Ethiopian TVET-System

# INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY

## Level-II

Based on May 2011 Occupational Standards

October, 2019

## Module Title: Performing installation of motor controller system

## TTLM Code: EELEMD2TTLM1019

## This module includes the following Learning Guides

**LG20: Plan and Prepare for Motor controller Installation**

**LG Code: EEL EMD2 M02LO1-LG20**

**LG21: Request materials, tools and equipment**

**LG Code: EEL EMD2 M02LO2-LG21**

**LG22: Inspect electrical materials and tools**

**LG Code: EEL EMD2 M02LO3-LG22**

**LG23: Assemble electrical motor controller**

**LG Code: EEL EMD2 M02LO4-LG23**

**LG24: Notify completion of work**

**LG Code: EEL EMD2 M02LO5-LG24**

**LG25: Clean-Up**

**LG Code: EEL EMD2 M02LO6-LG25**

| Instruction Sheet | LG20: Plan and Prepare for Motor controller Installation |
|---|---|

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

- Personal protective equipments (PPE)
- Tools and Test Instruments
- Reading industrial installation plan
- Wiring Diagrams and Layouts/shop drawings
- Motor control Components and wiring devices
- Correct size and degree of protection of enclosures
- Reporting complete data of Industrial

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- *Obtain Wiring diagrams* and layout/shop drawings according to job requirements
- read and interpret Drawings in accordance with job requirements
- verify Estimated work schedule with immediate superior
- Identify Correct rating, quantity, sizes and type of control *components and wiring devices* and other materials in line with job requirements
- verify Correct size and degree of protection of enclosures in line with job requirements
- select properly *Tools and testing instruments* in line with job requirements
- Identify and select Correct PPE in line with safety requirements

Submit complete data on inspection report based on job requirements to Immediate superior

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5, Sheet 6 and Sheet 7,-” **in page 3-8,10-16, 18-28,30-32,34-42,47-55 and ---** respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” **in page 9,17,29,33,43, 56 and ---** respectively
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page 57-62.**
6. Do the “LAP test” **in page 63**

| Information Sheet-1 | Personal protective equipments (PPE) |
|---|---|

## 1.1 Introduction to PPE

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The Occupational Safety and Health Administration (OSHA) require that employers protect their employees from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to the greatest extent possible. For example, building a barrier between the hazard and the employees is an engineering control; changing the way in which employees perform their work is a work practice control.

### 1.2 The Requirement for PPE

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

### *1.3 In general, employers are responsible for:*

- Performing a "hazard assessment" of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.

***In general, employees should:***

- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and
- Inform a supervisor of the need to repair or replace PPE.

Specific requirements for PPE are presented in many different OSHA standards, published in 29 CFR. Some standards require that employers provide PPE at no cost to the employee while others simply state that the employer must provide PPE. Appendix A at page 40 lists those standards that require the employer to provide PPE and those that require the employer to provide PPE at no cost to the employee.

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### 1.4 Training Employees in the Proper Use of PPE

Employers are required to train each employee who must use PPE. Employees must be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary?
- How to properly put on, take off, adjust and wear the PPE.
- The limitations of the PPE.
- Proper care, maintenance, useful life and disposal of PPE.

### 1.4.1 Eye and Face Protection

Many occupational eye injuries occur because workers are not wearing any eye protection while others result from wearing improper or poorly fitting eye protection. Employers must be sure that

their employees wear appropriate eye and face protection and that the selected form of protection is appropriate to the work being performed and properly fits each worker exposed to the hazard.

### *1.4.2 Eye Protection for Exposed Workers*

OSHA suggests that eye protection be routinely considered for use by carpenters, electricians, machinists, mechanics, millwrights, plumbers and pipefitters, Sheet metal workers and tinsmiths, assemblers, sanders, grinding machine operators, sawyers, welders, laborers, chemical process operators and handlers, and timber cutting and logging workers. Employers of workers in other job categories should decide whether there is a need for eye and face PPE through a hazard assessment.

Examples of potential eye or face injuries include:

- Dust, dirt, metal or wood chips entering the eye from activities such as chipping, grinding, sawing, hammering, the use of power tools or even strong wind forces.
- Chemical splashes from corrosive substances, hot liquids, solvents or other hazardous solutions.
- Objects swinging into the eye or face, such as tree limbs, chains, tools or ropes.
- Radiant energy from welding, harmful rays from the use of lasers or other radiant light (as well as heat, glare, sparks, splash and flying particles).

### *1.4.3 Types of Eye Protection*

Selecting the most suitable eye and face protection for employees should take into consideration the following elements:

- Ability to protect against specific workplace hazards.
- Should fit properly and be reasonably comfortable to wear.
- Should provide unrestricted vision and movement.
- Should be durable and cleanable.
- Should allow unrestricted functioning of any other required PPE.

Some of the most common types of eye and face protection include the following:

- **Safety spectacles.** These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models.
- **Goggles.** These are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses.
- **Welding shields.** Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. OSHA requires filter lenses to have a shade number appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.
- **Laser safety goggles.** These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace.
- **Face shields.** These transparent sheets of plastic extend from the eyebrows to below the chin and across the entire width of the employee's head. Some are polarized for glare

protection. Face shields protect against nuisance dusts and potential splashes or sprays of hazardous liquids but will not provide adequate protection against impact hazards. Face shields used in combination with goggles or safety spectacles will provide additional protection against impact hazards.

### 1.4.4 Head Protection

protecting employees from potential head injuries is a key element of any safety program. A head injury can impair an employee for life or it can be fatal. Wearing a safety helmet or hard hat is one of the easiest ways to protect an employee's head from injury. Hard hats can protect employees from impact and penetration hazards as well as from electrical shock and burn hazards.

Employers must ensure that their employees wear head protection if any of the following apply:

- Objects might fall from above and strike them on the head;
- They might bump their heads against fixed objects, such as exposed pipes or beams; or
- There is a possibility of accidental head contact with electrical hazards.

In general, protective helmets or hard hats should do the following:

- Resist penetration by objects.
- Absorb the shock of a blow.
- Be water-resistant and slow burning.
- Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

### 1.4.5 Foot and Leg Protection

Employees who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials should wear protective footwear. Also, employees whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet. If an employee's feet may be exposed to electrical hazards, non-conductive footwear should be worn. On the other hand, workplace exposure to static electricity may necessitate the use of conductive footwear.

Examples of situations in which an employee should wear foot and/or leg protection include:

- When heavy objects such as barrels or tools might roll onto or fall on the employee's feet;
  Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes;
  Exposure to molten metal that might splash on feet or legs;
  Working on or around hot, wet or slippery surfaces; and
- Working when electrical hazards are present.

#### *1.4.5.1 Special Purpose Shoes*

***1.4.5.1.1*** **electrically conductive shoes** provide protection against the buildup of static electricity. Employees working in explosive and hazardous locations such as explosives manufacturing facilities or grain elevators must wear conductive shoes to reduce the risk of static electricity buildup on the body that could produce a spark and cause an explosion or fire. Foot powder should not be used in conjunction with protective conductive footwear because it provides insulation, reducing the conductive ability of the shoes. Silk, wool and nylon socks

can produce static electricity and should not be worn with conductive footwear. Conductive shoes must be removed when the task requiring their use is completed. Note: Employees exposed to electrical hazards must never wear conductive shoes.

***1.4.5.1.2*** **Electrical hazard, safety-toe shoes** are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions and should be used in conjunction with other insulating equipment and additional precautions to reduce the risk of a worker becoming a path for hazardous electrical energy. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel, or workers touch conductive, grounded items. Note: Nonconductive footwear must not be used in explosive or hazardous locations.

### 1.4.6 Hand and Arm Protection (Glove)

### 1.4.6 .1 Care of Protective Gloves

Protective gloves should be inspected before each use to ensure that they are not torn, punctured or made ineffective in any way. A visual inspection will help detect cuts or tears but a more thorough inspection by filling the gloves with water and tightly rolling the cuff towards the fingers will help reveal any pinhole leaks. Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use or degradation from chemical exposure.
Any gloves with impaired protective ability should be discarded and replaced. Reuse of chemical-resistant gloves should be evaluated carefully, taking into consideration the absorptive qualities of the gloves. A decision to reuse chemically-exposed gloves should take into consideration the toxicity of the chemicals involved and factors such as duration of exposure, storage and temperature.

### 1.4.7 Body Protection

Employees who face possible bodily injury of any kind that cannot be eliminated through engineering, work practice or administrative controls, must wear appropriate body protection while performing their jobs. In addition to cuts and radiation, the following are examples of workplace hazards that could cause bodily injury:

- Temperature extremes;
- Hot splashes from molten metals and other hot liquids;
- Potential impacts from tools, machinery and materials;
- Hazardous chemicals

Protective clothing comes in a variety of materials, each effective against particular hazards, such as:

- **Paper-like fiber** used for disposable suits provide protection against dust and splashes.
- **Treated wool and cotton** adapts well to changing temperatures, is comfortable, and fire-resistant and protects against dust, abrasions and rough and irritating surfaces.
- **Duck** is a closely woven cotton fabric that protects against cuts and bruises when handling heavy, sharp or rough materials.

- **Leather** is often used to protect against dry heat and flames.
- **Rubber, rubberized fabrics, neoprene and plastics** protect against certain chemicals and physical hazards. When chemical or physical hazards are present, check with the clothing manufacturer to ensure that the material selected will provide protection against the specific hazard.

### 1.6 Safety and Health Program Management Guidelines

The guidelines identify four general elements critical to the development of a successful safety and health management program:

- Management leadership and employee involvement.
- Work analysis.
- Hazard prevention and control.
- Safety and health training.

| Self-Check 1 | Written Test |
|---|---|

**Part I: Enumeration**

**Direction:** Write on the blank space/List down the following

1. Some common types of eye and face protection equipment's
   a. _____
   b. _____
   c. _____
   d. _____

*2 . List Special Purpose Shoes*

   a. _____
   b. _____

3. List different types of Protective clothing comes in a variety of materials, each effective against particular hazards
   c. _____
   d. _____
   e. _____
   f. _____

**Answer Sheet**

| Score = _____ |
| --- |
| Rating: _____ |

Name: _____ Date: _____

| Information Sheet-2 | Tools and Test Instruments |
| --- | --- |

## 2.1 Testing instrument

## VOLTAGE TESTER

Is often used by the electrician to measure approximate circuit operating voltages. Its rugged construction makes it ideally suited for rough on-the-job handling.

## CLIP-ON AMMETER

It is sometimes called “clamp-on” is used to measure current without any direct electrical contact with the circuit.

## NEON TEST LIGHT

Is an inexpensive device that can be used by the homeowner to indicate the presence of a voltage.

## LOGIC PROBE

Is designed for quick checking and servicing of digital circuits. It visually displays the presence of correct logic levels by illumination of colored readouts.


## CONTINUITY TESTER

Is used for checking the continuity of dead circuits. This tester is powered by batteries and used to check for defective switches, broken leads, or to identify wire in multiwire cables. A light signal indicates completed circuits.

## MULTI-TESTER

A **multi meter** or a **multi tester**, also known as a **volt/ohm meter** or **VOM**, is an electronic measuring instrument that combines several measurement functions in one unit. A typical multi meter may include features such as the ability to measure voltage, current and resistance. Multi meters may use analog or digital circuits—**analog multi meters** and **digital multi meters** (often abbreviated **DMM** or **DVOM**.) Analog instruments are usually based on a micro ammeter whose pointer moves over a scale

calibration for all the different measurements that can be made; digital instruments usually display digits, but may display a bar of a length proportional to the quantity measured.

A multi meter can be a hand-held device useful for basic fault finding and field service work or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

Electronic **Multi-Tester** group

**Multi Tester Multi Tester**

Digital **Multi Tester** DT-830B

**Multi Tester**

Aquatronica **Multi Teste**


PMUT Presidium **Multi Tester**

YX-360 RNA **MULTI TESTER**

**Multi Tester**

DIGITAL **MULTI TESTER** METER

ELECTRIC **MULTI TESTER**


Analogue **Multi-tester**

**Multi Tester**

Picture Of **Multi tester**

Digital **Multi tester**

Presidium **Multi Tester** PMUT

Digital **Multi-Tester** with

**MULTI-TESTER** GB Electrical

GWS **Multi-Tester** MT-1

Caravan **Multi-Tester**

## 2.2 TOOLS

### SCREW DRIVERS

A **screwdriver** is a tool for driving screws and rotating other machine elements with the mating drive system. The screwdriver is made up of a head or tip, which engages with a screw, a mechanism to apply torque by rotating the tip, and some way to position and support the screwdriver. A typical hand screwdriver comprises an approximately cylindrical handle of a size and shape to be held by a human hand, and an axial shaft fixed to the handle, the tip of which is shaped to fit a particular type of screw. The handle and shaft allow the screwdriver to be positioned and supported and, when rotated, to apply torque. Screwdrivers are made in a variety of shapes, and the tip can be rotated manually or by an electric motor or other motor. A screw has a head with a contour such that an appropriate screwdriver tip can be engaged in it in such a way that the application of sufficient torque to the screwdriver will cause the screw to rotate.

**screwdrivers**

**Screwdrivers** come


Cushion Grip **Screwdrivers**

Klein **Screwdrivers**

Cordless **Screwdrivers**

**Screwdrivers** have

**Screwdrivers**

X celite **Screwdrivers**

Find a **Screwdriver** When

**screwdrivers**

**Screwdriver** set

all the **screwdrivers** I own

This holds the **screwdriver**

1 - Stubby **Screwdriver** 2

Main Products: **Screwdrivers**

**Screwdriver**

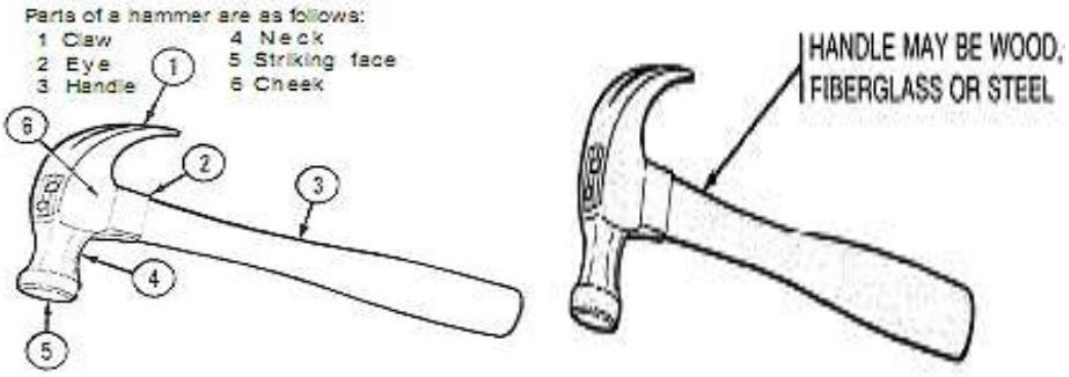
**Screwdrivers** & Bits

**Screwdriver** Sets

**Screwdriver** Review Roundup

## HAMMERS

Hammers are produced in a variety of head weights and are an important part of any tool kit.




The carpenter hammer is used for driving and pulling nails and tapping wood chisels. There are two types of claws.

## ❑ BUMPING BODY HAMMER

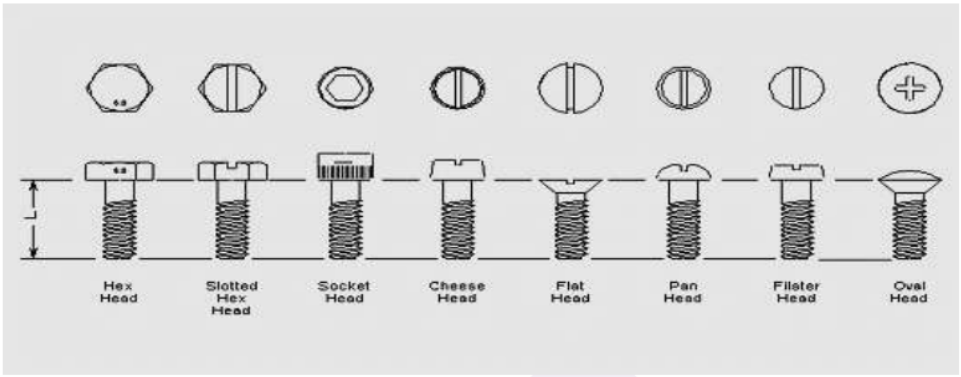
A bumping body hammer is used to straighten and form metal

### ELECTRIC DRILLS

Are used for drilling holes in wood, metal, and concrete. The size of a drill is determined by the chuck size and the power of the motor. The *chuck* is the part of a drill that holds the twist drill bit. A 3/8-inch drill will hold a bit of any size up to 3/8-inch in diameter. Reversible and battery-powered electric drills are also available.

## SCREW FASTENER

### ❑ MACHINE SCREW BOLT AND NUT UNITS




Are used primarily to join metal to a variety of other materials. They are produced in many thickness and thread pitches, depending on the amount of support strength and compression required. The coarse-thread bolt install faster, since the nut advances along the bolt a greater distance for each complete turn. Fine-threaded units require more turns of the nut to tighten the, but excellent compression is obtained between the surfaces joined.

| Self-Check 2 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write on the blank space/List down the following

_____1. A cutting tools used to removed insulator of wire

_____2. A hand tool used to driving nails and fastener cold chisel.

_____3. A tool used holding wires, gripping, twisting and cutting.

_____4. A driving tool used to driving screws with an X design.

_____5. A driving tool used to loosen tightens screw removing bolts with slotted

_____6. A tool used to measure current without any direct electrical contact.

_____ 7. Measuring devices used to measure voltage current resistance,

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-3 | Reading industrial installation plan |
|---|---|

## 3.1 Reading industrial installation Symbol

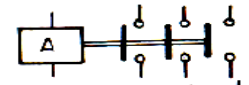
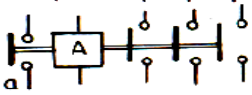
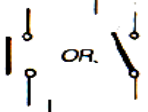
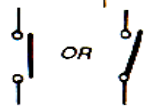
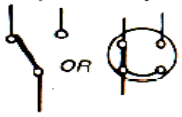
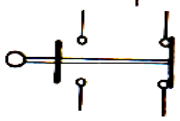
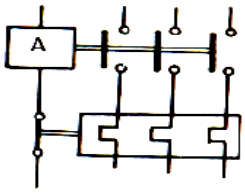
### INTRODUCTION

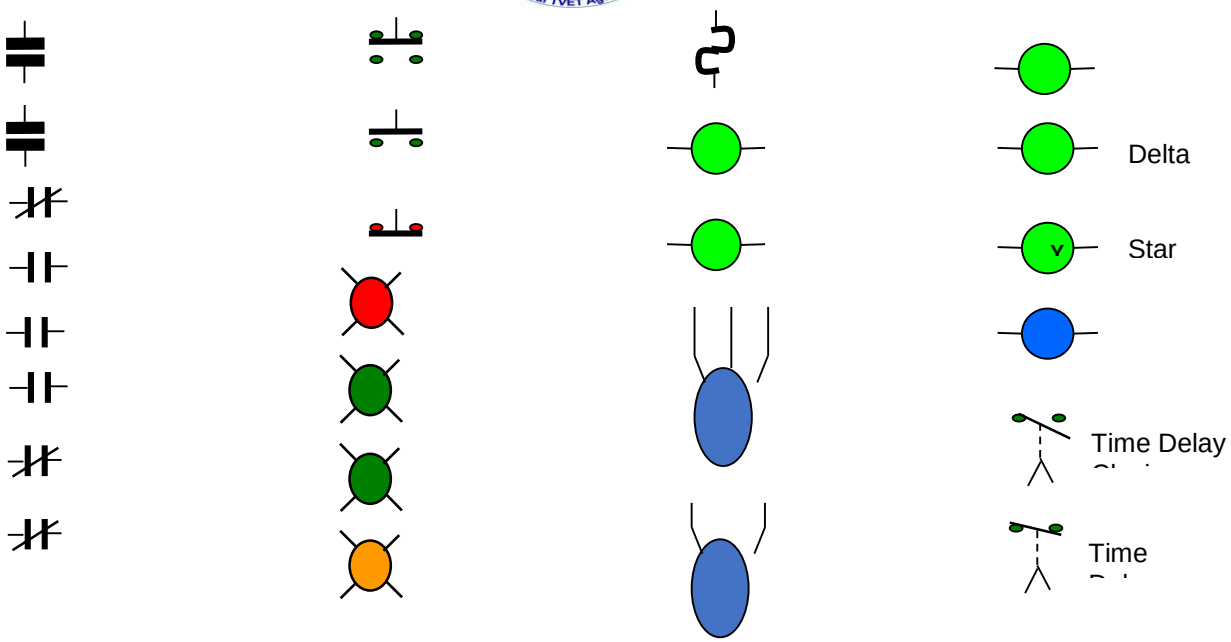
### Control symbols

We use drawings to convey the information about piece of equipment in a form which all those Involved
in its production installation and service will understand Tomake this possible standard drawin g **conventions** have been adopted by most companiesn
When you learned to readyou werefirst taught a set ofsymbolsthat represented different soundsTh isset ofsymbols is called the alphabet. Schematics and wiringdiagrams are the written language of motor controls.Before you can learn to properly determine the logicof a control circuit, you must first learn the writtenlanguage Unfortunately there is no actual standardused for mot or control symbols
Different manufacturers and companies often use their own sets of symbolsfor their in house schematicsAlso, schematics drawnin other countries may use entirely different sets ofs ymbols to represent different control components.Although symbols can vary from one manu facturerto another, or from one country to another once youhave learned to interpret circuit logi c it is generally sent by the way they are used in the schematic The
most standardized set of symbols in the United Stateis provided by the National Electrical Manuf acturer'sAssociation, or NEMA. Schematic and wiring diagrams are the written languageof control ci rcuitsMaintenance electriciansmust beable to interpret schematic and wiring diagrams to install co ntrol equipment or troubleshoot existing controlcircuits Schematic diagrams are also known as line di-agrams and ladder diagrams. *Schematic diagrams show componentsin their electrical sequence without regardto physical location.*Schematics are used m ore thananyother type of diagram to connector troubleshoot acontrol circuit.*Wiring diagrams sho w a picture of the controlcomponents with connecting wires.* Wiring diagramsare sometimes used to install new control circuits, butthey are seldom used for troubleshooting existing cir-cuit.

