BUILDING ELECTRICALINSTALLATION

Level-III

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Module Title: Selecting Wiring Systems and Cables for

Low Voltage General Electrical Installations

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LG #25	LO #1- LO#1- Prepare to select wiring systems and cables for general electrical installations

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- ❖ Determining the extent and nature of the electrical installation
- ❖ Identifying, Obtaining and understanding Safety and regulatory requirements
- ❖ Determining wiring system operations.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- ❖ Determine the extent and nature of the electrical installation
- ❖ Identify, Obtain and understand Safety and regulatory requirements
- ❖ Determine wiring system operations.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet-1	Determining the extent and nature of the electrical installation from job specifications

1.1 Introduction:

1.2 Determining the extent and nature of the electrical installation from job specifications

Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure. Wiring is subject to safety standards for design and installation. Allowable wire and cable types and sizes are specified according to the hence national standards follow an identical system of sections.

Extent of installation

The Contractor shall carry out all the necessary works for successful installation of the electrical services as described and set out in this section of the Technical Specification, Bills of Quantities, other sections of the electrical documents and accompanying Drawings in accordance with the General Electrical Specification herewith.

The Works, the major elements of which are scheduled below, includes the supply of all labour, material, equipment, plant and components necessary for complete installation and setting out work in respect of the entire electrical services requirements within the proposed development and rendering it in complete working condition in respect of but not limited to the following installations:

New Installations: Supply, Installation, testing and commissioning of the following installations:

- Incoming electricity supply intake and metering;
- Low Voltage Switchboards;
- Sub mains and distribution;
- Electrical power distribution;
- Trucking and cable trays;
- Lighting and power installations;
- Raw power installations;
- Solar Street lighting;
- Fire detection and alarm system;
- IT structured cabling system;

- ❖ TV system conduit;
- ❖ Earthling and grounding systems;

Lightning protection and transient over-voltage protection, etc. In general the installations shall be concealed in heavy gauge PVC conduits except in areas where surface installation is necessary. In such cases, installation will be carried out in trenching, galvanized steel conduit or cable tray as indicated on the Drawings.

LOW VOLTAGE SWITCH BOARD

A new distribution board shall be introduced in the Appeal Court building, which shall be connected to the new meter board via an underground low voltage cable.

The Contractor shall ensure that entry of cables, ducts, and conduits shall be neatly made and head boxes provided as required. All entries and openings shall be vermin-proof.

ELECTRICAL DISTRIBUTION SYSTEM

The Contractor shall supply and install, test and commission new distribution cables as indicated on the drawings and the specifications to complete the electrical distribution system,

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. One of the following to use protect dives
   A/ Circuit Barker
   B. fuses
   C. A & B

2. From the given choose which one is control dices.
   A/ Single pole switch
   B. Two way switch
   C. Dimmer switch
   D. intermediate switch
   E. all f. none

3. Supply, Installation, testing and commissioning
   A/ Low Voltage Switchboards;
   B/ Sub mains and distribution;
   C/ Electrical power distribution;
   D/ all

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information sheet - 2	Identifying, Obtaining and understanding Safety and regulatory requirement

2.1 **Introductions**

2.2 Identifying, Obtaining and understanding Safety and regulatory requirement

Determining an organization's legal and regulatory safety requirements is a critical first step in any workplace safety assessment and in building a credible safety program.

This manual provides information about policies, procedures, and guidelines related to health and safety at Stanford. Topics covered include responsibilities, services provided by the Department of Environmental Health and Safety (EH&S), a variety of topics related to workplace safety (e.g. asbestos, ergonomics), the management of hazardous materials, and how to prevent and handle emergencies.

Principles of safety

Safety is a core value at Stanford and the University is committed to continued advancement of an institutional safety culture with strong programs of personal safety, accident and injury prevention, wellness promotion, and compliance with applicable environmental and health and safety laws and regulations.

Stanford University makes all reasonable efforts to:

Promote occupational and personal safety, health and wellness;

Protect the health and safety of Stanford University faculty, staff and students;

Provide information to faculty, staff, and students about health and safety hazards;

Identify and correct health and safety hazards and encourage faculty, staff, and students to report potential hazards;

Conduct activities in a manner protective of the environment, and inform the Stanford community regarding environmental impacts associated with institutional operations; and

Maintain a risk-based emergency management program to reduce the impact of emergency events to the Stanford community.

Responsibility

Adherence to good health and safety practices and compliance with applicable health and safety regulations are a responsibility of all faculty, staff, and students. Line responsibility for good health and safety practice begins with the supervisor in the workplace, laboratory or classroom and proceeds upward through the levels of management. In academic areas, supervisors include faculty/principal investigators, laboratory directors, class instructors, or others having direct supervisory and/or oversight authority. Academic levels of management are the department chairperson or Independent Lab director, dean, the Dean of Research, and the Provost. Administrative levels of management include managers, directors, and vice presidents. Final responsibility for health and safety policy and programs rests with the President of the University.

A. Supervisory Responsibilities

University supervisors, including faculty supervisors and Principal Investigators (PIs), are responsible for protecting the health and safety of employees, students and visitors working under their direction or supervision. This responsibility entails:

Being current with and implementing Stanford University health and safety policies, practices and programs;

Ensuring that workplaces, including laboratories, and equipment are safe and well maintained;

Ensuring that workplaces or laboratories are in compliance with Stanford policies, programs and practices, and

Ensuring that employees, students and visitors under their supervision or within their work areas have been provided with appropriate safety training and information, and adhere to established safety practices and requirements.

B. Managerial Responsibilities

University managers, academic and administrative, are responsible for ensuring that:

Individuals under their management have the authority to implement appropriate health and safety policies, practices and programs;

Areas under their management have adequate resources for health and safety programs, practices, and equipment; and

Areas under their management are in compliance with Stanford University health and safety policies, practices and programs.

C. Environmental Health and Safety Responsibilities

Environmental Health and Safety (EH&S) is responsible for:

Reviewing legislation, recommending policies, and monitoring compliance with environmental and health and safety statutes and regulations and University health and safety policies and programs;

Developing institutional safety and compliance programs and assisting schools, departments, faculty, and managers with implementation

Providing guidance and technical assistance to supervisors and managers in the schools, departments, and other work units in identifying, evaluating, and correcting health and safety hazards;

Developing programs for the safe use of hazardous radiological, biological, and chemical substances and lasers;

Providing training materials, assistance, and programs in safe work practices;

Providing guidance on effective emergency management and business continuity programs, and providing emergency response services for incidents involving hazardous materials;

Providing fire prevention, inspection, engineering and systems maintenance services; and Hazardous waste management and disposal services.

D. Faculty, Staff, and Student Responsibilities

Faculty, staff and students are responsible for:

Keeping themselves informed of conditions affecting their health and safety;

Participating in safety training programs as required by Stanford policy and their supervisors and instructors;

Adhering to health and safety practices in their workplace, classroom, laboratory and student campus residences; Advising of or reporting to supervisors, instructors or EH&S potentially unsafe practices or serious hazards in the workplace, classroom or laboratory.

E. Safety Performance

Each individual at Stanford is expected to perform all work safely. Managers and supervisors shall establish and maintain a system of positive reinforcement and escalated discipline to support good health and safety practices. Safety performance shall be a part of every individual's role and responsibility as well as performance expectation and evaluation.

Safety Communication and Training

Safety and compliance required training shall be communicated in a manner readily understandable to faculty, staff and students, in accordance with the communication policy outlined below.

A. Systems of Communication

Managers and supervisors, both faculty and staff, shall establish, implement and maintain a system for communicating with employees and students about health and safety matters. Information should be presented in a manner readily understood by the affected employees and students. Due attention must be paid to levels of literacy and language barriers. Verbal communications should be supplemented with written materials or postings if appropriate. Whenever appropriate, statutes and policies affecting employees and students shall be available in the workplaces.

B. Communication about Hazards

Faculty, staff, and students who may come in contact with hazardous substances or practices either in the workplace or in laboratories shall be provided information concerning the particular hazards which may be posed, and the methods by which they may deal with such hazards in a safe and healthful manner.

C. Training

Supervisors, including faculty, shall be experienced, trained or knowledgeable in the safety and health hazards to which employees and students under their immediate direction and control may be exposed, and shall be knowledgeable of current practices and safety requirements in their field.

Faculty, staff and students shall have or be provided the knowledge to protect themselves from hazards in their working and learning environment. Supervisors, both faculty and staff, shall ensure that employees and students have received appropriate training and information regarding:

General health and safety practices of the workplace or laboratory, including emergency procedures;

Job-specific health and safety practices and hazards;

Recognition and assessment of health and safety risks; and,

How to minimize risks through sound safety practices and use of protective equipment; and,Awareness of appropriate practices to protect the environment.

Training shall occur when:

An employee is hired or student is new to the laboratory;

An employee or student is given a new assignment for which training has not previously been received; and

New hazards are introduced by new substances, processes or equipment.

