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HYDROCARBON SECTOR
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Participant Handbook

Sector
Hydrocarbon

Sub-Sector
Midstream, Construction & Services

Occupation
Operations-Oil & Gas Pipeline

Reference ID: **HYC/Q6304, V2.0, NSQF Level 2**

Excavator - Pipeline

This book is sponsored by

Hydrocarbon Sector Skill Council

OIDB Bhawan Tower C, 2nd Floor, Plot No. 2, Vikas Marg, Sector 73, Noida 201301 (UP)

Printed in India at

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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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HYDROCARBON SECTOR SKILL COUNCIL

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SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: **Excavator - Pipeline** QP No. **HYC/Q6304 NSQF Level 2**

Date of Issuance: March 4th, 2020

Valid up to*: March 3rd, 2024

*Valid up to the next review date of the Qualification Pack or the 'Valid up to' date mentioned above (whichever is earlier)

Authorised Signatory
Hydrocarbon Sector Skill Council

Acknowledgements

Hydrocarbon Sector Skill Council (HSSC) would like to express its gratitude to all the individuals and institutions who contributed in different ways towards the preparation of this **"Participant Handbook"**. Without their contribution it could not have been completed. Special thanks are extended to those who collaborated in the preparation of its different modules. Sincere appreciation is also extended to all who provided peer review for these modules.

The preparation of this manual would not have been possible without the Hydrocarbon 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 manual is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this guide

Welcome to the **"Excavator - Pipeline"** training programme. This Participant Hand Book (PHB) will facilitate and train the trainees/participants in the skills necessary to be a **"Excavator - Pipeline"**, in the Hydrocarbon Sector. Besides, it will also enable the trainers to identify the scope within which the training is to be conducted for Excavator - Pipeline at Level 2, The PHB will provide the knowledge and skills necessary for the job role.

"Excavator - Pipeline" is someone who adherence to laying oil and gas pipeline and earth backfilling in accordance with safe working practices, plans and approvals. Accordingly, the Participant Handbook (PHB) includes technical as well as behavioural skills required for this job role, and is based on National Skill Qualification Framework NSQF aligned Qualification Pack (QP) as follows:

1. **HYC/N6307** Perform excavation work for laying pipeline.
2. **HYC/N9301** Work effectively in a team.
3. **HYC/N9302** Follow health and safety procedure.

There are various practical and theoretical exercises given at the end of each unit, which may be used to test the understanding of the participant on a topic. Trainers can use them for formative and summative assessment. This book is just a beginning, and much of the most exciting learning processes will take place in the classroom and thereafter.

Successful completion of the programme shall certify the participant as a Excavator - Pipeline, thereby adding value for their employment opportunities as also the entrepreneurship capabilities.

Symbols Used


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It is recommended that all trainings include the appropriate Employability Skills Module Content for the same is available here:

https://www.skillindiadigital.gov.in/content/list

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1. Introduction to hydrocarbon sector

Unit 1.1 - Introduction to hydrocarbon sector

Unit 1.2 - Roles and responsibilities of excavator - pipeline

Key Learning Outcomes

At the end of this module, the participant will be able to:

1. Describe oil and gas sector and its sub-sectors.
2. List the three major segments in the hydrocarbon sector.
3. State the functions of upstream, midstream and downstream segments.
4. Describe the role of Hydrocarbon Sector Skill Council.
5. List the roles and responsibilities of Excavator - Pipeline.

Unit 1.1 - Introduction to hydrocarbon sector

Unit Objectives

At the end of this unit, the participant will be able to:

1. Describe about the hydrocarbon sector in India.
2. List the three major segments in the hydrocarbon sector.
3. Identify about the achievements of hydrocarbon sector.
4. Identify and perform about the roles and responsibilities of excavator - pipeline.
5. State about the essential skills of Excavator - Pipeline.

1.1.1 Hydrocarbon sector in India - overview

The oil and natural gas sector is amongst the 8 core industries driving economic growth in India and plays a crucial role in country's economic growth. The industry is broadly divided into following different segments which refers to different points in the process of exploring and extracting, collecting and processing and ultimately distributing the oil and natural gas for use.

India is expected to be one of the largest contributors to NON-OECD petroleum consumption growth globally. Crude oil import rose sharply to US $ 101.4 Billion in 2019-20 from US $ 70.72 Billion in 2016-17. India retained its spot as the third largest consumer of oil in the world in 2019 with consumption of 5.16 Million barrels per day (MBPD) of oil in 2019 compared to 4.56 MBPD in 2016.

As of October 01, 2020, India's oil refining capacity stood at 249.9 Million metric tonnes (MMT), making it the second-largest refiner in Asia. Private companies own about 35.29% Of the total refining capacity in FY 20.

In FY 20, crude oil production in India stood at 30.5 MMT. In FY 20, crude oil import increased to 4.54 MBPD from 4.53 MBPD in fy19. Natural gas consumption is forecast to reach 143.08 Million tonnes (MT) by 2040. India's LNG import stood at 33.68 BCM during FY 20.

India's consumption of petroleum products grew 4.5% To 213.69 MMT during FY 20 from 213.22 MMT in FY 19. The total value of petroleum products exported from the country increased to US $ 35.8 Billion in FY 20 from US $ 34.9 Billion in fy19. Export of petroleum products from India increased from 60.54 MMT in FY 16 to 65.7 MMT in FY 20.

Gas pipeline infrastructure in the country stood at 17,016 Kms as of June 30, 2020.

India has been the fourth-largest Liquefied Natural Gas (LNG) importer since 2011 after Japan, South Korea, and China.

The Government has adopted several policies to fulfil the increasing demand. It has allowed 100% Foreign Direct Investment (FDI) in many segments of the sector, including natural gas, petroleum products and refineries among others. Today, it attracts both domestic and foreign investment.

1.1.2 Major Segments in the hydrocarbon sector

The industry is broadly divided into following different segments which refers to various points in the process of exploring and extracting, collecting and processing and ultimately distributing the oil and natural gas for use.

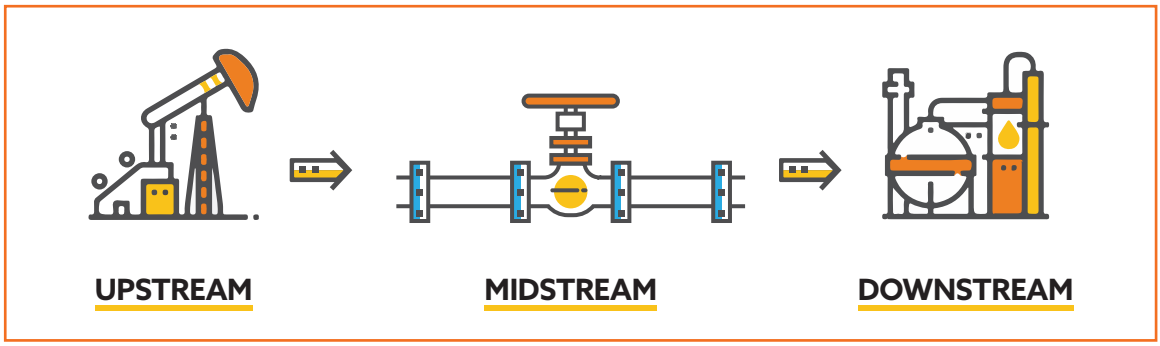

Fig: 1.1.1 Hydrocarbon Segments

The energy sector has three key areas: Upstream, midstream and downstream.

1. **Upstream:** Upstream is E&P (exploration and production). This involves the search for underwater and underground natural gas fields or crude oil fields and the drilling of exploration wells and drilling into established wells to recover oil and gas.

   The term 'upstream' also includes the steps involved in the actual drilling and bringing oil and natural gas resources to the surface, referred to as 'production'.

Fig: 1.1.2 Upstream

2. **Midstream:** Midstream entails the transportation, storage, and processing of oil and gas. Once resources are recovered, it has to be transported to a refinery, which is often in a completely different geographic region compared to the oil and gas reserves. Transportation can include anything from tanker ships to pipelines and trucking fleets.

Midstream includes pipelines and all the infrastructure needed to move these resources long distances, such as pumping stations, tank trucks, rail tank cars and transcontinental tankers.

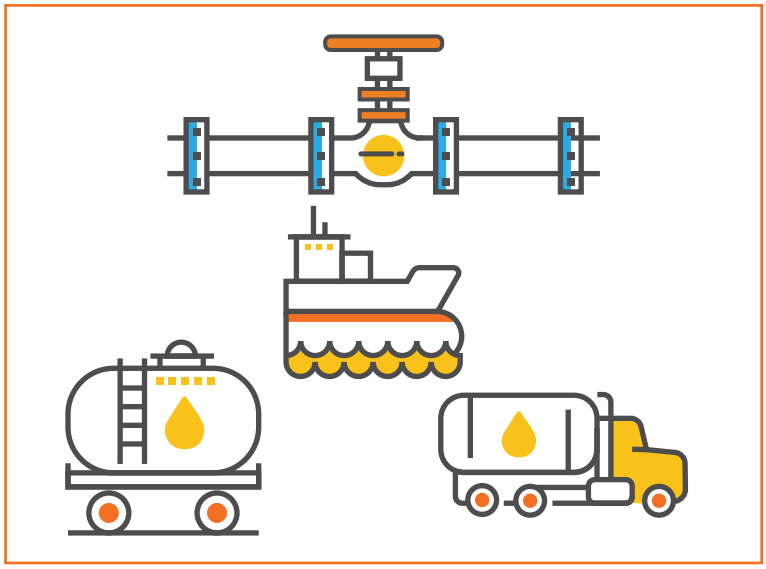

Fig: 1.1.3 midstream

3. **Downstream:** Downstream refers to the filtering of the raw materials obtained during the upstream phase. This means refining crude oil and purifying natural gas. The marketing and commercial distribution of these products to consumers and end users in a number of forms including natural gas, diesel oil, petrol, gasoline, lubricants, kerosene, jet fuel, asphalt, heating oil, LPG (liquefied petroleum gas) as well as a number of other types of petrochemicals.

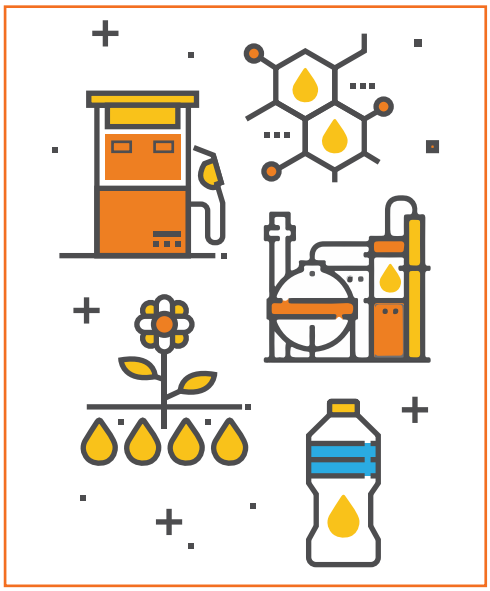

Fig: 1.1.4 Downstream

Oil and natural gas products are even used to make artificial limbs, hearing aids and flame-retardant clothing to protect fire fighters. In fact, paints, dyes, fibres and just about anything that is manufactured has some connection to oil and natural gas.

So now you know. 'Upstream' is about extracting oil and natural gas from the ground; 'midstream' is about safely moving them thousands of miles; and 'downstream' is converting these resources into the fuels and finished products we all depend on.

Together, these three sectors of the oil and natural gas industry sustain the steady flow of fuels and materials that make life better and safer for us all.

1.1.3 Hydrocarbon sector skill council (HSSC)

According to the data released by Department for Promotion of Industry and Internal Trade Policy (DPIIT), the petroleum and natural gas sector attracted FDI worth US$ 7.86 billion between April 2000 and September 2020.

Following are some of the major investments and developments in the oil and gas sector:

- The Indian oil and natural gas sector is likely to witness an investment of US$ 206 billion in the next eight to ten years.
- In December 2020, The Indian Oil Corporation (IOCL) announced plans to invest Rs. 1,689 crore (US$ 228.81 million) in new projects in Andhra Pradesh. This includes Rs. 1,522 crore (US$ 206.19 million) on petro products infrastructure and Rs.167 crore (US$ 22.62 million) on LPG storage facilities.
- In December 2020, Indian Oil launched a world-class premium grade Petrol (Octane 100) in India. Branded as XP100, the premium-grade petrol was launched across 10 cities.
- In November 2020, home-grown commercial vehicle and auto parts manufacturer JBM signed an MoU with the Ministry of Petroleum and Natural Gas (MoPNG), Govt. of India, for the development of Compressed Biogas (CBG) Projects. As part of the MoU, the renewable subsidiary of the company, JBM Renewable will endeavour to establish and operate 500 CBG production projects pan India.
- In October 2020, Torrent Gas Ltd. announced plan to spend Rs. 8,000 crore (US$ 1.1 billion) over the next five years to expand its urban gas operations with the aim of setting up 500 CNG dispensing pumps by March 2023.
- On September 15, 2020, PM Mr. Narendra Modi inaugurated three petroleum sector projects in Bihar worth more than Rs. 900 crore (US$ 122 million).
- In March 2020, Indian Oil Corp (IOC) began supply of the world's cleanest petrol and diesel across the country with all its 28,000 petrol pumps dispensing ultra-low sulphur fuel a good two weeks before the April 1 deadline.
- Indian Oil Corporation (IOC) plans to invest Rs. 500 crore (US$ 71.54 million) at Chitradurga in Karnataka.
- ExxonMobil and ONGC signed a memorandum of understanding (MoU) for offshore blocks.
- Foreign investors will have opportunities to invest in projects worth US$ 300 billion in India as the country looks to cut reliance on oil import by 10% by 2022 according to Mr. Dharmendra Pradhan, Minister of Petroleum and Natural Gas, Government of India.

Unit 1.2 - Roles and responsibilities of excavator - pipeline

Unit Objectives

At the end of this unit, the participant will be able to:

1. Identify roles and responsibilities of excavator - pipeline.
2. Identify essential skills of excavator - pipeline.

1.2.1 Introduction to excavator - pipeline

Excavator operators typically report to the foreman or the supervisor. They are responsible for operating plant to excavate and move earth, rock, vegetation and debris and then smooth and compact surfaces on sites for laying oil and gas pipeline. Many excavator operators have multiple tickets and experience that allows them to hop into different machines if required such as graders, bulldozers, loaders, rollers etc.

Roles and responsibilities of excavator - pipeline

- Perform daily maintenance and safety checks of equipment.
- Preparing and positioning plant for operation on site.
- Operate the machine and other heavy equipment in a safe and appropriate manner.
- Selecting, fitting and removing attachments such as buckets, scoops, shovel blades, rock breaking hammers, winches and blades.
- Work with ground personnel.
- Operating controls to excavate, break, drill, level, compact, gouge out, move, load and spread earth, rock, rubble, soil and other materials.
- Working from drawings, markers and verbal instructions.
- Servicing, lubricating, cleaning and refuelling plant and performing minor adjustments and repairs.
- Operates in crowded, fast-paced working environments, and exercises extreme caution with awareness of potential situational hazards to ensure site safety.
- Interprets verbal and non-verbal communication (including hand signals) from operators, ground personnel and swampers, and acts accordingly.
- Performs mechanical inspections and servicing including controls and operations, completing logbooks, performs maintenance and adjustments, ensures good housekeeping, and performs machine lubrication.
- Performs effective operation of equipment by recognizing unusual machine movements and sounds.
- Recognizes existing and potential hazards and knows how to identify these through conducting a field level pre-job hazard analysis, checking the machine for hazards and assessing any tasks before start.

1.2.2 Skills required for excavator - pipeline

- **Machine operation skill:** Excavators need to be very familiar with the principles of machine operation, including both excavators and related machinery such as bulldozers and trucks.
- **Physical stamina:** This role frequently requires long days of operating machinery, as well as climbing in and out of an excavator, so physical stamina and strength are both necessary a solid grasp of safety procedures and best practices for responsible operation.
- **Team collaboration:** Excavators work with construction crews, site engineers, and surveyors to determine the scope of excavation projects, so effective team communication and coordination are important.
- **Accuracy and attention to detail:** This role also requires excellent attention to detail and a high level of accuracy to ensure proper dimensions while digging for construction projects.
- **Technical knowledge:** Ability to communicate professionally and effectively with all employees on construction site.
- **Environmental adaptability:** Work inside and outside in all weather conditions, and various locations. Hard hat, hearing and eye protection required.

Working conditions

A typical day for an excavator operator is spent on a site in conditions that can be unpredictable; for example, working conditions may be noisy, cold, hot and dusty. However, most modern machines are air-conditioned and have soundproof cabs that may make work more comfortable. Hours can vary and depend on the job site you are on and can include weekends and night shifts.

The ideal candidate for excavator operator jobs has mechanical aptitude, is in good shape, and has good eyesight. They should be good at working on a team and handling problems in a timely, effective manner.

Exercise

1. **India's oil refining capacity was 249.9 million metric tons (MMT) as of October 1, 2020, making it the second largest refiner in Asia.** (True/False)
2. **In 2011, India became the fourth largest importer of Liquefied Natural Gas (LNG), after Japan, South Korea, and China.** (True/False)
3. **Production is another term used to describe the actual drilling and bringing of oil and natural gas to the surface, occasionally referred to as "upstream".**

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2. Perform excavation work for laying pipeline

Unit 2.1 - Carry out excavation work

Unit 2.2 - Maintain safety during excavation

HYC/N6307

Key Learning Outcomes

At the end of this module, the participant will be able to:

1. Carry out excavation work.
2. Maintain safety during excavation work.

Unit 2.1 - Carry out excavation work

Unit Objectives

At the end of this unit, the participant will be able to:

1. Define excavation.
2. Identify different types of excavation equipment.
3. Prepare for excavation work.
4. Illustrate excavation methods.
5. Define trench excavation.
6. Identify about the work procedure of excavation.
7. Illustrate the installation process of Pipeline.

2.1.1 Introduction to excavation

Excavation is the process of moving earth, rock or other materials with tools, equipment or explosives. It includes earthwork, trenching, wall shafts, tunnelling and underground. Excavation has a number of important applications including exploration, environmental restoration, mining and construction. Among these, construction is one of the most common applications for excavation. Excavation is used in construction to create building foundations, reservoirs and roads.

Some of the different processes used in excavation include trenching, digging, dredging and site development. Each of these processes requires unique techniques, tools and machinery to get the job done right. The processes used will depend upon the structure that will result from the construction process.

Fig: 2.1.1 Digging

How does the excavation process work?

Before the excavation and heavy earthworks process can begin, the site must be carefully examined to make sure that the natural habitat and artefacts surrounding it are persevered throughout the excavation process. Next, the plans for the size and depth of the site are made and the excavation contractors makes drawings from them to clearly mark the excavation site's boundaries. Once these two important steps have been taken, the excavation work can begin.

The entire excavation process includes:

- Setting out corner benchmarks.
- Surveying ground and top levels.
- Excavation to the approved depth.
- Dressing the loose soil.
- Making up to cut off level.
- The construction of de-watering wells and interconnecting trenches.
- Making boundaries of the building.
- The construction of protection bunds and drains.

2.1.1.1 Material type

On small sites or in confined spaces, excavation may be carried out by manual means using tools such as picks, shovels and wheelbarrows. Larger scale excavation works will require heavy plant such as bulldozers and back actors.

A common method of classification is by the material being excavated:

1. **Topsoil excavation:** This involves the removal of the exposed layer of the earth's surface, including any vegetation or decaying matter which could make the soil compressible and therefore unsuitable for bearing structural loads. The depth will vary from site to site, but is usually in a range of 150-300 mm.
2. **Earth excavation:** This involves the removal of the layer of soil directly beneath the topsoil. The removed material (referred to as 'spoil') is often stockpiled and used to construct embankments and foundations.
3. **Rock excavation:** This is the removal of material that cannot be excavated without using special excavation methods such as drilling (by hand or with heavy machinery) or blasting with explosives.
4. **Muck excavation:** This is the removal of excessively wet material and soil that is unsuitable for stockpiling.
5. **Unclassified excavation:** This is the removal of a combination of the above materials, such as where it is difficult to distinguish between the materials encountered.

2.1.2 Excavation equipment

Excavators

Excavators (also known as 'diggers') are one of the most versatile pieces of excavation equipment available. This is the machine most often associated with excavation projects. It has a long bucket arm attached to a cab where the operator sits and can rotate 360 degrees. Running on tracks, this is a large piece of equipment used for big jobs. It is typically used to dig trenches, demolition, snow and forestry removal, lift pipes and heavy objects, and grade the ground. You can also use different attachments for them, such as a clamshell attachment to pick up dirt and debris. They are used for:

- Digging trenches, holes & foundations.
- Forestry work.
- General grading & landscaping.
- Drilling shafts for footings, etc.
- And more.

There are several types of excavators, including:

- **Spider excavator:** Designed to work on all types of terrain, such as steep inclines and narrow ditches, it moves on **"legs"** instead of tracks.
- **Swamp excavator:** Specially made for jobs near water, it has a special kind of track that makes it perfect for dredging projects.
- **Zero swing excavators:** This machine has an arm that can only swing within its own width, making it the perfect piece of excavation equipment for confined spaces.

Fig: 2.1.2 Swamp excavator

Backhoes

Like the excavator, backhoes are generally used for digging. However, as you can see by the images above, there are quite a few differences between the two machines. Thanks to plenty of attachment options, backhoes can be used for:

- Construction
- Small demolition
- Landscaping
- Paving roads
- And more

Fig: 2.1 .3 Backhoes

Dozers

Bulldozers are made for pushing large quantities of soil, sand and other materials. Generally, you'll see dozers equipped with a blade at the front and a ripper at the back (as pictured above). Dozers are used to:

- Move earth and soil.
- Move topsoil away in preparation for road builds.
- Smooth out the fill for road builds.
- Strip off surface vegetation.
- And more.

Fig: 2.1.4 Dozers

Skis Steers

The skid steer is a compact machine used primarily for digging. While they are small, they're one of the most-handy pieces of excavation equipment. Especially for those tight-access sites. Ideal for construction and landscaping work skid steers can be used for:

- Digging & earthmoving.
- Grading.
- Demolition.
- Overhead work.
- And more.

Fig: 2.1.5 Skis Steers

Motor Graders

A grader is a piece of equipment with a long blade, used primarily for flattening and smoothing surfaces. Motor graders can assist with:

- Earthmoving.
- Levelling jobs.
- Scarifying.
- Mixing materials.
- Spreading materials such as soil & aggregates.
- Land grading.
- Ditching.
- And more.

Fig: 2.1.6 Motor Graders

Crawler loader

Combining the track mounted power of an excavator with the bucket capability of a backhoe; this machine is most helpful for moving materials off-site. You may often see them loading material into a truck or taking soil to a different location.

Trencher

You will find trenchers of many sizes and capabilities, such as walk-behind models and heavy trenching varieties. It operates with a conveyor system that takes the excavated material and moves it to an area next to the trench. There are different digging tools, depending on the type of excavation required and how hard the excavated material will be. You can find both wheeled and chain trenchers. For example, a professional might use it to dig up pavement or asphalt. They are most often used for drainage purposes, or laying pipes and cable. The right excavation equipment can prevent dangers like cave-ins.

a. **Wheeled Trenchers:** While both wheeled and chain trenchers are very similar, the main difference is the shape of the trenching device. Wheeled trenchers have a toothed metal wheel as a trenching tool attached to the cabin. The trenching wheel can be shifted either up or down to slowly make its way into the ground.

   They are available in both wheeled and tracked forms, however, due to its stability on rough surfaces, mining companies usually opt for tracked movement. Wheeled trenchers are great tools to cut into the ground and make a long trench while slowly moving forward in a line.

b. **Chain Trenchers:** Known to be the heavy-duty workhorse of trenching, chain trenchers have a striking resemblance to an oversized chainsaw. The machine has a toothed metal track that continuously rotates around a longer rounded frame known as the boom. By slowly creeping forward as the teeth dig away at the dirt, the machine can dig a long straight trench.

   Chain trenches can dig both narrow and wide trenches and can dig down quite deep. The sharp teeth can dig through much harder materials by rotating with rapid force. Most of the larger chain trenchers use a continuous track to move slowly forward while it digs.

   As you can see, although many excavation and trenching tools have similarities, they have quite varied applications. Depending on the needs of your task at hand, you may need one piece of machinery or even a few different types. If you're ever in doubt about what piece of machinery is right for your needs, have a chat to an experienced provider.

