

ELCEC302

ELECTRICAL CONDUIT SYSTEMS LYING

Lay electrical conduit system

Competence

REQF Level: 3

Credits: 5

Sector: Energy

Sub-sector: Domestic Electricity

Learning hours: 50



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Purpose statement

This module describes the skills, knowledge and attitude required to lay electrical conduit systems. It is intended for learners who have successfully completed the 9 years basic education or its equivalent and pursuing TVET Certificate III in Domestic electricity or other related qualifications. At the end of this module, learners will be able to Identify different types of electrical installation, install pipes and their fittings, install trunks and their fittings. Qualified learners deemed competent to this competency may work alone or with others on routine tasks in various places such as Home buildings, shops, warehouses, supermarket, hospitals, pharmacies, banks, schools, garage, market, home, churches, hotels under minimum supervision.

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Learning Unit 1: Identify different types of electrical installation

LO 1.1: Illustrate flush mounted/semi-built installation according to the area to be installed

Content/Topic 1. Steps of flush mounted/semi-built installation

A. Introduction

A.1 An electrical conduit (EC)

An electrical conduit is a piping system that is used to carry electrical wiring for either power or communication.

Steel conduit is used extensively in industrial premises. It has good mechanical strength and may be used as a CPC. Specialized tools are needed to install it, and steel conduit is not easily added to; it is subject to corrosion and is relatively expensive.

PVC conduit is used in commercial and light-industrial premises. It has quite high mechanical strength, and is inexpensive compared with steel. It does not corrode, is easily erected and no specialized tools are needed. It cannot stand extremes of temperature and distorts owing to its high degree of expansion unless this is compensated for; it cannot be used as a CPC.

Other types of conduit, including copper and aluminium, are available. these are termed non-ferrous conduits (non-magnetic) and are used in specialized environments only. Aluminium conduit is susceptible to a high degree of corrosion.

A.2. Advantages of using Electrical conduits than other wiring methods

- Electrical conduit provides very good protection to enclosed conductors from impact, moisture, and chemical vapors.
- Electrical Conduit is widely used to protect cables that carry various amounts of electrical current. For example, Rigid conduit is used to guard against crushing (to break with applying pressure) and shorting of cables.
- Conduit prevents accidental damage to the insulation.
- Varying numbers, sizes, and types of conductors can be pulled into a conduit, which simplifies design and construction compared to multiple runs of cables.
- Wiring systems in buildings may be subject to frequent alterations. Frequent wiring changes are made simpler and safer through the use of electrical conduit.
- Metal conduit can be used to shield in sensitive circuits from electromagnetic interference, and also can prevent emission of such interference from enclosed power cables.
- When installed with proper sealing fittings (well welded), a conduit will not permit the flow of flammable gases and vapors, which provides protection from fire and explosion hazard in areas handling volatile substances.
- Both metal and plastic conduit can be bent at the job site to allow a neat installation without excessive numbers of manufactured fittings.

A.3. Disadvantages of using Electrical conduits

- The cost of conduit installation is higher than other wiring methods due to the cost of materials and labour.
- Conductors installed within conduit cannot dissipate heat as readily as those installed in open wiring, so the current capacity of each conductor must be reduced if many are installed in one conduit.

B. Laying the electrical conduit in the slab

Lay the slab conduits between the top and bottom reinforcement. Use only deep junction boxes in slabs. Properly bind the PVC conduits using the binding wire. Check the wall drops carefully and determine the concrete thickness

- Slab conduits for house wiring should be done in 2 mm thick 25 mm size FR PVC conduits. Preferably Slab conduits shall be laid in between top and bottom reinforcement. Please ensure concrete thickness i.e. cover to PVC Conduits in case of singly reinforced slabs.
- Only Deep junction boxes shall be used in slabs. With Binding wire, properly bind the PVC conduits
- Preferably follow different color coding for conduits for data (LAN wire, telephone wire etc.,) and electrical wires
- Use grey PVC pipes for data and black PVC pipes for electrical wires. Use PVC solvent for jointing the accessories
- Wall drops shall be properly checked for face of wall/beam. Please ensure concrete thickness i.e. cover
- All the conducting shall be checked as per services drawing, which contains locations of switchboards and number of points to be installed at each location.
- Special precaution shall be taken during concreting of slab.
- All broken pipes are to be replaced
- All joints have are to be watertight joints to avoid choke up)
- GI wire passing shall be carried out immediately after de-shuttering of slab & beam. (any choke up to be documented and alternate routing to be shown in shop drawings and documented for future references).
- All necessary sleeves shall be provided in beams, columns, prior to slab casting as per electrical & air-conditioning.
- Pull boxes shall be provided at suitable locations.
- The pull and junction boxes shall not be clustered at one place and shall be so arranged that they should not be easily seen from heavy movement areas as per electrical drawings.

C. Laying Of Electrical Conduits In Walls

- The concealed conduit work shall be carried after construction of masonry walls but prior to plaster.
- Chasing work shall be carried out after completion of curing of brickwork (at least 7 days gap from brickwork).
- The wall chasing should be done with wall cutters only, this would avoid damage to walls.
- The conduits shall be fixed with approved clips to ensure proper routing and wiring later.

- After fixing the conduits, boxes, and accessories, the chiseled surface should be filled with cement mortar and chick mesh wrapped around conduits.
- Wall conducting activity shall start with level marking on the wall (usually box level), knowing its height above FFL(Finished floor level)
- The width of chasing shall be limited as per number of conduits.
- The depth of chasing to have conduit recess at least 10mm from masonry wall.
- All horizontal conduit runs shall be straight at box level. Light point conduit shall run straight vertical to switch box. No wall conduit shall be taken haphazardly.
- No Elbows & bends shall be used. In case of change in direction in pipe use spring to bend the pipe.
- Power conduits should not be run near any communication line.
- Conduits above false ceiling shall run with proper supports / suspenders. Conduits shall not be rested on false ceiling grid in any case. All vertical runs with open ends shall be sealed at top in case of false ceiling work, while masonry civil works going on.

D. Installation of Switch Board Back Boxes

- All concealed switch board shall be fixed properly in level as per given schedule (Height, distance from Finished Floor (FFL) should be as per architect's recommendation)
- The gap between two concealed switch boards shall be uniform & maintain same for all installation.
- The switchboards shall be readymade modular type metal boxes of approved makes & drawing.
- Concealed box shall be fixed 3 mm below the plastered surface.
- Box fixing shall be done before plastering work along with wall conduiting. These boxes shall be filled with thermocol while plastering work.

E. Installation of Distribution Boards

- DB's shall be concealed before plaster work
- DB box shall be fixed in proper line & level in the recess provided in brickwork
- DB's shall be ready-made as per design (fixing no. of conduits pipe entering DB)
- All PVC pipes shall enter in to DB from given entry holes only

LO 1.2 –Illustrate surface mounted/wall-mounted installation according to the area to be installed

Content/Topic 1.Physical appearances surface mounted/wall-mounted installation

A. Surface mounted

In the construction industry is anything this is physically mounted on the top of a surface, whether it is a wall, ceiling, floor or some other type of surface. Surface mounted is opposite from recessed or embedded into the surface



Figure 1.Surface mounted

B. Switch wall mounted

Wall-mounted luminaires are mounted directly to a wall surface. This type includes sconces, diffusers, and vanity lights. Track lighting can be also being mounted to the wall. Refer to Ceiling-Mounted Track or Adjustable Heads for more information. Wall-mounted luminaires are commonly used in homes because they are easy to install, are available in a wide variety of styles, and accommodate many lamp types. They can be used for most lighting techniques, particularly ambient, indirect, task, and special purposes. Purchase them from lighting stores, electrical suppliers, and building supply stores.

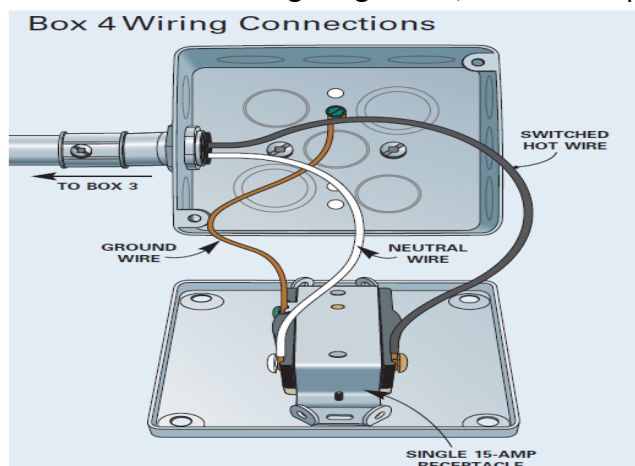


Figure 2.Switch connection

Energy and Lamps Installation Cautions Select wall-mounted luminaires with fluorescent lamps for energy savings. Wall-mounted luminaires are an appropriate choice for rooms with low ceilings. Direct glare potential is increased since wall-mounted luminaires are often directly in the field of view. Consider

mounting heights, aiming angles, and shielding of the luminaire. Also, wallmounted luminaires can limit the wall space that is available for furniture and artwork, so plan accordingly.

Use wall-mounted luminaires when plenum space is limited or structural elements, pipes, or ducts prohibit installing recessed luminaires. For high-rise multi-family housing, wall-mounted luminaires can be used where electrical distribution through the ceiling is limited or not available, such as in hallways and stairwells.

Also, for public spaces such as multi-family corridors, note that the Americans with Disabilities Act limits the outward extension of wall-mounted luminaires that are mounted below 80 inches (6 feet, 8 inches) above the floor.

They may not extend beyond 4 inches from the wall; make sure that the luminaire does not protrude beyond this limit. If a landing or balcony overlooks a room with wall-mounted luminaires, shield the lamps from view from above. Be careful with mounting heights and location to avoid physical contact. Surfaces may be hot and some luminaires can be damaged.

C. Socket outlet wall mounted

In other locations, power sockets are usually placed at a height of 15 to 20 cm above the finished floor surface. However, if you would like your home to be adaptable to changing needs then you should **place** them 40 to 50 cm above the floor.

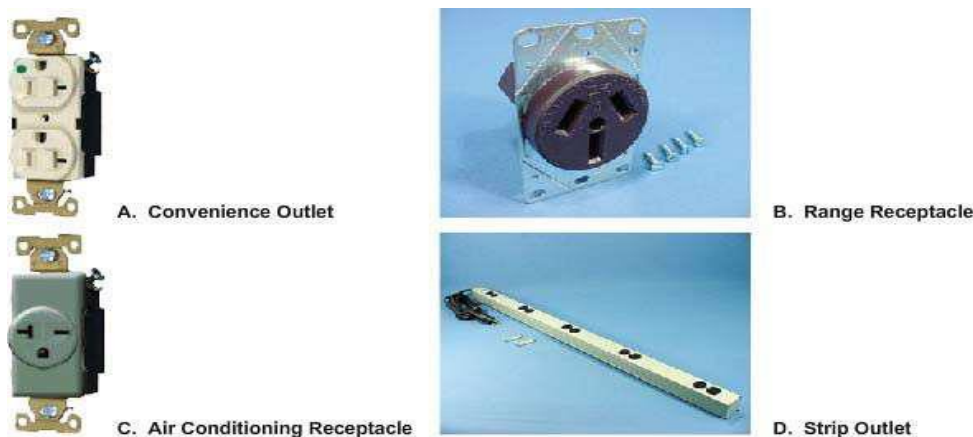


Figure 3.Socket outlet installation

- A convenience outlet (Figure, View A) is a duplex receptacle with two vertical or T-slots and a round contact for the ground. This ground is connected to the frame of the receptacle and is grounded to the box by way of screws that secure the receptacle to the box.
- A range receptacle (Figure, View B) may be either a surface type or a flush type. It has two slanted contacts and one vertical contact and is rated at 50 A. Receptacles for clothes dryers are similar but are rated at 30 A. Range and dryer receptacles are rated at 250 V and are used with three-wire, 115/230 V, two hot wires and a neutral.
- An air conditioner receptacle taking 230 V (Figure, View C) is made with two horizontal slots and one round contact for the ground.
- Strip receptacles (Figure, View D) used in the Navy allow movement of the receptacle to any desired location. These strips are available in 3-ft and 6-ft lengths and may be used around the entire room. They are particularly desirable with portable equipment or fixtures such as drafting

tables and audio-visual equipment. Exterior locations require special weatherproof outlets to resist weather damage and minimize potential hazards from water contacting the conductors.

D. Conduit wall mounted

PVC or GI conduits are laid on the surface of the wall or ceiling. These conduits are attached to the walls with a 2-hole strap and base clip at a regular certain distances. Electrical wires are laid inside the conduits.



Figure 4. Conduit wall mounted

Electrical codes allow multiple electrical wires to be pulled through a single conduit, but limit the number of wires allowed in a conduit run depending on the number of wires and the wire diameter or gauge.

The more wires you pull, the more crowded the conduit, so buy larger conduit---perhaps 3/4 inch instead of 1/2 inch.

E. Wire/cable wall mounted

Single or a group of wires are laid over a wooden batten. The wires are hold to the batten using a brass clip, which is attached to the wooden battens at an interval of 10-15 cms

F. Wire Connectors

Figure below shows various types of connectors used to join or splice conductors. The type used will depend on the type of installation and the wire size. Most connectors operate on the same principle, that of gripping or pressing the conductors together. Wire nuts are used extensively for connecting insulated single conductors (both solid and stranded) installed inside of buildings.

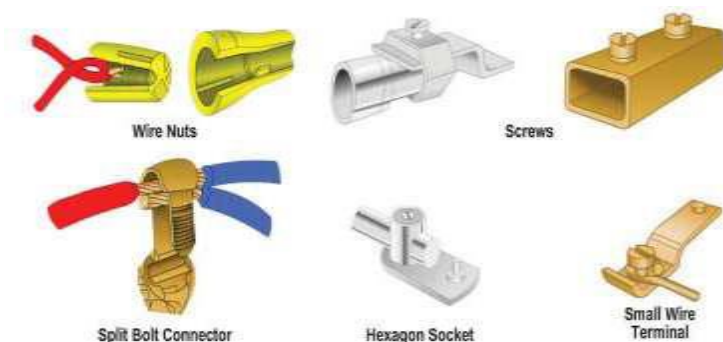


Figure 5. Wire Connectors

D. Distribution board wall mounted



Figure 6.distribution board

A distribution board (also known as panel board, breaker panel, or electric panel) is a component of an electricity supply system that divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit in a common enclosure. Normally, a main switch, and in recent boards, one or more residual-current devices (RCD) or residual current breakers with overcurrent protection (RCBO), are also incorporated

E. Junction box wall mounted

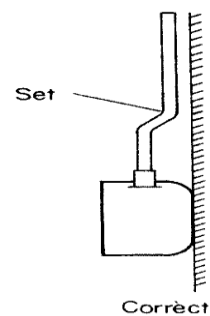
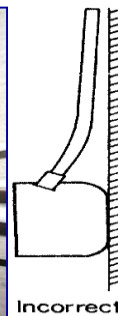
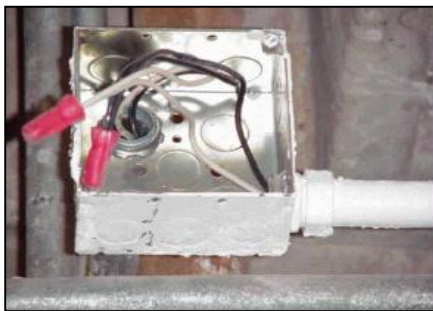


Figure 7Junction box mounting

There are several ways of joining and terminating conduit as shown below. Figure c shows a 'running coupler'. The conduits to be joined are threaded to a distance greater than the length of the coupler. The coupler is then screwed right on to one thread, the other conduit is butted to the first conduit and the coupler screwed back over the second thread. This method enables two conduits to be joined without

actually turning the conduits themselves. The locknuts are provided to prevent the coupler from moving.