Faculty, staff and students should, periodically, be retrained or demonstrate an understanding of current standard safety practices and requirements for their areas.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. How to minimize risks and use of protective equipment

A/ Training

B/ Awareness.

C.Understanding risk

D/ all

2. From the given alternatives which one is personal protective equipment?

A/ Safety goggles

B/ Safety shoes

C/ gloves

D/ ear protection

E/ all

3. Supervisors, including faculty, shall be experienced?

. A/ Systems of Communication

B/ Training

C/ Communication about Hazards D/ all

Score = _____

Rating: _____

Name: _____ Date: _____

Note: **Satisfactory rating - 10 points**	**Unsatisfactory - below 10 points**

Information sheet 3-Determining wiring system operations

3.1 Introduction

3.2 Determining wiring system operations

Electrical systems, also named *circuits* or *networks*, are designed as combinations of mainly three fundamental components—resistor, capacitor, and inductor—which are correspondingly defined by resistance, capacitance, and inductance, generally considered to be lumped parameters. In addition to these primary electrical components, in this chapter, we also discuss the operational amplifier. Producing the electron motion or voltage difference in an electrical circuit are the voltage or current sources, which are the counterparts of forces or moments in mechanical systems. The focus in this chapter is the formulation of mathematical models using methods of electrical circuit analysis.

All electrical systems must be provided with protection equipment, the purpose of which is to isolate faulty electrical equipment from the electrical supply system as rapidly as possible. This can be achieved by use of devices which respond directly to the current flowing (e.g. fuses) or by protective relays which respond to fault current flow and are used to initiate the tripping of other devices (e.g. circuit breakers).

So that only the faulty equipment is isolated from the supply, the protective devices provided throughout a power system must discriminate between faulty and healthy equipment. This discrimination of protective equipment is a key element in the design of electrical systems and the selection of protection devices for use within them. Each electrical system must be provided with an adequate number of suitably rated disconnecting devices located correctly throughout the power system. These must be so arranged that only appropriate devices operate to remove the faulty equipment from the supply.

Wiring" redirects here. For the software development platform, wiring (development platform).

This article is about building wiring. For power distribution, Electric power transmission and Electric power distribution.

Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure

Wiring is subject to safety standards for design and installation. Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals.

Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification. Wiring safety codes vary by locality, country or region

What is Electrical Wiring?

Electrical Wiring is a process of connecting cables and wires to the related devices such as fuse, switches, sockets, lights, fans etc to the main distribution board is a specific structure to the utility pole for continues power supply.

Methods of Electrical Wiring Systems Taking Connection

Wiring (a process of connecting various accessories for distribution of electrical energy from supplier's meter board to home appliances such as lamps, fans and other domestic appliances is known as Electrical Wiring) can be done using two methods which are

Joint box system or Tee system

Loop – in system

LG #26	**LO #2 select wiring systems and cables for general electrical installations**

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: ❖ Selecting *wiring* systems ❖ Selection *size of Wires* ❖ current-carrying capacity ❖ Earth fault-loop impedance ❖ Selecting circuit protective devices ❖ Obtaining evidence for selected electrical equipment This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: ❖ Selection *size of Wires* ❖ Select cable *conductor sizes* ❖ current-carries capacity ❖ Earth fault-loop impedance ❖ Select circuit protective devices ❖ Obtaining evidence for selected electrical equipmen
Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them. 4. Accomplish the “Self-checks” which are placed following all information sheets. 5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks). 6. If you earned a satisfactory evaluation proceed to “Operation sheets 7. Perform “the Learning activity performance test” which is placed following “Operation sheets” , 8. If your performance is satisfactory proceed to the next learning guide, 9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1- Selecting wiring systems

1.1 INTRODUCTION

1.2 Selecting wiring systems

Electrical wiring is an electrical system of cabling and linked devices like switches, distribution boards, plugs, and light equipment in a building. Wiring is subject to protection standards to strategy with installation.

Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals. Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification. The International Electro-technical Commission (IEC) is "struggling to harmonies wiring standards between member countries, while significant differences in design and installation necessities still exist. An electrical cable is a rally of one or more wires running side by side or bundled, which is applied to transfer electric current.

Electrical wiring is an electrical system of cabling and linked devices like switches, distribution boards, plugs, and light equipment in a building. Wiring is subject to protection standards to strategy with installation.

Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals. Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification.

The International Electro-technical Commission (IEC) is "struggling to harmonies wiring standards between member countries, while significant differences in design and installation necessities still exist. An electrical cable is a rally of one or more wires running side by side or bundled, which is applied to transfer electric current.

A cable rally is the composition of one or additional electrical cables and their corresponding connectors.

A cable rally is not necessarily suitable for connecting two devices but can be a partial product (e.g. to be soldered onto a printed circuit board with a connector mounted to the building). Cable assemblies can besides take the system of a cable tree or cable harness", applied to connect numerous terminals together.

There are essentially 5 types of electrical wires

A/ Triplex Electrical Wires: Triplex electrical wires are commonly applied in single-phase service drop conductors, among the power pole besides weather heads.

They are composed of two insulated aluminum wires wrapped with a third bare wire that is applied as a public neutral. The neutral is commonly of a smaller gauge besides grounded at each the electric meter plus the transformer.

Main Feeder Electrical Wires: Central power feeder wires act the wires that associate the service Weather head to the house.

They're made through Stranded or solid wire besides the cable installed act 30% further than the load essential.

B. Panel Feed Electrical Wires: Panel feed cables are normally black insulated THHN wire. These are applied to power the core junction container and the circuit breaker panels. Just like core power feeder electrical wires, the cables must be rated to 50% more than the actual load.

C. Non-Metallic Sheathed Electrical Wires: Non-metallic sheath electrical-wire is applied in most building besides has conductors, every with plastic insulation, besides a bare crushed wire. The separated wires are protected through another coating of non-metallic

Sheathing. Since it's moderately cheaper and available in ratings to (10 to 20 amps), this type is favorite in-house wiring.

D. Single Strand Electrical Wires: Single strand wire besides applications THHN wire, though there are other variants. Every wire is separate with numerous wires can be drawn together through a pipe certainly. Single strand electrical-wires are the most common choice for layouts[10-14] which use pipes to involve wires.,

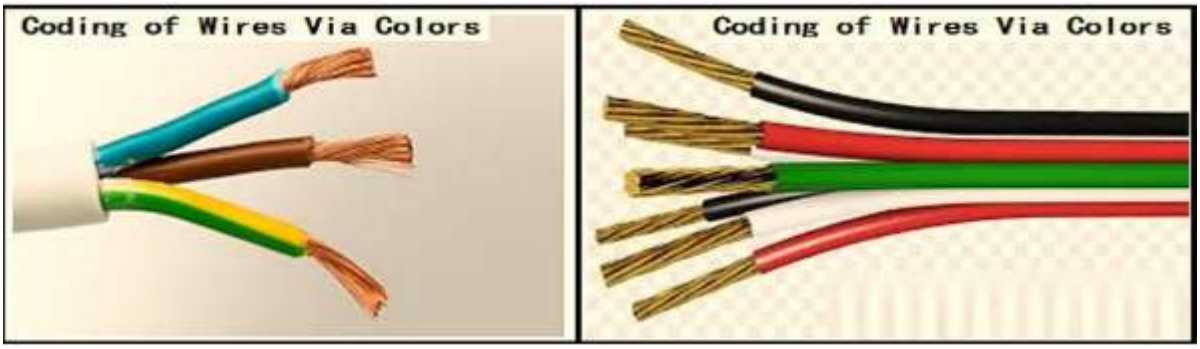

Fig (1): Coding of Wires Colors

E. Main Feeder Electrical Wires: Central power feeder wires act the wires that associate the service weather head to the house. They're made through stranded or solid THHN wire besides the cable installed act 30% further than the load essential.

F. Panel Feed Electrical Wires: Panel feed cables are normally black insulated THHN wire. These are applied to power the core junction container and the circuit breaker panels. Just like core power feeder electrical wires, the cables must be rated to 50% more than the actual load.

G. Non-Metallic Sheathed Electrical Wires: Non-metallic sheath electrical-wire, is applied in most building besides has (2 to 3) conductors, every with plastic insulation, besides a bare crushed wire. The separated wires are protected through another coating of non-metallic sheathing. Since it's moderately cheaper and available in ratings to (10 to 20 amps), this type is favorite in-house wiring.

H. Single Strand Electrical Wires : Single strand wire besides applications THHN wire, though there are other variants. Every wire is separate with numerous wires can be drawn together through a pipe certainly. Single strand electrical-wires are the most common choice for layouts [10-14] which use pipes to involve wires.

Classification of Electrical-Cables: There are other 10 different forms of cables available currently, designed to applications about from transmission to heavy industrial application. Selected of the most normally-used ones involve. Often applied to outdoor lighting and in-pounded uses and applications. Their high water-resistance makes them ideal to damp areas like gardens as well as open-to-air lamps, pumps, etc

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. One of the following use lighting circuit size of wire
   A/ 1.5 mm^2

   B. 2mm^2

   C. 2.5mm^2

2. From the given choose which one is use size of electrical wire mitad.

   A.3mm^2

   B. 2.5mm^2

   C. 4mm^2

   D. none

3. ------are commonly applied in single-phase service drop conductors, among the power pole besides weather heads.