2.1.3 Prepare for excavation work

Site marking

The centre and ends of each proposed excavated length shall be pegged directly above the pipeline axis.

Lateral alignment pegs shall be positioned to maintain the centre location after excavation has commenced and the centre peg has been removed. The alignment pegs shall be sited such that a line between them intersects the pipe axis at approximately 90° and such that they do not inconvenience the excavation working space, the spoil areas or right of way/access road.

The excavation site shall be planned with respect to the anticipated length of excavation, the topsoil storage area, spoil storage areas, and equipment access. The excavation site shall be barricaded or roped off and appropriate warning signs/devices installed in accordance with the requirements of specification and the company HSE manual.

Excavation site parameters

The project manager:

- Specifies the parameters of the proposed excavation site.
- **Reviews the latest revisions of all relevant drawings and alignment sheets to:** identify any indicated pipe bends or elevation changes.
- Identify the estimated location of utility installations, such as sewer, telephone, gas, electric, water lines, or other underground facilities that may be encountered during excavation work before digging.

Overhead power lines

Where access, staging areas, or the planned excavation is located near high voltage power lines, the following minimum clearances shall be maintained:

- Vehicular and/or mechanical equipment that has parts of its structure elevated near energized overhead power lines shall be operated so that a 10-foot clearance is maintained.
- If the voltage is higher than 50KV, the clearance shall be increased four inches for every 10KV over that voltage.
- **One should contact the overhead utility company if any of the following is required:**
  - Movement of poles.
  - Potential to undermine a pole.
  - Minimum specified distances cannot be maintained.

Excavation design requirements

The competent person shall confirm with the project manager the excavation design prior to commencing excavation work, and consult with the project manager as needed during the excavation.

During initial determination, the competent person verifies that the following requirements have been satisfied (when applicable):

- The depth and dimension of the excavation.
- Required services of a registered professional engineer.
- Soil classification.
- Sloping requirements.
- Shoring and/or shielding equipment.
- Pipeline supports.
- Supports for nearby structures.
- Placement of spoil piles.

When an excavation is anticipated to be 20 feet deep or more and large enough to occupy or otherwise affect the safety of workers, a registered professional engineer shall be used to design the excavation.

The size, type and configuration(s) of the material to be used in the protective system must be identified on the excavation plan. A copy of the design must remain at the excavation site until the excavation is complete.

Excavations that are four feet deep or more shall be evaluated by the competent person for the appropriate protective systems to be used.

2.1.4 Excavation methods

The nature of the excavation work being carried out will affect selecting an excavation method and a safe system of work. Careful consideration should be given to health and safety issues when planning the work where the excavation involves anything other than shallow trenching and small quantities of material.

Trenching

Persons conducting a business or undertaking (PCBUs) who propose to excavate a trench at least 1.5 Metres deep must ensure, so far as is reasonably practicable, that the work area is secured from unauthorised entry including inadvertent entry. Additionally, the PCBU must minimise the risk to any person arising from the collapse of the trench by ensuring that all sides of the trench are adequately supported by doing one or more of the following control measures:

- Shoring by shielding or other comparable means,
- Benching, or
- Battering.

Combining these control measures may be the most effective depending on the work environment and characteristics of the excavated material. In built up areas or streets the excavation may have to be fully or partly sheeted or supported to prevent collapse due to localised vehicle movement.

Where a worker enters a trench and there is a risk of engulfment, these control measures should be implemented regardless of the depth of the trench.

A report from a geo-technical engineer may be required to provide information on the stability and

safety of a trench excavation. The report should include details of the soil conditions, shoring or trench support requirements, de-watering requirements and longer term effects on stability and safety of the excavation. A competent person, for example an engineer should design support systems or be involved in selecting other ground collapse control measures, for example trench shields.

Shoring, benching and battering may not be required if written advice is received from a geo-technical engineer all sides of the trench are safe from collapse. Advice should state the period of time it applies to and may be subject to a condition that specified natural occurrences may create a risk of collapse.

Preparation and excavation

Bulldozers, scrapers, excavators and other types of earthmoving equipment are commonly used for either preparing work areas prior to trenching or for the trenching work itself.

For some trench excavations manual work, for example trimming by hand, will be required. Trimming can often be accomplished from outside the trench by shovelling or pushing the material with a long handled tool or shovel to the bottom of the excavation where it can be picked up by the excavation plant. Risks associated with falls and working with powered mobile plant must be controlled.

Tunnelling

The nature of tunnelling work is complex and highly specialised, requiring high levels of engineering expertise during the planning, investigation, design and construction stages.

Safe tunnel construction depends on adequate pre-construction engineering investigation of the ground and site and accurate interpretation of the information obtained.

Designers should:

- Obtain or be provided with all available relevant information.
- Be advised of gaps in the information for planning and construction.
- Undertake or be involved in data acquisition for the site investigation program, and.
- Have on-site involvement during the engineering investigation.

The information obtained from the engineering investigation and the anticipated excavation methods should be considered in preparing a tunnel design. The design should include:

- Details on the tunnel dimensions and allowable excavation tolerances.
- Temporary and final support and lining requirements for each location within the tunnel.
- Details of expected tunnel drive lengths and shaft location, and.
- Other requirements for the finished tunnel.

The design should also include information on the excavation methods and ground conditions considered in the design. This will allow the design to be reviewed if another excavation method is chosen or the ground conditions differ from that expected as the excavation proceeds.

The design also needs to take into account the construction methods used to construct the tunnel so that a safe design for construction purposes is achieved.

Tunnelling hazards and risks

Common hazards and risks in tunnel construction generally relate to the confines of working underground including:

- **Tunnel stability:** rock or earth falls and rock bursts.
- **Changing ground conditions:** strata and stress fluctuations.
- Limited space and access, with possible confined spaces involved.
- Air contamination or oxygen depletion.
- Fire or explosion.
- The use of fixed and powered mobile plant.
- The interaction of people and powered mobile plant.
- Temporary electrical supplies and circuits including loss of power for lighting and ventilation.
- Compressed air use and high pressure hydraulics.
- Large scale materials and equipment handling.
- Overhead seepage, ground and process water.
- Uneven and wet or other slippery surfaces.
- Falls of people or objects.
- Contaminated groundwater.
- Ground gas and water in-rush.
- Noise.
- Vibration.
- Heat and humidity.
- Ground loss or settlement.
- Hazardous substances.

Control measures include:

- Ground support, for example tunnelling shields, mesh, rock bolts and shot crete.
- Fall protection, for example temporary work platforms.
- Plant and vehicle traffic management systems.
- Regular plant maintenance.
- Pumps or de-watering systems to remove ground water.
- Mechanical ventilation to control airborne contaminants and air temperature/humidity.
- Dust extraction.
- Plant fitted with water scrubbers.
- Plant fitted with catalytic converters, and.
- Providing breathing equipment when a hazardous atmosphere is present and cannot be effectively ventilated by external means.

Using ground support designed for the unique circumstances of the work is essential to control the risk of a collapse or tunnel support failure. All excavation for tunnelling should be supported.

Shafts

Shafts are often constructed to provide access or ventilation to a tunnel. Comparatively shallow shafts can be sunk for investigating or constructing foundations, de-watering or providing openings to underground facilities.

Shafts vary greatly in design and construction technique, depending on their purpose and the local conditions. They may be vertical or inclined, lined or unlined, various shapes, and excavated using various techniques.

Shaft sinking involves excavating a shaft from the top, with access and spoil removal from the top. Other construction methods include raise-boring, which is a method of constructing a shaft or raise where underground access has already been established. Raised bored shafts can be from the surface or from one horizon to another underground. The method can be remotely executed, not requiring people to enter the shaft.

Access to shaft openings should be controlled by using a secure cover that is lockable and accessible only by a designated person. An alternative means is to use a suitable guard rail and toe board with gate for access and supporting the sides by steel frames or sets of timber. In special cases support can also be provided by installing pre cast concrete or steel liners.

Shafts can have special features so design and construction advice should be obtained from a competent person, for example an engineer before excavation and installation. In some cases, special ventilation facilities may be required.

Common hazards and risks involved in shaft construction include:

- The potential for ground instability for lifting and removing spoil.
- Falls and falling objects including fine material and water from the shaft wall.
- Hoisting equipment such as a winch, ropes and hooks.
- Hoisting and winching people, materials, spoil and plant.
- Water in-flow/in-rush and de-watering.
- Airborne contaminants and ventilation.
- Confined space.
- Manual tasks.
- Hazardous materials.
- Fire or explosion.
- Inadequate communication systems.
- Mobile plant.
- Noise, and.
- Emergency exits.

Control measures include:

- Stabilizing the ground at the head of the shaft and removal of spoil.
- Continuously lining or supporting the shaft.
- Providing fall protection, for example temporary work platforms.
- Providing and maintaining hoisting equipment.
- Installing de-watering systems.
- Installing mechanical ventilation to control airborne contaminants and air temperature/humidity.
- Isolating access to moving parts of plant and equipment.
- Guiding the working platforms and material.
- Avoiding overfilling material kibbles and cleaning kibbles before lifting.
- Closing shaft doors before tipping, and.
- Cleaning the spillage off doors, stage and steelwork.

2.1.5 Trench excavation

An excavation in which material removal forms a narrow opening in the ground. Unlike large excavations, a trench is generally deeper than it is wide.

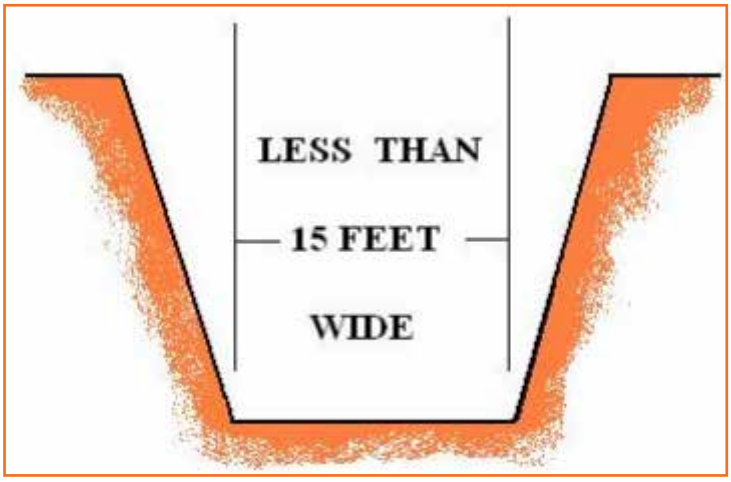

Fig: 2.1.7 Trench

Trench excavation means an open excavation in any material of whatever nature encountered for trenches into which pipes are to be laid or pipe appurtenances constructed. The pipe specified herein shall mean pipe made out of any kind of materials and for whatever purposes.

Parts of a trench

- **Wall (face, sides):** The sides of the trench.
- **Bottom (base, floor):** The bottom of the trench.
- **Spoil:** The pile of excavated earth that was removed to form the trench. The leading edge of this pile is called the toe.

- **Surcharged load:** Any weight on top of the surface of the soil, which would add extra stress to the walls of the trench. Spoil piles, backhoes, rocks, vehicles, buildings, or other loads placed near the trench opening would be surcharge loads.
- **Bedding:** A material that is usually placed around a pipe prior to backfilling. In most cases, bedding is gravel, sand, or fine crushed rock, and it extends from 5 inches below the pipe to 6 inches above the pipe.

2.1.5.1 Shape of the trench

The shape of a trench is determined by: Purpose of the trench.

The type of soil the trench is being dug in:

- The size of pipe or conduit that is going into the trench.
- Availability of shielding or shoring.
- Location of buildings, utilities, etc.
- Location of the trench (roadway, open field, etc.).
- Conduit loading requirements.

Specific trench shapes include:

- **Straight trench:** A trench where the sides are parallel and at right angles to the base. Straight trenches are usually used in areas where there is limited surface area to disturb, such as a roadway or near buildings. Protection systems such as shoring or trench boxes would be required.
- **Sloped trench:** A trench where the sides have been angled to prevent cave-in. The angle of the

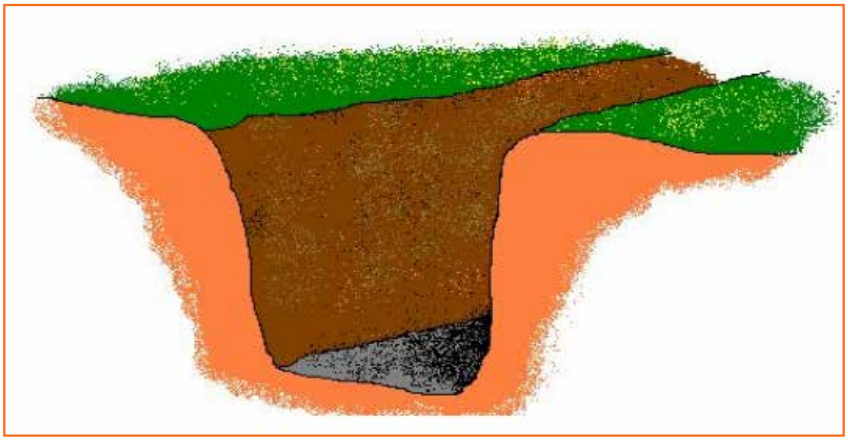

Fig: 2.1.8 Straight Trench

slope is determined by the soil type, trench depth, and in some cases, the time that the trench will remain open. This type of trench is common on new construction sites where disturbing a wider path of soil is not a problem or where other protection systems are not available. It may also be used when placing large pipes or culverts. Vertical side lower portion type trenches employ sloping and shielding.

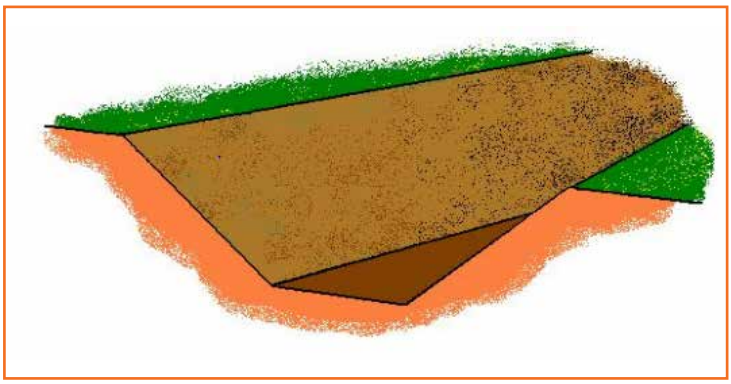

Fig: 2.1.9 Sloped Trench

- **Benched trench:** A trench where the sides have been cut away to form steps. Vertical distances (height of step) are determined by soil type. Multiple bench or single bench systems can be used.

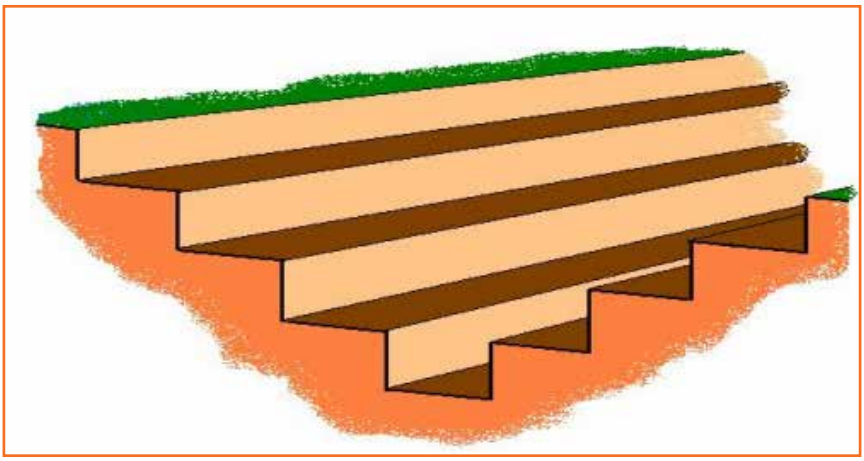

Fig: 2.1.10 Benched Trench

- **Bell bottom pier hole:** A trench which is usually used in footing placement. Its top is usually narrower than its bottom, thus giving it a bell shape in cross section. With the sides sloping inward over the floor of the hole, the possibility of collapse is much greater than in other styles of trenches. Additional protection systems are required for those who work in this type of excavation.

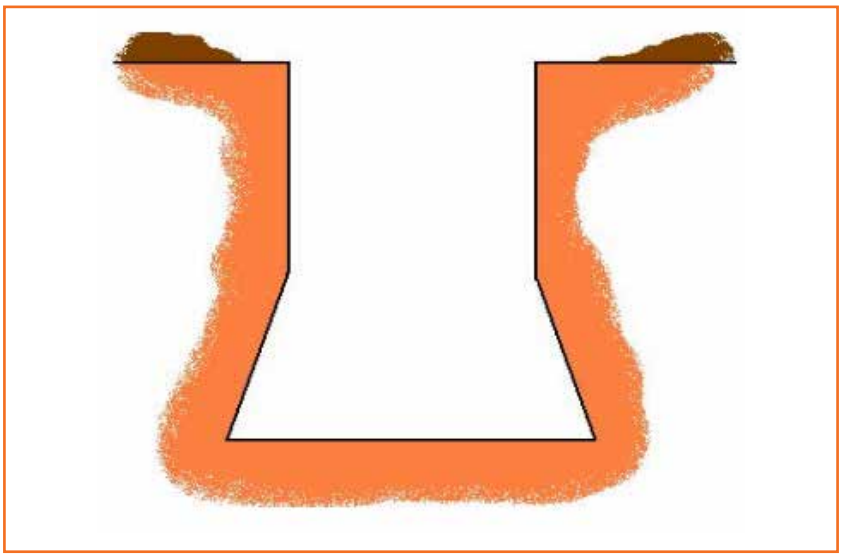

Fig: 2.1.11 Bell bottom pier hole

2.1.5.2 Trench excavation methods

The main methods of the execution of trenches are: Conventional methods: excavators +/- rock breakers

- Drill & blast.
- Trenching Although the most appropriate method depends on the terrain, lithology, etc., trenching turns out to be the most efficient system in most cases.

Drill & blast	Hydraulic rock breakers and backhoes (+/- ripping)	Chain trenchers
Application • In very strong, abrasive, massive rock. • Not suitable for rock masses composed of small, loose blocks. • Relatively easy to set up and execute. • Backhoes and dump trucks required to remove blasted material. • Particularly useful on steep slopes.	**Application** • In rock masses composed of small, loose blocks. • Not suitable in very strong, abrasive, massive rock. • Easy to set up but can be very time consuming. • Useful for tight curves. • Useful where the ground changes from soil to rock over short distances.	**Application** • In weak to strong rocks. • Generally not economic in very strong, abrasive, massive rock. • Unsuitable for rock masses containing loose cobbles and boulders or those containing pockets of wet clay. • Larger machines require considerable lateral working space and operate most efficiently over long distances in relatively homogeneous rocks.
Excavation effects • Significant over-excavation effect. • Very irregular, possibly unstable trench walls and floor. • Side-cast spoil causes ecological damage and increases risk of sediment release to watercourses. • Alternatively, spoil transported to temporary or permanent disposal sites.	**Excavation effects** • Moderate over-excavation. • Irregular trench walls and floor. • Side-cast spoil may cause ecological damage locally. • Some spoil may have to be transported to temporary or permanent disposal sites.	**Excavation effects** • Minimal over-excavation. • Regular trench walls and floor. • Spoil is deposited in a continuous windrow alongside the trench. • Where space is limited, spoil must be discharged to dump trucks and transported to temporary sites for processing: no side-cast spoil.

Security issues	Security issues	Security issues
• Potential restrictions on use of explosives. • Cannot be used in buit-up areas or in proximity to utilities, structures and other pipelines.	• Suitable for use in built up areas or in • Proximity to utilities, structures and other pipelines	• Smaller machines. • Suitable for use in built-up areas or in proximity to utilities, structures and other pipelines.

Examples of rock type	Appropriate trenching method	Chain trencher tooth wear	Potential reuse of spoil
Limestone	Chain trencher	Moderate	Good to fair
Dolomite	Chain trencher	Moderate	Good to fair
Sandstone	Chain trencher	Moderate - severe	Fair
Basalt gneiss	Chain trencher (may need Hydraulic breaker for high spots)	Severe	Fair to minimal
Granite and andesite	Hydraulic breaker + backhoe blasting. Note: chain trencher economically marginal	Extreme	Fair to minimal
Chert Rhyolite	Hydraulic breaker + backhoe. Blasting	Does not apply	Minimal to zero

2.1.6 Work procedure of excavation

Work procedure for excavation at site involves understanding of centre line and excavation drawings, setting out of plan on ground, excavation of soil and removal of excess soil. Quality checks such as recording ground level and marking of reference points should be done. Excavation is the process of moving earth, rock or other materials with tools, equipment or explosives. It also includes trenching, wall shafts, tunnelling and underground. It is the preliminary activity of the construction project.

Drawings required for excavation

1. **Centreline drawing or grid line drawing:** grid line drawings represents the grids marked in numbers and alphabets whose measurements are shown for site marking out reference. These

grid lines are so aligned that the line falls on the excavation and footing.

2. **Excavation drawing:** excavation drawing represents the length, width and depth of the excavation. Excavation line is marked in dotted line.

Scope of the work for excavation

The major works done before, while and after excavation are as follows: Setting out of corner benchmarks.

- Survey for ground levels.
- Survey for top levels.
- Excavation to approved depth.
- Dressing of loose soil.
- Making up to cut off level.
- Constructing de-watering wells and interconnecting trenches.
- Marking boundaries of the building.
- Constructing protection bunds and drains.

Working procedure of excavation

- The first and primary step involved in the excavation is to find out the extent of soil and clearing of site is of unwanted bushes, weeds and plants.
- Setting out or ground tracing is the process of laying down the excavation lines and centre lines etc. On the ground before the excavation is started.
- Maximum of 4 and minimum of 2 benchmarks are marked in the corner for the measurement of level. These benchmarks are marked on permanent structures like, plinth, road or tree.
- The tracing is marked by lime powder.
- With the reference of drawing and benchmarks the depth of the excavation is fixed.
- Excavation is done by manual or machine means depending on the availability.
- The excavated soil is to either removed out the site or stocked around the excavation pit. Minimum of 1m distance must be maintained between the stocking of excess soil and pit, so that due to rain or other forces the soil should not sweep into the pits.
- Dressing of excavated pits is to be done as specified in the drawings.
- If the site is located in loose soil area, proper shoring must be done to hold the loose soil.
- Construction of de-watering wells and interconnecting trenches are to provide if needed.
- All the sides of the building must be sealed for the safety propose.

Removal of excess soil

Estimate the excavated stuff to be re-utilized in filling, gardening, preparing roads, etc. As far as possible try to carry excavation and filling simultaneously to avoid double handling. Select and stack the required material in such a place that it should not obstruct other construction activities. The excess or unwanted material should immediately be carried away and disposed off.

Quality checks for excavation

- Recording initial ground level and check size of bottom.
- Disposal of unsuitable material for filling.
- Stacking suitable material for backfilling to avoid double handling.
- Strata classification approval by competent authority.
- Dressing bottom and sides of pits as per drawing with respect to centreline.
- Necessary safety measures observed.

Quality checks for filling

- Recording initial ground level.
- Sample is approved for back filling.
- Necessary marking/ reference points are established for final level of backfilling.
- Back filling is being carried out in layers (15cm to 20cm).
- Required watering, compaction is done.
- Required density is achieved.

2.1.7 Pipeline installation

Proper pipeline installation involves much more than just covering up the pipe. A buries pipe is a structure that incorporates both the properties of the pipe and the properties of the soil surrounding the pipe. The structural design of a pipeline is based on certain soil conditions, and construction control is important to ensure these conditions are met.

There are two basic types of pipe, rigid and flexible. Rigid pipe must be supported on the bottom portion of the pipe. Flexible pipe must be supported on both the bottom and on the sides of the pipe.

Proper soil support of the pipe is critical to the performance of both types of pipe, and proper inspection of pipe installation is essential in obtaining the required support.

Soil inspection

Inspection for proper soil support involves checking the:

- Adequacy of soil in trench walls and foundation.
- Type of soil used for bedding, embedment, and backfill.
- Distribution of soil around pipe.
- Density of soil around pipe.
- Deflection of flexible pipe.

