable sheath and joints due to creep. Transient optical loss due to vibration of fibres		–	–	–	–
Induced voltage (AC traction systems, power lines)	B	Damage to cable and hazards to personnel			–	–	–	–
DC current	B	–	Electrolytic corrosion	–	–	–	–	–
Petroleum gas leakage	B	–	Sheath degradation due to chemical attack	–	–	–	–	–
Fire	B	Sheath (and cable core) burning	–	–	Sheath (and cable core) burning	–	Sheath (and cable core) burning	
Nuclear radiation	B	Under consideration					–	–
Hydrogen	A	Increase in optical loss due to hydrogen					–	–
Installation practices	B	Cutting or breaking of the cables					–	–
	A/B	B-Strain due pulling-in for installation			A-Strain due pulling-in for installation		–	–
		–	–	–	A-Bending at pulley for installation			
	A/B	B-Bending & pulley for installation	B-Bending and squeezing due to burying machine		A-Bending at curve in duct	–	–	–
A Particular consideration for optical fibre cables B. Intrinsic consideration for outside plant								

Fig. 2.2.5 (c): Mechanical Factors

2.2.3 Factors Affecting Choosing of Cables

Let us understand how to choose cables on the basis of various factors that affect the cable performance:

Mechanical and environmental factors	Coated optical fibres	Cable core	Strength member	Water blocking materials	Sheath materials
Residual fibre strain	A	A	A	–	B
Impulsive fibre strain	A	A	–	–	A
Fibre macro-bending	A	A	B	–	A
Fibre microbend-ing	A	A	B	B	B
Water	A	A	–	A	A
Moisture	B	–	–	–	A
Hydrogen	B	B	B	B	B
Lightning	–	–	A	B	A
Nuclear radiation	Under consideration				
A. Primary factor to be considered B. Secondary factor to be considered					

Table: 2.2.1: Considerable factors for choosing cables

2.2.4 Handling Optical Fibre Cable

Handling Process

Gentle handling is needed during OFC handling and installation, and even a little damage can cause performance reduction. In case of any damage, the OFC needs to be replaced to avoid damage, and OFC needs to be handled carefully.

Always wear a suitable safety Helmet, safety glasses with side shields, and protective gloves while handling OFC. Handle the fibre optic splinters similar to glass splinters. Never look directly through the end of fibre cables till you ensure that there is no light source at the other end.

Cable Unloading

- Precautions to be taken while cable loading/unloading:
- Must not drop the cable drum on the floor, which can cause damage to the cable
- Roll the drum from the truck onto the receiving platform, and this needs to be done at the same height.
- A forklift can act as an alternative to unloading the drums from the truck.
- Do not lose control while rolling the drums
- Before handling the next drum, roll the drum away from the boom of the ramp.

Fig. 2.2.6: Unloading OFC

Cable Unwrapping

- Precautions need to be taken while cable unwrapping:
- Drum wrappers help to protect the OFC from damage.
- All drums are wrapped by wooden laggings to avoid damage.
- Removing the whole wrapping from the drum before cable installation is not advised.

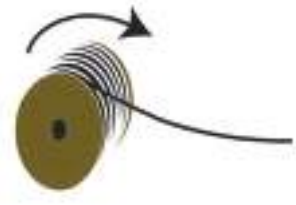


Fig. 2.2.7: Unwrapping OFC

Cable Storage

- Store the drums in an upright position. Any other position can cause winding defects.
- If the storage place is small, then store the completely wrapped drums on their flanges' edge.

Fig. 2.2.8: Storing OFC

Environmental Storage Issues:

- Wooden storage also can have a negative impact on the OFC. Wood materials can get degraded due to environmental factors, which can cause the degradation of wood.

Important Way to Address the issue

- Degradation can be avoided with in-house storage.
- In the case of storing outside, the wood storage needs to be hard, and no moist material should come in contact.
- Wood also needs to be prevented from insects which can cause degradation.
- It is important to close the drum using polythene to avoid moisture getting into the drum.

2.2.5 Pre Installation - Drum Inspection

One must check on the following points:

- It is important to test the drum for attenuation and damage before taking them to a site.
- Make sure that flanges are stencilled.
- Examine the above points of drum inspection before dispatching.
- Always have a backup drum.

Cable Inspection

Have a check on the following:

- In case of less clarification, remove the cable and examine it thoroughly.
- Have a check on the optical continuity, attenuation and length of the OFC.
- In case of any damage, contact the supplier for the replacement. 37 Optical Fibre
- Find the inner and outer end of the OFC.
- Remove pulling grips & end caps at both ends.
- Check the type and quantity of the cable
- Inspect the damage.
- Check on the manufacturer's default mistakes.

Opening the drum, check on the following:

- Drums need to be closed with wooden material with the help of an aluminium or iron strip.
- Remove the beans carefully to avoid damage to the cable.
- Use a strip cutter to cut.
- Place the hammer in between the iron strip cut and press the hammer at the opposite end so that the bean comes out of the flange.
- Carefully remove the beans without damaging the cable.
- Bend the straight nails with caution to avoid injury.
- Take out the thermal wrapper given over the cable. Preparation of Drum
- To prevent the cable from rubbing the drum flanges, arrange the cable drum in the pulling direction.
- To avoid the cable coming in contact with the floor, pay -out the cable from the top of the drum.

Preparation of Drum:

- To prevent the cable from rubbing the drum flanges, arrange the cable drum in the pulling direction.
- To avoid the cable coming in contact with the floor, pay -out the cable from the top of the drum.

Fig. 2.2.9: Preparing the drum

2.2.6 Colour Coding of Optical Fibre Cable

Colour codes are used in OFC to identify fibres, cables and connectors.

Cable Jacket Colours

Coloured outer jackets and/or prints may be used on Premises Distribution Cable, Premises Interconnect Cable or Interconnect Cord, or Premises Breakout Cable to identify the classification and fibre sizes of the fibre. Outdoor cables are generally black for protection against UV light, and markings are printed on the cable.

When coloured jackets are used to identify the type of fibre in cable containing only one fibre type, the colours shall be as indicated in the below table.

Other colours may be used, providing that the print on the outer jacket identifies fibre classifications. Such colours should be as agreed upon between manufacturer and user.

Unless otherwise specified, the outer jacket of the premises cable containing more than one fibre type shall use a printed legend to identify the quantities and types of fibres within the cable. The below table shows the preferred nomenclature for the various fibre types, for example, "12 Fibre, 8 x 50/125, 4 x SM." Some manufacturers use black as the jacket colour for hybrid or composite cables.

When the print on the outer jacket of the premises cable is used to identify the types and classifications of the fibre, the nomenclature of the below table is preferred for the various fibre types.

Fiber Type	Color Code		
	Non-military Applica-tions(3)	Military Applications	Suggested Print Nomenclature
Multimode (50/125) (OM2)	Orange	Orange	OM2, 50/125
Multimode (50/125) (850 nm Laser optimized) (OM3, OM4)	Aqua	Undefined	OM3 or OM4, 850 LO 50/125
Multimode (50/125) (850 nm Laser optimized) (OM5)	Lime Green	Undefined	OM5
Multimode (62.5/125) (OM1)	Orange	Slate	OM1, 62.5/125
Multimode (100/140)	Orange	Green	100/140
Single-mode (OS1, OS1a, OS2)	Yellow	Yellow	OS1, OS1a, OS2, SM/NZDS, SM
Polarization Maintaining Single-mode	Blue	Undefined	Undefined (2)

Fig. 2.2.10: Cable jacket colours

Connector Colour Codes

Since the earliest days of fibre optics, orange, black or grey was multi-mode and yellow single mode. However, the arrival of metallic connectors like the FC and ST made connector colour coding difficult, so coloured strain relief boots were often used.

Fiber type	Connector Body	Strain Relief/ Mating Adapter
62.5/125	Beige	Beige
50/125 OM2	Black	Black
50/125 laser optimized (OM3, OM4)	Aqua	Aqua

Fiber type	Connector Body	Strain Relief/ Mating Adapter
OM5 wideband fiber	Lime Green	Lime Green
Singlemode	Blue	Blue
Singlemode APC	Green	Green

Fig. 2.2.11: Connector Colour Codes

Fibre Colour Codes

Individual fibres will be colour coded for identification inside the cable or inside each tube in a loose tube cable. Fibres follow the convention created for telephone wires, except fibres are identified individually, not in pairs.

Buffer tubes follow the same colour sequence up to 12 tubes, then tubes 13-24 will repeat the colours with a black stripe (black will have a yellow stripe), tubes 25-36 will follow the same colour with an orange stripe, 37-48 use a green stripe, following the same colour code sequence for the stripe. Tubes containing more than 12 fibres will use binder tape to separate fibres into groups. Ribbon cables follow this colour sequence also.

For splicing, colour fibres are generally spliced to ensure continuity of colour codes throughout a cable run.

Fiber Number	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose
12	Aqua

Fig. 12.2.12: Fibre Colour Codes

Unit 2.3: Installation of Optical Fibre

Unit Objectives

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

1. Demonstrate and monitor installation of optical fibre – trenching, aerial cabling, ducting, figure-eight, cable pulling, blowing, and termination perform effective tests
2. Demonstrate effective reporting and documentation skills

2.2.1 Installing OFC

The actual installation process involves setting the cable, terminating it and then testing it. The following needs to be considered while installing an OFC:

- Always have the cable pulling plan.
- Make sure you have all the authorisation and permission documents.
- Make sure to have all the tools and devices while working.
- Make sure to share the plans with the installation team and stakeholders.
- It is a must for the installation team to know the access points and the splice locations.
- Once the network design gets completed, start the installation to make the operation communication system as per the design.
- The process of installation helps in choosing the contractor.
- The contractor needs to work with the customer during the installation project, which has the following stages:
  - Designing the plan
  - Installing
  - Testing
  - Troubleshooting
  - Documenting
  - Restoring

Steps of OFC Installation

- Once the plan has been made for the installation, the physical work starts based on the design
- The installation process turns the plan into an operating communication system
- It is important for the contractor to have experience in the process of installation

Following are the steps for installing an optical Fibre cable:

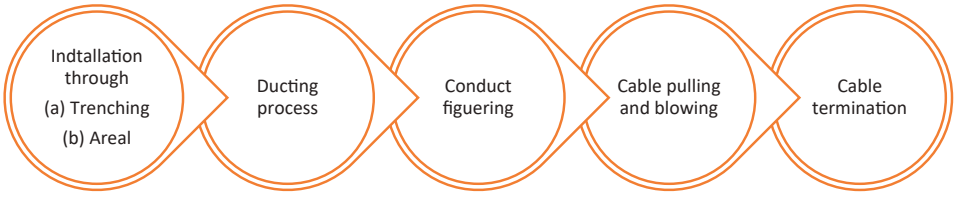


Fig. 2.3.1: OFC cable installation steps

Step 1 (a): Trenching

Trenching is a construction technique that involves digging a narrow channel in the ground for the installation, maintenance, or inspection of cables. This process takes time, and it is effective for short-distance applications

While digging the channel, obstructions are examined to avoid cable damage.

Trenching is often carried out in urban & suburban areas. It can be done using a machine or by manual methods. An appropriate width for a trench is 4 inches and a hole 20cm from the stand. The cable left for future splicing must have protective caps that must be sealed.

Always use warning tape to protect the OFC to prevent future digging. Mostly OFCs are buried under 3-4 feet to reduce the digging at the same place.

Process of Trenching:

- Dig a trench and bury the duct. It is about 4 inch plastic pipe and could have a pre-installed innerduct with a pulling tape to support the cable pulling process.
- For streets and sidewalks, directional boring is done to avoid surface digging.
- In dielectric cables and ducts, conductive marker tapes may be placed over the duct to facilitate future cable location and to warn anyone digging near the cable.

Fig. 2.3.2: Micro-trenching for optical fibre laying

- Trenching is generally done by using machinery. Some regions may need the trench to be dug by hand but to maintain speed; hand digging should only be done if essential.
- A trench should not be wider or deeper than what is required to maintain optimum trenching speed. The recommended minimum practical width of a trench is 4".

Precautions for Trenching:

- The cable should be buried at an undisturbed place.
- Ensure the cable is properly placed in the roadside trench and that future extending must not affect it.
- Take care of the route, which should not be affected by any natural process like drainage or other causes.
- Keep a label to indicate to others that the OFC has been installed.

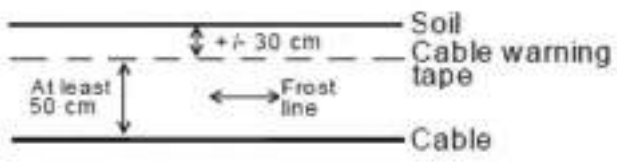


Fig. 2.3.3: Trenching precautions

Step 1 (b): Aerial Cabling

An aerial cable is an insulated cable containing required fibres for a telecommunication line, which is suspended between utility poles or electricity pylons.

The aerial installation also requires specialised equipment and procedure. It is used in long-duration operations.

Cables in aerial runs can be damaged by the wind, ice, stretch and pull. Hence, external support is a must during installation. This process uses a strong wire which is used to secure the cable.

The cable is lashed for protection. The lashers are chosen with the use of lashing tools. It is an armour buffered tube fibre cable.

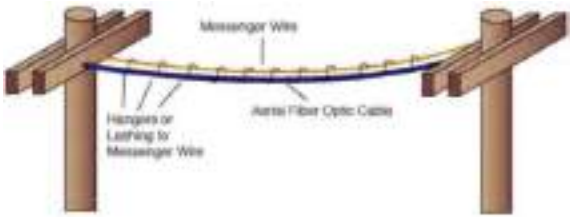


Fig. 2.3.4: Aerial cable installation

Step 2: Ducting Process

Ducts (or conduits) offer a highly protective environment for fibre-optic cables. They are typically buried, and then the cables are air-blown, jetted, pulled or pushed into the duct.

The major advantage of this process is that an old cable can be removed and a new cable can be installed. It causes no damage to the surrounding.

Ducting can be done through a manual or a mechanical process. A duct is made up of PVC material and must be twice the diameter of an OFC. Ducts are coated with an inner lining to protect the OFC from rubbing.

Various colours of lining are available for identification purposes. The installer measures the length of the duct, and it needs to be accurate and placed in the proper position.

Fig. 2.3.5: Duct installation of OFC

Step 3: Conduct figuring

Figure 8'ing'

- Mark two adjacent circles on the floor of 1.5 to 2-meter diameter so that they make a figure eight.
- Place pulled the cable from a pole or a pay-out trailer on this mark to make several layers, one on top of another.
- A cardboard sheet could be placed over each layer.

- Long lengths of cables and the ones with more weight require to be un-drummed to create more than one
- figure eight coils. This will facilitate turning over such coils for pulling in another direction.
- Turning figure 8 loop needs at least three persons; one at the centre and one at each end of the circle.
- Control winding of the cable either with hands or with cable drum brake to avert free running or jerking of
- the cable.

Fig. 2.3.6: Figure 8'ing' of OFC

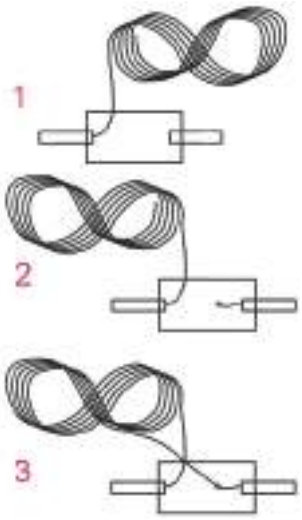


Fig. 2.3.7: Step-by-step process of Figure 8'ing' of OFC

Step 4: Cable Pulling & Blowing

Cable Pulling:

- Most organisations use cable connections for short distances and straight ways,
- which can be easily pulled with a hand. No equipment is needed.
- If the cable components are not locked, then the elongation in the jacket can occur, which can cause pullback of the cable.
- Equipment can be used to pull a cable with high mechanical force.
- Removing the jacket when pulling the cable using a pulling grip is important.
- It is essential to notice the pressure and force applied to the cable.
- It is necessary to use lubricants while pulling.

- It is very important to give only limited force while pulling.
- When using power in pulling, tension monitoring equipment should be used.
- Avoid twisting or bending during pulling
- For long runs, use two or more stages of pulling.
- Make sure enough cable is stored in the shape of 8.
- Initiate a pulling process in the middle location and then proceed in both directions.
- Rack the cable after pulling.
- The allowed pulling level is 3 feet/sec.

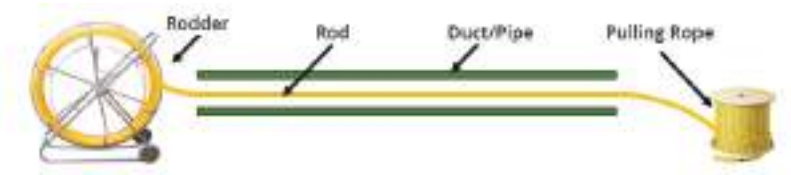


Fig. 2.3.8: Cable pulling

Cable Blowing:

The following steps need to be taken for cable blowing:

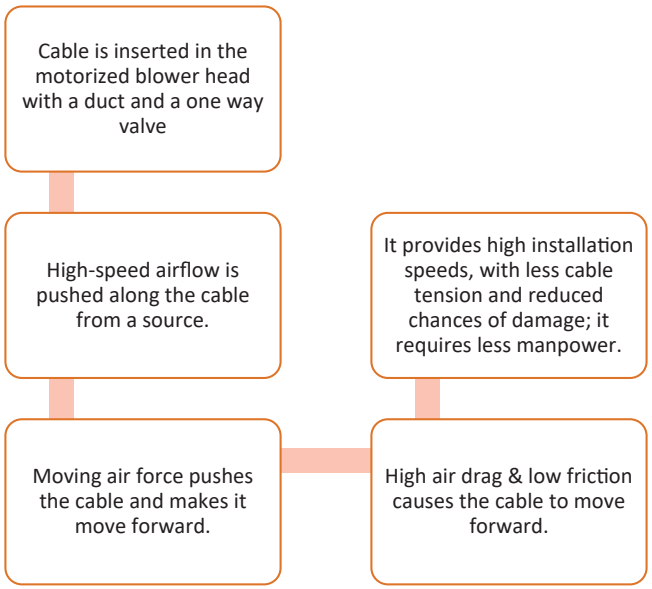


Fig. 2.3.9: Steps for cable blowing

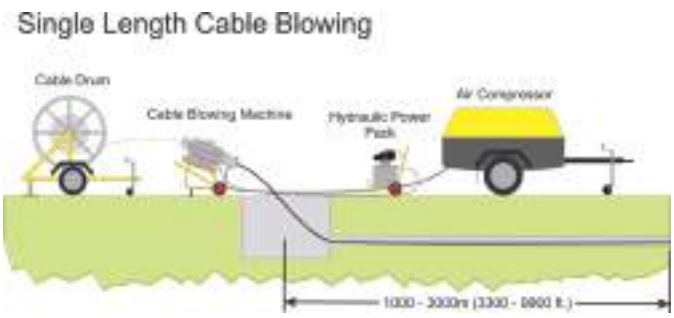


Fig. 2.3.10: Cable blowing process

Step 5: OFC Termination Method

There are 2 methods for terminating the fibre: The first is through the use of connectors that form a temporary joint, and the other is through splicing, which is actually connecting two bare fibre ends directly. The most common termination methods are:

- No-epoxy/no-polish
- Epoxy-and-polish
- Pigtail splicing

Steps to terminate OFC using fibre boot:

 Put on a fibre boot	 Measure 14 cm for striping as per specifications	 Strip the fibre using a wire stripper
 Use alcohol wipes to clean any residue	 Give the fibre a very slight bend	 Put the fibre in a cleaver holder at the 10.5 cm mark (as per specs) and cleave the fibre
 Put the fibre in the connector & squeeze the holder	 Slide the boot, and the connection is complete	

Table: 2.3.11: Steps to terminate OFC using fibre boot

2.2.2 Testing and Closing Activities

After installation, splicing and termination of the optical fibre, it must be tested for the following:

- Continuity and polarity
- End-to-end insertion loss
- Troubleshoot problems, if any
- Ensure marking for identification of route for future maintenance and troubleshooting
- Ensure appropriate cable markings as per recommended guidelines
- Backfill and clear site from debris and other items

Fig. 2.3.11: Testing equipment

2.2.3 Reporting and Documentation

Documentation is essential for reference and troubleshooting purposes. It is important to document the fibre designing and installation process of the fibre cable plant.