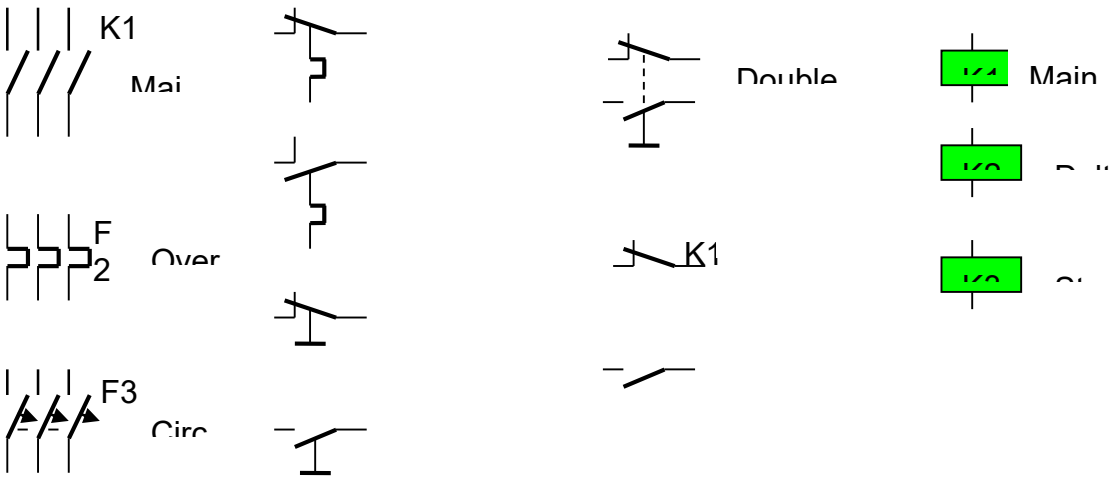
| | | | |
|---|---|---|---|
| Terminal Strip | 11 12 13 14 | Neon Lamp | H |
| Start Button (spring return) | I S | Relay Contacts | K |
| Stop Button (spring return) | O S | Contactor or Relay Coil | K |
| Non Automatic Return | | Contactor Main Contacts | KM |
| Emergency Stop (Mushroom Head) (Latching) | O S | Normal Open Auxillary Contact on KM3 | KM3 |
| Selector Switch 3 Position | S | Normally Closed Auxillary Contact On KM4 | KM4 |
| Float switch | | Resettable Thermal Overload Auxiliary Contacts | R F |
| Signal Lamp | H | Thermal Overload Relay Elements | F |
| Incandescent Signal Lamp | H | | |

| *Sl. No.* | *Name of Component* | *Electrical Symbols* |
|---|---|---|
| 1. | Push Button Normally Open NO, S = Start<br>Normally Closed NC. O = Off | S<br>O |
| 2. | Push Button with one NO and one NC contact operated together (1 NO + 1 NC) | OR |
| 3. | Three phase induction motor (Squirrel cage) | M |

| Sl. No. | Name of Component | Electrical Symbols |
|---|---|---|
| 4. | Slip ring induction motor |  |
| 5. | Electrically operated 3-pole contactor with power contacts (three phase supply contacts) or main contacts only |   |
| 6. | Electrically operated contactor with main (three phase or power contacts) and auxiliary (control circuit) contacts |   |
| 7. | Coil of a electromagnetic relay contactor |  |
| 8. | Auxiliary contact Normally Open (NO) |   |
| 9. | Auxiliary contact Normally Closed (NC) |   |
| 10. | Two-way contactor |   |
| 11. | Limit Switch contact Normally Closed |  |
| 12. | Limit Switch Contact Normally Open | |
| 13. | NO + NC Limit Switch Operated together |  |
| 14. | Signal Lamp |  |
| 15. | Contactor with thermal overload relay in all the three poles (phases) |   |




# Motor Controllers

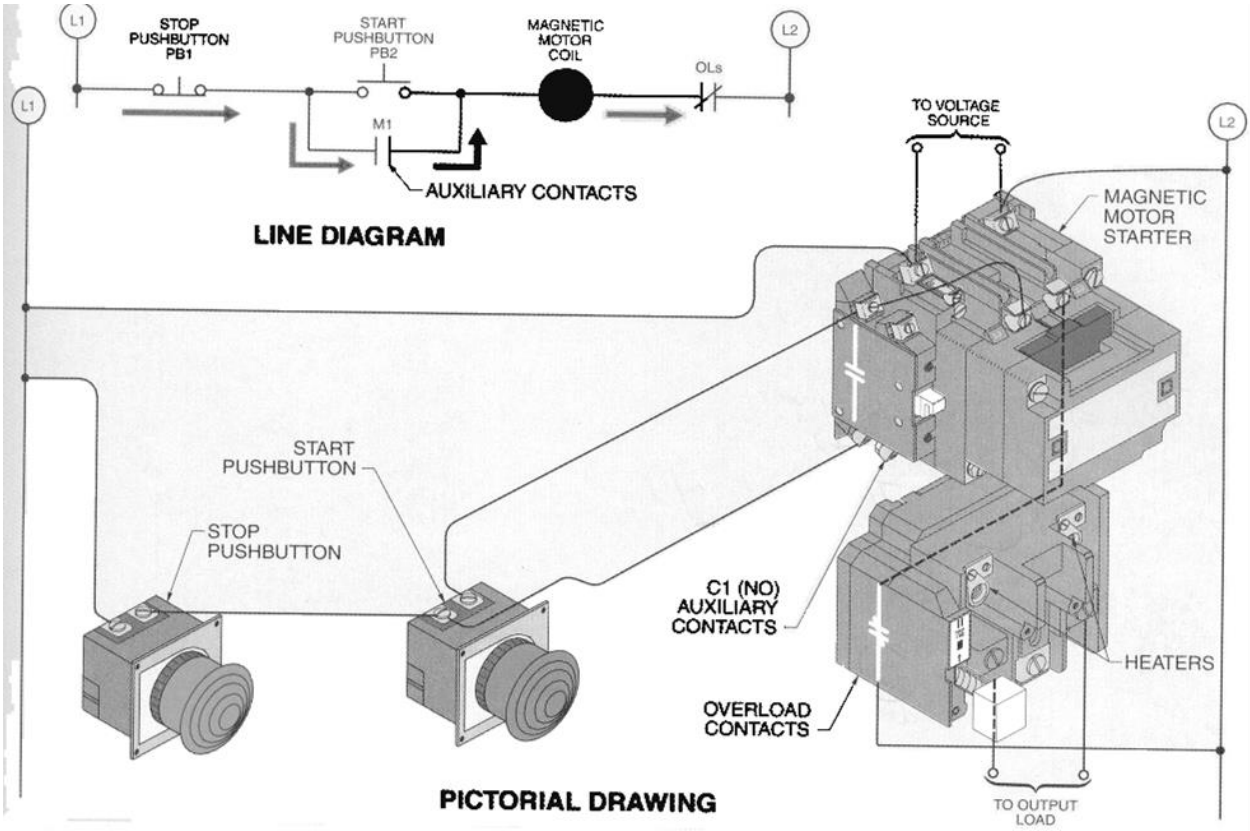



### 3.2 Magnetic Motor Starters

- A magnetic motor starter is an electrically-operated switch (contactor) that includes motor overload protection.
- Magnetic motor starters are identical to contactors except that they have *overloads* attached to them.

- The overloads have heaters or electronic overloads (located in the power circuit) which sense excessive current flow to the motor.
- The heaters open the NC overload contacts (located in the control circuit) when the overload becomes dangerous to the motor.

**Magnetic Starter**




**Magnetic Motor Starter**

L1 (1) - first line in from power source (phase 1 for 3ph / Neutral for 1ph)

L2 (3) - second line in from power source (phase 2 for 3ph / Hot for 1ph* see below for alternate wiring using L2 & L3)

L3 (5) - third line in from power source (phase 3 for 3ph / NC for for 1ph)

COIL

T1 (2) - first line out to motor (phase 1 for 3ph / Hot for 1ph)

T2 (4) - second line out to motor (phase 2 for 3ph / NC for 1ph* see below for alternate wiring)

T3 (6) - third line out to motor (phase 3 for 3ph / Neutral for 1ph)

- **Motor Starter Control Circuit**

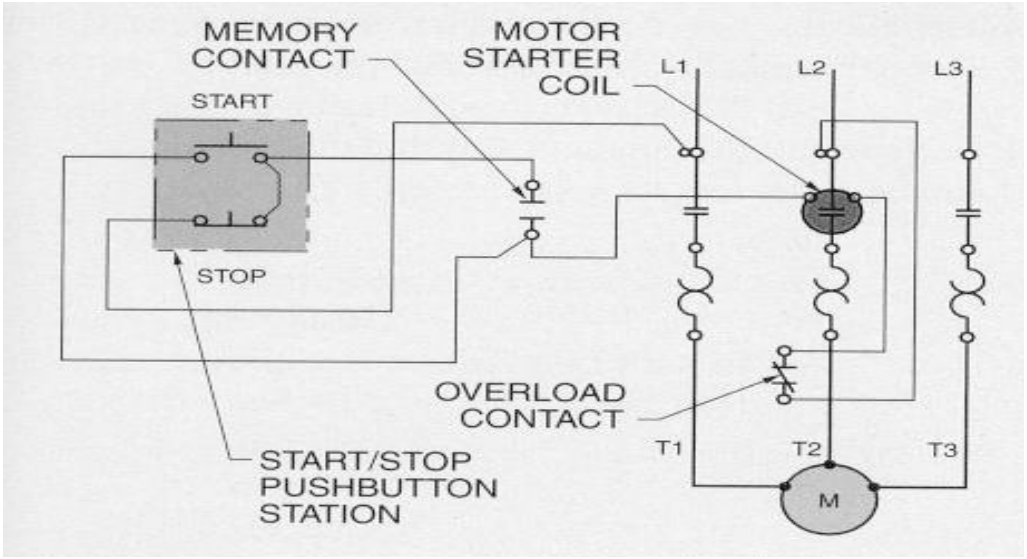


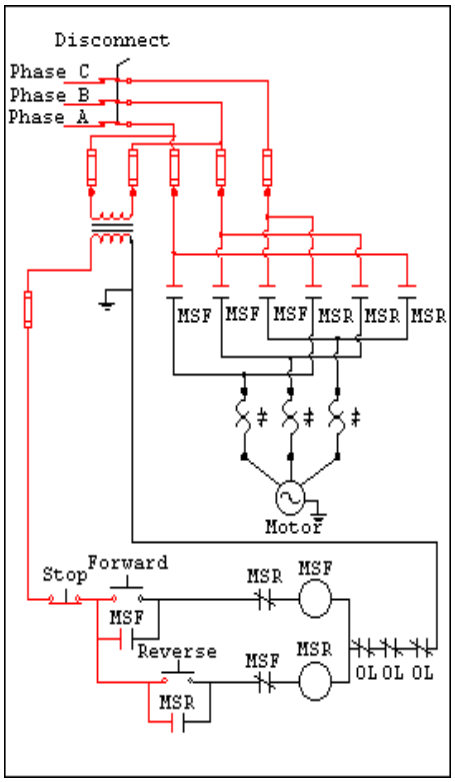

**Fig. Alternate method of drawing the electrical circuit**

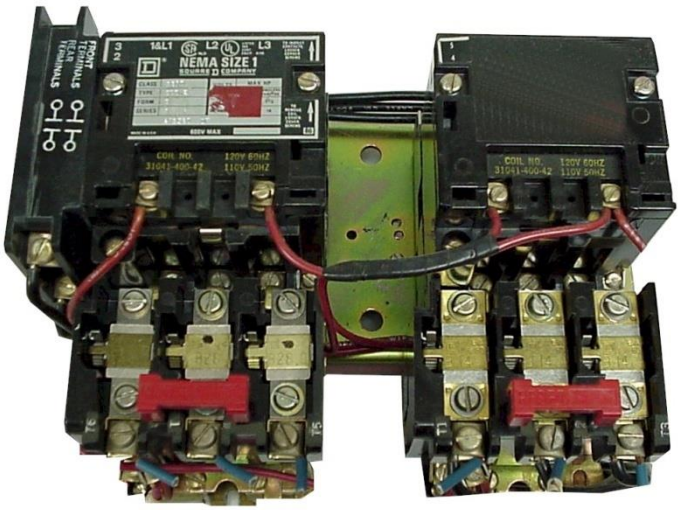
**NEMA vs. IEC**

*If we compare the NEMA magnetic motor starter to the IEC magnetic motor starter, the following differences would be noticed:*

- An IEC device is physically smaller than a comparable NEMA device.
- An IEC device is usually less expensive than a comparable NEMA device.
- An IEC device has a life cycle of approximately one million operations while a comparable NEMA device has a life cycle of almost four times that number.
- An IEC device should normally be protected with fast-acting, current-limiting fuses while a NEMA device can be protected with conventional time delay fuses.