   A/ Triplex electrical wires

   B/ voltage

   C/ Current

   D/ all

Score = _____

Rating: _____

Name: _____ Date: _____

Note: **Satisfactory rating - 10 points**	**Unsatisfactory - below 10 points**

Information sheet 2- Selection *size of Wires*

2.1 INTRODUCTION

2.2 Selection *size of Wires*

Electrical wiring is an electrical system of cabling and linked devices like switches, distribution boards, plugs, and light equipment in a building. Wiring is subject to protection standards to strategy with installation. Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals. Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification. Wiring protection codes vary via locality [1-3], state or region. The International Electro-technical Commission (IEC) is "struggling to harmonies wiring standards between member countries, while significant differences in design and installation necessities still exist. An electrical cable is a rally of one or more wires running side by side or bundled, which is applied to transfer electric

Electrical Wiring (Types, Sizes and Installation Electrical wiring is an electrical system of cabling and linked devices like switches, distribution boards, plugs, and light equipment in a building. Wiring is subject to protection standards to strategy with installation. E,g $2.5mm^{2,}$ $1.5m^2$ 2 mm & $4mm^{2`}$

Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals. Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification. Technical Commission is "struggling to harmonies wiring standards between member countries, while significant differences in design and Installation necessities still exist. An electrical cable is a rally of one or more wires running side by side or bundled, which is applied to transfer electric current.

A cable rally is the composition of one or additional electrical cables and their corresponding connectors. A cable rally is not necessarily suitable for connecting two devices but can be a partial product (e.g. to be soldered onto a printed circuit board with a connector mounted to the building).

Flexible wires

Flexible cables, or 'continuous-flex' cables, are electrical cables specially designed to cope with the tight bending radii and physical stress associated with moving applications, such as inside cable carriers.

Due to increasing demands within the field of automation technology in the 1980s, such as increasing loads, moving cables guided inside cable carriers often failed, although the cable carriers themselves did not. In extreme cases, failures caused by "corkscrews" and core ruptures brought entire production lines to a standstill, at high cost. As a result, specialized, highly flexible cables were developed with unique characteristics to differentiate them from standard designs. These are sometimes called “chain-suitable,” “high-flex,” or “continuous flex” cables.

Flexible cables can be divided into two types: those with conductors stranded in layers inside the cable, and those that have bundled or braided conductors.

Figure 2 flexible wire

P.V.C (polyvinyl chloride insulation wire

PVC (Polyvinyl chloride) is widely used in electrical cable construction for insulation, bedding and sheathing. It was the 1950s when PVC started to replace rubber insulated and sheathed cables in general household wiring due to its ease of processing.

Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it’s vital

To gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it’s crucial to find the current carrying capacity (A, ampere) and voltage drop per

Ampere meter (MV/A/m) of the cable. The current carrying capacity of a cable is the maximum current that can flow continuously through a cable without damaging the cable's insulation and other components. Short circuit temperature rise and earth fault loop impedance are significant

Factors to verify the cable size [1].

Every conductors and cables except superconductor have some amount of resistance.

This resistance is directly proportional to the length and inversely proportional to the diameter of the conductor.

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers

Test I: Choose the best answer (6 point)

1. Which one of the following use calling system current rating

A/10A

B. 6A

C. 16A

2. From the given choose which one of high current rating.

A. Fixable wire

B. hard wire

C. stranded wire

D. none

3. ….is an electrical system of cabling and linked devices like switches, distribution boards,

A/Electrical wiring

B/ fuse

C/ circuit

D/ all

Score = _____

Rating: _____

Name: _____ Date: _____

Note: **Satisfactory rating - 6 points**	**Unsatisfactory - below 6 points**

Information sheet 3- Selecting cable conductor sizes

3.1 Introduction

3.2 Selecting cable conductor sizes

There are four primary reasons that the cable sizing is very important at design stage.

First and foremost, cable sizing is important to operate continuously under full load condition

Without being damaged. Moreover, it is necessary to withstand the worst short circuit currents

Flowing through the cable. Ensure that the protective devices are effective during an earth fault.

Ensure that, the supply to the load with a suitable voltage and avoid excessive voltage drops.

Cable Selection, Sizing and Other Parameters

Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it's vital to gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it's crucial to find the current carrying capacity (A, ampere) and voltage drop per

Ampere meter (MV/A/m) of the cable. The current carrying capacity of a cable is the maximum

Current that can flow continuously through a cable without damaging the cable's insulation and

Other components. Short circuit temperature rise and earth fault loop impedance are significant

Factors to verify the cable size.

There are four primary reasons that the cable sizing is very important at design stage.

First and foremost, cable sizing is important to operate continuously under full load condition

Without being damaged. Moreover, it is necessary to withstand the worst short circuit currents

Flowing through the cable. Ensure that the protective devices are effective during an earth fault.

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There are four primary reasons that the cable sizing is very important at design stage.

First and foremost, cable sizing is important to operate continuously under full load condition

Without being damaged. Moreover, it is necessary to withstand the worst short circuit currents

Flowing through the cable. Ensure that the protective devices are effective during an earth fault.

Ensure that, the supply to the load with a suitable voltage and avoid excessive voltage drops.

The inspection personnel should ensure that installation crews do not exceed these values during installations. It is also important that correct bending radius be maintained in order to avoid unnecessary stress points. Once a correct installation is made, routine inspection, testing, and maintenance should be carried out on a regular basis to chart the gradual deterioration and upkeep of the cable system.

Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it's vital to gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it's crucial to find the current carrying capacity (A, ampere) and voltage drop per ampere meter (MV/A/m) of the cable.

The current carrying capacity of a cable is the maximum current that can flow continuously through a cable without damaging the cable's insulation and other components. Short circuit temperature rise and earth fault loop impedance are significant factors to verify the cable size

Every conductors and cables except superconductor have some amount of resistance.

This resistance is directly proportional to the length and inversely proportional to the diameter of the conductor.

Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it's vital to gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it's crucial to find the current carrying capacity (A, ampere) and voltage drop per

Ampere meter (MV/A/m) of the cable. The current carrying capacity of a cable is the maximum

Current that can flow continuously through a cable without damaging the cable's insulation and other components. Short circuit temperature rise and earth fault loop impedance are significant factors to verify the cable size.

Every conductors and cables except superconductor have some amount of resistance.

This resistance is directly proportional to the length and inversely proportional to the diameter of

The conductor there is four primary reasons that the cable sizing is very important at design stage. First and foremost, cable sizing is important to operate continuously under full load condition without being damaged. Moreover, it is necessary to withstand the worst short circuit currents flowing through the cable. Ensure that the protective devices are effective during an earth fault.

Ensure that, the supply to the load with a suitable voltage and avoid excessive voltage drops

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Flowing sthrough the cable. Ensure that the protective devices are effective during an earth fault.

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Careful selection of the sizes of the conductors in wiring systems and the characteristics of protection devices will ensure basic protection of the installation:- Protection against overloads- Limitation of voltage drops- Protection against short-circuits- Checking of the thermal stresses- Protection against indirect contact.

What is cable conductor size?

The Gauge size of stranded conductors is often expressed as a combination of the overall size and the size of the individual strand. EXAMPLE: 16 AWG 26/30 - 16 represents the overall gauge size, 26 is the number of strands, and 30 is the gauge size of each of the 26 wires. This can also be expressed as 26/.

Cable selection and application

It is essential to know cable construction, characteristics, and ratings to understand problems related to cable systems. However, to correctly select a cable system and assure its satisfactory operation, additional knowledge is required. This knowledge may consist of service conditions, type of load served, mode of operation and maintenance, and the like.

5 key factors to the correct cable selection and application (photo credit: testguy.net)

The key to the successful operation of a cable system is to select the most suitable cable for the application, make a correct installation, and perform the required maintenance.

In this technical article, discussion is based on the correct cable selection and application for power distribution and utilization.

- Cable selection can be based upon the following five key factors:
- Cable installation
- Cable construction
- Cable operation (voltage and current)
- Cable size
- Shielding requirements
- Cable installation

Cables can be used for outdoor or indoor installations depending upon the distribution system and the load served.

A good understanding of local conditions, installation crews, and maintenance personnel is essential to assure that the selected cable system will operate satisfactorily! Many times cable insulation is damaged or weakened during installation by applying the incorrect pulling tensions.

Designs of conduit systems not only should minimize the number of conduit bends and distances between manholes but also should specify the pulling tensions.