Major advantages of documentation:

- Proper planning and making a layout reduces the time and cost.
- The materials are pre-determined to avoid confusion.
- It leaves a path to update the existing plan.
- It speeds up the cable pulling and installation.
- It helps to track the process and to identify the mistakes.
- The testing documentation can help show the installation's accuracy and faults.
- It helps for routing the path easily.

Information record about the cable, splice, fibre, paths, etc. is a must and should be captured as follows:

Cable

- Manufacturer, type, ID, length & drum number
- Splice and terminalon points (at distance markers)

Fibre

Fibre type and size, splice and connectionon data, losses

Connection

- Types (splice or connectors and types), fibres connected, losses

Paths

- Where the link path goes in every cable

Storage

- A database that contains component, connetion, and test data can be used to store most of the data.

Fig. 2.3.12: Information record

Record storage importance:

- It is very important to store the records in a safe way.
- Always have more than one copy of the document.
- Spare copy is important while storing on a computer or paper.
- Make sure only an authorised person gets access to the records.

Content and update of the report:

Always make sure to capture the information given below:

- Pending issues
- Challenges
- Faults & serviceability
- NOC for cable integration
- Final closure of the job

UNIT 2.4: Preparing the Cable for Splicing

Unit Objectives

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

1. Inspect Optical Time Domain Reflectometer (OTDR), Power Meter, Splicer, Cleaver, and other mechanical tools/equipment for any fault and calibration status
2. Discuss the importance of calibrating the test equipment
3. Demonstrate the steps of preparing the cable for splicing for new installation

2.4.1 Instruments used for Testing and Splicing of OFC

Optical Time Domain Reflectometer (OTDR)

An Optical Time Domain Reflectometer (OTDR) is a device that tests the integrity of a fibre cable. It is used for building, maintaining, certifying, and troubleshooting fibre optic systems. It uses **Rayleigh scattering and Fresnel reflections** to measure fibres' characteristics. Rayleigh scattering refers to the irregular scattering generated as optical signals transmitting in the fibre.

Optical Time Domain Reflectometer distance and attenuation scales are calibrated using the External Source Method. Commonly used methods based on recirculating loop and reference attenuation artefact are used to check the obtained results.

Fig. 2.4.1: Optical Time Domain Reflectometer

Power Meter

An optical power meter (OPM) is a device used to measure the power in an optical signal. The term usually refers to a device for testing the average power in fibre optic systems.

Fig. 2.4.2: Optic Power Meter

Splicer

An optical fibre splicing machine is a core-to-core alignment module used to perform the fusion splicing process, fusing or welding two fibres together, usually by an electric arc.

Fig. 2.4.3: Fusion splicer machine

2.4.2 Calibration of Test Equipment

The objective of calibration is to minimise any measurement uncertainty by ensuring the precision of test equipment. Calibration measures and controls errors or uncertainties within the measurement processes to an acceptable level.

Manufacturer's specifications will direct how often to calibrate their tools. However, critical measurements may require different intervals. Most equipment in the fibre optic industry generally has an annual requirement.

Regular instrument calibration is necessary because their measurements' accuracy starts to drop over time. You need to ensure that the instruments don't get out of calibration.

You will notice that the accuracy of the major components will vary over time. However, this shift is minor and won't affect the measurements if you maintain a good calibration schedule, as timely calibrating of your equipment will identify and correct the changes.

There are three main reasons for calibrating the instruments:

- To ensure readings from an instrument are consistent with other measurements.
- To determine the accuracy of the instrument readings.
- To establish the reliability of the instrument, i.e., that it can be trusted.

Calibration of fibre optical communication system:

- **Optical Time Domain Reflectometer**

  Calibrating kilometric attenuation and fibre optical distance realising a fibre-optical-artefact-reflectometer calibration procedure

- **Optical Power Meter Calibration**

  Calibrating optical power meter for multi-mode/Single mode/plastic data communication networks including fibre optical receiver's absolute calibration factor and non-linearity, traceable to PTB and METAS

- **Optical Light Source Verification**

  Calibrating optical power, stability, half-value of width, wavelength on fibre optical sources and transmitters

- **Optical Attenuator Verification**

  Calibrating fibre optical attenuation, linearity and repeatability.

- **PMD Calibration**

  NPL traceable PMD artefact for 10ps Low Mode Coupled PMD (Polarization Mode Dispersion).

2.4.3 Steps of Preparing the Cable for Splicing for New Installation

The first step is to mark the cable before putting it into the splicer. If you miss doing it, you will need to check which fibres go to which module, which is very inconvenient and confusing.

For marking, the below-shown paper labels are used, which usually come with the splice closure.

Fig. 2.4.4: Markings for optical fibre splicing

The next step is measuring fibres in the fibre optic cable organiser. However, when fusing a large number of optical fibres, they should still be measured, and the easiest way should be chosen: in a circle, without tricky complex loops and channel transitions. With most cable organisers, it is necessary to measure out: there will be serious problems when laying fibres unless you measure fibres in advance and think about how they will fit into the cable organiser after fusion.

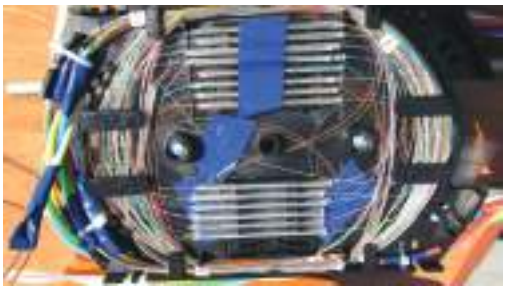


Fig. 2.4.5: Fibre optic cable organiser

When two optical fibres that are to be fused are in the modules, which enter the cable organiser "counter" each other, it is enough to measure each of them by simply laying several (usually two) turns and cutting off above the cradle, where it is planned to lay the FSPK (Fusion Splice Protection Kit) of this splice.

Use a protective sleeve (FSKP)

These are disposable composite heat shrink sleeve that protects the splice. These generally come with fibre optic splice closures/ODFs, and are inexpensive.

It consists of 3 parts: a tube of readily fusible plastic inside, a plastic tube with shrink properties outside, and iron wire for rigidity. The protective sleeves are put on one of the fibres to be fused (prior to fusion); when fibres are successfully fused, it is pushed to the splice site so that to completely hide the glass, and a slightly stretched fibre is put into the fusion splicer oven for about 20-40 seconds. The inner plastic melts inside the oven, wrapping the fused fibres, and the outer plastic is heat shrunk.

Fig. 2.4.6: Fusion Splice Protection Kit

When you cut the fibre optic with a fibre optic stripper, it is important to do everything slowly and carefully so that not to break optical fibres. If you cut the optical fibre too much, then after the fibre has been cleaved, the remaining tip will be too short, and the fibre container rollers may not be able to trap it. If you cut too little, then this cleaved tip will be so long that it won't fit in the fibre container and will stick out of it. Both options are undesirable.

However, suppose 2-3 splices in a row are unsuccessful. In that case, the fibre becomes short, and to save fibre, it is necessary to cut it short deliberately, just enough for the cleaver to cleave. The remaining tip can be put into the fibre container with tweezers or insulated with electrical tape.

Summary

- Discussing the characteristics of Optical Fibre
- Identifying the tools and equipment required for optical fibre splicing
- Conducting fault analysis procedures and implement safety measures for different tools and mechani-cal equipment
- Discussing the importance of calibrating the test equipment
- Explaining the colour coding of optical fibre cable
- Demonstrating the steps to prepare the cable for splicing for new installation
- Performing tests on OFC using an optical inspection microscope, OTDR and visual fault locator
- Illustrating bare fibre testing

Exercise

Multiple-choice Question

1. When a ray of light crosses an interface into a medium with a higher refractive index, it bends towards the _____.

   a) normal
   b) abnormal
   c) new normal
   d) none of the above

2. A light wave that is vibrating in more than one plane is referred to as _____.

   a) unpolarised light
   b) polarised light
   c) bipolarised light
   d) none of the above

3. The _____ of an optical fibre is the amount of light lost between input and output.

   a) attenuation
   b) attention
   c) accention
   d) none of the above

4. It is a _____ which is applied to the cable to avoid damage.

   a) protector
   b) detector
   c) projtector
   d) none of the above

5. _____ help to protect the OFC from damage.

   a) Drum wrappers
   b) guitar wrappers
   c) keyboard wrappers
   d) None of the above

Answer the following:

1. Explain the characteristics of Optical Fibre.
2. What is Total Internal Reflection?
3. Describe the process of installing OFC.
4. What is Trenching? Explain.
5. Describe OFC termination method.

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=G-UyeFDsXII

Characteristics of Optical Fibre

https://www.youtube.com/watch?v=SDPfA8k0dUc

Various Optical Equipment

https://www.youtube.com/watch?v=77dOO5hvd58

Specifications of Fibre Optic Cable

https://www.youtube.com/watch?v=1oYYB7AGeMo

Factors Affecting Choosing of Cables

https://www.youtube.com/watch?v=eCpujviAo9g

Colour Coding of Optical Fibre Cable

https://www.youtube.com/watch?v=fYwBgqDdLLQ

Installing OFC

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

Telecom
Sector
Skill
Council

3. Maintenance and Splicing of Optical Fiber

Unit 3.1 - Optical Fibre Splicing

Unit 3.2 - Maintenance of Fibre Optics

TEL/N6400

Key Learning Outcomes

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

1. Demonstrate splicing the optical fibre
2. Discuss signal strength and quality KPIs of optical fibre cables
3. Perform sealing joint closure heat shrinking/multi-diameter seals/mechanical seals, etc.
4. Interpret the standard operating procedures while performing preventive maintenance of the laid optical fibre cables

UNIT 3.1: Optical Fibre Splicing

Unit Objectives

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

1. Elaborate the optical fibre splicing process
2. Explain different types of optical fibre splicing
3. Identify spicing problems and troubleshoot them
4. Demonstrate effective safety norms during splicing

3.1.1 Splicing of OFC

It is a process of connecting two optical fibres permanently.

It is commonly used in long cable runs, which need more than one cable connection. This can connect different cables and can interlink various locations. It is used to terminate the single Fibres. It is commonly used in OSP applications because cables are pulled and terminated. There are two types of splicing:

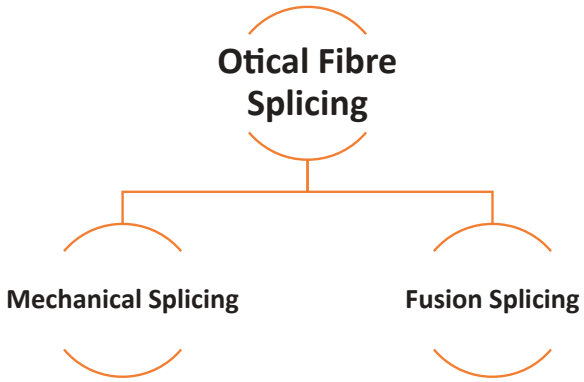


Fig. 3.1.1: Types of splicing of OFC

Why do we need to splice optical fibres?

Following are the reasons for carrying out 'Splicing':

- It is used when a long fibre cable is required
- It is used to connect two or more small fibre cables, which are bound to make a single connection using small cables
- Cut-off fibre links may need splicing to join them
- It is used in terminating the optical fibre to network and fibre panels

3.1.2 Types of Optical Fibre Splicing

As already discussed above, optical fibre splicing is of two types – Mechanical and Fusion. Let us discuss both types in detail.

Mechanical Splicing

This splicing technique comprises the precise alignment of two fibre optic cables, held in place by a self-contained assembly rather than a permanent bond. A mechanical splice is used to hold two fibre optic cables, allowing the light to pass through seamlessly, with a typical loss of around 10% (or 0.3 dB).

In this process, you must use an alignment device along with an index matching gel. The gel used must have a similar refractive index to enhance the light transmission across the joint, with minimal back reflection.

Steps to perform mechanical splicing:

Step 1: Prepare the fibres

The first step is to precisely strip the fibres of their protective coatings, jackets, tubes and strength.

Fig. 3.1.2: Preparing fibre for mechanical splicing

Step 2: Cleave the fibres

After stripping, the next step is to break your cables using a fibre cleaver. Now, use the cleaver to create a small, clean cut on the cables with ends perpendicular to the fibre axis.

Step 3: Mechanical joining of fibres

In this step, you just have to place the fibre accurately ends together in the mechanical splice unit. The index matching gel inside the equipment will do the rest, like linking the light to the ends of your cables. If using an older unit, you may have to use epoxy instead of the index matching gel to align the fibres correctly.

Step 4: Securing united fibres

Once done with these steps, place the fibres in a splice tray and then inside a splice closure. Now the completed mechanical splice renders its own protection for the splice. Ensure to seal the cables carefully, as this will prevent your cables from experiencing moisture damage.

Fig. 3.1.3: Mechanical Splicing

Types of mechanical splicing

V-Grooved Splicing

This technique takes a V-shaped substrate, and the two fibre ends are butted in the groove. Once the two are properly placed inside the groove, they are bonded by an index matching gel. This index matching gel provides proper grip to the connection. The V substrate can be composed of ceramic, plastic, silicon, or any metal.

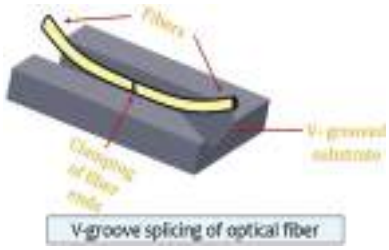


Fig. 3.1.4: Mechanical Splicing (V-Groove Splicing)

However, the fibre losses are more in this technique as compared to the fusion technique. These losses are due to the core and cladding diameter and core position with respect to the centre. Here, the two fibres do not form a continuous smooth connection as the joint is semi-permanent.

Elastic-Tube Splicing

It is a technique of splicing the fibre with the help of the elastic tube, which majorly finds its application in the case of multi-mode optical fibre. Here the fibre loss is similar to that of the fusion technique. However, the need for the equipment and skill is slightly less than the fusion splicing technique.

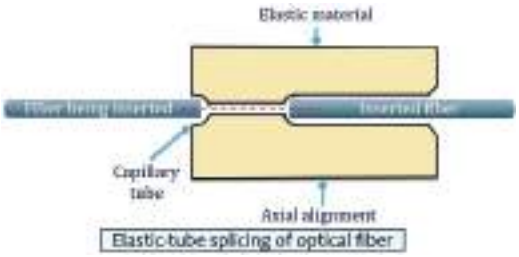


Fig. 3.1.5: Mechanical Splicing (Elastic-tube splicing)

Here, the elastic material is rubber, inside which a small hole is present. The diameter of this hole is less than the diameter of the fibre to be spliced. Tapering is done at the ends of both the fibres to allow easy insertion inside the tube.

When the fibre with a slightly larger diameter than the hole is inserted inside the hole, then it ultimately gets expanded. Due to this symmetricity, a proper alignment between the two fibres is achieved.

Fusion Splicing

Another method to join fibre optic cables together to form a permanent connection is fusion splicing. Here, a machine or an electric arc is used to produce heat and fuse/weld glass ends that are precisely aligned together for seamless transmission of light. It has a much lower attenuation of around 0.1 dB.

Fig. 3.1.5: Fusion Splicing

Overview of Fusion Splicing

Stripping the Fibre:

- It is a process of removing the protective layer, which is a polymer, from around the fibre.
- This process of splicing begins by fusing the two ends together.
- It is done by passing the fibre via a mechanical stripping device. We can also use a special procedure for stripping, which can be done using sulphuric acid.
- Sometimes, hot air is also used to remove the coating.
- There is also a method which uses chemicals under a defined time. It is called as solvent capture method.
- This procedure also helps to get rid of coatings and claddings.
- Tools used in cleaning the stripping and cleaving are very important.

Cleaning the Fibre:

- It is a process of cleaning the Fibres with alcohol and wipes like alcopad.
- Use of IPA is not advisable, as it attracts impurities.
- IPA is hygroscopic in nature, which is why it absorbs moisture.
- So, most aqueous-based cleaners are used in cleaning.

Cleaving the Fibre:

- The fibre is cleaved using the score and break method to make it flat and perpendicular to its axis.
- A microscope is used to analyse the quality of the fibre.

Splicing the Fibre

- Using core or cladding alignment, the fusion splicer automatically aligns the two cleaved fibres in the x,y,z plane; then, the fibres are fused together.
- Proof-test is done to confirm that the splice is firm enough to tolerate handling, packaging and prolonged use. Then, it is removed from the fusion splicer.
- Recoating is done, or a splice protector (heat shrinkable tube with strength membrane) is used to safeguard the bare fibre area.

Optical splicing procedure

- Placement of splicing process. Inspecting fibre optic splice closure content and the supplementary kits.

- Cable installation in the oval outlet.
- Cable preparation.
- Organisation of the fibres within the tray.
- Installing heat shrinkable sleeve and testing it.

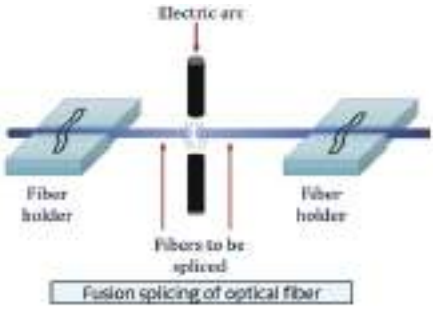


Fig. 3.1.7: Fusion splicing process

Fibre Spliced Still Unprotected

- The basic fusion splicing apparatus has two fixtures (sheath clamps) for mounting the fibres and two electrodes
- An inspection microscope is used to place ready fibre ends into the fusion-splicing apparatus. The fibres are then aligned and fused together
- Nichrome wire was used earlier in fusion splicing as the heating element to fuse fibres together
- Carbon dioxide (CO2) lasers, electric arcs, or gas flames are used to fuse the fibres.
- Electric arc fusion (arc fusion) has become a popular technique for splicing due to small-sized and automatic fusion splicers.
- Optical fibre connectors or mechanical splices can be used but have higher insertion losses, lower reliability and higher return losses than fusion splicing.

Fig. 3.1.8: Basic splicing instrument

Cable Preparation for Splicing

Following are the checks to prepare OFC for splicing:

- Check the installed cable and whether it has all the parameters as per the plan.
- Look for the damage or any issues
- Make sure those bend ratios are as per the measurement.
- Make sure that the cable is placed on a stable joining pit.
- Secure the cable properly to avoid damage.
- Check that the fibres are joined as per the colour coding and sequence.