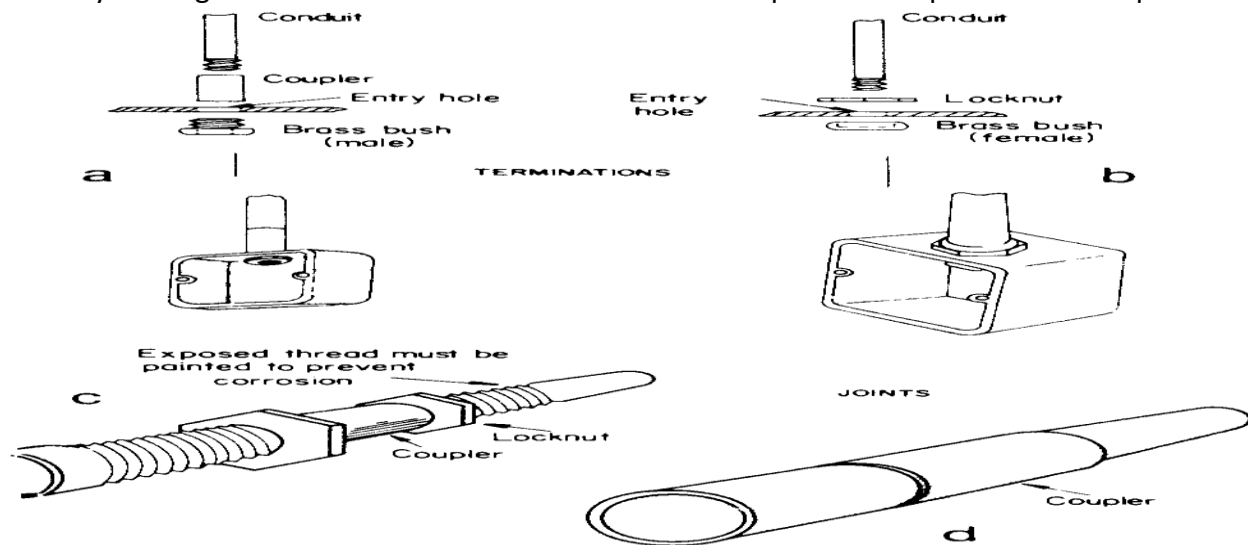
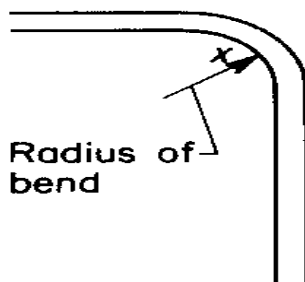


Figure 8 Fitting of junction box

F. Conduit fittings wall mounted

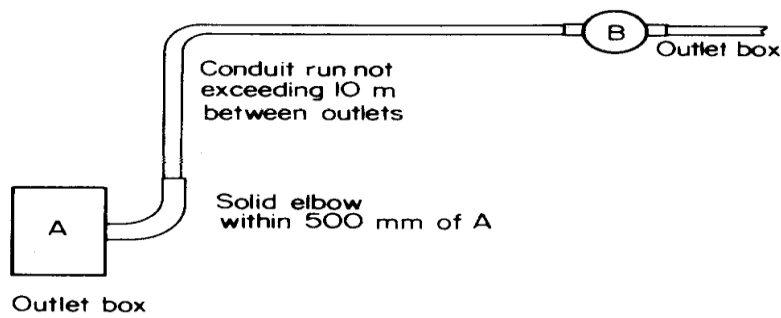
I.1. Points to note

- The conduit system for each circuit of an installation must be completely erected before any cables are drawn in.
- Inspection-type fittings must always be accessible for the removal or addition of cables.
- The number of cables drawn into a conduit may be achieved by selecting the size of conduit using the tables shown in the guidance notes to the Regulations. The system used applies to trunking as well as conduit. The
- When conduit is bent, the radius of any bend must not be less than 2.5 times the outside diameter of the conduit



e.g. for 20mm conduit
must not be less
than $2.5 \times 20 = 50\text{mm}$

- If non-inspection elbows or tees are used, they must be installed only at the end of a conduit immediately behind a luminaire (light fitting) or outlet box etc. of the inspection type. Alternatively one solid elbow may be located not more than 500 mm from a readily accessible outlet box in a conduit not exceeding 10 m between two outlet points providing that all other bends do not add up to more than 90°



- The ends of conduit must be reamed and entries to boxes and accessories must be bushed in order to prevent damage to cables.
- As we have already seen, a conductor carrying a current has a magnetic field around it and as a.c. causes the field to change direction continually the field will cut across any metal close to it and in so doing induce e.m.f.s and eddy currents (heating) in that metal. Running another conductor close to the first with its current flowing in the opposite direction will cancel out the fields. Hence cables of a.c. circuits installed in steel conduit should have all phases and neutral (if any) bunched in the same conduit.
- Flexible metal conduit must not be used as a circuit protective conductor; a separate such conductor must be run.
- Non-metallic conduits must not be installed where extremes of ambient temperature are likely to occur.
- The supports for rigid PVC conduit must allow for expansion and contraction of the conduit.
- Drainage points should be provided at the lowest point of a metallic conduit installation to allow moisture due to condensation to drain away.

I.2.Flexible conduit

Flexible conduit is of great use when a rigid conduit system is supplying machinery. The use of a short connecting length of flexible conduit ensures that the vibration of the motor does not affect the rigid conduit, and enables the motor easily to be aligned, or removed for repair.

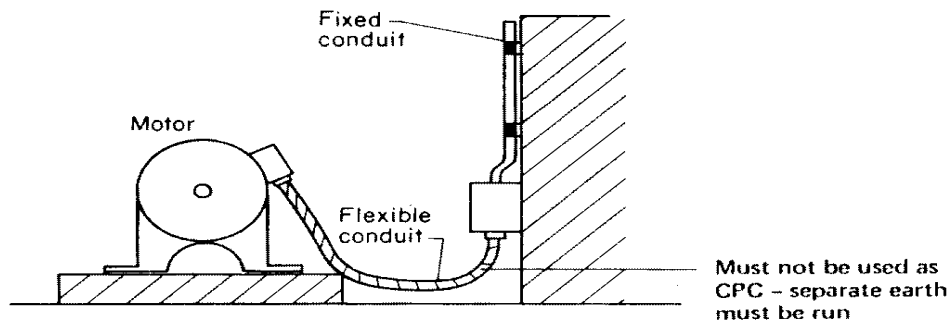


Figure 9.Flexible conduit

Non-metallic (PVC) conduit

PVC conduit is especially suitable for installation systems in light-industrial premises or offices where surface wiring is required. The fittings are identical to those used for metal conduit with the exception that the system is connected not by screwing but by the use of an adhesive. PVC conduit may be bent by hand using a bending spring. This spring, the same diameter as the inside of the conduit, is pushed inside the conduit. The conduit may now be bent by hand, the spring ensuring that the conduit keeps its shape. In cold weather a little warmth may need to be applied to achieve a successful bend.

LO 1.3 –Illustrate water proof installation according to the area to be installed.

While you are doing domestic installation, first of all you must think about type of installation are going to do either built in installation, semi-built in installation, visible installation or water proof installation.

You must also think about the route where the wiring pass through and materials used to secure the wire such as conduct (pipes) or trunking and how it must be placed. You must also think about the location of every materials are going to be used in domestic electrical installation such junction box, switches, outlet socket, lamps.

Content/Topic 1 .Physical appearance water proof installation

A. Switch wall mounted

Switches placement: In domestic electrical installation switches must be placed where are easy accessible by the use when they enter into the house. It mean near of entrance door of house. These switches also must be placed to the distance of 1.25 meters (125 cm) from the house floor.

B. Socket outlet wall mounted

Outlet Boxes: An outlet box is simply a metal (or plastic) container, set flush or nearly flush with the wall, floor, or ceiling, into which an outlet receptacle or switch will be inserted and fastened. Outlet boxes used in Navy construction are usually made of galvanized steel. However, along with the increase of other plastic materials in construction, nonmetallic boxes made of rigid plastic compounds are being used for approved installation.

Outlet boxes bind together the elements of a conduit or cable system in a continuously grounded system. They also provide a means of holding conduit in position, along with space and protection for mounted switches and receptacles, and working space for making splices and connections. Boxes can be round, octagonal, square, or rectangular. Commonly used outlet boxes are shown below

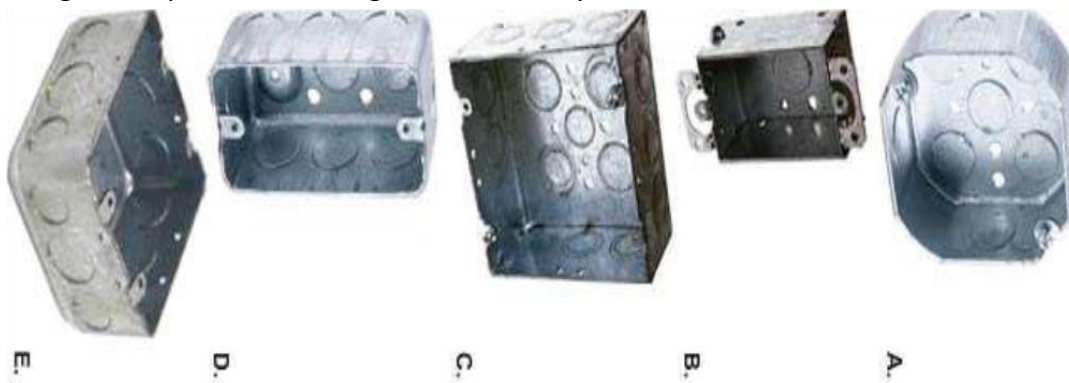


Figure 10.Steel boxes

- C. View A - a 4-in. octagon box used for ceiling outlets. This box is made with 1/2- or 3/4-in. knockouts-indentations that can be knocked out to make holes for the admission of conductors and connectors.
- D. View B - a 4 11/16-in. square box used for heavy duty, such as a range or dryer receptacle. It is made with knockouts up to 1 in. in diameter.
- E. View C - a single receptacle gang box used for switches or receptacles. Two or more boxes can be ganged (combined) to install more than one switch or receptacle at a location.
- F. View D - a utility box, called a handy box, made with 1/2- or 3/4-in. knockouts and used principally for open-type work.

- G. View E - a 4-in. square box with 1/2- or 3/4-in. knockouts, used quite often for switch or receptacle installation. It is equipped with plastic rings having flanges of various depths so that the box may be set in plaster walls of various thicknesses. Besides the boxes shown, special boxes called conduit gang boxes are made to accommodate three, four, five, or six switches.
- H. The NEC® requires outlet boxes be 1 1/2 in. deep except where the use of a box that deep would result in injury to the building structure or is impractical. In such cases, a box not less than 1/2 in. deep may be used. For switch boxes, 2 1/2-in. in depth is the most widely used.
- I. Also per NEC® requirements, outside edges of outlet and switch boxes without flush plates cannot be recessed more than 1/4 in. below the surface of the finished wall.

C. Conduit wall mounted

The common methods used for securing or fixing conduit.

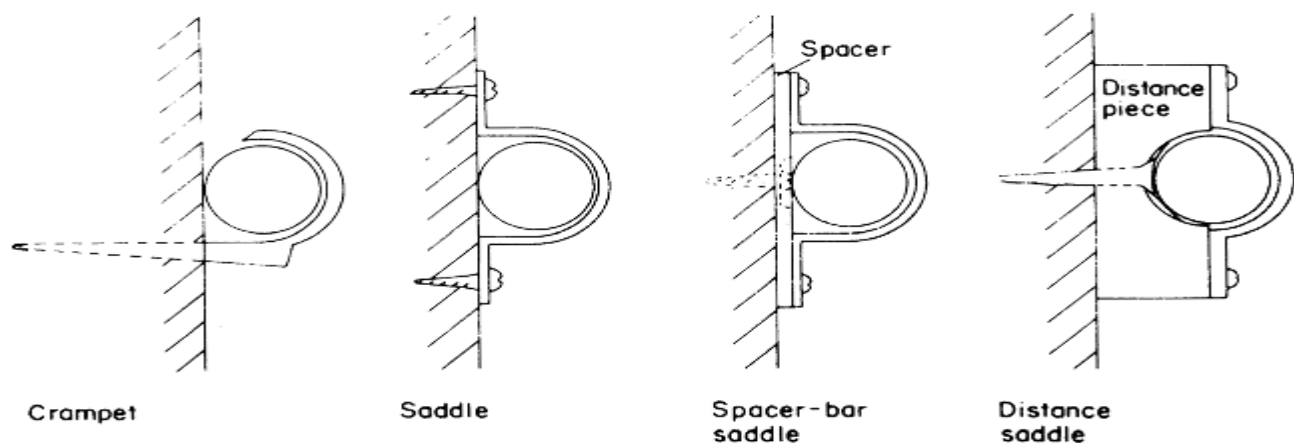


Figure 11. Conduit wall mounting (pipes)

Crampets are used for securing conduit in place prior to covering with plaster. Spacer-bar types are often used to space the conduit out from a wall in order to avoid the need for 'sets'.

Distance saddles space the conduit far enough from the fixing surface to prevent dust from collecting between the conduit and the surface. They are often used in hospitals.

D. Wire/cable wall mounted

This type of "decorative" conduit is designed to provide an aesthetically acceptable passageway for wiring without hiding it inside or behind a wall. This is used where additional wiring is required, but where going through a wall would be difficult or require remodelling. The conduit has an open face with removable cover, secured to the surface, and wire is placed inside. Plastic raceway is often used for telecommunication wiring, such as network cables in an older structure, where it is not practical to drill through concrete block.

Advantages

- Allows adding new wiring to an existing building without removing or cutting holes into the drywall, lath and plaster, concrete, or other wall finish.
- Allows circuits to be easily locatable and accessible for future changes, thus enabling minimum effort upgrades.

Disadvantages

- a. Appearance may not be acceptable to all observers.
- b. Distribution board wall mounted

E. Junction box wall mounted

Placement of junction box: Junction box are where the all installation connection, must be done. In this case junction box must be placed in location where you need derivation of wires for different purposes like outlet installation, switches and lamps installation.