In general, installation requirements are different for each of the following cases:

- Rigid pipe.
- Flexible pipe.

- 250-Mm (10-inch) diameter pipe and smaller.

1. **Rigid pipe:** Rigid pipe is designed to transmit the backfill load on the pipe through the pipe walls to the foundation beneath the pipe. The pipe walls must be strong enough to carry this load.

   A line load at the top and bottom of a pipe is the worst possible loading case. If the load can be distributed over a large area at the top and at the bottom of the pipe. The pipe walls will not have to be designed as strong as for a line load. The backfill load is normally well distributed over the top of the pipe. However, proper pipe support must be constructed on the bottom of the pipe to distribute the load.

   Proper soil support under the bottom of the pipe is also necessary to maintain grade (elevation) of the pipe. Continuous, uniform support under the pipe prevents unequal settlement of the pipeline.

   If a rigid pipe is overloaded, or if the load is not distributed around the pipe, a rigid pipe will fail by cracking.

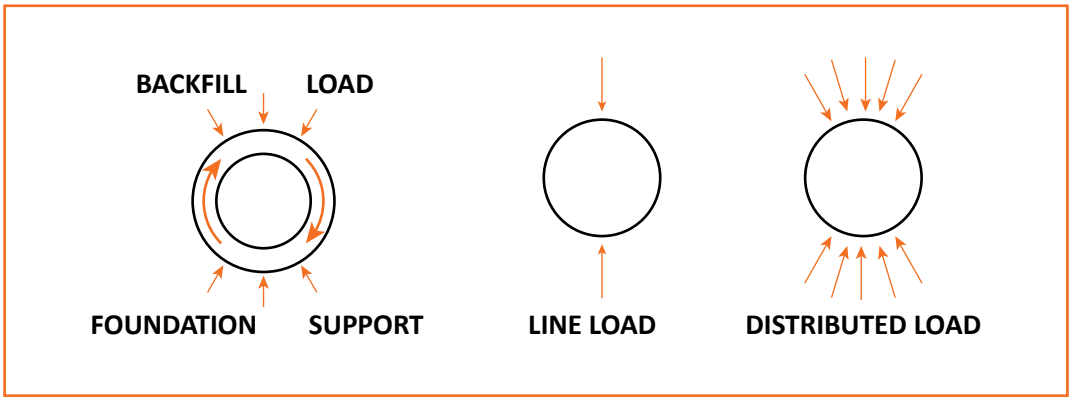

Fig: 2.1.11 Rigid Pipe

Types of rigid pipe

- Reinforced concrete pipe.
- Ductile iron pipe 500 mm (20 inch) in diameter and smaller.
- Reinforced concrete cylinder pipe.

2. **Flexible pipe:** Flexible pipe is designed to transmit the load on the pipe to the soil at the sides of the pipe. As the load on the pipe increases, the vertical diameter of the pipe decreases and the horizontal diameter increases. The increase in horizontal diameter is resisted by the soil at the sides of the pipe. The soil must be strong enough so the pipe does not deflect significantly. The allowable amount of deflection varies according to the type of pipe, and ranges from 2 to 7.5 Percent.

Deflection is expressed as a percentage and is calculated from the following equation:

$$\text{Percentage Deflection} = \frac{\text{Change in Diameter}}{\text{Original Diameter}} \times 100$$

A 1-inch deflection in a 36-inch-diameter pipe would be almost 3 percent

$$\text{Percentage Deflection} = \frac{1 \text{ in}}{36 \text{ in}} \times 100 = 2.8 \text{ Percent}$$

Adequate soil support on the sides of the pipe is essential for proper performance of the pipe. Over deflection of the pipe can cause the pipe to collapse or cause cracking in protective coatings and linings of metal pipe that would result in corrosion failures.

Proper soil support on the bottom of the pipe is also necessary to maintain the grade of the pipe and to provide uniform support.

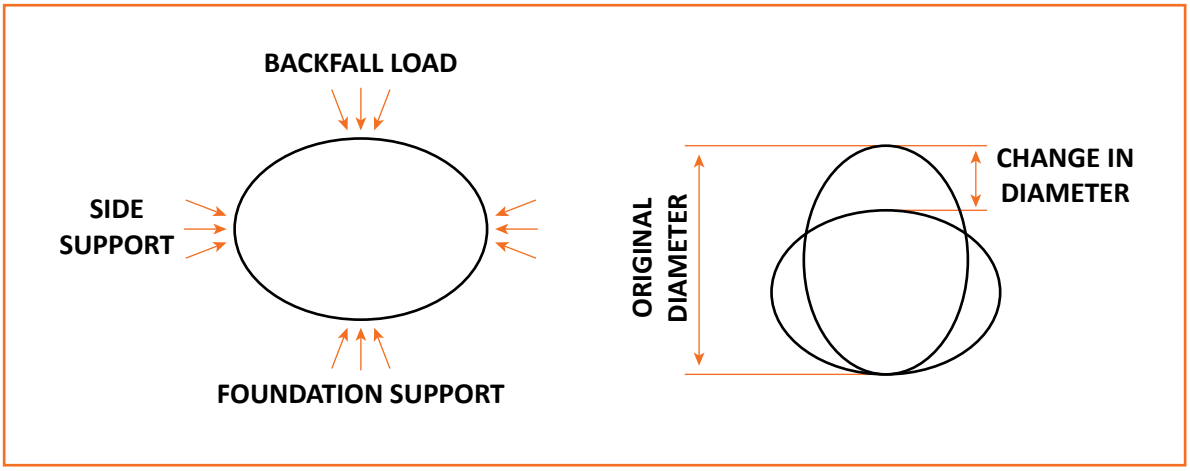

Fig: 2.1.12 Flexible Pipe

Types of flexible pipe

- Steel pipe.
- Pre tensioned concrete cylinder pipe.
- Ductile iron pipe 600 mm (24 in) and larger.
- CMP (corrugated metal pipe). Steel or aluminium.
- Fibreglass pipe.
- Polyvinyl chloride (PVC) pipe.
- Polyethylene (PE) pipe.

Installing a pipeline

Installing a pipeline is much like an assembly line process, with sections of the pipeline being completed in stages. First, the path of the pipeline is cleared of trees, boulders, brush, and anything else that may prohibit the construction. Once the pipeline's path has been cleared sufficiently to allow construction

equipment to gain access, topsoil from both the permanent and temporary easement is removed and stockpiled along the edge of the temporary easement, taking steps to avoid compaction during removal and stockpiling. Tops soil may also be referred to as a or AP horizon, the soil layers at the surface. On agricultural land where clearing is not necessary, topsoil removal is the first construction activity. Sections of pipes are then laid out along the intended path - a process called **"stringing"** the pipe. These pipe sections are typically from 40 to 80 feet long and are specific to their destination - that is, certain areas have different requirements for coating material and pipe thickness.

After the pipe is in place, trenches are dug alongside the laid-out pipe. These trenches are typically 5 to 6 feet deep. In certain areas, however, including road crossings and bodies of water, the pipe is buried deeper. Soil from trenching is stockpiled separately from the topsoil stockpiles, again taking steps to avoid compaction. Once the trenches are dug, the pipe is assembled and contoured. This includes welding the sections of pipe together into one continuous pipeline and bending it slightly, if needed, to fit the contour of the pipeline's path. Coating is applied to the ends of the pipes (the coating applied at a coating mill typically leaves the ends of the pipe clean, so as not to interfere with welding), and the entire coating of the pipe is inspected to ensure that it is free from defects.

Fig: 2.1.13 Stringing pipe

Fig: 2.1.13 Contouring or bending pipe to fit the contours of the landscape

Fig: 2.1.14 Pipe ready to be placed underground after contouring and welding.

Lowering the pipe into the trench

Once the pipe is welded, bent, and coated, it can be lowered into the previously dug trenches. This is done with specialized tracked construction equipment acting in tandem to lift the pipe relatively uniformly and lower it into the trench. After the pipe has been lowered into the ground, the trench is filled in carefully to ensure that the pipe and its coating do not incur damage. The last step in pipeline construction is the hydrostatic test, which consists of filling the pipe with water at pressures higher than will be needed for natural gas transportation, through the entire length of the pipe. This serves as a test to ensure that the pipeline is strong enough and absent of any leaks or fissures before natural gas is pumped through the pipeline.

Fig: 2.1.15 Lowering pipe into the trench

Fig: 2.1.156 Same section of right-of-way during construction (left) and ready for topsoil to be placed back over surface (right)

Restoring the pipeline's pathway

Once the pipeline has been installed and covered, efforts are taken to restore the pipeline's pathway to its original state, or to mitigate for any environmental or other impacts that may have occurred during the construction process. This often includes replacing topsoil, fences, and anything else (including

removing debris and reseeding) that may have been removed or disturbed during the construction process. Significant soil compaction often results from pipeline construction equipment traffic in the easement and excavation and replacement of soil. This can result in reduced crop yields on agricultural soils and reduced tree growth on forested soils for several years. Steps should be taken to minimize soil compaction throughout the construction process and to mitigate compaction during restoration. Such steps include using only low-ground-pressure construction equipment and ceasing operations when soils are wet and most susceptible to compactive forces.

After replacement of subsoil material in the trench and grading of the easement, the entire area should be deep ripped to a depth of 16 inches to loosen the exposed subsoil. On agricultural soils any rocks pulled to the surface during ripping should be collected and removed. The stockpiled topsoil should then be replaced over the easement, again taking steps to avoid compaction. The replaced topsoil should then be loosened by deep ripping to a depth of 16 inches, and, on agricultural soils, any rocks brought to the surface should be collected and removed. Recovery of full productivity of agricultural soils can sometimes be accelerated by incorporating compost or manure in the topsoil.

Summary

- Excavation is the process of moving earth, rock or other materials with tools, equipment or explosives. It includes earthwork, trenching, wall shafts, tunnelling and underground.
- Before the excavation and heavy earthworks process can begin, the site must be carefully examined to make sure that the natural habitat and artefacts surrounding it are persevered throughout the excavation process.
- Excavators (also known as 'diggers') are one of the most versatile pieces of excavation equipment available. This is the machine most often associated with excavation projects.
- There are several types of excavators, including:
  - Spider excavator
  - Swamp excavator
  - Zero swing excavators
- A grader is a piece of equipment with a long blade, used primarily for flattening and smoothing surfaces. The centre and ends of each proposed excavated length shall be pegged directly above the pipeline axis.
- The Competent Person shall confirm with the Project Manager the Excavation design prior to commencing Excavation Work, and consult with the Project Manager as needed during the Excavation.
- Bulldozers, scrapers, excavators and other types of earthmoving equipment are commonly used for either preparing work areas prior to trenching or for the trenching work itself.
- Safe tunnel construction depends on adequate pre-construction engineering investigation of the ground and site and accurate interpretation of the information obtained.

- Shafts are often constructed to provide access or ventilation to a tunnel. Comparatively shallow shafts can be sunk for investigating or constructing foundations, de-watering or providing openings to underground facilities.
- Trench excavation means an open excavation in any material of whatever nature encountered for trenches into which pipes are to be laid or pipe appurtenances constructed.
- Parts of a trench:
  - Wall
  - Bottom
  - Spoil
  - Surcharged Load
  - Bedding
- Purpose of the trench
- **The type of soil the trench is being dug in:**
  - The size of pipe or conduit that is going into the trench
  - Availability of shielding or shoring
  - Location of buildings, utilities, etc.
  - Location of the trench (roadway, open field, etc.)
  - Conduit loading requirements.
- The first and primary step involved in the excavation is to find out the extent of soil and Clearing of site is of unwanted bushes, weeds and plants.
- Proper pipeline installation involves much more than just covering up the pipe. A Buries pipe is a structure that incorporates both the properties of the pipe and the properties of the soil surrounding the pipe. The structural design of a pipeline is based on certain soil conditions, and construction control is important to ensure these conditions are met.

Exercise

1. Excavation is the process of moving ..... with explosives.
   a. Earth (Ans)
   b. Soil
   c. River
   d. Dust
2. Which of the following include in the excavation process?
   a. Dressing the loose soil
   b. Setting out corner benchmarks
   c. Making boundaries of the building
   d. All the above

3. ..... involves the removal of the exposed layer of the earth's surface.
    a. Topsoil Excavation
    b. Earth Excavation
    c. Muck Excavation
    d. Rock Excavation
4. ..... involves the removal of the layer of soil directly beneath the topsoil.
    a. Rock Excavation
    b. Earth Excavation
    c. Unclassified Excavation
    d. Muck Excavation
5. ..... is the removal of excessively wet material and soil that is unsuitable for stockpiling.
    a. Topsoil Excavation
    b. Rock Excavation
    c. Muck Excavation
    d. Earth Excavation
6. Which excavator is designed to work on all types of terrain, such as steep inclines and narrow ditches?
    a. Spider excavator
    b. Swamp excavator
    c. Zero swing excavators
    d. All the above
7. Bulldozers are made for pushing large quantities of soil, sand and other materials. (True/False)
8. The skid steer is a compact machine used primarily for digging. (True/False)
9. Which of the following are common hazards and risks in tunnel construction?
    a. Ground gas and water in-rush
    b. Noise
    c. Vibration
    d. All the above
10. The shape of a trench is determined by which of the following factor?
    a. Availability of shielding or shoring
    b. Conduit loading requirements
    c. Location of buildings, utilities, etc.
    d. All the above
11. What is Trenching?

    .....

Unit 2.2 - Maintain safety during excavation

Unit Objectives

At the end of this unit, the participant will be able to:

1. Identify about the safety precautions in excavation.
2. Identify about the personal protective equipment.
3. Identify about the safety signs.

2.2.1 Safety precautions in excavation

Excavation work involves the removal of soil or a mixture of soil and rock, and even some of the most experienced workers have been trapped, buried and injured in an excavation due to:

- Collapse of the sides or by external material falling in to the excavation or workers falling into the excavation.
- Unsafe access and insufficient means of escape in case of flooding.
- Vehicles driven into or too close to the edge of an excavation, particularly while reversing, causing the sides to collapse.
- Asphyxiation or poisoning caused by fumes heavier than air entering the excavation, e.g. Exhaust fumes from diesel and petrol engines.
- Due to insects, leeches, vermin, snakes and poisons plant present in soil.
- Avoiding use of personal safety equipments and not providing fence and guards and warning signals.

It is quite necessary for the workers and officials to be aware about the various safety precautions to be adopted during excavation work.

Safety precautions

Checklist in the form of do's and don'ts for safety precautions as per is 3764:1992 (excavation work- code of safety) to be adopted when the depth of trench is more than 1.5m is:

- Supervisor in charge should be competent person with adequate knowledge of safety rules.
- Complete information on the underground structures (such as water pipelines, sewers, gas mains, electrical conduit system and other civic facilities) should be taken.
- No excavation or earthwork below the level of any foundation of building or structure shall be commenced or continued unless adequate steps are taken to prevent danger from collapse of the structure or fall of any part thereof.
- Sides of excavation should be inspected by supervisor during the course of excavation from time to time and after every rain, storm or other hazard increasing occurrence and protection against slides and carvings should be increased and recorded.
- Safety helmets shall be worn by all persons entering trench where hazards from falling stones,

timber or other materials exist.

- Appropriate safety footwear (rubber boots, protective covers, etc.) Shall be worn by workers/ employees who are engaged in work requiring such protection.
- Only qualified man should be permitted to do work.
- Proper precautions should be taken to prevent accident to the workmen engaged in excavation work and calamities for the general public.
- Proper lighting arrangement and warning signal and boards should be displayed.
- First aid facilities like a first-aid kit should be maintained at the site of work.
- First aid kit should be kept at a conspicuous place in the charge of trained person(s).
- The kit should be recouped periodically.
- Nearby medical facilities available should be paint on notice board.
- Visitors would not permitted to enter the scene of excavations unless they are accompanied by a supervisor or foreman.
- Excavation areas shall be adequately lighted for night work.
- The vertical sides should be shored and the shoring shall extend at least 30 cm above the vertical sides.
- The side of the excavation or trench should be sloped or battered back to a safe angle of repose, usually 45 degree or be supported by timbering or other suitable means to prevent collapse.
- All trenches in soil more than 1.5m deep and all trenches in friable or unstable rock exceeding 2m in depth should be securely shored and timbered.
- Material used in shoring and timbering as per the code is:3764:1992 (excavation work-code of safety).

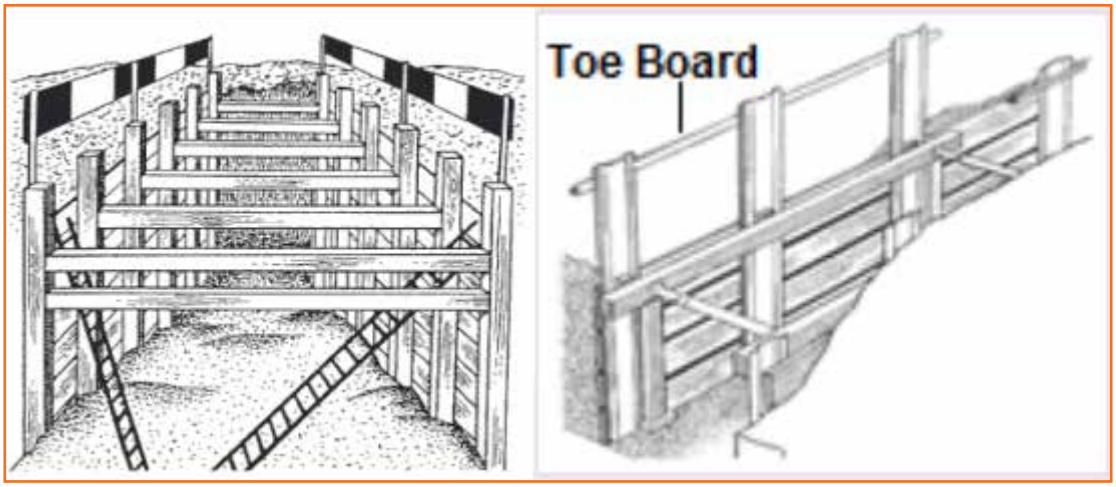

Fig: 2.1.16 Safety Precaution in Excavation

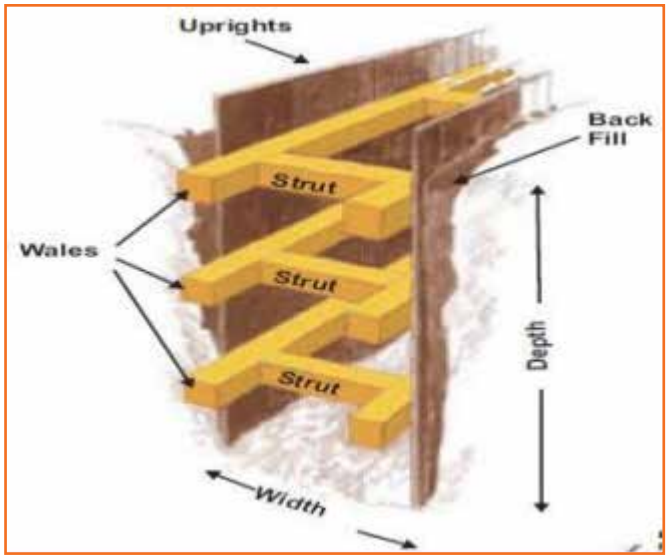

Fig: 2.1.17 Excavation Diagram

Do's:

- When open space seating is used a toe board should be provided to prevent material rolling down the slope and falling into the part of the trench with vertical walls.
- Shoring and timbering shall be carried along with the opening of a trench but when conditions permit, protection work, such as sheet piling may be done before the excavation commences.
- All loose stones, earth, unstable material which might come down on the workers in the trench shall be either removed or the excavated sides adequately braced.
- Do provide a clear berm of a width of not less than one third the final depth of excavation or as required by design.
- In special cases, where the disposal area is limited or where the application of this requirement is impracticable, the person in charge may adopt a berm of reduced width in any case not less than 1m provided the material being excavated is sufficiently stable and the shoring is designed to carry the additional load. In all such cases substantial toe-boards should be provided to prevent 'roll backs' into the trench.

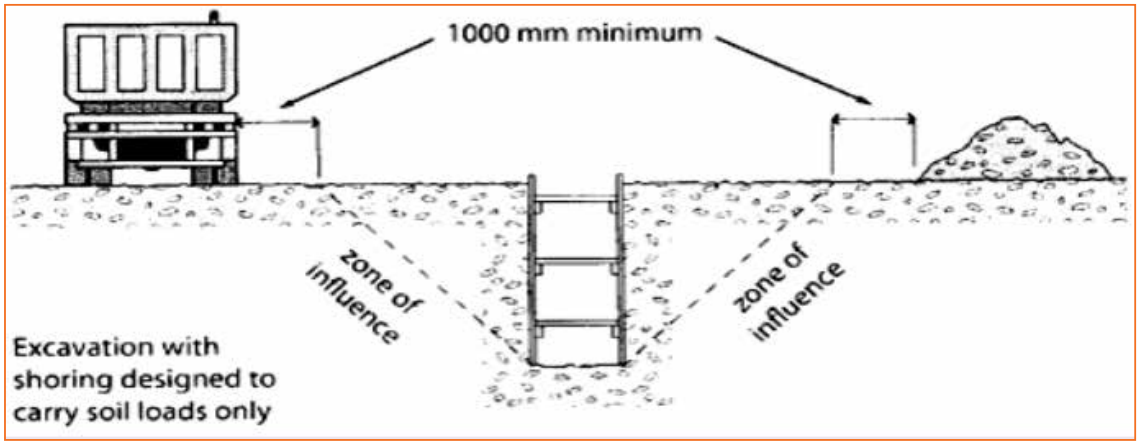

Fig: 2.1.18 Excavation Diagram

- Tools or material, such as wheel barrows, shovels, picks, tile, cement and lumber, far enough from the edge of the trench to prevent their being inadvertently knocked into the trench.
- The use of power shovels or drag lines in a trench, because of his violent thrust or blows delivered, rapidly renders the banks of the trench unstable and dangerous to people working nearby. These conditions shall be watched for and suitably remedied or eliminated.
- Heavy equipment, such as excavating machinery and road traffic shall be kept back from the excavated sides at a distance not less than the depth of trench or at least 6 metre for trench deeper than 6 metre.
- Adequate and well anchored stop block shall be provided on the surface to prevent operating vehicles from falling accidentally into excavation pit. Stop block should be kept at distance not less than the depth of trench (d).

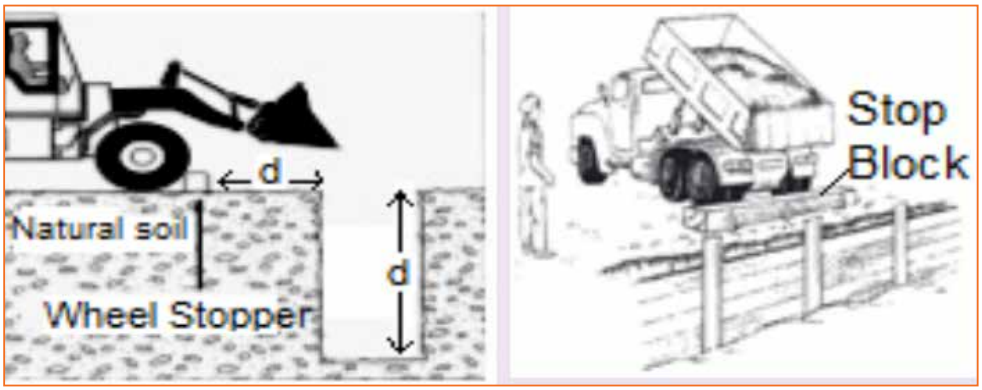

Fig: 2.1.19 Stop block

- The workmen shall be adequately spaced to avoid being accidentally struck by tools of fellow workmen.
- Pathways shall be non-slippery and shall be of adequate width not less than 75 cm and strong enough.
- Gangways should be of proper construction and adequate width. If planks are used, they shall be laid parallel to the length of gangway and fastened together against displacement.
- Planks should be uniform in thickness and shall be provided with cleats to ensure safe walking
- Gangways shall be kept clear of excavated material or other obstruction.
- Wherever pathways and gangways are suspended, these should have guard rails and side supports on both sides to prevent fall of workmen into the excavation.