Material and Equipment Used for Splicing

 Fibre optic cable	 Pig tail (2 in number)	 Stripper
 Mechanical splice	 Fusion splicer	 IPA cleaner & wipes
 Cleaver		

Table 3.1.1: Equipment Used for Splicing

Steps for fusion splicing

Step 1: Prepare the fibres

The first step is to strip the fibres of their protective coatings precisely.

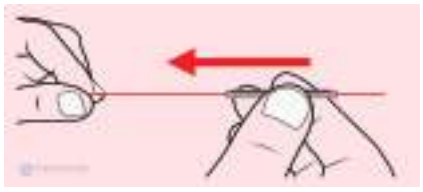


Fig. 3.1.9: Prepare the fibres

Then, similar to mechanical splicing, strip the protective coating around the optical fibre using a mechanical fibre stripper until you reach the bare fibre cores. Clean the stripping tools before starting the process.

Step 2: Clean and cleave the fibres

Clean the bare fibre using an Isopropyl Alcohol wipe. Do it twice using a different part of the wipe.

Once cleaned, avoid touching or contaminating the surface.

Now, use the cleaver to create a small, clean cut on the cables with ends perpendicular to the fibre axis.

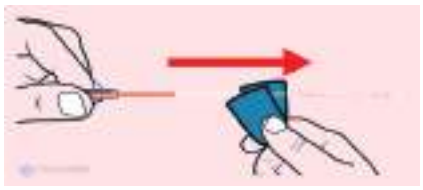


Fig. 3.1.10: Clean and cleave the fibres

Step 3: Fuse the fibres

The fibre is now ready to fuse using the fusion splicer. It involves the alignment of the fibres and heating to melt the fibre ends and fuse them.

Alignment can be manual or automatic, depending on the fusion splicer you are using. Once the end faces of the fibre are flawlessly aligned and centred on the electrodes, the splicer unit uses an electric arc to melt the two fibre ends and fuse them together.

Fig. 3.1.10: Fusion of fibres

If the fusion splicer stops the process in between, it may be due to the following issues:

- Poor alignment of the wires on their guides
- Fibres are not cleaved at a perfect 90-degree angle
- Due to the presence of some residual plastic cover or dirt on the end of the fibre

Step 4: Protect the fibre

A fusion splice usually has a tensile strength between 0.5 and 1.5 lbs and will not break during normal handling. Even then, it is advisable to provide protection from bending and pulling forces and ensure the fibre doesn't break during routine use.

After the fibres are successfully fused together, it's time to either re-apply a coating or use a splice protector.

You can use silicone gel, heat shrink plastic, or mechanical crimp protectors to secure the splice from external damage and breakage.

3.1.3 Tips for Better Splices

1. **Tips 1:** Thoroughly and frequently clean your splicing tools. When working with fibre, keep in mind that particles not visible to the naked eye could cause tremendous problems when working with fibre optics. Excessive cleaning of your fibre and tools will save you time and money.
2. **Tips 2:** Properly maintain and operate your cleaver. The cleaver is your most valuable tool in fibre splicing. Within mechanical splicing you need the proper angle to insure proper end faces or too much light escaping into the air gaps between the two fibres will occur. The index matching gel will eliminate most of the light escape but cannot overcome a low quality cleave
3. **Tips 3:** For Fusion splicing, you need an even more precise cleaver to achieve the exceptional low loss (0.05 dB and less). If you have a poor cleave the fibre ends might not melt together properly causing light loss and high reflection problems. Maintaining your cleaver by following manufacturer instructions for cleaning as well as using the tool properly will provide you with a long lasting piece of equipment and ensuring the job is done right the first time.
4. **Tips 4:** Fusion parameters must be adjusted minimally and methodically. If you start changing the fusion parameters on the splicer as soon as there is a hint of a problem you might lose your desired setting. Fusion time and fusion current are the two key factors for splicing. High time and low current result in the same outcome as high current and low time. Make sure to change one variable at a time and keep checking until you have found the right fusion parameters for your fibre type.

3.1.4 Evaluating Splices

Good Splices

You can look at the splice after the installation using both X and Y views. Some of the damage does not have any effect on the optical transmission. These are acceptable, and the examples for good splices are shown in the image given below. Some Fibres can cause white and black lines in the splice but are not considered faults. These are shown in the following figure:

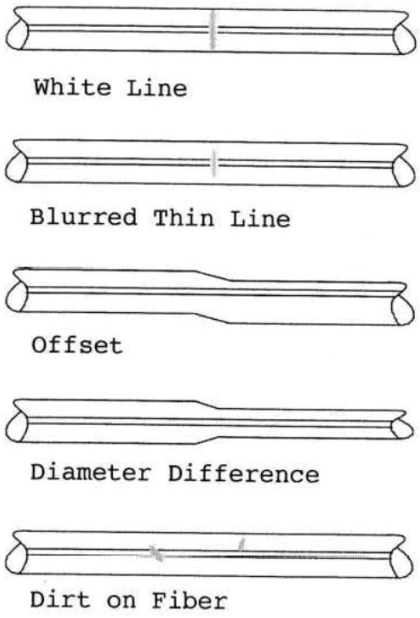


Fig. 3.1.12: These flaws do not affect optical transmission

Bad Splices

Splicing black spots or lines are known as bad splices, and these can be corrected. But they cannot be corrected more than twice. Other bad splices' identities are core offsets, bubbles and bulging splices.

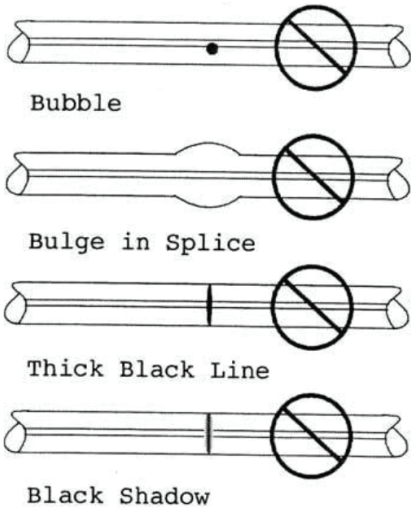


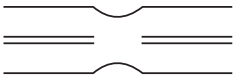
Fig. 3.1.13: These flaws require a redo

Splice Problem Troubleshooting

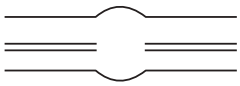
Some common problems and their likely causes are shown in the following figure:

Not fused through
Fusion current too low. Pre-fusion time too short.

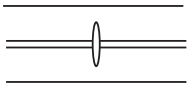
Contaminated electrodes. Fusion current much too high. Pre-fusion time much too long. Pre-fusion current much too high. Auto feed too small. Gap too large.



Current too high.
Feed rate too slow.
Pre-fusion time too long.
Pre-fusion current too high.
Gap too wide. Contaminated electrodes.



Enlargement
Auto-feed too fast.
Incorrect current.



Bubble or Inclusion
Contaminated fiber end faces. Poor cleave. Fusion current too high.. Pre-fusion current or time too low.

Additional problems

Fusion splicers generally have stored programs for most fibers and the user can modity those program parameters or create new ones. Refer to the instruction manual or ask the manufacturer is there is any question about using the splicer with the fiber you are installing.

It is sometimes necessary to splice older fibers, either in restoration or modifying networks. Older fibers may become brittle and hard to strip.

Fig. 3.1.14: Splice Problem Troubleshooting

3.1.5 Optical Fibre Safety Overview

Keep all food and beverages out of the work area. If fiber particles are ingested they can cause internal hemorrhaging	Wear disposable aprons to minimize fiber particles on your clothing, Fiber particles on your clothing can later get into food, drinks, and/or be ingested by other means.	Always wear safety glasses with side shields and protective gloves. Treat fiber optic splinters the same as you would glass splinters.
Never look directly into the end of fiber cables until you are positive that there is no light source at the other end. Use a fiber optic power meter to make certain the fiber is dark. When using an optical tracer or continuity checker, look at the fiber from an angle at least 6 inches away from your eye to determine if the visible light is present.		Only work in well ventilated areas.
Contact wearers must not handle their lenses until they have thoroughly washed their hands.	Do not touch your eyes while working with fiber optic systems until they have been thoroughly washed.	Keep all combustible materials safely away from the curing ovens.
Put all cut fiber pieces in a safe place.	Thoroughly clean your work area when you are done.	Do not smoke while working with fiber optic systems.

Fig. 3.1.14: Safety rules

3.1.6 Splicing Safety – Norms and Rules

During splicing following safety rules must be followed:

- It is advised to wear safety goggles at all times of installation and other exercises and activities. You must insist the person working without a glass wear it
- Dispose of the bi-products at the proper disposal area. Make sure they are removed carefully, and no one gets harmed because of the waste
- Cover the tools before storing
- Clean the tools properly for the next use
- Always make use of FDU. You can replace FDU with the use of water or soda
- Always have scraps which can be used to pick the diffused products into the skin
- The objects and wastes are very tiny and can diffuse into the skin, which is very difficult to remove with bare hands. So, make sure to wear protective clothing
- Make use of scotch tape to pick the small pieces of fibre
- Use dark colour paper while working, because these can help show the small particles that are emitted while working
- Always use IPA, epoxy and anaerobic adhesive while working
- Always wipe the tool with alcohol
- Remember that epoxy cannot be removed from clothes
- Never touch any Fibre with bare hands or fingers
- Terminators are very hot from the curing ovens. So be cautious while handling them
- Be careful while handling a glass piece as it can cut the skin

UNIT 3.2: Maintenance of Fibre Optics

Unit Objectives

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

1. Discuss the principles of optical transport media
2. Discuss signal strength and quality KPIs of optical fibre cables
3. Illustrate the processes of preventive maintenance of the laid optical fibre cables
4. List the factors that affect the performance of fibre optic cables
5. Demonstrate sealing joint closure heat shrinking/multi-diameter seals/mechanical seals, etc.
6. Perform regular maintenance activities for the laid fibre cable

3.2.1 Principles of Optical Transport Media

Optical Fibre works on the principle of Total Internal Reflection. When a ray of light strikes at the internal surface of optical fibre, such that the incidence angle is greater than the critical angle, then the incident light ray reflects in the same medium and this phenomenon repeats.

Optical Transport Network

OTN is a telecommunications industry-standard protocol defined in various ITU Recommendations, such as G.709 and G.798, that provides an efficient way to transport, switch, and multiplex different services onto high-capacity wavelengths across the optical network. Currently, network service providers rely on OTN-enabled technology in their optical networks to gain benefits that include increased resiliency, simplified operations, enhanced Service Level Agreements (SLA), an extended reach with Forward Error Correction (FEC), and the ability to efficiently maximise wavelength fill as well as guaranteed end-to-end service delivery.

OTN-enabled technology underpins next-generation optical networks with its ability to support flexible packet technologies that include new Ethernet interfaces, Multi-Protocol Label Switching (MPLS), Segment Routing, and Time Sensitive Networking (TSN), to name a few.

Optical Transport Medium

The OTM is the information structure transported across the optical interface. It has two parts:

- Digital structure
- Optical structure

The Optical Channel Payload Unit (OPU) contains the payload frames. The payload area of the OPU structure is comprised of end-user services such as IP, Ethernet, or any other protocol. The OPU overhead is associated with the mapping of client data into the payload area.

The Optical Channel Data Unit (ODU) contains the OPU overhead and payload area, plus added overhead Tandem Connection Monitoring (TCM), and so on. The ODU represents the OTN path service within an OTN network.

3.2.2 Signal Strength of Optical Fibre Cables

Signal strength is the magnitude of an electric field at a reference point, which is located at a significant distance from a transmitting antenna. This is expressed in terms of the signal power of the receiver or the voltage per length received by the reference antenna.

Fibre-optic internet has greater signal strength when compared to copper internet connections. The signal strength of the fibre-optic internet is unmatched as it does not degrade when the user moves away from the switch. This is particularly helpful when office spaces are located at a significant distance from the telecommunication rooms. Fibre-optic cables can run up to almost 25 miles before they lose signal strength, which makes them a better and stronger option overall.

Quality KPIs of Optical Fibre Cables

Fibre-optic cable has an astonishing bandwidth and is often restricted by the hardware on either side of the cable rather than the bandwidth of the cable itself.

Let us discuss some of the crucial factors affecting the performance of fibre optic installations.

1. **Poor connector terminations**
   - The connector chosen must match the existing patch panel connectors as the different types are not interchangeable and don't fit into one another.
   - If the fibre optic cabling connector ends are poorly terminated or the ends bent too sharply, then the light passing through will either be limited or at too low a range for the transmission to be connected. The light could still be shining through fibre optic cabling links but not have enough transmission quality to create the data link.
2. **Dirty connector ends**
   - The connector chosen must match the existing patch panel connectors as the different types are not interchangeable and don't fit into one another.
   - If the fibre optic cabling connector ends are poorly terminated or the ends bent too sharply, then the light passing through will either be limited or at too low a range for the transmission to be connected. The light could still be shining through fibre optic cabling links but not have enough transmission quality to create the data link.
3. **Poor installation**
   - Fibre optic cabling has a specific bend radius and pulling tension guideline when installing the main cabling runs. If the cable becomes stretched or bent too tightly, then the quality of light down the cable will be compromised which will result poor performance.
   - The cable construction has strands of Kevlar surrounding the inner cores, which protects the cable from being damaged. However, the fibre optic cable is at its weakest at the termination ends where the glass cores are exposed for termination. Adequate precaution should be taken at the termination ends to avoid excessive bending or crimping of the cable into place for termination, as this causes breaks in the cable cores. The correct termination box or panel should be selected to help eliminate this problem
4. **Patch leads**
   - With regular patching and un-patching, the patch leads can become scratched or dirty. The weakest part of the link creates the overall quality of the link, which means a poor patch lead can create a poor one overall. Fibre optic patch leads should be cleaned each time they are re-patched.
   - There are also several different categories of fibre optic cabling with different performance, core-sizes and suitability. Installing a lower category of the patch lead to a higher level cable, which will reduce the performance of the over link.

5. **Crossed over patch leads**
   - The main reason a fibre optic link doesn't work after installation is the patch leads are not patched for the correct fibre optic cabling link. In a standard fibre optic link core 1 on the transmitting end will send to core 2 on the receiving end and vice versa. However, some installations will directly match and connect the cores to transmit from position one and receive on position one. Crossover patch leads are used in this scenario to create the transmit and return loop.
   - The first way to check when a link doesn't work is by swapping around the patch lead cores at one end and re-testing the link.

3.2.2 Signal Strength of Optical Fibre Cables

Preventive maintenance means performing regularly scheduled maintenance activities to help prevent unexpected failures in the future.

- **Reception of an alarm or trouble reports**

  Testing and cable repair or removal after a fault are classified as post-fault maintenance. Both preventative maintenance and post-fault maintenance can be described as having three activities.

Maintenance category	Maintenance activity	Functions	Status
Preventative maintenance	**Surveillance** (e.g. Periodic testing)	Detection of fibre loss increase Detection of fibre deterioration Detection of water penetration	Optional (Note 1) Optional (Note 2) Optional
	Testing (e.g. Fibre degradation testing)	Measurement of fibre fault location Measurement of fibre strain distribution Measurement of water location.	Optional Optional (Note 2) Optional
	Control (e.g. Network element control)	Fibre identification Fibre transfer system	Optional Optional (Note 3)
Post-fault maintenance	**Surveillance** (e.g. Reception of transmission system alarm or customer trouble report)	Interface with path operation system Interface with customer service operation	Optional Optional
	Testing (e.g. Fibre fault testing)	Fault distinction between transmission equipment and fibre network Measurement of fibre fault location	Required Required
	Remedy (eg. Cable repair/removal)	Restoration/permanent repair Fibre identification Fibre transfer system	Required Required Required (Note 4)

NOTE 1-For point-to-point networks, the detection of fibre loss increase is recommended.
NOTE 2-Further study is required.
NOTE 3-When the monitoring system is multiplexed with the transmission signals onto working (active) fibres, synchronous control of fibre transfer may be an option.
NOTE 4-Fibre transfer may be achieved in a variety of ways, for example:

- by the use of fibre transfer splicing (optionally synchronous);
- by switching the transmission equipment to prior connected standby circuits which may be provided by a ring topology or diverse or duplicated fibre feeds.

Passive optical network elements such as splitters or wavelength division multiplexing components can be housed in casily replaceable units.

Fig 3.2.2 Preventive maintenance

Conventional fibre optics maintenance has followed the concept of metallic cable maintenance, which is neither effective nor efficient because the knowledge about the bit-error rate is insufficient to determine whether the trouble is occurring in the transmission equipment or in the optical fibre network. Hence, a lot of time is taken in the series of work, starting from the reception of the trouble report to a return to normality.

Consequently, a need has risen to effectively and efficiently maintain fibre networks. However, this technique differs from that of metallic cable maintenance because optical fibre faults may be caused by residual strain, increased fibre loss, and water penetration.

The end of a fibre optic cable and the inner surface of an optical module lens constitute optical surfaces that should be properly cleaned and maintained to ensure optimum reliability and system performance.

Small oil micro-deposits and dust particles on fibre optic cable optical surfaces may cause a loss of light or degraded signal power which may ultimately cause intermittent problems in the optical connection. The figure shows the oil and dust that can collect on fibre cable connector tips and canals.

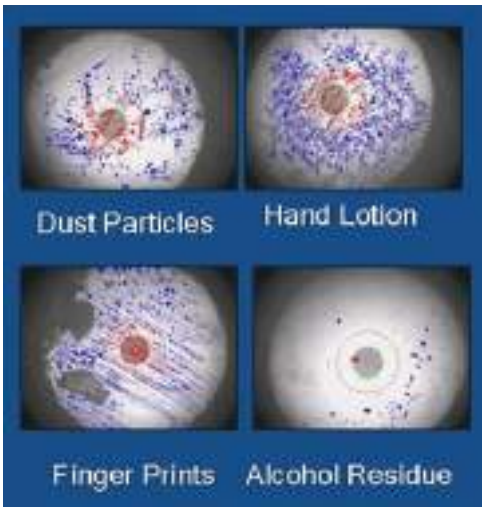


Fig. 3.2.4 (a): Contamination on fibre optics

Laser power density may eventually burn contaminants into the optical surfaces causing the fibre to produce inaccurate results, effectively rendering it unusable.

By extension, contaminated cable connectors may often transfer contaminants and particulates into the "Optical Sub-Assembly" (OSA) barrels of the Optical Module they are inserted into.

The general practice of cleaning optical cables is a good and recommended habit to ensure overall system reliability and high performance.

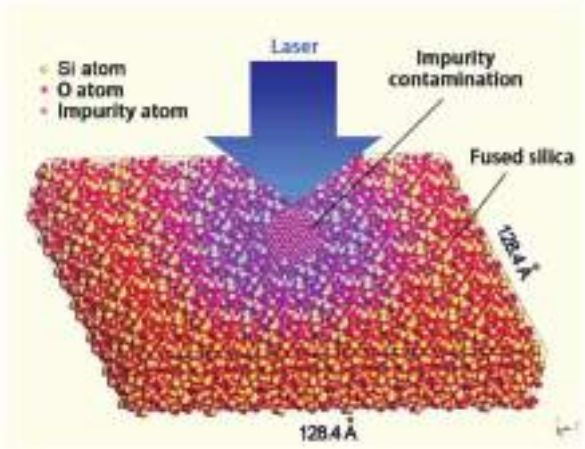


Fig. 3.2.4 (b): Contamination on fibre optics

In fact, such kind of maintenance, which reviews fibre degradation and conducts required fibre degradation testing and fibre transfer control before any fibre fault occurs, is called preventive maintenance.