F. Conduit fittings wall mounted

Pipes and trunking used in domestic electrical installation are placed according to the placement of several materials used like switches, outlet socket and junction box as it conducts wire to those materials in installation. It must be placed verticality and horizontality in installation in order to ensure the esthetic of installation. Those are steps for installation of electrical conduit pipe/trunk

- Step 1: Anchor Boxes. Anchor metal boxes to the wall with screws. ...
- Step 2: Measure Conduit. Once the boxes are installed, measure the conduit for cutting. ...
- Step 3: Cut Conduit. Cut the conduit to fit with a hacksaw. ...
- Step 4: Slide in Conduit. ...
- Step 5: Anchor Conduit

Learning Unit 2 – Install pipes and their fittings

LO 2.1 – Implement hazard control and safety measures related to pipe installations

Content/Topic 1 .Electrical hazard

A. Damaged insulation

Cord damage: A flexible cord may be damaged by door or window edges, by staples and fastenings, by abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire.

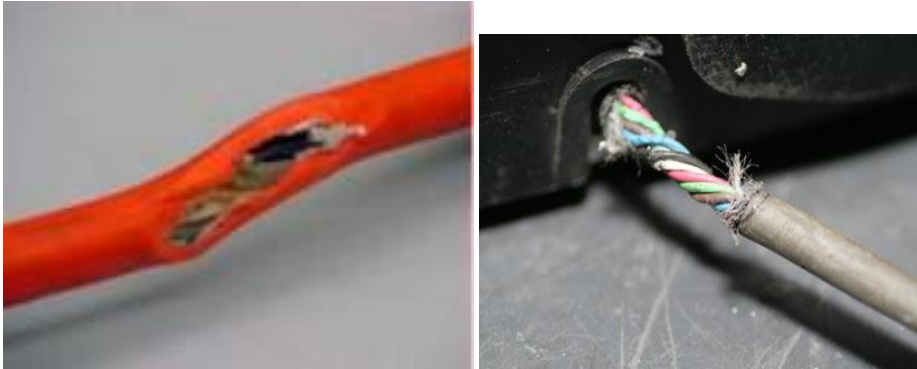


Figure 12.Damaged insulator

- Using modified cords or tools such as removing ground prongs, face plates, insulation
- Using cords or tools with worn insulation or exposed wires.
- Ensure that cords from electric tools do not present a tripping hazard.

Flexible cords: With the wide use of power tools on construction sites, flexible extension cords often are necessary. Because they are exposed, flexible, and unsecured, they are more susceptible to damage than is fixed wiring. Hazards are created when cords, cord connectors, receptacles, and cord- and plug-connected equipment are improperly used and maintained.

Strain Relief: To reduce hazards, flexible cords must connect to devices and to fittings in ways that prevent tension at joints and terminal screws. Flexible cords are finely stranded for flexibility, so straining a cord can cause the strands of one conductor to loosen from under terminal screws and touch another conductor.

B. Damaged tools and equipment

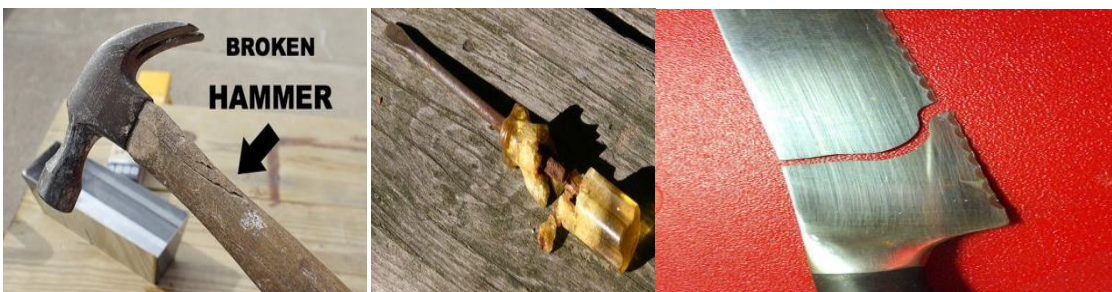


Figure 13.Damaged tools

Tools are very useful to us in our homes especially to our job. But tools that are no longer functional may cause harm.

- a) Make an inventory of functional and non-functional tools in your shop.
- b) Classify your tools according to its function.

Method of identifying non-functional tools and equipment

- Visual inspection. It refers to the visual observation of an expert on the appearance of the tools and equipment.
- Functionality. Vibration or extra noise from the operation means problems on parts and accessories started to develop.
- Performance. When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.
- Power supply (for electrically operated only). Failure to meet the required power supply, malfunction will occur in the part of hand tools or equipment.
- Person's involved. It refers to the technical person who has the knowledge and skills about the technology.

C. Wet conditions

Wet conditions: When a cord connector is wet, electric current can leak to the equipment grounding conductor, and to humans who pick up that connector if they provide a path to ground. Such leakage can occur not just on the face of the connector, but at any wetted portion. Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors.

Content/Topic 2. Accident prevention

A. Personal protective equipment (PPE)

PPE is defined as all equipment designed to be worn, or held, to protect against a risk to health and safety for workers from hazard. Workers must wear the following personal protective equipment (PPE) as it is required at the workplace and when by the supervisor instructed:

- **Shoes or strong/rubber boots:** Those are for protection against any sharp object on the floor.
- **gloves:** This is for Hand and Fingers protection from injuries in the work place
- **Helmet:** Those are for Head protection from any dropped materials or tools to the head. This device is needed where heavy machines are suspended. This is a must in all construction companies.
- **Overalls:** Those are work clothes to prevent your everyday clothing from becoming contaminated by oils, grease fluxes or general dust and dirt.
- **Goggle and Eye lids:** This equipment protects the eyes during welding and grinding operations.
- **Earmuff /Nose protection mask:** Those are for ear protection from noise.
- **Security belt:** is used in conjunction with other safety equipment when working on the Utility poles, the reason of this is to avoid fall hazard.

B. INSPECT TOOLS AND EQUIPMENT

B.1. Hand tools

1. Clean dirt and debris from tools after each use.
2. Oil metal parts to prevent rust.
3. Lightly sand rough wooden handles and apply linseed oil.

4. Repair loose handles.
5. Sharpen blades of cutting tools.
6. Store tools in a clean dry storage area.
7. Protect surfaces of cutting tools in storage.

B.2.Power tools:

1. Read and follow the maintenance schedule in the owner's manual for each piece of power equipment.
2. Change the oil.
3. Clean the air filter.
4. Lubricate moving parts.
5. Sharpen dull blades or replace worn blades according to the owner's manual.
6. Replace spark plugs.
7. Drain oil and gasoline before long-term storage.
8. Check electric cords and connections on electric-powered tools.
9. Store tools in a clean dry storage area.

B.3.Equipment:

1. Store equipment in a clean dry storage area.
2. Rinse and clean spray equipment after each use.
3. Clean spreaders and check wheel-driven gears.
4. Clean carts and wheelbarrows after use.

C. Check your tools before use.

Ensure the tools you are intending to use for a certain job are in good condition. For example, ensure the handles are not loose, especially in hammers, axes, hoes saw and the likes. If the handles are loose in such tools, their use could cause serious damage to the user or others around. Also checking for sharpness in tools that need to be sharpened, blunt tools could slip and hurt the user or others in the workshop.

D. Ensure your work environment is safe

Ensure your environment is clean and neat. A cluttered work environment could lead to tripping or slipping, this means one could hurt themselves especially when using sharp tools such as chisel, knives or even screwdrivers. A safe work environment also means picking up after yourself and storing the tools in the correct place e.g. a tool box or tool rack.

E. Effective and correct use of the safety gear.

In every workshop there should be safety gear provided. This includes but is not limited to, hard boots, helmet or hard hats, safety goggles and work gloves. When using hand tools, ensure safety gear is put on in the right manner, to avoid accidents such as splinters in the eyes or fingers. A tool belt is also very important in the workshop. A tool belt ensures your tools are carried and stored safely while working especially so for sharp tools. Also ensure the tools belt is used effectively, i.e. the tools are put in the tool belt in the correct manner

F. Use of the right tools.

Ensure the right tool is used for the right purpose. Using the wrong tool for a certain job may cause accidents. For example, one should not use a mallet in place of a hammer; this may lead to smashed

fingers. Using wrong tools may also cause slips which may lead to serious accidents to the user of the tool or even those around.

G. Proper training on use of tools.

Training in any field is important. This is most important in handling any tool. As seen in all the above precautions, one needs basic knowledge in handling of hand tools. One needs to know what tool is used for what job, how to check for validity or condition of tools is a key skill when using any tool. Therefore, before handling any hand tool ensure you have basic knowledge on the tool, to avoid hurting yourself or those around you.

LO 2.2: Identify different pipe and fittings in accordance with the type of electrical installation.

Content/Topic 1.Types of pipes for wiring

Conduit systems are classified by the wall thickness, mechanical stiffness, and material used to make the tubing.

A. Steel pipes (Metal Conduit)

Steel conduit has been in use as a “raceway system” for electrical conductors since the early 1900s. The wall thickness and strength of steel make metal conduit the wiring method recognized as providing the most mechanical protection to the enclosed conductors. An additional benefit of using steel conduit is that the NEC recognizes a properly installed metal conduit system as an equipment grounding conductor. Three basic types of steel conduit are in use today: rigid metal conduit, intermediate metal conduit, and electrical metallic tubing and Aluminum conduit. Let's take a closer look at the features of each type.

1. Rigid metal conduit — RMC (ferrous metal).

RMC is thick-walled, threaded tubing. It is generally made of coated steel, stainless steel, or aluminum. The conduit is connected together by screwing connectors to the main tubes. Rigid metal conduit provides significant protection from impacts and other damage. It can be used as a grounding conductor for short runs, but it is best practice to use wiring that has a grounding wire. The thicker walls of RMC protect the cables inside from electromagnetic interference (EMI), which can be harmful to sensitive equipment. The following image shows rigid metal conduit with threaded screw fittings. The conduits are hung from metal channel framing.



Figure 14.Rigid metal conduit

RMC can be made corrosion-resistant by applying a coating such as PVC or by galvanizing the metal. The corrosion protection resists damage from water or other chemicals that can degrade metal. There are three common types of corrosion treatment:

- Galvanized Rigid Conduit (GRC), which is the most popular form of RMC, is used in commercial and industrial buildings.
- PVC-coated aluminum, which is suitable where chemical fumes that are corrosive to steel are present.
- Bronze alloy, which is suitable for coastal areas, chemical plants, oil refineries and underwater situations.
- PVC-coated rigid steel, which is resistant to oils, grease, acids, alkalis, and moisture and is flame-retardant.

When cut, the ends of rigid metal conduit should be reamed (remove burrs and rough edges) to protect the wire insulation from abrasion. In addition, any fittings should match the type of metal used for the conduit tubing to prevent problems from galvanic action.

There are two main disadvantages to using rigid metal conduit. First, since all connections are threaded, there is much more labor required when installing the system – this makes RMC much more expensive. Second, the thick walls of the tubing make the conduit much heavier, which also makes installation more labor intensive and expensive.

2. Intermediate Metal Conduit — IMC (ferrous metal).

Developed in the '70s, IMC is a listed threaded steel raceway of circular cross section with a coupling that can be either a standard straight-tapped conduit coupling or the integral type (**Photo 2**). Just as with RMC, industry color-coded thread protectors protect the uncoupled ends of the conduit and keep them clean and sharp, and aid in trade size recognition.



Figure 15. Intermediate Metal Conduit

IMC is available in trade sizes $\frac{1}{2}$ through 4. Thread protectors for trade sizes 1, 2, 3 and 4 are color-coded orange; trade sizes $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, and $3\frac{1}{2}$ are yellow; and trade sizes $\frac{3}{4}$ and $1\frac{1}{4}$ are green. The standard finished length of IMC, with coupling, is 10 feet.

IMC has a thinner wall than RMC and weighs about one-third less than RMC. The outside has a zinc-based coating, and the inside has an approved organic corrosion-resistant coating. IMC is interchangeable with galvanized RMC. Both have threads with a 0.75-inch-per-foot taper, use the same couplings and fittings, have the same support requirements, and are permitted in the same locations.

3. Electrical Metallic Tubing — EMT (ferrous metal).

Also commonly called thin-wall, EMT is a listed steel raceway of circular cross section, which is unthreaded and normally 10 feet long.



Figure 16. Electrical Metallic Tubing

The outside corrosion protection is zinc-based, and the inside features an approved corrosion-resistant organic coating. EMT with integral couplings is available in trade sizes 2½ through 4.

EMT is installed by use of setscrew, identification or compression-type couplings and connectors. It can have an integral coupling that comprises an expanded, “bell” shaped tube on one end with setscrews. In addition to standard RMC, IMC, and EMT, PVC-coated steel conduit (PVC) is also available in one of three types. Couplings are supplied separately.

- Primary PVC coating over bare steel, which is a listed rigid conduit for environmentally suitable locations.
- A PVC coating over listed galvanized steel conduit. This is a supplementary coating intended for added protection in severely corrosive locations.
- A primary PVC coating over a supplementary coating of zinc. This is also intended for severely corrosive locations.



4. Aluminum conduit:

It is similar to galvanized steel conduit, is a rigid conduit, generally used in commercial and industrial applications, where a higher resistance to corrosion is needed. Such locations would include food processing plants, where large amounts of water and cleaning chemicals would make galvanized conduit unsuitable. Aluminum cannot be directly embedded in concrete, since the metal reacts with the alkalis in cement. The conduit may be coated to prevent corrosion by incidental contact with concrete.

Applications. There are two primary reasons to use steel conduit. It's the best possible protection of your electrical conductor and wiring systems, and it facilitates the insertion and extraction for conductors and wiring. Today, steel conduit is used in virtually every application where electrical conduit and wiring is present: commercial, retail and residential buildings, manufacturing and other industrial facilities, health-

care, educational and other institutions, and a wide variety of indoor, outdoor, and underground applications, even where corrosive and hazardous conditions exist.

In some cases, different types of steel conduit are best for specific applications. For example:

- RMC has the thickest wall, which makes it the heaviest steel conduit. It can be used indoors, outdoors, underground, and in both concealed and exposed applications.
- IMC has a thinner wall and weighs less than RMC. IMC can be used for the same applications as galvanized RMC.
- EMT is the lightest-weight steel conduit manufactured. Field workers typically find it easy to alter, reuse, or redirect EMT. Even though EMT is made of lighter-walled steel, it still provides substantial physical protection and can be used in most exposed locations, except where severe physical damage is a possibility.
- PVC coatings may be used over bare or galvanized steel conduit or conduit that has a supplementary zinc coating. PVC coatings used over galvanized steel conduit, or over steel conduit, which has a supplementary coating of zinc, may also be used in severely corrosive locations and atmospheres.

B. Second: Non-metal Conduits

1. PVC conduit,
2. Non-Metal Conduit
 - a) Rigid Non-metallic Conduit (RNM),
 - b) Electrical Non-metallic Tubing (ENT).

B.1. Plastic pipe

PVC is a tubular section, or hollow cylinder, made of plastic. It is usually, but not necessarily, of circular cross-section, used mainly to convey substances which can flow liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipes are far stiffer per unit weight than solid members.



Figure 17.PVC

Plastic pipe work is used for the conveyance of wires, drinking, waste water, chemicals, heating fluid and cooling fluids, foodstuffs, ultra-pure liquids, slurries, gases, compressed air, irrigation, plastic pressure pipe systems, and vacuum system applications.