**Reversing Starter**




### 3.3 Relay Timers

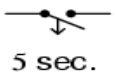
**ON Delay**

Normally-open, timed-closed

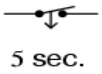

Normally-closed, timed-open


**OFF Delay**

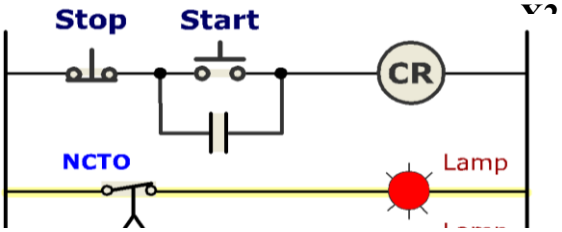
Normally-open, timed-open

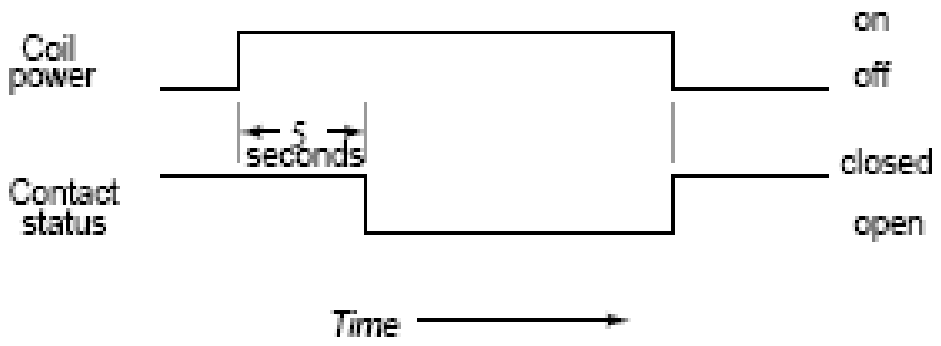


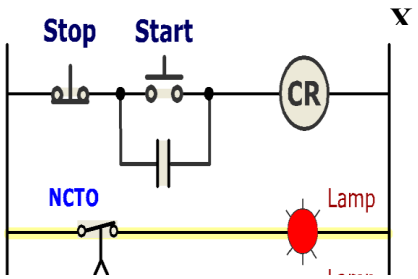

Normally-closed, timed-closed



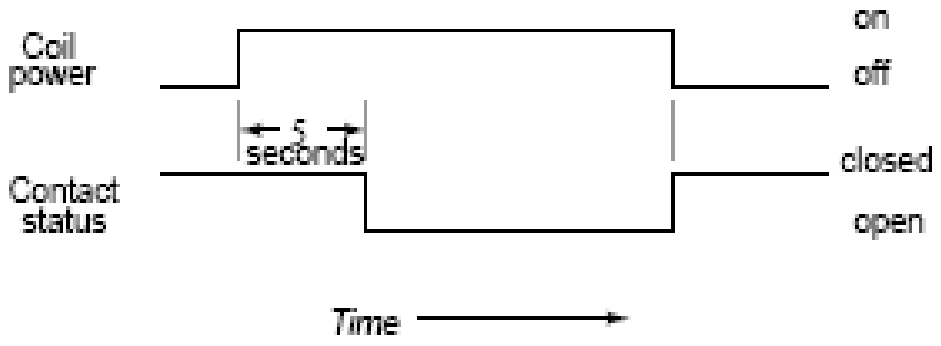

**Wired ON Delay**

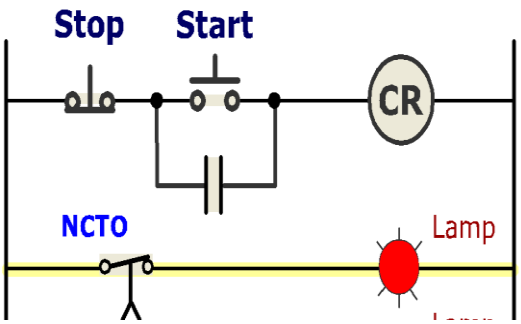


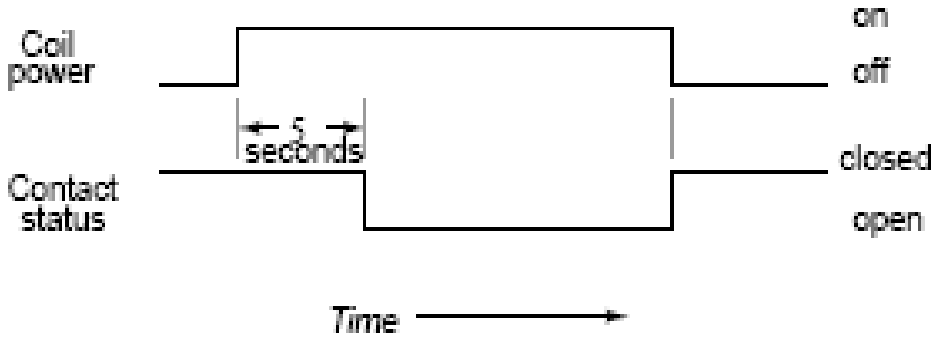

Coil
power
on
off
5
seconds
Contact
status
closed
open
Time


Stop
Start
CR
NCTO
Lamp

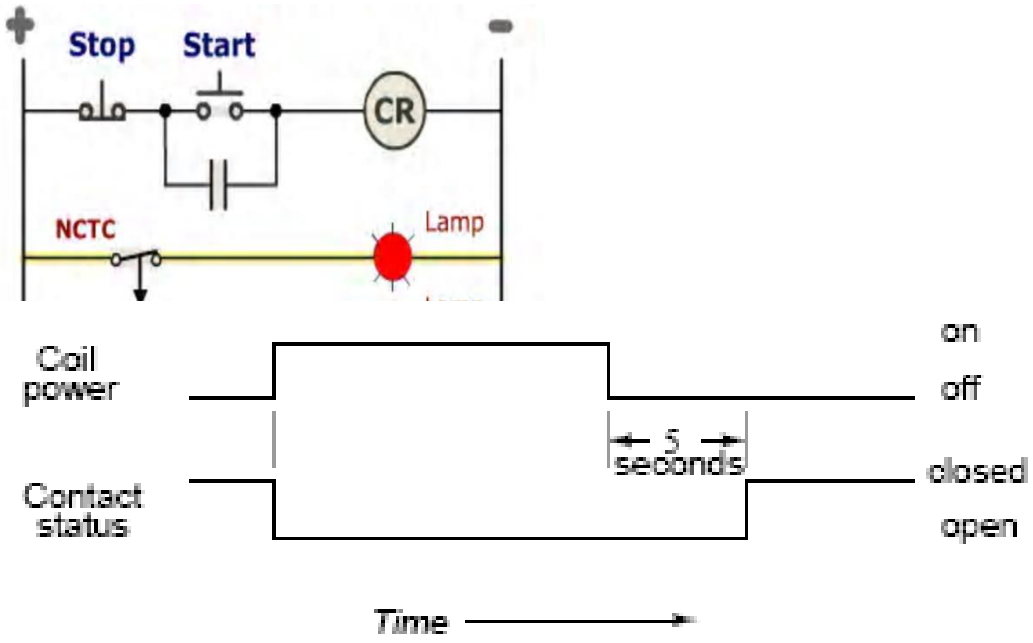
x

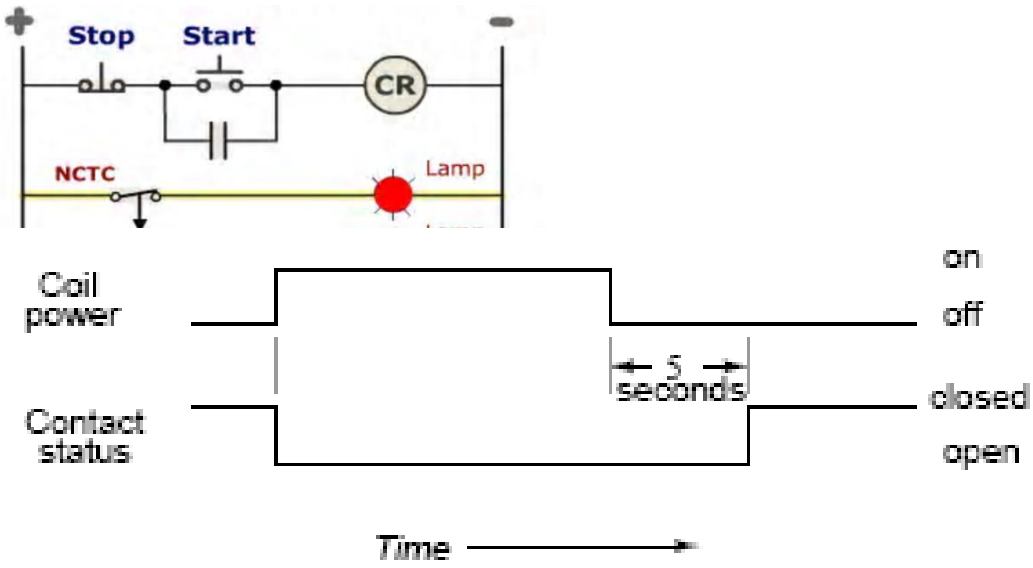

Coil
power
on
off
5
seconds
Contact
status
closed
open
Time

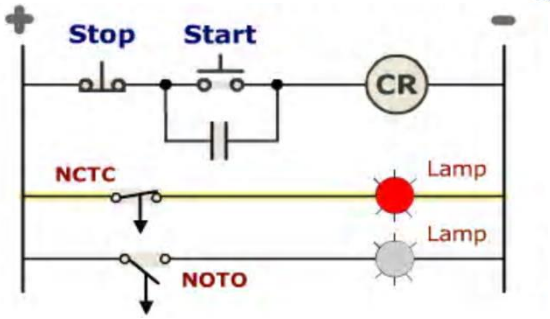

Stop
Start
CR
NCTO
Lamp

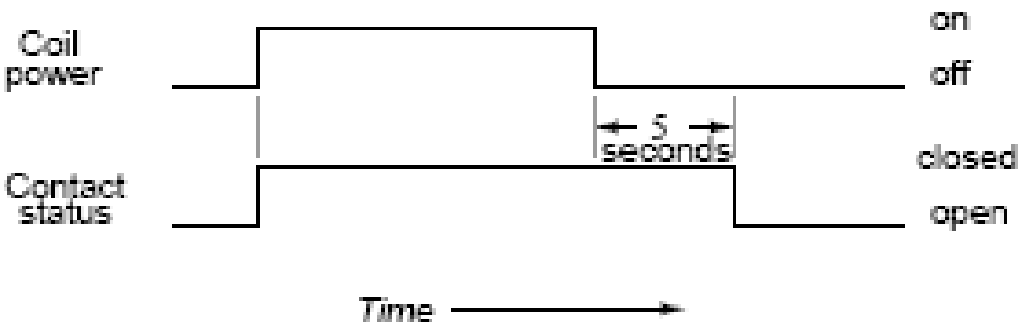

Coil
power
on
off
5
seconds
Contact
status
closed
open
Time

**The Normally Closed contact will take 5 seconds To Open when the coil is energized.**

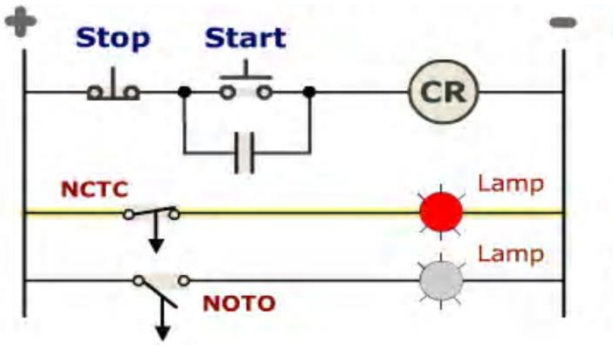


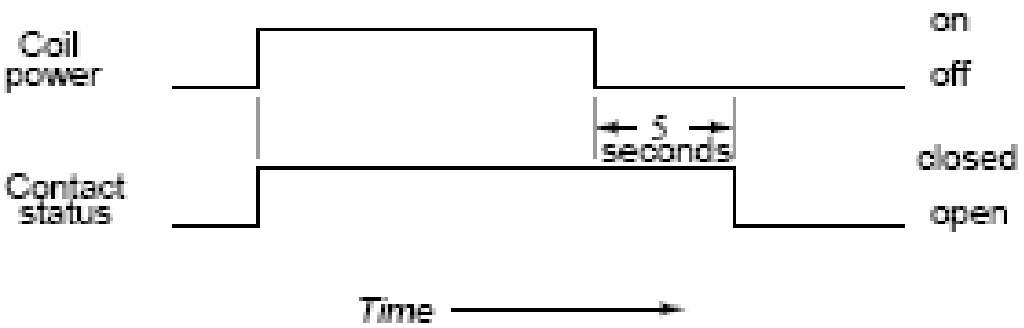





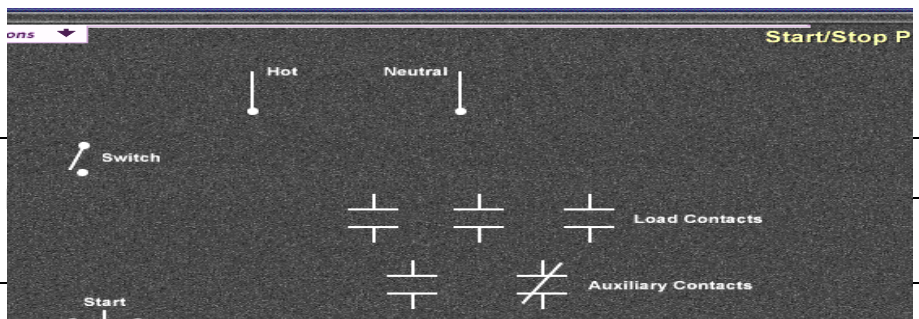

# OFF Delay - NOTO



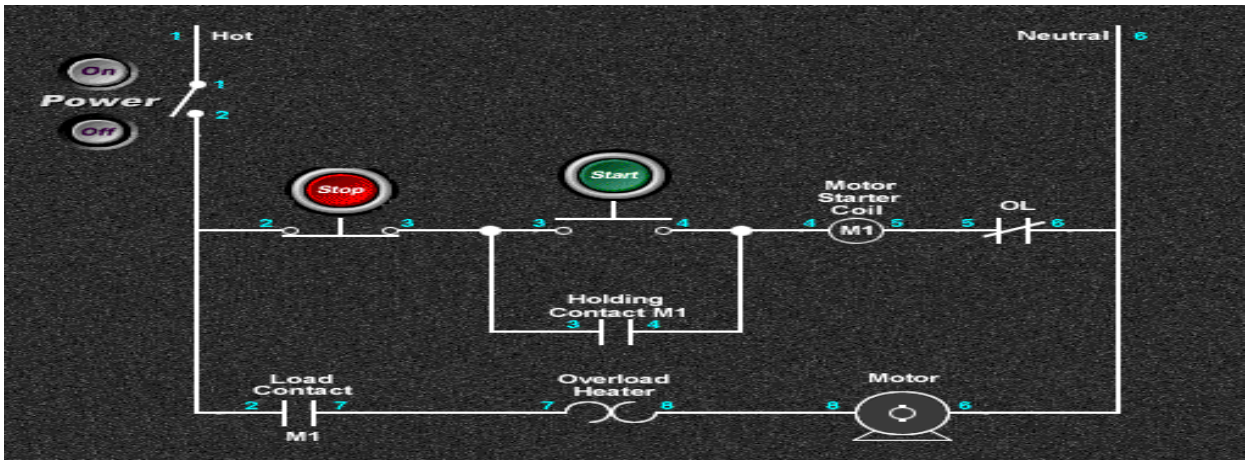




## Connection and Schematic diagram of Start/stop push button.

### A. Connection diagram of Start/stop push button



**B. Schematic diagram of Start/stop push button.**



| Self-Check 3 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Draw/write on the blank space/List down the following

1. List different Types of electrical Diagram
2. _____Is an electrically-operated switch (contactor) that includes motor overload protection
3. Draw the Schematic diagram of Start/stop push button

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-4 | Wiring Diagrams and Layouts/shop drawings |
|---|---|

## 4.1 Circuit or schematic Diagram

The circuits drawn for motor control circuits are in two forms :( a) Circuit or schematic diagram
(b) Wiring diagram.

**(a) Schematic or Circuit Diagram**: While designing a control circuit, the schematic diagram is drawn first as it is easy, simple, clear and easy to follow for implementation in practical wiring diagram. 'The diagram drawn below is a schematic diagram for a simple D.OL starter. The main thing which is to be settled in mind is that practically, the contactor coil and its auxiliary contacts are close to each other but in schematic diagram, they are at different places.

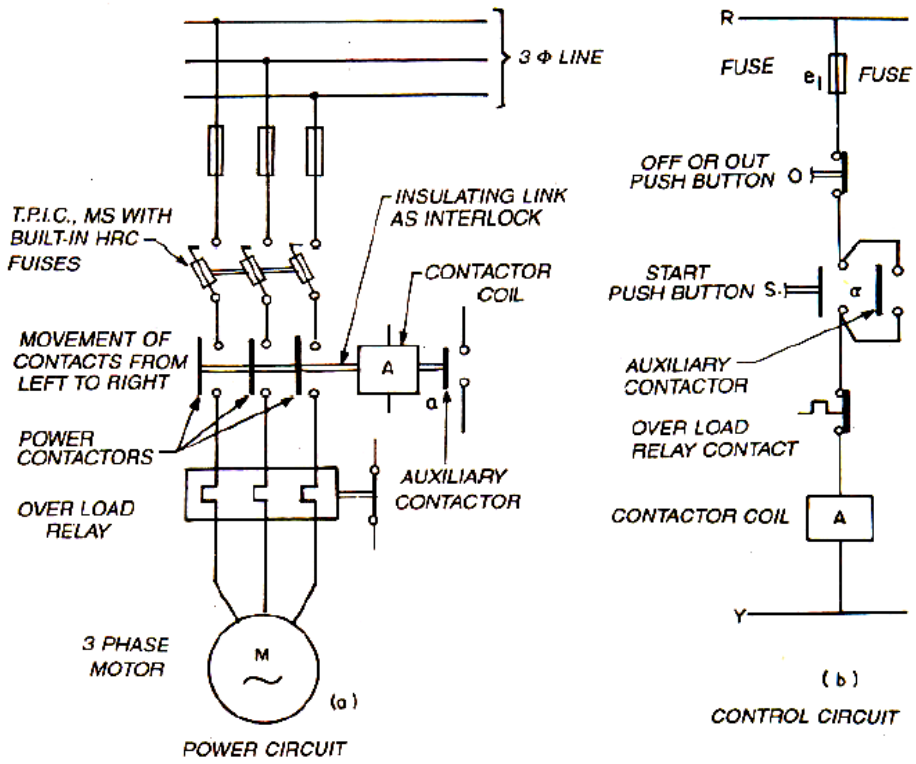



Fig. The contactor coil A and auxiliary contact 'a' are practically close together but in control circuit or schematic diagram, they are at different places. The power contactors, coil and auxiliary contacts are Mounted over a common insulating link.

**(b) Wiring Diagram**": The wiring diagram is practically implemented design showing connection

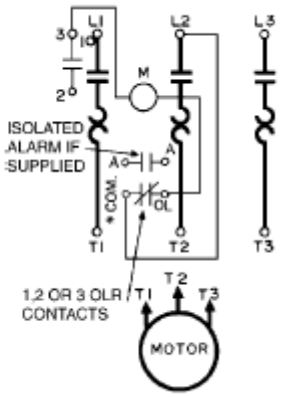
to various components, While designing the control circuit, the schematic diagram is drawn first and then

on the basis of connections shown on schematic diagram, the power circuit wiring diagram is prepared showing layout and connections to component

A wiring diagram shows, as closely as possible, the actual location of all component parts of the device. The open terminals (marked by an open circle) and arrows represent connections made by the user.

Since wiring connections and terminal markings are shown, this type of diagram is helpful when wiring the device or tracing wires when troubleshooting. Bold lines denote the power circuit and thin lines are used to show the control circuit. Black wires are conventionally used in power circuits and red wire in control circuits for AC magnetic equipment.

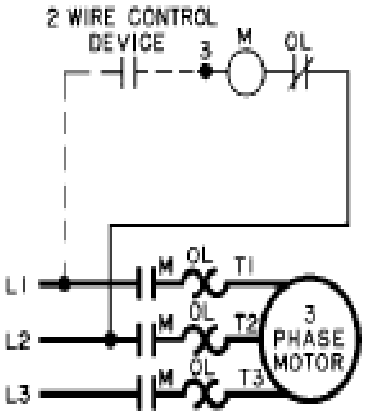
A wiring diagram is limited in its ability to completely convey the controller's sequence of operation. The elementary diagram is used where an illustration of the circuit in its simplest form is desired.




## Elementary Diagram

An elementary diagram is a simplified circuit illustration. Devices and components are not shown in their actual positions. All control circuit components are shown as directly as possible, between a pair of vertical lines representing the control power supply. Components are arranged to show the sequence of operation of the devices and how the device operates. The effect of operating various auxiliary contacts and control devices can be readily seen. This helps in troubleshooting, particularly with the more complex controllers.

This form of electrical diagram is sometimes referred to as a "schematic" or "line" diagram.




DESIGN GUIDELINES

1. The supply to relay or contactor coil should commence by pressing start push button.

2. The supply to relay coil should continue through its contactor even if push button is released.

3. The schematic diagram is prepared first.

4. While drawing wiring diagram, mark the layout of components and then make connections purely on the basis of schematic diagram. For example, upper terminal of contactor 'a', lower terminal of off push button and upper terminal of start push button are connected together in the schematic diagram identify the same terminals in wiring diagram wherever they are, and connect them.

5. The 3 phase supply lines are to be shown horizontal while the power circuit lines are to be drawn vertical.

6. The movement of contacts and push buttons to be shown from left to right.

7. The main switches and other switches are to be shown in off position.

8. The contactors and, push buttons are to be drawn in non-actuated position.

9. Crossings of lines in the wiring diagram should be minimized. .

10. If there is sequence of operation, the circuit, which is energized, first should be more to the right.

11. All letters and numerical should be kept clear of the guidelines. Words may be underlined in a drawing where preferred.

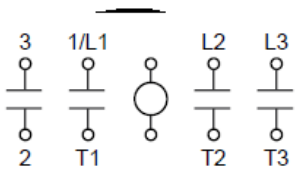
12. Lettering should be done on the drawing in such a way that it may be read when the drawing is viewed from the bottom edge or from bottom and right hand edges.

## 4.2 Standard Elementary Diagram Symbol

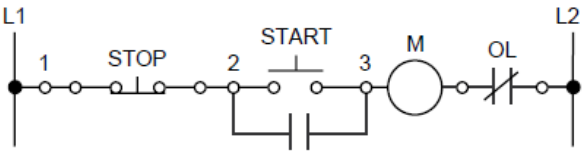
### Switch

### 4.2.1 NEMA and IEC Controller marking and Elementry Diagram

NEMA

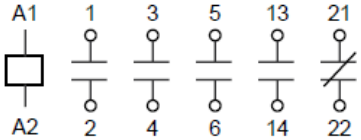



Typical Controller Markings

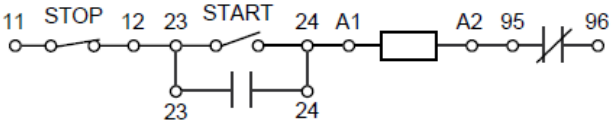



Typical Elementary Diagram

IEC




Typical Controller Markings




Typical Elementary Diagram

| Self-Check 4 | Written Test |
|---|---|

**Part II: Enumeration**
**Direction:** Write/List down the following

1. _____Is practically implemented design showing connection

To various components

2. Draw NEMA and IEC Controller marking and Elementry Diagram

**Answer Sheet**

Score = _____

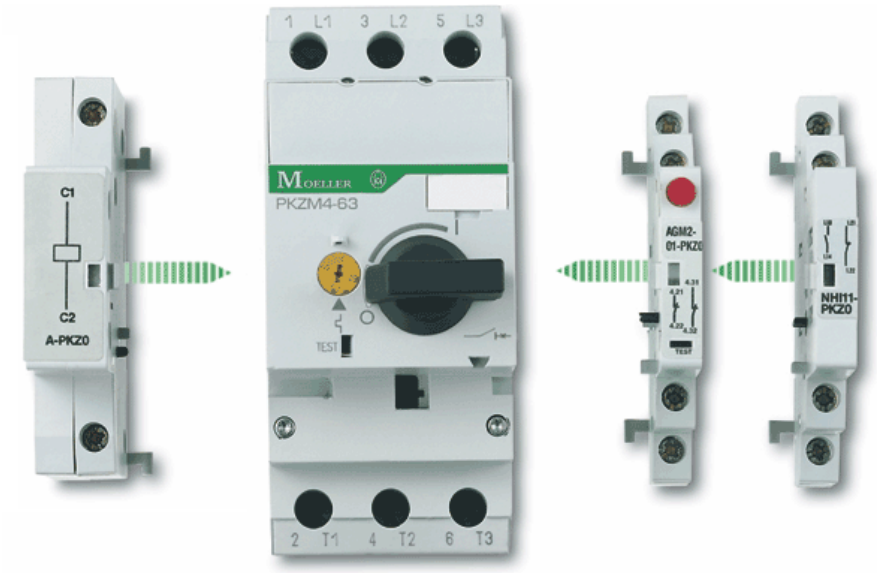
Rating: _____

Name: _____ Date: _____

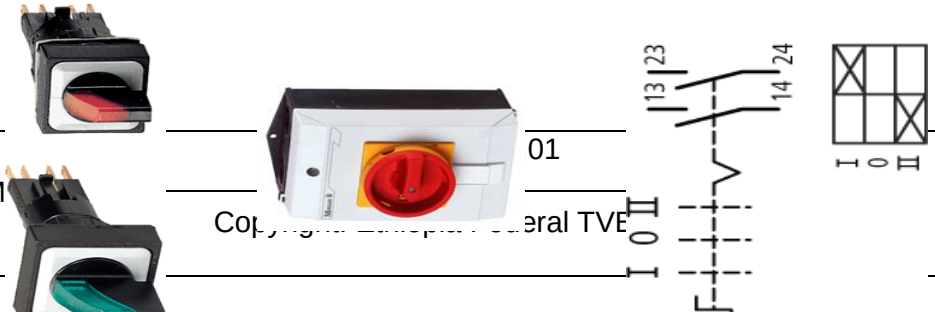
| Information Sheet-5 | Motor control Components and wiring devices |
|---|---|

**1. Disconnecting switches: -** It isolates the motor from the power sources, selected to carry the nominal full-load current of the motor and to with stand short circuits currents for brief interval.

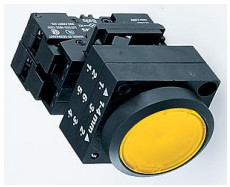
**2. Manual circuit breaker: -** Opens and closes a circuit like toggle switch. It opens or trips automatically when current exceeds a predetermined limit, after tripping it can be reset manually.

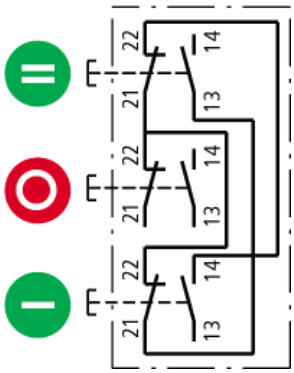



**3. Cam switch: -** Have a group of fixed contacts and an equal number of moveable contacts. The contacts can be made to open and close in preset sequence by rotating a handle or knob, Used to control the motion and position of hoists, machine and tools.



**4. Push buttons: -** A switch activated by finger pressure, two or more contacts open or close the button is depressed. Usually spring loaded so as to return to their normal position when pressure is removed.

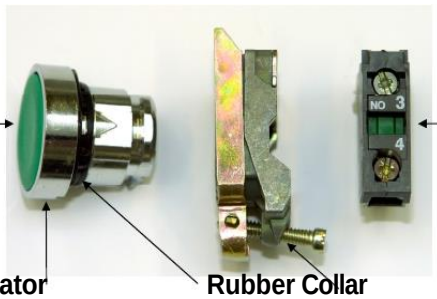





## *Start Button*

A start button consists of a **green** coloured actuator, which when pressed operates a normally **open** contact. On pressing the green actuator the normally open contact will close. These are fitted on the panel door via a mounting collar. The actuator is fitted through a suitable hole in the panel door. A rubber washer is used on the outside to provide ingress protection. The actuator is locked into the collar. The collar is secured to the panel door by a screw. This action compresses the rubber seal on the actuator. Finally the contact block is simply clipped on to the

**clor indicato**




**Mounting Seal**

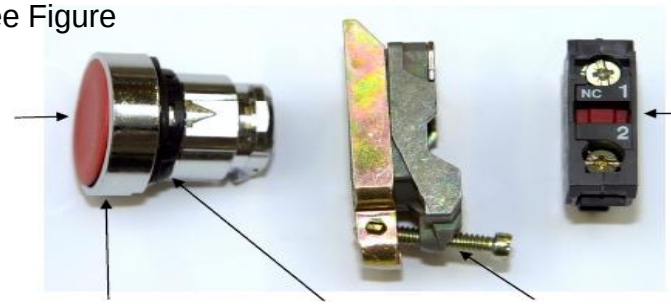
**Actuator**

**Rubber Collar**

### *Stop Button*

A stop button consists of a **red** coloured actuator, which when pressed operates a normally **closed** contact. On pressing the red actuator the normally closed contact will open.

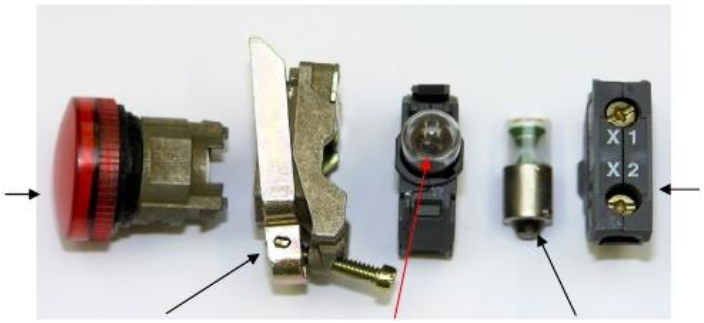
See Figure



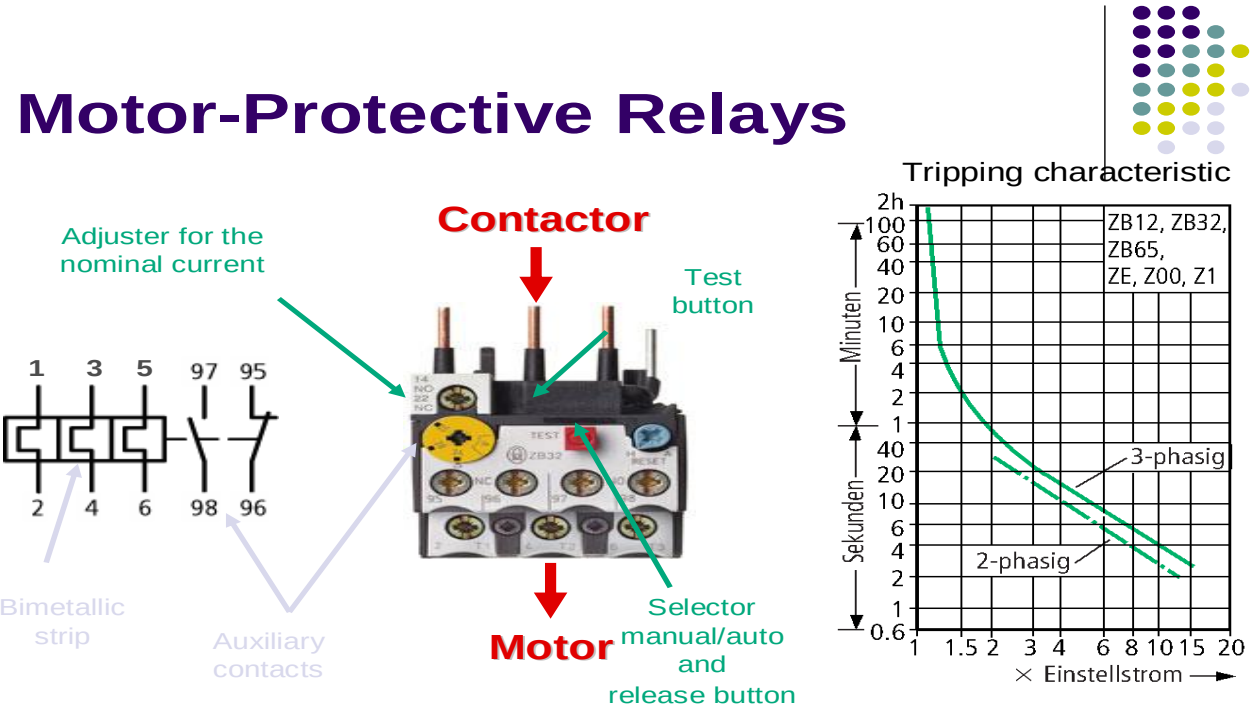

### *Emergency Stop Button*

This is an emergency stop button and it differs from a standard stop button as follows:

- It has a large, easy to operate, mushroom shaped actuator.
- This actuator must be mounted on a yellow background.
- When operated, the actuator latches in the “Off “ position.
- The actuator is released by twisting the mushroom shaped head.



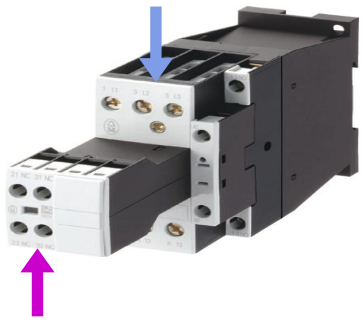
**5. Thermal relays or over load relay: -** It is a temperature sensitive device whose contacts open or close when the motor currents exceeds a preset limit. The current follows through small calibrated heating elements which raises the temperature of the relay. It is an inherent time delay devices because the temperature cannot follow the instantaneous changes in current.

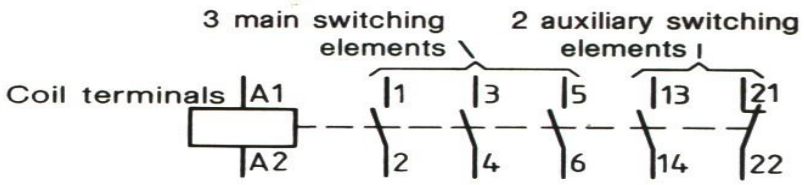


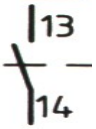

**6. Magnetic contactor**

It is basically a large control relay designed to open and close a power circuit. It possesses a relay coil and magnetic plungers which carries a set of movable contacts. When the relay coil is energized, it attracts the magnetic plunger, causing it to rise quickly against the force of gravity. The movable contacts come in contacts with a set of fixed contacts there by closing the power circuit. When the relay coil de-energized the plunger falls there by opening and closing the respective contacts, Used to control motors from 0.5hp to several hundred horse power.