Unlike conventional cable maintenance, which is generally activated after trouble occurs, preventive maintenance takes action before a fibre fault occurs to ensure high reliability of the optical fibre cable network and therefore reduces the number of customer complaints and trouble reports.

Procedures for preventive maintenance:

1. **Measurement of fibre fault location -** The standard testing tool for fault locating is the Optical Time Domain Reflectometer (OTDR). It has adequate resolution to measure backs catter over even the longest fibre. A fault point caused by loss increase is easy to locate using a testing light on an active fibre as a remote unit to the fibre cable maintenance centre.
2. **Measurement of fibre strain distribution -** Fibre strain distributions, especially tensile strain distributions, in fibres, can be measured by Brillouin Optical fibre Time Domain Analysis (B-OTDA).
3. **Measurement of water location -** The water absorbent material in the sensor expands and causes a loss in the spare fibre due to macro bending. If the water-absorbent sensor is identified beforehand, the location where water was penetrated can be repaired as soon as the fibre loss is monitored.

3.2.4 Sealing Joints

Fibre optic splice closures protect fibre optic splices from the elements while providing fast and easy no-cost reentry. The closure comprises a plastic moulded dome-shaped housing with fibre management trays inside. There are five round cable entry ports and a single oval cable entry port for the main distribution cable. These ports are sealed using heat shrink sleeves and a blow torch. No special tools are required for assembling. They are available in different configurations. They have various cable constructions and splice capacities. Each tray can hold up to 24 fibres. There is a provision for fibre slack storage beneath the tray holder for expressed stranded fibre. The slack storage and splice capacity depend on factors such as cable construction, splice type and slack fibre lengths.

Fig. 3.2.5: Fibre optic splice closures

3.2.5 Heat Shrinking

Heat shrinkable tubes are often used for protecting the splices of single optical fibres and of optical ribbon fibres. This tube is applied over an end of a single fibre or of an optical fibre cable such as a ribbon fibre, and then the cable is spliced to another cable. At last, the heat-shrinkable tube is moved to cover the bare portions of the optical fibres and then heated, making it shrink and be firmly attached around the bare portions and to the splice.

During heating, it must be carefully observed that no air remains inside the shrinking tube since such remaining air degrades the tube's mechanical supporting and protecting function.

Fig. 3.2.6: Heat sink for fibre optics closure

3.2.6 Multi-diameter Seals

Optic cable, single mode or multi-mode types, are available as an airtight, gas-tight, fluid-tight, vacuum-tight bulkhead passthrough seal for both low and high Pressure And Vacuum Electrical uses for either pressure or vacuum or bi-directional pressures. Operating temperatures can vary depending on the design and materials from -200C to 200C or as required by the customer's use.

All PAVE seals are airtight and will pass a deficient helium leak test, regardless of the leak test shown on the drawings, which also can be modified upon customer request. In most cases, the seals are also capable of higher pressure as well than what may be shown on the drawings, with special designs capable of sealing up to 10,000 to 25,000 psi.

3.2.7 Alignment errors in fibre optic cable

Alignment error occurs when the laser beam deviates from its theoretical position relative to the actual position of the optical fibre, including longitudinal error l, lateral error d and angular error γ, as shown below.

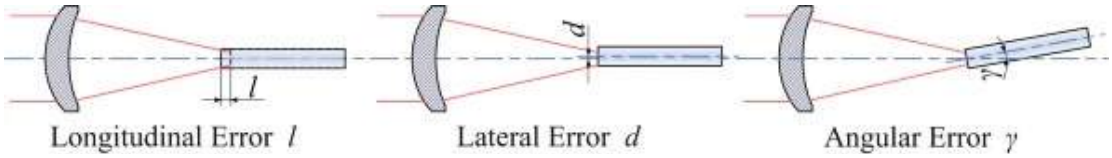


Fig. 3.2.7: Alignment errors of fibre optic cable

Most optical networks have many fibre couplings, and even minor losses at these junctions will produce significant signal losses that cause problems in data transmission. Precise fibre alignment at the optical couplings in a network is, therefore, a pre-requisite for accurate and reliable optical data transmission since it produces the least signal loss before assembly or packaging of an optical system.

The minimal signal loss also results in the lowest optical power requirements, which, in turn, means fewer repeaters, lower capital costs and reduced incidence of failure.

- The first of these loss mechanisms, lateral misalignment, is the largest contributor to the total loss in a fibre connection. Lateral misalignment is the failure of the cross sections of the two fibre cores to overlap perfectly.
- Axial separation contributes to the connection loss when the end surfaces of the two fibres do not come into contact with each other.
- Angular misalignment's third loss mechanism generally does not contribute significantly to connection losses because manufacturing tolerances virtually eliminate this misalignment in connectors and splices and because the fibre connection itself is more tolerant of angular misalignments.

Summary

- Demonstrating splicing the optical fibre
- Discussing signal strength and quality KPIs of optical fibre cables
- Performing sealing joint closure heat shrinking/multi-diameter seals/mechanical seals, etc.
- Interpreting the standard operating procedures while performing preventive maintenance of the laid optical fibre cables

Exercise

Multiple-choice Question

1. _____ is a process of connecting two optical fibres permanently.
   a) Splicing of OFC
   b) Splicing of OBC
   c) Slicing of ODC
   d) none of the above

2. _____ technique comprises the precise alignment of two fibre optic cables, held in place by a self-contained assembly rather than a permanent bond.
   a) Mechanical Splicing
   b) Manual Splicing
   c) Technical Splicing
   d) None of the above

3. A fusion splice usually has a tensile strength between 0.5 and _____ lbs.
   a) 1.5
   b) 2.5
   c) 0.5
   d) None of the above

4. _____ is a process of removing the protective layer, which is a polymer, from around the fibre.
   a) Stripping the fibre
   b) Ripping the fibre
   c) pulling the fibre
   d) None of the above

5. _____ is a technique of splicing the fibre with the help of the elastic tube.
   a) Elastic-Tube Splicing
   b) Plastic-Tube Splicing
   c) Drastic-Tube Splicing
   d) None of the above

Answer the following:

1. Explain the process of Optical fibre splicing.
2. Elaborate the steps of Mechanical Splicing
3. Describe various types of splicing techniques.
4. Describe the process to evaluate splices
5. What are the safety rules of Fibre Optic Installation?

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=xba2MThR9Ls

Splicing of OFC

https://www.youtube.com/watch?v=rr9hHjYRbw8

Types of Optical Fibre Splicing

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

Telecom
Sector
Skill
Council

4. Fiber Testing and Documentation

Unit 4.1 - Working in a team environment

Unit 4.2 - Hazards Associated with Fibre Optics

TEL/N6401

Key Learning Outcomes

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

1. Explain the working procedures of OTDR (Optical Time Domain Reflectometer) and Power meter
2. Elaborate the need and the method/procedure to measure the optical losses in the optical fibre cable
3. Discuss commonly occurring hazards, like Earth Potential Rise (EPR), while carrying out the work
4. Perform the procedure of troubleshooting optical fibre
5. Record all jointing test readings and analyse the test result to generate the acceptance report
6. Perform the procedure to generate a sample report using the results/findings in proper formats

UNIT 4.1: Working in a team environment

Unit Objectives

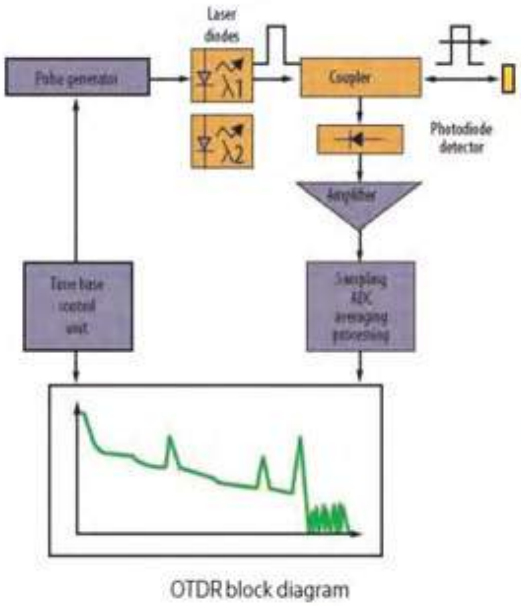
By the end of this unit, the participants will be able to:

1. Demonstrate the testing the effectiveness of optical fibre cable using OTDR (Optical Time Domain Reflectometer)
2. Explain the importance of adhering to the standards and following optimal values of OTDR, power meter and light meter for the test results
3. **Explain various losses in optical fibre**

4.1.1 OTDR (Optical Time-Domain Reflectometer)

An OTDR is a fibre optics tester used to test optical networks that support telecommunications. It works like a 1D radar system. It is used to detect, locate, and measure elements at any location on a Fibre optic link.

An Optical Time Domain Reflectometer (OTDR) is a device that tests the integrity of a fibre cable and is used for building, certifying, maintaining, and troubleshooting fibre optic systems. It is a fibre optic instrument used to characterise, troubleshoot and maintain optical telecommunication networks. OTDR testing is performed by transmitting and analysing pulsed laser light travelling through an optical fibre. The measurement is unidirectional as the light is inserted at the extremity of the fibre optic cable link.



Graphical representation of the fiber optic link, also called an OTDR trace

Fig. 4.1.1: OTDR Block Diagram

Need of an OTDR

- It ensures that the network delivers a reliable and robust service.
- The telecom industry business organisation wants to save the investment on the network that is protected.

- In an OTDR, every cable is tested, and quality is checked as 100%.
- Many tests are conducted on the OTDR.
- High level of accuracy is there.
- Troubleshooting is done.
- It is cost-effective
- The loss level is less
- One gets to know the exact fault or break of the fibre.

Fig. 4.1.2: Multimode ODTR for troubleshooting

4.1.2 Key OTDR specifications

- **Wavelengths:**
  - 850 nm and/or 1300 nm wavelengths are suitable for multi-mode fibre links.
  - 1310 nm and 1550 nm, and 1625 nm wavelengths are suitable for single-mode fibre links.
  - Filtered 1625 nm or 1650 nm are apt for in-service troubleshooting of single-mode fibre links.
  - CWDM wavelengths (from 1271 nm to 1611 nm with a channel spacing of 20 nm) are apt for commissioning and troubleshooting single-mode fibre links carrying CWDM transmission.
  - 1490 nm wavelength is apt for FTTH systems. The test can be done at 1490 nm, but it is recommended to test at 1550 nm to reduce additional costs.

  Investigating a wavelength will help to identify the fault location, and dual-wavelength will help to identify the Fibre bends and troubleshooting.

- **Dynamic Range:**

Wavelength	1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Dynamic range	35 dB	35 dB	40 dB	40 dB	45 dB	45 dB	50 dB	50 dB
Typical maximum OTDR measurement range	80 km	125 km	95 km	150 km	110 km	180 km	125 km	220 km

Fig. 4.1.3: Key OTDR specification table

It helps to identify the OTDR measurement, which is the longest pulse expressed in decibels dB.

- **Dead Zones:** Dead zones identify the events between fibre links. These are specified at the shortest pulse width and calculated in meters.
- **The event dead zone (EDZ):** It is the least distance where two consecutive reflective events (such as two pairs of connectors) can be traced by OTDR.
- **The Attenuation Dead Zone (ADZ):** It is the least distance are a reflective event (such as a pair of connectors) up to a non-reflective event (for instance, a splice).
- **Pulse Widths:** Dynamic range and dead zone relation are directly proportional. For testing long fibres, high dynamic range and wide pulse of light are needed. As the dynamic range increases, the pulse width increases, and the dead zone increases by the OTDR. For short distances, short pulse widths should be used to reduce the dead zones. The pulse width is specified in nanoseconds (ns) or microseconds.

  You must choose the OTDR based on the applications. There are various OTDR models which are available and used for different tests and needs. So, it is important to understand the OTDR to select it based on Client needs.

4.1.3 Other Important Product Specifications

- It is not difficult to operate the OTDR, but it needs the experience to handle it properly
- The correct interpretation, analysis and measurement can be done by an experienced candidate
- Less experienced candidates cannot accurately analyse the measurements in an OTDR
- Integration of the software into an OTDR instrument can help to calculate efficiently
- There is no experience needed for the person who handles the integrated OTDR system with the software with accurate

Fig. 4.1.4: OTDR Trace view

4.1.4 Factors to Take into Account when Choosing an OTDR

The size and the weight of the OTDR: Needs to be especially considered if climbing a cell tower or working inside a building is involved. The display size of the OTDR: Display size should be at least 5". OTDRs comprising small-sized displays are cheaper, but the OTDR trace analysis becomes difficult with them.

Battery life of the OTDR: The battery should last at least 8 hours so that an entire day of work can be done in the field.

Trace or results storage in the OTDR: The internal memory should be at least 128 MB with provision for external storage (such as USB memory sticks).

Bluetooth and/or Wi-Fi wireless technology: Wireless connectivity allows fast export of test results to PCs/laptops/tablets.

Modularity/Upgradability: An upgradeable platform is desirable, which could make it expensive while purchasing but will prove to be economical in the long run.

Post-processing software provision: This makes assessing and documenting test results easy and convenient, although the same can be done from the test instrument.

OTDR Best Practices: Several best practices ensure reliable OTDR testing. These are shown in the following figure:

Use of Launch/Receive Cables: These consist of rolls of fibre with specific distances. They must be connected to both ends of the fibre link to be tested. This enables qualifying the front end and the far end connectors with an OTDR. Their length is as per the link being tested; Multi-mode testing requires about 300 m to 500 m, and single-mode testing 1000m to 2000m. A very long haul requires about 4000 m.

Proactive Connector Inspection: Fibre connections should be properly examined with a fibre microscope probe to avoid dirty connections, improve the overall signal performance, and reduce network downtime and troubleshooting. Ensure that the fibre end faces are clean before mang them with connectors. OTDR port or launch/receive cable connectors need to be clean for OTDR measurement. It must be inspected and cleaned before connecting with the launch cable. A reliable fibre optic network will ensure customer satisfaction, customer loyalty, good returns on investment and sustained profits.

4.1.5 Losses in the Optical Fibre Cables

Losses in the optical fibre can be categorified into intrinsic optical fibre losses and extrinsic optical fibre loss depending on whether intrinsic fibre characteristics or operating conditions cause the loss. Intrinsic Optical Fibre Losses comprise absorption loss, dispersion loss and scattering loss caused by structural defects. Extrinsic Optical Fibre Losses contain splicing, connector, and bending loss.

The optical fibre consists of a number of glass fibres which transmit the information as light. The transmission of information through these fibres results in loss of information. The losses in optical fibre are Absorption loss, scattering loss, dispersion loss, radiation loss and coupling loss.

Fibre loss can also be called fibre optic attenuation or attenuation loss, which measures the amount of light loss between input and output. Factors causing fibre loss are various, such as intrinsic material absorption, bending, connector loss, etc.

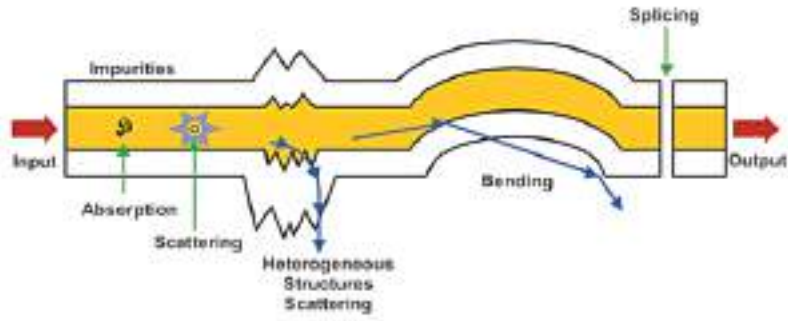


Fig. 4.1.5: Different losses in Fibre optics

Intrinsic Optical Fibre losses:

Absorption loss: Due to the presence of impurities in fibre cables, some of the residues still remain, resulting in absorption. The composition of the fibre and its fabrication of fibre results in absorption loss. There is the dissipation of optical power in the fibre cable. The wavelength of light and its concentration affects the amount of absorption.

Dispersion loss: In dispersion, the temporal spreading occurs when a light pulse propagates through an optical fibre. Sometimes, the propagation time delay causes the pulse to broaden. Delay distortion is another name for dispersion loss.

Scattering loss: Within the fibre, when there is an interaction of light with density fluctuation, scattering losses occur. There is a density change in the optical fibre when manufactured.

- **Linear Scattering Losses:** Linear scattering occurs when the energy is transferred from the dominant mode to the adjacent mode. In the dominant mode, the linear scattering is proportional to the input power injected. Mie scattering and Rayleigh scattering are two types of linear scattering.
- **Non-Linear Scattering Losses:** The optical fibre is said to operate in non-linear mode when the optical power at the output of the fibre does not change proportionally with the power change at the input of the fibre. Stimulated Raman Scattering and Stimulated Brillouin Scattering are two categories of non-linear scattering losses.

Splicing Loss: As we have already read, an optical fibre beam travelling through the core of an optical fibre cable will gradually lose its signal strength. This phenomenon is called attenuation or fibre optic loss. While there are various ways it could occur, attenuation also happens in the form of optical fibre splice loss.

Splice loss in optical fibre is defined as the part of optical power that is not transmitted through the splice and is radiated out of the fibre instead. It is measured in decibels (dB), and the formula is given:

$$\alpha splice = 10 \log_{10} Pin/Ptrans$$

Here:

αsplice = Fibre splicing loss

Pin = Total power incident on the fusion splice

Plans = Desirable portion of the optical power transmitted across the fusion splice

splice loss in optical fibre is measured using Optical Time Domain Reflectometer (OTDR).

Bending loss or Radiative losses:

- The bending losses or radiative losses are more predominant when the fibre is curved.
- Radiation loss occurs in optical fibre due to bend. Bend occurs in optical fibre only for two reasons.
- First reason is that the curvature radius of the bend is much larger than the diameter of the fibre. The second reason is the micro bend. Bend losses mean that optical fibres exhibit additional propagation losses by coupling light from core modes (guided modes) to cladding modes when they are bent.
- There are two types of losses: micro bending losses and macro bending. Hence, Micro bending losses and Macro bending losses are two types of radiative or bending losses.

Connector Loss: Optical loss, also called attenuation, is simply the reduction of optical power induced by transmission through a medium such as a pair of fibre optic connectors. The 'return loss' is the amount of light reflected from a single discontinuity in an optical fibre link such as a connector pair.

Coupling Loss: Fibre optic systems face some communication losses, which occur from the material, cable length, cable bend, couple the more no of fibre optic cable, splicing the fibre cable etc. In coupling loss, the fibre coupler will act as a loss in that Fibre Optic System. Fibre coupler used for couple two fibre cable. During this coupling process, some light signal was lost in that Fibre Optic System, which is known as coupling loss.

4.1.6 Insertion Loss Test

Absolute & relative are the main two types of measurement. The measurement is represented in dB. The loss of power is calculated as the power that is lost in the place between the receiver and the transmitter. This can be a cable, a splice or a connector.

The loss of power is called optical loss, and it helps to calculate the performance of the cable, the connector and the splice.

Insertion Loss Test:

It is a simple test which is carried out between the light source and the power meter to detect the performance of the fibre optic link. There are two ends in which one end has the light source, and another has the transmitter connected to the fibre. The power loss is calculated at the transmitter site.

Tools used for Insertion Loss Test:

Following are the tools required for measuring 'Insertion Loss':

Fig. 4.1.5: Insertion loss tools

The steps to test the insertion loss are shown in the following figure:

Step 1: Inspect and clean end faces (alcohol wipes) prior to through adapters.