Types PVC pipes

Solid wall pipe: Extruded: pipes consisting of one layer of a homogeneous matrix of thermoplastic material which is ready for use in a pipeline.

Structured wall pipe: Structured-wall pipes and fittings are products which have an optimized design with regard to material usage to achieve the physical, mechanical and performance requirements. Structured Wall Pipes are tailor made solutions of piping systems, for a variety of applications and in most cases developed in cooperation with users.

Barrier pipe: Pipe incorporating a flexible metallic layer as the middle of three bonded layers. Barrier pipe is used, for example, to provide additional protection for the contents passing through the pipe (particularly drinking water) from aggressive chemicals or other pollution when laid in ground contaminated by previous use.

Most plastic pipe systems are made from thermoplastic materials. The production method involves melting the material, shaping and then cooling. Pipes are normally produced by extrusion.

B.2.Types of Non-Metal Conduit

Non-metal conduit is made of plastic, also called PVC. It is used in areas where metals can cause problems, such as in hospital MRI rooms. It is also used where it will be in contact with water, such as below ground or encased in concrete. PVC conduit will not rust or corrode when exposed to water.

1. Rigid Non metallic Conduit (RNC)

RNC is the lightest conduit available and is generally the least expensive. Fittings slipped onto the tubing and welded with a solvent, which is faster than the fittings used in metal conduits. In addition, the welded joints are water-tight. Plastic conduit can be heated with special tools so that it can be bent in the field.



Figure 18.Rigid Non metallic Conduit

RNC Pipe is most commonly available as schedule 40 or schedule 80 pipe, but can also be manufactured in other sizes and wall thicknesses. It is also available in extra-heavy wall thicknesses for areas where extra protection is needed; however, thicker walls make the conduit harder to bend.

The main disadvantages are that plastic conduit will not stand up to impacts as well as metal conduits. In addition, plastic conduits cannot be used for grounding, so a grounding conductor will need to be pulled along with the other conductors. Finally, plastic conduit expands and contracts more than metal conduit when exposed to heat, which needs to be taken into account when designing long runs.

2. Electrical Non metallic Tubing (ENT)

ENT is thin-walled corrugated tubing that is flexible so it can be bent without special tools, however it will not permanently hold the bend. It is easier to install than RNC because it can be routed around obstructions without cutting and welding the pipe.



Figure 19. Electrical Non metallic Tubing

Special ENT connectors are used – these are generally snap-in connections and are not watertight. Liquid-Tight Flexible Non-metallic Conduit (LFNC) is also available for use where the conduit will be subjected to moisture

C. Third: Flexible Conduits

1. Flexible Metallic Conduit (FMC),
2. Liquid tight Flexible Metal Conduit (LFMC),
3. Flexible Metallic Tubing (FMT),
4. Liquid tight Flexible Nonmetallic Conduit (LFNC).

1. Flexible Metallic Conduit (FMC)

Flexible metal conduit (FMC) is typically available in diameters between 3/8" and 3", but larger sizes can sometimes be found. It is made by coiling self-interlocked aluminum or steel strips, which forms a hollow tube that wires can be pulled through. FMC comes in a standard wall (sometimes called full wall) thickness or a reduced wall thickness. Most manufacturers also produce an extra-flexible FMC for tighter bend radiuses, but this is generally not UL approved. The following photo shows flexible metal conduit with a connector attached to the end:



Figure 20. Flexible Metallic Conduit

Standard FMC is recommended in dry areas where it would be impractical to install EMT or other non-flexible conduit, yet where metallic strength to protect conductors is still required. Because of its flexibility, the FMC can help reduce vibrations from passing from motor to structure through the conduit.

2. Liquid tight Flexible Metal Conduit (LFMC)

It is a metallic flexible conduit covered by a waterproof plastic coating. The interior is similar to FMC. The NEC specifies that liquid-tight flexible conduit must not be exposed to physical damage. This type of conduit must not be installed where the ambient temperature or the conductor rating is above the rating of the conduit.

3. Liquid tight Flexible Non-metallic Conduit (LFNC)

It refers to several types of flame-resistant non-metallic tubing. Interior surfaces may be smooth or corrugated. There may be integral reinforcement within the conduit wall. It is also known as FNMC.



Figure 21. Liquid tight Flexible Non-metallic Conduit

D. SIZING

EMT Weights and Dimensions (<u>North America</u>)							
EMT is available in trade sizes 1/2" through 4", and 10' and 20' lengths.							
Some manufacturers also produce EMT in a range of colors for easy system identification.							
EMT Sizing		Nominal Wt. per 100 Ft. (30.5m)		Nominal Outside Diameter		Nominal Wall Thickness	
USA	Metric	lb.	kg	in.	mm	in.	mm
1/2	16	30	13.6	0.706	17.9	0.042	1.07
3/4	21	46	20.9	0.922	23.4	0.049	1.25
1	27	67	30.4	1.163	29.5	0.057	1.45
1 1/4	35	101	45.8	1.51	38.4	0.065	1.65
1 1/2	41	116	52.6	1.74	44.2	0.065	1.65
2	53	148	67.1	2.197	55.8	0.065	1.65
2 1/2	63	216	98	2.875	73	0.072	1.83
3	78	263	119.3	3.5	88.9	0.072	1.83
3 1/2	91	349	158.3	4	101.6	0.083	2.11
4	103	393	178.2	4.5	114.3	0.083	2.11

Application of trunking, PVC pipe, and metals pipe

In domestic electrical installation, the choice of materials to be used is in hands of technician who are going to realize that electrical installation. It is in this case, depend on type of installation is going to be done, technician decide where to use trunking, PVC pipes and metals pipes.

- **Trunking:** Trunking are used mostly in visible installation, where it cannot be possible to drill the canal of pipes, for example on bricks house or in the office made in wood materials and aesthetics are required. It also used normal temperature, non-permanent and unexpected installation.
- **PVC pipe:** PVC pipe are used in built in installation and water proof installation where temperature in normal and is used in residential houses.
- **Metal pipes:** Are used in high temperature and industrial buildings

Content/Topic 2. Types of pipes fittings

A. INTRODUCTION

Pipes junction: In domestic electrical installation, pipes sometime need to joined between them in order to continue it route or deviate it route to another depend on the location of used materials or location of junction box. It can deviate from vertical route to horizontal route. In this case several methods of joining pipes are used and fittings accessories must be in place to accomplish the joining task.



Figure 22 Types of pipes fittings

Other accessories for use with conduit include elbows (sharp 90° bends), bends (gentle 90° bends) and tees. All of these are available in the inspection and non-inspection varieties. There are also circular boxes with removable lids, to permit ease of wiring a conduit system. Some of these accessories are shown below

B. Wye Tee

A fitting with three openings, a wye joins (or creates) branch lines. It is a waste-fitting tee in which the side inlet pipe enters at a 45° angle. A standard wye is a Y-shaped fitting which allows one pipe to be joined to another at a 45° angle. A wye may also be used to split a branch line equally in two directions, such as the splitting of a main line into two smaller branches.

Tee-wyes are similar to tees, except for the angling of the branch line to reduce friction and turbulence. They are commonly used to attach a vertical drainpipe to a horizontal one, while reducing the deposition of any entrained solids at the junction. The connection is typically at 45°, rather than 90°; if a branch turns out further at the end to 90° (perpendicular), the fitting becomes a combo tee. Wyes and combo wyes follow a long-sweep pattern relative to sanitary tees and other short-sweep bends, which have a smaller radius and require less space.

Wyes also have industrial applications. Although low-priced wyes are often spot-welded, industrial-strength wyes are flash-welded at each seam. In long-distance pipeline applications, a specialized wye is used for allow insertion of pigging to keep pipes clear and maintain flow.

C. Coupling

Conduit couplings are essential for almost any coupling system, for securely linking together lengths of conduit and attaching site-fabricated bends. Even though PVC conduits with a belled side can be linked without couplings, they would still be needed for sections where the conduit has been cut to size.

Couplings are available in a variety of sizes and some of them, like rigid conduit couplings, are threaded on the inside. However, when the conduit is passing through a wall or making some other transition, consider using a conduit body instead. Even for the first sections of conduit entering or leaving the box or enclosure, use pull boxes or bodies so the conductors can easily be retracted if the enclosure needs to be removed.

Couplings are used to extend the overall length of a piece of conduit. Thin-wall conduit couplings are electrical fittings used to attach or couple the length of one conduit to another.

D. Single Tee

A tee, the most common pipe fitting, is used to combine or divide fluid flow. It is available with female thread sockets, solvent-weld sockets or opposed solvent-weld sockets and a female-threaded side outlet. Tees can connect pipes of different diameters or change the direction of a pipe run, or both. Available in a variety of materials, sizes and finishes, they may also be used to transport two-fluid mixtures. Tees may be equal or unequal in size of their three connections, with equal tees the most common



E. Connecters

This is a method used to join two pipes which are in the same route at horizontal plan or vertical plan. (Those pipes are made angle of 180° between them.)

F. Elbow pipe (45°): When you want to join two pipes, one perpendicular to another at 45° , this method of pipe joining is used.

G. Elbow pipe (90°)

When you want to join two pipes, one perpendicular to another at 90° , this method of pipe joining is used

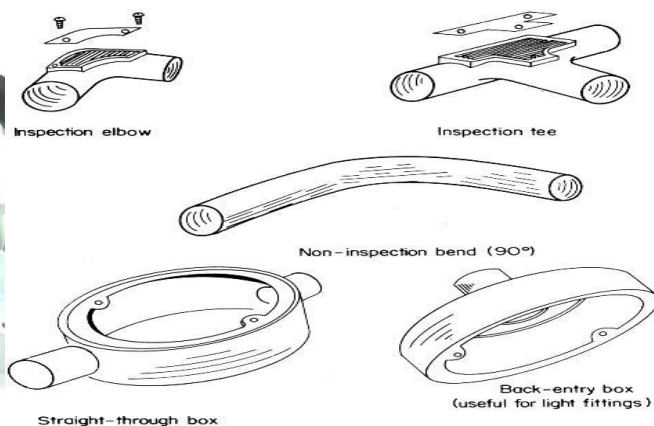


Figure 23.connectors

H. Through joint

I. End joint

Nipples. A nipple is a short length of conduit or tubing material that's used to extend a conduit system. Nipples are used between conduit or tubing and items such as, but not limited to, fittings, boxes, and enclosures or between two boxes, two enclosures, etc. When nipples are used to extend a conduit run to an enclosure, box, etc

When a nipple is installed between boxes, enclosures, etc. and it doesn't exceed 24 inches, wire fill is permitted to be 60%. Factory-made RMC nipples are threaded on both ends and are available in all sizes in lengths up to and including 12 inches. Longer lengths are available by special order or may be field-fabricated.

LO 2.3 -Mark the area to be installed according to the electrical diagram.

Content/Topic 1 .Mark the location of each pipe and fittings by drawing lines using pencils

The marking location of each pipe, fittings and other electrical equipments to be installed is very important, it will help the electrician to select the length of pipes, conductors and to select types of fittings by reducing number of bends

Marking location of pipes will help also to install with good esthetic in installation, by selecting the location of pipes and fittings, you will be helped to design all requirements in your installation and you will be able to reduce errors during installation

Content/Topic 2.Use the spirit level to verify that the path is straight

A spirit level, bubble level, or simply a level, is an instrument designed to indicate whether a surface is horizontal (level) or vertical (plumb). Different types of spirit levels may be used by electricians, carpenters, stonemasons, bricklayers, other building trades workers, surveyors, millwrights and other metalworkers, and in some photographic or video graphic work .A spirit level gets its name from the mineral spirit solution inside the levels. The best spirit level is accurate to within plus or minus 0.5 millimeters/meter, or 0.005 inches/inch or .029 degrees. The next level of accuracy displayed is 0.75mm/m or.043 degrees.

How to Read a Spirit Level

- Locate the bottom edge of the level. This rests against the surface you're trying to level.
- Some models feature magnetic edges, which "stick" to metal surfaces for ease of use.
- Inspect the body of the level and check for grabbing points where you won't block the vials with your hand(s).
- Most levels feature a punched hole on at least one end for hanging above your workbench.
- The tube vial in the center of the level helps you find the true horizontal.
- Tube vials on the ends finds the true vertical.

How to Use a Spirit Level

- Clean the level, removing all build up and dirt from the edges.
- Mark a line along the bottom edge on the wall.
- Flip the level over so that the bottom becomes the top. Put the new top edge along the marked line. If the bubble is centered, your level is accurate. If not, it is defective.

- Place the level on the surface of the object for which you want to find the true horizontal (the "horizon"). Make sure the spirit tube runs parallel to the object. Allow the bubble to float to the top of the spirit tube. Put your eyes at level with the spirit tube. In order to get an accurate reading, close one eye.
- Take note of where the bubble is inside the spirit tube. If it's centered between the lines on the tube, your object is level. If the bubble is to the right of the lines, your object slopes downward right-to-left. If the bubble is to the left of the lines, your object slopes downward left-to-right.

To find the true vertical or "plumb," repeat the same process vertically

Learning Outcome 2.4: Select tools in accordance with the preparation needed for pipes.

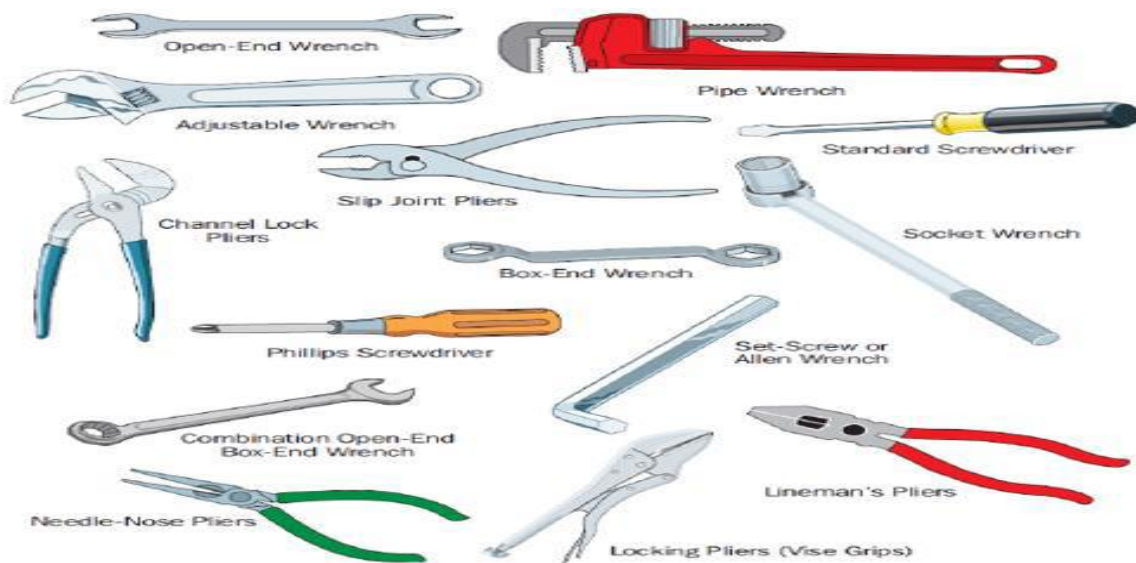


Figure 24.Electrician tools

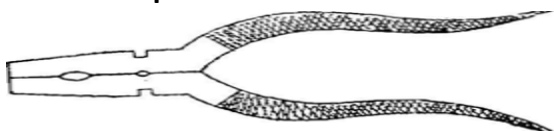
Content/Topic 1: hand tools

Stripping plier



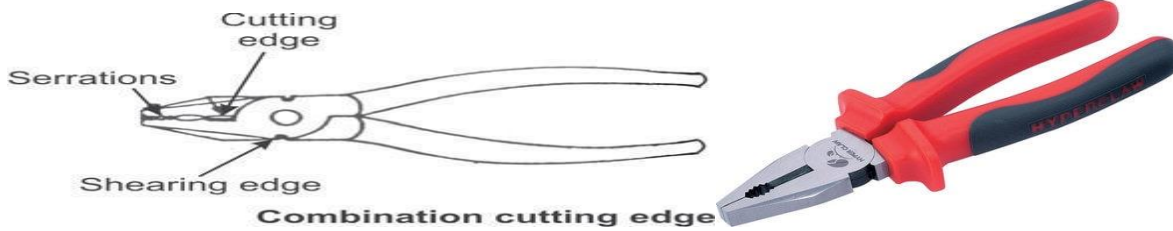
It is used to remove insulator on conductors/wires to be joined together or fixed in contacts

Side cutter pliers



In electrical tool cutting plier is the most important tool. it is used to cut the cable and to tighten them. The handle of the plier is wrapped by rubber to be used in current supply. it is also used to fix or remove screws

Combination plier



This is made of tool steel and is used for cutting as well as for gripping the work.