# Contactors



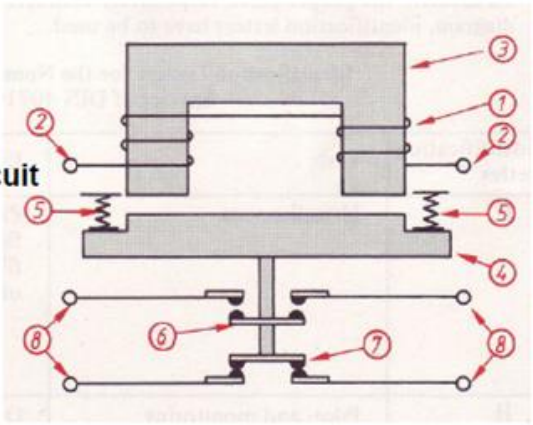




| Type of contact | Symbol | Function digit |
|---|---|---|
| **Normally Open (NO)** Make contact |  | **3** and **4** |
| **Normally Closed (NC)** Break contact |  | **1** and **2** |

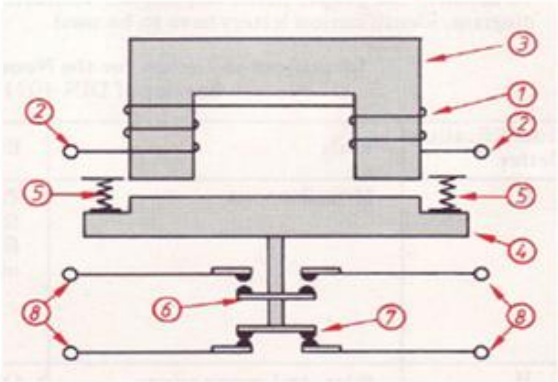


**Structure**

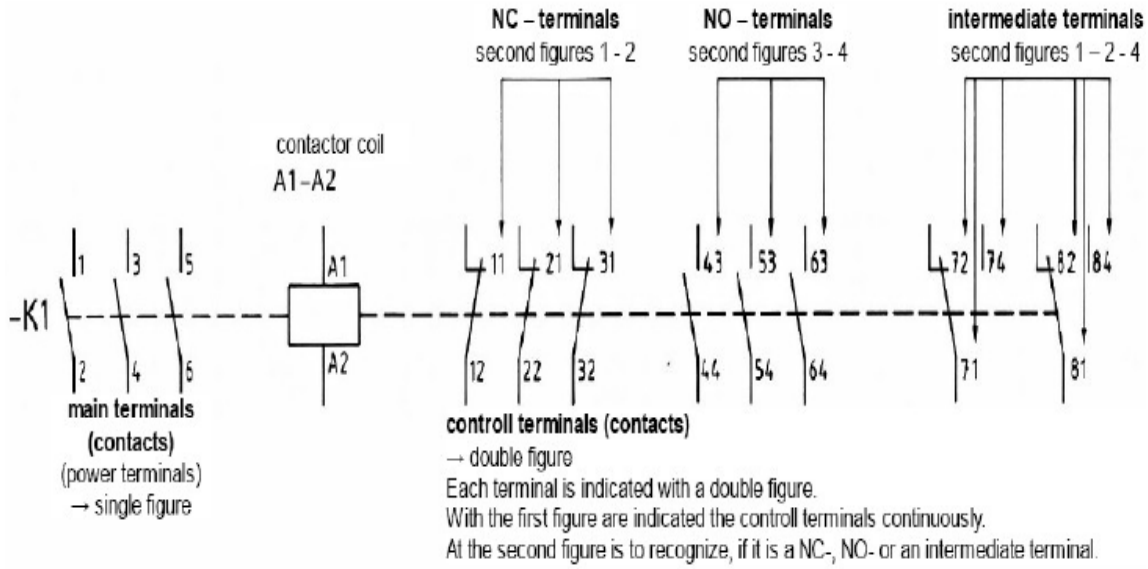
1. coil
2. connection for the control circuit
3. iron core
4. armature
5. armature spring
6. Contacts normally open
7. Contacts normallv closed
8. Terminals for the power circuit

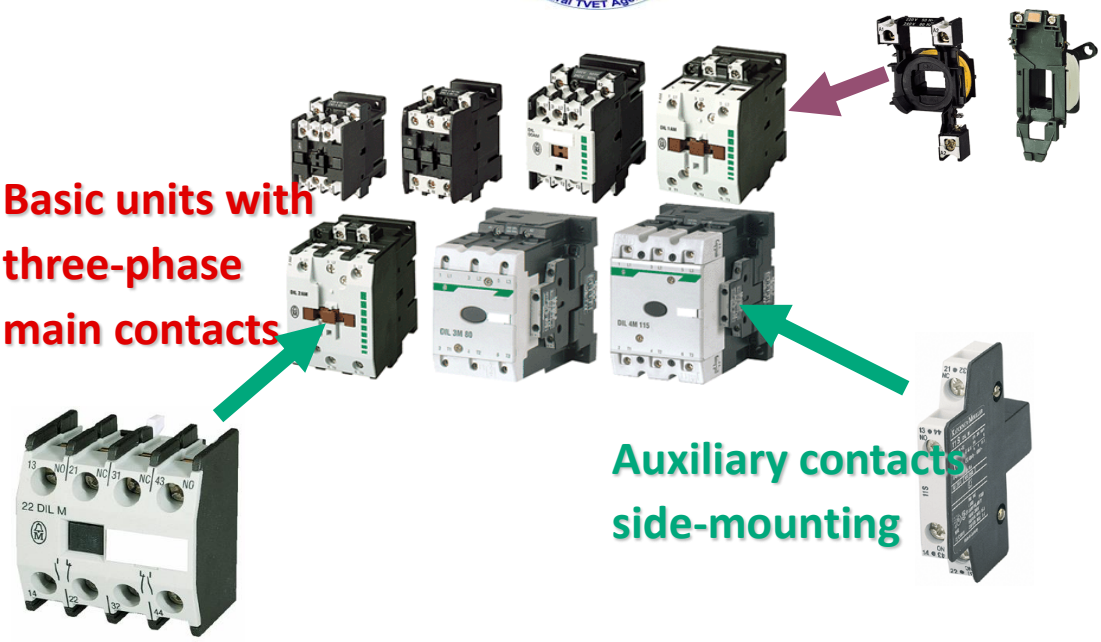


If the coil (1) is energized via the terminals (2) of the control circuit ,
a magnetic field is generated in the core (3).
The armature (4) kept back by springs (5) will be attracted by the core (3).
The attraction of the armature operates the set of contacts (6) (7) (open or close).
By operation of the contacts the operated circuit (8) will be opened or closed.




Contactors may have different arrangements of contacts. One has to differentiate between primary contacts (main contacts) and secondary contacts (auxiliary / control contacts).as shown in the fig.2.1.

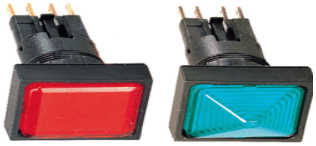


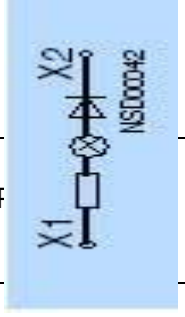



**Difference between Contactor and Relay**

- Since a contractor is required for a higher load, a relay is always cheaper than a contractor.
- A relay is normally used in appliances below 5KW, while a contactor is preferred when the appliance is heavier.
- A relay is used only in control circuit while a contactor can be used in both control and power circuits.
- In general contactors are little slower than relays
- Contactor is so designed that it can be repaired while it is not normally done in the case of relays.

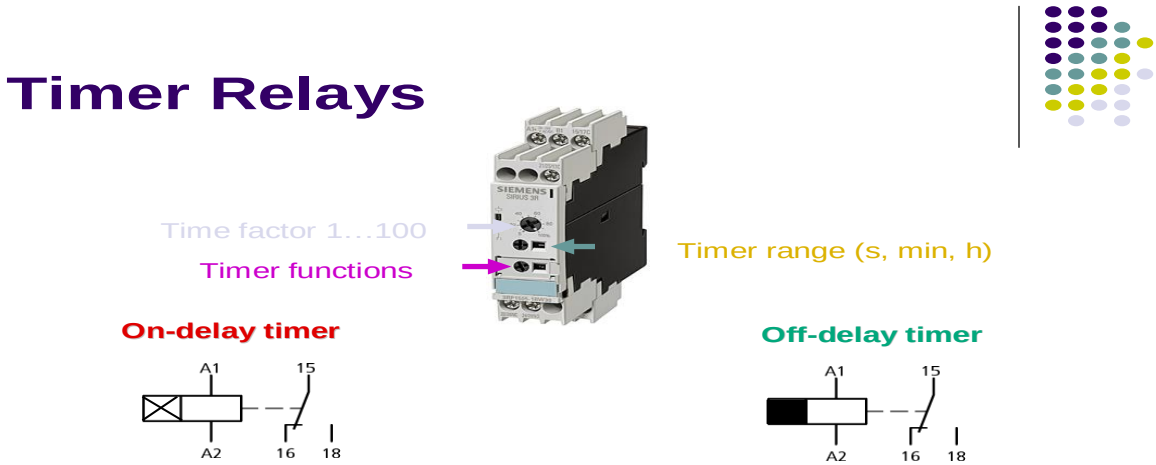
**7. Pilot lights: -** It Indicates the ON/OFF states of remote components in control systems.





**8. Proximity detectors:-**Sealed devices that can detect objects without coming in direct contact with them, their service life is independent of the number of operations. They are wire to an external DC source and generate an alternating magnetic field by means of internal oscillators. When a metal objects comes within a few millimeters of the detector, the magnetic field decreases which in turns cause a DC motor current flows.


**9. Timers**




In automated plants many sequences are controlled time-dependent. In the lower range of performance with conventional contactor controls, delay time relays with different functions are used. Modern timers with digital electronics are often multi-functionally toggleable.

# Timer Characteristics

On-delay timer


Off-delay timer


| Self-Check 5 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write/List down the following

1. Write the Difference between Contactor and Relay
2. _____ is a temperature sensitive device whose contacts open or close when the motor currents exceeds a preset limit
3. _____is Sealed devices that can detect objects without coming in direct contact with them, their service life is independent of the number of operations

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-6 | Correct size and degree of protection of enclosures |
|---|---|

## 6.1 Motor Overload Protection

Motors larger than 1 horsepower must be provided separate motor overload protection devices. The most common devices typically used include:

1) Magnetic or thermal overload devices
2) Electronic overload relays
3) Fuses

### 6.1.1 Magnetic & Thermal Overloads

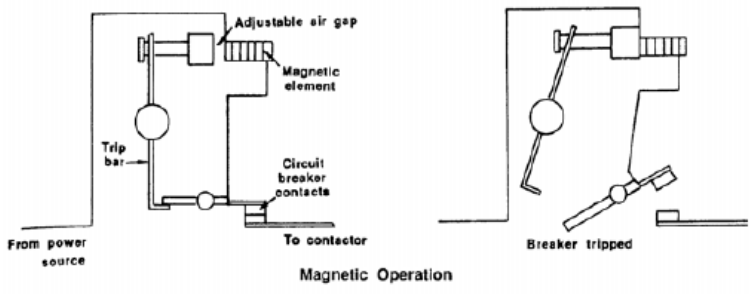
Overload devices are usually located in the motor's starter and connected in series with the motors electrical supply circuit and can be operated by either magnetic or thermal action.

- The same amount of current passes through the overload relay and the motor.
- If the current or heat through the overload device is higher than the device's rating, it trips and shuts down the electric power to the motor

## Magnetic Overload Relays

A magnetic overload relay is an electro-mechanical relay operated by the current flow in a circuit.

- When the level of current in the circuit reaches a preset value, the increased magnetic field opens a set of contacts.
- Electromagnetic overload relays operate on the magnetic action of the load current flowing through a coil.
- When the load current becomes too high, a plunger is pulled up into the coil interrupting the circuit.



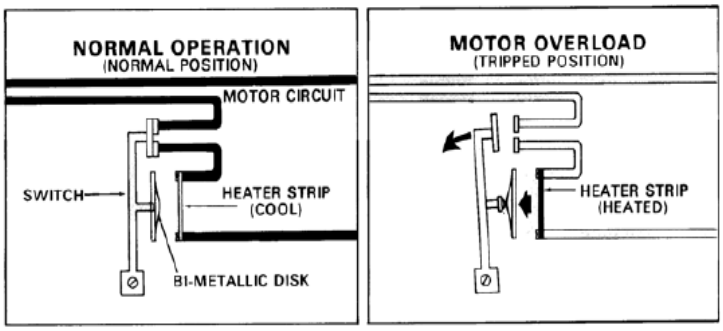
Magnetic Operation

- The tripping current is adjusted by altering the initial position of the plunger with respect to the coil.

## Automatic Reset Devices

Automatic reset is an advantage where the starter is inaccessible and the motor is provided three wire control from a magnetic starter.

- This control doesn't allow the motor to restart until the start push button is manually pushed.
- This permits the overload condition to be removed before the motor restarts.




## 6.1.2 Electronic Overloads

Electronic overloads sense the load current and the heating effect on the motor is computed. If an overload condition exists, the sensing circuit interrupts the power circuit.

- The tripping current can be adjusted to suit the particular application.

- Electronic overloads often perform additional protective functions such as ground fault and phase loss protection.

**Fuses**

Fuses have limited application as the primary means of overload protection for motors but can be effectively used to provide backup overload protection.

• Single-element fuses are not designed to provide overload protection.

- Their basic function is to protect against short circuits and ground faults.
- If sized to provide overload protection, they would blow when the motor starts due to high motor inrush current.

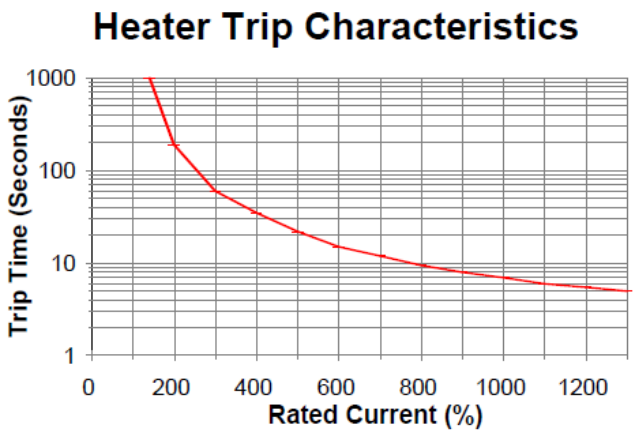
• Dual-element fuses can provide motor overload protection, but they have to be replaced When they blow which can be a disadvantage.

• There is a risk of single-phasing damage to the motor when only one fuse blows unless Single-phase protection is provided.

**Overload Trip Time**

The time it takes an overload to trip depends on the length of time the overload current exists.

- A Heater Trip Characteristics chart shows the relationship between the time an overload takes to trip and the current flowing in the circuit based on the standard 40• ℃ ambient temperature installation.




- The larger the overload (horizontal axis), the shorter the time required to trip the overload (vertical axis).
- Any change from ambient temperature affects the tripping time of an overload.

– For temperatures higher than 40• ℃, the overloads trip at a current rating less than the value of the overload.

- **Example:** At 50• ℃ the overloads trip at 90% of their rated value. For temperatures lower than 40• ℃, the overloads trip at a current rating greater than the rated value of the overload.

## 6.2 Sizing Motor Overload Protection

There are several types of devices that can be used to provide overload protection and the sizing procedure can vary depending on the type of device used.

- It is important to keep differences in the procedures separate and understood well so as not to install overloads that do not provide adequate protection to the motor.
- The simplest and most straightforward sizing procedures for motor overload protection are applied when sizing overload relays using the cover of the motor starter, control center, or Manufacturer's catalog.
- The National Electrical Code specifies methods to calculate the maximum size motor overload protection for specific motors if a manufacturers chart is not available. Installations relying on fuses and circuit breakers as back-up overload protection must be calculated using the NEC method.

**NEC Calculations**

The NEC in general requires the maximum size overload device be set to open at 115% or 125% of the motor's full-load current rating, depending upon the service factor and/or temperature rise of the motor. There are however, exceptions.

• For motors rated 40EC with a Service Factor of 1.15 or greater, 125% of the motors FLA is used to calculate the maximum size device for overload protection.

• For motors rated greater than 40EC or unmarked, 115% of the motors FLA is used to calculate the maximum size device regardless of the motor's Service Factor.

• If use of the previous size rules results in the motor tripping off line during starting, the Device can be increased to a maximum of 140% of the motors FLA.

Example: Find the maximum size overload device to provide overload protection to a 3 phase, 230 Volt, 10 Horsepower motor with FLA of 28 amps if:

Ambient Temp = 40EC, S.F.=1.15: 28 amps X 125% = 35 amps

Ambient Temp = 40EC, S.F.=1.00: 28 amps X 115% = 32.2 amps

Ambient Temp = 50EC, S.F.=1.15 28 amps X 115% = 32.2 amps

Ambient Temp = 50EC, S.F.=1.00 28 amps X 115% = 32.2 amps

If use of the size calculated results in the motor tripping off line when started, the overload device may be increased to a maximum of: Maximum size allowable: 28 amps X 140% = 39.2 amps

**Selecting Overloads From Starter Covers or Charts**

21 The size overloads required to protect the windings of a motor can be determined by taking the

motor's full-load current rating and selecting the size overloads from the cover of a magnetic starter,

a motor control center, or the manufacturer's catalog.

- The following things should be kept in mind when using manufacturer's charts.
- When the overload size is selected from the cover of a magnetic starter or controller, the nameplate full-load running current of the motor is used. The full-load running current is

**NOT** increased by 125% when the overloads are selected in this manner.

• The charts are usually based on only the specific manufacturer's equipment.

• Sizes from the charts may be different from those of calculated values from the National

Electrical Code.

- Manufacturer s' charts often provide smaller rated devices than the NEC would allow as a measure of extra protection.

• Manufacturers' typically list the most common sizes in their charts. Certain sizes may require calculations if the chart is not available from the manufacturer.

• If the motor will operate at/near service factor, the appropriate FLA of the motor at its Service Factor should be used to select the overload size from the manufacturer's chart

**OVERLOAD CHART**

| AMPERAGE | OVERLOAD UNIT |
|---|---|
| 20.6-23.3 | H1042 |
| 23.4-26.0 | H1043 |
| 26.1-30.5 | H1044 |
| 30.6-33.6 | H1045 |
| 33.7-37.9 | H1046 |
| 38.0-42.9 | H1047 |
| 43.0-48.2 | H1048 |
| 48.3-54.6 | H1049 |
| 54.7-61.2 | H1050 |
| 61.3-67.6 | H1051 |
| 67.7-75.9 | H0152 |
| 76.0-87.1 | H1054 |
| 87.2-97.5 | H1055 |
| 97.6-109.0 | H1056 |
| 110.0-112.0 | H1057 |
| 123.0-135.0 | H1058 |

rating of 39 amps and a Service Factor of 1.00 requires three overload units with catalog number H1047.

Overload units number H1047 are selected because the 39-amp full-load current rating of the motor is between 38.0 and 42.9 amps.

What if the previous motor had a 1.15 Service Factor?

39 amps X 1.15 = 44.85 amps

The motor requires three overload units with catalog number H1048 because the 44.85 amps of the motor at Service Factor is between 43.0 and 48.2 amps.

Example:

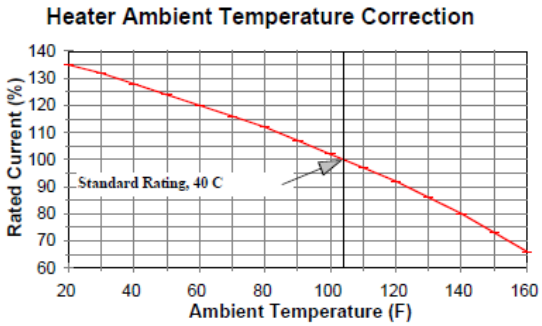
A three-phase motor with a full-load current

## Ambient Temperature Compensation

The ambient temperature in which a starter and motor is located must be considered when selecting overloads because a high ambient temperature reduces overload trip time.

•• Reduced overload trip time can lead to nuisance tripping if a motor is located in a cooler ambient temperature than the starter and lead to motor burnout when the motor is located in a hotter ambient temperature than the starter.

- Most thermal overload devices are rated for use at a maximum temperature of 40 degrees C which is about 104 degrees F.
- The overload device trips at less than 100 percent rated current when the ambient temperature exceeds 104 degrees F which can result in "nuisance tripping".

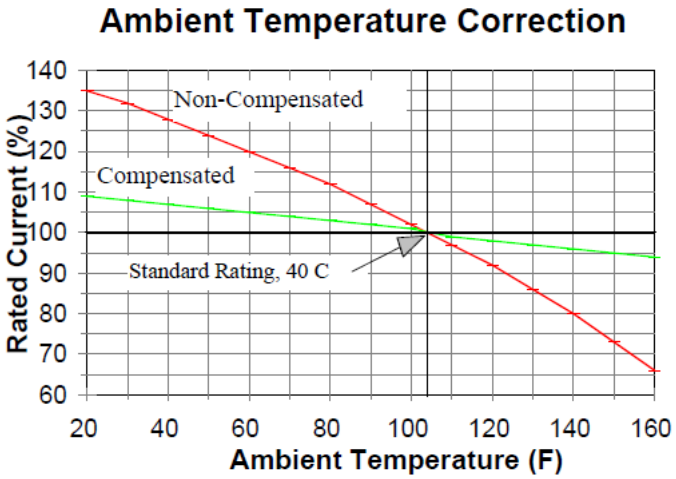



If the temperature is significantly below 104 degrees F, the overload device allows significantly more current through than it is rated for resulting in potential motor overload and failure without the overload tripping the motor off.

- A higher overload heater can be selected when the ambient temperature at the starter is higher than the temperature at the motor and a lower value selected when the ambient temperature at the starter is lower than the temperature at the motor.
- If the temperature varies widely during the year, the motor may not be protected when the temperature swings dramatically the other way unless the original overloads are switched back.

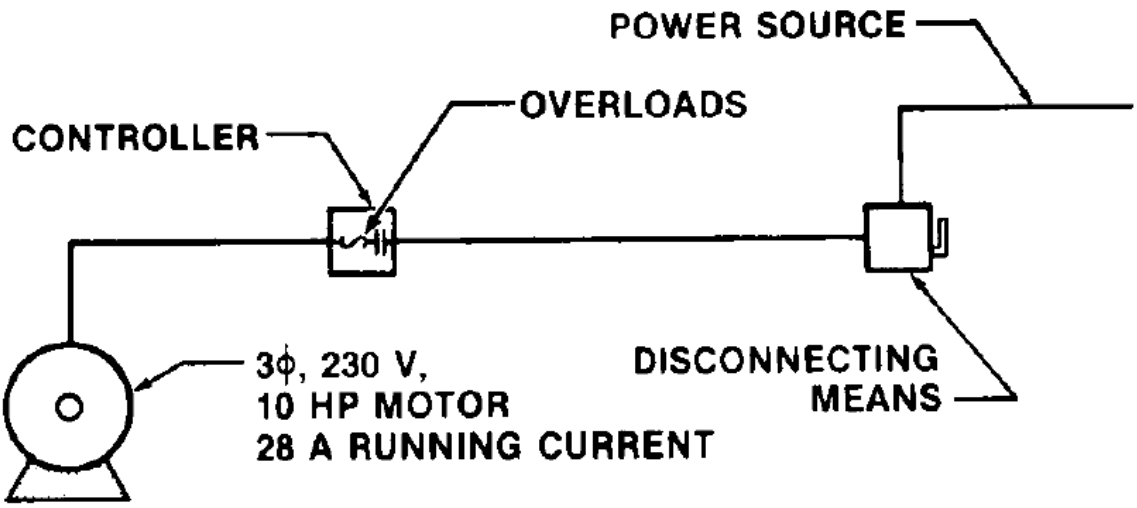
Ambient Compensated Heaters

For this reason, special **Ambient Compensated Heaters** which have a much "flatter" temperature response should be used in most outdoor applications and where ambient operating temperatures are significantly different.