Fig: 2.1.20 prevent fall of workmen into the excavation

- Ladders shall extend at least one metre above the top of the cut.
- Excavations shall have at least one ladder per 15m of length in case of hazardous work and per 30m of length in case of less hazardous works.
- Every part of a trench, in public areas, fences, guards or barricades shall be provided to prevent any accidents.

Fig: 2.1.21 barricades and signs

- Excavation areas shall be adequately lighted for night work. During the hours of darkness all public sidewalks and walkways shall be adequately illuminated and warning lights shall be placed in proper sites to ensure safety of pedestrians and the vehicular traffic.
- At all approaches and exits of the sites of excavations, danger and warning signals shall be placed. In busy or otherwise risky locations a flagman with a red flag shall be posted to warn the public and the approaching trucks and to guide them in proper direction.
- At every part of a trench likely to be frequented by public, suitable warning signal/red light to prevent a person from falling into the trench shall be provided and maintained in place at all times.
- When a workman is required to enter a hazardous trench, a safety rope shall be securely tied to the safety belt worn by him, so that, if necessary he may be assisted. Or drawn to safety.
- Ensured that no harmful gases or fumes were present in the trench.
- If such gases were present, provide mechanical ventilation to protect the health and safety of persons working in the trench.
- If mechanical ventilators are not adequate, provide respiratory protective equipment.

Fig: 2.1.22 Gas Mask

- Protection against hazards involving insects, vermin, leeches, snakes, and poisonous plants shall involve following precautions.
  - □ The poisons plants shall be removed or destroyed.
  - □ Appropriate protective clothing, gloves, boots, hoods, netting, masks, or other necessary

personal protection shall be taken

Fig: 2.1.23 Safety Shoes, Gloves and First Aid Kit

- □ Repellents.
- □ Drainage or spraying of breading areas.
- □ Burning or destruction of nests.
- □ Use of smudge pots for protecting small areas.
- □ Elimination of unsanitary conditions which propagate insects or vermin's.
- □ Extermination measures against rodents.
- □ Fumigation.
- □ Inoculation.
- □ Approved first-aid remedies for the affected.
- □ Protective ointments shall be provided.
- □ Soap and wafer shall be available for washing exposed parts.
- □ Immunization treatments, where applicable.

- An overhang is generally made up of overburden frozen or cemented gravel, sand, boulders etc. Which is just out from the trench wall or may be part of wall which is standing less perpendicular position shall be removed before further material is taken from that part of the trench where they occur.
- In any trench where such methods have been followed, the cavities left shall be eliminated by cutting back the bank slope before removing any further material from the section of the trench.
- A suitable shelter at a safe location should be provided for workmen to have their lunch and find shelter from sudden storms.
- Foundations, adjacent to and below which excavation is to be made, shall be supported by shoring, bracing or underpinning as long as the trench remains open.
- All trenches over which men or equipment are required to cross shall be provided with walk-ways or bridges. Where the trenches are more than 2m deep guard rails shall be provided.

Don'ts

- Should not be permitted to workmen one above the other on steep slopes.

- Location of stockpile should not obstruct the easy access.
- Should not locate the stockpiles in the immediate vicinity of overhead power lines.
- Materials should not be piled against walls as this may endanger the walls.
- Should not be work under the raised or suspended load.
- Should not be pile up excavated material or load on the edge of excavation, shaft, pit or opening in the ground.
- The vehicle shall not be permitted to be driven near the lip of the excavation.
- Should not forget to warn workers and others when work is in progress.
- Should not block the exists in an excavation area.
- Should not be permitted lone worker in the trench unless there is at least one worker on the ground close by on duty.
- Should not be permitted borrowing or mining
- No internal combustion engine shall be operated in a trench.
- Drilling and blasting operations should be encountered; safety precautions as laid down in 4081:1986 should be taken.
- Should not ignore the poisons plant like ivy, oak, surmac or other poisonous plants.
- Should not be avoid to use necessary protective clothing, gloves, boots, hoods, netting, masks etc.
- Avoid steep working face result in from the nature of machinery used. If steep faces, it shall be broken down to a stable slope.

2.2.2 Personal protective equipment

Personal protective equipment (PPE) is a clothing or equipment worn by workers to protect them from fire, exposure to toxic chemicals and direct impact. PPE should only be used when engineering designs and operating or maintenance practices do not provide a sufficiently safe work environment.

The need for PPE can be determined with a risk analysis, which will be structured along the following lines:

Fig: 2.1.24 Safety Face Shield

- Can the hazard be removed? If so, there will be no need for PPE.
- Can the consequences of the hazard be reduced? If so, it may be possible to work with a lower level of PPE.
- Can the likelihood of occurrence be reduced? This may not change PPE requirements, but it will reduce the chance of someone being injured.

Only when the above analysis has been completed, should consideration be given to the types of PPE to be used. A job hazards analysis (JHA) will help determine what type of PPE is needed and when and where it should be worn.

Clothing

Proper clothing will help keep acidic, corrosive, oily, dirty, or dusty materials off the body. Even if clothing with special PPE capabilities is not required, the following rules should be observed at all times and in all work site locations.

- Shorts are never permitted. Workers should always wear full-length pants (trousers) that cover the entire leg.
- Full cover shoes should always be worn. They should have non slip soles. Many companies require that shoes always have toe protection - often in the form of a steel toe cap.
- Hard hats should always be worn.

Fig: 2.1.25 Protective Cloth (PPE)

The effectiveness of clothing with regard to safety and health is affected by the following three factors:

- **Insulation:** high insulation is generally desired in cold weather and not wanted when temperatures are high.
- **Permeability:** this is the measure of the resistance to water vapour movement throughout the clothing.
- **Ventilation:** the ability of ambient air to move throughout the fabric itself or through garment openings.

Flame-resistant clothing

If normal clothing catches fire, it will continue to burn even if the ignition source is removed or if the affected worker moves away from the fire. Flame-resistant material self-extinguishes on removal of the ignition source. Clothing made of flame-resistant material is known as flame-resistant clothing (FRC), which will not continue to burn in such situations, nor will it melt like some synthetic fabrics.

It is used to make coveralls, lab coats, and fire hoods, and is now routinely worn by workers on process facilities at all times. It is also worn by workers who come in contact with energized electrical equipment.

Impervious clothing: impervious clothing provides protection from splash and should be worn during jobs where it is possible to come in contact with highly acidic or corrosive materials.

Such jobs may include the following:

- Breaking lines.
- Opening equipment.
- Jobs where liquid materials could splash or spray.

Workers wearing impervious clothing are more likely to suffer from heat stress.

Laboratory clothing: the clothing requirements for laboratory work will depend on the materials being handled.

Laboratory workers often handle hazardous chemicals directly; therefore, they will often be required to wear coats, goggles, and chemical-resistant gloves.

Emergency PPE

Emergency responders need specialized PPE in order to fight fires and to enter areas that may be contaminated with toxic chemicals.

Fire fighter protective clothing: fire fighter protective clothing, sometimes referred to as bunker gear, is worn by all members of fire teams and helideck fire guards. (Only those who are properly trained should wear this type of clothing.) Its use is required for those fighting fires beyond the incipient stage.

The type of clothing will vary according to the local environment. However, the following should be the minimum requirements:

- Fire helmet with clear visor (safety helmets are not required).
- Fire coat and/or leggings. The coat should be of knee length.
- Insulated fire boots - at least calf height with non-slip sole tread and reinforced safety toe cap.
- Safety gloves.
- Self-contained breathing apparatus (SCBAs) for entering smoky areas.

Fire fighter clothing should not restrict the person's movements. It should also be stored such that it cannot be contaminated or affected by heat, sunlight, or dampness.

Proximity suits: heat-reflecting proximity suits are used by properly trained persons for taking actions such as closing a critical valve that is located close to a fire that has not yet been extinguished. On many offshore platforms, at least one person wearing a proximity suit will be on the helideck when helicopters are landing and taking off.

Fire entry suits are used for entering flame areas but only for precise snatch rescue work where the casualty location is known and not for fire fighting under any circumstance.

Respiratory protection

Although every attempt should be made to make sure that workers are never exposed to toxic or harmful vapours, there will be times when some form of respiratory protection is needed, if only as a precaution.

- Fixed breathing air systems - respiratory protective equipment should be used in areas that do not have a safe breathing environment, or where there is the possibility of an unexpected release

of toxic gas or particulates.

When respirators are used in atmospheres where the concentration of toxic gases could approach the immediately damaging to life and health (IDLH) level, standby personnel carrying SCBA should be present, along with suitable rescue equipment such as harnesses and hoists.

Respirators - the five most widely used types of respirator are as follows:

- **Air-purifying respirators:** Air-purifying respirators contain material that traps and purifies the air that the worker is breathing. They can trap either solid materials (particulates or dust) or toxic gases depending on the material used in the filter. Respirators of this type can be single or multiple use (replacement cartridges are put into the respirator for multiple use). In general, respirators in this category do not provide a high level of protection and should not be used when the concentration of toxic gas is close to IDLH (immediately dangerous to life or health).
- **Supplied air respirators:** Supplied air respirators are connected via a hose to a supply of air. The air can come from a compressor or from cylinders. (If a compressor is used, it is essential that the air supply cannot become contaminated by fumes in the area.) Respirators of this type are safer than any type of system that purifies air because they do not rely on trapping or containing hazardous chemicals.
- **Self-contained breathing apparatus (SCBA):** SCBAs are similar to supplied air respirators except that the air is supplied from a cylinder, usually carried by the worker. They are used for short-duration tasks, emergency rescue, escape, and process control procedures. The air supply is generally rated for 30 minutes, but this time is reduced if the work being performed is strenuous.

  SCBAs should be inspected before each use; emergency units should be inspected at least monthly.
- **Chemical canister re-breathers:** Chemical canister re-breathers are used only for emergency egress. The canister contains a special chemical that evolves as oxygen when contacted by the moisture and carbon dioxide in exhaled breath (the co2 and moisture are retained).

  They are suitable for high concentrations of contaminants and oxygen deficient atmospheres, but they are negative-pressure respirators that rely upon a perfect face-to-mask seal, which limits their use to emergency situations only.
- **Disposable respirators:** These are intended for single use. They are primarily used for protection against nuisance dusts and non-toxic particles.

Use of respirators

Before using a respirator, the following checks should be carried out:

- The respirator should be checked for correct fitness before every use.
- Employees should not wear items such as facial hair or eyeglasses that could prevent a good seal. Employees who wear prescription glasses while working should be provided with specially designed units.
- All respirators should be inspected before each use to assure all parts are present and in good working order. There should be no cracks in the rubber or lenses and head straps should be

properly elastic. Hoses should be checked by being stretched and then looking for cracks.

- A check for leaks should be carried out by covering the mask with the palms of the hands and then inhaling gently. If the mask is pulled toward the face then the fit is good. The leak check is particularly important for negative pressure respirators.
- The pressure in SCBA tanks should be as specified. The regulator pressure should be about the same as that of the cylinder. The low-pressure alarm should be checked.

Head protection

Hard hats/helmets protect the head from impact and penetration from falling or flying objects, overhead spills of hot or hazardous liquids, and electric shock.

They should be worn at:

- Construction sites.
- When near lifting operations or overhead work.
- All process plant areas.

Fig: 2.1.26 Safety Hamlet

Hard hats are made of rigid plastic, sometimes with a mid line reinforcement ridge. Different styles are available (those made in the form of a traditional cowboy hat are often not permitted on process facilities).

Inside the helmet is a suspension that spreads the helmet's weight over the top of the head and that also provides a space of approximately 30 millimetre between the helmet's shell and the wearer's head so that if an object strikes the shell, the impact is less likely to be transmitted directly to the skull. The suspension generally has an adjustment knob or strap so that the hat can be used for different head sizes.

Hand protection

Gloves should be worn when hands are exposed to hazardous substances or to sharp, rough, or hot objects. The following types of glove are used:

- Leather palm gloves are often worn when carrying out heavy duty work. They resist heat, sparks, sharp, and rough objects, and provide some cushioning against blows, but they provide minimal protection from hydrocarbons and liquids.
- Impervious gloves are made of materials such as neoprene, PVC, or nitrile. They are used when handling hydrocarbons or corrosive chemicals such as acids and caustic.
- Gauntlet-type gloves, which extend above the cuff and protect the wrist and forearm, should be worn when there is a possibility of splashing.
- Cotton gloves protect against dirt and abrasion but are not heavy enough for use with rough or sharp materials.
- Latex gloves provide for maximum dexterity but provide limited protection.
- They are used in light service, such as laboratory work and to keep oil, grease, and liquids off the skin.

- Welders gloves are made from treated leather that provides protection against heat, welding sparks, splatter, and hot slag.
- Insulated gloves are used in laboratories for handling distillation pots and other hot objects.
- Electrician gloves protect against electrical shock.

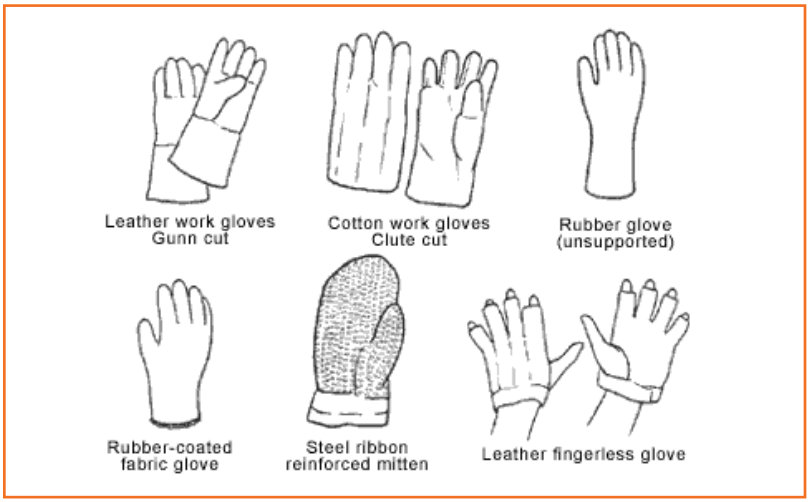

Fig: 2.1.27 Safety Gloves

Foot protection

Shoes used in process facilities should be notched or grooved to prevent slipping on oily or wet surfaces. They should also have a heel to assist with climbing ladders. Boots or shoes with steel toe caps should be used when a dropped object could crush a person's foot.

The following guidelines should be considered:

- Soles should be notched or grooved to prevent slipping on oily or wet surfaces.
- Boots or shoes should have oil-resistant soles and a heel.
- Rubber boots or overshoes can be worn to protect the feet and shoes from excessive water, oil, muck, or corrosive material.

Footwear of the following types should not be worn:

- Tennis and deck styles.
- Deep lug and hiking style soles.
- Crepe soles.
- Smooth leather soles.
- Western style or narrow throat boots.
- Lace-up and zipper style boot higher than 8 inches.
- Slip-on boot higher than 12 inches.

Fig: 2.1.28 Safety Shoes

Eye protection

- Eye protection should be used when there is a reasonable probability of eye injury.
- Employers must ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapours, or potentially injurious light radiation.
- Employers must ensure that each affected employee uses eye protection that provides side protection when there is a hazard from flying objects.
- Detachable side protectors (e.g., Clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable.
- Employers must ensure that each affected employee who wears prescription lenses while engaged in operations that involve eye hazards wears eye protection that incorporates the prescription in its design or wears eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.
- Employers must ensure that each affected employee uses equipment with filter lenses that have a shade number appropriate for the work being performed for protection from injurious light radiation.

Safety glasses

In general, safety glasses should be worn whenever a person is working outside at a process facility, working indoors with hazardous chemicals, and in most non office work areas. Prescriptive lenses must comply with the overall safety glass policy.

Chemical goggles

Chemical goggles protect against splashing liquids, flying solids, and other harmful materials. Examples of work that may require chemical goggles are the following:

- Light chipping.
- Dusty work.
- Cutting wire.
- Using grinders.
- Handling mineral wool or fibreglass.
- Handling hazardous liquids.

2.2.3 Signs

Signs are widely used throughout the process industries to advise people of hazardous conditions and to provide directions as to what actions to take in various situations. It should, however, be remembered that **"red lights don't stop cars - brakes stop cars"**; it is always best to engineer a solution to a hazard than to warn people about that hazard.

Training programs should include an explanation of the signs that are used by the company.

Where possible signs should be symbolic only, i.e., They should not contain wording. This policy reduces problems communicating with an international workforce. However, some signs that use symbols only can be confusing. For example, the **"falling rock"** sign would appear to warn against rocks falling on vehicles. In fact, it is more to do with the fact that fallen rocks may be on the roadway. If supplemental wording is necessary, then all the languages that are typically used at the site should be included.

Types of sign

Guidance as to the types of signs and their meanings is provided in the following sections.

Fig: 2.1.29 Prohibition Sign

Prohibition

Prohibition signs mean **"you must not"** or **"do not do. . .,"** Or **"stop."** Signs of this type have a red circle, a white interior, and a red bar, the sign can be supplemented with more specific information.

Other examples of prohibition signs include the following:

Other examples of prohibition signs include the following:

- No smoking.
- No open flames.
- Non-potable water.
- Prohibition sign.
- Prohibition sign with information.
- Do not enter.
- Do not fish.
- Do not use crane for personnel transfer.

Mandatory action

Mandatory signs mean **"you must do. . ."** Or **"carry out this action,"** or simply **"obey."** They are often used when special PPE (personal protective equipment) is required.


Fig: 2.1.30 Mandatory sign

Other examples of mandatory signs include the following:

- Hearing protection required.
- Wash hands.
- Chock wheels.

- Ground fuel truck.
- Hard hat area.
- Doors must be kept closed.
- Goggles required.
- Face shield required.

Warning

Warning signs are yellow triangles using black lettering.

Fig: 2.1.31 Warning Sign

Other examples of warning signs include:

- H2s gas.
- Corrosive liquids.
- Radiation.
- Equipment automatic start.
- Open trenches.
- High temperature.
- Flammables.

Safe condition

A green square or rectangle indicates a safe condition, a means of escape or the location of safety equipment.

Fig: 2.1.32 Photo Luminescent Sign

Other examples of safe condition signs include:

- Emergency shower station.
- Emergency eyewash station.
- Potable water.
- Emergency shut down.
- First aid.
- Trash.

Fire safety

Red square or rectangle is to do with fire safety.

Fig: 2.1.31 Fire Exit Sign

Summary

- Checklist in the form of Do's and Don'ts for safety precautions as per IS 3764:1992 (Excavation work- Code of safety) to be adopted when the depth of trench is more than 1.5m
- Proper precautions should be taken to prevent accident to the workmen engaged in excavation work and calamities for the general public
- All trenches in soil more than 1.5m deep and all trenches in friable or unstable rock exceeding 2m in depth should be securely shored and timbered
- Shoring and timbering shall be carried along with the opening of a trench but when conditions permit, protection work, such as sheet piling may be done before the excavation commences
- Excavation areas shall be adequately lighted for night work. During the hours of darkness all public sidewalks and walkways shall be adequately illuminated and warning lights shall be placed in proper sites to ensure safety of pedestrians and the vehicular traffic
- Personal protective equipment (PPE) is a clothing or equipment worn by workers to protect them from fire, exposure to toxic chemicals and direct impact. PPE should only be used when engineering designs and operating or maintenance practices do not provide a sufficiently safe work environment.
- Gloves should be worn when hands are exposed to hazardous substances or to sharp, rough, or hot objects.
- Shoes used in process facilities should be notched or grooved to prevent slipping on oily or wet surfaces. They should also have a heel to assist with climbing ladders. Boots or shoes with steel toe caps should be used when a dropped object could crush a person's foot.

Exercise

1. The material used in shoring and timbering should be as per the which work code of safety?
    a. IS:3764:1992
    b. IS:3764:1982
    c. IS:3764:1999
    d. IS:3764:1993
2. Protection against hazards involving insects, vermin's, leeches, snakes, and poisonous plants shall involve which of the following precautions.
    a. Keeping the poisons plants
    b. Safely keeping the nest
    c. Fumigation (Ans)
    d. No protective ointments shall be provided

3. Proper ..... will help keep acidic, corrosive, oily, dirty, or dusty materials off the body.
    a. Bathing
    b. Ventilation
    c. Clothing
    d. Sleeping
4. Flame-resistant material self-extinguishes on removal of the ignition source. (True/False)
5. Which of the following are the most widely used types of respirator?
    a. Self-contained breathing apparatus (Ans)
    b. Proximity suits
    c. Fire fighter protective clothing
    d. Laboratory clothing
6. ..... are made of rigid plastic, sometimes with a mid line reinforcement ridge.
    a. Hard Hat
    b. Gloves
    c. Boots
    d. Safety Glasses
7. Identify the sign shown in the image below:
    a. Prohibition sign
    b. Mandatory sign
    c. Warning sign.
    d. Fire Exit Sign
8. Identify the sign shown in the image below:
    a. Prohibition sign
    b. Mandatory sign
    c. Warning sign
    d. Fire Exit Sign
9. Signs are widely used throughout the process industries to advise people of hazardous conditions and to provide directions as to what actions to take in various situations. (True/False)
10. What are reasons of injuries during an excavation work?
    a. Collapse of the sides
    b. Unsafe access
    c. Due to Insects
    d. All the above

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Personal protective equipment

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Types of safety signs and symbols

Notes

Notes

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3. Working effectively in a team

Unit 3.1 - Working effectively in a team

HYC/N9301

Key Learning Outcomes

At the end of this module, the participant will be able to:

1. Discuss the communication skills.
2. Define the teamwork and communication in handling patient.

Unit 3.1 - Working effectively in a team

Unit Objectives

At the end of this unit, the participant will be able to:

1. Identify importance of effective communication.
2. List out essential skills required for effective communication.
3. Identify barriers to effective communication.
4. Define how to work effectively in team.

3.1.1 Effective communication

Effective communication is a process of exchanging ideas, thoughts, knowledge and information such that the purpose or intention is fulfilled in the best possible manner. In simple words, it is nothing but the presentation of views by the sender in a way best understood by the receiver.

We can say that it generally involves;

- **Sender:** The person who initiates the process of communication by sending a message;
- **Receiver:** The one to whom the message is to be delivered.

Characteristics of effective communication

Just delivering a message is not enough; it must meet the purpose of the sender. Keeping this in mind, let us discuss the elements which make communication effective;

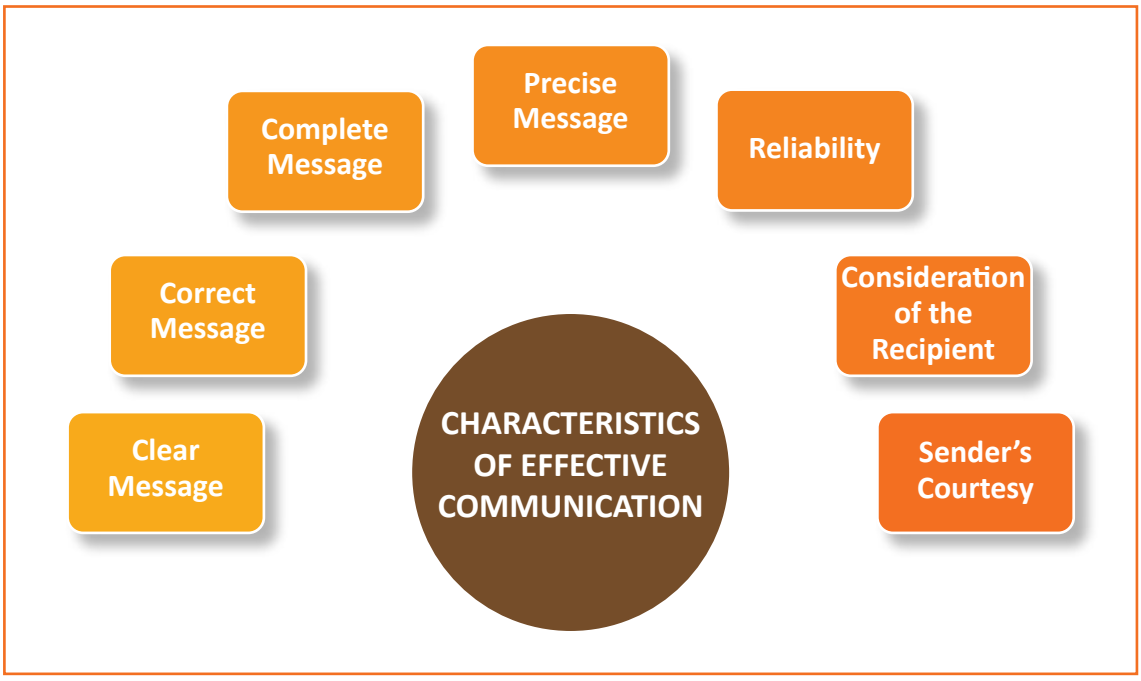

Fig: 3.1.1 Characteristics of effective communication

- **Clear message:** The message which the sender wants to convey must be simple, easy to understand and systematically framed to retain its meaningfulness.
- **Correct message:** The information communicated must not be vague or false in any sense; it must be free from errors and grammatical mistakes.
- **Complete message:** Communication is the base for decision making. If the information is incomplete, it may lead to wrong decisions.
- **Precise message:** The message sent must be short and concise to facilitate straightforward interpretation and take the desired steps.
- **Reliability:** The sender must be sure from his end that whatever he is conveying is right by his knowledge. Even the receiver must have trust on the sender and can rely on the message sent.
- **Consideration of the recipient:** The medium of communication and other physical settings must be planned, keeping in mind the attitude, language, knowledge, education level and position of the receiver.
- **Sender's courtesy:** The message so drafted must reflect the sender's courtesy, humbleness and respect towards the receiver.