Step 2: Set up Light Source, Power Meter, e.g., adapters, power supply, data entry, etc. (Please note this equipment requires warm-up time for stabilisation).

Step 3: Setup launch cable for calibration before actual tests.

Step 4: Connect actual leads to the launch cable in order to check loss at one end.

Step 5: Connect actual leads to the launch cable in order to check loss at the end.

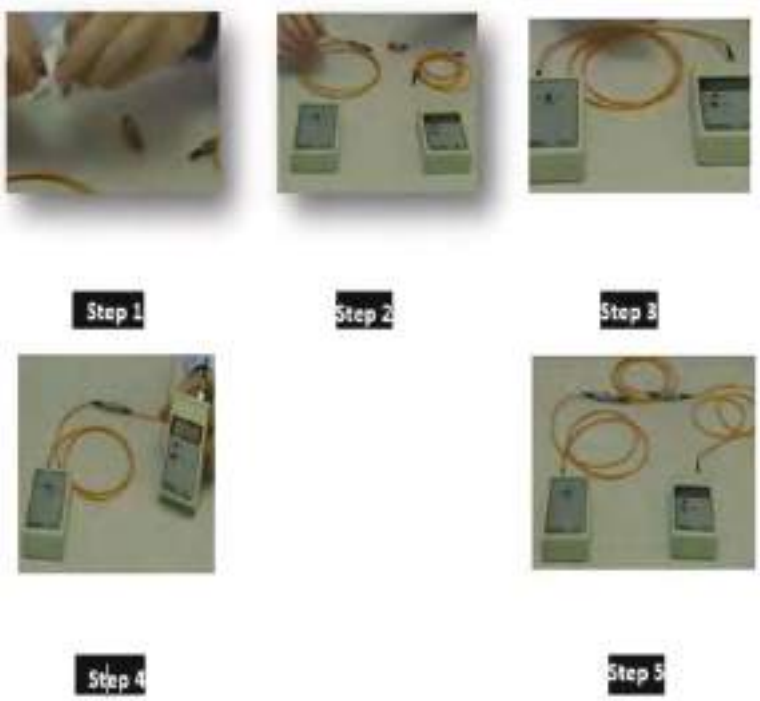


Fig. 4.1.6: Testing of insertion loss

Optical Return Loss Test procedure:

Optical return loss includes the following points:

- It is also called back reflection.
- This is calculated as the light that is reflected back from the fibre from the light source and the interference caused by the air connectors and the surface.
- The other name for this process is Fresnel reflection. This is caused when the light index refraction changes between the fibre and the air.
- This process is considered a primary problem, and it can also have a major effect on the mechanical splices.
- Mechanical splices have index matching to avoid this reflectance.

Fig. 4.1.7: Return loss

Insertion loss Test procedure:

Step 1 Optical Reference Loss (ORL) referencing: measure the output power level at the fibre jumper with a separate power meter.

Step 2 Measure the ORL of the front connector (jumper to test equipment connection). Needs the use of connectors.

Step 3 Connect to the fibre under test ORL is measured in dB and is a positive value. Higher the number, the smaller the reflection – giving the required result. ORL is generally measured at 1310, 1550 and 1625nm single-mode wavelength.

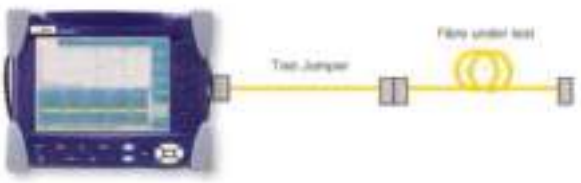


Fig. 4.1.8: Optical return loss test

Miscellaneous Test

- The other checks that should be done are shown in the following figure:
- Test the fibre joint with OTDR to verify conformance to design specifications.
- Seal off joint closure with heat shrinking/ mul diameter seals/ mechanical seals as suitable.
- Use FRP - fibre reinforced plastic to toughen the joint as needed.
- Test the fibre at both ends for cases of cross fibre using power source and power meter tests and ensure their removal.

Precautions to be taken:

- Joint is kept within the chamber carefully.
- Spare cable (loop) is rolled properly & placed within the joint.
- Sand is filled within the chamber up to the brim, and the chamber covers are laid properly.
- Joint indicator is placed 1 m behind the location of the chamber (away from the road).
- The indicator is painted in appropriate colour (such as yellow for the joint).

4.1.7 OTDR Creating a Work Report for Optical Fibre Construction

A work report that includes an OTDR trace is sometimes required after installation or maintenance is completed. The report function in the OTDR can create a report in PDF format that includes the measured data and can be used as a work report. This function supports batch processing, which can generate several reports in a single operation.

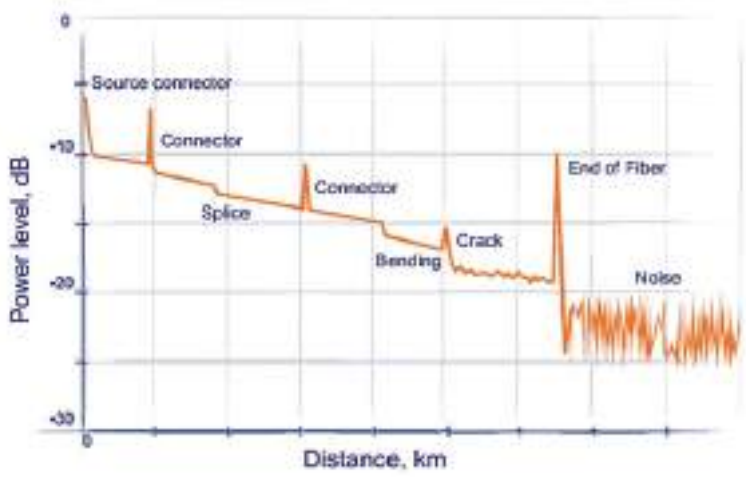


Fig. 4.1.9: OTDR report

The report includes the following information about measurement conditions, measurement data (OTDR traces, fibre end face image and trace overview, etc.) and analysis results (measurement results, marker information, event detection conditions, Pass/Fail judgment conditions, etc.). The format can be selected according to your preference.

Some of the measurement information such as serial number, model name, firmware number and measurement date cannot be modified, while other information such as company name, label, cable ID, fibre ID, fibre types, cable code, originating location, terminating location, construction procedure, etc. can be modified. All the information that can be modified is stored in advance for later recall.

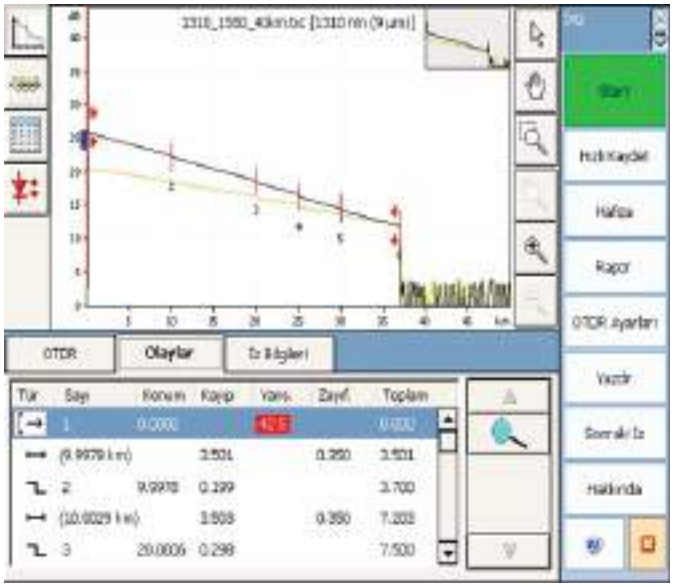


Fig. 4.1.10: OTDR report

UNIT 4.2: Hazards Associated with Fibre Optics

Unit Objectives

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

1. List commonly occurring hazards while carrying out the work
2. Discuss fibre optics installation safety procedure

4.2.1 Eye Safety

Fibre optic splinters can be dangerous if they get into your eyes. They are the same as glass splinters. These strands are smaller than a hypodermic needle and are a potential threat if not handled carefully.

Eye safety tips while working with fibre optics:

- Wear safety glasses or goggles
- Never look directly into the end of fibre cables
- Don't touch/rub your eyes while working with OFC

4.2.2 Materials Safety

Fibre optic splicing uses various chemicals and adhesives as part of the process. Normal handling procedures for such substances should be observed.

- Always work in well-ventilated areas.
- Avoid skin contact as much as possible, and stop using chemicals that cause allergic reactions. Even simple isopropyl alcohol, used as a cleaner, is flammable and should be handled carefully.

Fig. 4.2.1: Material safety

Earth Potential Rise (EPR)

It is caused by electrical faults at electrical power plants, substations, or high-voltage transmission lines. Short-circuit current flows through the equipment and into the grounding electrode.

Fibre Optic Installation Safety Rules

An Optical Fiber Splicer should adhere to the below guidelines to create a safe work environment:

- All food and beverages should be kept away from the work area. If the fibre particles are ingested, they can cause internal haemorrhaging
- Appropriate PPE must be worn to minimise the accumulation of fibre particles on the clothing. These particles from the clothing can later get into food and drinks or be ingested by other means
- Fibre optic splinters are equally dangerous as glass splinters. Always wear safety goggles with side shields and protective gloves to avoid eye and hand injuries caused by these fibre optic splinters
- Try to avoid looking directly into the end of fibre cables until you are confident that there is no light source at the other end. Instead, use a fibre optic power meter to make certain the fibre is dark
- When using an optical tracer or continuity checker, look at the fibre from an angle at least 6 inches away from your eye to determine if the visible light is present
- The work area should be well ventilated
- If using contact lenses, they must not handle their lenses until they have thoroughly washed their hands
- Wash your hands thoroughly with water before touching your eyes
- Keep combustible materials safely away from the curing ovens
- Dispose of all cut fibre pieces in a safe place
- The work area should be thoroughly cleaned once the work is over
- Smoke while working with the fibre optic system is strictly prohibited

Summary

- Explaining the working procedures of OTDR (Optical Time Domain Reflectometer) and Power meter
- Elaborating the need and the method/procedure to measure the optical losses in the optical fibre cable
- Discussing commonly occurring hazards, like Earth Potential Rise (EPR), while carrying out the work
- Performing the procedure of troubleshooting optical fibre
- Recording all jointing test readings and analyse the test result to generate the acceptance report
- Performing the procedure to generate a sample report using the results/findings in proper formats

Exercise

Multiple-choice Question

1. An _____ is a fibre optics tester used to test optical networks that support telecommunications.
   a) OTDR
   b) OTCR
   c) OTBR
   d) None of the above

2. Full form of OTDR is _____.
   a) Optical Time Domain Reflectometer
   b) Optical Time Domain Reflectter
   c) Original Time Domain Reflectometer
   d) None of the above

3. _____ is the least distance where two consecutive reflective events can be traced by OTDR.
   a) event dead zone
   b) event alive zone
   c) event dead drone
   d) none of the above

4. Losses in the optical fibre can be categorified into intrinsic optical fibre losses and _____ optical fibre loss.
   a) extrinsic
   b) external
   c) exclusive
   d) none of the above

5. Absolute and _____ are the main two types of measurement.
   a) relative
   b) related
   c) relating
   d) none of the above

6. _____ also called back reflection.
   a) Optical return loss
   b) Optical loss
   c) Optical return loss
   d) none of the above

Answer the following:

1. Explain the importance following optimal values of OTDR.
2. Explain the factors required to take into account when choosing an OTDR.
3. Explain the insertion loss procedure.
4. Discuss the commonly occurring hazards associated with fibre optics.
5. Discuss the Fibre Optic Installation Safety Rules.

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=tXWa3xFUVGA

OTDR (Optical Time-Domain Reflectometer)

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

5. Plan Work Effectively, Optimise Resources and Implement Safety Practices

Telecom Sector Skill Council

Unit 5.1 - Workplace Health & Safety

Unit 5.2 - Different types of Health Hazards

Unit 5.3 - Importance of Safe Working Practices

Unit 5.4 - Reporting Safety Hazards

Unit 5.5 - Waste Management

Unit 5.6 - Organizations' Focus on the Greening of jobs

TEL/N9101

Key Learning Outcomes

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

1. Explain about the work place health and safety
2. Differentiate various health hazards
3. Demonstrate various first aid techniques
4. Importance of safety at workplace
5. Understand Basic hygiene Practices and hand washing techniques
6. Explain the need for social distancing
7. Understand the reporting of hazards at workplace
8. Explain e-waste and process of disposing them
9. Explain Greening of jobs

UNIT 5.1: Workplace Health & Safety

Unit Objectives

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

1. Understand about workplace health and safety
2. Explain tips to design a safe workplace
3. Explain precautions to be taken at a workplace

5.1.1 Safety: Tips to Design a Safe Workplace

Every organization is obligated to ensure that the workplace follows the highest possible safety protocol. When setting up a business some tips to remember:

- Use ergonomically designed furniture and equipment to avoid stooping and twisting
- Provide mechanical aids to avoid lifting or carrying heavy objects
- Have protective equipment on hand for hazardous jobs
- Ensure presence of emergency exits and they are easily accessible
- Set down health codes and ensure they are implemented
- Follow the practice of regular safety inspections in and around the workplace
- Get expert advice on workplace safety and follow it
- Get regular inspection of electrical wiring and also the electrical switches and gadgets
- Install fire extinguishers and fire alarms.

5.1.2 Non-Negotiable Employee Safety Habits

Every employee is obligated to follow all safety protocols put in place by the organization.

All employees must make it a habit to:

- Immediately report unsafe conditions to the supervisor
- Recognize and report safety hazards that could lead to slips, trips and falls
- Report all injuries and accidents to the supervisor
- Wear the correct protective equipment when required
- Learn how to correctly use equipment provided for safety purposes
- Be aware of and avoid actions that could endanger other people
- Always be alert
- Educate the employees about the first/emergency exits on the floor, and also where the fire extinguishers are kept.

Tips

- Be aware of what emergency number to call at the time of a workplace emergency
- Practice evacuation drills regularly to avoid chaotic evacuations

UNIT 5.2: Different types of Health Hazards

Unit Objectives

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

1. Understand the health hazards
2. Demonstrate First Aid Techniques

5.2.1 First Aid

Illness, injuries, and pain are part of human life. This can happen anyway. Every individual is prone to illness and injuries at any time and anywhere.

In case of any of these, some kind of immediate medical attention or treatment is needed to reduce the discomfort, pain, and deterioration of the condition. The medical attention that is given at the first instance before seeking professional medical help is called “First Aid”. First aid is the immediate and temporary treatment given to the victim of an accident or sudden illness while awaiting the arrival of “Medical Aid”. First Aid means providing the initial treatment and life support for people with an injury or illness. However, First Aid has its limitations and does not take the place of professional medical treatment. Proper early assistance given by First Aider helps in saving the life of a patient.

Illness and injuries can happen anywhere, be at home, the workplace, or in the market place. Whatever safety measures we adopt, we are all prone to illness sometime or the other.

Some common injuries and their rescue techniques:

5.2.2 First Aid Techniques

- Direct pressure must be applied to the cut or wound with a clean cloth, tissue, or piece of gauze, until bleeding stops.
- If blood soaks through the material, it is highly recommended not to remove it.
- More cloth or gauze must be put on top of it, and pressure must be continued.
- If the wound is on the arm or leg, the limb must be raised above the heart to help slow the bleeding.
- Hands must be washed again after giving first aid and before cleaning and dressing the wound.
- A tourniquet must not be applied unless the bleeding is severe and not stopped with direct pressure.

Fig. 5.2.1: Apply pressure

Clean cut or wound

- The wound must be cleaned with soap and lukewarm water.
- To prevent irritation and burning sensation, the soap solution must be rinsed out of the wound.
- Hydrogen peroxide or iodine must not be used to clean or treat the wound since they are corrosive and can damage live tissues.

Fig. 5.2.2: Clean cut or wound

Protect the wound

- Antiseptic cream or solution must be applied to the wound to reduce the risk of infection.
- Then the wound must be gently covered with a sterile bandage.
- Till the wound heals, the bandage must be changed (dressed) daily to keep the wound clean and dry.

Fig. 5.2.3: Protect the wound

Call the Emergency Helpline if:

- The bleeding is severe and deep
- You suspect Internal Bleeding
- Abdominal or Chest wound exists
- Bleeding continues even after 10 minutes of firm and steady pressure

For Burns:

- Immediately put the burnt area under cold water for a minimum of 10 minutes
- If the burned area is covered, take clean scissors, cut and remove the fabric covering the area
- In case clothing is stuck to the burned area, leave it as it is
- Before sterile dressing application, remove jewellery (if any)
- It is better to leave the burned area open
- Do not apply any medication or ointment
- Breaking a blister – it is an absolute no-no!

Fig. 5.2.4: Put Burnt Area under Water

For Broken Bones and Fractures

- **Protruding bone must be left alone**
  - If a bone has broken through the skin, it must not be pushed back into place.
  - The area must be covered with a clean bandage and immediate medical attention must be sought.
- **Bleeding must be stopped**
  - Steady and direct pressure must be applied with a clean piece of cloth for 15 minutes and the wound must be elevated.
  - If a blood soaks through, one must apply another cloth over the first and seek immediate medical attention.
- **Swelling must be controlled**
  - The RICE (Rest, Ice, Compression and Elevation) therapy must be applied to control and reduce swelling.
  - Rest the injured part by having the person stay off of it.
  - Ice must be applied on the area with the help of an ice pack or by wrapping the ice in a clean cloth. Ice must not be directly placed against the skin.

For Heart Attack/Stroke

- Think FAST. Face: is there weakness on one side of the face? Arms: can they raise both arms? Speech: is their speech easily understood? Time: to call Emergency helpline
- Immediately call medical/ambulance helpline or get someone else to do it

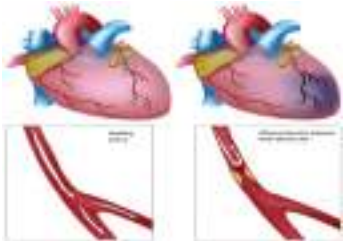


Fig 5.2.5: Anatomy of Heart Attack

For Head Injury

- Ask the victim to rest and apply a cold compress to the injury (e.g. ice bag)
- If the victim becomes drowsy or vomits, call Medical helpline or get someone else to do it

Steps of using breathing apparatus:

Check the parts of the breathing apparatus thoroughly.

Check the bypass knob (red). Close it if you see it open. After this, press the reset button (area above bypass nob – black)

Inspect the facemask to see that it is undamaged.

Lift the cylinder ensuring that on the top the cylinder valve should be present.

The back plate of the cylinder should face the wearer.

Wear the breathing apparatus on the shoulder like a bag pack and by the neck strap, hang the facemask.

After wearing the breathing apparatus tighten shoulder straps and fasten the waist belt

The cylinder valve should be opened slowly to inspect the pressure gauge.

Make sure that 80% of the cylinder is full.

Wear the mask slowly by resting your chin in the resting cusp and pull the head strap slowly over your head.

Pull the head straps for a snug but comfortable fit.

	
Breath in and normally to see if you can breathe normally or not.	Now insert a finger sidewise of the facemask for easy outward airflow.
	
Slowly close the cylinder valve without leaving the knob. Be steady for 10 minutes and hold your breath or extremely slow to listen to any wheezing sound. Also, check the pressure gauge for any dip in the pressure.	Normally Breathe to vent system Listen for a whistle alarm while observing the pressure gauge at 55 bar (+/-5 bar)

Table: 5.2.1: Steps of using breathing apparatus

Briefing and Guidance for Fire Fighters

There are basically three methods with the help of which people can be rescued from a building engulfed in a blazing fire. To ensure on-site reception, here are two of the important steps that we will discuss now. These come under the best safe lifting and carrying practices.