Long nose plier



It is used to fix and remove screws in narrow gaps. it is widely used while repairing radios and speakers

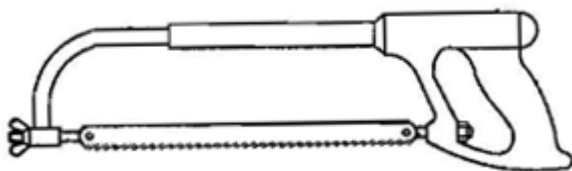
Electrician knife

It is used to remove the insulation in electrical cables. The handle of a knife is made up of wooden or plastic. Its length is in four or five inches to keep easily in shirt pocket

Measuring tape

This tool is important during electrical install, it is used to measure (indicate) the distance between two electrical components installed in the same circuit

Hack saw



It is used to cut PVC or metal frames. The blade of hack saw is made up of iron and the handle is made up of wood. A clip is fixed in its other end to adjust the length

Screw driver

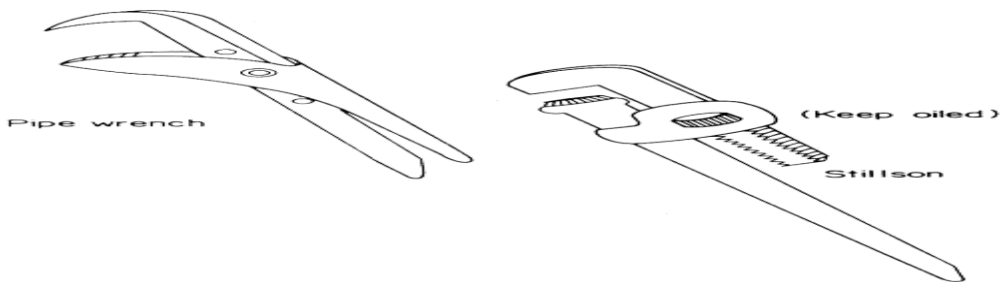
It is used to fix and tighten the screws. The point of a screw driver should be flat to be fixed gap in the head of a screw. it is available in different sizes from 4.5 inches to 12 inches. Its handle is made up of wood or plastic. wooden handle are better to be used for long period than plastic handle screw driver

Hammer

- Club hammer. This is for use with cold chisels and bolsters. Ensure that the handle is in good condition. Do not use the hammer if the head is loose.
- Scutch hammer and combs. These tools are used for chasing brickwork.
- Claw hammer. For de-nailing joists and floorboards. The precautions to be taken are the same as those for a club hammer.

Spirit level

- Bolster (large and small). This tool is used for chasing walls and brickwork and for making holes for metal boxes. Ensure no mushrooming
- Floorboard chisel. This is similar to a bolster but with a longer handle. The same precautions should be taken as for bolsters.
- Cold chisels (a selection of various sizes). These are for use on brickwork and concrete. The same precautions should be taken as for bolsters.
- Brace and wood bits. These are used for drilling joists etc. Wood bits should be kept sharp, and ratchets oiled.
- Rawlplug tool and bits. These are for making holes in brickwork and concrete in order to insert Rawlplugs. Watch for mushrooming of the head.
- Adjustable pipe wrench and Stillson Used for tightening and untightening conduit.



Content/Topic 2: Power tools

A. Crimping tools

Clamping (Vising) PVC-Coated Conduit: Various manufacturers offer modified jaws for use in standard vises to protect the coating (see Figure below). When using either a “jaw type” or a chain type” vise, the PVC-coated conduit can also be protected by half-shell clamps. These are available as a manufactured clamp or can be made in the field from RMC as follows.



B. Drilling machine

Bench Drilling Machine

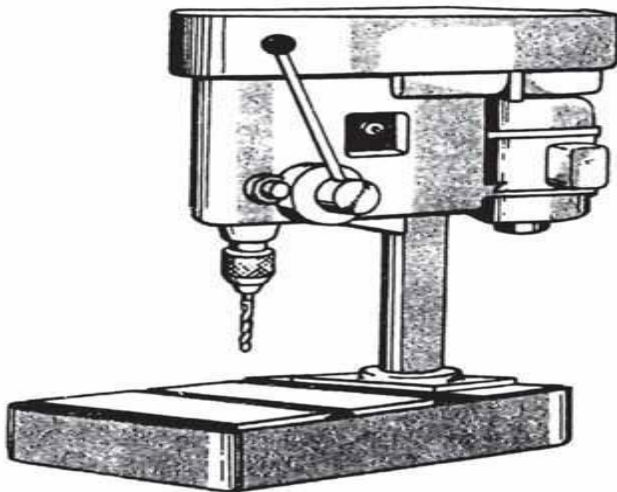
Generally, it is fixed on the work bench and is suitable for drilling holes with a diameter up to about 10 mm. It is a light and high-speed machine and used for light duty work. It can be used for drilling holes from 1.5 to 15 mm diameter.



Figure 25. Drilling machines

It is mounted on a bench and hence the name, "Bench-drilling machine". In this, the drill is fed into the work piece by hand only. Here, the operator can feel or sense the travel of the drill. Hence, this machine is rightly called, "Sensitive drilling machine".

Figure shows a bench-drilling machine. The main parts of this machine are: Base, column, portable, spindle head, and drive mechanism.



Bench drilling machine

Portable Power Drill

Portable power drills are available with double insulation. The range varies from 6 mm to 20 mm drill diameter.

It is the most useful of all kinds of drilling equipment. It is readily portable and convenient for use. It can be used for drilling holes in any position which is not possible with conventional drilling machines. An individual motor drives this machine. The entire drilling mechanism is enclosed in a compact case, as shown in figure. The motor is generally a universal type and can be operated both on A.C and D.C supply. Since the diameter of the holes to be drilled is small; the portable electric drill is operated at high speeds.



The capacity of the portable electric drill is designated by the maximum diameter of the hole it can drill in steel. Hand drill and electric drill. These are for use with metal drills and masonry drills. An electric drill should preferably have two speeds and a hammer action.

- A selection of files. Files are used for removing sharp edges and burrs. Always use a handle on a file.
- Stock and dies. These tools are used for cutting threads. A recommended lubricant such as tallow should be used. Dies must be kept clean; do not allow a build-up of tallow and metal.
- Bush spanner: This tool is for use on inaccessible bush nuts.
- Draw tape. Used for pulling cables through conduit.
- Measuring tape. Steel tapes must not be used near live equipment.
- Set of twist drills. For use with a hand or electric drill. Cutting edges should be kept sharp. A hot drill must never be quenched in water.
- Selection of spanners. For general use.
- Spirit level.
- Set-square. For use in marking out trunking.
- Scriber. Used for marking metal. The points should be kept sharp.
- Centre punch. For marking metal prior to drilling.
- Hole saw. This type of saw is used for cutting holes in trunking. It should be used only with a hand drill or a low-speed electric drill.
- Putty knife and pointing trowel. For making good the plasterwork, etc.
- Bending springs. Used for PVC conduit.
- Solder, soldering iron, blowlamp. These are used for all general electrical soldering.
- Approved test lamp. Used on live circuits. Moisture must be kept away.
- First-aid kit. This must be kept stocked at all times.

Steps in drilling, using a portable electric drill

- Layout and mark the centers of each hole, with a center punch.
- Select properly size drill bit and fix it in the chuck properly.
- Clamp the work in a vice or to the bench.
- With the power-off position the drill point at the center punch mark. Make sure that the tool is square with the surface.
- Hold the drill with one hand and steady it with the other. Put-on the power and apply pressure steadily.
- Release the pressure slightly, when the point of the drill pierces the lower surface of the metal.
- Remove the tool from the hole and put it off.

Learning Outcome 2.5: Prepare pipes and their fittings in accordance with the expected measurement.

Content/Topic 1. Technics for pipe and fitting preparation

A. INTRODUCTION

Electrical conduit fittings form the outer covering for most electrical wiring from one point to the next. They shield the wires from the external environment so as to make the wire last longer and also to keep humans and pets safe from electric shocks or other such vulnerabilities. Electrical conduits are predominantly made of insulating and sturdy material for optimum functionality. Although it is best suited for a professional electrician to accomplish most electrical conduit fittings, there are some minor ones that you can easily do on your own.

B. Selection of Pipes and Fittings

Choose the right material for installing electrical conduit fittings: The most preferred material is known as EMT (Electrical Metallic Tubing). EMT is very easy to install as you can effortlessly bend it and assemble it as per your needs. Also, you can conveniently take it off in case your wiring goes wrong somewhere. If you do not have it in your house, you can buy EMT from any of the electrical surplus stores for pretty cheap

C. Measurement of pipe and fittings

Measure the amount of conduit that you would need: Make appropriate marks in pencil wherever you think the bends should be, and measure the total length of the conduit that would be needed to finish the entire electrical conduit fittings. Now cut the length that you just measured with a tool called hacksaw. The cut ends are likely to have burrs which can be removed using a deburring tool or with pliers

D. Marking out

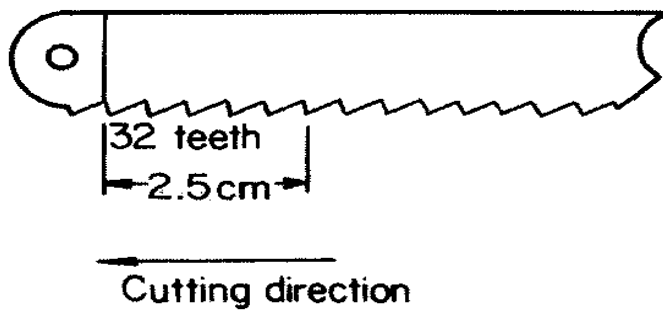
Chalk out a wiring plan: Find out the location of the electrical boxes on your wall to trace the route of the conduit. Draw the path from the main power source to the electrical box

Make the necessary bends: It is now time to make bends that you had marked on the pipe in the previous step. Owing to the easy flexibility of EMT, this should not be very difficult. Conduit benders come in handy for doing this bending

E. Cutting

Tools for Cutting Electrical Conduit

- Thin-wall metal conduit can be cut with a special electrical conduit cutter. To use the cutter, clamp it around the conduit. To cut the conduit, tighten the knurled nut in the handle.
- As you tighten, force the cutter around the conduit. The sharp cutting blade cuts a groove that deepens with each revolution, making a smooth, quick cut. After cutting through the conduit, file off any burrs around the edge of the cut.
- Another tool for use on conduit is a hacksaw frame taking hand blades with 32 teeth per 2.5 cm, the blade must be used in the correct direction.



F. Bending

PVC conduit bending procedure

Bending pipe is a process used to change the direction of pipe without using joining accessories. When you want to bend pipe first of all is necessary to know type of pipe, PVC pipe or metal pipe. If you are going to bend PVC pipe first of all you must apply heat pressure on it. (pipe burning). There are methods used to bend PVC pipes.

➤ **Spring used method**

This is the method used to bend PVC pipe by putting a spring inside the pipe, then apply heat pressure on pipe and bend it to the required angle, and cool it.

➤ **Sand used method**

Here, sand are used in place of spring. This is the method used to bend PVC pipe by putting sand inside the pipe, then apply heat pressure on pipe and bend it to the required angle, and cool it.

➤ **Bending Steel Conduit:** The most common method of bending steel conduit is to use a bending machine. However, for bending 32mm diameter or larger conduits it is recommended to use a portable ratchet bender. The following are the main steps to be taken when using a bending machine.

- Insert the conduit under the stop and into the groove in the former.
- Pull down the handle, allowing the roller to bend the conduit around the former.
- Use a template to compare the angle of the bend formed with the desired angle.

For metals pipes, pipes are fixed in engineering vice (vice) then pressure are applied on it by person.

G. Cleaning

All conduits and accessories shall be cleaned and painted with two coats of bituminous paint before installation. Where conduits are installed in straight run, draw boxes shall be provided at intervals not exceeding 30 feet (9 meters). Between two consecutive draw boxes, the right angle bends shall not exceed two in number. Conduits shall be properly threaded and screwed in to the accessories.

H. Joining fittings and pipes

Attach fittings to the wall: You can use screws and straps with either single or double holes, available at electrical surplus shops, to attach electrical conduit fittings to the wall

Conduit usually comes in 10-foot lengths. Couplings are used to extend the overall length of a piece of conduit. Thin-wall conduit couplings are electrical fittings used to attach or couple the length of one conduit to another.

EMT does not require threads to be cut on the ends. It uses specially made connectors for the ends so that

it can be attached to boxes, panels, and other devices. (Rain-tight fittings should be used outside.) How EMT is fitted into a conduit box, and how EMT fittings are installed:

1. To install connectors

- a. Insert conduit into fitting.
- b. Tighten screw with screwdriver, or tighten compression nut with wrench.
- c. Remove lock nut from fitting.
- d. Insert fitting into knockout in outlet box.
- e. Turn lock nut on fitting from inside box and tighten by lapping with a screwdriver blade until teeth bite into box.

2. To install couplings

- a. Insert conduit into fitting.
- b. Tighten screws with screwdriver, or tighten compression nuts with wrench.

3. Secure conduit with straps

- a. Install minimum of one strap for every 10 feet of conduit run.
- b. Always use a strap within 3 feet of a box.

4. Offset connectors are used to connect conduit that is flat against wall with an outlet box without bending the conduit.

5. Pulling elbows are made for corners and is installed onto conduit by tightening screws with screwdriver. Wires can be readily pulled through the fitting by simply removing the cover. A variety of fittings used on EMT.