Effective communication skills

Conveying a message effectively is an art as well as a skill developed after continuous practice and experience. The predetermined set of skills required for an influential communication process are as follows;

Fig: 3.1.2 Effective communication skills

- **Observance:** A person must possess sharp observing skills to gain more and more knowledge and information.
- **Clarity and brevity:** The message must be drafted in simple words, and it should be clear and precise to create the desired impact over the receiver.
- **Listening and understanding:** The most crucial skill in a person is he must be a good, alert and patient listener. He must be able to understand and interpret the message well.
- **Emotional intelligence:** A person must be emotionally aware and the ability to influence others from within.

- **Self-efficacy:** Also, he/she must have faith in himself and his capabilities to achieve the objectives of communication.
- **Self-confidence:** Being one of the essential communication skills, confidence enhances the worthiness of the message being delivered.
- **Respectfulness:** Delivering a message with courtesy and respecting the values, believes, opinions and ideas of the receiver is the essence of effective communication.
- **Non-verbal communication:** To connect with the receiver in a better way, the sender must involve the non-verbal means communication too. These include gestures, facial expressions, eye contact, postures, etc.
- **Selection of the right medium:** Choice of the correct medium for communication is also a skill. It is necessary to select an appropriate medium according to the situation, priority of the message, the receiver's point of view, etc.
- **Providing feedback:** Effective communication is always a two-way process. A person must take as well as give feedback to bring forward the other person's perspective too.

Barriers to effective communication

There are certain obstacles which sometimes hinder the process of communication, making it less useful for the sender as well as the receiver. These barriers are categorized under three groups. Let us understand these in detail below.

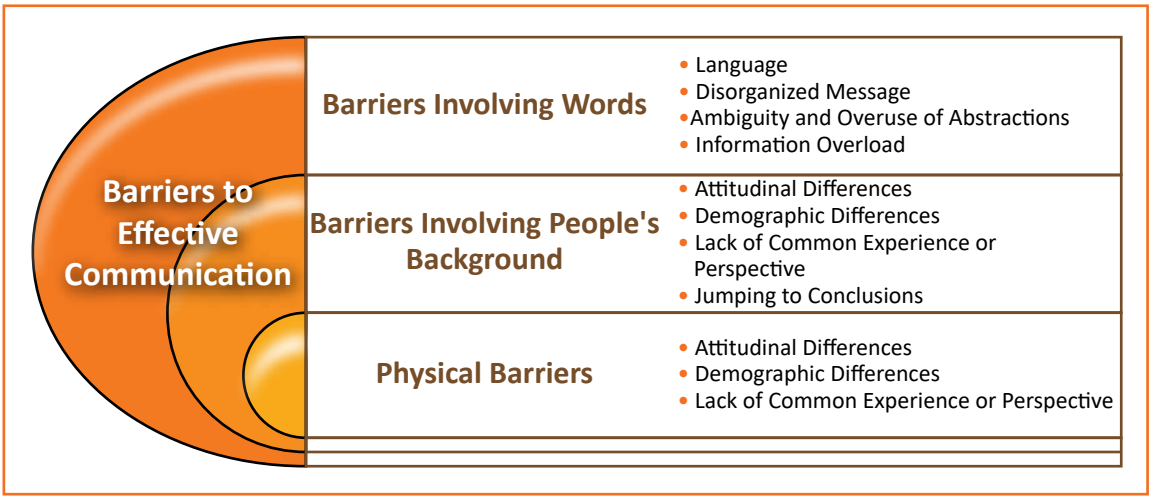

Fig: 3.1.3 Barriers to effective communication

Barriers involving words

Words play an essential role in the process of communication. Any disturbance or distraction in the way a message is presented may lead to miscommunication. Following are the different types of communication barriers related to words.

- **Language:** It is a medium of communication. If the sender is making excessive use of technical terms, it will become difficult for the receiver to understand the message clearly.
- **Ambiguity and overuse of abstractions:** Even if the message is presented in a non-realistic or vague context involving a lot of notions, the receiver won't be able to connect with the idea properly.

- **Disorganized message:** When the words are not organized systematically to form a powerful message, it loses its efficiency and meaning.
- **Information overload:** The effectiveness of communication reduces when a person keeps on speaking for an extended period. Thus, leading to the receiver's exhaustion, who won't be able to keep track of everything that is conveyed.

Barriers involving people's background

People belong to different backgrounds, i.e., Culture, education level, gender, etc. These attributes majorly affect the efficiency of the communication process. It involves the following related obstacles.

- **Attitudinal differences:** At times, people are resistant to understand or change their mind when they have set their views about a particular topic. Their attitude obstructs meeting the purpose of the communication.
- **Demographic differences:** The difference in age, generation, gender, status, tradition, etc., Creates a lack of understanding among people and thus, hinders the process of communication.
- **Lack of common experience or perspective:** The experiences of a person develops their perspective of seeing things in a particular way. This perspective varies from person to person. Therefore, it becomes difficult for a receiver to relate with the sender's experience or views as he might have never gone through it himself.
- **Jumping to conclusions:** Some people lack the patience of listening to others and often jump to conclusions between the communications, thus neglecting the motive of the message.

Physical barriers

These barriers can be experienced directly but challenging to overcome. These include:

- **Physical distance:** When people communicate over long distances, they miss out the non-verbal aspect of communication, since the gestures and expressions of the receiver cannot be interpreted.
- **Noise:** The environment or the communication system sometimes involve unwanted noise which interrupts the process of communication making it inefficient.
- **Physiological barriers:** One of the most common barriers to effective communication is the physical disability of the people involved. Some of these are hearing impairment, poor eyesight, stammering, etc.

Thus, we can say that the significant purpose of communication is to pass on the information to the receiver in such a manner that it does not lose its significance. At the same time, the message must be received in its purest form.

3.1.2 Communicate with supervisor

Good communication with your supervisor is important to both of you. There are five important aspects to remember when communicating with your supervisor.

- You must be able to follow instructions.
- You need to know how to ask questions.
- You should report any problems and results of your work.
- You should accurately record and give messages to your supervisor.
- You need to discuss your job performance.

Following instructions is important at all times, but especially during your training period. Your supervisor will be watching to see how well you do this. Use your senses to follow instructions correctly.

- **Concentrate:** Focus your attention on the supervisor. Don't be distracted by noise and movement.
- **Listen:** Pay attention to the words being spoken. If you hear unfamiliar words or terms, ask for clarification. Listening also means interpreting body language, voice inflections, and gestures. If this non verbal communication is confusing, ask the supervisor to clarify what you don't understand.
- **Watch:** Sometimes a supervisor demonstrates how a task is performed. If necessary, ask the supervisor to repeat the process until you understand it completely. Sometimes a task may be too complex or time-consuming to demonstrate. In such cases, you probably will receive general instructions. If there are details you don't understand, ask for guidance to continue the task.
- **Question:** After you have listened and watched, ask questions. A good supervisor will encourage you to ask questions. It's better to ask a question than to make a mistake because you didn't understand.
- **Write:** Write down in a small notebook the important points to remember about the instructions you get. Don't write while your supervisor is talking or demonstrating something. Do it at a break in the instructions.
- **Practice:** With your supervisor's permission, perform the task. Make sure you have fully completed the job. This may include putting tools away or cleaning up your work area. Don't leave your work partially completed.

3.1.3 Achieve goals in the workplace

Creating goals in the workplace can help you achieve personal and professional success. Setting timeliness and taking steps to reach milestones can help you excel in your role and advance your career.

What is the importance of achieving goals in the workplace?

Setting goals is important because it helps you define how you should move toward achieving professional short- and long-term objectives both for your personal career and your company. They can give you motivation for improving skill sets, learning new skills or growing your responsibilities. Setting and achieving workplace goals can also show management that you are committed to the success of the

organization. Some benefits of setting workplace goals are:

- **They give you direction:** A well-planned goal helps you move forward in the direction you need or want to go. For example, if you want to become a sales manager someday, writing down that goal with specifics on what steps you will take to achieve it can help you to begin working on your goal right away.
- **They help you stay on track:** A specific goal gives you a solid plan for accomplishing a task or project. You can look often at your goal to help you stay motivated. For example, if you need to write a training guide for new employees, you can look at the time line needed to reach that goal on a daily or weekly basis. This reminder can help you meet your deadline.
- **They make large projects easier:** You can divide your goals into smaller tasks so you do not become overwhelmed with a large project. For example, writing an entire training guide might seem daunting. However, if you set a goal to write one section of the guide each day or week, you will see progress on the task and feel a sense of accomplishment.
- **They help with time management:** When you have a deadline for a task, setting specific goals for each phase of the project will help you finish the task on time and eliminate distractions.

How to accomplish goals

Use these steps to help you set and achieve workplace goals to advance your career or succeed in your role.

1. **Create goals that inspire you:** When setting workplace goals, choose ones that will inspire you. Think of tasks or accomplishments that will advance your career or relate to your core values. Your desire to accomplish these goals will help you remain motivated and work toward achieving them.

   You can also use rewards to help motivate you to complete your goals. Develop a system to celebrate your progress, such as taking a break or having a snack for achieving small goals during the day, or attending an event or taking a vacation after accomplishing larger goals.

2. **Write down your goals:** Writing out your goals on paper, a calendar or a computer can reinforce them and provide a visual reminder to work toward them. Written goals allow you to access and view them often. To begin achieving your goals, write down each one and create a plan and time line to reach them.
3. **Use smart goals:** Smart goals are a methodology for setting goals that makes them easier to track and accomplish. Using this method gives you clear directions on how to define and plan achieving your goals. Here are the components of a smart goal.

   - **Specific:** This part of the goal-setting process is critical for the success of accomplishing goals. Write the goals in a well-defined and clear manner so that you or anyone else in the workplace can understand them. Always use precise action words. For example, **"increase sales"** or **"earn a promotion"** are unspecific goals, but **"increase sales by 10% this month"** or **"become assistant manager by the end of the year"** are specific goals, and their clarity makes them easier to work toward.
   - **Measurable:** Use numbers, dates and other objective criteria when setting your goals so you

can measure and view your progress.

- **Achievable:** When you set a goal, check that it is feasible. Look at how much time you have each day, week or month to accomplish a task and set a realistic plan for accomplishing it. Be sure you have the training, tools and resources to achieve the goal.
- **Relevant:** When you are trying to reach goals, especially in the workplace, they should relate to your career and the direction you want to go. Understand your particular skill sets and expertise in the job, and make the goal relevant to them.
- **Time-bound:** Similarly to the measurable aspect of smart goals, you should have a clear time frame for accomplishing every goal. Knowing when a project needs to be completed will help you focus on all the tasks that need to be accomplished to meet the deadline.

4. **Re-evaluate your goals periodically:** It is important to look at the progress of your goals regularly. Depending on the depth of the plan, you can re-evaluate daily, weekly, monthly or biannually. Look at the actions you've taken to move forward with your goal, and if they are successful, continue to do those things. If you find that the goal is harder to achieve than you originally planned, make adjustments so you can increase your progress.

   For example, if you have committed to writing five blog posts per week for the company website, and you are finding it difficult to accomplish those numbers, try writing only four posts per week or changing your schedule so you have more time to write. Speak with your team members or management and get approval for the new plan.

5. **Keep striving toward your goals:** As you move toward accomplishing your goals, you want to maintain the excitement of and commitment to achieving them. Here are a few things to keep in mind when you are accomplishing your goals.

   - **Be excited about the process:** One of the reasons you created goals was because you wanted a change. Stay passionate about the **"why"** of your goal. Keep positive on the small steps you are making toward the plan, and reward yourself when a time-bound goal is met.
   - **Find support and encouragement:** Surround yourself with people who encourage you to accomplish your goals. Spend time with positive co-workers, friends, family members and others who believe in what you are trying to achieve. A kind and encouraging word can inspire you to keep moving toward the completion of your goal.
   - **Visualize your success:** One of the best aspects of goal setting is enjoying the results at the end. Always visualize yourself succeeding, and use your goals to help you be happy and successful in the workplace.

3.1.4 Work effectively in a team

When a mix of people with different skills and varying levels of experience are pulled together in a team, it can lead to more effective and innovative solutions, which is great news for businesses. Employees can often feel happier being part of something bigger too, which can lead to higher productivity and lower staff turnover. As a result, team working is an important skill that employers often look for in job candidates. It's therefore a skill you shouldn't overlook.

Tips to improve your teamwork

Working with other people may seem simple enough but working in a team can be a complicated dynamic to navigate effectively. Here are nine key tips you should follow to improve your team working skills.

1. **Get into the right mindset:** Working alone means that you can set your own schedule and tackle tasks in a way that suits you best. In a team, you need to share ideas, divide workloads and go with group consensuses for decisions. By understanding this shift and accepting the differences, you will be able to set the right mindset and get stuck into the new team dynamic.
2. **Understand what's required of you:** Before you begin, make sure you understand your role, responsibilities in the team, deadlines, how everyone plans to work together, why the team was created, the teamwork processes and practices as well as what the ultimate goal of the team is. By doing this, you will be able to contribute much more effectively.
3. **Put in 100% effort:** Don't hide behind others or let other team members take on the bulk of the work. Be prepared to put in an equal amount of effort as others, so you complete the work assigned to you within the time frame that's been set. A good team player would also notice when others are struggling and help. The overall team will perform better as a result.
4. **Communicate, communicate and communicate:** The importance of communication in a team can't be underestimated. It's vital that everyone shares their progress and raises issues quickly so they can be dealt with. Don't forget that communication isn't just about talking but listening to others too. Without this level of open and honest conversation, problems may be missed, and projects can rapidly fall behind.
5. **Share your ideas:** When you've come up with an exciting new idea, you may want to rush to your boss to share it. But when working as a team, you must share your ideas and resources with your team members. Arguing afterwards over who gets the credit won't do any favours for you, as your boss will see that you're not a team player.
6. **Keep an open mind:** Brainstorming as a team is a great way to come up with a range of new and exciting ideas. While you may think your idea is the best, others might not always agree with you. You may also not agree with everyone else's ideas. Don't be difficult or overly negative about other people's ideas. Understand that everyone has the right to their own opinions and as a team, you will go with the consensus.
7. **Get to know each other:** Take time to get to know the rest of your team. This will make it much easier for you all to work together effectively going forward. There may be instances when you don't get on with a certain team member, but for the benefit of everyone, it's important that you always try and remain professional.
8. **Stay positive:** Don't complain all the time or place blame on single members of the team. You're

all in it together. If you notice the morale is dropping, provide encouragement where needed. Take time to celebrate your team's achievements too. A happier, more positive team will work much better together and achieve even better results.

9. **Be adaptable:** When working on a project, deliverables may change, team members may come and go, or you may face unexpected obstacles. You need to be someone who can adapt quickly to new situations, which will ensure the team continues to work together effectively.

Summary

- Effective communication is a process of exchanging ideas, thoughts, knowledge and information such that the purpose or intention is fulfilled in the best possible manner.
- Listening and understanding is the most crucial skill in a person is he must be a good, alert and patient listener.
- The effective communication certain characteristics such as clear, correct, precise, complete, and reliable message.
- Non-verbal communication includes, gestures, facial expressions, eye-contact, postures, etc.
- Effective communication is always a two-way process and providing feedback is an essential part of it.
- Certain obstacles sometimes hinder the process of communication, language barriers, ambiguity, overuse of abstractions, information overload.
- Physiological barriers are the physical disability of the people involved. Some of these are hearing impairment, poor eyesight, stammering, etc.
- Goal setting gives direction and help with time management.
- Smart goals are a methodology for setting goals that makes them easier to track and accomplish.
- Working effectively in a team can lead to more effective and innovative solutions at workplace.

Exercise

1. **The clear exchange of ideas and information is .....**
   a) Listening
   b) Communication
   c) Sympathy
   d) Social isolation

2. **The characteristics of communication when the sender must be sure from his end that whatever he is conveying is right by his knowledge is called .....**
   a) Correct message
   b) Complete message
   c) Reliability
   d) Sender's Courtesy

3. **Which type of barriers to effective communication is the physical disability of the people to communicate effectively?**
   a) Noise
   b) Physiological Barriers
   c) Physical Barriers
   d) Emotional Barriers

4. **SMART goals are a methodology for setting goals that makes them easier to track and accomplish. What does S stand for in SMART?**
   a) Sales
   b) Specific
   c) Smart
   d) Seamless

5. **..... as a team is a great way to come up with a range of new and exciting ideas.**
   a) Reflection
   b) Staying positive
   c) Brainstorming
   d) Communication

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5 steps to manage conflict between team members

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Why team building is important

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How to manage conflict in a team

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Good Teamwork and Bad Teamwork

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4. Maintain health, safety & security procedures

Unit 4.1 - Maintain health, safety and security procedures

HYC/N9302

Key Learning Outcomes

At the end of this module, the participant will be able to:

1. Practice health and safety measures.
2. Follow fire safety procedures.
3. Follow emergencies, rescue and first-aid procedures.

Unit 4.1 - Maintain a safe working environment

Unit Objectives

At the end of this unit, the participant will be able to:

1. Identify the importance of promoting a safe working environment.
2. Identify how to reduce risk.
3. Define hospital electrical safety measures.
4. Define protective clothing/equipment.
5. Explain the procedure of dealing with medical emergency.
6. Identify the basic fire awareness.
7. Explain the First Aid process.
8. Identify common safety signs, displayed in various areas.
9. Explain the Cardiopulmonary Resuscitation (CPR) process.

4.1.1 Introduction

Commitment to health and safety should be at the top. Everyone at a workplace, including employer, supervisor, workers, employees and customers must take the responsibility to promote health, hygiene and safety.

Definition of health

As defined by the world health organization (who), health is a "state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity''.

Definition of safety

Safety is the state of being 'safe', the condition of being protected from harm or other non-desirable outcomes. Regular risk assessments should be conducted at retail stores to identify health and safety problems, and initiate necessary measures to eliminate or mitigate them as far as possible.

4.1.2. Health and safety requirements

It is imperative to ensure that the retail space is safe for everyone in the area especially for employees and the customers. It is always expected from every sales associate to identify and follow health and safety needs laid down by the retailer and the law, which are in place to act as a monitor to avoid all kinds of health or safety hazards.

Following are the factors to keep in mind while undertaking health and safety measures at a retail store:

1. **Abiding by the law:** A retailer has to show that he or she is following all safety practices in his retail store.
2. **Risk assessment:** A risk assessment examines the hazardous conditions at a workplace to identify risks and implement measures to prevent or reduce the risks.
3. **Safety readiness from expected perils:** As per the health and safety legislation, it is required to follow health and safety rules.
4. **Ergonomics:** It is the science of matching a retail store's requirements to the retailer's capabilities. For example, if a retailer hires a weak person to lift heavy boxes for hours on end, there are more chances of risk injury to the employee due to poor ergonomics.
5. **Air quality:** Without inadequate ventilation, air starts to collect mold, fungus, bacteria or odours in a retail store. Law recommends installing machines that cycle fresh outdoor air and circulates it throughout the store.
6. **Visual inspection of premise:** As per the law, it is important to visually inspect the store premises to ensure no hazards are visible, which include uneven flooring, spills and misplaced boxes.
7. **Crime:** The retailer should install a surveillance camera in different parts of the store for safety purposes. Hiring a guard may also help monitor the store.
8. **Training:** Employees of the retail store should be trained to tackle any situation inviting danger.
9. **Insurance:** The retailer must get the retail store insured.

4.1.3 Housekeeping

Good housekeeping is central to all types of operational, maintenance, and safety work. The quality of housekeeping also provides auditors and other outsiders with an opportunity to provide a quick evaluation of the overall level of operational excellence in a facility.

General neatness

The first, and the most obvious, aspect of housekeeping is general neatness. The following checklist provides some of the instructions that should be followed to ensure a high level of housekeeping:

- Ensure that all discarded materials, particularly those that are potential fire hazards, are disposed of properly and continuously throughout the job progress.
- Avoid accumulation of combustible items such as spilled oil, woods, and rags because they can be a fuel source during a fire. Oil-soaked rags should always be promptly disposed of in covered metal cans.
- Remove tripping hazards.
- Keep drain openings and free-flowing drainage systems free of debris.
- Keep aisles and walkways free and clear of maintenance equipment and tools in order to eliminate tripping hazards and to ensure that emergency evacuation is not restricted and that access to fire fighting equipment is not hampered.

- Ensure that junction and switch box covers on electrical circuits are secure and tight.
- Promptly eliminate trace hydrocarbon leaks from lines, valves, and stuffing boxes (this is often a strict requirement of the environmental regulations).
- Remove and replace oil-soaked insulation.
- Clean up spills at once.
- Nails, staples, and other puncturing metals should be bent under or removed from spent packing or lumber and stacked with points on bottom.

Proper placement

Proper placement means **"a place for everything and everything in its place."** Tools should be in their correct location and all fire fighting equipment is where it should be and ready to operate immediately.

Stacked material should be secured to prevent materials from falling over, with the heaviest objects closest to the floor.

Grass and brush

Dry grass, brush, or weeds can help spread a fire or transfer a fire from one area to another. On most properties, this can be avoided by appropriate use of weed killers and/or mowers. In some locations, carefully controlled and supervised burning of dry grass and weeds will reduce the risk of accidental fire.

Equipment and piping

Housekeeping includes checking that equipment and piping is in good condition. All process and utility piping should be horizontal or vertical (a few process applications do call for piping to be sloped). Any equipment that is in a deteriorated condition, say due to corrosion, should be identified and a repair work order issued. Damaged or contaminated insulation should be replaced, along with the insulation covers.

Storage and handling of flammable liquids

The storage and handling of flammable and combustible liquids can be hazardous since workers are often working closely with the containers and their contents. Also, the vapours generated by the liquids can be close to sources of ignition such as an internal combustion engine.

4.1.4 How to reduce risk

To reduce risk, you must:

- Make sure that your own health and hygiene does not pose a risk to others.
- Make sure that your seniors know where you are.
- Check for health, safety and security risks when working and report if you see any hazards.
- **Use approved procedures when carrying out work that could be dangerous including:**

    1. Correct moving and handling techniques.
    2. Appropriate hygiene procedures.

3. Correct protective clothing for the situation, environment and activities.
4. Storing equipment and materials and dealing with spillages and getting rid of waste.

- **Take immediate and appropriate action to deal with emergencies, including:**

1. Security problems.
2. Accidents.
3. Fire.

- **Use your skills and experience until appropriate help arrives: you must:**

1. Call for the appropriate help.
2. Continue to provide help until someone who is qualified to deal with the emergency is available.
3. Support patients and others including family carers who may be affected by the emergency.
4. Record and report incidents and emergencies accurately and fully in line with your organisation's policies.

4.1.5 Near misses and dangerous occurrences

Not only is the investigation of accidents and incidents important, it is also useful to investigate near misses and dangerous occurrences which did not result in injury. Just because no- one has been injured on one occasion does not mean that if the event happened again the result would be the same.

Whether the incident is classed as an accident, a near miss or a dangerous occurrence, the investigation should carry the same degree of importance, and the findings will be as useful in any event in preventing a recurrence. Specific lessons should be noted to identify why control measures already in place failed to prevent the incident and what further measures should be introduced to rectify the situation. General lessons learned from one incident will also be useful throughout an organization to increase awareness about health and safety issues.