Conventional Technique: This is a good method if there is an open area close by. The first rescuers will make the victim sit reach under their armpits and finally, grab their wrist. The other rescuer will cross the ankle (victim), pull up that person's legs on his shoulder. Finally, on the count of 3, both will lift the person up and move out.

Fig. 5.2.6: Fast Strap

Fast Strap: In case the victim is completely incapable of moving out of the fire zone. The rescuers should follow this method. One of the rescuers will place their knee between victim's shoulder and head. Pin the loop of webbing to the ground with the help of the knee. This acts as an anchor. With the non- dominant hand hold the other end of the webbing and make a loop. With steady hands, pull the victim's hand in from the loop, tie it securely and finally clip the webbing loops.

Fig. 5.2.7: Fast Strap

Essentials for Smooth Evacuation: The following are essential to have a smooth evacuation during an outbreak:

- Clear passageways to all escape routes
- Signage indicating escape routes should be clearly marked
- Enough exits and routes should be present to allow a large number of people to be evacuated quickly
- Emergency doors that open easily
- Emergency lighting where needed
- Training for all employees to know and use the escape routes
- A safe meeting point or assembly area for staff
- Instructions on not using the Elevator during a fire

Special Evacuation Requirements For Specially Abled Persons

- **The Visually Impaired**
  - Announce the type of emergency
  - Offer your arm for help
- **With Impaired Hearing**
  - Turn lights on/off to gain the person's attention, or indicate directions with gestures, or write a note with evacuation directions
- **People with Prosthetic Limbs, Crutches, Canes, Walkers**
  - Evacuate these individuals as injured persons.
  - Assist and accompany to evacuation site if possible.
  - Use a sturdy chair, or a wheeled one, to move the person to an enclosed stairwell
  - Notify emergency crew of their location

5.2.3 Importance of Fire Safety Drills

Fire drills are indispensable in any workplace or public building for rehearsing what to do in the event of a fire. They are also a lawful obligation under the Fire Safety Order of 2005 and all workers in a company must partake. Here's how to get the most out of your fire practice.

Why have fire drills?

There are numerous reasons why fire drills are vital; first of all, fire drills are a chance to practice evacuation techniques to make sure all staff are acquainted with them. The staff will vacate the building quickly and therefore in a real life situation panic will be decreased, as everyone will know what they need to do. Fire drills are also beneficial for testing escape methods to assess their efficiency.

During fire drills, checks can also be carried out on alarm systems to make certain they are working properly and that emergency exits are passable. Overall fire drills help increase safety, so that you will be best equipped if a real fire does happen.

How often?

Ideally there should be two fire drills a year, although this may vary according to the workplace and after checking the firm's risk assessment. If there are people who work in shifts, suitable preparations should be made to ensure all staff partake in at least one fire drill per year and to educate them as to how to handle the situation.

Should you inform staff beforehand?

There are arguments for and against making people conscious of fire drills before they take place. Some people contend that not notifying staff gives an element of surprise, so that people take drills more sincerely. However, this can also have the reverse effect in a real fire, as on overhearing the alarm people may reason that it's only a drill.

The benefit of notifying all staff of fire drills in advance is that initially, they will not panic, which circumvents potential injuries that could be instigated in a rush to exit a building. Furthermore, if the alarm sounds, lacking a prior warning, there will be no uncertainty as to if it is a drill or not and people will act correctly. In public places such as shopping centres, it is prudent to make members of the public alert when a drill is about to happen.

Fig. 5.2.8: Fire exit signage

UNIT 5.3: Importance of Safe Working Practices

Unit Objectives

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

1. Explain Basic Hygiene Practices
2. Understand the importance of Social Distancing
3. Demonstrate the safe working practices

5.3.1 Basic Hygiene Practices

We are living in an environment with millions of germs and viruses. And our body can be a breeding space for these microbial organisms. They grow and multiply and cause many diseases which sometimes can prove to be fatal for the human beings. These disease-causing mi-crobial organisms kill over 17 million people every year. Some simple hacks and little changes of basic personal hygiene habits can bring amazing changes to all of us. We can prevent contracting these diseases if we follow these hygiene practices every day.

Personal Hygiene

Personal hygiene is all about managing your body hy-giene, essentially caring for your well-being incorporat-ing some physical hygiene habits. Also, there are mental health benefits as well, as they affect each other im-mensely.

What are good personal hygiene habits?

Good personal hygiene includes but not limited to-

- Take regular shower
- Maintain oral hygiene
- Wash your hands frequently
- Wash your genitals
- Keep your clothes and surrounding dry and clean

These habits should be practiced on a regular basis, at home, at work, basically where you are!

That's the whole idea of preventing your body system collapse over a tiny mi-crobe!

Personal Hygiene Practices at Home

Your home should be the most comfortable and conven-ient for you to keep up your personal hygiene level to a standard, yet, we find ourselves procrastinating over hygiene issues when we are at home. Even though some of these tasks barely take a minute.

1. **Take Regular shower**

   Do not wait up to feel the dried sweat in your body to feel the urge to take shower, make it a routine, you have the choice to either take them before you head to work or after the long day or even before you head to sleep, whichever one suits your routine. Make sure to rinse your body thoroughly, especially the genitals and underarms as they produce more sweat and are more prone to fungal activities.

2. **Wash your hands frequently**

We use our hands to do our most physical acts, from picking up the keys, browsing through our phones, cooking or eating to attending our pets. While we agree and accept the importance of washing hands before eating and after visiting the toilet, it is also important to wash our hands with soap or sanitizer every now and then. The pandemic covid-19 which crippled the life all over the world has taught us an important lesson that sanitizing our hands regularly is the only way we can avoid transmission of the disease. Use alcohol based sanitizer to wash hands well to prevent the spread of communicable diseases.

Fig. 5.3.1: 7 steps for Handwashing

3. **Maintain oral hygiene practices**

It is very important to take care of the teeth and gum, to prevent tooth decay and bad odour. Just brushing them twice a day is not enough, but using fluoride toothpaste and brushing properly is very essential. And wash it well with water to remove any food particles that is stuck in the gap in between the teeth. It is advised to wash the teeth everyday twice to maintain healthy teeth and gum.

4. **Nails and hairs hygiene**

The cleanliness of nails and hair is also very important. They store dirt and grease. And even the microbes could be in there stuck and spreading. If the nail is not clean they can cause severe food poisoning, as we use our hands to eat food. Trim the nails once in a fortnight and wash hair at least twice a week with a shampoo to keep them healthy

5. **Nose and ears hygiene**

Wherever we are most likely to breathe in some pollutants, and most of the particles are bound to be stuck in the nasal hair. So, rinse the nose and ear with warm water once you return from outside.

6. **Wear fresh and clean clothes**

Changing into neat and clean clothes will prevent many infectious diseases. It will also give the mental effect immediately and it will boost the mind. Wash clothes with a good detergent every day and dry it in the sun. This will ward off any microbes attached to the clothes. If possible, Dettol can be used while rinsing which is an anti-disinfectant.

7. **Food hygiene**

   You can get severely sick from food-borne diseases, as most of your foods are raw, purchased from outside, they risk being cross-contaminated with harmful microbes. Food hygiene is basical-ly the idea of better storage, handling, and preparation of food to prevent contamination and to prevent food poisoning.

5.3.2 Importance of Social Distancing

Preventing communicable diseases:

All these above practices will help us to prevent communicable diseases. These diseases are highly infectious and contagious and spread through air, urine, feaces, saliva, skin (through touch) and using same towels and utensils.

Social Distancing and isolation, Self-Quarantine:

Ever since the spread of the pandemic covid-19, several health organisations have been insisting on following social distancing and isolation. Communicable diseases mainly spread through coming close to the infected individual and through physical touch. If a person is infected with diseases like normal flu or cold and spread it to others, the symptoms and may remain with the infected person for a day or two. The virus may be destroyed by taking an antibiotic. But in severe cases like corona virus the infection is severe and can prove fatal to the affected people. To prevent the spread of the virus, the entire world adopted lockdown, social distancing and compulsory face mask. And the infected person has to be in self isolation and quarantine till the time the symptoms are over. This was the advisory from the World Health Organisation, and the entire world followed it to prevent the rapid spread of the virus. The same can be applicable to all types of communicable diseases that are spread mainly through air and touch.

As communities reopen and people are more often in public after the pandemic, the term “physical distanc-ing” (instead of social distancing) is being used to rein-force the need to stay at least 6 feet from others, as well as wearing face masks. Historically, social distanc-ing was also used interchangeably to indicate physical distancing which is defined below. However, social dis-tancing is a strategy distinct from the physical distanc-ing behavior.

What is self-quarantine?

Self quarantine was imposed on people who have been exposed to the new covid-19 and who are at risk for getting infected with the virus were recommended to practice self-quarantine. Health experts advised the self-quarantine for 14 days or two weeks. Two weeks provides enough time for them to know whether or not they will become ill and be contagious to other people.

Self-quarantine was also recommended for people who have recently returned from traveling to a part of the country or the world where COVID-19 was spreading rapidly, or if a person has knowingly been exposed to an infected person.

Self-quarantine involves:

- Using standard hygiene and washing hands frequently
- Not sharing things like towels and utensils
- Staying at home
- Not having visitors
- Staying at least 6 feet away from other people in your household

Once your quarantine period has ended, if the symptoms are not there, then the person may return to normal routine as per doctor's advice.

What is isolation?

Anybody who is infected with a contagious disease needs to practice isolation in order to prevent the spread of the germs to their near and dear ones. This became very popular and was strictly adhered to during the covid-19 pandemic. People who were confirmed to have COVID-19, isolation was mandatory. Isolation is a health care term that means keeping people who are in-fected with a contagious illness away from those who are not infected. Isolation can take place at home or at a hospital or care facility. Special personal protective equipment will be used to care for these patients in health care settings. They are attended by well trained nurses and specialised doctors. And these people have to be in the PPE kits all through their presence in the hospital.

Fig. 5.3.2: Complete PPE Kit

Disposing off the PPE Kits

The PPE kits are worn by health workers and doctors who are attending to patients with highly infectious diseases and who are kept is isolation in order to arrest the spread. They have to wear it every time they go near the patient and have to remove it once their duty is over. Most of the PPE components are used for single use, however the face mask and goggles can be reused provided they are sanitised properly. The PPE kits have to be disposed off safely as they might have contaminants stuck to them and they may infect the healthy person if they are not discarded properly. The health workers may be all the more vulnerable to contact the disease.

5.3.3 Safe Workplace Practices

Every company has the provision of first aid box. As you have already read about the types of injuries that technicians can receive in their field of work, it is imperative for the companies to have appropriate first aid accessories.

The basic first aid supplies and accessories that a first aid box should have are:

Supplies and Accessories in the First Aid Box

Splint

Elastic wraps

Latex gloves

Adhesive tape

Tweezers

Blanket

Scissors

Wound cleaning agent

Triangular bandages

Gauze roller bandage

Adhesive bandages

Gauze pads

Antiseptic cleansing wipes

Burn cream or gel

Eyewash liquid

CPR Kit

Chemical hazards are caused by toxic materials, which are poisonous. And being poisonous in nature, they can either be fatal or cause serious damages in case the preventive actions are not taken on time. Now, the exposure to chemicals can be in 3 forms.

They can be:

- Inhaled (entering the body through nose)
- Directly in contact with skin
- Ingested (consumed)

The symptoms, in this case, will be:

- Seizures
- Partial or complete loss of responsiveness
- Burning sensation
- Stomach Cramping with bouts of excruciating pain
- Nausea
- Vomiting (and in times with blood-stains)

Now, where there are problem, their solutions come side by side. In such situations, the person giving first aid requires to be calm and take certain preventative actions.

Some of the essential actions are:

- Using insulated equipment
- Wearing protective clothing, goggles, masks, shoes and gloves
- Ensuring the place has enough ample ventilation

Remedial action

- The foremost thing that one should do is to provide immediate first aid. However, it is to be remembered that the victim should not be given any kind of fluid (water, milk) until doctors from Poison control unit gives a green signal.
- Aside from this, there are a few things a person can perform to the victim of toxic material exposure.
- Remove the victim from the toxic zone or vicinity
- Call for an ambulance

- Remove contaminated clothing
- Splash water in the eyes
- If ingested, do not try to make the victim puke (vomit)
- Wash their mouth with water

Fig. 5.3.3: CPR

- In case the victim's breathing has stopped, give CPR (Cardiopulmonary resuscitation)
- In case of burning due to toxic material, apply burn gel or water gel on that area.
- Avoid any cream based or oil based lotion or ointment
- Even though giving first aid is the right thing to do in the first place, it is also important to report the incident to their supervisor.

UNIT 5.4: Reporting Safety Hazards

Unit Objectives

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

1. Discuss the process of reporting in case of emergency (safety hazards)
2. Understand methods of reporting hazards

5.4.1 Methods of Reporting Safety Hazards

Every organization, from every industry, has a standard reporting protocol, comprising the details of people in the reporting hierarchy as well as the guidelines to be followed to report emergencies. However, the structure of this reporting hierarchy varies between organizations, but the basic purpose behind the reporting procedure remains same.

The general highlights of the Organizational Reporting Protocol, commonly known as the 6Cs, are:

- Communicate First
  - The first source of information during emergency is the preferred source.
  - Crises situations are time-bound and hence it is important to communicate promptly.
- Communicate Rightly
  - Distortion of information due to panic must be avoided.
  - Proper, accurate information must be provided to concerned authorities and this can save lives.
- Communicate Credibly
  - Integrity and truthfulness must never be forgotten during emergencies.
- Communicate empathetically
  - One must wear the shoes of the victims while communicating emergencies.
- Communicate to instigate appropriate action
  - Communicating to the right authorities help in taking the necessary action.
- Communicate to promote respect
  - Communicating with the victims with respect help in earning their trust and thus eases the disaster management process.

Hazards and potential risks / threats can be identified and then reported to supervisors or other authorized persons in the following ways:

While identifying and reporting a hazard / potential threat / potential risk, one must describe the following:

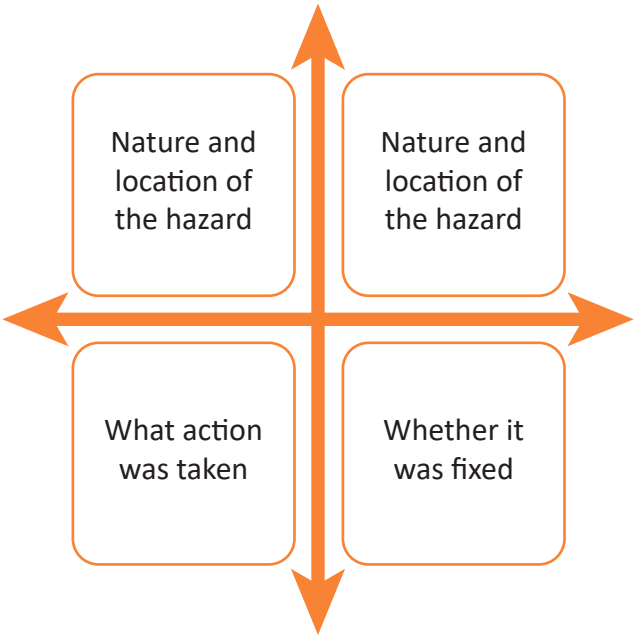


Fig. 5.4.1: Describing hazard matrix

Part A: To be completed by the Worker Details Required:

- Name of Worker
- Designation
- Date of filling up the form
- Time of incident / accident
- Supervisor / Manager Name
- Work Location / Address
- Description of the hazard / what happened (Includes area, task, equipment, tools and people involved)
- Possible solutions to prevent recurrence (Suggestions)

Part B: To be completed by the Supervisor / Manager Details Required:

- Results of Investigation (Comment on if the hazard is severe enough to cause an injury and mention the causes of the incident / accident)

Part C: To be completed by the Supervisor / Manager Details Required:

- Actions taken / Measures adopted (Identify and devise actions to prevent further injury, illness and casualty)

Action	Responsibility	Completion Date

Any job role and any occupation in this world have some hazards, in varying severity, associated with it. These are called Occupational Hazards. Occupational Hazard can be defined as "a risk accepted as a consequence of a particular occupation". According to the Collins English Dictionary, it is defined as "something unpleasant that one may suffer or experience as a result of doing his or her job". Occupational Hazards are caused by the following:

Hazard Report Form	
Name:	Date:
Location:	
Tool/Equipment:	
Description of the hazard:	
Suggested correction action:	
Signature:	
Supercisor's remarks:	
Corrective Action taken:	
Sinature of Supervisor:	Date:

Fig 5.4.2: Sample form of reporting hazards

UNIT 5.5: Waste Management

Unit Objectives

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

1. Understand what is e-waste
2. Understand the concept of waste management
3. Explain the process of recycling of e-waste

5.5.1 Introduction to E-Waste

Electrical and electronic products are all around us. We can't imagine a world without these gadgets. Our life is indispensable without electricity and electronic devices. Growth in the IT and communication sectors has increased the usage of electronic equipment immensely. Frequent change on the technological features of electronic products is forcing consumers to discard their old electronic products very quickly, which, in turn, adds to e-waste to the solid waste pool. What this translates to is mountainous masses of electrical and electronic waste which has a high potential to pollute the environment. This growing menace of e-waste calls for a greater focus on recycling e-waste and better e-waste management.

E-waste means electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment, and repair processes. E-waste usually is made up of usable and non-usable material. Some of the waste if left unattended will be destructive to the environment. E-waste is made up of hazardous substances like lead, mercury, toxic material, and gases.

There are many companies these days who are engaged in the collection, handling, and disposal of this e-waste in a safer and more secure place to protect the environment.

5.5.2 What is E-Waste?

The amount of e-wastes comprising computers and computer parts, electronic devices, mobile phones, entertainment electronics, refrigerators, microwaves, TV, fridges, and industrial electronics that are obsolete or that have become unserviceable is growing. All these electronic devices contain plastics, ceramics, glass, and metals such as copper, lead, beryllium, cadmium, and mercury and all these metals are harmful to humans, animals, and the earth. Improper disposal only leads to poisoning the Earth and water and therefore all life forms. Our effort is meant to preserve the environment and prevent pollution by proper handling of e-waste. While it will take a lot of effort to educate people to dispose of such wastes in the right way, we are doing our part by providing a channel to collect e-wastes and dispose off them in a sustainably safe manner. We convert waste to usable resources.

The electronic industry is not only the world's largest industry but also a fast-growing manufacturing industry. It has been instrumental in the socio-economic and technological growth of the developing society of India.

At the same time, it poses a major threat in the form of e-waste or electronics waste which is causing harmful effects on the whole nation. e-waste is creating a new challenge to the already suffering Solid waste management, which is already a critical task in India.