The inspection personnel should ensure that installation crews do not exceed these values during installations. It is also important that correct bending radius be maintained in order to avoid unnecessary stress points. Once a correct installation is made, routine inspection, testing, and

maintenance should be carried out on a regular basis to chart the gradual deterioration and upkeep of the cable system.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6point)

1. **Which one of the following Lighting current rating**

A/ 10 A

B/ 20A

C/ 230v

D. 50 Hz/220v

2. From the given choose which one is personal protective equipment.

A/ Safety goggles

B. Safety shoes

C. Clothes

D. ear protection

3. Cable selection can be based upon

A/ Cable installation

B/ Cable construction

C/ size of cable

D/ all

Score = _____

Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information sheet -4 current-carrying capacity

4.1 Introduction

4.2 current-carrying capacities

The current-carrying capacity of a long transmission line may be determined by, voltage regulation, system stability or the cost of resistive power losses. In the case of a shorter transmission line, the rating may be limited by the maximum permissible temperature of the conductors, which controls the maximum sag of the conductors, and the time distribution of the conductor temperature, which determines the rate of annealing and, hence, the cumulative loss of tensile strength of the conductors.

Cable ratings and forced cooling

The considerations in the general section on current carrying capacity are applicable also to transmission cables, but because of the much greater power carried, the effects of heat dissipation in the ground are of particular importance. First, it is necessary to inspect the soil to determine its thermal resistivity: 1.2°C m/W is taken as a representative value, but it may be much higher in sand, shingle or made-up ground, or if the soil is likely to be permanently dry. The moisture content is a significant factor in ground thermal resistivity; this became apparent when cables were loaded continuously so that moisture could not seep back during reduced load periods.

If a new characteristic is specified, it is mandatory to establish: - a suitable definition - a realistic test method allowing determining compliance with the requirements of this new characteristic alternately this specification requirement should be taken out, or replaced by a commonly used requirement. Current carrying capacity or better amp city is determined traditionally in the cable industry based upon the maximum performance temperature of the insulted and jacketed wire. This maximum performance temperature of the wire in turn is based upon - the heat generated in the conductor - the heat generated in the insulation - the heat generated in the jacket - the heat dissipation properties of the conductor - the heat dissipation properties of the insulation - the heat dissipation properties of the jacket The heat dissipation properties by convection and/or conduction of the insulated and jacketed wire depend upon its environmental conditions like - ambient temperature - maximum allowable temperature differential - stacking density of the jacketed wires in ducts, raceways or plenums - insulation material and its color - jacket material and its color - air movement

Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it’s vital

To gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it's crucial to find the current carrying capacity (A, ampere) and voltage drop per

Ampere meter (MV/A/m) of the cable. The current carrying capacity of a cable is the maximum

Current that can flow continuously through a cable without damaging the cable's insulation and

Other components. Short circuit temperature rise and earth fault loop impedance are significant

Factors to verify the cable size

Every conductors and cables except superconductor have some amount of resistance.

This resistance is directly proportional to the length and inversely proportional to the diameter of

The conductor. Sizing Cable sizing methods follow the unchanged basic step process. Firstly, it's vital

To gather data about the cables, installation surroundings, and the load that it will carry. In

Addition, it's crucial to find the current carrying capacity (A, ampere) and voltage drop per

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Other components. Short circuit temperature rise and earth fault loop impedance are significant

Factors to verify the cable size. Every conductors and cables except superconductor have some amount of resistance.

This resistance is directly proportional to the length and inversely proportional to the diameter of

The conductor.

35,00 mm^2	158A	135A
50,00 mm^2	198A	168A
70,00 mm^2	245A	207A
95,00 mm^2	292A	250A
120,00 mm^2	344A	292A
150,00 mm^2	391A	335A
185,00 mm^2	448A	382A
240,00 mm^2	528A	453A
300,00 mm^2	608A	523A

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. **One of the following is electrical hazard**
   A/ Electrical shock

   B. electrical risk

   C. A & B

2. From the given choose which one is personal protective equipment.

   A. Safety goggles

   B. Clothes

   C. gloves

   D. ear protection E. all

3. The current-carrying capacity of a long transmission line.

   A/ loose current

   B/ loose voltage

   C/ all

Score = _____

Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points	

Information sheet 5- voltage-drop

5.1 Introduction

5.2 voltage-drops

Everyone knows that the consumer is required to pay for the electricity supplied by the electric cooperative that is measured at the kilowatt-hour meter. But part of that electricity between the meter and the end location where it is to be used will get “lost” due to a condition called voltage drop. Voltage drop can be thought of as wasted electricity. It is simply the difference between the voltage measurement at the source and the voltage measurement at the point of use. Besides paying for electricity you don’t receive, voltage drop can cause other problems as well.

Reducing Voltage Drop It’s not possible to have zero voltage drops — because some voltage loss is going to occur naturally from the resistance of the conductors themselves — simply because it takes effort (voltage) to push current through a conductor. However, the goal is to minimize the voltage drop as much as possible. Besides wasting electricity that you are paying for, there are other reasons to keep voltage drop to a minimum when performing electrical wiring. These reasons include:

• System efficiency. If a circuit has much of a load, a larger conductor (that allows less voltage drop) pays for itself many times over in energy savings alone.

• System performance. As stated before, excessive voltage drop in a circuit can cause lights to fl ickier and/or burn dimly; heaters to heat poorly; and can cause overheating, inefficiency, and shorter life span of motors.

• Troubleshooting. When one follows the Code voltage drop recommendations, the electrician doing troubleshooting does not have to guess whether his low voltage fi eld measurements indicate

A problem or (2) that voltage drops was not accounted for in the design.

Causes of voltage drop there are various causes of voltage drop. One of the main causes is the conductor itself that is being used. The following four factors determine the resistance found in a conductor:

• Type of Material from which the conductor is made – Copper conducts electricity better than aluminum and will cause less voltage drop than aluminum for a given length and conductor size.

• Diameter of the Conductor (size or gauge of the conductors) – Conductors with larger diameters will result in less voltage drop than conductors with smaller diameters of the same length.

• Conductor Length – Shorter conductors will have less voltage drop than longer conductors for the same conductor size.

• Temperature of the Conductor – As a general rule, most conductive materials will increase their resistance with an increase of temperature.

Calculating Voltage Drop Since we know that it is necessary to keep voltage drop to a minimum, sometimes one may find it necessary to compute the voltage drop of an installation when the length, size Voltage Drop 3 of wire, and current of the load are known.

The earth fault loop in an MEN system comprises the following components:

1. The protective earthling conductor (PE). The objective of the earth fault loop impedance calculation (see Section 4) is to properly determine earth cable size.

2. The neutral return path consisting of the neutral conductor (N) between the main neutral terminal and the transformer neutral point.

3. The path through the transformer winding.

4. The active conductor (A) as far as the point of the fault.

Voltage drop considerations

The first consideration for voltage drop is that under the steady-state conditions of normal load, the voltage at the utilization equipment must be adequate.

Figure 3 voltage drop

Fine-print notes in the NEC recommend sizing feeders and branch circuits so that the maximum voltage drop in either does not exceed 3%, with the total voltage drop for feeders and branch circuits not to exceed 5%, for efficiency of operation.

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. **Cause of voltage drop**
   A/ lose connection

   B. temperature

   C. A & B

2. From the given choose which one is stove circuit Electrical wire size.

   A/ 2.5mm2.

   B/ 3mm2

   C. 4mm^2

   D. none

3. The cause of low voltage?

   A/ loose current

   B/ high current

   C High resistance

   D/ C&A

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

satisfactory - below 10 points	**Unsatisfactory - below 10 points**

Information sheet 6- Earth fault loop impedance

6.1 Introduction

6.2 Earth fault loop impedance

Calculating Fault Loop Impedance compliance requires that if an active to earth fault occurs then the total impedance in the fault loop path (consisting of all conductors, connections and contacts as well as the transformer windings) must be low enough to generate sufficient fault current to operate the circuit protective device within an adequate time.

Theoretical background behind fault loop impedance

The earth fault loop in an MEN system comprises the following components:

The protective earthling conductor (PE) including the main earthling terminal/connection or bar and MEN connection.

The neutral return path consisting of the neutral conductor (N) between the main neutral terminal and the transformer neutral point the path through the transformer winding the active conductor (A) as far as the point of the fault

The earth fault loop is normally regarded as consisting of the following two parts:

Conductors upstream or ‘external’ to the reference point.

Conductors downstream or ‘internal’ to the circuit from the reference point.

Earth loop impedance of final circuits

For each final circuit and distribution circuit, it must be confirmed that the value of line-earth loop impedance (Zs) is low enough to achieve automatic disconnection of supply to the circuit within the relevant maximum time species in Regulation in the event of an earth fault.

Gives the maximum disconnection times permitted for final circuits and distribution circuits in TN and TT systems at a nominal voltage to earth of 230 V. When checking that the value of Zs is sufficiently low to achieve disconnection within the required maximum time, account must be taken of characteristics of the protective device used for automatic disconnection.

Consequences when performing earth loop impedance tests

For new installations, earth loop impedance testing should present few operational problems during the initial frication process, as the installation will not have been put into service.