## Sizing Motor Protection Systems

Given the following motor, size the conductors, motor overcurrent and motor overloads to adequately protect the motor and conductors.
Nameplate Info: FLA = 22 Service Factor = 1.00 Ambient = 40 C




**STEP 1:** Determine the motor's FLA (full load amps)

- Go to the appropriate NEC Table to find the design FLA
- NEC Table 430-150 for 3 phase: For 10 Hp, 230 Volt Motor = 28 amps

**STEP 2:** Determine the size of branch circuit conductor required.

- NEC 430-22 says the conductor ampacity equals the FLA x 125%
- Conductors supplying a single motor used for a continuous duty load must have a current Carrying capacity of not less than 125% of the motor's full load current (FLA) rating as Given in NEC tables 430-148 or 430-150.
- Conductor Ampacity = 28 amps X 1.25 = 35 amps
- Use NEC Table 310-16 to select the conductor with the required ampacity
- From NEC Table 310-16: #8 AWG Copper
- The NEC procedure requires use of the #8 AWG conductor so it will be large enough for any motor of the same size in the future.

**STEP 3**: Determine the branch circuit over current device size.

The maximum branch circuit over current device size is calculated based on the type of protective device selected (standard fuse, time-delay fuse, instantaneous breaker, inverse time breaker) and percentage multiplier from NEC Table 430-152.

- Multiply the motors design FLA by the appropriate percentage in NEC Table 430-152.

1. When the value found does not match a standard fuse/breaker size the NEC permits the next higher STANDARD size for a branch circuit over current device.

| | |
|---|---|
| **Standard Fuse** | 28 X 300% = 84 amps<br>Next Highest: 90 amps |
| **Time-Delay Fuse** | 28 X 175% = 49 amps<br>Next Highest: 50 amps |
| **Instantaneous Breaker** | 28 X 800% = 224 amps<br>Next Highest: 225 amps |
| **Inverse Time Delay Breaker** | 28 X 250% = 70 amps<br>Next Highest: 80 amps |

**STEP 4:** Determine the required size for the motor running overload protection.
1. Use the nameplate FLA directly to find the appropriate overload device heater on the motor Starter cover or from manufacturers tables.
2. Use the nameplate FLA and NEC Section 430-32 to calculate the maximum size for the motor overload protection in amps.

- NEC Section 430-32 specifies the maximum overload protection size for most installations if nameplate amps aren't available. (FLA X 115% or FLA X 125% depending on criteria).
- Since the motor's ambient rating was 40 deg C and the S.F. was 1.0, use 115%. For Ambient of 40 deg C and S.F. = 1.0: 22 amps X 115% = 25.3 amps
- NEC Section 430-34 specifies the maximum size if th calculated value in Section 430-32 will not allow the motor to start consistently. (Motor FLA X 140%).
  22 amps X 140% = 30.8 amps MAXIMUM

| Self-Check 6 | Written Test |
|---|---|

1. _____Is have limited application as the primary means of overload protection for motors but can be effectively used to provide backup overload protection.
2. _____Is sense the load current and the heating effect on the motor is computed. If an overload condition exists, the sensing circuit interrupts the power circuit.
3. _____are usually located in the motor's starter and connected in series with the motors electrical supply circuit and can be operated by either magnetic or thermal action.

| Information Sheet-7 | Reporting complete data of Industrial |
|---|---|

| Self-Check 7 | Written Test |
|---|---|

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| **Operation Sheet 1** | |
|---|---|
| **Operation Title:** | Using magnetic contactor |
| **Purpose:** | To construct and test a circuit using a magnetic contactor in order to understand the operation of a contractor. |
| **Equipment, Tools and Materials:** | Magnetic contactor, two push buttons, test lamp, screw driver, pliers, wire |
| **Conditions or Situations for the Operation:** | No fuse and overload relay. |
| **Procedures:** | |

1. **Select the required components and arrange them on the working table.**
2. **Test the components using continuity tester. (Whether NO contacts are open and NC contacts are closed)**
3. **Connects the components as shown on figure 1 below.**

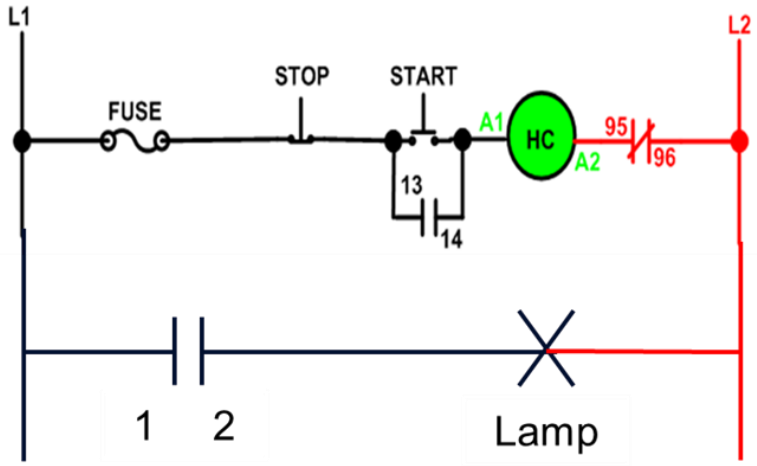



**Figure 1**

4. **When you have completed the connections of the circuit, check the circuit with continuity tester.**
5. **Connect the circuit to the electrical supply and tests its operation. Write your observation and explain how the circuit is operated briefly in the space below.**

6. **Disconnect the circuit from the supply. Disconnect the contactor contact No 13-14. Test the operation after giving the supply back. Write your observation in the space below.**

7. **What is the purpose of contactor terminal No 13-14 which connected across the START pushbutton. Explain briefly its function in the space below.**

| | |
|---|---|
| **Precaution:** | 1. **Be sure your hands are dry when you are working with electricity. You may get electrical shock.**<br>2. **Turn off the power and disconnect the cord before making any adjustment on the circuits.**<br>3. **Each time you use instrument, be sure to check functions selected and ranges.** |
| **Quality Criterion:** | • **Safe work exercise.**<br>• **Neat and clear circuit constructed.**<br>• **Circuit operated correctly.** |

| | |
|---|---|
| **Operation Sheet-2** | |
| **Operation Title:** | Thermal Overload Relay(LR2 D type) |
| **Purpose:** | To understand the operation of thermal overload relay. |
| **Equipment, Tools and Materials:** | Thermal overload relay, lamps (5), pliers, screwdrivers (flat, Philips), wire. |
| **Conditions or Situations for the Operation:** | |

**Procedures:**

**Note:**

Thermal overload relays are 3 poles. The motor current flows through their bimetals (1 per phase) which are indirectly heated. Under the effect of the heating, the bimetals bend; cause the relay to trip and the position of the auxiliary contacts to change. The relay setting range is graduated in amps. In compliance with international and national standards, the setting current is the motor nominal current and not the tripping current.

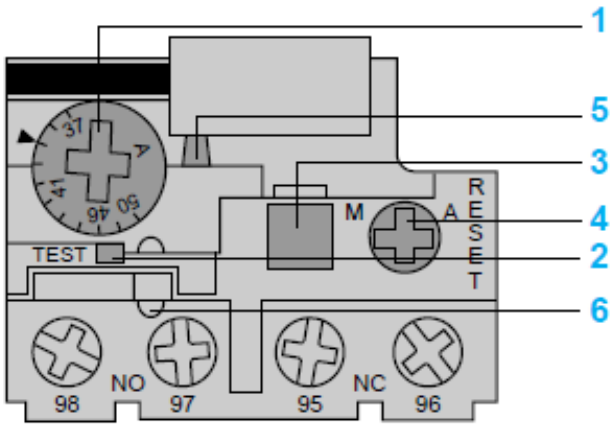
A conventional thermal overload relay protects the motor in the following two cases:

- overload, by monitoring the current drawn by each phase,
- Phase imbalance or failure, by its differential mechanism.

Nevertheless, it has the disadvantage of not taking into account, with sufficient accuracy, the therma state of the motor.

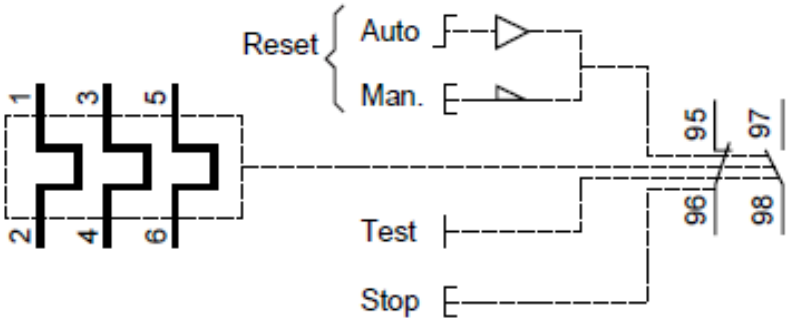
**LR2-D thermal overload relays** are used in a circuit of 50/60 Hz, rated insulation voltage of 660V and rated current of 0.1-93A to protect AC circuits and motors against overloads, phase failure, long starting times and prolonged stalling of the motor. They can be plugged in KLC1-D series AC contactors. **LR2 D1321**has18A current rating with scale of current rating from 12A to 18A.

**Description**(for LRD 3322…4369, LR2 D type relay):




1. Adjustment dials ($I_r$).
2. Test button.
   Operation of the Test button allows:
   - checking of control circuit wiring,
   - Simulation of relay tripping (actuates both the N/O and N/C contacts).
3. Stop button. Actuates the N/C contact; does not affect the N/O contact.
4. Reset button (manual, automatic).
5. Trip indicator.
6. Setting locked by sealing the cover.

**Schematics** (for LRD, LR2 D and LR3 D type relay):




**Procedures:**

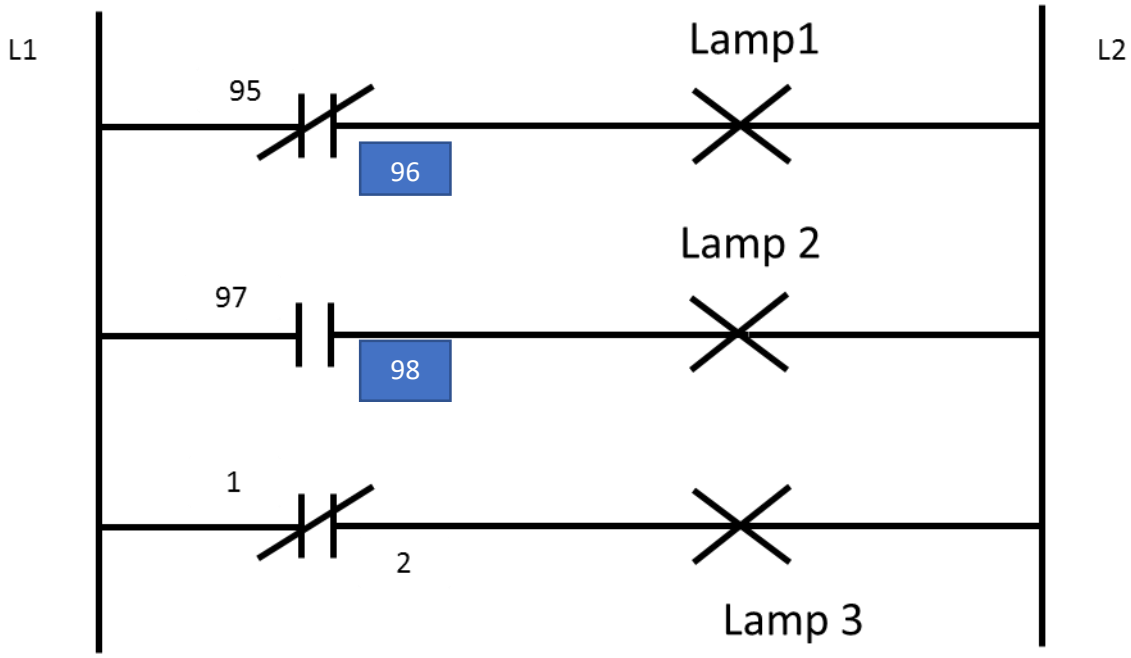
1. Identify the parts of the overload relay given.
2. Fill the ratings of the relay in the table below.

| Model No | Frequency (Hz) | Voltage (V) | Current (A) | Current –range (A) |
|---|---|---|---|---|
| | | | | |

3. Test the tripping contact (95-96) ,signaling contact (97-98) and line contacts using continuity tester and write the result:

   95-96=_____ 97-98=_____1-2/3-4/5-6 =_____

4. Construct the circuit shown below




5. Fill the table below (Relay not tripped-Automatic reset)

| Button operated | Contact | Relay tripped | | Relay not tripped | |
|---|---|---|---|---|---|
| | | Manual reset | Automatic reset | Manual reset | Automatic reset |
| STOP | 95,96 (NC) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | 97,98 (NO) | | | | |
| | 1,2 (NC) | | | | |
| TEST | 95,96 (NC) | | | | |
| | 97,98 (NO) | | | | |
| | 1,2 (NC) | | | | |

| | |
|---|---|
| **Precaution:** | **2. Be sure your hands are dry when you are working with electricity. You may get electrical shock.**<br>**3. Turn off the power and disconnect the cord before making any adjustment on the circuits.**<br>**4. Each time you use instrument, be sure to check functions selected and ranges.** |
| **Quality Criterion:** | • **Safe work exercise.**<br>• **Neat and clear circuit constructed.**<br>• **Circuit operated correctly.** |

| | |
|---|---|
| **LAP Test 1** | **Practical Demonstration** |

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

**Task 1- Install** magnetic contactor

| LAP Test 2 | Practical Demonstration |
|---|---|

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

**Task 1-** Install magnetic contactor

| | | |
|---|---|---|
| | **OTHER REFERENCES** | **Performing Installation of Motor Controller System** |


1. Basics of Motor Control Centers..Centers.. series,. Siemens

2. Industrial Motor control Laboratory

3. Cutler-Hammer: LEARNING MODULE 19: STARTERS AND. CONTACTORS


| Instruction Sheet | LG22: Inspect electrical materials and tools |
|---|---|

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

- check/inspect the delivered materials and tools
- identify defective/sub standard materials and Test
- Reporting Inspection/ check deliveries

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- check/inspect/ test Delivered materials according to quantity, usage and specifications
- Identify Defective/Sub-standard electrical materials according to physical damaged and quality are reported to immediate superior
- Defective/sub-standard/wrong specification electrical materials are returned to warehouseman/stockman for

**Learning Instructions:**

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below 3 to 6.
9. Read the information written in the information “Sheet 1, Sheet 2, and Sheet 3,-” **in page 3,5-6, and 8** respectively.
10. Accomplish the “Self-check 1, Self-check t 2, and Self-check 3” ,---” **in page 4,7, and 9** respectively
11. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, ” **in page 10.**
12. Do the “LAP test” **in page 11**

| **Information Sheet-1** | **check/inspect the delivered materials and tools** |
|---|---|

## 1. INSPECTION AND TESTING

## 1.1 IN-PROCESS INSPECTION AND TESTING

Suppliers shall establish and maintain documented procedures for inspections and tests of the equipment during manufacturing and assembly. The procedures shall provide for the verification by inspections or tests, at appropriate points in the manufacturing and assembly process, that the characteristics of the item conform to the requirement specified for that stage of the process. In general the verification should be made as close as possible to the point of realization of the characteristic. The in-process verification may include:

- Set-up and first piece inspection.
- Inspection or test by machine operator.
- Automatic inspection or test.
- Fixed inspection stations.

Equipment shall be held until the required inspection and test has been completed.

Equipment shall not be released for further use until it has been verified and the results of the verification are satisfactory.

## 1.2 FINAL INSPECTION AND TESTING

The contractor shall carry out all final inspection and testing in accordance with the quality plan and/or documented procedures to complete the evidence of the conformance of the finished equipment to the specified requirements. The quality plan and/or documented procedures for all final inspection and testing shall require that all specified inspections and tests, including those specified on receipt of equipment or in-process, have been carried out and that the results meet specified requirements. Inspections and tests procedures shall define:

- The location where the inspection or test is to be performed (supplier premises or client organization site or CERN site).
- The parameters to be measured.
- The characteristics or functions that have to be verified.
- The acceptance criteria, including any applicable standards or codes. The requirements for special tools, fixtures, gauges, test set-ups and measuring equipment. Special instructions relative to handling and storage of the equipment.
- Guidelines for the use of sampling inspection if appropriate.
- The data and records that are required and in which form.
- When and how the inspections and tests results are to be reported to the client organization. No equipment shall be dispatched until all activities specified in the quality plan and/or documented procedures have been satisfactorily completed and the associated data and documentation are available

| Self-Check 1 | Written Test |
|---|---|

**Part I: Enumeration**

**Direction:** Write on blank space/List down the following

1. List at list three criteria of Inspections and tests procedures selecting laboratory equipment.
2. List two types of Inspection and Test

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-2 | Identify defective/sub standard materials and Test |
|---|---|

## 2. CONTROL OF INSPECTION, MEASURING AND TEST EQUIPMENT

Suppliers shall establish and maintain documented procedures to control calibrate and maintain inspection, measuring and test equipment used to demonstrate the conformance of manufactured and/or assembled equipment to the specified requirements. Inspection, measuring and test equipment shall be used in a manner that ensures that the measurement uncertainty is known and is consistent with the required measurement capability. Where the availability of technical data pertaining to the inspection, measuring and test equipment is a specified requirement, such data shall be made available, when required by the client organization or its representative, for verification that the inspection, measuring and test equipment is functionally adequate. Measuring and test equipment that is found to be out of calibration shall be marked and removed from service until re-calibrated.

## 3. INSPECTION AND TEST STATUS

Suppliers shall establish and maintain documented procedures for the identification of the inspection and test status of equipment throughout manufacturing, assembly, installation and servicing. These procedures shall provide documentary proof that the equipment has been:

- Approved through the inspection processes, or
- Not inspected, or
- Inspected and failed.

The procedure shall ensure that only equipment that has been inspected successfully, or released under a "use-as-is" non-conformity concession, is delivered, used or installed.

## 3. HANDLING, STORAGE, PACKAGING AND DELIVERY

Suppliers shall establish and maintain documented procedures for the handling, storage, packaging and delivery of equipment.

### 3.1 HANDLING

The supplier shall provide methods of handling raw materials, client supplied

Equipment, subcontracted equipment, and finished equipment that ensure that Equipment is not damaged as it is moved during production, and when moved from Production line to the storage area. Careful handling at all times and the use of Appropriate handling equipment is essential to prevent damage or deterioration.

### 3.2 STORAGE

The supplier shall use designated storage areas or stock rooms to prevent damage or deterioration of raw materials, client supplied items, subcontracted items and the finished equipment pending use or delivery. Appropriate methods for authorizing receipt to and dispatch from such areas shall be stipulated. In order to detect deterioration, the condition of items in stock shall be assessed at appropriate intervals.

### 3.3 PACKAGING

The supplier shall control packing, packaging and marking processes (including materials used) to the extent necessary to ensure conformance to the specified requirements.

### 3.4 PRESERVATION

Appropriate methods of equipment preservation shall be implemented (such as cold or chilled storage) while the equipment is under the supplier's control.

### 3.5 DELIVERY

The equipment must be protected during transportation and must be delivered in sound condition. Where third-party hailers are used the same responsibility applies. This applies to the quality of all equipment following final inspection and test procedures. All deliveries and/or collection by the client organization shall be documented.

| Self-Check 2 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write on blank space/List down the following

1. ---------- Is processes (including materials used) to the extent necessary to ensure conformance to the specified requirements.
2. ----------Is equipment that is found to be out of calibration shall be marked and removed from service until re-calibrated?

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-3 | Reporting Inspection/ check deliveries |
|---|---|

## 3. INSPECTION AND TEST RECORDS

3.1 GENERALITIES

The supplier shall establish and maintain records that provide evidence that the

Equipment has been inspected and tested. The records shall show clearly whether the

Equipment has passed or failed the inspections and tests. Where the equipment fails
To pass any inspection or test, the procedure for control of non-conforming equipment shall apply.

3.2 TRACEABILITY OF MATERIALS, PARTS AND EQUIPMENT

To install, commission, operate and maintain the equipment, access to inspection and

Test records must be ensured over many years. This shall be achieved by storing and

Maintaining all the necessary inspection and test records in the Engineering Data

Management System (EDMS) used for the LHC project at CERN. This is a computer System providing document management facilities for all kind of electronic documents

And data. Use of the CERN EDMS requires that all quality records be in computer

Readable forms. In cases where the use of a computer form is impractical, paper forms May be used and scanned to produce a computer readable document.

## 3.3 CAPTURE OF INSPECTION AND TEST DATA

The capture and storage of inspection and test records at the supplier's premises may be carried out in one of two ways:

- Use of the CERN traveler application. This software tool is accessible with a World Wide Web browser such as Netscape. It enables on-line storage of inspection and test records in the CERN EDMS.
- Use of the supplier's own production follow-up system. Use of such a system will require appropriate formatting and structuring of the data and documents prior to their copy from the supplier system to the CERN EDM

| Self-Check 3 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write on blank space/List down the following

1. List at list three Types of INSPECTION AND TEST RECORDS.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Operation Sheet-1 | |
|---|---|
| **Operation Title** | **Commercial and Industrial Inspections** |
| **Purpose** | **checking/inspecting the delivered the Commercial and Industrial Motor by using the inspection check list** |

**Procedure:**

**1.Prepare Inspection Check List**
**2. Prepare Tools and Materials for Inspection**
**3. Identify area of Inspection**
**4. Inspect and test based on Inspection Check List**

**Checklist 1-1: Motors (cont.)**

| ✓ | Item | Inspection Activity |
|---|---|---|
| ☐ | 1. | Check motor control circuits for proper over current protection |
| ☐ | 2. | Verify that motor controllers are provided for motors and that they are of the proper type and have adequate ratings, including Short-circuit current ratings. |
| ☐ | 3. | Check MCCs for proper ratings, protection, workspace, and Dedicated space. |
| ☐ | 4. | Verify that motor disconnects are of the proper type and rating. , |
| ☐ | 5. | Verify that controller disconnects are in sight of controllers, are Readily accessible, and have adequate workspace. |
| ☐ | 6. | Verify that motor disconnects are in sight of motors, are readily accessible, and have adequate workspace., |

| LAP Test | Practical Demonstration |
|---|---|

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

**Task 1-** Prepare Inspection check list for motor Control circuit

| Instruction Sheet | LG23: Assemble electrical motor controller |
|---|---|

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

- Enterprise, Governments and manufacturer safety Regulations & procedures
- Work schedules and work instruction
- Installing manual switches
- Installing magnetic contactors
- Ongoing checks of quality of work

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Follow Safety procedures according to enterprise, government and manufacturers regulations

- laid-out, mount or install Electrical components and wiring devices according to drawings, plans, specifications and standards
- Wire correctly Electrical control components in accordance with wiring diagrams and standards
- Follow Work schedule to ensure job is completed on time in accordance to a quality standard and minimum wastage.
- Further instructions are sought from the immediate superior in case of unplanned events or conditions occurring.
- Ongoing checks of quality of the work are undertaken with strict compliance in accordance with instructions and requirements.
- Conduct Preliminary checks/tests in line with job requirements

**Learning Instructions:**

13. Read the specific objectives of this Learning Guide.
14. Follow the instructions described below 3 to 6.
15. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6,-" **in page 3-4,6-8, 10-12,14-20 and 22-23** respectively.
16. Accomplish the "Self-check 1, Self-check t 2, Self-check 3 and Self-check 4" ,---" **in page 5,9,13,21 and 24** respectively
17. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page 25-30.**
18. Do the "LAP test" **in page 32-34**

| **Information Sheet-1** | Enterprise, Governments and manufacturer safety Regulations & procedures |
|---|---|

## 1. Enterprise, Governments and manufacturer safety Regulations &

procedures

### 1.2 Electrical Safety is a Serious Issue

Electrical Safety in the workplace is the most important ob of an electrical worker. No matter how much training one has received or how much employers try to safeguard their workers, Electrical Safety is ultimately the responsibility of the electrical worker. The human factor associated with electrical accidents can be immeasurable. No one can replace a worker or loved one that has died or suffered the irreparable consequences of an electrical accident.

