DRAFT

Consumer Energy Meter Technician

(Job Role)

Qualification Pack: Ref. Id. PSS/Q0107

Sector: Power

Textbook for Class X

विद्यया ऽमृतमश्नुते

एन सी ई आर टी
NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

FOREWORD

The National Curriculum Framework–2005 (NCF–2005) recommends bringing work and education into the domain of the curricular, infusing it in all areas of learning while giving it an identity of its own at relevant stages. It explains that work transforms knowledge into experience and generates important personal and social values such as self-reliance, creativity and cooperation. Through work one learns to find one's place in the society. It is an educational activity with an inherent potential for inclusion. Therefore, an experience of involvement in productive work in an educational setting will make one appreciate the worth of social life and what is valued and appreciated in society. Work involves interaction with material or other people (mostly both), thus creating a deeper comprehension and increased practical knowledge of natural substances and social relationships.

Through work and education, school knowledge can be easily linked to learners' life outside the school. This also makes a departure from the legacy of bookish learning and bridges the gap between the school, home, community and the workplace. The NCF – 2005 also emphasises on Vocational Education and Training (VET) for all those children who wish to acquire additional skills and/or seek livelihood through vocational education after either discontinuing or completing their school education. VET is expected to provide a 'preferred and dignified' choice rather than a terminal or 'last-resort' option.

As a follow-up of this, NCERT has attempted to infuse work across the subject areas and also contributed in the development of the National Skill Qualification Framework (NSQF) for the country, which was notified on 27 December 2013. It is a quality assurance framework that organises all qualifications according to levels of knowledge, skills and attitude. These levels, graded from one to ten, are defined in terms of learning outcomes, which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The NSQF sets common principles and guidelines for a nationally recognised qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities.

It is under this backdrop that Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, a constituent of NCERT has developed learning outcomes based modular curricula for the vocational subjects from Classes IX to XII. This has been developed under the Centrally Sponsored Scheme of Vocationalisation of Secondary and Higher Secondary Education of the Ministry of Human Resource Development.

This textbook has been developed as per the learning outcomes based curriculum, keeping in view the National Occupational Standards (NOS) for the job role and to promote experiential learning related to the vocation. This will enable the students to acquire necessary skills, knowledge and attitude.

I acknowledge the contribution of the development team, reviewers and all the institutions and organisations, which have supported in the development of this textbook.

NCERT would welcome suggestions from students, teachers and parents, which would help us to further improve the quality of the material in subsequent editions.

HRUSHIKESH SENAPATY
Director
National Council of Educational
Research and Training

New Delhi
June 2018

About the Textbook

Power is one of the most critical components of infrastructure and crucial for the welfare of the nation. The power sector plays a vital role in the economic growth and human development of any country. Electricity consumption is one of the most important indices for measuring the development level of a nation.

India has the fifth largest power generation capacity in the world. The country ranks third globally in terms of electricity production. As per the 13th Five Year Plan, India is targeting a total of 100GW of power capacity addition by 2022. In order to meet the increasing demand for electricity in the country, massive addition to the installed generating capacity is required for efficient and effective production of goods and services along with skilled manpower.

A Consumer Energy Meter Technician manages the installation, repair and maintenance of electrical fittings and fixtures. The textbook for the job role of 'Consumer Energy Meter Technician' has been developed to impart knowledge and skills through hands-on-learning experience, which forms a part of the experiential learning. Experiential learning focusses on the learning process for the individual. Therefore, the learning activities are student-centred rather than teacher-centred.

This textbook has been developed with the contribution of the expertise from the subject and industry experts and academicians for making it a useful and inspiring teaching-learning resource material for the students of vocational education. Adequate care has been taken to align the content of the textbook with the National Occupational Standards (NOSs) for the job role so that the students acquire necessary knowledge and skills as per the performance criteria mentioned in the respective NOSs of the Qualification Pack (QP). The textbook has been reviewed by experts so as to make sure that the content is not only aligned with the NOSs, but is also of good quality.

The NOSs for the job role of Consumer Energy Meter Technician covered through this textbook are as follows:

1. PSS/N0114/N0301 Manually remove, change and install low voltage, single- and 3-phase meters
2. PSS/N2001 Use basic health and safety practices at workplace
3. CSC/N1336 Work effectively with others

Unit 1 of the textbook talks about electricity and its uses. Unit 2 focusses on handling tools and equipment used by a Consumer Energy Meter Technician. Unit 3 deals with the electrical wiring components and accessories and Unit 4 discusses the energy meter, its types and uses.