4.1.6 Categorizing incidents

Hazards related to oil and gas industry

Hazards in oil and gas industry can be divided into two broad categories:

1. **Safety and injury hazards:** workers in oil and gas industry are generally susceptible to the following safety and injury hazards.

Safety and injured hazard	Possible causes
Motor vehicle accident	• Often the roads leading to well sites lack firm shoulders and other safety features. • Fatigue due to long driving distance and long working shifts.

Safety and injured hazard	Possible causes
Contact injuries	• Workers being stuck by, entangled, or crushed by tools, machinery or other objects
Fire and explosions	• Presence of highly combustible hydrocarbons • Presence of oxygen/ignition source
Slip, trips and falls	• Frequent need to work at elevations • Uneven surface • Improper use or non-availability of fall protection systems
Confined space	**According to NIOHS, confined space refers to space, which by design has:** • Limited openings for entry and exit • Unfavourable natural ventilation • Not designed for continuous employee occupancy Example of confined space in oil and gas industry are storage tanks, pipelines, silos, etc.

Table: 4.1.1 Possible cause of injure/hazard

Health and illnesses hazards

Workers in oil and gas industry are generally susceptible to following agents which lead to various health and illnesses hazards: chemical hazards (toxic, corrosive, carcinogens, asphyxiates, irritant and sensitizing substances); physical hazards (noise, vibration, radiations, extreme temperature); biological hazards (virus, parasites, bacteria); ergonomic hazards (manual handling activities, repetitive motions, awkward postures); and psychosocial hazards (overwork, odd working hours, isolated sites, violence).

The following table identifies the potential health effects from key processes in oil and gas industry.

4.1.7 Ergonomics

Ergonomics is the science of studying people at work and of their working environment. Ergonomics seeks to make a better match between workers' physical capabilities and limitations and workplace conditions and activities. In practice, most ergonomics programs focus on preventing injury and illness by controlling or eliminating work-related Musculoskeletal disorders (MSDS).

Musculoskeletal disorders

MSDS are illnesses and injuries that affect one or more parts of the musculoskeletal system (bones, muscles, tendons, ligaments, joints, cartilage, peripheral nerves, and blood vessels). Injuries of this type account for a large percentage of recordable events. It is important that workers recognize the symptoms of incipient MSD problems and are able to obtain appropriate help.

Five responses that are usually taken in response to injuries of this type:

- **Fix the person:** This approach is basically post-event, i.e., Someone suffers an injury and is given medical treatment. It is the least desirable of the control options because it assumes that workers are going to be injured-it does not rely on prevention.
- **Fit the person to the task:** Some people are not physically able to carry out certain tasks. For example, heavy weights should only be lifted by workers strong enough to do so. And it is common for people who have been injured to be put on light duties such as classroom training or filing government reports.
- **Change the person:** Sometimes the persons performing a task can improve their capabilities. An example of this occurred at a medium-sized refinery. The operations manager noted that the organization spent many thousands of dollars on preventive maintenance and other reliability programs for their equipment, but did not invest at all in the fitness of their employees. So he installed a fitness work room at the refinery; it was open to all employees.
- **Change performance:** A better approach to reducing problems with MSDS is to change how a person performs the work using behavioural modification. Workers are trained in how to carry out tasks effectively and safely.
- **Change the work or workplace:** Rather than trying to change people and their capabilities, it is best to change the manner in which a task is organized or structured such that the persons carrying out the work are exposed to a lower MSD risk.

Work stations

The topic of ergonomics is often associated with the design and use of work stations, including office computers and control panels. The following guidance to do with this topic should be considered:

- Equipment should be designed and adjusted to fit the workers' physiology.
- Documents that are being typed should be adjusted so as to be easy to read without the worker having to move his or her neck too often.
- Shiny paper that could cause dazzle should be avoided.
- Good visibility angles to the screen should be provided.
- The keyboard should be independent and mobile, thus allowing the worker to adjust it according ergonomics is the science of studying people at work and of their working environment. Ergonomics seeks to make a better match between workers' physical capabilities and limitations and workplace conditions and activities. In practice, most ergonomics programs focus on preventing injury and illness by controlling or eliminating work-related musculoskeletal disorders (MSDs).

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- Documents that are being typed should be adjusted so as to be easy to read without the worker having to move his or her neck too often.
- Shiny paper that could cause dazzle should be avoided.
- Good visibility angles to the screen should be provided.
- The keyboard should be independent and mobile, thus allowing the worker to adjust it according to the tasks to be performed.
- The screen, the keyboard, and the support for documents should be positioned so that the eye-screen, eye-keyboard, and eye-document distances are approximately the same.
- Work surfaces should be adjustable.
- The maximum number of required touches of keys on the keyboard should not be over 8,000 per hour.
- A person should not work for more than 5 hours at a computer. Work conducted after that time period should not involve repetitive moves and visual effort.

4.1.8. Managing occupational safety and health risks

The aim of occupational safety and health risk management is to identify and assess safety and health hazards existing at the workplace and to define appropriate control and retrieval steps.

Business processes in oil and gas industry are very complex. Hence it is essential that a systematized approach should be used for managing occupational safety and health hazards. Its solution model can be based on the PDCA cycle:

Segments	Key Processes	Agents	Possible Health Effects
Upstream	• Seismic Survey and evaluation • Exploring drilling • Development and production • Decommissioning	• Pathogenic microorganisms • Infected transmitting vectors • Drilling mud • Petroleum products (Hydrocarbons) • Radioactive sources • Chemical and additives • Extream temperatures • Silica/Asbestos • Nois/Vibration • Mechanical • Ergonomic • Psychosocial	• Infectious and parasitic diseases (e.g., Hepatitis A, Cholera, Typhoid Fever) • Cumulative trauma disorders • Chronic obstructive pulmonary disease • Gastrointestinal disorders • Dermal and eye issues • Spinal Disorders • Neoplasms/Cancer • Heat Stroke • Stress • Sleep deficits • Noise induces hearing loss • Drug and alcohol abuse
Midstream	• Pipelines • Transport and storage • Marketing	• Petroleum products (Hydrocarbons) • Dust from filling and scalling from cleaning of pipes and tanks)	• Dermal and eye issue • Pulmonary disorders • Gastrontestinal disorders • Neoplasms/Cancer
Midstream	• Products refining • Petro chemicals • Sales and Distribution	• Petroleum products (Hydrocarbons) • Treatment chemicals • Metals (Pb, Cd, Mn, etc.) • Silica/Asbestos • Solvents • Noise/Vibrations	• Dermal and eye issue • Pulmonary disorders • Gastrontestinal disorders • Neoplasms/Cancer • Noise induces hearing loss

Fig: 4.1.1 Potential health effects from key processes

Fig: 4.1.2 PDCA Cycle

4.1.9 Risk management process

Risk management is crucial for preventing work related injury and illness. It includes:

- Identifying the risks.
- Evaluating and prioritizing the risks.
- Implementing preventive/protective measures to control the risk.

There are a number of circumstances in the oil and gas industry where a proper risk management process is essential. For example:

- **Job safety analysis:** it is a process of systematically evaluating certain jobs, tasks, processes or procedures and eliminating or reducing the risks or hazards to as low as reasonably practical (ALARP) in order to protect workers from injury or illness.
- Workplace inspections and audits.
- Change management - identification of new hazards, introduction of new equipment/process, or regulatory needs.

Generally risk management process in the oil and gas industry involves the following key steps:

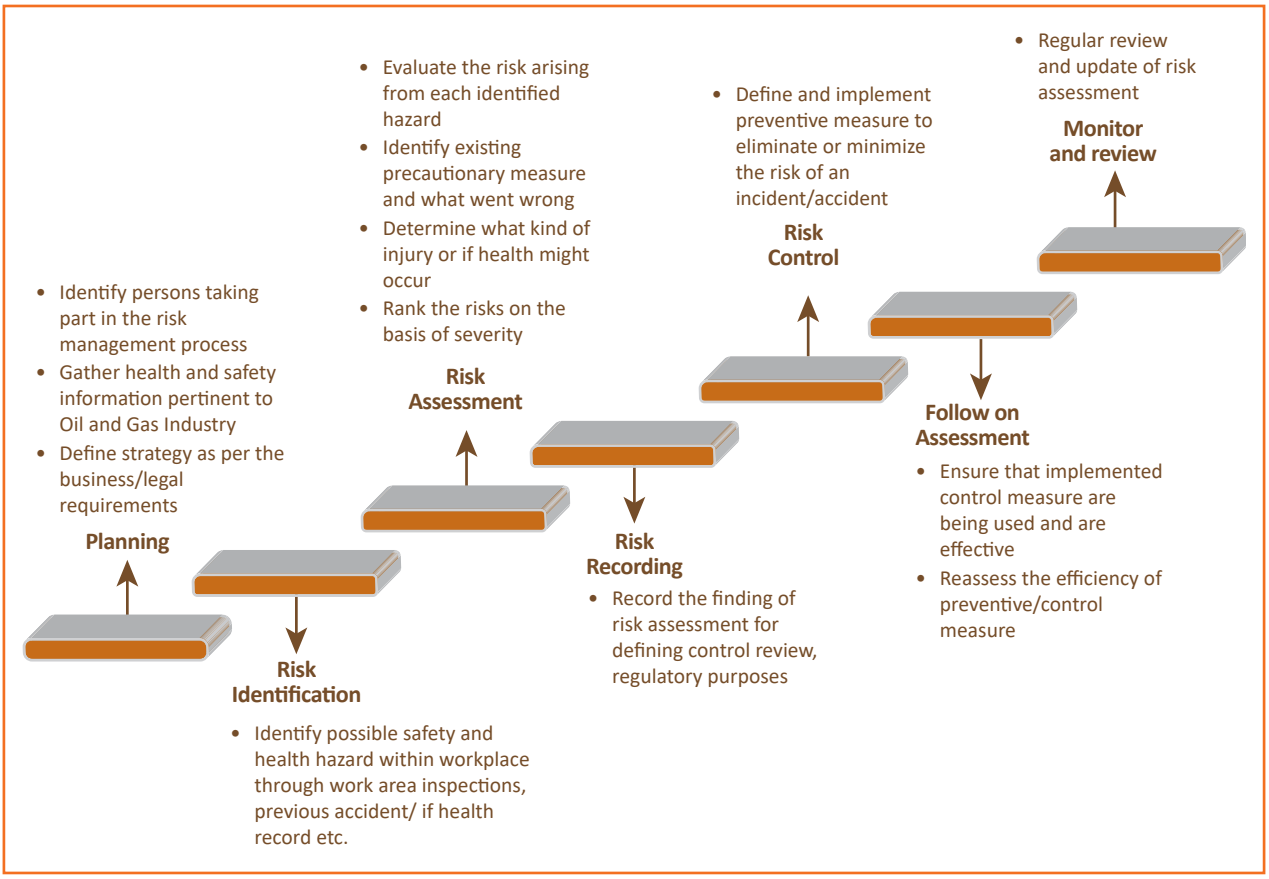


Fig: 4.1.3 Risk Management process

4.1.10 Medical emergencies

Everyone plans for emergencies. That is the reason why we keep a first aid kit with ourselves. At work, however one is exposed to a lot of stress and physical activity. This could lead to certain medical emergencies. It's better to be prepared with the first aid measures and knowledge of implementing them on ourselves and on others. This module equips you with that information. Pay attention to these medical emergency procedures to understand how to conduct you in theses crucial movements. Pay attention during these sessions.

Dealing with medical emergency

A medical emergency is an accidental injury or a medical crisis that is severe. These could be situation where.

- The person is not breathing.
- Stroke or heart attack.
- Severe bleeding.
- Shock.
- Poisoning.
- Burns.

A medical emergency requires your immediate attention, sometimes even before you call emergency services for help.

It is crucial that you know the emergency medical service (EMS) number, for your own safety and the safety of others.

Do not

- Give the victim anything to eat or drink.
- Hold the victim.
- Splash or pour any liquid on the victim's face.
- Shift the victim to another place (unless it is the only option to safeguard the victim from the injury).

Bleeding

- Put pressure to the wound with a pressure bandage. Raise the wounded portion to slow the bleeding.
- Pressure the associated points if necessary then apply an additional pressure to reduce the bleeding.

Fainting

- Fainting is a small loss of consciousness which is caused by a momentary reduction of the blood flow to the brain.
- A small loss of consciousness can cause the person to fall.
- A very slow pulse.
- Cold skin with sweat and pale appearance.

Causes of fainting:

1. Taking in too little quantity of foodstuff and liquids (dehydration).
2. Low BP.
3. Deprivation of sleep.
4. Fatigue.

First aid for fainting:

1. Place the victim lying on his/her back and raise his/her legs above the heart level.
2. Check the victim's airway to ensure it is clear.
3. Check for the indications of breathing, coughing, or movement.
4. Loosen clothing (neck ties, collars, belts etc.).
5. If consciousness is not regained within one minute call ems.

Shock

Shock occurs with the failure of the circulatory system due to which insufficient oxygen reaches the tissues. If this condition is not treated immediately, important organs can fail, which can ultimately lead to death. Fear and pain makes effect of shock worse.

First aid for shock:

1. Place the victims resting down (if feasible).
2. Raise the legs 10-12 inches, unless you doubt for a back injury or broken bones.
3. Cover the victim to preserve the body temperature.
4. Give the victim room for fresh air.
5. If victim wants to vomit then- position him/her on his/her left side.
6. Loosen restrictive clothing.

Muscle cramps

- Stretch out the cramped muscle to neutralize the cramp.
- Give massage to the cramped muscle rigidly.
- Apply hot water bottle to the affected area.
- Seek medical help if the cramp continues.
- Avoid unnecessary movements and activities which can cause pain.
- Apply some ice which will help in reducing pain and swelling.
- Apply light pressure with an elastic wrap or a bandage which can also help in reducing the swelling.
- Raise the cramped limb at the level of the heart which further reduces pain and swelling.

Fractures

A fracture is a break or crack in the continuity of the bone

Dislocation

A dislocation is the displacement of one or a lot of bones at a joint. It usually happens in the shoulders, elbow, thumb, fingers and also the lower jaw.

First aid for dislocations & fractures:

1. Immobilize the effected part.
2. Stabilise the effected part.
3. Use a cloth as a sling.
4. Use board as a sling.
5. Carefully transfer the victim on a stretcher.
6. Call a doctor.

4.1.11 Basic fire awareness

Fire is a chemical reaction that requires three elements to be present for the reaction to take place and continue.

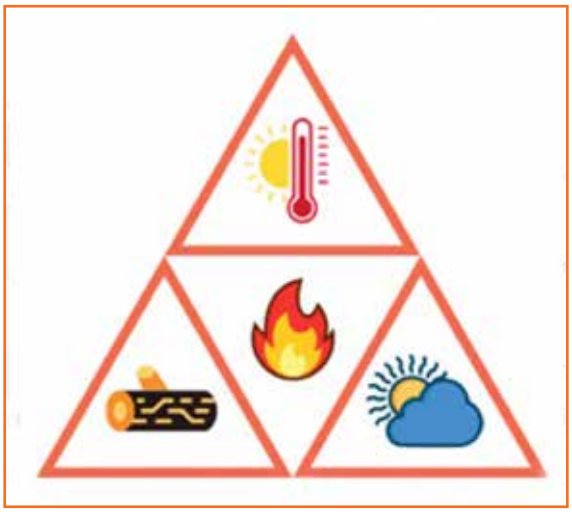


Fig: 4.1.10 Basic cause for fire

1. **Heat:** A heat source is responsible for the initial ignition of fire, and is also needed to maintain the fire and enable it to spread. Heat allows fire to spread by drying out and preheating nearby fuel and warming surrounding air.
2. **Fuel:** Fuel is any kind of combustible material. It's characterized by its moisture content, size, shape, quantity and the arrangement in which it is spread over the landscape. The moisture content determines how easily it will burn.
3. **Oxygen:** Air contains about 21 per cent oxygen, and most fires require at least 16 percent oxygen content to burn. Oxygen supports the chemical processes that occur during fire. When fuel burns, it reacts with oxygen from the surrounding air, releasing heat and generating combustion products (gases, smoke, embers, etc.). This process is known as oxidation.

These three elements typically are referred to as the **"fire triangle."** Fire is the result of the reaction

between the fuel and oxygen in the air

Causes of fire

- **Electrical:** e.g. Overloading of circuits, faulty old or bad connections causing sparks or generating a heat source, poor maintenance, lack of ventilation and cooling, static electricity etc.
- **Heating appliances:** For example clothing left on boilers to dry, no sparks guards on open fires or stoves, left unattended while cooling, sited close to combustible materials, faulty temperature control etc.
- **Process dangers:** e.g. Overheating of machinery, heat generated by friction, uncontrolled sparking, breakdown in cooling process, chemical reaction, poor quality ventilation and temperature control etc.
- **Flammable dusts:** e.g. Poor extraction, process proximity to heat or spark source, no containment system, no monitoring or measuring system etc.
- **Carelessness:** For example smoking, inadequate precautions while welding, drilling or cutting, horseplay or interference with safety equipment, removal of guards etc.
- **Bad housekeeping:** For example lack of maintenance of work area and equipment, oil/fuel leaks and spillage's ignored, overflowing bins and waste baskets, no safe procedures for disposing of combustible waste etc.
- **Spontaneous combustion:** For example chemicals not stored at correct temperature, chemicals mixed incorrectly, combustible materials or waste left unattended etc.
- Poor judgment and human error.
- Failure to follow instructions.
- Misuse of faulty electrical equipment.
- **Electrical appliances:** Many fire started by electrical appliances are associated with lamps and heat developed by filament. Portable lamps are a frequent source of trouble the common causes as follows.

  i. Lead wires damaged.

  ii. Lamp taken in to atmosphere which has explosive dust, gas or vapour.

  iii. Bulb loose in socket.

  iv. Bulb easily broken (take care properly).

Classification of fire

Before we move forward and study about fire prevention and the safety equipment required for the same, we need to understand the different types of fire. This information is extremely important as it can help you choose the appropriate means to extinguish the fire.

Classes of fire	
Class A Fires are related to solid materials (wood, paper, cloth, trash, rubber and plastics, charcoal, etc.).	
Class B Fires are related to flammable liquids (paint, diesel, gasoline, petroleum oil, and pain).	
Class C Fires are related to flammable gases (energized electrical equipment like motors, appliances, transformers, propane, and methane). Electrical equipment such as appliances, wiring, and breaker panels, etc. These categories of fires become class a, b, and d fires when the electrical equipment that initiated the fire is no longer receiving electricity).	
Class D Fires are related to flammable metals (combustible material like aluminium, sodium, potassium, magnesium). These fires burn at extremely high temperatures and require special suppression agents.	
Class E Fires are related to electrically energized objects, wiring, and electrical appliances. These fires are caused because of faulty heaters or electrical appliances overheating.	
Class K Fires related to cooking oil and greases like vegetable fat and animal fat.	

Table: 4.1.2 Classification of fire

Fire extinguisher

Fire extinguishers are designed to tackle specific types of fire. There are five different classes of fire and several different types of fire extinguishers.

Types of fire extinguisher	Identification		
	Use	Fire class	Colour code
Water extinguisher 	• Water removes heat and extinguishes the fire. • Water must not be used on fires involving live electrical equipment as it can cause electrocution. • Water must not be used on metal fires.	**Class A fire**	Signal red 
Dry chemical powder (DCP) extinguisher 	• DCP extinguishers put out fire by coating the fuel surface with chemical powder. • This separates the fuel from the oxygen in the air and prevents vapour formation.	**Class B & C fire**	Red with a blue panel above the operating instructions. 
Foam type extinguisher 	• The extinguishing agent is aqueous film forming concentrate in water which forms air foams when discharged through an aspirating nozzle. • It has a blanketing effect excluding oxygen from the surface of the fuel as it spreads on the fuel. • Prevents vapour formation from the surface of the burning liquid.	**Class A & B fire**	Red with a cream panel above the operating instructions 

Types of fire extinguisher	Identification		
	Use	Fire class	Colour code
Carbon dioxide extinguisher 	• CO2 extinguish the fire by displacing oxygen in the surrounding air. • Its principal advantage is that it does not leave any residue. • Can be used on electrical/ electronic equipment. • CO2 is not suitable for fires involving metals.	**Class B & C fire**	Red with a black panel above the operating instructions 
Special dry powder	• Special extinguishing agents are used for extinguishing metallic fires. • Dry powders extinguish the fire by forming a crust on metal surface excluding air and also absorb heat from the metal surface.	**Class D fire**	Red with a blue panel above the operating instructions 

Table: 4.1.3 Classes of fire extinguisher

Correct use of a fire extinguisher

The method of using a fire extinguisher is to follow P.A.S.S. Pass is the acronym for, pull the pin (p), aim (a), squeeze (s) and sweep (s).

1. **Pull the pin:** To use an extinguisher in a proper way, the first step is to pull the handle's pin.
2. **Aim:** The next step is to aim the extinguisher's nozzle. The direction should be towards the fire's base. This is because the sprayed foam at the top will diminish or extinguish only the fire at the top. This will not serve the purpose for which the extinguisher is used. The burned down flame may spring up to life if it gets enough oxygen or any combustible material.
3. **Squeeze:** Then, in an extremely controlled manner, you need to release the agent. This can be done by squeezing the trigger.
4. **Sweep:** If you see in the second step, you already read that you should direct the nozzle at the fire's base. You will sweep the extinguisher's nozzle from left to right. Continue with this process until you put out the fire. You need to act fast as most extinguishers' discharge time is nearly 10-20 seconds.

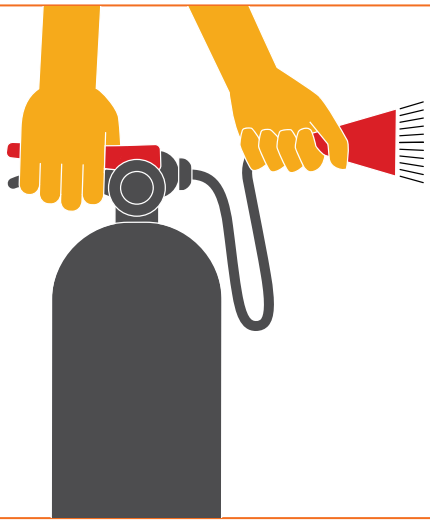
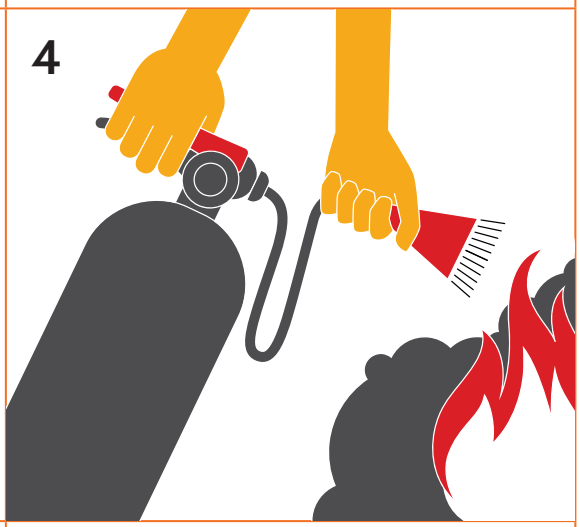
Pass technique	
1 	2 
Pull out the safety pin as instructed on the label	**Aim the nozzle at the base of the fire**
3 	4 
Squeeze the lever	**Sweep the fire using the extinguisher's discharge**

Table: 4.1.4 Fire extinguisher pass method

How to deal with fire

If the house has got fire, you need to take following steps:

- If the fire is very small and can be handled, you should deal with it yourself. Otherwise, you should come out of the house with other family members.
- Call the fire brigade and also the neighbours for help.
- If your clothes got fire, lie down on the floor and roll around so that the flames may smooth.
- If you are trapped in a fire in a room, bent down on your knees and try not to inhale the smoke as much as possible.
- You should crawl toward the exit as soon as you can.

- You can use the fire extinguisher on the small fire, but you should get yourself trained on it.

Methods of starving fire

On discovery of a fire, everything possible should be done to starve the fire by removing the oxygen and combustible material. The prevention procedure is as follows.

- Close all the doors and windows;
- Cover small fires with a blanket or other suitable objects;
- Cool the fire down;
- Remove combustibles;
- Switch off all electricity main switch; and
- If available, use the appropriate extinguishers.