### 1.3 Machine safety

Machine safety is one of the key factors in ensuring that your production is efficient. Reliable systems that are simple to operate and maintain reduce the probability of accidents as well as the susceptibility of your equipment to faults.

### 1.4 Maximum safety for the manufacturing industry

You can only achieve plant safety if existing risks are recognized in advance and, where necessary, reduced as quickly as possible. The manufacturing industry also faces the challenges of meeting current standards and legislation, such as IEC 62061, ISO 13849-1 ISO 14121, and MRL 2006/42/EG Safety systems must fulfill very high standards today. The probability of a fault, for example, must be calculated for every protection function. On the other hand, you can also gain flexibility with new standards which, for instance, allow complex safety functions to be assessed. Functions such as these allow the design of a dynamic protection zone – dependent on the tool used – as well as the possibility of selectively disconnecting danger zones. This means that you can optimally adapt the safety systems to your production processes. To determine the risk potential arising from your plants and systems, you need an effective and systematic risk assessment process. This is the only way to reliably define suitable measures and imple- ment them quickly. The challenge here is to develop a “functional safety management” system in which safety technology is defined for every phase of the plant life cycle. This enables you to avoid systemic faults from the outset.

### 1.5 Regulations & procedures

.

## Regulation 66. Speed-Limiting Devices

*Governors*

1. All prime movers, except prime movers not connected by shafting, couplings or gears to a constant load, and reversing engines without flywheels, shall be equipped with effective governors to control automatically the speed of the prime mover under varying loads.

*Automatic Stops*

2. Governors shall be provided with automatic stopping devices to shut off the driving medium if the governor fails to function.

3. Prime movers not equipped with governor stops shall be provided with independent automatic speed-limiting devices.

*Ball Guards*

4. Revolving governor balls when so placed as to constitute a source of danger shall be guarded with enclosures of standard construction, extending to the top of the governor balls when at their highest position.

## Regulation 67. Emergency Stops

Speed-limiting devices, safety stops or emergency shut-off valves shall be provided with remote controls, so that in an emergency the prime mover may be shut down from a safe place.

| Self-Check 1 | Written Test |
|---|---|

**Part I: Enumeration**
**Direction:** Write on the blank space/List down the following

1. ---------*is the most important ob of an electrical worker.*
2. ----------is one of the key factors in ensuring that your production is efficient.

**3.** ---------type of system in which safety technology is defined for every phase of the plant life cycle.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-2 | Work schedules and work instruction |
|---|---|

**2. Work schedules and work instruction**

2.1 Work Procedures. Work procedures are established to ensure that:

1. NRC requirements and SAR commitments are properly translated into the work procedures (construction specifications, drawings, and work instructions) for adequate control and installation of instrument components and associated items. Areas to review shall include, but are not limited to, the following:

(a) Instrument components (type, range, accuracy, materials, etc.) are

Identified, located, oriented, and supported as specified.

(b) Physical separation and independence requirements of redundant

Components are met.

(c) Slope of instrument lines with respect to applicable requirements.

2. Interface controls are adequate when multiple contractors are involved.

3. Procedures cover special handling, installation, and maintenance requirements, including those pertaining to protection, preservation of internal cleanliness, and maintenance of component qualification requirements. For example, all covers, seals, plugs, internal preservatives, and protective coatings are left intact until installation and/or use, as appropriate

**2.2 Contactor components:** If you sat down and took apart a contactor as

shown in Figure 5, you would find the following components: an *electromagnet* (E-frame), an *armature*, a **coil,** a **spring,** and two sets of **contacts**, one movable set and one stationary set.

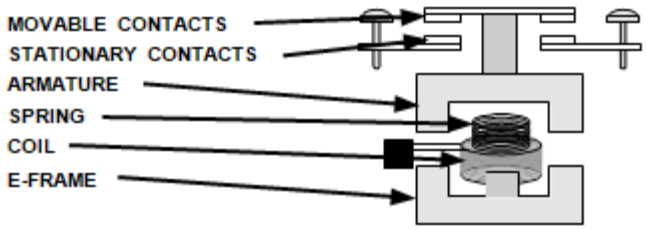



FIGURE 5. MAGNETIC CONTACTOR COMPONENTS

**2.3 How the Contactor Operates:** So, how exactly does the contactor open and close? The **E-Frame**, when energized by the **coil**, becomes an electromagnet. The **armature**, a companion to the E- frame, is connected to a set of **contacts**. The armature is moveable but is held by a **spring**. When the **coil** is energized, the **moveable contacts** are pulled toward the **stationary contacts**, because the **armature** is pulled toward the **E-frame**. Once the two sets of contacts meet, power can flow through the contactor to the load. When the coil is de-energized, the magnetic field is broken, and the spring forces the two sets of contacts apart. In Figure 6 on the next page, we step through the process again, using pictures to help you understand.

Contactors are used when no overload protection is necessary, and at lower levels of electrical current. Applications include lighting circuits, heaters, and transformers. In summary, **contactors operate electromechanically and use a small control current to open and close the circuit**. (We will discuss control current in more detail in the section on starters.) The electro mechanics do the work, not the human hand, as in a knife blade switch or a manual controller.

**2.4 How Motors A Work:** Part of understanding overload protection is understanding how motors work. **Motor goes through three stages during normal operation: resting, starting, and operating under load.**

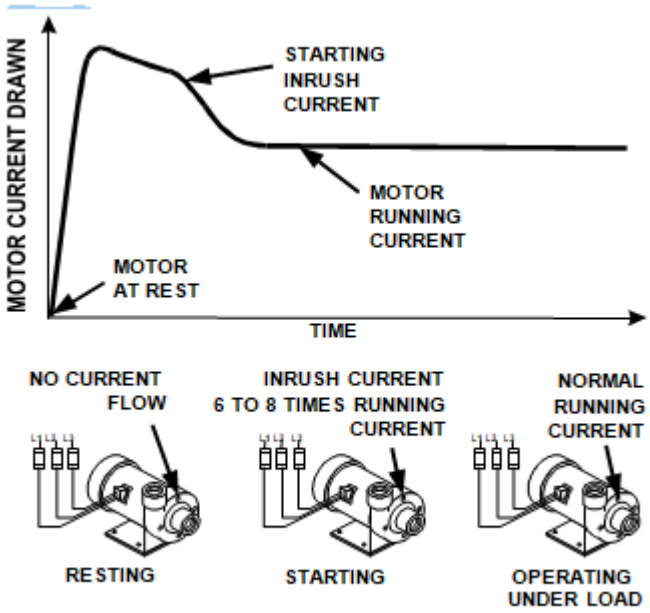



FIGURE 9. MOTOR OPERATION STAGES

**A motor at rest requires no current** because the circuit is open. But **once the circuit is closed**, the motor starts drawing a tremendous *inrush* current; as much as 6-8 times its running current. Here is the problem: **this large inrush current can cause immediate tripping of the circuit breaker**. A fuse or circuit breaker sized to handle the normal running load of the motor will open the circuit during startup. You might think that sizing the fuse or circuit breaker for the spike in current draw would solve the problem. But if you did this, once the motor was running, only the most extreme *overload* would open the circuit. Smaller overloads would not *trip* the breakers, and the motor would burn out.

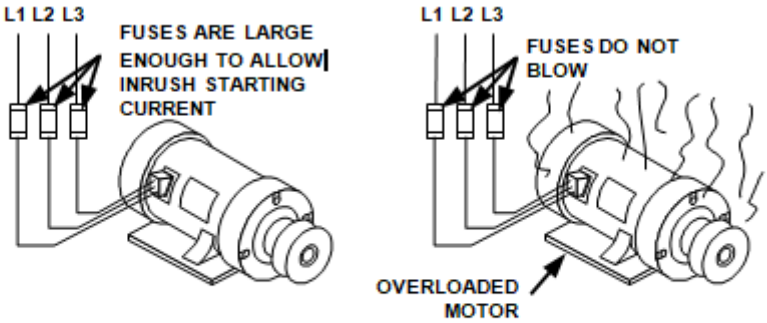



FIGURE 10. THE PROBLEM WITH OVERSIZED FUSES

**2.5 Features of Motor Starters:** All motor starters share the following power control functions:

- Rated by current (amperes) or power (horsepower)
- Remote ON/OFF control
- Motor overload protection
- Starting and stopping (electrical life)
- Plugging and jogging (rapid making and breaking current)

| Self-Check 2 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write on the blank space/List down the following

, 1. List Features of Motor Starters Function.

2. Motor goes through three stages during normal operation:

2.1----------

2.2----------

2.3----------

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-3 | Installing manual switches |
|---|---|

## 3 Installing manual switches

### 3.1 Manual Controller

**The manual controller was the next step up the evolutionary ladder**, offering several important new features:

- The unit is encased, not exposed
- *Double break contacts* are used, instead of single break
- The unit is physically smaller
- The unit is much safer to operate

**Double-break contacts open the circuit in two places simultaneously.** Dividing the connection over two sets of contacts allows you to work with more current in a smaller space than you get with a single-break contact. In addition, the mechanical Linkage more quickly and consistently opens and closes the circuit, sparing the Metal from some of the arcing experienced under knife blade switches.

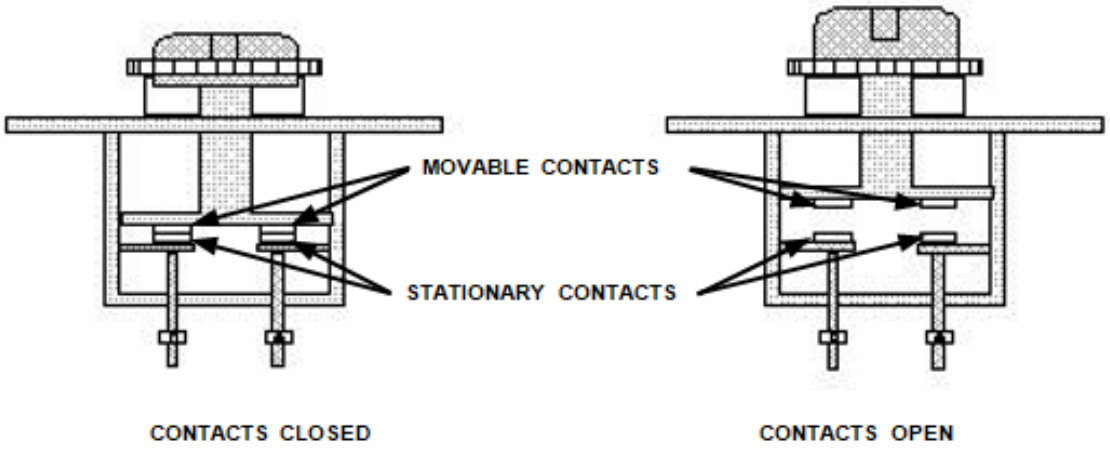



FIGURE 3. DOUBLE-BREAK CONTACTOR

With a manual controller, the operator presses a button or moves a switch that is integral to the electrical equipment being run. In other words, the button or switch is physically attached to the controller itself, and is not operated remotely. When an operator activates a manual controller, the *power circuit* engages, **carrying the electricity to the load.** The manual contactor was a big improvement over the knife blade switch. Variations of manual contactors are still in use today.

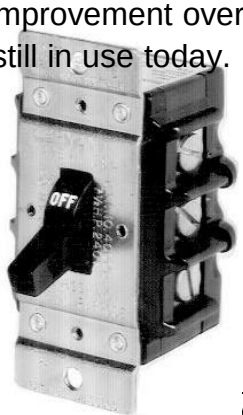
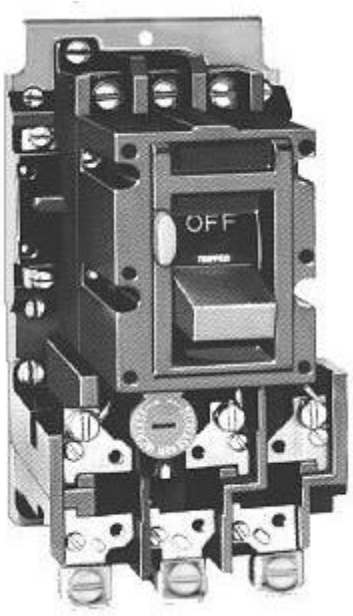



Fig. **MANUAL MOTOR CONTROLLER** ENCLOSED **MANUAL MOTOR CONTROLLER**

**FIGURE4. TWO TYPICAL MANUAL CONTACTORS STILL IN USE TODAY**

**3.2 Manual Starter:** As the name implies, **a manual starter is operated manually**. Operating a manual starter is fairly simple and straightforward: you press a button or toggle (mounted directly on the starter) to start or stop the connected electrical equipment. Mechanical linkages from the buttons or toggle force the contacts to open and close, starting and stopping the motor.



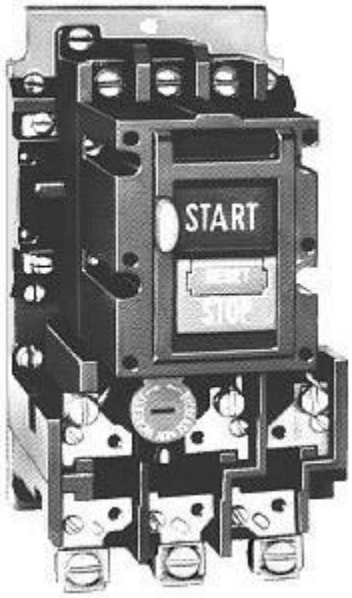




**FIGURE14. TOGGLE OPERATED STARTER STARTER**

**FIGURE 15. PUSHBUTTON OPERATED**

Often, a manual starter is the best choice for an application, because it offers:

- Compact physical size
- Choice of enclosures
- Low initial cost
- Motor overload protection

## 3.3 Safe and economical operation

*Low-voltage protection* (LVP), which prevents automatic restarting of equipment after a power failure, is usually not possible with a manual starter. This means, if the power fails, the power contacts remain closed (toggle or button in ON position). When the power is restored, the motor automatically restarts itself. This could create a dangerous situation, depending on the

application. Because of this, **manual starters are generally used on smaller loads where low voltage protection is not needed**. On applications like pumps and blowers, where the motor should run continuously, and restart automatically, this is actually an advantage.

| Self-Check 3 | Written Test |
|---|---|

**Part III: Enumeration**

**Direction:** Write on the blank space/List down the following

1. ----------is operated manually.
2. ----------which prevents automatic restarting of equipment after a power failure, is usually not possible with a manual starter.
3. List the criteria of choice manual starter best for an application.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-4 | Installing magnetic contactors |
|---|---|

**4. Installing magnetic contactors**

**4.1 Magnetic Contactor:** Engineers eventually made a breakthrough with the magnetic contactor.

**A magnetic contactor is operated electromechanically without manual intervention.** This means that the contactor can be operated remotely, without the need for putting a person in a potentially dangerous location. Magnetic contactors use a small control current to open and close the circuit.

**NOTE:** From this point forward, the term “contactor” will refer only to an **AC magnetic contactor**

**4.2 Motor Controllers**

- A motor controller is a switching device which makes the motor turn-on or turn-off.
- It is used to change the direction of the motor’s rotation.
- It is utilized to protect the motor from overloading.
- It is used to minimize the motor’s drawn current during starting period.
- It is used to control the speed of the motor.

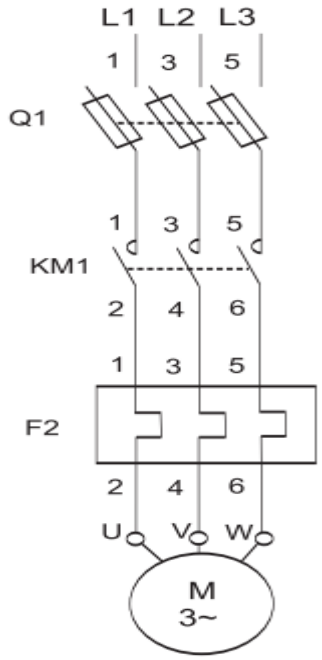
4.2.1 Motor starting

Motor Starter is a device which connects with motor in series to decrease the current at starting time and increase current after starting the motor (in other words start or stop the motor) and provide overload protection.

1. Magnetic starter (Direct on line)
2. Reduced voltage starting
    - Star-Delta
    - Primary resistor
    - Auto transformer
    - Part winding
    - Soft starter
3. Wound Rotor starting
4. VFD (Variable frequency Drive)

4.2.2 direct on line starting

- This is the most common starting method available in the market. The components consist of only a main contractor and thermal or electronic overload relay.
- Current on starting = 5 to 8 rated Current.
- The average starting torque is T on starting = 0.5 to 1.5 rated T.




4.2.2.1 ADVANTAGE OF DOL

- Most Economical and Cheapest Starter
- Simple to establish, operate and maintain
- Simple Control Circuitry
- Easy to understand and trouble-shoot.
- It provides 100% torque at the time of starting.
- the machine to drive does not need to speed up gradually

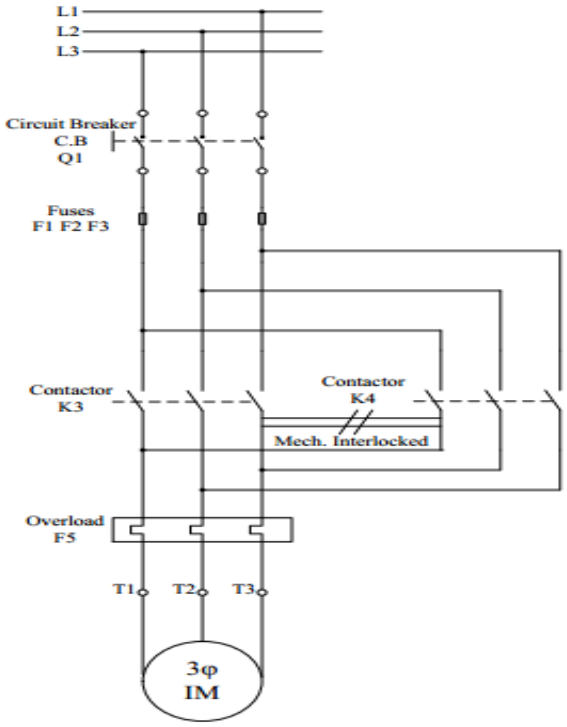
4.2.2.2 DISADVANTAGE OF DOL

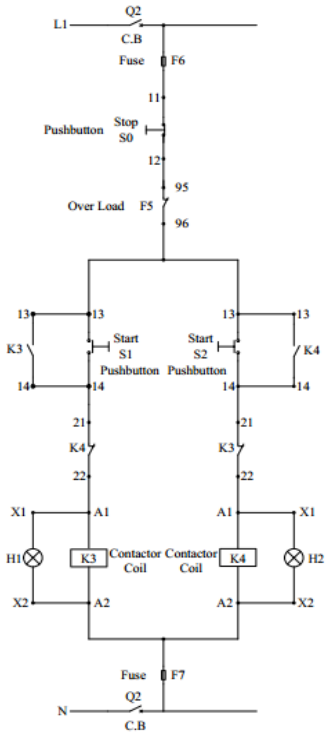
- It does not reduce the starting current of the motor.
- **High Starting Current:** Very High Starting Current (Typically 6 to 8 times the FLC of the motor).
- **Mechanically Harsh:** Thermal Stress on the motor, thereby reducing its life.
- **Voltage Dip:** There is a big voltage dip in the electrical installation because of high in-rush current affecting other customers connected to the same lines and therefore not suitable for higher size squirrel cage motors

- **High starting Torque:** Unnecessary high starting torque, even when not required by the load, thereby increased mechanical stress on the mechanical systems such as rotor shaft, bearings, gearbox, coupling, chain drive, connected equipments, etc. leading to premature failure and plant downtimes**.**

### 4.2.3 Forward/Reverse Motor

To change the direction a three phase induction machine rotation, two of its phases needs to be exchanged, thus changing the phase sequence form, say ABC to CBA. This can be accomplished by using two contactors, one for the forward or CW rotation and one for the reverse or CCW rotation.




### 4.2.4 *Star-Delta Starter Starting Method*

- This is a starting method that reduces the starting current and starting torque.