SAURABH PRAKASH
Professor
Department of Engineering and Technology

TEXTBOOK DEVELOPMENT TEAM

MEMBERS

Gaurav Kathel, *Consultant*, Department of Engineering and Technology, PSSCIVE, Bhopal

R. Vishwanathan Iyer, *Deputy General Manager* (Retd), Madhya Pradesh Electricity Board, Bhopal

Sandeep Ratnere, *Work Education Teacher*, Regional Institute of Education, Shyamla Hills, Bhopal

S.P. Tiwari, *Lecturer*, Government Excellent Higher Secondary School, Bina

Sunanda Kumari, *Assistant Programmer*, Oriental Institute of Science and Technology, Bhopal

MEMBER-COORDINATOR

Saurabh Prakash, *Professor*, Department of Engineering and Technology, PSSCIVE, NCERT, Bhopal

ACKNOWLEDGEMENTS

The National Council of Educational Research and Training (NCERT) expresses its gratitude to the members of the Project Approval Board (PAB) and the officials of the Ministry of Human Resource Development (MHRD), Government of India for the financial support to the project for development of learning outcome based curricula.

The Council acknowledges the contribution of the Review Committee members — K.L. Bhatia, *Professor* (Retd.), NCERT; Kanihya Lal, *Professor* (Retd), NCERT, and V.P. Srivastava, *Professor* (Retd), NCERT for sharing their expertise and time. The Council would also like to thank Rajesh Khambayat, *Joint Director*, PSS Central Institute of Vocational Education (PSSCIVE), Bhopal for providing support and guidance in the development of this textbook.

The Council is also grateful to Saroj Yadav, *Professor* and *Dean* (A), and Ranjana Arora, *Professor* and *Head*, Department of Curriculum Studies, NCERT, for their sincere efforts in coordinating the review workshops for the finalisation of this book.

The contribution of Kuldeep Singh Patel, *Junior Project Fellow* and Avinash Singh, *Consultant*, Department of Engineering and Technology, PSSCIVE, Bhopal is also acknowledged.

The Council also acknowledges the copyediting and valuable contribution of Shilpa Mohan, *Assistant Editor* (Contractual) and Chanchal Chauhan, *Proofreader* (Contractual), Publication Division, NCERT, in shaping this book. The efforts of Pawan Kumar Barriar, *DTP Operator* and Neha Pal, *DTP Operator* (Contractual), Publication Division, NCERT, Akhilesh Kashiv, *Computer Operator*, Vikas Kumar Kogey, *Graphic Artist* (Contractual) and Pinki Tiwari, *Graphic Designer* (Contractual), PCCSIVE, for layout design are also acknowledged.

CONTENTS

Foreword	*iii*
About the Textbook	*V*
Unit 1: Installation and removal of the low voltage single and three phase meter	**1**
Session 1: **Regulations for managing the installation of meters.**	
Session 2: **Installation and Removal of Meters**	
Session 3: **Calibration and testing of meter**	
Session 4: **Meter installation practices**	
Session 5: **Planning of Installation of meter**	
Session 6: Practical knowledge of installation of meter	
Unit 2: Meter reading and post installation procedure	
Session 1: Meter reading process	
Session 2: Post installation and practice	
Unit 3: Bus Bar and distribution box connected to the meter	
Session 1: **Multistory building bus bar and Meter Arrangements**	
Session 2: **Wiring drawing of control panel**	
Session 3: **Electro mechanical Assembly**	
Unit 4: Safety precaution for electric work	
Session 1: Safe working practIce	
Session 2: Basic First Aid Procedures	

Answer Key	
Acronyms	
Glossary	
List of Credits	90

Unit 1

Installation and removal of the low voltage single and three phase meter

Introduction

Energy meter is one of the measuring instruments. It is used to measure the electrical energy consumed in premise either it residential or it is industrial. The electrical connection is given to a consumer in a so many ways i.e. single phase connection; three phase connection for residential, commercial (shops, showroom, cinema etc.) and industrial connections. To measure the energy consumed in these organization single phase and three phase energy meters are used, for big show room, cinema and industrial organization LT CT meters are used. There are 11KV, 33KV, 132KV, 220KV energy meters are also available for very high load industrial organization like HEG Mandideep, BHEL Bhopal etc.

Prepaid Meter

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- explain the Regulations for managing the meters
- explain the procedure of installation and removal of meters
- discuss Calibration and testing of meter
- explain the meter installation practices
- discuss Planning of installation of meter

Session 1

Regulations for managing the installation of meters.