How to thread electrical wires through conduit

A fish tape is a thin, flexible metal tape with a hook on one end. The tape is usually packaged on some type of reel. The tape is used to pull wires through conduit or through openings in walls. For conduit use, the tape is inserted in one conduit opening and worked through to the next opening. The wires to be drawn through the conduit are bent around the hook on the fish tape.

If the run is long and has a few bends it is a good idea to wrap some electrical tape around the wires to hold them on the hook. The tape is then reeled in to draw the wires through the conduit. A slow, steady is less likely to kink the tape or jam the wires than is a series of sharp.

Learning Outcome 2.6: Fix pipes and their fittings based on the architectural diagram.

Content/Topic 1 .Classification of pipe fixing.

A. Surface installation



Figure 26. Surface installation

- **Choose the right material for installing electrical conduit fittings:** The most preferred material is known as EMT (Electrical Metallic Tubing). EMT is very easy to install as you can effortlessly bend it and assemble it as per your needs. Also, you can conveniently take it off in case your wiring goes wrong somewhere. If you do not have it in your house, you can buy EMT from any of the electrical surplus stores for pretty cheap
- **Chalk out a wiring plan:** Find out the location of the electrical boxes on your wall to trace the route of the conduit. Draw the path from the main power source to the electrical box
- **Measure the amount of conduit that you would need:** Make appropriate marks in pencil wherever you think the bends should be, and measure the total length of the conduit that would be needed to finish the entire electrical conduit fittings. Now cut the length that you just measured with a tool called hacksaw. The cut ends are likely to have burrs which can be removed using a deburring tool or with pliers
- **Make the necessary bends:** It is now time to make bends that you had marked on the pipe in the previous step. Owing to the easy flexibility of EMT, this should not be very difficult. Conduit benders come in handy for doing this bending
- **Attach fittings to the wall:** You can use screws and straps with either single or double holes, available at electrical surplus shops, to attach electrical conduit fittings to the wall
- **Tape the ends and put the wires in place:** Use a widely available fish tape and run it through the entire route of the conduit fittings you just installed. Fix together the ends along with the electrical wires with the same fish tape. Give a finishing touch by pulling all the wire in the pipe in their right place

B. Semi-built installation

The installation is semi built in when there is some part of it, are hidden and another are visible externally. When an electrical installation is done through the pipes, the following techniques must be followed.

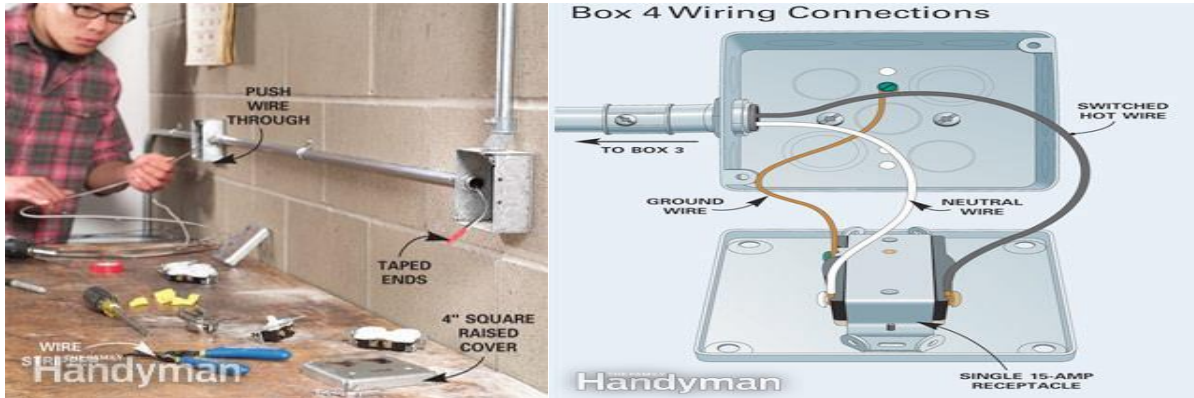
- Mark the placement of different installation materials such as switches, outlet socket, lamps, junction box.
- Draw the route where the circuit of installation pass through
- Measuring the pipe length are required to be used
- Drill the canal for the pipes
- Pipe placement and fixation.
- Conduits above false ceiling shall run with proper supports / suspenders. Conduits shall not be rested on false ceiling grid in any case. All vertical runs with open ends shall be sealed at top in case of false ceiling work, while masonry civil works going on.
-

Content/Topic 2. Technics of each classification

A. How to Install Surface-Mounted Wiring and Conduit

Tape together ends of one black and one white 14-gauge wire and push the taped ends through the conduit. Cut the wires, leaving 8 in. extra at each box. Repeat this step from Box 3 to Box 4.

When running wire short distances with few bends, such as between Boxes 2 and 3, and 3 and 4, you can simply tape the two wire ends together and push them through the conduit. For longer distances, or runs that have two or more bends, run a fish tape through the conduit and tape the wires to it



B. LAYING OF CONDUITS FOR SEMI BUILT IN INSTALLATION

Piping techniques

When an electrical installation is done through the pipes, the following techniques must be followed.

- Mark the placement of different installation materials such as switches, outlet socket, lamps, junction box.
- Draw the route where the circuit of installation pass through
- Measuring the pipe length are required to be used
- Drill the canal for the pipes
- Pipe placement and fixation.
- Conduits which are to be taken in the ceiling slab shall be laid on the prepared shuttering work of the ceiling slab before concrete is poured. The conduits, boxes, accessories, joints, etc. shall be laid along with the conduits.
- Conduits recessed in walls be fixed rigidly with staples at maximum 1 M intervals. All chases shall be properly filled and concreted and finished. The conduit boxes, accessories, joints, etc. shall be laid along with the conduits. The chases shall be sufficiently deep and properly filled with cement mortar.
- All chases, grooves shall be neatly made to proper dimensions to accommodate the required number and size of conduits and staples. The outlet boxes, point control boxes, inspection and draw boxes shall be fixed as a when conduit is being laid. The recessing of conduits in walls shall be so arranged as to allow at least 12 mm plaster over the same.
- All grooves, chases, etc. shall be refilled with cement mortar and finished up to the wall surface before plastering of walls is taken up by the General Contractor. Where conduits pass through expansion joints in the building, adequate expansion fittings or other approved services shall be

used to take care of any relative movement. As far as possible, chasing of wall to embed the conduits to be avoided. Conduits with switch boxes to be fixed and supported before brick work has commenced.

- Wherever surface conduit system is specified, only steel conduits shall be used and conduits shall be fixed by means of GI saddles. Conduits shall be run in square and symmetrical line with proper drawing.
- Concealed conduits in slabs shall be brought out as vertical drops in beams, wherever such drops are required. All vertical conduits in beams shall be left protruding from the bottom of the beam, at least 150 mm in length. All such ends of conduits protruding from bottom of beams shall be provided with couplings to receive extension. The open ends should be protected during concreting.
- Vertical conduits in wall shall be laid and terminated in switch boxes, before the brick walls are erected. Chiselling of brick walls for laying such conduits will not be allowed. The terminations of conduits shall be in GI PVC boxes and the size of the boxes shall be suitable to accommodate all control switches required for that particular location.
- The switch boxes shall be of GI/PVC and shall be fixed to the conduits with adapters. The switch box shall be flush with the plaster and it shall be contractors' responsibility to cut open the brick work and plaster wherever necessary to make good the surface for achieving flush finish. The height of the switch boxes shall be as indicated in the drawings. The switch boxes should be sufficient depth to give minimum 20 mm plaster cover to conduits embedded.

Learning Unit 3: Install trunks and their fittings

LO 3.1 – Implement hazard control and safety measures related to trunk installations.

Content/Topic1.Electrical hazard

A. INTRODUCTION

A.1.Watch Out

Do not attempt to work on your electrical wiring, switches, or outlets unless you are properly trained and equipped to do so. Electrical components in a building can easily cause an electrical shock, burn, or even death.

Even when a hot line switch is off, one terminal on the switch is still connected to the power source. Before doing any work on the switch, the power source must be turned off by setting a circuit breaker to OFF or removing a fuse.

Electrical conduit for wiring has some advantages in protecting wires and also in running multiple wires to a location. The proper selection of electrical conduit materials, fittings, and installation are important for safe electrical wiring.

A.2.Electrical Safety

Before starting any installation work, first and foremost thing is the concern of safety of the personnel. Electricity is dangerous, direct or indirect contact of electrical equipment or wires with the power turned ON can result serious injuries or sometimes even causes to death. Follow the below steps to maintain the safety at the workplace.

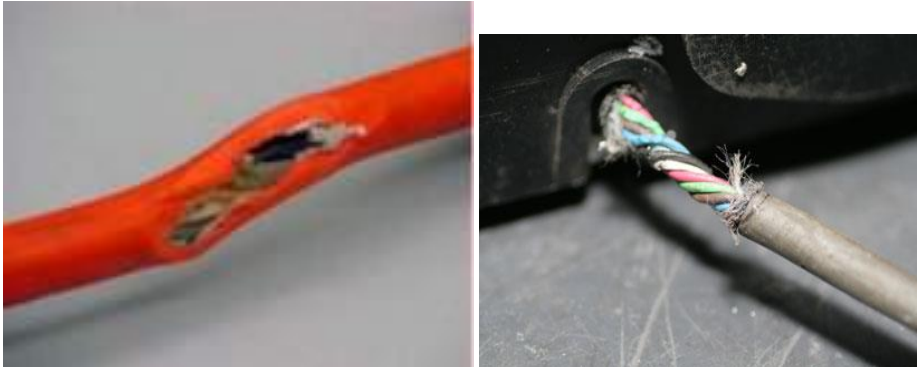


- Always use safety equipment like goggles, gloves, shoes, etc. and avoid the direct contact with live or energized circuits.
- Have the skills and techniques to distinguish the exposed live parts of the electrical equipment.
- Disconnect the source supply while installing or connecting wires.
- The power supplied to the installation must be controlled on the main switchboard which should consist of circuit breaker.
- Conductive tools and materials must be kept at a safe distance from live parts of the circuit or equipment.
- Use non-conductive hand tools for which they are rated to perform electrical work. If they are used for voltage (or current) rating other than rated, the insulation strength of the tool breakdown and causes electric shock

B. Damaged insulation

B.1 Cord damage

A flexible cord may be damaged by door or window edges, by staples and fastenings, by abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire.



- Using modified cords or tools such as removing ground prongs, face plates, insulation
- Using cords or tools with worn insulation or exposed wires.
- Ensure that cords from electric tools do not present a tripping hazard.

B.2.Flexible cords

With the wide use of power tools on construction sites, flexible extension cords often are necessary. Because they are exposed, flexible, and unsecured, they are more susceptible to damage than is fixed wiring. Hazards are created when cords, cord connectors, receptacles, and cord- and plug-connected equipment are improperly used and maintained.

Strain Relief

To reduce hazards, flexible cords must connect to devices and to fittings in ways that prevent tension at joints and terminal screws. Flexible cords are finely stranded for flexibility, so straining a cord can cause the strands of one conductor to loosen from under terminal screws and touch another conductor.

C. Damaged tools and equipment



Tools are very useful to us in our homes especially to our job. But tools that are no longer functional may cause harm.

- c) Make an inventory of functional and non-functional tools in your shop.
- d) Classify your tools according to is function.

Method of identifying non-functional tools and equipment

- Visual inspection. It refers to the visual observation of an expert on the appearance of the tools and equipment.
- Functionality. Vibration or extra noise from the operation means problems on parts and accessories started to develop.
- Performance. When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.
- Power supply (for electrically operated only). Failure to meet the required power supply, malfunction will occurs in the part of hand tools or equipment.
- Person's involved. It refers to the technical person who has the knowledge and skills about the technology.

D. Wet conditions

Wet conditions: When a cord connector is wet, electric current can leak to the equipment grounding conductor, and to humans who pick up that connector if they provide a path to ground. Such leakage can occur not just on the face of the connector, but at any wetted portion. Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors.

E. How to avoid Hazards.

- Use only equipment that is approved to meet DOSH standards.
- Use all equipment according to the manufacturer's instructions.
- Do not modify cords or use them incorrectly.
- Be sure equipment that has been shop fabricated or altered is in compliance.

Use double-insulated tools - Portable electrical tools are classified by the number of insulation barriers between the electrical conductors in the tool and the worker.



Use the right tool correctly. Use tools correctly and for their intended purposes. Follow the safety directions and operating procedures recommended by the manufacturer. When working on a circuit, use approved tools with insulated handles.



Common Examples of Misused Equipment: Using multi-receptacle boxes designed to be mounted by fitting them with a power cord and placing them on the floor.

Using circuit breakers or fuses with the wrong rating for over-current protection, e.g. using a 30-amp breaker in a system with 15- or 20-amp receptacles. Protection is lost because it will not trip when the system's load has been exceeded.

Content/Topic 2.aaccident prevention

A. Personal protective equipment (PPE)

Personal Protective Equipment (PPE) are gadgets to protect workers from injury or illness caused by having contact with the dangers/hazards in the workplace whether they are chemical, biological, radiation, physical, electrical, mechanical and others.

- **Shoes or strong/rubber boots:** Those are for protection against any sharp object on the floor.
- **gloves:** This is for Hand and Fingers protection from injuries in the work place
- **Helmet:** Those are for Head protection from any dropped materials or tools to the head. This device is needed where heavy machines are suspended. This is a must in all construction companies.
- **Overalls:** Those are work clothes to prevent your everyday clothing from becoming contaminated by oils, grease fluxes or general dust and dirt.
- **Goggle and Eye lids:** This equipment protects the eyes during welding and grinding operations.
- **Earmuff /Nose protection mask:** Those are for ear protection from noise.
- **Security belt:** is used in conjunction with other safety equipment when working on the Utility poles, the reason of this is to avoid fall hazard.

REMEMBER

1. Personal protective equipment should be taken care of as of the other tools and equipment. Wipe your helmets, gloves, safety shoes before keeping it.
2. It should also be cleaned, kept in proper tool rack/ cabinet.
3. It should be stored in dry places so that it will not have mold build-up.
4. Over-all suits should be washed regularly so that perspirations and other dirt will be washed clean.

B. Inspect tools and equipment

Because power tools are so common in construction, workers are constantly exposed to a variety of hazards. The very tool that makes their job easy and efficient may become the cause of a tragic accident.

Tool Safety Tips:

- Never carry a tool by the cord.
- Never yank the cord to disconnect it from the receptacle.
- Keep cords away from heat, oil, and sharp edges (including the cutting surface of a power saw or drill).
- Disconnect tools when not in use, before servicing, and when changing accessories such as blades, bits, etc.

- Avoid accidental starting. Do not hold fingers on the switch button while carrying a plugged-in tool.
- Use gloves and appropriate safety footwear when using electric tools.
- Store electric tools in a dry place when not in use.
- Do not use electric tools in damp or wet locations unless they are approved for that purpose.
- Keep work areas well lighted when operating electric tools.
- Remove all damaged portable electric tools from use and tag them: "Do Not Use."
- Use double-insulated tools.
- Hand-held tools manufactured with non-metallic cases are called double-insulated. If approved, they do not require grounding under the National Electrical Code. Although this design method reduces the risk of grounding deficiencies, a shock hazard can still exist.