However, for an installation that is in service, there may be serious consequences for the user of the premises if, for example, computer data is lost or a home life support system switched off as a result of an inadvertent interruption of supply during the test, such as might be caused by the unintended operation of an RCD.

Inadvertent disconnection of a circuit, group of circuits, distribution board or even a whole installation could occur if an RCD operates when an earth fault loop impedance test is carried out. As a result, a number of methods have been developed to minimize the likelihood of an RCD operating during such a test.

The impedance of the earth fault current loop starting and ending at the point of earth fault. This impedance is denoted by the symbol (Zs).

The circuit breaker curve describes how value of fault current affects the time of its opening during fault condition. Because of this the IEC provide a specific values of earth fault loop impedance to maintain the integrity of our protective devices.

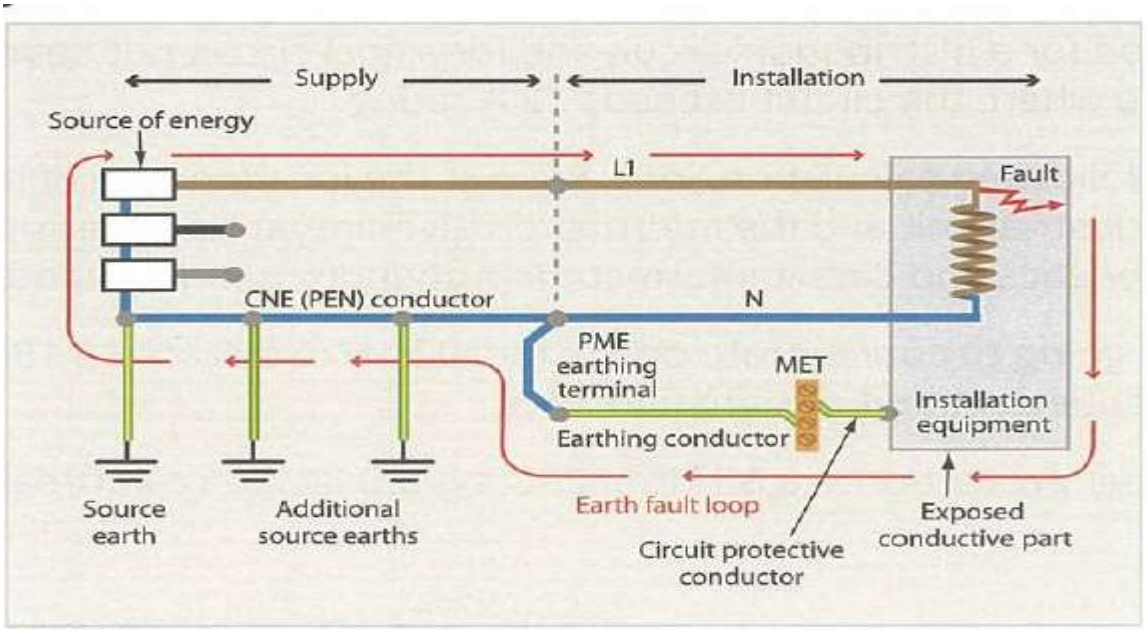


Figure 5 foliate earth

How to obtain Earth Foliate Loop value?

There are different methods on how to obtain the value of EFL. One method is calculation which will be discussed in details in other article. But the most practical way is the use of EFL tester.

Procedure on how to measure EFL by using EFL tester:

Isolate and secure the installation main switch in the off position.

Ensure, for reasons of safety, that all main protective bonding is connected to the main earthling terminal. If the supplier's cable is faulty, a fault current may be introduced to extraneous parts of the installation.

Disconnect the earthling conductor from the main earthling terminal.

Check instrument for safety and correct settings.

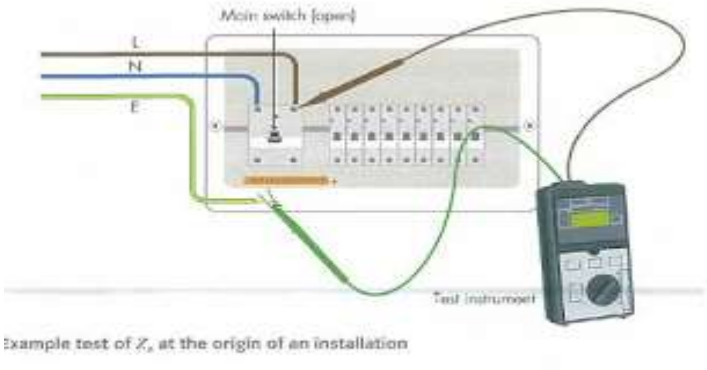
Connect the earth clip to the disconnected earthling conductor, then connect the test instrument line probe to the supply line terminal of the main switch.

Press the test button and note the result.

For three-phase installations, repeat this test for all line conductors. For three-phase installations, the highest reading obtained is recorded as the external earth fault loop impedance.

For a single-phase installation, record the value.

Reconnect the earthling conductor to the MET.



Source: City and Guilds

Figure 6

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. w/c one of the following is not protective device

A/ Breaker

B. tethering

C. fuse

D/ all

2. From the given choose which one is personal protective equipment.

A / Safety shoes

B/ Clothes

C/ gloves

D/ all

Score = _____
Rating: _____

Name----------date----------

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information sheet 7- Selecting circuit protective devices

7.1 Introduction

7.2 Selecting circuit protective devices

An electrical unit is built with great care to ensure that each separate electrical circuit is fully insulated from all the others. This is done so that the current in a circuit will follow its intended path. Once the unit is placed into service, however, many things can happen to alter the original circuitry. Some of the changes can cause serious problems if they are not detected and corrected. While circuit protection devices cannot correct an abnormal current condition, they can indicate that an abnormal condition exists and protect personnel and circuits from that conduit.

Over current protection

This must be provided on all systems to prevent abnormally high currents from overheating and causin g mechanical stress on equipment. Overcurrent in a power system usually indicates that current is bein g diverted from its normal path by a short circuit. In low-voltage, distribution-
type circuits, such as those found in homes, adequate overcurrent protection can be provided by fuses that melt when current exceeds a predetermined value.

Small thermaltype circuit breakers also provide overcurrent protection for this class of circuit. As the siz e of circuits and systems increases, the problems associated with interruption of large fault currents dict ate the use of power circuit breakers. Normally these breakers are not equipped with elements to fault c onditions, and therefore overcurrent relays are applied to measure the current continuously. When the current has reached a predetermined value, the relay contacts close. This actuates the trip circuit of a p articular breaker, causing it to open and thus isolate the fault.

Protection devices for electrical circuits accomplish two main functions namely consistency as well as protection. Protection is assured through detaching power supply in a circuit through over current protection, which removes fire hazards and electrocution. Additionally, the accurate protection may be required to obey with organization principles for some products. Designers must take time to know the different protection devices for circuits. Protection devices used to protect circuits from extreme voltages or currents. This article discusses what is a protection device, and types of protection devices used in electrical and electronic circuits.

Circuit protection devices

All of the conditions mentioned are potentially dangerous and require the use of circuit protection devices. Circuit protection devices are used to stop current flow or open the circuit. To do this, a circuit protection device must ALWAYS be connected in series with the circuit it is protecting.

Device is connected in parallel; current will simply flow around the protection device and continue in the circuit.

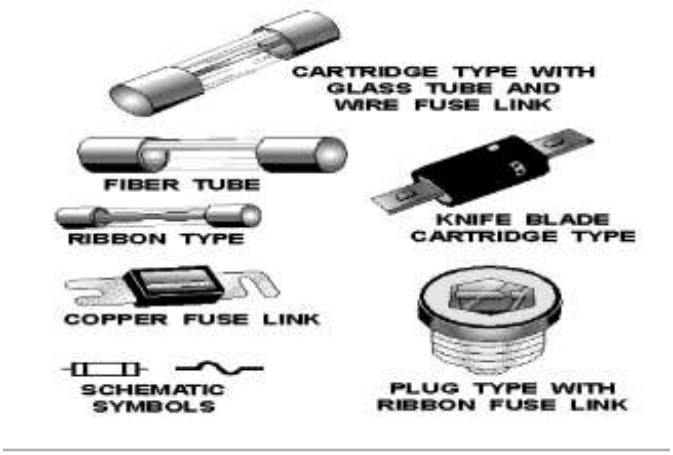
A circuit protection device operates by opening and interrupting current to the circuit. The opening of a protection device shows that something is wrong in the circuit and should be corrected before the current is restored. When a problem exists and the protection device opens, the device should isolate the faulty circuit from the other unaffected circuits, and should respond in time to protect unaffected components in the faulty circuit. The protection device should NOT open during normal circuit operation. The two types of circuit protection devices discussed in this chapter are fuses and circuit breakers.