5.5.3 Electronic Goods/gadgets are Classified Under Three Major Heads

White goods: Household appliances,

Brown goods: TVs, camcorders, cameras etc.,

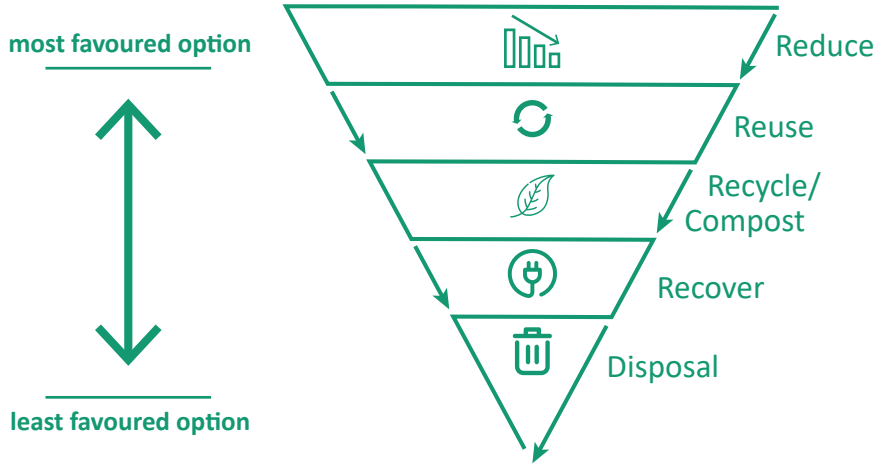
Grey goods: Computers, printers, fax machines, scanners etc.

The complete process is carried out as per the government guidelines.

5.5.4 E-waste Management Process

- Collection of e-waste from all the electronic stores, manufacturing companies, etc.
- Transport of e-waste to the disposal units
- Segregation of e-waste at the disposal unit
- Manual dismantling of e-waste to segregate components into various types such as metal, plastics and ceramics
- Convert into raw material (recycle and reuse)
- Supply recovered raw material to processors and electrical/electronic industries
- Dispatch hazardous e-waste for safe disposal

Waste management is carried out to ensure that all types of waste and garbage are collected, transported, and disposed of properly. It also includes recycling waste so that it can be used again.



5.5.5 Recyclable and Non-Recyclable Waste

Recyclable waste is renewable or can be reused. This means that the waste product is converted into new products or raw material, like paper, corrugated cardboard (OCC), glass, plastics containers and bags, hard plastic, metal, wood products, e-waste, textile, etc

Recycling not only conserves important areas in our landfills but also assists decrease greenhouse gas emissions.

Contrary to this, Non-recyclable waste cannot be recycled and cause a major threat to the environment.

The following items cannot be recycled:

Shredded paper, aerosol cans, paper coffee cups, milk and juice cans, used baby diapers, and bottle caps.

Recycling is one of the best ways to have a favorable influence on the world where we live.

Recycling will greatly help us to save both the environment and us from pollution. If we take immediate action, we can control this, as the quantity of waste we are accumulating is increasing all the time.

5.5.6 Colour Codes of Waste Collecting Bins

Waste collecting bins colour code

India's urban population of 429 million citizens produce a whopping 62 million tonnes of garbage every year. Out of this, 5.6 million tonnes is the plastic waste, 0.17 million tonnes is the biomedical waste, 7.90 million tonnes is hazardous waste and 15 lakh tonnes is e-waste.

According to an estimate, 40% of municipal waste in the city is 'wet' waste, which can easily be composted and used as manure. Nearly 30% of the municipal waste comprises of plastic and metal, which can be sent to an authorized dealer for recycling, and about 20% of it is e-waste, from which precious metals can be taken apart and recycled. However, out of the total municipal waste collected, 94% is dumped on land and only 5% is composted. To gather the garbage two color bin system was suggested. Green bin for wet waste and blue for dry waste. However, there is a drawback in that system. People do through the sanitary napkins and children's diaper along with wet waste causing the contamination of things. Hence the government has come up with three colored garbage collection bins.

1. **Green Bin**

   The green coloured bin is used to dump biodegradable waste. This bin could be used to dispose off wet/organic material including cooked food/leftover food, vegetable/ fruit peels, egg shell, rotten eggs, chicken/fish bones, tea bags/coffee grinds, coconut shells and garden waste including fallen leaves/twigs or the puja flowers/garlands will all go into the green bin.

2. **Blue bin**

   The blue coloured bin is used for segregating dry or recyclable left over. This category includes waste like plastic covers, bottles, boxes, cups, toffee wrappers, soap or chocolate wrapper and paper waste including magazines, newspapers, tetra packs, cardboard cartons, pizza boxes or paper cups/plates will have to be thrown into the white bin. Metallic items like tins/cans foil paper and containers and even the dry waste including cosmetics, hair, rubber/thermocol (polystyrene), old mops/dusters/sponges.

3. **Black bin**

   Black bin, make up for the third category, which is used for domestic hazardous waste like sanitary napkins, diapers, blades, bandages, CFL, tube light, printer cartridges, broken thermometer, batteries, button cells, expired medicine etc.

5.5.7 Waste Disposal Methods

- Incineration: Combusting waste in a controlled manner to minimize incombustible matter like waste gas and ash.
- Waste Compaction: Waste materials are compacted in blocks and are further sent away for recycling.
- Landfill: Waste that can't be recycled or reused can be thinly spread out in the low-lying areas of the city.
- Composting: Decay of organic material over time by microorganisms.
- Biogas Generation: With the help of fungi, bacteria, and microbes, biodegradable waste is converted to biogas in bio-degradation plants.
- Vermicomposting: Transforming the organic waste into nutrient-rich manure by degradation through worms.

5.5.8 Sources of Waste

1. **Construction waste –** waste coming from construction or demolition of buildings.
2. **Commercial waste-** waste from commercial enterprises
3. **Household waste-** garbage from households is either organic or inorganic
4. **Medical or clinical waste -** wastes from the medical facilities- like used needles and syringes, surgical wastes, blood, wound dressing
5. **Agricultural waste-** Waste generated by agricultural activities that include empty pesticide containers, old silage packages, obsolete medicines, used tires, extra milk, cocoa pods, wheat husks, chemical fertilizers, etc.
6. **Industrial waste-** The waste from manufacturing and processing industries like cement plants, chemical plants, textile, and power plants
7. **Electronic waste-** The defective, non-working electronic appliances are referred to as electronic waste. These are also called e-waste. Some e-waste (such as televisions) contains lead, mercury, and cadmium, which are harmful to humans and the environment
8. **Mining waste-** chemical gases emitted in mine blasting pollutes the environment. And the mining activity greatly alters the environment and nature.
9. **Chemical waste-** waste from the chemical substance is called chemical waste.
10. **Radioactive waste-** radioactive waste includes nuclear reactors, extraction of radioactive materials, and atomic explosions.

5.5.9 Source of Pollution

All these above-mentioned waste also adds to environmental pollution.

The contaminants that cause detrimental change to the environment are called pollution. It is one of the most serious problems faced by humanity and other life forms on our planet. The earth's physical and biological components have been affected to such an extent that normal environmental processes could not be carried out properly.

5.5.10 Types of Pollution

Types of Pollution	Detail/Pollutants involved
Air pollution	• Solid particles and gases mixed in the air cause air pollution • Pollutants: emissions from the car, factories emitting chemical dust, and pollen
Water pollution	• Water gets polluted when toxic substances enter water bodies such as lakes, rivers, oceans, and so on. They get dissolved in it and cause it unfit for consumption. • Pollutants that contaminate the water are discharges of untreated sewage, and chemical contaminants, release of waste and contaminants into surface
Soil pollution	• It is the presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk to human health and/or the ecosystem • Sources of soil pollution include metals, inorganic ions, and salts (e.g. phosphates, carbonates, sulfates, nitrates),
Noise pollution	• Noise pollution happens when the sound coming from planes, industry or other sources reaches harmful levels • Underwater noise pollution coming from ships has been shown to upset whales' navigation systems and kill other species that depend on the natural underwater world
Light pollution	• Light pollution is the excess amount of light in the night sky. • Light pollution, also called photo pollution, is almost always found in urban areas. • Light pollution can disrupt ecosystems by confusing the distinction between night and day.

UNIT 5.6: Organizations' Focus on the Greening of jobs

Unit Objectives

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

1. Understand the concept of ESG
2. Explain the different factors of ESG

5.6.1 What is ESG?

The ESG is the short form of environmental, social, and governance. ESG guidelines are used to evaluate businesses on how well they control emissions, governance, human rights, and other factors of their business.

Several companies audit these companies for ESG compliance. They will let the companies know how well the ESG policies are implemented in their company hat let companies know how well their ESG policy is working.

Every business enterprise is deeply intertwined with Environmental, Social, and Governance (ESG) issues. ESG has been looked at seriously by the corporate, government establishments and stakeholders.

ESG is important as it creates high value, drives long-term returns, and global stakeholders are paying attention to the topic.

ESG is said to have created high value, and focuses on long-term returns, and stakeholders are focusing more on this concept.

5.6.2 Factors of ESG

Several factors are used to determine how well a business is doing in maintaining its ESG policies. For creating the ESG Policy, thorough knowledge of these factors are critical.

The factors are divided into three categories; environmental, social, and governance. Knowing about these factors come a long way in designing the effective ESG policy.

Environmental

Environmental factors relate to a business's impact on the environment. Examples include:

- Usage of renewable energy
- Effective waste management
- Policies for protecting and preserving the environment

Social

Social factors relate to the people of the organization. How they are treated in the organization is what it focuses on. The major entities are the stakeholders, employees, and customers. Examples include:

- diversity and inclusion
- proper work conditions and labor standards
- relationships with the community

Governance

Governance factors relate to the company policies for effectively running it. They include:

- tax strategies
- structure of the company
- relationship with stakeholders
- payments to the employees and CEO

Every factor is important and matters a lot to the overall rating of the company in ESG compliance. Ignoring one aspect in favor of another can affect the rating and in turn the reputation of the company.

The companies make a clear communication about these policies to all the employees, and to the public, they should mention what their various activities are that will protect the environment, people, and the governing factors.

Summary

- Every organization is obligated to ensure that the workplace follows the highest possible safety protocol.
- Every employee is obligated to follow all safety protocols put in place by the organization
- The medical attention that is given at the first instance before seeking professional medical help is called “First Aid”.
- Every company has the provision of first aid box.
- Chemical hazards are caused by toxic materials, which are poisonous.
- Any job role and any occupation in this world have some hazards, in varying severity, associated with it. These are called Occupational Hazards.
- Time management is the process of organizing your time, and deciding how to allocate your time between different activities.
- Giving committed service to customers every time and on time is very crucial for the success of the brand.
- An escalation matrix is made up of several levels of contact based on the specific problem at hand.
- Key Performance Indicators or KPI is used to evaluate the success of an employee in meeting objectives for performance.
- Managing emotions in the workplace is very important. We cannot overreact under emotional stress.
- The one-on-one, face-to-face communication with each member of the team will give the manager the chance to read their emotions and the expression on their face.
- E-waste means electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment, and repair processes.
- Recycling is one of the best ways to have a favourable influence on the world where we live.
- The ESG is the short form of environmental, social, and governance. ESG guidelines are used to evaluate businesses on how well they control emissions, governance, human rights, and other factors of their business.

Exercise

Multiple-choice Questions

1. The medical attention that is given at the first instance before seeking professional medical help is called _____.
   a. First Aid
   b. Hospitalisation
   c. CPR
   d. None of the above

2. A wound must be cleaned with soap and _____ water.
   a. Cold
   b. Luke warm
   c. Hot
   d. None of the above

3. _____ cream or solution must be applied to the wound to reduce the risk of infection.
   a. Antiseptic
   b. Moisturing
   c. Ice
   d. None of the above

4. _____ are caused by toxic materials, which are poisonous.
   a. Chemical hazards
   b. Physical hazards
   c. Ergonomic hazards
   d. Noen of the above

5. CPR is _____.
   a. Cardio Pulmonary Resuscitation
   b. Cardio Pulmonary Restriction
   c. Central Pulmonary Resuscitation
   d. Cardio Pulsive Resuscitation

Answer the following:

1. What is ESG?
2. What are the special evacuation requirements for specially abled persons.
3. Explain the first aid steps for burns.
4. Explain the benefits of time management.
5. What is Maslow's Hierarchy of Needs?

Notes

Scan the QR codes or click on the link to watch the related videos

youtu.be/GrxevjEvk_s

First Aid at Work Place

https://youtu.be/IsgLivAD2FE

How to properly wash your hands

https://youtu.be/qzdLmL4Er9E

How to give CPR to an Adult, a Child or an infant

youtu.be/ccAZ9nCZSLc

Escalation Matrix PowerPoint Presentation Slides

youtu.be/dq7bBZUFR14

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6. Communication and Interpersonal Skills

Unit 6.1 - Interaction with Supervisor, Peers and Customers

TEL/N9102

Key Learning Outcomes

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

1. Understand what is communication and the importance of communication in the workplace
2. Understand effective communication and communicate effectively for success
3. Discuss types of communication -verbal and non-verbal
4. Communicate at workplace
5. Communicate effectively with superiors
6. Communicate effectively with colleagues and customers using different modes viz face-to face, telephonic and email communication
7. Understand the hurdles for effective communication
8. Conduct professionally at work place
9. Respect differences in gender and ability
10. Communicate effectively with person with disabilities
11. Respect for disable people

UNIT 6.1: Interaction with Supervisor, Peers and Customers

Unit Objectives

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

1. Understand the importance of communication
2. Understand types of communication

6.1.1 Why is Communication Important?

- Communication Skills are more important than ever, for all fields of endeavor.
- Whatever the role a person is holding in the organization, having a firm grasp of effective communication will undoubtedly be a key role in the individual's as well as the organization's success
- Oftentimes, people with excellent technical skills don't get promoted to higher roles because of their inability to communicate effectively
- Hence one fundamental skill everybody should be proficient along with the technical skill is Communication Skills
- Effective communication help us to build rapport with the customer both internal and external and help us resolve issues and conflicts easily and quickly.

6.1.2 What is Communication?

- Communication is the process of sending and receiving information among people.
- It is imparting or exchanging of information by speaking, writing, or using some other medium
- The purpose of communication is to convey your thoughts and opinions to others.
- Communication is said to be successful only when both the sender and the receiver perceive it in the same way.
- In your personal and professional life, you would be communicating with the following people-
  - Colleagues
  - Customers
  - Friends
  - Parents
  - Relatives

6.1.3 Effective Communication

Effective communication is the process of delivering messages to a target audience in a way that guarantees satisfactory reception and understanding. If the communication is effective, both the sender and the receiver will share the same information at the end of the process. Effective communication is about more than just exchanging information. It's about understanding the emotion and intentions behind the information

6.1.4 Effective Communication for Success

Effective Communication is critical to a business's success. From top to bottom, among colleagues, from subordinates to superiors, and from the organization to the outside, several messages are delivered daily. All the people must communicate these messages properly. Content, language, remarks, tone of voice, and non-verbal communication are elements that affect the effectiveness of messages

Clear and effective communication will

- Increase customer satisfaction
- Bring more business to the company
- Increase productivity among team members

6.1.5 Types of Communication

Communication has been divided into two types:-

- Verbal Communication
- Non-Verbal Communication

Verbal communication takes place when people exchange words with each other, either spoken or written. It includes the choice and use of words and language to convey a message. Examples of verbal communication are face-to-face conversation, telephonic conversation, and a speech or presentation.

Speech

Face to face communication

Phone conversation

Voice chat over internet

Newspapers, e-mails, etc.

Speech has certain characteristics which will affect the message that is being spoken:

- Volume – loud speech may sound bossy, very quiet speech cannot be heard.
- Tone – use warm tones without sounding over-friendly. Cool tones are very unwelcoming.
- Pace – fast speech is not easy to follow. Speak at a reasonable pace so that the other person has a chance to understand.

Correct body language also plays an important role in effective communication. For example, a warm smile accompanying 'Have a nice day' or looking directly at the person who is being spoken to give a positive image of the organisation.

Non –Verbal Communication

Non-verbal communication includes the overall body language of a person. There are two kinds of non-verbal communication:

1. **Signs and symbols:** for example pictures, or notices, or signboards, or even photographs, sketches and paintings. Here are some examples of different signs and symbols:

2. **Gestures and expressions:** hand signs, facial expressions, body postures or body language that can help to convey a message. You can learn to communicate better with others if you learn to recognise some of these.

   Facial expressions - A smile or a frown

   Gestures - movements of hands and body to help explain or emphasize the verbal message

   Body posture - how we stand or sit. Maintain a good posture. When you are talking to a colleague or guest, remember to stand up straight, look professional and be positive. Do not slouch, lean against something or fidget with equipment or your hands.

   Orientation - whether we face the other person or turn away

   Eye contact - whether we look at the other person and for how long

   Proximity - the distance we are from a person

   Head nods - for encouragement, indication of agreement or disagreement

   Appearance - dress and grooming

   Non-verbal aspects of speech - tone and pitch of voice

These non-verbal clues are important as they can be used to improve the quality of communication. They can be used to reinforce any verbal communication; for example, leaning forward and looking at the person you are speaking to and smiling naturally. Your expressions, posture and appearance must be appropriate and should tell the guest that you are professional, competent and willing to help.

6.1.6 Communication at Workplace

In every situation, while interacting with people, we make use of both verbal and Non-Verbal Communication. It is the key to the success of any organization. Be it communication with customers, supervisors, or peers. In today's scenario having technical skills alone is not enough to get the work done, but communication skill is also equally important. Completing the task must require the support of the whole team, and without proper communication, it cannot happen. Effective Communication helps managers to perform their jobs and responsibilities and it serves as a foundation for planning.

6.1.7 Communication with Supervisors

Effective and open communication within a team will build a common purpose among team members that will allow them to reach their goals. Team leaders know that group communication enhances organizational efficiency. The team members should always follow the communication guidelines. Some of the points to remember while interacting with supervisors:

1. Be aware of the communication guidelines of the organization.
2. Understand and interpret clearly, the work requirements from the supervisor.
3. Keep the supervisor informed about the progress of the task assigned.
4. Participate in all the discussions which call for decision-making, and provide facts and figures
5. Give/ accept suggestions during the discussions.
6. Accept the feedback positively and work towards rectifying errors if any. Make sure the same mistakes are not repeated.

6.1.8 Communication with Colleagues & Customers

- The main responsibility is to handle customers' concerns
- Interaction with colleagues/peers is also equally essential and it enhances productivity in the workplace.
- Be polite in speaking to your peers at the office.
- Value other people's time as much as you value your own.
- Before you begin discussing something, ask your coworker if it is the right time to talk, and give a true picture of how much time you expect to take. Always start the conversation
- Communication with colleagues/customers can be through face-to-face, telephonic, or email.
- Keeping a few points in mind while communicating will make the interaction pleasant and fruitful.

6.1.9 Face-to-face Communication

This is an important medium of oral communication, wherein two or more persons talk to each other and see each other physically. This form of communication is direct or straight. Things to remember while you are communicating face to face

1. Adjust the tone of voice, don't be too loud
2. Make eye contact
3. Use appropriate language
4. Maintain adequate distance
5. Acknowledge, nod during interaction
6. Use appropriate non-verbal gestures to communicate with persons with disabilities

Benefits of face-to-face communication

- Instant feedback
- Information conveyed clearly
- Build rapport

6.1.10 Telephonic Communication

Another widely adopted mode of communication is through the telephone. This is the person-to-person conversation where nobody sees others but hears each other and interacts instantly. Nowadays mobile phones are becoming more popular along with landlines as a mechanical media of oral communication.

The following suggestions are recommended to follow while making telephone calls-

1. Make the call at the appropriate time
2. Provide details about your identity like name, company, department, etc.
3. Discuss the purpose of the call
4. Think about the tone of your voice
5. Listen carefully
6. Speak clearly
7. If you don't understand something, ask
8. Use please, thank you, sorry wherever necessary
9. Follow the organization's policies and procedures while interacting on the telephone.

6.1.11 Email Communication

Email or Electronic mail is a method of exchanging messages using electronic media. The official or business communication between colleagues or inter-department communication usually happens through email. The advantage of email is you can send communication to many people at the same time.