Remove bystanders from the danger area to a safe place. Keep an access route open for the fire brigade or emergency services and look out for looters as people may take advantage of the confusion caused by the fire to steal valuables.

Fire emergency procedures (do's & don'ts)

The general principles (do's and don'ts) when conducting basic fire-fighting is as follows.

Do's

- Ensure the back-up assistance is available before tackling a fire;
- Ensure that an escape route is available before tackling the fire;
- Follow instructions on the extinguisher's label;
- Apply the extinguisher medium to the base of the flames and move the nozzle in a rapid side-to-side action;
- Drive the flames away from you;
- For vertical fires, start at the base of the flames and move upwards;
- If the fire is outdoors, approach the fire from the windward side;
- When approaching the fire, adopt a crouching position that provides protection against heat and smoke;
- Keep alert for any changes in the fire pattern;
- When tackling a fire involving electrical equipment, isolate the power as soon as possible to prevent re-ignition; and
- Ensure that the fire has been completely extinguished and no spark remains.

Don'ts

- Do not place yourself at risk;
- If the fire is too big, evacuate the area immediately;
- Never tilt or invert any extinguisher during operation unless it is the turnover type;
- When extinguishing the fire of a flammable spillage, never walk on the liquid spillage. This can

prevent injuries in the event of the names flashing back;

- When tackling flammable liquid fires using a controllable discharge type extinguisher, spray the medium until the fire is completely extinguished; and
- After the fire has been extinguished, back off slowly and never turn your back on it.

Fire evacuation steps

The sequence of an evacuation situation is:

- Detection
- Decision
- Alarm
- Reaction
- The movement to an area of refuge or an assembly station/ area
- Transportation

Rescue techniques during fire hazard

(A) Responding to fire

- The fire alarm system must be initiated, and an alert must be raised.
- A safe evacuation path must be identified before dealing with the fire.
- The appropriate class of fire extinguisher must be chosen.
- The P.A.S.S. technique must be adopted for extinguishing the fire.
- Immediate evacuation must be initiated if the extinguisher is exhausted and the fire still exists.
- Call security or local emergency services.
- Summon the fire fighting services at the earliest.
- Stay as far as possible from smoke, because the smoke may comprise toxic gases.
- Cover your mouth and nose with a damp cloth. Place a damp cloth above the person too and ensure that the person does not inhale toxic gases.
- Look out for the nearest emergency exit routes and call out for people, who you can take along with you.
- While opening a door, first touch the door with the back of your palm.
- Wrap the person with a blanket to protect him/ her from fire.
- Start moving out of the building carefully as you have to carry a person with yourself.
- Always use a staircase and not the elevator.
- Do not rush
- As you move out of the building, gather people, whoever you come across.
- Always move downstairs and avoid returning to the burning premises, until the fire-fighters arrive.

(B) Initiate evacuation

- Stop your work immediately but do not panic.

- Gather and carry only the most important items like a cell phone before leaving with the person.
- Leave the house via the nearest door bearing an **"exit"** sign.
- Report to the person's parents over the telephone if they are not present.
- Call 101 for fire emergency or 108 for other natural disaster help.
- Incorporate first aid treatment to the person, if needed.

(C) Emergency evacuation process

- On hearing an evacuation alarm or instruction of any people inside or outside the house regarding fire, immediately cease all activity and secure personal valuables.
- Assist any person in immediate danger, but only if safe to do so.
- If practical, and only if safe to do so, secure any activity or process that may become hazardous or suffer damage if left unattended as a consequence of evacuation.
- Act in accordance with directions given by emergency control personnel and evacuate the building immediately.
- Assist with the general evacuation if directed to do so by emergency control personnel.
- Assist with the evacuation of disabled occupants.
- In a fire, do not use a lift to evacuate a building.
- Move calmly to the nominated evacuation assembly area and do not leave the evacuation assembly area until the all clear has been given.
- Follow the instructions of relevant emergency services personnel and campus emergency control personnel.

How to deal with fire

If the house has got fire, you need to take following steps:

- If the fire is very small and can be handled, you should deal with it yourself. Otherwise, you should come out of the house with other family members.
- Call the fire brigade and also the neighbours for help.
- If your clothes got fire, lie down on the floor and roll around so that the flames may smooth.
- If you are trapped in a fire in a room, bent down on your knees and try not to inhale the smoke as much as possible.
- You should crawl toward the exit as soon as you can.
- You can use the fire extinguisher on the small fire, but you should get yourself trained on it.

4.1.12 Fire hazards, risks and controls relating to hydrocarbons

Lightning

A lightning strike is a massive discharge of electricity from the atmosphere, where the electrical charge has built up, to the earth.

The threat from lightning cannot be entirely eliminated, particularly with floating roof tanks where vapour is usually present around the rim seal. In these circumstances, measures to mitigate the consequences of a fire should be provided, including automatic rim seal fire extinguisher systems.

Threats from a lightning strike include:

- Sparks which can cause a fire or explosion.
- Power surges to electrical equipment, particularly monitoring and safety devices which can render them inoperable.

Protection from lightning strikes is a specialist area requiring expert knowledge as to what systems are suitable for each facility. However, in general they include the following:

- A 'dissipation array system' which reduces the potential between the site and any storm cloud cell that might be in the vicinity.
- A grounding system called a 'current collector'. This provides an electrically isolated area within which the facility will be located. This is normally made up of wire buried to a depth of about 25 centimetres and which surrounds the protected area. This wire is also connected to rods which are driven into the earth at about 10- metre intervals. Finally, the enclosed area is integrated by a net of cross- conductors which are also connected to any structures within the area, as well as the grounding system itself. This allows any current to discharge to earth safely.
- Electrical surge suppression devices. These devices have two distinct functions to perform. First, to stop direct strikes within the facility, and second, to prevent fast- rising, high current surges.

In general, the necessary precautions are:

- To keep the lightning channelled far away from the immediate neighbourhood of flammable and explosive materials.
- To avoid sparking or flash over in joints and clamps, and at nearby components.
- To prevent the overheating of conductors.
- To prevent flash over or sparking due to induced voltages.
- To prevent raising the potential of the earth termination system.
- All metal containers to be of sufficient thickness (usually 5 mm minimum).
- Down- conductors fitted to all other metal structures and in sufficient numbers as to subdivide any current surge adequately.
- All earthing systems to be interconnected to a single earth termination system. This usually takes the form of a mesh or grid pattern around the site.

Potential consequences of explosions and thermal radiation

Fire can be defined as "the rapid oxidization of a material or substance". This is known as combustion, which releases light, heat and various reaction products such as smoke and gas. Fire is made up of three interdependent elements known as the fire triangle. These are:

- Heat or a source of ignition.
- Fuel.
- Oxygen.

This is known as the fire triangle.

1. **Explosions:** An explosion is a type of fire but one which combusted with such a rapid force that it causes an effect known as over- pressure (explosion). Under certain conditions, the speed of the front of the flame may move to a supersonic level, resulting in a significantly more powerful explosion.

   There are three types of explosion that are associated with the oil and gas industry. These are:

   - Boiling liquid expanding vapour explosion (BLEVE).
   - Confined vapour cloud explosion (CVCE).
   - Unconfined vapour cloud explosion (UVCE).

2. **Thermal radiation:** Thermal radiation is the transfer of heat from one source to another. This can be a structure or a person. Where the recipient source is a person, the consequences can be severe.

   The initial effect of exposure to a source of heat (fire) is to warm the skin. This then becomes painful as the amount of energy absorbed increases. Thereafter, second- degree burns begin to take effect, with the depth of burn increasing with time for a steady level of radiation. Ultimately, the full thickness of the skin will burn and the underlying flesh will start to be damaged, resulting in third- degree burns.

   When plant, including pipework and vessels, is exposed to thermal radiation the effect is the transfer of heat to the product inside the plant. This can change the characteristic of the product and make it less stable. These characteristics include the potential to make the product expand and/or increase the amount of vapour given off, amongst other things. This can result in loss of containment, with an ensuing vapour cloud explosion, jet fire, pool fire or running liquid fire.

Electrostatic charges

Whenever a liquid moves against a solid object, such as the inside of a pipe, it generates a static electrical charge. This is caused by ions (charged atoms) being transferred from the liquid to the surface of the pipe or vessel.

The most common cause of static electricity build- up is where there is a flow (transfer) or movement (mixing process) of liquid within a process.

The amount and rate of static generation can be dictated by a number of factors. These factors, or

their elimination or reduction, can also be used to control the risks associated with static electrical generation. These include:

- The conductivity of the liquid.
- The amount of turbulence in the liquid.
- The amount of surface area contact between the liquid and other surfaces.
- The velocity of the liquid.
- The presence of impurities in the liquid.
- The atmospheric conditions. Static build-up is enhanced when the air is dry.

Let's look at some typical areas within a process where static electricity is most likely to occur, as well as some simple control measures.

1. **Electrostatic charges - piping systems:** As we've mentioned, the flow of liquid through piping systems can generate a static charge. However, there are factors which can influence the amount of charge generated. These include the rate of flow and the velocity of the liquid.

   Control measures include keeping the rate and velocity of the liquid low. This can be achieved by ensuring pipe dimensions are appropriate for the volume of liquid flowing through them; and also ensuring the length of pipe is as short as possible.

2. **Electrostatic charges - filling operations:** Filling operations, which involve large flows of liquid and splashing, generate turbulence. This turbulence allows the large amounts of liquid to pass against the vessel surfaces which in turn generates a static charge. If the liquid has already passed through piping to get to the filling operation, this will only serve to increase the accumulated charge already generated.

   Control measures include:

   - Ensuring filling operations do not involve the free-fall of liquids. This will reduce the amount of splashing taking place.
   - Lowering the velocity of the liquid being filled.
   - Ensure fill pipes touch the bottom of the container being filled.
   - Tanks which have been filled with products that have a low conductivity, i.e. Jet fuels and diesels, should be given time to relax before the process continues.
   - Tanks which have been filled with product should not have any ullage (vapour space) for a set period of time. Nor should any dipping of the product take place, again for a set period of time.

3. **Electrostatic charges - filtration:** by their very nature, filters have large surface areas, and this can generate as much as 200 times the amount of electrostatic charge in a piping system that has a filtration system within it, as compared with the same piping system without filtration. Control measures include ensuring good bonding and grounding is in place.
4. **Electrostatic charges - other issues:**

   - Liquids which have particles within them are more susceptible to the generation of static charge than those without.

- Static can be generated when liquids are mixed together.
- Piping or vessels which allow a space for vapour to accumulate are a particular concern as any spark generated from a discharge of static electricity may cause an explosion inside the pipe.

Methods of controlling static charges

Although the generation of static electricity cannot be totally eliminated, the rate of generation and its accumulation can be reduced by the following control measures:

1. **Methods of controlling static charges - additives:** In some instances, anti- static additives can be introduced to reduce static charge build up.
2. **Methods of controlling static charges - bonding and grounding:** Bonding and grounding techniques are a very effective means of minimizing the risk of spark generation from a build- up of static electricity.

A bonding system is where all the various pieces of equipment within a process system are connected together. This ensures that they all have the same electrical potential, which means there is no possibility of a discharge of electricity, by way of a spark, from one piece of equipment to another.

Grounding is where pieces of equipment (which may be bonded together or not) are connected to an earthing point. This ensures any electrical charge in the equipment is given the means to constantly flow to earth, thus ensuring there is no potentially dangerous build- up of charge which could lead to a sudden discharge of electricity, by way of a spark.

All equipment which is involved in processing or storing flammable liquid, gas or vapour should be bonded and grounded.

Some other considerations are:

- Incidental objects and equipment, such as probes, thermometers and spray nozzles, which are isolated, but which can become sufficiently charged to cause a static spark, may need special consideration.
- The cables used for bonding and grounding cables should be heavy duty cables. This is to ensure that they can cope with physical wear and tear without compromising their grounding ability. It is also to ensure that their electrical resistance is as low as possible.
- The bonding of process equipment to conductors must be direct and positive.
- Using an inert gas, such as nitrogen, within the ullage space of a storage vessel will prevent an explosion or flash fire occurring if an electrostatic spark does occur. The inert gas lowers the oxygen content of the gas in the ullage space, thus ensuring there is insufficient oxygen to support a burning process (oxygen being part of the fire triangle).
- Operators should wear anti-static clothing.

The identification of ignition sources

1. **Fire hazards, risks and controls:** In the oil and gas industry, the severity of any incident involving fire and/or explosion is likely to be very grave, possibly involving loss of life, severe damage or

destruction of plant, as well as having a potential impact on local communities. Consequently, any type of fire or explosion is unacceptable and controls must be put in place to prevent such an occurrence. These controls fall into two main categories.

First, any product should remain contained or under control throughout the process it is undergoing. In simple terms this means that any leak of product is regarded as highly undesirable. However, if a leak does occur there should be systems in place to detect it immediately and for appropriate action to be taken to control it and/or mitigate any consequences.

Second, all sources of ignition should be eradicated as far as possible in areas where product is processed and has the potential to escape.

Where it is necessary to introduce an ignition source into such an area, such as maintenance involving hot work, then an appropriate risk assessment should be undertaken to identify and evaluate the risks, as well as introducing a permit- to- work regime. These measures may well be accompanied by other appropriate controls, such as temporarily shutting down the process and having fire- fighting equipment to hand.

2. **Identifying sources of ignition:** We will now look at potential ignition sources which need to be considered when conducting a risk assessment. Some of the sources of ignition have had basic control measures added.

   - **Smoking and smoking material:** A total ban on smoking and the taking of smoking materials into controlled areas should be enforced.
   - **Vehicles:** Vehicles may be totally prohibited or restricted to only specially adapted vehicles
   - **Hot work such as welding, grinding, burning, etc.:** Implement a permit-to-work regime.
   - **Electrical equipment:** The equipment should be suitable for the zone it is intended to be used in. It should also be properly and regularly inspected and maintained.
   - Machinery such as generators, compressors, etc.
   - Hot surfaces such as those heated by process or by local weather (hot deserts).
   - Heated process equipment such as dryers and furnaces.
   - Flames such as pilot lights.
   - Space heating equipment.
   - **Sparks from lights and switches:** Use only electrical equipment and instrumentation classified for the zone in which it is located.
   - Impact sparks.
   - **Stray current from electrical equipment:** Ensure all equipment is bonded and earthed.
   - **Electrostatic discharge sparks:** Bond and ground all plant and equipment
   - **Electromagnetic radiation:** Make the correct selection of equipment to avoid high intensity electromagnetic radiation sources, e.g. Limitation on the power input to fibre optic systems, avoidance of high intensity lasers or sources of infrared radiation.
   - **Lightning:** We have covered the control measures for lightning earlier in this section.

There should be measures in place which reduce the potential of a lightning strike, as well as a grounding system to disperse any charge that may affect the installation. A further consideration is to look at weather windows (i.e. To not work during electrical storms).

Other control measures include:

- Controls over activities that create intermittent hazardous areas, e.g. Tanker loading/unloading.
- Control of maintenance activities that may cause sparks or flames through a permit- to-work system.
- Precautions to control the risk from pyrophoric scale. This is where a substance can ignite spontaneously in air, particularly humid air, and is usually associated with formation of ferrous sulphide.
- Where control and/or detection equipment is regarded as critical, such as smoke and flame detectors, then a back-up or secondary system may be considered appropriate.

  All of these control measures are supplementary to the main control and fire- fighting systems such as emergency shut down systems, fire deluge systems, sprinkler systems, etc.

Zoning/hazardous area classification and selection of suitable ignition- protected electrical and mechanical equipment and critical control equipment

Gases and vapours can create explosive atmospheres. Consequently, areas where these potentially hazardous airborne substances present themselves are classed as hazardous areas so that appropriate controls can be implemented.

However, how often these substances present themselves is also a factor in determining the appropriate level of control. For example, if the presence of a flammable vapour only happens once every three months, it would not be sensible to apply the same level of control to an area where a flammable vapour is present all day, every day.

The answer is to apply a classification to areas - called zoning - which places appropriate controls on the type of equipment that can be used in that area and which potentially can create a source of ignition, particularly electrical equipment, which reflect the risk involved.

This zoning is determined by the frequency and extent of explosive atmospheres being present over a fixed period of time and the likelihood of an explosive atmosphere occurring at the same time as an ignition source becomes active. All of these parameters are established through a rigorous risk assessment.

1. **Zoning:** A place where an explosive atmosphere may occur on a basis frequent enough to be regarded as requiring special precautions to reduce the risk of a fire or explosion to an acceptable level is called a ‘hazardous place’.

   A place where an explosive atmosphere is not expected to occur on a basis frequent enough to be regarded as requiring special precautions is called a ‘non- hazardous place’.

   Under these circumstances, ‘special precautions’ means applying measures to control sources of ignition within an area designated as a hazardous place.

   Determining which areas are hazardous places, and to what extent, is called a ‘hazardous area

classification study'. A hazardous area classification study is a method of analysing the extent and frequency to which an area is subject to having an explosive atmosphere. The main purpose of this is to facilitate the appropriate selection and installation of apparatus, tools and equipment which can be used safely within the environment, even if an explosive atmosphere is present.

A hazardous area classification study involves giving due consideration to the following:

- The flammable materials that may be present.
- The physical properties and characteristics of each of the flammable materials.
- The source of potential releases and how they can form explosive atmospheres.
- Prevailing operating temperatures and pressures.
- Presence, degree and availability of ventilation (forced and natural).
- Dispersion of released vapours to below flammable limits.
- The probability of each release scenario.

Consideration of these factors will enable the appropriate selection of zone classification for each area regarded as hazardous, as well as the geographical extent of each zone. The results of this work should be documented in hazardous area classification data sheets. These sheets should be supported by appropriate reference drawings which will show the extent of the zones around various plant items.

Hazardous areas are classified into zones based on an assessment of two factors:

A) the frequency of the occurrence of an explosive gas atmosphere.

B) the duration of an explosive gas atmosphere.

These two factors in combination will then facilitate the decision- making process which will determine which zone will apply to the area under consideration.

- **Zone 0:** An area in which an explosive gas atmosphere is present continuously or for long periods of time.
- **Zone 1:** An area in which an explosive gas atmosphere is likely to occur in normal operation.
- **Zone 2:** An area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, will only exist for a short period of time.

As the zone definitions only take into account the frequency and duration of explosive atmospheres being present, and not the consequences of an explosion, it may be deemed necessary, because of the severe consequences of any explosion, to upgrade any equipment specified for use within that area to a higher level. This will be a discretionary option open to the analysis team.

2. **Selection of equipment:** The whole idea of zoning is to determine what apparatus, tools and equipment may be installed or used in a particular zone. The issue with electrical equipment is that it normally creates sparks, either as a result of the brushes coming in contact within the rotating armature, or when a switch is activated. Either event can ignite any flammable gas present in the atmosphere in the vicinity of the equipment.

Consequently, manufacturers have designed specialized equipment which overcomes, in various ways, the issue of having sparks which are exposed to the local atmosphere. The particular solution which is incorporated into each piece of equipment is signified by a code which is marked on the equipment's product identification label. For example, 'd' signifies equipment which has the motor and switch enclosed in a flame proof enclosure, or 'q' powder filled. Both pieces of equipment are safe to use in zones 1 and 2.

Tools and equipment categorization in zoned areas

Zone 0 An area in which an explosive gas atmosphere is present continuously or for long periods of time.	**Zone 1** An area in which an explosive gas atmosphere is likely to occur in normal operation.	**Zone 3** An area in which explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, will only exist for a short period of time.
Category 1 equipment Note: although this equipment is categorized for use in zone 0, it can also be used in zone 1 and zone 2.	**Category 2 equipment** Note: although this equipment is categorized for use in zone 1, it can also be used in and zone 2.	**Category 3 equipment** Note: this equipment is also used in zone 3.
1a - intrinsically safe Ex s - special protection if specifically certified for zone 0.	'D' flame proof enclosure 'P' pressurized 'Q' power filled 'O' - oil immersion 'E' - intrinsically safe 'M' - encapsulated 'S' - special protection	Electrical type 'n'

Table: 4.1.1 Tools and equipments categories

Temperature classification for tools and equipment in zoned areas

Temperature	Maximum surface temperature	Substances can be used which will not auto ignite at temperatures below.
T1	450 ºC	450 ºC
T2	300 ºC	300 ºC
T3	200 ºC	200 ºC
T4	100 ºC	100 ºC
T5	85 ºC	85 ºC

Table: 4.1.2 Temperature classification for tools in zonal areas

4.1.13 Emergency evacuation procedures

Decisions relating to the method of emergency evacuation are made at the time a building is designed and based on such factors as the proposed purpose group and the size of the building. Once a building is occupied, it will be necessary to devise detailed emergency evacuation procedures that take into account the design features and fixed installation of a building.

When devising emergency procedures the responsible person will need to consider:

- The characteristics of the occupants, their disposition within the building, their physical and mental state.
- The characteristics of the building in terms of its size, use and construction.
- The physical provisions for means of escape in the building.
- The circumstances under which it will be necessary to evacuate.
- What the arrangements are for fighting the fire.
- What type of evacuation will be appropriate, e.g. Phased or full.
- How the evacuation is to be initiated.
- What arrangements are needed to call the fire service.
- What special roles are required to support the procedure, e.g. Fire warden and fire incident controllers.
- What information, instruction and training is necessary to support the procedure.

The fire risk assessment will provide much of this information and it will also give an indication of the time available for the occupants of a building to reach a place of safety. In most cases, the full evacuation of a building should be achieved in the region of 2.5–3 Minutes. This time will be extended where a phased/sequential procedure is adopted.

The procedure

The procedure should cover:

- What to do on discovering a fire or smell smoke.
- What to do on hearing the alarm.
- Roles and responsibilities of staff, e.g. Conducting in assisting disabled occupants.
- Arrangements for calling the fire service.
- How to save time, e.g. Leaving personal belongings behind.
- Where to evacuate to.
- Any special precautions that may need to be taken.

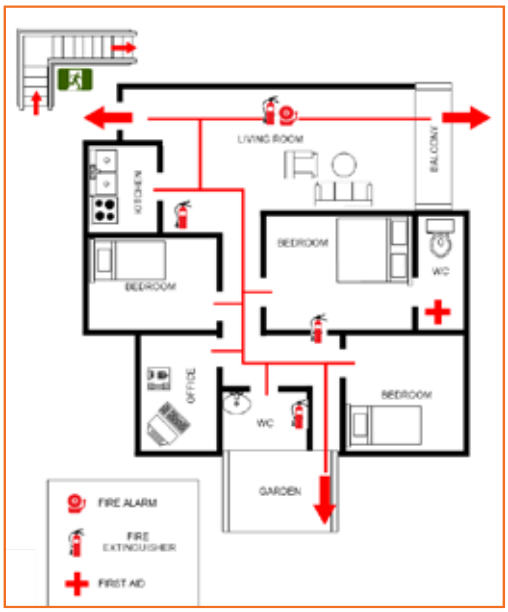


Fig: 4.1.11 Emergency Evacuation map

Clear concise arrangements should be displayed; they may also be supplemented by additional information such as escape route plans in hotels and licensed premises.

Competent staff

In order to ensure the safe evacuation of people in the event of fire it is not possible merely to rely on building design, adequate means of escape, fire alarms, emergency lighting, etc. In all but the smallest workplaces it will be necessary to have staff that have been trained to assist with emergency evacuation. Specifically those people responsible for fire safety within buildings and outside venues will need to consider the provision of fire wardens/marshals, crowd safety stewards, fire alarm verifiers and fire incident controllers.

Fire safety technician's role in emergency evacuation procedures

It is important to realise that fire safety technicians contribute to the safety of people in fire. First, they have a proactive role that requires them to support the ongoing management of fire safety by carrying out such duties as:

- Carrying out an ongoing fire risk assessment while at work.

Identifying fire hazards and removing them or reporting them to management, for example:

- Taking action to reduce the risk of arson.
- Ensuring flammable liquids are stored and used correctly.
- Ensuring sources of ignition are limited or controlled (for example, checking permits to work for any hot work).
- Monitoring smoking in the workplace.
- Monitoring the build-up of combustible storage and waste.

Monitoring fire protection measures, for example:

- Ensuring fire doors are in good condition and kept locked or closed shut as necessary.
- Ensuring fire fighting equipment is in position, tested and in good condition.
- Ensuring means of escape including corridors and final exit doors are not obstructed particularly with combustible material.
- Ensuring all doors required to provide emergency egress are clearly marked and operate as they should.
- Knowing what action to take in the event of a fire.
- Being trained to tackle fire should the need arise.
- Being competent to assist in the full and safe evacuation of people in the event of a fire.