Fuses

A fuse is the simplest circuit protection device. It derives its name from the Latin word "fuses," meaning "to melt." Fuses have been used almost from the beginning of the use of electricity. The earliest type of fuse was simply a bare wire between two connections. The wire was smaller than the conductor it was protecting and, therefore, would melt before the conductor it was protecting was harmed. Some "copper fuse link" types are still in use, but most fuses no longer use copper as the fuse element (the part of the fuse that melts). After changing from copper to other metals, tubes or enclosures were developed to hold the melting metal.

Fuses of this type are commonly found in automobile lighting circuits. Figure 2-1 shows several fuses and the symbols used on schematics.

Figure 7 breaker & fuse



Fuse Figure 8

Types of fuse Circuit Breakers

While a fuse protects a circuit, it is destroyed in the process of opening the circuit. Once the problem that caused the increased current or heat is corrected, a new fuse must be placed in the circuit. A circuit protection device that can be used more than once solves the problems of replacement fuses.

Such a device is safe, reliable, and tampers proof. It is also resettable, so it can be reused without replacing any parts. This device is called a CIRCUIT BREAKER because it breaks (opens) the circuit.

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. Which one is correct current lighting rating?

A/ 10A

B. 12A

C. A & B

2. From the given choose which one is personal protective equipment.

A/ Safety goggles

B. Safety shoes

C. Clothes

D. gloves

E. ear protection

F. all

Score = _____
Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information sheet 8- Circuit protective devices

8.1 INTRODUCTION

8.2 Circuit protective devices

An electrical unit is built with great care to ensure that each separate electrical circuit is fully insulated from all the others. This is done so that the current in a circuit will follow its intended path. Once the unit is placed into service, however, many things can happen to alter the original circuitry. Some of the changes can cause serious problems if they are not detected and corrected. While circuit protection devices cannot correct an abnormal current condition, they can indicate that an abnormal condition exists and protect personnel and circuits from that condition. In this chapter, you will learn what circuit conditions require protection devices and the types of protection devices used.

CIRCUIT PROTECTION DEVICES

1. State the reasons circuit protection is needed and three conditions requiring circuit protection.

2. Define a direct short, an excessive current condition, and an excessive heat condition. 3. State the way in which circuit protection devices are connected in a circuit.

4. Identify two types of circuit protection devices and label the schematic symbols for each type.

5. Identify a plug-type and a cartridge-type fuse (open and not open) from illustrations. 6. List the three characteristics by which fuses are rated and state the meaning of each rating. Identify a plug-type and a cartridge-type fuse (open and not open) from illustrations.

7. List the three categories of time delay rating for fuses and state a use for each type of time-delay rated fuse.

8. List the three categories of time delay rating for fuses and state a use for each type of time-delay rated fuse. Identify fuses as to voltage, current, and time delay ratings using fuses marked with the old military, new military, old commercial, and new commercial systems. List the three categories of time delay rating for fuses and state a use for each type of time-delay rated fuse.

9. Identify a clip-type and a post-type fuse holder from illustrations and identify the connections used on a post-type fuse holder for power source and load connections.

10. List the methods of checking for an open fuse, the items to check when replacing a fuse, the safety precautions to be observed when checking and replacing fuses, and the conditions to be checked for when conducting preventive maintenance on fuses.

11. Select a proper replacement and substitute fuse from a listing of fuses.

12. List the five main components of a circuit breaker and the three types of circuit breaker trip elements.

13. Describe the way in which each type of trip element reacts to excessive current.

14. Define the circuit breaker terms trip-free and nontrip-free and state one example for the use of each of these types of circuit breakers.

15. List the three time delay ratings of circuit breakers.

16. Define selective tripping, state why it is used, and state the way in which the time delay ratings of circuit breakers are used to design a selective tripping system.

17. Identify the factors used in selecting circuit breakers

Circuit breakers

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

Circuit breakers are made in varying sizes, from small devices that protect low-current circuits or individual household appliance, up to large switchgear designed to protect high voltage circuits feeding an entire city. The generic function of a circuit breaker, or fuse, as an automatic means of removing power from a faulty system is often abbreviated as OCPD (Over Current Protection Device).

Electronic fuse

In electronics and electrical engineering, a fuse is an electrical safety device that operates to provide over current protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby stopping or interrupting the current. It is a sacrificial device; once a fuse has operated it is an open circuit, and must be replaced or rewired, depending on its type.

Fuses have been used as essential safety devices from the early days of electrical engineering. Today there are thousands of different fuse designs which have specific current and voltage ratings, breaking capacity and response times, depending on the application. The time and current operating characteristics of fuses are chosen to provide adequate protection without needless interruption. Wiring regulations usually define a maximum fuse current rating for particular circuits. Short circuits, overloading, mismatched loads, or device failure are the prime or some of the reasons for fuse operation.

Fuse holders

Fuse holders are devices for containing, protecting and mounting fuses. Fuse holders come in two basic types, open or fully enclosed. ... The fully enclosed variety may use a fuse carrier that is inserted into a holder or have other means to fully enclose the fuse.

Fuse holder

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. ----------are devices for containing, protecting and mounting fuses.

A. Fuse holders

B. ckt beaker

C. switch

D. all

2. From the given choose which one is personal protective equipment.

A/ Safety goggles

B. Safety shoes

C. Clothes

D. gloves

E. ear protection

F. all

Score = _____

Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information -9 Selecting earthling system components

9.1 Introduction

9.2 Selecting earthling system components

The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthling. The electrical ear thing is done by connecting the non-current carrying part of the equipment or neutral of supply system to the ground.

Types of Electrical Earthling

The electrical equipment mainly consists of two non-current carrying parts. These parts are neutral of the system or frame of the electrical equipment. From the earthing of these two non-current carrying parts of the electrical system earthling can be classified into two types.

- Neutral Earthling
- Equipment Earthling.
- Neutral Earthling

In neutral ear thing, the neutral of the system is directly connected to earth by the help of the GI wire. The neutral farthing is also called the system ear thing. Such type of earthling is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer, motor etc.

Equipment Earthling

Such type of earthling is provided to the electrical equipment. The non-current carrying part of the equipment like their metallic frame is connected to the earth by the help of the conducting wire. If any

fault occurs in the apparatus, the short-circuit current to pass the earth by the help of wire. Thus, protect the system from damage.

An earthling system or grounding system (US) connects specific parts of an electric power for earthling pits/ground; see Ground (electricity) In addition to electric power systems, other systems may require grounding for Safety or function.

An earthling system or grounding system (US) connects specific parts of an electric power system with the ground, typically the Earth's conductive surface, for safety and functional purposes The choice of earthling system can affect the safety and electromagnetic compatibility of the installation. Regulations for earthling systems vary considerably among countries, though most follow the recommendations of the International Electro technical Commission. Regulations may identify special cases for earthling in mines, in patient care areas, or in hazardous areas of industrial plants.

In addition to electric power systems, other systems may require grounding for safety or function. Tall structures may have lightning rods as part of a system to protect them from lightning strikes. Telegraph lines may use the Earth as one conductor of a circuit, saving the cost of installation of a return wire over a long circuit. Radio antennas may require particular grounding for operation, as well as to control static electricity and provide lightning protection.

Importance of Farthing

The earthling is essential because of the following reasons

The farthing protects the personnel from the short-circuit current.

The earthling provides the easiest path to the flow of short-circuit current even after the failure of the insulation.

The farthing protects the apparatus and personnel from the high voltage surges and lightning discharge.

Earthling can be done by electrically connecting the respective parts in the installation to some system of electrical conductors or electrodes placed near the soil or below the ground level. The earthling mat or electrode under the ground level have flat iron riser through which all the non-current-carrying metallic parts of the equipment are connected.

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 point)

1. Write Types of Electrical Earthling,
   A/ Neutral Earthling

   B/ Equipment Earthling

   C/ Neutral Earthling

   D/ all

2. From the given choose which one is personal protective equipment.
   A/ Safety goggles

   B. Safety shoes

   C. Clothes

   D. gloves

   E. ear protection

   F. all

Score = _____

Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information 10- Obtaining evidence that electrical equipment selected complies with safety requirements

10.1 Introduction

10.2 Obtaining evidence that electrical equipment selected complies with safety

Requirements

There are three major hazards of electricity: electrical shock, electrical arc-flash and electrical arc-blast. These electrical hazards in the workplace pose a significant risk of injury or death to any employee who may be in the vicinity of electrical equipment when energized parts are exposed or when a failure occurs. The principal legal requirements for electrical safety in the

United States are developed and issued by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor. these regulations include:

Design Safety Standards for Electrical Systems

Electrical Safety-Related Work Practices

Control of Hazardous Energy Source (Lockout/Tag out)

Electrical Power Generation, Transmission, and Distribution

Personal Protective Equipment (PPE)

Permit-Required Confined Spaces

A person conducting a business or undertaking must manage risks by identifying reasonably foreseeable hazards that could give rise to a risk, eliminating those risks so far as is reasonably

practicable, or if that is not possible, minimizing those risks by implementing control measures. Unsafe electrical equipment and electrical installations at the workplace Particular energized electrical work—testing and fault finding may regard a code of practice as evidence of what is known about a hazard, risk or regulation also specifies safety switch requirements for certain types of work at a workplace