- Construction power tools are often used in areas where there is considerable moisture or wetness. Although the user is insulated from the electrical wiring components, water can still enter the tool's housing. Ordinary water is a conductor of electricity. If water contacts the energized parts inside the housing, it provides a path to the outside, bypassing the double insulation. When a person holding a hand tool under these conditions contacts another conductive surface, an electric shock occurs.
- If a power tool, even when double-insulated, is dropped into water, the employee should resist the initial human response to grab for the equipment without first disconnecting the power source.
- Another potential hazard is using extension cords with portable tools. In construction, these cords suffer a lot of wear and tear. Often, the damage is only to the insulation, exposing energized conductors. When a person handling the damaged cord contacts the exposed wires while holding a metal tool case or contacting a conductive surface, serious electrical shock can result, causing a fall, physical injury, or death.
- Since neither insulation nor grounding protects you from these conditions, use other protective measures. One acceptable method is a ground-fault circuit interrupter (GFCI).
- If electrical equipment is used in ways for which it is not designed, you can no longer depend on safety features built in by the manufacturer. This may damage your equipment and cause employee injuries.

Equipment Not Used In Manner Prescribed: If electrical equipment is used in ways for which it is not designed, you can no longer depend on safety features built in by the manufacturer. This may damage your equipment and cause employee injuries.

LO 3.2 –Identify different types of trunks used for surface mounted installation.

Content/Topic 1 .Types of Electrical trunks

A. Introduction

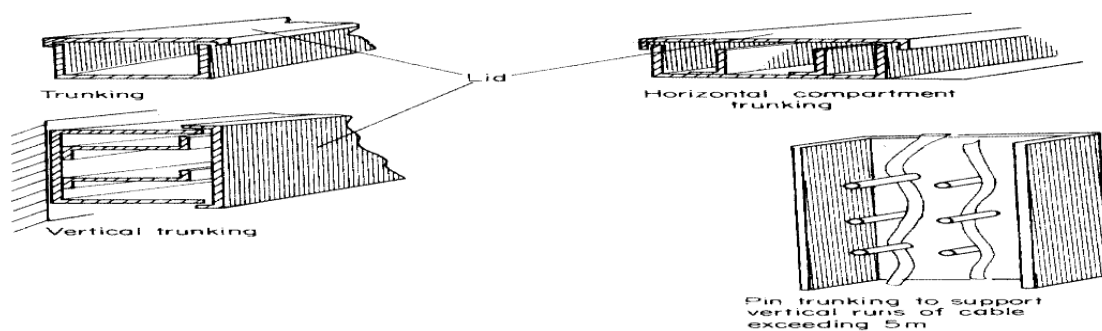
Trunking is an enclosure provided for the protection of cables which is normally square or rectangular in cross-section, having one removable side. The term trunking is used in the United Kingdom for electrical wire ways, generally rectangular in cross section with removable lids. Mini trunking is a term used in the UK for small form-factor (usually 6 mm to 25 mm square or rectangle sectioned) PVC wire ways. In India, this trunking is available with self-fixing tape to ease off installation.

In some countries including Iran, the term 'Trunking' is a channel that enables us to install some modules on it such as switches and sockets. . Wall duct raceway is the term for the type that can be enclosed in a wall.

Wirable trunking is used extensively in industry. It is a versatile system allowing the easy addition of further sections. A greater number of cables can be run than in conduit. No specialized tools are needed and there is a range of sizes. It allows different circuits to be segregated. It is, however, more expensive than conduit. The bus-bar type of trunking is used for rising mains, distribution boards, and overhead supplies to machines. The tap-off box system is popular as it gives a measure of control, and selective isolation. The bus-bar type of trunking is used for rising mains, distribution boards, and overhead supplies to machines. The tap-off box system is popular as it gives a measure of control, and selective isolation.

Trunking may be thought of as simply a larger and more accessible conduit system. It is available in two ranges, ordinary wiring trunking and bus-bar trunking. The ordinary system is further available in either metal or PVC.

B. **Metallic trunks**



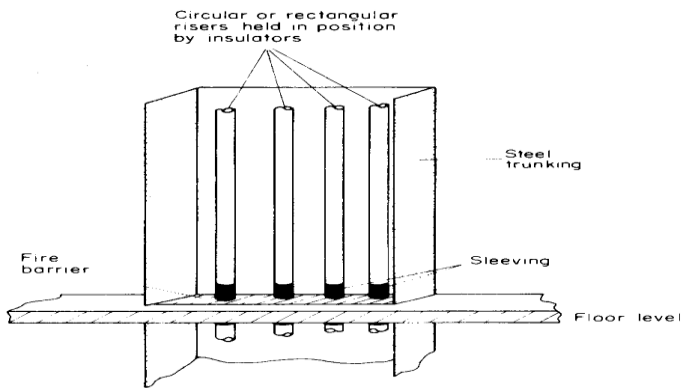
Metal trunking is used extensively in engineering premises. It allows a large number of cables to be drawn into one system with relative ease and because of its accessibility enable changes or additions to circuits to be made with the minimum of effort. As with conduit, it is available either painted or galvanized. A whole range of fittings is available, enabling the most difficult runs to be constructed.

It is available in many different sizes and designs. For example, compartment trunking allows the segregation of certain currents and support of cables in vertical runs.

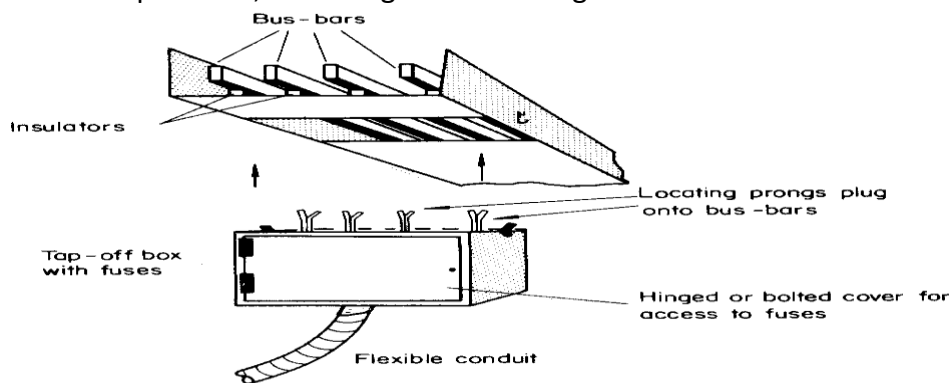
C. **Non-metallic/PVC trunks**

The main areas in which PVC trunking is used are domestic and office premises. All necessary fitting are available to complete any shape of run with little difficulty. The accessories are usually secured to the lengths of Trunking with a PVC solvent adhesive

D. Bus-bar trunking



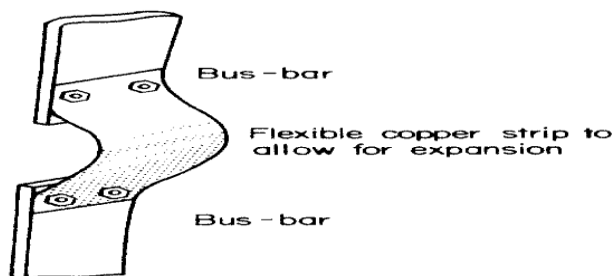
There are two main types of bus-bar trunking, the overhead type of bus-bar used for distribution in industrial premises, and rising-main trunking



Overhead bus-bar trunking is ideal for distribution in factories. It is run at high level and the tap-off boxes enable machinery to be moved easily. When connected in the form of a ring and incorporating section switches, this system enables parts of the trunking to be isolated when necessary, without all machines losing supply.

E. Points to note

- Where trunking passes through floors, walls or ceilings, a fire barrier must be provided.
- Many installations contain circuits of different types. These circuits are divided into two voltage bands:
 - a) Band 1 Extra low voltage (ELV) circuits, including bell and call systems, telecommunication and alarm systems.
 - b) Band 2 Low voltage circuits (LV), i.e. typical domestic, commercial and industrial arrangements.
- In trunking systems these bands may be enclosed together provided that either:
 - a) Band 1 cables are insulated to the highest voltage present, or
 - b) Band 1 and 2 circuits are in separate compartments in the trunking.
- All conductors of bus-bar trunking must be identifiable.
- Bus-bar trunking must be installed so that the conductors are inaccessible to unauthorized persons.
- Bus-bars must be free to expand and contract with variations in temperature



- All phases and neutral (if any) of a.c. circuits must be contained in the same metal trunking.
- Entry to trunking must be so placed as to prevent water from entering.
- The size of trunking may be determined from the guidance notes to the Regulations.
- When metal trunking is used as a circuit protective conductor, copper straps should be fitted across joints to ensure electrical continuity.

Learning Outcome 3.3: Identify different electrical fittings used for surface mounted installation.

Content/Topic 1 .Types of electrical fittings

Trunking, and in particular steel trunking, can be fabricated into various shapes to allow for bends and tees, etc. This process is, however, laborious and there are many different manufactured shapes available which simply bolt onto straight sections to allow versatility in installation.



➤ Coupler (Straight joint.)

This is a method used to join two trunking which are in the same route at horizontal plan or vertical plan.

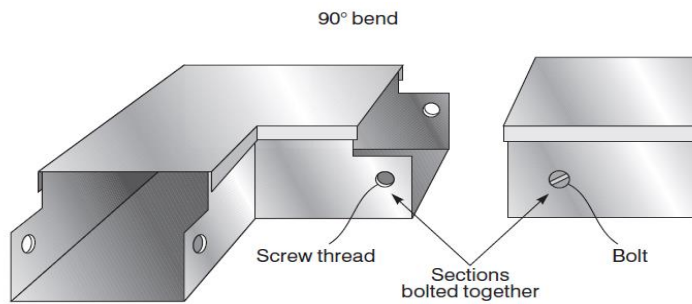


➤ L joint or elbow (at 45°)

When you want to join two trunking, one perpendicular to another at 45°, this method of trunking joining is used.

➤ L joint or elbow (at 90°)

When you want to join two trunking, one perpendicular to another at 90°, this method of trunking joining is used.



Junction box

Boxes are used to make connections of wiring or to mount switch boxes and fixtures. There are many types of metallic and non-metallic boxes.

Non-metallic PVC switches boxes and receptacle boxes are used in residential wiring. The roughing-in time can be reduced by using these boxes, inasmuch as they have their own connectors molded into the box. They can also be used in remodeling old work.

When you install an “old work” box into hollow walls, two arms swing out behind the wall. Tighten two screws and the arms draw tightly against the wall. Installation is completed with a few turns of the screwdriver. A template is included in the box to ensure an accurate cut in the wall.

The swing-arm box can be used with wall material from 1/4-inch to 5/8-inch thick or from paneling to drywall. A cable clamp is molded into the box. Just push the wire in and pull back slightly to activate the clamping action.

PVC boxes are made for switches and ceiling installations. The ceiling boxes will support fixtures up to 50 pounds. Mounting posts have a pair of holes 3/4 inches and three and half inches at the enter to accept fixture canopies that require either of these spacings.

Heavy-duty nails are already inserted. Just make sure you don't miss and hit the box with a hammer the results can be disastrous. The plastic does crack when hit a hard blow with a hammer that missed its target. The PVC boxes are usually of bright color. They may be gold or blue, to name but two of the manufacturers' colors

Horizontal TEE

This method used to join three trunking which two made angle of 180° between them and made to one which is vertical to them an angle of 90° (join pipes from three direction).

Learning Outcome 3.4: Select tools in accordance with the preparation needed for trunks.

A. Introduction

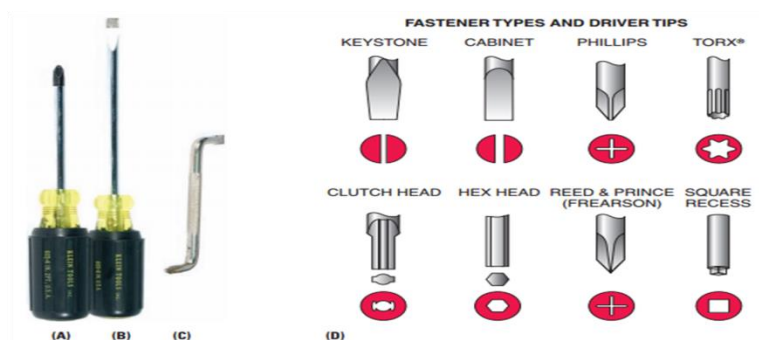
The quality of electrician in most cases can be judged from his appearance and tools, kits occupied by his firms clients, his closing should be wet and tidy with no loose end hanging around.

A tool is a device that can be used to produce an item or accomplish a task, but that is not consumed in the process. It can be considered as extension of the human hand thus increasing speed, power, and accuracy and on the other hands equipment includes any machine powered by electricity.

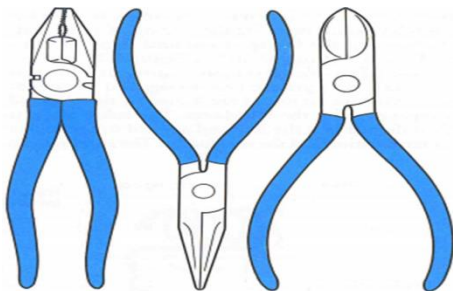
B. Hand tools

Hand tools are tools manipulated by hands without using electrical energy such as: puller, hacksaw, pull-push rule, pliers, hammer, and others.

- **Screw drivers:** variety of screw drivers from small terminal one up to a large size for open/ close screws. The common type has a single flat blade for driving screws with slotted heads. The other type has the cross slotted head.



- **Pliers:** are specified types of adjustable wrenches. The two legs move on a pivot so that items of various sizes can be gripped. They are used for cutting cables and twisting or bending conductors for entry into terminals



- **Spanners:** open/close bolts and nuts
 - **Hand drilling machine:** for drilling different holes
 - **Hammer:** used with chisels and for nailing and fitting
- **Measuring tape:** Is a flexible ruler and used to measure distance. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear measurement markings. It is a common measuring tool.



- **Spirit level:** indicate the verticality and horizontality of the surface.



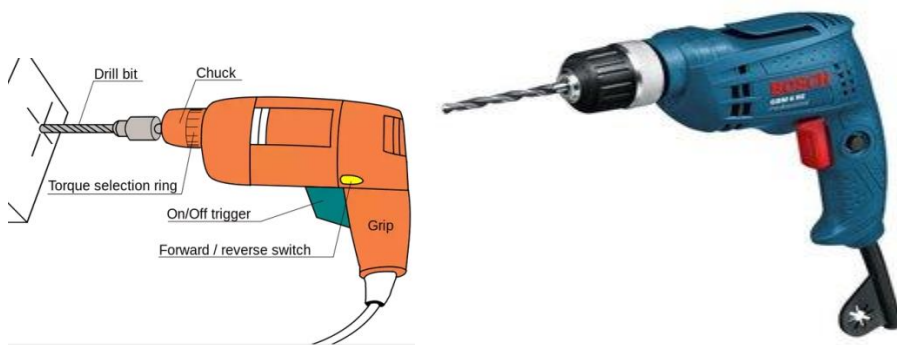
- **Wrenches.** They are used to turn screws, nuts and bolts with hexagonal heads. Hexagonal|| means six-sided. A variety of wrenches are used in the shop.