- The received starting current is about 30 % of the starting current during direct on line start and the starting torque is reduced to about 25 % of the torque available at a D.O.L start.
- The change from star connection to delta connection is controlled by a timer.
- Star-delta starting is suitable for machines with a low resistive torque or which start with no load
- It is relatively cheap compared to other reduced voltage methods.
- The principle is to start the motor by connecting the star windings at mains voltage, which divides the motor's rated star voltage by √3 (in the example above, the mains voltage at 380V = 660V / √3).
- The starting current peak (SC) is divided by 3: - SC = 1.5 to 2.6 RC (RC rated Current ).
- As the starting torque (ST) is proportional to the square of the supply voltage, it is also divided by 3:
- **S**T = 0.2 to 0.5 RT (RT Rated Torque)

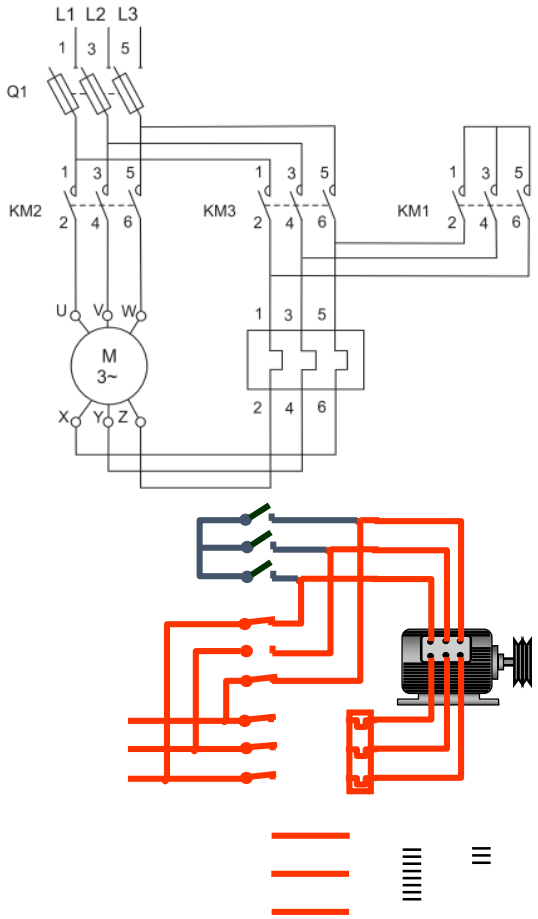
4.2.4.1 Advantages of Star-Delta starter:

- The operation of the star-delta method is simple and rugged
- It is relatively cheap compared to other reduced voltage methods.
- Good Torque/Current Performance.
- It draws 2 times starting current of the full load ampere of the motor connected

4.2.4.2 Disadvantages of Star-Delta starter:

- Low Starting Torque (Torque = (Square of Voltage) is also reduce).
- Break In Supply – Possible Transients
- Six Terminal Motor Required (Delta Connected).
- It requires 2 set of cables from starter to motor.
- It provides only 33% starting torque and if the load connected to the subject motor requires higher starting torque at the time of starting than very heavy transients and stresses are produced while changing from star to delta connections, and because of these transients and stresses many electrical and mechanical break-down occurs

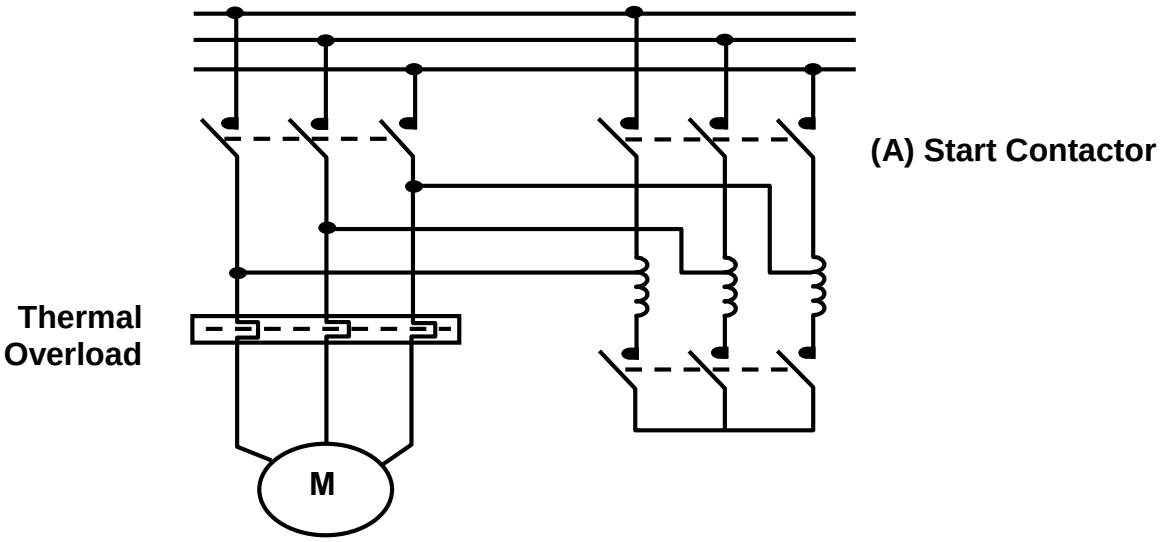
Star-Delta starter:




*4 .2.5 Autotransformer Starter Starting Method*

- This is another starting method that reduces the starting current and starting torque but contrary to Star-Delta starting where this starting method needs three wires and three terminals on the motor.
- When the motor reaches the 80 to 95% of the nominal speed, the star contactor opens. Then the line contactor closes and the autotransformer contactor opens. The motor is never disconnected from the power supply during starting (closed transition) and reduces transient phenomena.
- The process is run at a reduced voltage which depends on the transformation ratio.

*Autotransformer Starter Starting Method*




4.2.5 Variable Frequency Drive

- The Variable Frequency Drive is a particular kind of adjustable-speed drive that is used to control the speed of an AC motor.
- Commonly used in a myriad of applications, a Variable Frequency Drive can be found operating ventilation systems, pumps, conveyors and machine tool drives.

4.2.5.1 **Advantages of a Variable Frequency Drive**

- Process temperature can be controlled without a separate controller
- Low maintenance
- Longer lifespan for the AC motor and other machinery
- Lower operating costs
  Equipment in the system that cannot handle excessive torque is protected
- energy saving
- Protection from electrical faults like short circuit in i/p or o/p circuits Etc.
- FWD/ Rev operations
- Speed control
- Smooth startup and controlling brake operations.
- controlled acceleration and deceleration which can be set by VFD parameters.

❖ There is no disadvantage of using VFD. Cost is the only factor.

### 4.2.6 Wound motor starting (liquid Resistance Starter)

- A slip ring motor cannot be started direct on-line with its rotor windings short-circuited; otherwise it would cause unacceptable current peaks. Resistors must therefore be inserted in the rotor circuit and then gradually short-circuited, while the stator is powered at full mains voltage.
- The resistance inserted in each phase is calculated to ascertain the torque-speed curve with strict accuracy. The result is that it has to be fully inserted on starting and that full speed is reached when it is completely short-circuited.

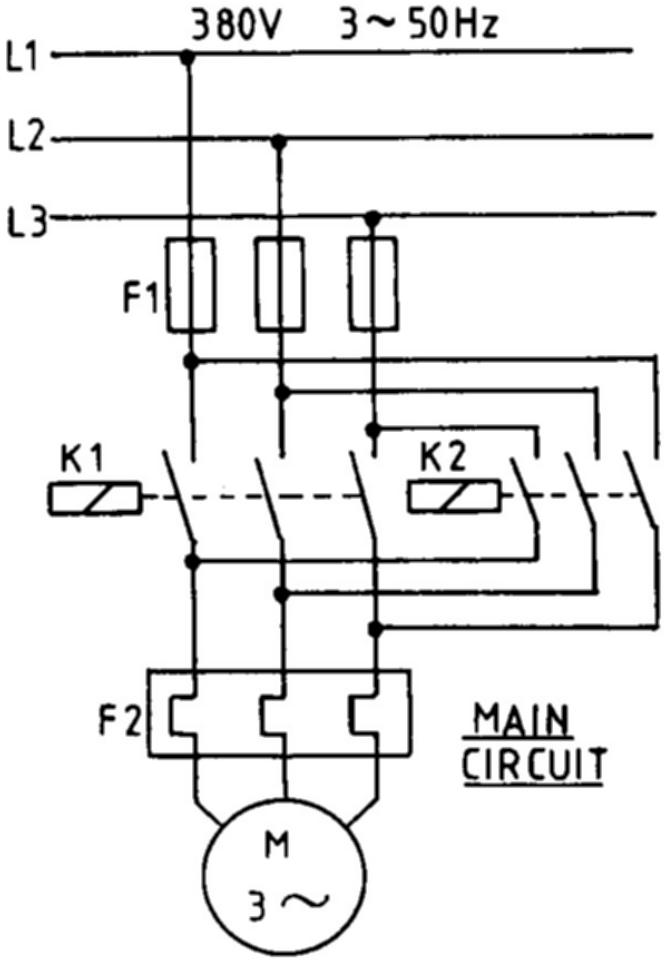
### 4.2.7 Direction changing circuit

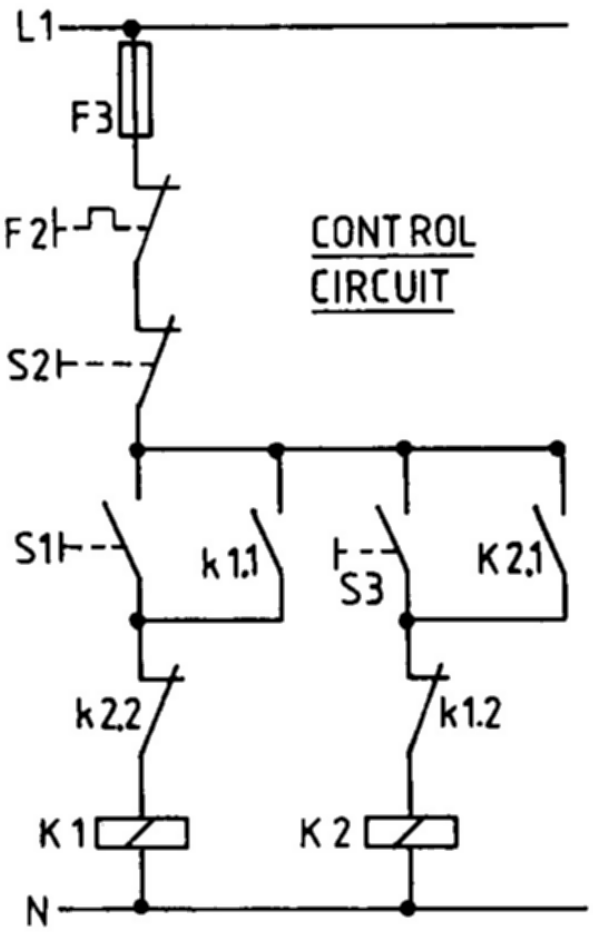
Direction changing circuits allow the direction of the rotation to be changed from clockwise to anti-clockwise (or vice versa). For example by pressing a push button Care must be taken, that both types of commands do not reach the motor simultaneously.

***There must therefore be an interlocking mechanism of either the contactors or the push button controls or even by both.***

The circuit below shows contactor interlocking.

S1 energizes the contactor K1 and the contact k1.2 opens and locks contactor K2. Contact k1.1 holds K1, bridging S1. Contactor K2 for anti-clockwise operation can only be energized by S3 after K1 has been de-energized via S2. Push button S3 then can be pressed to operate the motor anti-clockwise, simultaneously causing contact k2.2 to lock contactor K1, while k2.1 bridges S3 and holds K2.


380V 3~50Hz
L1
L2
L3
F1
K1
K2
F2
MAIN
CIRCUIT
M
3~


L1
F3
F2
CONTROL
CIRCUIT
S2
S1
k1.1
S3
K2.1
k2.2
k1.2
K1
K2
N

.

| Self-Check 4 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Choice The Best answer

1.Which one of the following is not true about direct on line motor control?

A. This is the most common starting method available in the market.

B.The components consist of two main contractor and thermal or electronic overload relay.

C. Current on starting = 5 to 8 rated Current.

D.The average starting torque is T on starting = 0.5 to 1.5 rated T

2. Which type of motor controlling circuit to change the direction a three phase induction machine rotation?

A.Direct on line motor controlling circuit. B. Forward Reverse motor controlling circuit.

C. Star Delta motor controlling circuit. D. All of them are correct.

3.Which one of the following is a particular kind of adjustable-speed drive that is used to control the speed of an AC motor

A. The Variable Frequency Drive B. The Fixed Frequency Drive

C. liquid Resistance Starter D. Wound motor starting

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-5 | Ongoing checks of quality of work |
|---|---|

## 5. Ongoing checks of quality of work

### 5.1 WORK TASK QUALITY INSPECTIONS

[Company Name] identifies a list of work tasks which will be quality controlled. Each work task is subject to a series of inspections; before, during, and after completion.

Each inspection verifies compliance with full scope of the relevant specifications; not limited to inspection form checkpoints.

The initial work task-ready inspection occurs when work is ready to start and ensures that work begins only when it does not adversely impact quality results.

Incoming material inspections verify that materials are as specified and meet all requirements necessary to assure quality results.

Work-in-process inspections continuously verify that work conforms to project specifications and quality expectations. Work continues only when it does not adversely impact quality results. At completion of the work task an inspection verifies that work has been completed in accordance with project quality requirements. Inspection results are recorded and maintained as part of the project files.

The Quality Manager identifies each Task that is a phase of construction that requires separate quality controls to assure and control quality results. Each Task triggers as set of requirements for quality control inspections before, during and after work tasks.

Independent quality audits are conducted to verify that the task quality controls are operating effectively.

Construction projects may execute a work task multiple times in a

project, in which case a series of quality inspections are required for each work task.

Independent quality control audits are conducted to verify that the task quality controls are operating effectively.

## 5.2 M. CONTROL OF CORRECTIONS AND NONCONFORMANCES

Should a problem occur in the quality of work, we systematically contain the issue and quickly make corrections. Our first action is to clearly mark the item by tape, tag, or other easily observable signal to prevent inadvertent cover-up.

Then we expedite a corrective action that brings the workmanship or material issue into conformance by repair, replacement, or rework. Previously completed work is reinserted for similar nonconformance.

In the event that we cannot correct the item to meet contract specifications, the customer will be notified and customer approval of corrective actions is required before proceeding. Fixing problems found is not sufficient. [Company Name] systematically prevents recurrences to improve quality. First enhanced controls and management monitoring are put into place to assure work proceeds without incident. Then using a structured problem solving process, [Company Name] identifies root causes and initiates solutions. Solutions may involve a combination of enhanced process controls, training, upgrading of personnel qualifications, improved processes, and/or the use of higher-grade materials. Follow-up ensures that a problem is completely resolved. If problems remain, the process is repeated.

Nonconformance and their resolution are recorded on a Nonconformance Report form. A Nonconformance Report form exhibit is included in this subsection.

## 5.3 MARKING OF NONCONFORMANCES AND OBSERVATIONS

When the Quality Manager, Project Foreman, inspector, or customer identifies a nonconformance or an observation, the item is quickly and clearly marked by tape, tag, or other easily observable signal to prevent inadvertent cover-up.

## 5.4 **CONTROL THE CONTINUATION OF WORK**

After the item is marked, the Project Foreman determines if work can continue in the affected area:

CONTINUE WORK: When continuing work does not adversely affect

quality or hide the defect, work may continue in the affected area while the disposition of the item is resolved. The Project Foreman may place Limitations on the continuation of work.

STOP WORK ORDER: When continuing work can adversely affect quality or hide the defect, work must stop in the affected area until the disposition of the item resolved. The Project Foreman identifies the Limits of the affected area. The Project Foreman quickly and clearly identifies the boundaries of the stop work area.

5.5 **RECORDING OF NONCONFORMANCES**

If nonconformance's or observed items exist by the work task completion inspection, the Project Foreman or inspector records the nonconformance's on a nonconformance report. The Project Foreman sends the nonconformance report to the Quality Manager.

Part II: Enumeration

Direction: Write/List down the following

1. ---------Is occur in the quality of work, we systematically contain the issue and quickly make corrections
2. list two types of CONTROL THE CONTINUATION OF WORK.
   - 2.1----------
   - 2.2----------

**Answer Sheet**

Score = _____

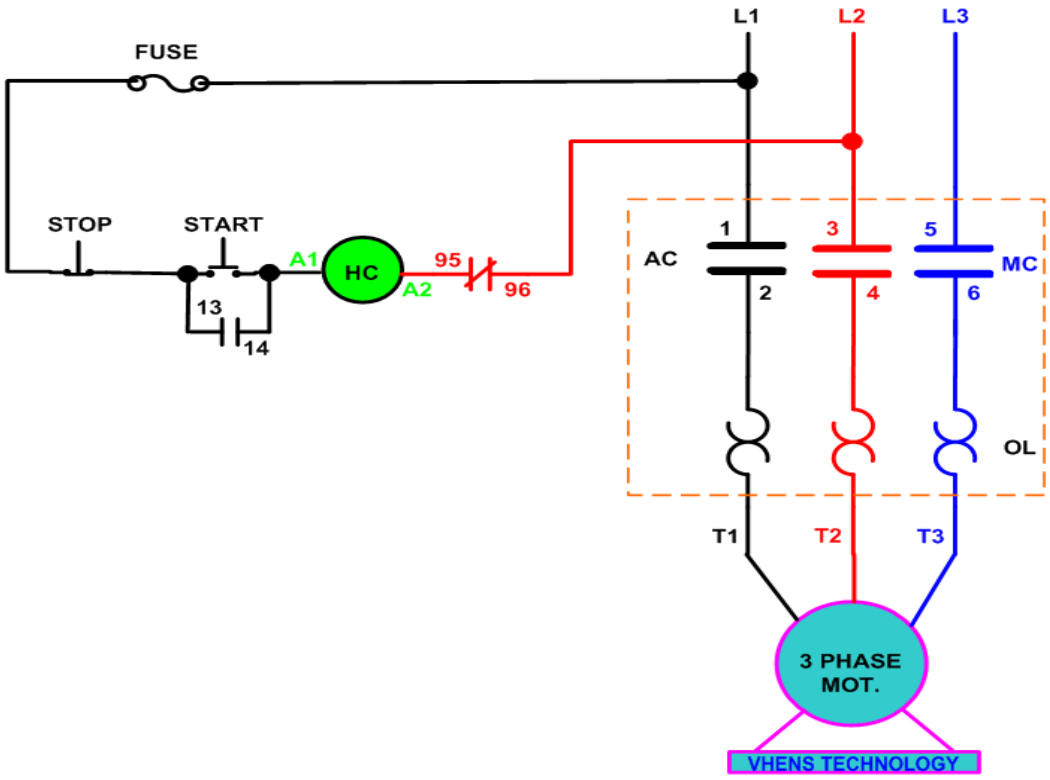
Rating: _____

Name: _____ Date: _____

| | |
|---|---|
| **Operation sheet :1** | |
| **Operation Title:** | Direct-on-line (DOL) motor control. |
| **Purpose:** | To construct and test a DOL motor starter. |

**Procedures:**

8. **Select the required components and arrange them on the working table.**
9. **Test the components using continuity tester. (Whether NO contacts are open and NC contacts are closed)**
10. **Connects the components as shown below.**




| | |
|---|---|
| **Precaution:** | 3. **Be sure your hands are dry when you are working with electricity. You may get electrical shock.**<br>4. **Turn off the power and disconnect the cord before making any adjustment on the circuits.**<br>5. **Each time you use instrument, be sure to check functions selected and ranges.** |
| **Quality Criterion:** | • **Safe work exercise.**<br>• **Neat and clear circuit constructed.**<br>• **Circuit operated correctly.** |

| Operation sheet :2 | |
|---|---|
| **Operation Title** | Starting-Stopping-Reversing manually using 1 NO + 1 NC Push Buttons |
| **Purpose** | To change direction of rotation of three phase induction motor in safe way. |

Procedures: -

1. Read the given control and power Starting-Stopping Reversing manually circuit.
2. Prepare cables/ wires and mounting rail according to circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button
8. Test the output on the motor terminals by use of Multimeter.
9. Do commissioning of an electrical motor circuit.
10. Connect both power and control circuit as shown in the figure.

Precautions: - Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

Quality criteria:-

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. The motor operate correctly

| Operation sheet :3 | |
|---|---|
| **Operation Title** | **Start Forward-Reverse-Forward-Reverse and so on Automatically Using Timers** |
| **Purpose** | To change direction of rotation of three phase induction motor in safe way with timer. |

**Procedures: -**

1. Read the control and power Start Forward-Reverse-Forward-Reverse circuit.
2. Prepare cables/ wires and mounting rail according to circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button.
8. Test the output on the motor terminals by use of multimeter
9. Do commissioning of an electrical motor circuit.

Precautions: - Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

Quality criteria:-

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. the motor operate correctly

| Operation sheet :4 | |
|---|---|
| **Operation Title** | **Sequence Starting of Two Motors Manually** |
| **Purpose** | operate three phase induction motor in sequence. |

**Procedures: -**

1. Read the given control and power Circuit.
2. Prepare cables/ wires and mounting rail according circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button.
8. Test the output on the motor terminals by use of multimeter.
9. Do commissioning of an electrical motor circuit.
10. Connect both power and control circuit according to circuit diagram.

Precautions: - Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

**Quality criteria:-**

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. the motor operate correctly

| Operation sheet :5 | |
|---|---|
| **Operation Title** | **Sequence Starting of Two Motors automatically with time delay** |
| **Purpose** | To operate three phase induction motor in sequence automatically. |

**Procedures: -**

1. Read the control and power circuit of Sequence Starting of Two Motors automatically with time delay.
2. Prepare cables/ wires and mounting rail according to circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button.
8. Test the output on the motor terminals by use of multimeter.
9. Do commissioning of an electrical motor circuit.
10. Connect both power and control circuit

**Precautions: -** Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

**Quality criteria:-**

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. the motor operate correctly
5. neatness/good looking

| Operation sheet :6 | |
|---|---|
| **Operation Title** | Automatic Star – Delta Starter with contactors |

| | |
|---|---|
| **Purpose** | To start three phase induction motor safely by decreasing the starting current of the motor. In Star – Delta Starter *the line voltage is reduced to 220v from 380v. This means 58% of the line voltage is reduced there by reducing the starting current. After it is changed to delta, the motor takes full voltage i.e 380v.* |

**Procedures: -**

1. Read the given control and power circuit of automatic Star – Delta Starter with contactors.
2. Prepare cables/ wires and mounting rail according to circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button.
8. Test the output on the motor terminals by use of multimeter.
9. Do commissioning of an electrical motor circuit.
10. Connect both power and control circuit.

**Precautions: -** Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

**Quality criteria:-**

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. the motor operate correctly
5. neatness/good looking

| Operation sheet :7 | |
|---|---|
| **Operation Title** | Dahlander pole changing two speed circuit |
| **Purpose** | Change the speed of three phase induction motor by changing the pole of the motors. |

**Procedures: -**

1. Read the given control and power circuit of Dahlander pole changing two speed circuit.
2. Prepare cables/ wires and mounting rail according to circuit diagram.
3. Install cables, wires, mounting rail and push button holder (if any) on the installation board according to the installation drawing.
4. Fix or mount contactor, over load relay, circuit breakers, and push buttons and block terminals according to drawing.
5. Perform the wiring of the circuit according to drawing.
6. Connect the power supply cables.
7. Test the correct function of the circuit by operating it with push button.
8. Test the out put on the motor terminals by use of multimeter.
9. Do commissioning of an electrical motor circuit.
10. Connect both power and control circuit.

**Precautions: -** Do not start the motor without circuit breaker. Do not start the motor without permission of instructor. If a tool is defective, remove it from service, and tag it clearly "Out of service for repair". Replace damaged tools immediately and do not use defective tools "temporarily". Never test a cutting edge with your fingers, test on a scrap material instead. Never use any tool, hand or power tool unless you are trained to do so and are familiar with its use Keep cutting edges sharp.