LG #27	LO3 Document electrical installation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Obtaining evidence from manufacturers/suppliers that ***electrical equipment*** selected complies with safety requirements.
- ***electrical equipment*** *and tools*
- Documenting reasons for selection
- Documenting electrical installation arrangement and specifications.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Obtain evidence from manufacturers/suppliers that ***electrical equipment*** selected complies with safety requirements.
- ***electrical equipment*** *and tools*
- Document reasons for selection
- Document electrical installation arrangement and specifications.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet -1	Obtaining evidence from manufacturers/suppliers that electrical equipment selected complies with safety requirements

1.1 Introduction

1.2 Obtaining evidence from manufacturers/suppliers that electrical equipment selected complies with safety requirements

Safety Fundamentals Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements. Safety Requirements An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered ‘overarching’ requirements, are expressed as ‘shall’ statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

Safety Guides Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures

recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

Evidence is obtained from manufacturers/suppliers that electrical equipment selected c compliance with the health and safety duties in the WHS Act, in relation to the ... Courts may regard a code of practice as evidence of what is known about requirements for residual current devices in certain high-risk environments.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. Unsafe work in terms of personal safety, work shop safety, and tools and equipment safety leads to

A/ Accident

B. Damage

B/ risk

D/ all

2. From the given choose which one is personal protective equipment.

A/ Safety goggles

B. Safety shoes

C. Clothes

D. gloves

E. ear protection

F. all

Score = _____
Rating: _____

Answer Sheet

Name: _____ Date: _____

satisfactory - below 10 points	**Unsatisfactory - below 10 points**

Information 2- electrical equipment and tools

electrical equipment and tools

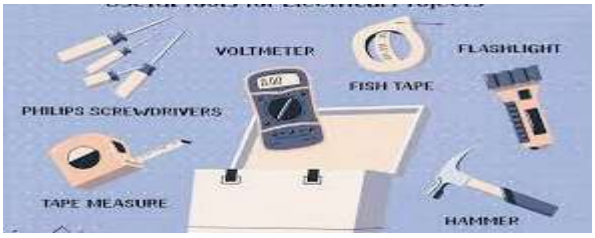
Pliers

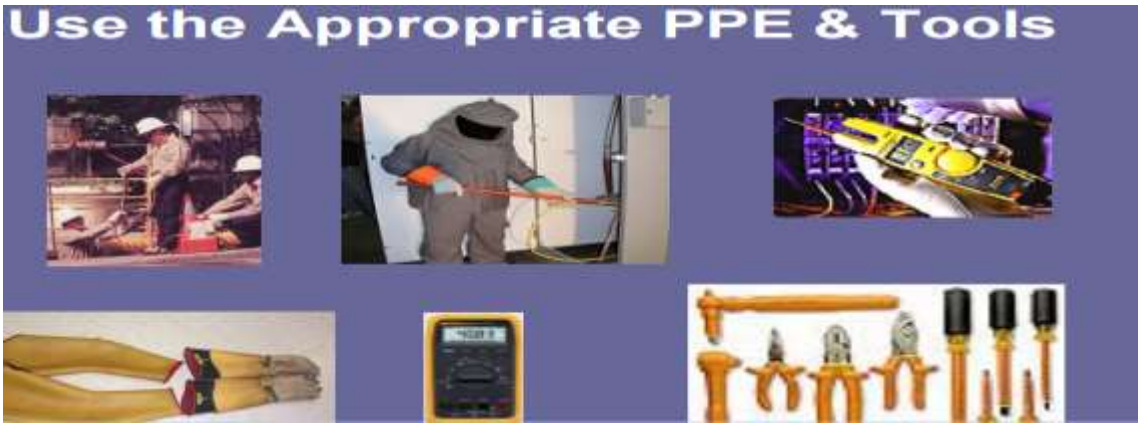
Pliers are available in different types, shape, and sizes. They are also available in both insulated and uninsulated handles. An insulated handle should be used when working on or near hot wires. It is also used for cutting big and small wires.

Screw Drivers A screwdriver comes in various sizes and with several tip shapes. Screwdrivers used by electricians should have insulated handles. Using a screwdriver for a particular job, the width of the screwdriver tip should match the width of the screw slot.

Figure 9 screw drivers

Drilling Equipment Drilling equipment is needed to make holes in building structure passages of conduits and wires.





Explosion-unprotected electrical equipment including electrical heating elements located in nonhazardous mechanically ventilated areas shall be isolated upon a single low-gas detection alarm in HVAC intakes. Electrical equipment, except heating elements, located inside rooms may be kept alive until detection of confirmed gas in HVAC intake, provided a safety analysis has documented sufficiently low ignition probability

Electrical equipment should conform to national standards of the host nation for underground storage sites.

Diesel-operated equipment should be fitted with an effective means of preventing sparks or flames from exhaust outlets. Any portion of the exhaust system or exposed parts of the engine, which may develop a surface temperature exceeding 100°C, should be suitably screened to ensure that all exposed surfaces are below that temperature. If the engine is to be kept running during loading and unloading within the storage site, it should conform to the host nation standards for underground (confined space) operations.

Basic electrical tools which are used by an electrician

Electrical tools are used to do the electrical work like electrical wiring installations by using this tool we can do the installation of electrical wire properly and quickly. We must be able to choose the right equipment or tools to do the electrical work then only the quality of our work will improve. By using electrical tools we could do the electrical tasks effortlessly.

Wire strippers Wire strippers are used to remove the insulation of wires, mostly medium-sized wires ranging from gauge 10 to gauge 16. Wire strippers are also used to remove the insulation of rubber covered wires from gauge 26 to gauge10.

Testing instruments

Electronic test equipment is used to create signals and capture responses from electronic devices under test (DUTs). In this way, the proper operation of the DUT can be proven or faults in the device can be traced. Use of electronic test equipment is essential to any serious work on electronics systems.

Practical electronics engineering and assembly requires the use of many different kinds of electronic test equipment ranging from the very simple and inexpensive (such as a test light consisting of just a light bulb and a test lead) to extremely complex and sophisticated such as automatic.

Generally, more advanced test gear is necessary when developing circuits and systems than is needed when doing production testing or when troubleshooting existing production units in the field.

Figure 10 Testing instruments

Electrical switch

In electrical engineering, a switch is an electrical component that can disconnect or connect the each set of contacts can be in one of two states: either “closed” meaning the contacts are touching or electricity

a switch is an electrical component that can disconnect or connect the conducting path in an electrical circuit, interrupting the electric current or diverting it from one conductor to another. the most common

type of switch is an electromechanical device consisting of one or more sets of movable electrical contacts connected to external circuits. When a pair of contacts is touching current can pass between them, while when the contacts are separated no current can flow.

Switches are made in many different configurations; they may have multiple sets of contacts controlled by the same knob or actuator, and the contacts may operate simultaneously, sequentially, or alternately.

Two way switches

Figure 10.1

Lamp holder

A device for securing a lamp to its support; specifically, a socket or holder fitted with electric terminals, into which the top of the glass globe of an incandescent lamp is fitted, or from which it hangs.

Figure 10.2

Socket out let

Socket for an electric plug that is fixed to a wall and connected to an electricity supply

The regulations do not affect small jobs such as providing a socket outlet, or adding a light switches to an existing circuit.'

Figure 10.3 Socket outlet

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. A device for securing a lamp to its support, Accident
   A/. Lamp holder

   B/ junction box

   C/ SDB

   D/ all

2. From the given choose which one is personal protective equipment.

   A. Safety goggles

   B. Safety shoes

   C. Clothes

   D. all

3. ---------- are available in different types, shape, and sizes

   A/ Pliers

   B/ wire

   C/ cable

Name: _____ Date: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information sheet 3- Documenting reasons for selection

3.1 Introduction

3.2 Documenting reasons for selection

Employee documentation is important for several reasons. Documentation justifies employment actions, from recruitment and selection to resignation, retirement or termination. Training and development and compensation and benefits are parts of employee documentation as well. Maintaining accurate and complete documentation supports human resources objectives, such as succession planning and promoting from within. Employee documentation, when prepared carefully, confidentially and according to company policies, is the backbone of a human resources department.

Documenting electrical installation arrangement and specifications for all selected items

A specification often refers to a set of documented requirements to be satisfied by a material, design, product, or service. A specification is often a type of technical standard.

There are different types of technical or engineering specifications (specs), and the term is used differently in different technical contexts. They often refer to particular documents, and/or particular information within them. The word specification is broadly defined as "to state explicitly or in detail" or "to be specific".

A requirement specification is a documented requirement, or set of documented requirements, to be satisfied by a given material, design, product, service, etc.[2] It is a common early part of engineering design and product development processes, in many fields.