However, the emergency role of a fire safety technician must include the following:

- Knowing how to raise the alarm.
- Knowing how to call the fire service.
- Knowing where the means of escape for the part of the workplace that they are responsible for is.
- Being prepared and trained to use fire fighting equipment if it is safe to do so.

Assisting the evacuation of people by:

- Donning a high visibility jacket or waistcoat in order to be easily recognised.
- Assisting disabled staff members in accordance with individual peeps.
- Conducting a quick but thorough check or sweep of all rooms including walk-in cupboards, plant rooms and toilets.
- Ensuring heat generating equipment is turned off.
- Closing doors and windows if possible.
- Reporting to the fire incident controller the situation within their area of responsibility).
- Take a roll call.
- Assist the return to the workplace when the fire service confirm it is safe to do so.

The purpose of drills, evacuation and roll-calls

There is no evidence from research to suggest that a fire exit sign will necessarily encourage people to head towards it in the event of a fire, unless the route is already familiar. Occupants may choose to ignore specific fire exit routes and choose familiar routes. It is quite likely that people would often be more inclined to move to a familiar exit which is further away than an unfamiliar exit nearby. Therefore it is vital that where possible people who may need to use an exit in the event of an emergency are familiar with it.

The purpose of practising an evacuation procedure is to ensure it functions adequately, to ensure all those with a specific role in the procedure are aware of and competent in their role and are able to demonstrate to all parties that arrangements have been put in place to achieve a reasonable level of safety in the event of fire.

The object of a fire evacuation procedure is to practise good evacuation behaviour, so that people do not experience or develop serious health effects associated with being exposed to the effects of fire.

Confirming the building is clear

In the event of a fire in a building the fire service will need to know, among other things, whether or not there are still people left in the building. It is important to provide the fire service with clear information regarding the situation relating to people in the building. If the fire service officer on the scene has any doubt as to whether there are persons in a building their first priority becomes the rescue of those people. This will involve committing Fire fighters into the building to conduct search and rescue operations and is very likely to delay an attack on the main seat of the fire.

In order to be confident when reporting to the fire service, the fire incident controller will need to know that everyone has either left the building or, if people are still in the building, where they are likely to be found. The two methods used by a fire incident controller are the ‘sweep’ and ‘roll-call’.

1. **Sweep:** The sweep technique is simply the application of a systematic and progressive checking of all the areas within a building or within the area of responsibility of a fire warden/marshal. When conducting a sweep of an area it is important to ensure that all areas that may be occupied are swept. This includes any plant rooms where contractors may be working, any walk-in cupboards or storerooms and any toilets or rest facilities. During a sweep of an area the fire warden/marshal

should also ensure that where possible and without causing undue delay any doors or windows are closed, any heat generating equipment is turned off and any signs of fire are noted and, if appropriate, dealt with.

In order to ensure that an effective sweep is made of a building at the time of an emergency evacuation it is necessary for the fire safety manager or fire incident controller to allocate specific areas of the building to specific fire wardens/marshals. In the case of multi story offices this is often achieved by nominating two to three fire wardens per floor, whereas, in the case of an open plan factory, fire wardens may be allocated to production areas.

When planning the division of a large building to be swept by fire wardens it is important to bear in mind that the area to be swept by one individual must be of a size and nature that will allow the sweep to be conducted and the warden to evacuate within 2½ and 3 minutes of the alarm sounding.

2. **Roll-call:** In addition to a sweep of the premises it is often the case that some form of roll-call will be taken at the fire assembly point. The level and nature of the roll-call will be determined by the fire risk assessment and be dependent upon factors such as
    - The size and nature of the workforce.
    - The number and nature of any visitors that may be present in the building.
    - The resources required to maintain an accurate roll-call of persons in the building.

4.1.14 First aid

First aid is the first assistance or treatment given to a casualty or a sick person for any injury or sudden illness before the arrival of an ambulance, the arrival of a qualified paramedical or medical person or before arriving at a facility that can provide professional medical care.

Aims of first aid

The aims of first aid are:

- To preserve life,
- To prevent the worsening of one's medical condition,
- To promote recovery, and
- To help to ensure safe transportation to the nearest healthcare facility.

Role of first aider: remember pact

P - Protect
A - Assess
C - Care
T - Transport-Triage

(A) Vital signs

Vital signs are measurements of the body's basic functions. Normal vital signs change with age, sex, weight, exercise tolerance, and overall health. The four main vital signs that are usually monitored are given as follows.

Vital Signs	Good	Poor
Heart Rate	60-100 beats per minute	Less than 60 or greater than 100 beats per minute
Respirations	14-16 breaths per minute	Less than 14 breaths per minute
Skin	Warm, pink and dry	Cool, pale and moist
Consciousness	Alert and orientated	Drowsy or unconscious

Table: 5.1.5 Vital sign

(B) four a's

Awareness	Assessment	Action	After care
• Observe • Stop to Help	• Assess what is required to be done. • Ask yourself, 'Can I do it?'	• Do what you can • Call for expert medical help. • Take care of your and the bystander's safety.	• Once you have assisted the victim, stay with him/her till expert care arrives.

Table: 5.1.6 Four a's

(C) Degrees of burns

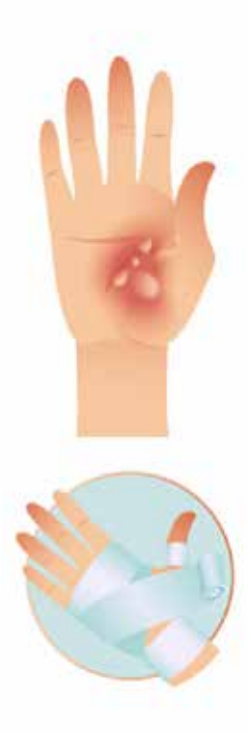
1st degree burn	2nd degree burn	3rd degree burn	4th degree burn
Will recover by it-self in a few days. Action required: place under running water. 	Serious but recovers in a few weeks. Action required: place clean wet cloth over the burnt area. 	Very serious and will require skin grafting. Action required: place a clean dry cloth over the burnt area. 	Extremely serious and requires many years with repeated plastic surgery and skin grafting, is life threatening. Action required: leave open and prevent infection. 

Table: 5.1.7 Burn classification

(D) First aid techniques for common injuries

Some common techniques to first aid common injuries.

Injury	Symptom	Do's	Don'ts
Fracture	• Pain • Swelling • Visible bone	• Immobilise the affected part. • Stabilise the affected part. • Use a cloth as a sling. • Use board as a sling. • Carefully transfer the victim on a stretcher.	• Do not move the affected part. • Do not wash or probe the injured area.

Injury	Symptom	Do's	Don'ts
Burns (see degrees of burn table)	• Redness of skin • Blistered skin • Injury marks • Headache/seizures	• In case of electrical burn, cut-off the power supply. • In case of fire, put out fire with blanket/coat. • Use water to douse the flames. • Remove any jewellery from the affected area. • Wash the burn with water. 	• Do not pull off any clothing stuck to the burnt skin. • Do not place ice on the burn. • Do not use cotton to cover the burn.
Bleeding	• Bruises. • Visible blood loss from body. • Coughing blood. • Wound/ injury marks. • Unconsciousness due to blood loss. • Dizziness. • Pale skin.	• Check victim's breathing. • Elevate the wound above heart level. • Apply direct pressure to the wound with a clean cloth or hands. • Remove any visible objects from the wounds. • Apply bandage once the bleeding stops.	• Do not clean the wound from out to in direction. • Do not apply too much pressure (not more than 15 mins). • Do not give water to the victim.

Table: 4.1.8 First aid techniques for common injuries

4.1.14 Cardiopulmonary resuscitation (CPR)

Cardiopulmonary resuscitation (CPR) is a lifesaving technique. It aims to keep blood and oxygen flowing through the body when a person's heart and breathing have stopped. CPR can be performed by any trained person. It involves external chest compressions and rescue breathing. CPR performed within the first six minutes of the heart stopping can keep someone alive until medical help arrives.

Fundamentally these are referred to as abc of life. The process is always referred to perform in an emergency:

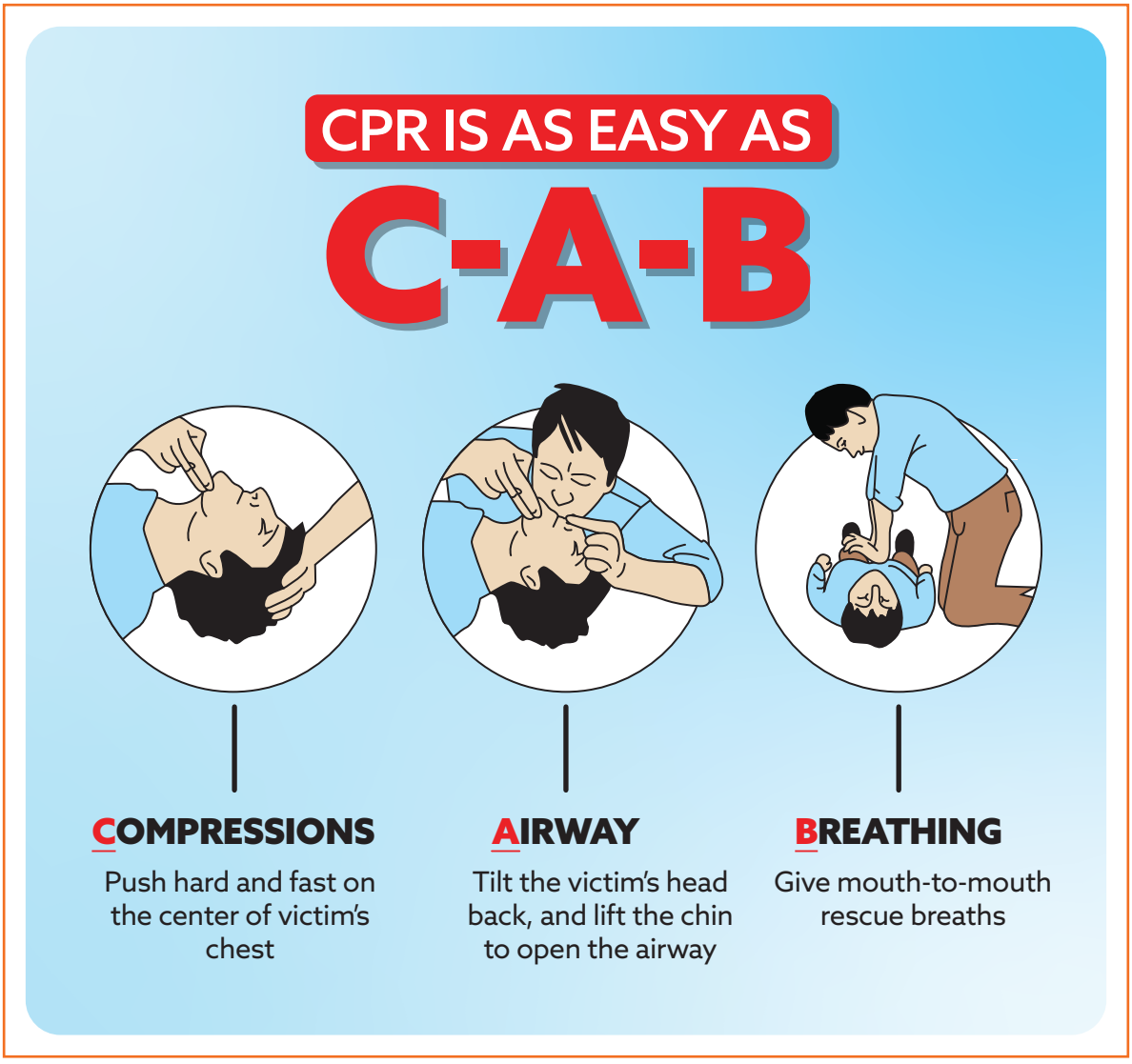


Fig: 4.1.12 CPR Process

Performing hands-only CPR

If a person is not breathing, his or her heartbeat will stop. These CPR steps (chest compressions and rescue breaths) will help circulation and get oxygen into the body.

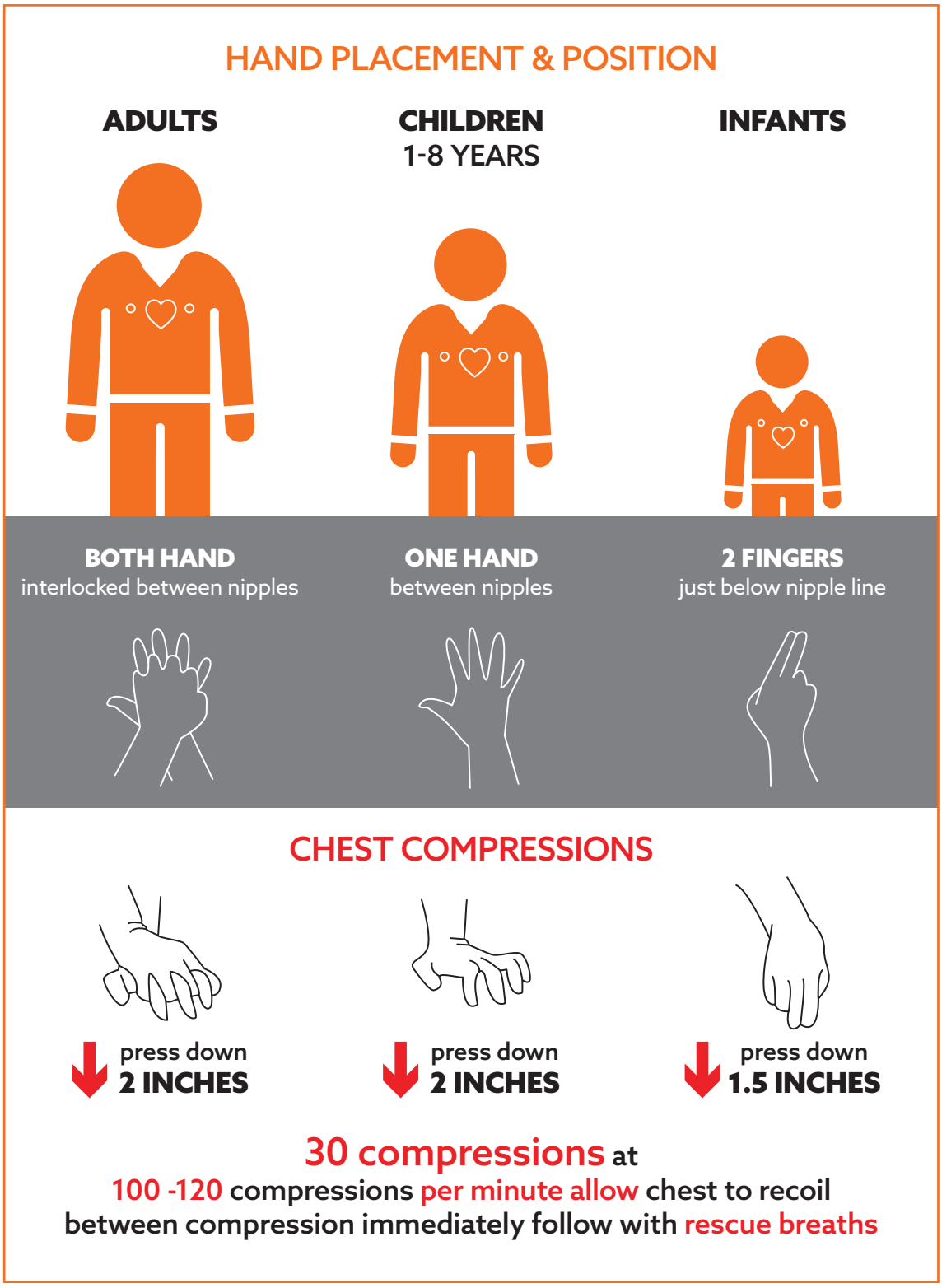


Fig: 4.1.12 Performing CPR Steps

Step 1: Position your hand Make sure the victim is lying on his back on a firm surface. Kneel beside him and place the heel of your hand on the centre of the chest.	
Step 2: Interlock fingers Keeping your arms straight, cover the first hand with the heel of your other hand and interlock the fingers of both hands together. Keep your fingers raised so they do not touch the Victim's chest or rib cage.	
Step 3: Give chest compressions Lean forward so that your shoulders are directly over the victim's chest and press down on the chest about two inches. Release the pressure, but not your hands, and let the chest come back up. Repeat to give 30 compressions at a rate of 100 compressions per minute.	
Step 4: Open the airway Move to the victim's head. Tilt his head and lift his chin to open the airway again. Let his mouth fall open slightly.	
Step 5: Give rescue breaths Pinch the nostrils closed with the hand that was on the forehead and support the victim's chin with your other hand. Take a normal breath, put your mouth over the victim's, and blow until you can see his chest rise.	
Step 6: Watch chest fall Remove your mouth from the victim's and look along the chest, watching the chest fall. Repeat steps five and six once.	
Step 7: Repeat chest compressions and rescue breaths Place your hands on the chest again and repeat the cycle of 30 chest compressions, followed by two rescue breaths. Continue the cycle.	

Table: 4.1.9 Performing CPR steps

4.1.15 Accident/incident report forms

There are many kinds of accident/incident report forms but all do the same job - they all include the findings of the investigation and determine the causes of the incident. They also provide recommendations to prevent further occurrences. There are also various computer programs which have been developed to record and analyse data. Whatever the format, they all state:

- **What happened:** The injuries/losses/costs.
- **How it happened:** The event itself.
- **Why it happened:** The causes - root, underlying and immediate.
- **Recommendations:** Any action to be taken to remedy the situation and prevent any recurrences.

The use of standardized report forms ensures that the investigation process is correctly adhered to and that information can be reported back to management. Follow- up actions can easily be taken following appropriate recommendations within the report. Standardized report forms can also act as a checklist.

An efficient recording system will:

- Ensure the information is correctly and accurately presented.
- Allow the data to be analysed easily in order to discover common causes or trends.
- Ensure data which may be required for future reference is included.
- Identify issues which may help prevent any recurrence of the accident.

Report forms should be reviewed on a regular basis to ensure that any recommendations have been implemented.

Exercise

Choose one option amongst the following and complete the sentence.

1. The terms **"……."** and **"……."** are often used interchangeably.
   a) Light and bright
   b) Hazard and risk
   c) Care and careful
   d) Right and write

2. **Occupational health and safety encompass the social, mental and physical well-being of workers that is the "……."**
   a) Complete person
   b) Single person
   c) Whole person
   d) Similar person

3. **"Poor working conditions of any type have the potential to affect a worker's health and ……."**
   a) Safety
   b) Personality
   c) Dignity
   d) Speed.

4. **Complete the sentence:**

   Values (such as .....
   .....

.....

..... (planned or not planned).

5. **State True and False**

"The costs to employers of occupational accidents or illnesses are also estimated to be enormous." ☐ True ☐ False

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Classes of fire

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Types of fire and fire extinguishers

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Clean agent fire suppression system

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Transforming the skill landscape

HSSC
HYDROCARBON SECTOR
SKILL COUNCIL

5. Annexure

Sl No.	Module No.	Unit No. and Name	Topic Name	Page No.	URL	QR Code (s)
1	Module 2	Unit 2.1 - Carry out excavation work	2.1.1 Introduction to excavation	55	https://youtu.be/nC9c3D3VknM	Typical Stages of Pipeline Construction
2	Module 2	Unit 2.1 - Carry out excavation work	2.1.1 Introduction to excavation	55	https://youtu.be/-ZYb1cGQ-mw	Pipeline Construction Process
3	Module 2	Unit 2.1 - Carry out excavation work	2.1.1.1 Material Type	55	https://youtu.be/Eqr3KobUqsk	Excavations In Construction Soil Classification
4	Module 2	Unit 2.1 - Carry out excavation work	2.1.2 Excavation equipment	55	https://youtu.be/zl6dGZY59r0	Types of Excavation Equipments in Construction

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5	Module 2	Unit 2.1 - Carry out excavation work	2.1.2 Excavation equipment	55	https://youtu.be/cnmZ5jkcSCU	Trencher in Action
6	Module 2	Unit 2.1 - Carry out excavation work	2.1.4 Excavation Methods	55	https://youtu.be/CI7kENjXv20	Massive Trenchers on Gas Pipeline
7	Module 2	Unit 2.1 - Carry out excavation work	2.1.4 Excavation Methods	55	https://youtu.be/cl8BBoCV7gU	Horizontal Direction Drilling
8	Module 2	Unit 2.1 - Carry out excavation work	2.1.4 Excavation Methods	55	https://youtu.be/0QYpYWijb9E	Excavation Safety Training
9	Module 2	Unit 2.1 - Carry out excavation work	2.1.5 Trench Excavation	56	https://youtu.be/pP046HTKjkU	Safety Toolbox Talks: Trenching and Excavation Safety

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10	Module 2	Unit 2.1 - Carry out excavation work	2.1.6 Work Procedure of Excavation	56	https://youtu.be/kUqBUJEqwKA	Trenching: Prevention Video: Excavations in Construction
11	Module 2	Unit 2.1 - Carry out excavation work	2.1.7 Pipeline Installation	56	https://youtu.be/miPagtqT0IQ	Union Gas Pipeline Installation
12	Module 2	Unit 2.2 - Maintain safety during excavation	2.2.1 Safety Precautions in Excavation	56	https://youtu.be/p6IryUsdpZE	Excavation Safety
13	Module 2	Unit 2.2 - Maintain safety during excavation	2.2.1 Safety Precautions in Excavation	56	https://youtu.be/3vNRIW9p374	Excavation Safety in Hindi
14	Module 2	Unit 2.2 - Maintain safety during excavation	2.2.1 Safety Precautions in Excavation	56	https://youtu.be/-ExP-0b4Wv0	Excavation Safety

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15	Module 2	Unit 2.2 - Maintain safety during excavation	2.2.2 Use of personal protective equipments	56	https://youtu.be/QEB7wE-YFXg	Personal protective equipment
16	Module 2	Unit 2.2 - Maintain safety during excavation	2.2.3 Signs	56	https://youtu.be/2V2FFQUfxj0	Types of safety signs and symbols
17	Module 3	Unit 3.1 - Working effectively in a team	3.1.1 Conflict management	70	https://youtu.be/EDMY39JE1sY	5 steps to manage conflict between team members
18	Module 3	Unit 3.1 - Working effectively in a team	3.1.3 Achieve Goals in the Workplace	70	https://youtu.be/9MO1aY1xC80	Motivation - leader and teamwork!
19	Module 3	Unit 3.1 - Working effectively in a team	3.1.4 Working Effectively in a Team	70	https://youtu.be/6fbE52YDEjU	Team work can make the dream work

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20	Module 3	Unit 3.1 - Working effectively in a team	3.1.4 Work Effectively in a Team	70	https://youtu.be/H_vOfqIpD60	Why team building is important
21	Module 3	Unit 3.1 - Working effectively in a team	3.1.4 Work Effectively in a Team	71	https://youtu.be/WTa4wvFVX_Y	How to manage conflict in a team
22	Module 3	Unit 3.1 - Working effectively in a team	3.1.4 Work Effectively in a Team	71	https://youtu.be/fUXdrl9ch_Q	Good Teamwork and Bad Teamwork
23	Module 4	Unit 4.1 - Maintain health, safety and security procedures	4.1.11 Types of fire	114	https://youtu.be/xnZZruGjKBA	Classes of fire
24	Module 4	Unit 4.1 - Maintain health, safety and security procedures	4.1.11 Techniques of using the different fire extinguishers	114	https://youtu.be/aU1P7-Cn72s	Types of fire and fire extinguishers

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25	Module 4	Unit 4.1 - Maintain health, safety and security procedures	4.1.11 Techniques of using the different fire extinguishers	114	https://youtu.be/XmPnXzQVLQg	Clean agent fire suppression system
26	Module 4	Unit 4.1 - Maintain health, safety and security procedures	4.1.11 Different methods of extinguishing fire	114	https://youtu.be/9igRiyURobE	How to use a fire extinguisher
27	Module 4	Unit 4.1 - Maintain health, safety and security procedures	4.1.11 Techniques of using the different fire extinguishers	114	https://youtu.be/3nakKzM66hk	Fire extinguishing agents

Notes

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Transforming the skill landscape

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Price: ₹