Content/Topic 2.Power tools

Machine/Power tools are tools manipulated by our hands and with the use of electrical energy such as: electric drill, grinding wheels, vacuum cleaner and others.

A. Drilling machines

Drill/Rotary Drill: This is a general hand held electric drill machine, having a normal drill chuck. It is used for drilling in wood, metal and plastics. Also used for screw driving.

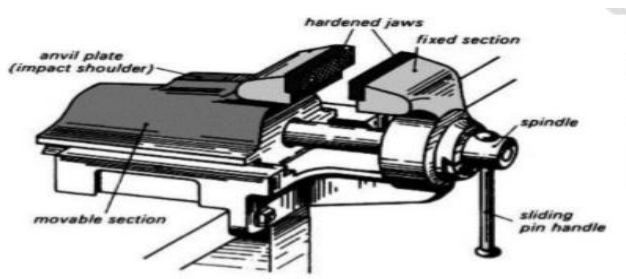


B. Clamping tools

Are those tools used to fix or to hold the piece for different operations. Among clamping tools, we can say bench vice, c-clamp. U-clamp,

Bench vice

A bench vice is the device for holding the work piece where most hand processes to be carried out. The body of the vice is made of cast iron while the two clamping jaws are made of hardened tool steel. Some bench vice has a swivel base, which can set the work piece at an angle to the table.



The vice height should be correct ergonomically. Vice clamps, made of copper are fitted over the vice jaws when holding finished work to avoid damage to the finish surfaces.

Grinding tool can be either bench-mounted or installed on a pedestal. They may either have a grinding wheel, v-flap wheel, or two grinding wheels.



Pneumatic tools are tools or instruments activated by air pressure. Pneumatic tools are designed around three basic devices: the air cylinder, the vane motor, and the sprayer

1. **Pneumatic Torque Wrench.** This wrench uses compressed air to quickly and powerfully turn nuts, bolts, and other objects.



2. **Air chisel** uses reciprocating motion to drive a cutting hammering tool. An air hammer drives a chisel to cut off a nut that has frozen to a stud. It can be used with a variety of tools-cutters and punches to do many jobs.



3. **Air drill** is lighter than a comparable electric drill. Repeatedly stalling or overloading does not damage or overheat the air drill



Learning Outcome 3.5: Fix trunks and their fittings based on the architectural diagram.

Content/Topic 1.Types of fixing

A. Trunking techniques

When an electrical installation is done through the trunking, the following techniques must be followed.

- Mark the placement of different installation materials such as switches, outlet socket, lamps, junction box.

- Draw the route where the circuit of installation pass through
- Measuring the trunking length are required to be used
- Drill the holes for trunking body fixation
- Fixation of the main body of trunking
- Placement of wires
- Fermentation of trunking with cover body of trunking

Fixing into masonry

- Plastic Raw plug
- Rawl bolt

Trunking may be secured direct to a surface or suspended by means of brackets. As trunking material is thin; there is no room for countersunk holes. Roundhead screws are suggested, unless of course the fixing surface requires bolts.



There are occasions when the trunking has to be suspended by means of brackets. Figure below shows two typical brackets.



Fixing into Partition

- Spring toggle
- Brolley fixing

One important aspect of installation work is the fixing of accessories to various surfaces. Figure below shows several different methods of fixing.

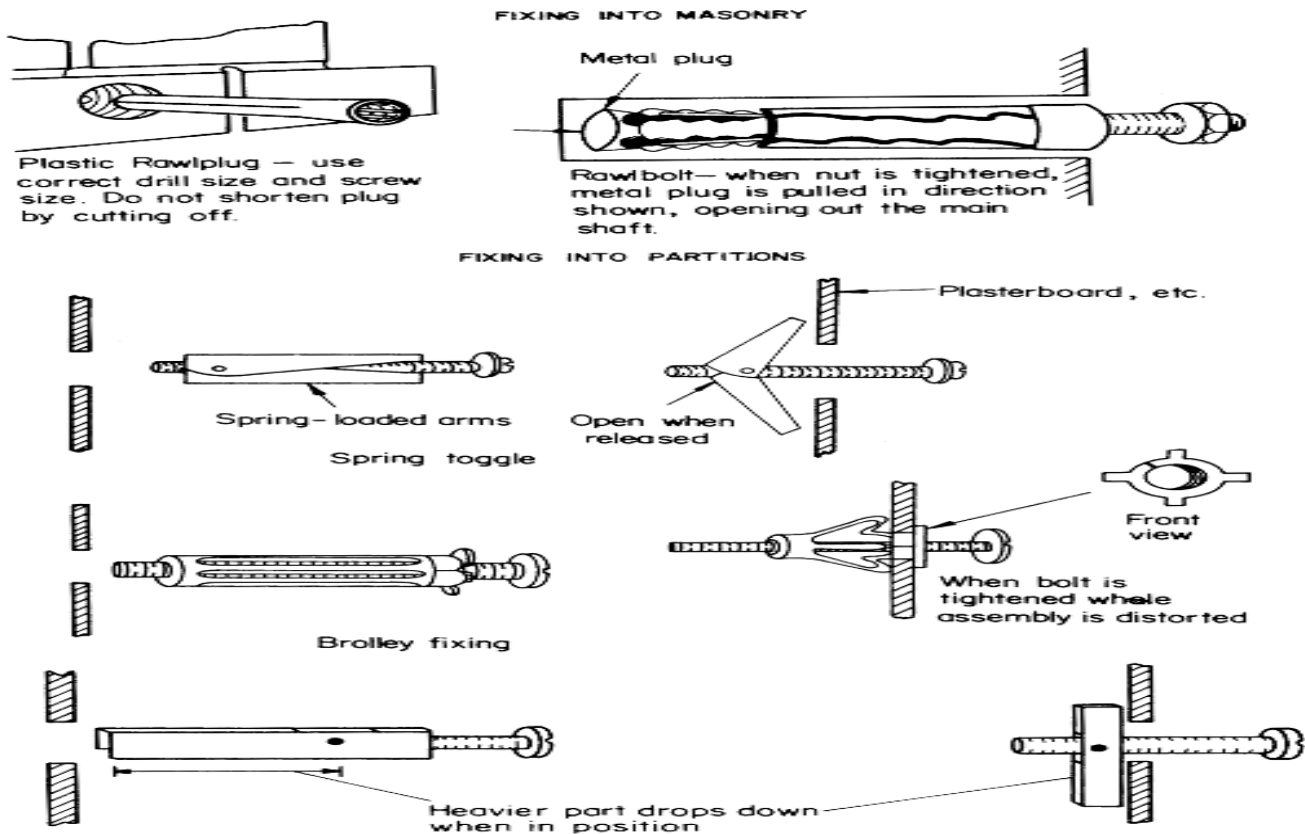


Figure 27. Fixing methods of trunking

The main disadvantage of gravity and spring toggles is that it is not possible to remove the bolt without losing the toggle.

- **Choose the right material for installing electrical conduit fittings:** The most preferred material is known as EMT (Electrical Metallic Tubing). EMT is very easy to install as you can effortlessly bend it and assemble it as per your needs. Also, you can conveniently take it off in case your wiring goes wrong somewhere. If you do not have it in your house, you can buy EMT from any of the electrical surplus stores for pretty cheap
- **Chalk out a wiring plan:** Find out the location of the electrical boxes on your wall to trace the route of the conduit. Draw the path from the main power source to the electrical box
- **Measure the amount of conduit that you would need:** Make appropriate marks in pencil wherever you think the bends should be, and measure the total length of the conduit that would be needed to finish the entire electrical conduit fittings. Now cut the length that you just measured with a tool called hacksaw. The cut ends are likely to have burrs which can be removed using a deburring tool or with pliers
- **Make the necessary bends:** It is now time to make bends that you had marked on the pipe in the previous step. Owing to the easy flexibility of EMT, this should not be very difficult. Conduit benders come in handy for doing this bending
- **Attach fittings to the wall:** You can use screws and straps with either single or double holes, available at electrical surplus shops, to attach electrical conduit fittings to the wall
- **Tape the ends and put the wires in place:** Use a widely available fish tape and run it through the entire route of the conduit fittings you just installed. Fix together the ends along with the electrical wires with the same fish tape. Give a finishing touch by pulling all the wire in the pipe in their right place

Learning Outcome 3.6: Arrange tools, materials and equipment in the workplace.

Content/Topic 1.Steps for arrangement of tools, material and equipment

A. Introduction

An important aspect of any business is the maintenance and storage of tools and equipment. The investment in tools and equipment is a significant part of the overhead expenses in any operation. Proper selection and maintenance of equipment are important factors in managing business. Selecting the proper tool for the job and using the tool properly will increase efficiency and reduce maintenance problems. Purchase tools, which are well-made and suited to the intended use. Commercial usage may entail more heavy duty demands on equipment.

B. Methods of cleaning tools and equipment

B.1.Cleaning with Solvents

Solvent is a component of a solution that dissolves solute and is usually present in large proportion or amount. It can be classified as polar and nonpolar. Polar solvents are solvents which dissolve/are soluble in water; while nonpolar solvents are solvents which do not dissolve/are insoluble in water. Solvents are usually used for cleaning in workshops. They are water, gasoline, kerosene, thinner and detergent soap.

Kinds of cleaning solvent based on their solubility in water:

Cleaning Solvents	Solubility in Water	Polar	Nonpolar
a. water	soluble	x	
b. gasoline	insoluble		x
c. kerosene	insoluble		x
d. thinner	insoluble		x
e. detergent soap	soluble	x	

Uses of Cleaning Solvents

Cleaning Solvents	Uses
Gasoline	Wash greasy tools/ equipment.
Kerosene	Remove dust, grease oil, paint, etc.
Thinner	Remove spilled paint on the floor, walls and tools.
Water	Wash dust in the floor, walls, etc.
Detergent Soap and water	Wash/clean benches, tables, cabinets, etc.

B.2.Cleaning tool and equipment by brush

A **brush** is a common tool with bristles, wire or other filaments. It is used for cleaning, grooming hair, makeup, painting, and surface finishing and for many other purposes. It is one of the most basic and versatile tools in use today, and the average household may contain several dozen varieties.



Figure 28.brush

They generally consist of a handle or block to which filaments are affixed either parallel- or perpendicular-wise, depending on the way the brush is to be gripped during use. The material of both the block and bristles or filaments is chosen to withstand hazards of its application, such as corrosive chemicals, heat or abrasion. Brushes used for cleaning come in various sizes, ranging from that of a toothbrush, to the standard household version accompanied by a dustpan, to deck brushes.

cleaning tool and equipment by air brower

Air blower machine is a simple and effective electrical device used at home and industries to low away dust from every corner and on any tool or equipment

C. Clean your tools

Hand tools cleaning technique: Regularly cleaning and maintaining your tools and equipment gives you the opportunity to carry out regular inspections and ensure your tools are all functioning properly and safely. If you notice they're not, you can make the necessary adjustments straight away. Cleaning and maintaining your tools after a busy day of work is extremely important.

Whether it is hand tools or power tools, they should be cleaned regularly to protect them from dust. With proper cleaning and maintenance, you extend the tools' life and ensure that they will remain rust-free. Where cleaning hand tools is quite easy, power tools require a more delicate touch. They cannot be cleaned with water and soap, as both may seep into the crevices and cause an electrical spark when the tool is plugged in.

We all like to keep a toolbox ready in our garage to make small fixes on our own. A staple that is missing from your tool box is the WD-40 specialist degreaser. This solvent is degreaser which can clean your tools.

A mistake that most people make is that they throw away the instruction manual and then try to clean the tools with lubricants they aren't even sure will remove the grease and rust. Sometimes they aren't even aware of the fact that these lubricants might even cause some damage to the tools.

Clean out the Dust. To make sure that your electric tools are ready to go when you are, keep them clean and free of dust. Spend some time to clean out the dust every once in a while on your tools while they are inactive in storage.



Figure 29.Cleaning of tools

D. Cleaning Hand Tools

Grease and rust build-up on hand tools are quite common. We usually leave them out lying on the kitchen slab, few are kept in our car and others rot in the garage. It is important to clean these tools regularly because with time, the sharp ends become blunt and develop small cracks. It's possible that they might shatter from a hard impact.

Instructions

1. Clean dirt and debris from tools after each use.
2. Oil metal parts to prevent rust.
3. Lightly sand rough wooden handles and apply linseed oil.
4. Repair loose handles.
5. Sharpen blades of cutting tools.
6. Store tools in a clean dry storage area.
7. Protect surfaces of cutting tools in storage.

E. Protect electrical cords

Check the Cords. Look for tear/cut insulator on the power cords on your electric tools. This will ensure that your electric tool can get the power that it needs to function without an accident.



Figure 30.electrical cords

Protect your Tools. Keep tools and cords away from heat, oil, and sharp objects. These hazards can damage insulation. If a tool or cord heats up, stop using it. Report the condition to a supervisor or instructor immediately.

D. Lubricate tools

A lubricant is a substance introduced to lessen friction between moving surfaces. It may also transport external particles. The property of reducing friction is known as lubricity.

Types of lubricants

- Anti-rust lubricant spray

- Wire Pulling Lubricant
- All Purpose Anti Rust Lubricant
- Lubricant Oil and Engine Oil. Silicon Lubricant

A good lubricant possesses the following characteristics

- High boiling point.
- Low freezing point.
- High viscosity index.
- Thermal stability.
- Corrosion prevention.
- High resistance to oxidation.

E. Inspection tools

E.1.Hand tools

1. Clean dirt and debris from tools after each use.
2. Oil metal parts to prevent rust.
3. Lightly sand rough wooden handles and apply linseed oil.
4. Repair loose handles.
5. Sharpen blades of cutting tools.
6. Store tools in a clean dry storage area.
7. Protect surfaces of cutting tools in storage.

E.2.Power tools:

1. Read and follow the maintenance schedule in the owner's manual for each piece of power equipment.
2. Change the oil.
3. Clean the air filter.
4. Lubricate moving parts.
5. Sharpen dull blades or replace worn blades according to the owner's manual.
6. Replace spark plugs.
7. Drain oil and gasoline before long-term storage.
8. Check electric cords and connections on electric-powered tools.
9. Store tools in a clean dry storage area.

E.3.Equipment:

1. Store equipment in a clean dry storage area.
2. Rinse and clean spray equipment after each use.
3. Clean spreaders and check wheel-driven gears.
4. Clean carts and wheelbarrows after use.

F. Store tools, material and equipment with care

To ensure that your electric tools work when you need them, you must take proper care of them. A good routine of maintenance for your tools is one thing that you can do to make sure that the tool you need is working when you need it.



Figure 31.toolbox

Keep your electric tools stored in their original cases and containers. This will keep them free of dust and dirt while they are not being used.

Classifications of tools and equipment according to their uses:

- Measuring tools
- Holding tools
- Cutting tools
- Driving tools
- Boring tools
- Electrical equipment



Figure 32.Storring of tools

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