**Quality criteria:-**

1. Reading the circuit properly.
2. Safety procedures were followed
3. All hand tools were cleaned
4. the motor operate correctly
5. neatness/good looking

| Lap Test-1 | Installing manual control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.
Task 1- Installing Starting-Stopping-Reversing manually using 1 NO + 1 NC Push Buttons

| Lap Test-2 | Installing Magnetic control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour

**Task 2- Installing direct on line motor control circuit.**

| Lap Test-3 | Installing Magnetic control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour
**Task 3- Installing** Forward-Reverse and so on Automatically Using Timers

| Lap Test-4 | Installing manual control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour

Task 4-Installing Sequence Starting of Two Motors Manually

| Lap Test-5 | Installing Magnetic control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour

Task 5- Installing Sequence Starting of Two Motors automatically with time delay

| Lap Test-6 | Installing manual control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour

Task 6- Installing Automatic Star – Delta Starter with contactors

| Lap Test-7 | Installing Magnetic control switch |
|---|---|

Name: _____ Date: _____
Time started: _____Time finished: _____
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour

**Task 7- Installing** Dahlander pole changing two speed circuit

| | | |
|---|---|---|
| | **OTHER REFERENCES** | **Performing Installation of Motor Controller System** |


1. Basics of Motor Control Centers..Centers.. series,. Siemens

2. Industrial Motor control Laboratory

3. Cutler-Hammer: LEARNING MODULE 19: STARTERS AND. CONTACTORS

4. **Contact: First Time Quality 410-451-8006**

| Instruction Sheet | LG24: Notify completion of work |
|---|---|

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

- Immediate Superior work completion
- work Performance Test

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Notify immediate superior upon completion of work.
- Made Performance tests to ensure that work conforms to instructions and job Requirements

**Learning Instructions:**

19. Read the specific objectives of this Learning Guide.
20. Follow the instructions described below 3 to 6.
21. Read the information written in the information “Sheet 1and Sheet 6,-” **in page 3-4 and 6-7** respectively.
22. Accomplish the “Self-check 1, Self-check 2 **in page 5 and 8** respectively
23. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page**
24. Do the “LAP test” **in page**

| **Information Sheet-1** | Notify immediate superior upon completion of work. |
|---|---|

# 1. Notify completion of work

## 1.1 Introduction to notify completion of work

Definition: Written notice issued by the owner of a project (or his or her agent) to notify concerned parties that all work on the project has been completed. This notice also sets the period within which concerned parties may exercise their lien rights against one another. OR

Notice of Completion:

A document recorded by a property owner to notify potential Mechanics Lien claimants that a specific construction project has been completed. The effect of a properly recorded Notice of Completion is to reduce the time in which a subcontractor, material supplier or general contractor can record a Mechanics Lien against a private works construction project.

## 1.2 Works completion

This concept is not defined nor is there any set date but it follows from practical completion. The process starts with the principal agent issuing a works completion list to the contractor which details defective and incomplete work present at

practical completion but which are not required to achieve practical completion. The contractor must remedy the defects in this list in order to achieve works completion.

Once the contractor has addressed all incomplete and defective items on the 'works completion list' he must notify the principal agent to inspect these items, and if satisfied, issue a certificate of works completion. If the principal agent remains unsatisfied then he is required to identify which items have not been completed or rectified to his satisfaction and the contractor must carry out the rectification and completion procedure again in accordance with sub-clause. This procedure may be repeated several times until the principal agent is satisfied that all the items on the work completion list have been appropriately addressed.

Alternatively, should the principal agent not issue a works completion list within 5 working days of the date of practical completion the contractor is obliged to notify both the employer and principal agent in this regard and the principal agent is required to submit a works completion list within 5 working days of receipt of the contractor's notice. Should the principal agent fail to submit the works completion list thereafter, works completion shall be deemed to have been achieved on the expiry of the initial 5 working day period after the issue of the certificate of practical completion.

The only evident incentives that exist for the contractor in relation to works completion is that the contractor has 20 working days to complete and / or rectify the items on the works completion list in order not to forego compensatory interest on the value of outstanding work . The issue of the works completion certificate marks the commencement of the 90 calendar day defects liability period. (NB The Contractor is not entitled to compensatory interest on the value of outstanding work).

### 1.3 Final completion

At the end of the defects liability period, or when the contractor believes the defects liability period has come to an end, he must submit a notice to the principal agent who is obliged to inspect the works within the period specified in order to determine whether any defects are present. Should any defects be identified, the principal agent is obliged to provide the contractor with a defects list, which have arisen during the defects liability period and which the contractor must rectify in order to achieve final completion of the works.

Similarly, as provided for under works completion, if the principal agent does not issue a defects list within the period prescribed of 5 working days from the end of the defects liability period, the contractor is obliged to notify both the employer and principal agent in this regard and the principal agent is required to submit the defects list within 5 working days of receipt of the contractor's notice. Should the principal agent fail to submit the works completion list thereafter, final completion

shall be deemed to have been achieved on the expiry of the initial 5 working day period after the end of the defects liability period.

The achievement of final completion by the contractor has the following consequences:

• all the contractor's liabilities and obligations in relation to a subcontractor's defects comes to an end and any remaining portion of the subcontractor's defects period is agreed and assumed by the employer ;

• All guarantees, warranties and indemnities provided by the contractor, subcontractors and suppliers are ceded to the employer on the date which the certificate of final completion is issued; and

• The certificate of final completion constitutes conclusive evidence as to the sufficiency of the works and that the contractors obligations have been fulfilled other than latent defects.

### 1.5 Conclusion

Practical completion, works completion and final completion deal exclusively with the construction period. Once the contractor has achieved final completion he still retains certain obligations in relation to the latent defects liability period. The latent defects liability period commences when construction begins and ends 5 years after the date when final completion was achieved.

| Self-Check 1 | Written Test |
|---|---|

**Part I: Enumeration**

**Direction:** Write on blank space/List down the following

. 1. List the achievement of final completion by the contractor:

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| **Information Sheet-2** | Work Performance Test |
|---|---|

## 2. Work Performance Test

### 2.1 Purpose

This procedure establishes the minimum requirements for lockout of energy sources that could cause injury to personnel. All employees shall comply with the procedure.

### 2.2 Responsibility

The responsibility for seeing that this procedure is followed is binding upon all employees. All employees shall be instructed in the safety significance of the lockout procedure by (designated individual). Each new or transferred affected employee shall be instructed by (designated individuals) in the purpose and use of the lockout procedure.

### 2.3 Preparation for Lockout

Employees authorized to perform lockout shall be certain as to which switch, valve, or other energy isolating devices apply to the equipment being locked out. More than one energy source (electrical, mechanical, or others) may be involved. Any questionable identification of sources shall be cleared by the employees with their supervisors. Before lockout commences, job authorization should be obtained.

### 2.4 Sequence of Lockout Procedure

1. Notify all affected employees that a lockout is required and the reason therefore.
2. If the equipment is operating, shut it down by the normal stopping procedure (such as: depress stop button,

   Open toggle switch).
3. Operate the switch, valve, or other energy isolating devices so that the energy source(s) (electrical, Mechanical, hydraulic, other) is disconnected or isolated from the equipment.
4. Lockout energy isolating devices with an assigned individual lock.
5. Stored energy, such as that in capacitors, springs, elevated machine members, rotating fly wheels, hydraulic systems, and air, gas, steam or water pressure, must also be dissipated or retained by methods

such as grounding, repositioning, blocking, bleeding down.

6. After ensuring that no personnel are exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate. CAUTION: Return operating controls to neutral position after the test.

7. The equipment is now locked out.

## 2.5 Restoring Equipment to Service

1. When the job is complete and equipment is ready for testing or normal service, check the equipment area to see that no one is exposed.

2. When equipment is clear, remove all locks. The energy isolating devices may be operated to restore energy to equipment.

## 2.6 Procedure Involving More Than One Person

In the preceding steps, if more than one individual is required to lock out equipment, each shall place his/her own personal lock on the energy isolating device(s). One designated individual of a work crew or a supervisor, with the knowledge of the crew, may lock out equipment for the whole crew. In such cases, it may be the responsibility of the individual to carry out all steps of the lockout procedure and inform the crew when it is safe to work on the equipment. Additionally, the designated individual shall not remove a crew lock until it has been verified that all individuals are clear.

## 2.7 Rules for Using Lockout Procedure

All equipment shall be locked out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy isolating device bearing a lock.

| Self-Check 2 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write/List down the following

**1.** List two types of Restoring Equipment to Service.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| | | |
|---|---|---|
| | **OTHER REFERENCES** | **For notify compilation work** |

**1.** SAMPLE 1 - GENERAL LOCKOUT/TAGOUT PROCEDURE

| Instruction Sheet | LG25: Clean-Up |
|---|---|

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

- Checking and maintaining tools and equipment
- Clean work area
- Returning Surplus Materials

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Clear and materials dispose of, reuse or recycle work area in accordance with legislation/regulations/codes of practice and job specification
- clean, check, maintain and store plant, tools and equipment in accordance with manufacturers' recommendations and standard work practices
- Return Surplus materials to warehouse

**Learning Instructions:**

25. Read the specific objectives of this Learning Guide.
26. Follow the instructions described below 3 to 6.
27. Read the information written in the information "Sheet 1, Sheet 2and Sheet 3,-" **in page 3-4, 6-9 and 11-12** respectively.
28. Accomplish the "Self-check 1, Self-check 2 and Self-check 3 **in page 5,10 and 13** respectively
29. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page**
30. Do the "LAP test" **in page**

| **Information Sheet-1** | Checking and maintaining tools and equipment |
|---|---|

1. Checking and maintaining tools and equipment

1.1 TOOL WORK HABITS

LEARNING OBJECTIVES: Describe the Tool Control Program. List several good tool work habits. "A place for everything and everything in its place" is just good common sense. You can't do an efficient repair job if you have to stop and look around for each tool you need. The following rules will make your job easier and safer.

1.2 KEEP EACH TOOL IN ITS PROPER STOWAGE

PLACE. All divisions have incorporated a Tool Control Program as directed by the Aircraft Launch and Recovery Equipment Maintenance Program (ALREMP).

The Tool Control Program is based on the concept of a family of specialized tool boxes and pouches configured for instant inventory before and after each maintenance action. The content and configuration of each container is tailored to the task, work center, and equipment maintained. Work center containers are assigned to and maintained within a work center. Other boxes and specialized tools are checked out from the tool control center (tool room).

Keep your tools in good condition. Protect them from rust, nicks, burrs, and breakage.

Keep your tool allowance complete.

When you are issued a toolbox, each tool should be placed in it when not in use. When the toolbox is not actually at the work site, it should be locked and stored in a designated area.

1.3 USE EACH TOOL ONLY FOR THE JOB IT WAS DESIGNED TO DO.

Each particular type of tool has a specific purpose. If you use the wrong tool when performing maintenance or repairs, you may cause damage to the equipment you're working on or damage the tool itself. Remember, improper use of tools results in improper maintenance. Improper maintenance results in damage to equipment and possible injury or death to you or others.

1.4 SAFE MAINTENANCE PRACTICES

Always avoid placing tools on or above machinery or an electrical apparatus. Never leave tools unattended where machinery or aircraft engines are running.

1.5 NEVER USE DAMAGED TOOLS.

A battered screwdriver may slip and spoil the screw slot, damage other parts, or cause painful injury. A gauge strained out of shape will result in inaccurate measurements.

Remember, the efficiency of craftsmen and the tools they use are determined to a great extent by the way they keep their tools. Likewise, they are frequently judged by the manner in which they handle and care for them. Anyone watching skilled craftsmen at work notices the care and precision with which they use the tools of their trade. The care of hand tools should follow the same pattern as for personal articles; that is, always keep hand tools clean and free from dirt, grease, and foreign matter. After use, return tools promptly to their proper place in the toolbox. Improve your own efficiency by organizing your tools so that those used most frequently can be reached easily without digging through the entire contents of the box. Avoid accumulating unnecessary junk

1.6 CARE OF HAND TOOLS LEARNING OBJECTIVES: List several principles that apply to the care of hand tools.

Tools are expensive; tools are vital equipment. When the need for their use arises, common sense plus a little preventive maintenance prolongs their usefulness. The following precautions for the care of tools should be observed:

• Clean tools after each use. Oily, dirty, and greasy tools are slippery and dangerous to use.

• NEVER hammer with a wrench.

• NEVER leave tools scattered about. When they are not in use, stow them neatly on racks or in toolboxes.

• Apply a light film of oil after cleaning to prevent rust on tools.

• INVENTORY tools after use to prevent loss.

1.7 MAINTENANCE AIDS

LEARNING OBJECTIVES: Read and interpret blueprints, drawings, diagrams, and other maintenance aids. As an ABE you will be required to read blueprints and drawings during the performance of many maintenance actions required to maintain the operational readiness of the catapults and the arresting gear engines. As you advance in rating you may also be required to make sketches and drawings, which will assist you in the training of less-experienced maintenance personnel by making it possible for them to visualize the system or object you are explaining.

1.8 BLUEPRINTS AND DRAWINGS

Blueprints are exact copies of mechanical or other types of drawings and employ a language of their own. It is a form of sign language or shorthand that uses lines, graphic symbols, dimensions, and notations to accurately describe the form size, kind of material, finish, and construction of an object. It can be said that blueprint reading is largely a matter of translating these lines and symbols into terms of procedure, materials, and other details needed to repair, maintain, or fabricate the object described on the print. Usually you can look at a blueprint and recognize the object if you are familiar with the actual part. But when you are required to make or check on a certain part, the applicable blueprint must be referred to in order to get dimensions and other pertinent information. The important thing is to know what the different symbols stand for and where to look for the important information on a blueprint. Some of the important facts listed on all blueprints are discussed in the following paragraphs.

| Self-Check 1 | Written Test |
|---|---|

**Part I:**

**Enumeration**

**Direction:** If the statement is correct write TRUE if the statement is in correct write FALSE

_____1.Good general ventilation plus local exhaust ventilation to remove air contaminants at the source.

_____ 2. Keep your tools in good condition. Protect them from rust, nicks, burrs, and breakage.

_____ 3. Always avoid placing tools on or above machinery or an electrical apparatus.

_____ 4. Remember, improper use of tools results in improper maintenance.

_____5. Use each tool only for the job it was designed to do.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-2 | Clean work area |
|---|---|

**2. Clean work area**

Work station is defined as an area, in an office, outfitted with equipment and furnishings for one or more workers. Normally leather goods are operated in awork shop therefor e the work station for a leather goods worker would be the workshop. It is necessary for a worke r to prepare his work station and the pieces to bedone but before doing so a worker should be w ell aware of the safety rules andregulations.

**2.1 Housekeeping**

Good housekeeping involves every phase of industrial operations and should apply throughout the entire premises, indoors and out. It is more than mere cleanliness. It requires orderly conditions, the avoidance of congestion, and

attention to such details as an orderly layout of the whole workplace, the markingof aisles, ade quate storage arrangements, and suitable provision for cleaning and maintenance.
Efficient production and a good working environment are complementary. Theelimination of inefficiencies and accident hazards caused by unfavorable conditions in and about the workplace is essential in getting the job done properly and safely. The attention to these important details—which may be overlooked when management's attention is concentrated upon such amenities as good cloakrooms, canteens, rest rooms, recreational facilities, etc.—is widely referred to as "good housekeeping.
A clean, well-ordered, attractive work environment sets the tone of your establishment. It encourages tidy work habits in employees. It helps reduce fatigue. It promotes good worker-management relations. It also gives a lift to morale, which is reflected in the quality of production and overall efficiency. Good housekeeping is also a good advertisement for your company. Customers and clients have more confidence in an organization when they we work being carried out efficiently in clean, pleasant, well ordered surroundings. There's an even more important reason why good housekeeping matters — it makes the undertaking a safer place to work in.
Good housekeeping is a vital factor in preventing accidents. The great majority of all work accidents are caused during the handling of goods or materials, and by people falling, being hit by falling objects, or striking against objects in the workplace. All these causes can be reduced by good housekeeping practices in fact; good housekeeping is the only cure for hundreds of accidents that occur.
Here are some kinds of accidents commonly caused by *bad* housekeeping:

- Tripping over loose objects on floors, stairs and platforms
- Articles dropping from above
- Slipping on greasy, wet or dirty surfaces
- Striking against projecting, poorly stacked, or misplaced material
- Tearing the hands or other parts of the body on projecting nails, wire, steel strapping on bales or crates, etc.

Typical examples of poor housekeeping that lead to these accidents are:

- Excessive material, waste or chips in the working area
- Congested aisles
- Tools left on machines
- Waste containers overflowing
- Lockers and workrooms in disorder
- Acids in open containers

- Broken glass
- Electric leads or air lines across aisles
- Dirty light fittings, windows and skylights

Where housekeeping is bad, fire is a constant hazard. It can be caused by many

housekeeping problems such as oil-soaked rags and clothing igniting from spontaneous combustion; dust collectors not being properly or frequently cleaned; or piles of paper and other packing materials being allowed to accumulate. Poor housekeeping can also lead to infestation by pests such as rodents and cockroaches and create serious health risks.

### 2.2 Elements of a Good Housekeeping

The following are the basic elements of a good housekeeping:

- **Aisles**: Wide enough for traffic movements, marked off by floor lines from work positions and storage areas.
- **Space:** Insuring sufficient room for the individual to work.
- **Storage**: Adequate and convenient space for materials and tools.
- **Materials Handling**: Layout planned for materials flow, with efficient methods and equipment.
- **Ventilation**: Good general ventilation plus local exhaust ventilation to remove air contaminants at the source.
- **Floors and Walls**: They need to be constructed with materials that are easy to clean and if needed easy to repair.
- **Lighting** Welldistributed artificial light and effective use of available daylight.
- **Amenities**: Clean, up-to date washrooms and lockers for clothing, and clean and inviting lunch room for employees to eat their meals.
- **Waste Removal**: Adequate facilities to prevent congestion and disorr.

**Let us look at some of these elements in detail:**

**Keep Aisles Clear**: Aisle space should be reserved for the movement ofpersonnel, products and materials. It should be kept clean and clear and shouldnever be used for "bottleneck" or "overflow'' storage. This also applies to passageways and emergency exits. Blind corners should be eliminated or beadequately protected by warning signs.

Aisle boundary markings should be drawn to show clearly the space which has been reserved for traffic. Markings should be sufficiently wide (say a minimum of 30 mm) and of a color to make them clearly visible. Paint or durable plastic strips can be used.

**Improve Storage Facilities**: Tidiness and order are essential in overcoming storage problems, both in storerooms and in the yard. Good storage utilizes air space instead of floor space, and also saves time-wasting delays. It's important to prevent stores and scraps accumulating on the floor and around machines. Never keep more stores and materials than necessary near machines and provide

proper facilities (such as bins, shelves, boxes, racks, etc.) in which to store them.
**Keep Floors Clean**: Every year thousands of work injuries are caused by people falling. Floor conditions are responsible for many of these accidents. When floors are given the right treatment they are much easier to keep clean and hygienic.Spilt oil and other liquids should be cleaned up at once. Chips, shavings, dust,and similar w astes should never be allowed to accumulate. They should beremoved frequentl y, or better still, be suitably trapped before they reach the floor
**Paint the Walls**: Paint is one of the cheapest means of renovating walls, and a fresh coat of paint can give a boost to morale. Light-colored walls reflect light. Dirty or dark-colored walls absorb light. Dirty walls have a depressing effect and encourage dirty habits and sloppy attitudes. Choose suitable colors to paint walls, ceilings and working surfaces. See that the paintwork is cleaned down periodically. Color can be harnessed to assist with safety. For example it can be used to warn of physical hazards and to mark obstructions such as pillars. Painting handrails, machine guards and other safety equipment renders them distinctive and also prevents rust. Color can be used to highlight the hazardous parts of machinery but it can never substitute for a needed guard.
**Maintain Light Fittings**: Attention to light fittings should be an integral part of any good housekeeping programme. Dirty lamps and shades, and lamps whose output has deteriorated with use, deprive employees of essential light. It's been found that lighting efficiency may be improved by 20 to 30 percent simply by cleaning the lamps and reflectors.
**Clean the Windows**: Clean windows let in light; dirty ones keep it out. Insufficient light causes eye strain and leads to accidents because employees are unable to see properly. Ensure that windows are not blocked by stacked
**Dispose of Scrap and Prevent Spillage:** It's a common practice to let the floor catch all the waste and then spend time and energy cleaning it up. It is obviously better to provide convenient containers for scrap and waste and educate employees to use them. Safety will benefit, expense will be saved, and the factory will be a better place in which to work. Oily floors are a common accident and fire hazard. Splash guards and drip pans should be installed wherever oil spills or drips may occur. Prevent accidents by keeping oil and grease off the floor.
**Get Rid of Dust and Dirt:** In some jobs, dust, dirt, chips, etc., are unavoidable. If they can't be collected as part of the process (e.g. by enclosure and exhaust methods) you need a way to clean them up. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt collect. If light dust is removed by sweeping, floors should be dampened first rather than swept dry. Oiling floors occasionally with light oil helps to lay the dust but take care that slipping hazards do not occur. Remember, it is not only floors

that need sweeping. Dust and grime also collect on ledges, shelves, piping, conduits, lamps, reflectors, windows, cupboards, lockers, and so on and all these places need attention.

| Self-Check 2 | Written Test |
|---|---|

**Part II: Enumeration**

**Direction:** Write/List down the following

**1.** ----------is defined as an area, in an office, outfitted with equipment and furnishings for one or more workers.

**2.** List at list five the basic elements of a good housekeeping.

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

| Information Sheet-3 | Returning Surplus Materials |
|---|---|

# 3. Returning Surplus Materials

## 3.1 How to Handle Surplus Materials after an Installation Is Completed

**SUMMARY**

The Installed Sales contract has been updated with a new Certificate of Completion (COC), which explains the customer's options for handling surplus materials left over from an Installed Sales project. The customer must decide how they want to handle surplus materials, and indicate their choice by initialing beside it on the COC.
Only **unused receipted** surplus materials may be offered to customers, as clarified below.

- Customer has the option to receive some or all **unused, receipted** surplus
- materials from their installation Customer does **NOT** have the option to receive items not listed on the installed sales contract or receipt
- ***Examples***: tack strip for carpet installs, caulking and shims for door installs, fasteners for roofing and cabinet installs, countertop scrap cutouts for countertop installs, and installer-supplied lumber materials used for storage building installs

**Note**: It is still the installer's responsibility to remove and properly dispose of scraps and waste materials as part of the normal job site clean-up.

## 3.2 **SURPLUS MATERIAL OPTIONS on the COC**

The customer must choose one of the 3 surplus material options on the COC by initialing beside it; see below.
**Note:** A signed COC will be considered incomplete unless the customer initials beside 1 of the 3 options.
**Option 1: _____ There were no such surplus materials**
*Example*: There were no surplus materials, because all receipted product was used during the installation.
**Option 2: _____ I accepted all surplus materials I wanted**
*Example*: At completion of install, there were unused receipted materials, and the customer accepted Lowe's offer to give them the surplus materials. (The customer marks this option if they want to keep some or all surplus materials, **OR** if they want to receive return credit or a refund for some or all of the surplus materials. [If so, the items need to be transported to the store for the customer and processed as a return under Lowe's Return Policy.])

**Option 3: _____ I declined to receive any surplus materials**

*Example*: At completion of install, there were unused receipted materials, and the customer decided not to accept Lowe's offer to give them the surplus materials. (The customer marks this option if they do not want to keep any of the surplus materials and they do not want to receive return credit or a refund for some or all of the surplus materials. [The unused receipted items must be transported to the store for the customer and processed/handled, but no credit or refund will be given to the customer.])

**3.3 INSTRUCTIONS for INSTALLER RETURNING SURPLUS MATERIALS to the STORE**

1. Installer transports unused receipted surplus material from job site to the store.
2. The Manager on Duty (MOD), Department Manager of Installed Sales (DMIS), or Installed Sales Coordinator ( ISC) must log into an LRT or Genesis to create an MR for the returned surplus material.
3. Once the MR has been submitted, the MOD must approve the MR.
4. Installer will be given a copy of the MR Worksheet.

***Note:*** Installers returning product to the store must obtain a copy of the MR worksheet. This will serve as proof of the return.

| Self-Check 3 | Written Test |
|---|---|

**Part III: Enumeration**

**Direction:** Write on the blank space/List down the following

**1. List Three OPTIONS SURPLUS MATERIAL on the COC.**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____