Points to remember in email communication

1. Be clear and concise
2. Keep the content short and to the point

3. Avoid using jargon and short forms
4. Re-read the message, before sending it for grammar and spelling mistakes
5. The subject line should describe the main mail content
6. Use readable font size (don't keep it too small)
7. Add signature at the bottom of the mail body
8. Check the attachments for viruses before sending

6.1.12 Importance of Timely Completion of Tasks

Time is a major factor that evaluates the success or failure of a project. Even when the whole team has done a wonderful job and produced high-quality results, with half the cost allotted to the project, everything will be a waste if it was not delivered on time. Any deviation from the timeline will call for a penalty and sometimes may result in losing the project and eventually the customer. so adhering to the timeline is important when it comes to any organization who are into products and services.

Benefits of adhering to timelines:

1. Increased and improved customer satisfaction
2. Increased productivity and efficiency of the individual
3. Team feels motivated
4. Sense of adhering to the SLA's and Standard Operating Procedures
5. Shows the commitment toward the work and the organization
6. Good word of mouth from the customers

6.1.13 Standard Operating Procedure

A Standard Operating Procedure (SOP) is a standardized process that outlines a set of detailed instructions to help workers perform complex tasks properly and safely. The main objective of standard operating procedures is to develop an effective quality system and comply with industry- specific regulations and standards. Failure to follow SOPs can cause significant errors in operations and services.

For a mobile repairing center, the SOP defines the different process of operations, namely handling customer, repairs, sales and interaction among the staff within the repair center.

SOP also clearly defines the responsibility of each and every designated person in the organisation and what is expected from them. It further defines what the various levels of engineers will handle with respect to the handsets coming for repair.

The escalation matrix specifies how the different levels escalate the issue to the next level and adhere to the timelines for repair and communication to the customer.

SOP is created keeping in mind the customer satisfaction as a main motive.

Each and every person in the organisation is expected to read the SOP thoroughly and work accordingly. Because every customer when they go for purchasing a product, one of the main things they see is the post-sales Support. If they find the brands deliver good service support then they don't mind even spending few extra moneys.

6.1.14 Escalation Matrix

Escalation matrix is made up of several levels of contact based on the specific problem at hand. This is being followed by all who are working on that product and have to adhere to the service guidelines. And the problem has to be closed at a minimum turnaround time, and for any reason the repair is taking time proper reason has to be mentioned and notified to all the people concerned including the customer.

6.1.15 Escalation Mechanism

Customer service is a very important aspect of a typical service industry. Giving committed service to customers every time and on time is very crucial for the success of the brand. In recent times, customers do research on how the after-sales support of a product is, and based on that rating they will decide which brand to buy. If the customer service is not good, they will not go for that product even though the product is very good. Hence customer service is a second important aspect of a product and services organization.

For electrical home appliances, the customer logs a complaint and the service engineer is sent to the site for looking into the problem and repairing.

For electronic devices like mobile phones and tablets, the customer is expected to take the product to their service center to get it checked and repaired.

The resolution time matters a lot, as mobile phones have become an indispensable device for people. Their business cannot function without that. Hence too much downtime is also not good. Once at the service center, the technicians at L1 level look for the problem and try to resolve it. If it's beyond their area of resolution the same is escalated to the next level. Every organization has Standard Operating Procedures clearly state the workflow for the repair of the smart phones. Every individual working there must be aware of the same and adhere to the deadline for faster service and enriched customer satisfaction.

6.1.16 Escalation through CRM

Customer Relationship Management is a software, through which most of these companies who are into customer service, manage their customers. The customer details are entered in the system and also the services which are logged against a particular customer. This is the automated system, which takes a particular action after a period of time. For example, if a service request is assigned to an engineer for rectifying a problem of a client, and if the engineer does not update the status of the service in the system within a specified period of time, the problem is automatically escalated to the next level for resolution. Then the new engineer who is responsible for resolving pick it and try to find a solution. This system helps to maintain a track of a particular problem and the current status which will help the organization in effectively managing the customer queries. The complete escalation route is mentioned in the SOP and the same is implemented through the CRM software. This eases the manual escalation procedure which is time consuming and slow.

6.1.17 Escalation Issues at Work

Whether an issue arises among team members or with customers, sometimes the severity of the circumstance requires an escalation to manage-ment. Understanding how to approach an escala-tion can help you better find a solution when con-flicts arise. We explore what it means to escalate an issue in the workplace and provide tips for how to do so successfully.

What does it mean to escalate an issue at work?

Escalating an issue in the workplace is the process of bypassing those involved by contacting upper/ senior management. It involves raising awareness of the context to the right people in order to resolve a chal-lenging situation. Typically, escalation occurs when there is an issue that the current staff working on the problem can't resolve and requires assistance from those with more authority and resources

When should you escalate an issue at work?

Deciding when to escalate an issue depends on the amount of risk it can bring to the company. Because escalating an issue can lead to difficult meetings and cause disruptions in work, you should reserve them for issues that truly require escalation. You can often avoid escalating an issue by solving the problem with the individual first.

However, some issues require support from those with higher authority. Consider escalating an issue at work when:

- You have already tried other strategies but that did not work.
- Resolving may incur additional cost to the company or the customer, while rectifying the
- problem.
- Because of the non-availability of certain parts the repair work is taking longer than usual.
- The engineer broke another part while repairing a part. So escala-tion is required to get the approval to replace the broken part by the company.

6.1.18 Hurdles for Effective Communication

Following are factors contribute to communication not being effective.

Stress and out-of-control emotion. When you are stressed or emotionally disturbed, you're more likely to misread other people and send confusing non-verbal signals. Calm down before continuing the conversation.

Lack of focus. You can't communicate effectively when you're multitasking. If you're checking your phone, planning what you're going to say next, or daydreaming, you're almost certain to miss nonverbal cues in the conversation. To communicate effectively, you need to avoid distractions and stay focused.

Inconsistent body language. Nonverbal communication should support what is being said, not contradict it. If you say one thing, but your body language says something else, your listener will likely feel that you're being dishonest. For example, you can't say "yes" while shaking your head no.

Negative body language. If you disagree with or dislike what's being said, you might use negative body language to ignore the other person's message, such as crossing your arms, avoiding eye contact, or tapping your feet. You don't have to agree with, or even like what's being said, but to communicate effectively and not put the other person on the defensive, it's important to avoid sending negative signals.

6.1.19 Professional Conduct

There are six basic rules to be followed for professional conduct:

- **Be on time:** Being late impedes a company's operations and demonstrates a lack of consideration of the time concerns of others. If you are constantly late for work, meetings, or are always late with your reports and other tasks; it demonstrates to others that you are probably not executive material because you disregard the value of time.
- **Be discreet:** Keep company secrets such as new product designs, sales figures or any other confidences to yourself.
- **Be courteous, pleasant, and positive:** No matter how demanding your clients, customers, co-workers or employees might be; always remain upbeat and positive. Projecting a positive company image has the same effect.
- **Be concerned with others, not just yourself:** Finding out a customer or client's point of view naturally helps you get ahead in any industry. Concern for others should include your superiors, co-workers and subordinates as well.
- **Dress appropriately:** Dress to be comfortable in your environment. Dressing poorly or too casually does not convey a good image, neither does overdressing, which breeds suspicion and mistrust, and will be seen as inappropriate.
- **Use proper written and spoken language:** People who can express themselves clearly are at an advantage. This goes beyond using good grammar, proper spelling, and appropriate diction in all your communications; you should also speak and write to the point.

6.1.20 Respect Gender Differences

In any business, be it a small company to a big corporate, the workforce is a mix of both genders. The ratio of men vs. women varies from 70:30 or 60:40. Studies show that business teams with an equal gender mix perform significantly better than male-dominated teams when it comes to both sales and profits. No two women or men are alike and yet at the same time there are some work related traits that are gender specific. Both men and women approach their work in a different way and deal with many hurdles that come their way. Since they all share the same workspace every organization has devised a policy as to how they treat the opposite gender at the workplace and what are the implications of any abuses

Some of the points to remember while interacting with female colleagues

1. Treat them with respect
2. Support them in case they approach you
3. Value their opinion and suggestions
4. Involve and include the opposite gender in all the discussions

6.1.21 Communication with Disabled Person

A disability is any condition that makes it more difficult for a person to do certain tasks or interact with the people around them (socially or materially). These conditions, or defects, may be cognitive, developmental, intellectual, mental, physical, sensory, or a combination of multiple conditions. Defects may be present from birth or can be acquired during a person's lifetime. Often, disabled people are excluded from full participation in any activity."

But things are changing; every organization has allotted some percentage of employees from this section of the society. They are also allowed to exhibit their skills in a few jobs which they can perform without putting their life at risk

General tips for communication with disabled people

1. Speak to them as you would speak to anyone else in a soft and low tone.
2. Respect the person first, not their disability. For example, use the term 'a person with disability' rather than 'a disabled person'.
3. Do not use phrases such as 'suffers from' and 'crippled' rather the phrase should be 'people who use a wheelchair' rather than 'wheelchair bound.
4. Don't drag or push a person's wheelchair, and don't move their crutches or walking stick without their permission. It has to be in their personal space.
5. When talking to a person who is in a wheelchair, try to sit in such a way you could reach their eye level. This would not strain them much, to lift their head and talk.

6.1.22 Communicating with People with a Hearing Impairment

Keep these points in mind while interacting with people with a hearing problem

1. Draw the person's attention before you speak. Give a gentle tap on their shoulder, a wave of some other visual signal to the person's attention
2. Stand in front of the person and maintain eye contact
3. Don't cover the mouth while talking. They can figure out what is being said by just looking at the lip movement
4. Speak at a normal pace don't speak fast or slow
5. Choose the words wisely
6. Use short sentence
7. Be gentle while speaking don't raise the tone

6.1.23 Respect People with Disability

Learn the proper way to act and speak around someone with a disability.

1. Do not use offensive or derogatory words like 'handicapped', 'crippled', and retarded etc.
2. Don't criticize or blame them. Don't shout at them or use abusive language
3. Talk slowly with a low tone. Pause while talking
4. Avoid excessive whispering, joking and laughing unnecessarily
5. Assuming things about them or their situation.
6. Don't make jokes about their condition or be sarcastic
7. Don't look down upon them because of their disability
8. Appreciate them for their efforts and work, and motivate them to perform better

6.1.24 Safety at Workplace for People with Disability

Disabilities of all types affect employees and can pose various mental or physical challenges. In many situations, a disability may impact the amount of time it takes for an employee to complete a task or get from one part of a facility to another. Some disabilities may be known while others remain unknown to an employer.

Health and safety legislation should not prevent disabled people from finding or staying in employment so it should not be used as an excuse to justify discrimination against them.

Disabled people and those with health conditions, including mental health conditions, should be given the opportunity to both get into and stay in work.

Responsibilities of an employer towards disabled people

The employer is responsible for the health, safety and welfare of all of their employees, whether they have a disability or not.

Disability is not always obvious so one might not realise a worker is disabled or they might choose not to tell you, particularly if their disability has no impact on their ability to do their job.

Workers do not have to tell anybody unless they have a disability that could foreseeably affect the safety of themselves or anyone else connected to their work. If they do not reveal and there are no obvious indicators of any disability, then the organization are not under any obligation to make workplace adjustments.

Periodically, consult with the employees (whether directly or through their representatives) on issues relating to health and safety. These discussions reflect good safety practice because employees have day-to-day understanding of the job, so they are likely to have good ideas on keeping themselves and others safe.

6.1.25 Workplace Adaptations for People with Disability

Few changes in the workplace to make it a safe place for the disable people will go a long way in the employee satisfaction for an organisation.

Workplace Adaptations

Workplace should be easily accessible for these people with special needs. One major compliance concern deals with accessibility. For example, if workplaces have been adjusted or created more accessible entrances and exits to their facilities, allowing more independence for persons in wheelchairs, would be a great idea. Other subtle changes may include the width of bathroom stalls, hand rails inside the stalls and long ramps instead of stairs. The path of travel that employees take should never be obstructed; there should be no barriers to prevent someone from getting to safety in an emergency.

Workstations easily can be adapted to follow this universal design. Many companies now use slide- out keyboard trays and monitors on swinging arms to allow employees to adjust to their needs.

Desks can accommodate wheelchairs in place of regular chairs, and general work spaces can be lowered to allow easier access. The main goal is to remove all barriers and allow everyone to concentrate more on completing their tasks.

The biggest challenge with universal design is accommodating the multitude of challenges that different disabilities present. Not all disabilities are the same, and not all will present the same challenges for employees. Some employees may have issues with their right hand while others have issues with their left. For some, it may involve not being able to stand or sit. Some may need low lighting, while others need bright lighting. Designing a facility to accommodate all is always going to be a challenge.

Complying with government guidelines can be more difficult in regards to employees with disabilities. This difficulty lies with ensuring that employees are aware of all hazards in the workplace. Multiple disabilities will create multiple reasons that may keep employees from recognizing hazards. Employees with impaired vision, for example, must have other means of identifying hazards. This may be remedied with audible alarms or touch-activated devices that warn employees not to go in an area. Other employees may have difficulties reading and may benefit from shapes or colors to further identify hazardous areas. For workers who lack hearing ability, employers can utilize signs to demonstrate hazards or use flashing strobes to identify when employees need to evacuate an area and head to safety.

Every organization has to make few adaptations in order to make it a better place to work even for people with disabilities. It should provide an environment where they feel they are safe and can carry out their work rather than worrying about their safety.

Summary

- Communication Skills are more important than ever, for all fields of endeavour. Oftentimes, people with excellent technical skills don't get promoted to higher roles because of their inability to communicate effectively
- Communication is the process of sending and receiving information among people.
- Effective communication is the process of delivering messages to a target audience in a way that guarantees satisfactory reception and understanding.
- Communication has been divided into two types – Verbal ad Non Verbal
- Verbal communication takes place when people exchange words with each other, either spoken or written.
- Non-verbal communication includes the overall body language of a person.
- Email or Electronic mail is a method of exchanging messages using electronic media.
- Telephone communication is the person-to-person conversation where nobody sees others but hears each other and interacts instantly.
- In any business, be it a small company to a big corporate, the workforce is a mix of both genders. The ratio of men vs. women varies from 70:30 or 60:40.
- A disability is any condition that makes it more difficult for a person to do certain tasks or interact with the people around them (socially or materially). These conditions, or defects, may be cognitive, developmental, intellectual, mental, physical, sensory, or a combination of multiple conditions.

Exercise

Multiple-choice Questions

1. Add your _____ at the bottom of your mail.

   a. Signature
   b. Address
   c. DOB
   d. None of the above

2. Being _____ impedes a company's operations and demonstrates a lack of consideration of the time concerns of others.

   a. Late
   b. Courteous
   c. Appropriate
   d. Discreet

3. Be _____ in speaking to your peers at the office.

   a. Rude
   b. Polite
   c. Agreesive
   d. None of the above

4. _____ are movements of hands and body to help explain or emphasize the verbal message.

   a. Gestures
   b. Body posture
   c. Head nods
   d. None of the above

5. _____is the process of delivering messages to a target audience in a way that guarantees satisfactory reception and understanding.

a. Active listing
b. Effective communication
c. Articulation
d. None of the above

Answer the following:

1. What is communication?
2. How to communicate with people with hearing impairment?
3. What are the three points you will focus on when you talk to people face to face?
4. Explain the importance of gender sensetisation.
5. List the hurdles of effective communication.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/8v60jWtecrQ

Effective Telephone Tips from Successfully Speaking

youtu.be/K5qQ77cmNPs

Types of Communication?

youtu.be/wnzwgExFRR4

Communication with Customer and Colleagues

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& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

Telecom
Sector
Skill
Council

7. Annexure

Module No.	Unit No.	Topic Name	Page No	Link for QR Code (s)	QR code (s)
Module 1: Introduction to the Telecom Sector and the Role of Optical Fibre Splicer	UNIT - 1.2: Tele-com Sector in India	1.2.1 Introduction to Telecom Industry	19	https://youtu.be/Cag-bcbivtM	Introduction to Telecom Industry
		1.2.3 Broad Band Industry		https://www.youtube.com/watch?v=5SoTmES2UKM	Broad Band Industry
		1.2.4 Optical Fibre Technology		https://www.youtube.com/watch?v=jZOg39v73c4	Optical Fibre Technology
		1.2.5 Types of Optical Fibre		https://www.youtube.com/watch?v=pavBq7HIoIE	Types of Optical Fibre
		1.2.6 Optical Fibre Splicer		https://www.youtube.com/watch?v=d-xth2HzVYU	Optical Fibre Splicer
	UNIT - 1.3: Tele-com Basics	1.3.1 Basics of Telecom		https://www.youtube.com/watch?v=xRFe9jWY0hg	Basics of Telecom

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		2.1.2 Various Optical Equipment		https://www.youtube.com/watch?v=SDPfA8k0dUc	Various Optical Equipment
	UNIT - 2.2 Pre-Installation Procedures	2.2.1 Specifications of Fibre Optic Cable		https://www.youtube.com/watch?v=77dOO5hvd58	Specifications of Fibre Optic Cable
		2.2.3 Factors Affecting Choosing of Cables		https://www.youtube.com/watch?v=1oYYB7AGeMo	Factors Affecting Choosing of Cables
		2.2.6 Colour Coding of Optical Fibre Cable		https://www.youtube.com/watch?v=eCpujviAo9g	Colour Coding of Optical Fibre Cable
	UNIT - 2.3 Installation of Optical Fibre	2.2.1 Installing OFC		https://www.youtube.com/watch?v=fYwBgqDdLLQ	Installing OFC

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		3.1.2 Types of Optical Fibre Splicing		https://www.youtube.com/watch?v=rr9hHjYRbw8	Types of Optical Fibre Splicing
Module 4: Fibre Testing and Documentation	UNIT - 4.1: Testing Optical Fibre Cable	4.1.1 OTDR (Optical Time-Domain Reflectometer)	89	https://www.youtube.com/watch?v=tXWa3xFUVGA	OTDR (Optical Time-Domain Reflectometer)
5. Organize Work and Resources as per Health and Safety Standards	UNIT 5.2: Different Types of Health Hazards	5.1.2 First Aid Techniques	90	youtu.be/GrxevjEvk_s	First Aid at Work Place
	UNIT 5.3: Importance of Safe Working Practices	5.3.1 Basic Hygiene Practices		https://youtu.be/IsgLivAD2FE	How to properly wash your hands
	UNIT 5.3: Importance of Safe Working Practices	5.3.3 Safe Workplace Practices		https://youtu.be/qzdLmL4Er9E	How to give CPR to an Adult, a Child or an infant

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	UNIT 5.9: Waste Management	5.9.6 E-waste Management Process	90	youtu.be/dq7bBZUFR14	E-Waste Recycling and Management
6. Communication and Interpersonal Skills	UNIT 6.1: Interaction with Supervisor, Peers and Customers	6.1.3 Effective Communication		https://youtu.be/8v60jWtecrQ	Effective Telephone Tips from Successfully Speaking
	UNIT 6.1: Interaction with Supervisor, Peers and Customers	6.1.5 Types of Communication	106	youtu.be/K5qQ77cmNPs	Types of Communication?
	UNIT 6.1: Interaction with Supervisor, Peers and Customers	6.1.8 Communication with Colleagues & Customers	106	youtu.be/wnzwgExFRR4	Communication with Customer and Colleagues
Employability Skills				https://www.skillindiadigital.gov.in/content/listlogin	

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