Employee documentation is important for several reasons. Documentation justifies employment actions, from recruitment and selection to resignation, retirement or termination. Training and development and compensation and benefits are parts of employee documentation as well. Maintaining accurate and complete documentation supports human resources objectives, such as succession planning and promoting from within. Employee documentation, when prepared carefully, confidentially and according to company policies, is the backbone of a human resources department.

Recruitment and Selection

Even if your recruitment and selection process starts with online application submission via an applicant tracking system, documentation is still an important component of the hiring process. At a minimum, the hiring process includes preliminary telephone screenings, face-to-face interviews and interviewer evaluations. Documentation is essential to this process--taking notes during personal interviews is practically a requirement to help make a wise hiring decision. In addition, if you want to pass along a candidate's qualifications to another hiring manager, it helps to share your interview notes. Interview notes contain your personal assessments and opinions. Therefore, unless notes from the recruitment and interview process contain test scores or restate certain facts about the candidate's skill set, this type of documentation does not usually become part of the personnel file. Importantly, employee documentation also substantiates employment eligibility

Employee Training and Development

Documenting employee performance is important for maintaining job satisfaction, productivity and engagement. Your performance management system includes a number of components, such as job descriptions, informal feedback, training, disciplinary action and annual performance evaluations. All of these components require documentation for your performance management system to stay on track. Lack of documentation is close to lack of communication in this area. Employees depend on feedback to inspire motivation and raise employee morale. Without documentation, employees lack the tools necessary to meet the employer's expectations.

Compensation and Benefits

Employee documentation is an essential element of your compensation and benefits structure. Without this type of documentation, it is impossible to track employee wages, merit increases, year-end bonuses and mandatory and voluntary deductions. Documentation also maintains employee benefits status, such as health care options, dependent care and flexible spending accounts. The payroll division records much of the employee documentation in this area; however, your privacy officer has exclusive access to all medical-related documentation to preserve the confidential nature of employee information.

Employment End When an employee's tenure with the company comes to an end, documentation is extremely important. Regardless of the reason, you must prepare and file paperwork that documents this employment action. If you terminate an employee, documentation will justify your decision. Employee discharge related to poor performance, policy violations or gross misconduct require documentation to support the involuntary termination. Should the employee decide to file a complaint for wrongful discharge, documentation can protect your company assets if the complaint escalates to litigation. If an employee retires or resigns, documentation is necessary for continuing health and income benefits.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. ----------is important for several reasons.,
   A/ Employee documentation

   B/ tanner document

   C/ instructor document

   D/ all

2. From the given choose which one is personal protective equipment.
   A/ Safety goggles

   B. Safety shoes

   C. Clothes

   D. gloves

   E. ear protection

   F. all

Name: _____ Date: _____

Score = _____

Rating: _____

satisfactory - below 10 points	Unsatisfactory - below 10 points

Information sheet 4- Documenting electrical installation arrangement and specifications

4 .1 Introduction

4.2 Documenting electrical installation arrangement and specifications

Successful human resource should identify human resource needs in the organization. Recruitment is the discovering of potential candidates for actual or anticipated organizational vacancies. Or, from another perspective, it is a linking activity bringing together those with jobs to fill and those seeking job. The ideal recruitment effort will attract a large number of qualified applicants who will take the job if it is offered. It should also provide information so that unqualified applicants can self select themselves out of job candidacy; this is, a good recruiting program should attract the qualified and not attract the unqualified. This dual objective will minimize the cost of processing unqualified candidates.

Scope of work

The Work included in these Specifications is for the complete Electrical Services for the Project. The Work described and included in this Specification is for the manufacture works, testing, supply, delivery to site, erection, connection, site testing, demonstrating, commissioning and maintaining for required duration, all equipment and installation as described in this Specifications and shown on Contract Drawings. Additionally all equipment and installation shall conform to local authorities Specifications. Any Works whether or not shown on the Drawings and/or described in the Specifications but which can reasonably be inferred as necessary for the completion and proper operation of the works will also form part of the extent of the Contract B. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The scope of works shall include.

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. The Work included in these Specifications is for the complete Electrical Services for the Project Accident

   A/ scope of work

   B/ boundary

   C/ all

2. From the given choose which one is personal protective equipment.

   A/ Safety goggles

   B. Safety shoes

   C. Clothes

   D. all

Score = _____

Rating: _____

Name: _____ Date: _____

satisfactory - below 10 points	**Unsatisfactory - below 10 points**

Operation sheet 1– Prepare to select wiring systems and cables for general electrical installations

Steps / Procedures for Checking for Preparing to select wiring systems and cables for general

Electrical installations

Step 1 - Establishing Standards and Methods for Selecting *wiring and cable size*

Systems

Step 2 - Measuring the current –carrying capacity

Step 3 - Determination of Whether the size of electrical wire and cable the Standard,

Step 4 – check the continuities of circuit diagram without electrical power

Step 5- Taking Corrective Action

Operation sheet – 2	select wiring systems and cables for general electrical installations

Operation title: selecting wiring systems and cables for general electrical installations

Purpose: To develop the ability to perform selecting electrical wiring operations in accordance with operational standards

Material: electrical wire, electrical cable, rigude conduit lamp holder, different Lamps & wire clip etc

Tool and measurements: digital melitemeter, different type's pliers, screw driver etc

Description of Technical data and Standard Quality

Electrical wire parallel to color code standard e.g read, blue green & yellow etc.

Thickness, width are the given standard 1.5 mm^2 ,2.5mm^2, 2mm^2 4mm^2 etc

Accuracy for the given standard used for Lighting circuit 1.5 mm^2 , stove circuit 2.5mm^2, normal socket outlet 2mm^2 and electrical mittad 4mm^2

Use:

Parallels are used in selecting wiring system operations, to accurately support

a clamped work piece from underneath, to eliminate the work piece being pushed down by the force of the cutting tool, to give hand tools i.e side cut pliers companion pliers screw driver size of electrical wire capacity of current i.e

10A, 6A, 16A 20 A 25 A and 32 A etc..

Condition for the operation: Fully organized work shop, good working condition

Precautions: - Wear protective clothing

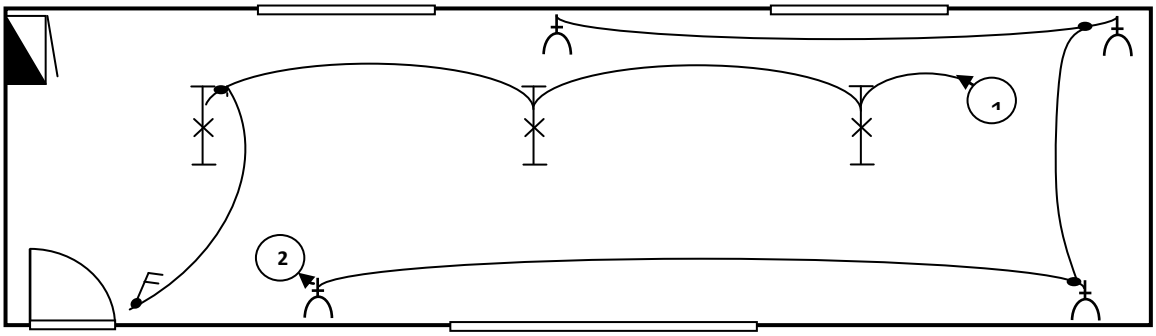
Tools and equipment:

Venire caliper

Students Guide

Goggles

Working drawing



Procedures for Preparing to select wiring systems and cables for general

Electrical installations

Quality criteria: The electrical wire must be made to the given standard and dimensional accuracy.

LAP TEST	Performance Test

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1:30** hour. The project is expected from each student to do it.

Task-1 selecting and preparing electrical wire according to the given circuit diagram?

Task-2 installing electrical wire, rigud conduct fixing junction box and scatola?

Task-3 terminating and connecting electrical apparatus?

Task-4 inspecting electrical circuit without electrical power?

Task-5 checking each circuit with feeding electrical power?

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Reference Materials

Book:

WEB ADDRESSES

http://www.qualitygurus.com/courses/mod/forum/discuss.php?d=1557

http://www.iitg.ac.in/spal/Methods%20of%20mounting%20of%20jobs%20and%20cutting%20tools.ppt

http://www.iitb.ac.in/safety/sites/default/files/Machine%20Safety_0_0.pdf)

https://www.fda.gov/media/109408/download

https://www.flexiblemachining.com/pdf/quality_policy.pdf

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This Teaching, Training and Learning Materials (TTLM) was developed on December 2020 at Adama, comforte International Hotel.

Answer sheet

Module Title: Selecting Wiring Systems and Cables for Low Voltage General Electrical Installations

LG25-LG28

LG	LO	Self-check	Question number and answer				
			1	2	3	4	5
#25	LO 1	1	C	E	D		
		2	D	E	D		
#26	LO 2	1	A	C	A		
		2	B	B	A		
		3	A	E	D		
		4	C	E	C		
		5	C	A	D		
		6	B	D			
		7	A	F			
		8	D	F			
		9	D	F			
#27	LO3	1	D	F			
		2	D	D	D		
		3	D	D			
		4	C	D			