LEARNING OUTCOMES

On completion of this session the student will be able to:

- explain about regulations for managing the installation and operation of meters.
- discuss about the types of meters.
- explain location of meters

Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006

NOTIFICATION

No.501/70/CEA/DP&D

In exercise of the powers conferred by sub-section (1) of section 55 and clause (e) of section 73 read with sub-section (2) of the section 177 of Electricity Act, 2003, the Central Electricity Authority hereby makes the following regulations for managing the installation and operation of meters:

Applicability of Regulation

These regulations shall be applicable to meters installed and to be installed by all the generating companies and licensees who are engaged in the business of generation, transmission, trading, distribution, supply of electricity and to all categories of consumers.

After coming into force of these regulations, the provisions of the Indian Electricity Rules, 1956, related to installation and operation of meters in this regard, shall not be applicable.

These regulations provide for type, standards, ownership, location, accuracy class, installation, operation, testing and maintenance, access, sealing, safety, meter reading and recording, meter failure or discrepancies, anti-tampering features, quality assurance, calibration and periodical testing of meters, additional meters and adoption of new technologies in respect of the following meters for correct accounting, billing and audit of electricity.

Types of Meters

All interface meters, consumer meters and energy accounting and audit meters shall be of static type.

The meters not complying with these regulations shall be replaced by the licensee on his own or on request of the consumer. The meters may also be replaced as per the regulation or direction of the appropriate commission or pursuant to the reforms programme of the appropriate government.

Standards

All interface meters, consumer meters and energy accounting and audit meters shall:

Comply with the relevant standards of Bureau of Indian Standards (BIS). If BIS Standards are not available for a particular equipment or material, the relevant British Standards (BS), International Electro-technical Commission (IEC) Standards, or any other equivalent Standard shall be followed.

Provide that whenever an International Standard or IEC Standard is followed, necessary corrections or modifications shall be made for nominal system frequency, nominal system voltage, ambient temperature, humidity and other conditions prevailing in India before actual adoption of the said standard.

Conform to the standards on 'Installation and Operation of Meters' as specified in schedule annexed to these regulations and as amended from time to time.

Ownership of Meters

Consumer meters shall generally be owned by the licensee.

If any consumer elects to purchase a meter, the same may be purchased by him. Meter purchased by the consumer shall be tested, installed and sealed by the licensee. The consumer shall claim the meter purchased by him as his asset only after it is permanently removed from the system of the licensee.

All consumer meters shall bear BIS mark, meet the requirements of these regulations and have additional features as approved by the appropriate Commission or pursuant to the reforms programme of the appropriate government. To facilitate this, the licensee shall provide a list of makes and models of the meters.

Location of Meters

As far as the location of interface meters, consumer meters and energy accounting and audit meters is concerned, the generating companies or licensees may install meters at additional locations in their systems depending upon the requirement.

fig. 1.1 Selection of Location of Meter Installation

Consumer Meters

The consumer meter shall be installed by the licensee either at consumer premises or outside the consumer premises.

(a) Provided that where the licensee installs the meter outside the premises of the consumer, the licensee shall provide real-time display unit at the consumer premises for information to indicate the electricity consumed by the consumer.

(b) Provided further that for the billing purpose, reading of consumer meter and not the display unit shall be taken into account.

In the event the appropriate Commission allows supply of electricity directly from a generating company to consumer on a dedicated transmission system, the location of the meter will be as per their mutual agreement.

Fig. 1.2 Consumer Meters

Accuracy Class of Meters

Every meter shall meet the requirement of accuracy class as specified in the standards given in the schedule.

Exercise

1. Fill in the blanks
   a. Data is transfer through ..... in smart meter.
   b. Electrical energy is measured by .....
   c. ..... is called age old watt hour meter
   d. 1000 Watts is equal to .....
2. If we consume 2000 watts for an hour, the total unit consume is
   a. 2 units
   b. 1 units
   c. 0.5 units
   d. None of the above
3. In smart meters, to facilitate communication we use
   a. Telephone
   b. Mobile
   c. Modem
   d. Direct line
4. Basic form of energy meter is
   a. Electronic meter
   b. Electro mechanical meter
   c. Anlog meter
   d. Digital meter

Session 2
Installation and Removal of Meters

LEARNING OUTCOMES

On completion of this session the student will be able to:

- explain procedure of meter installation
- discuss operation, testing and maintenance of meters
- describe the procedure of sealing of meters

Fig. 1.3 Installation of Electric Meters

Generating company or licensee, as the case may be, shall examine, test and regulate all meters before installation and only correct meters shall be installed.

The meter shall be installed at locations, which are easily accessible for installation, testing, commissioning, reading, recording and maintenance. The place of installation of meter shall be such that minimum inconvenience and disruptions are caused to the site owners and the concerned organisations.

In case of single phase meters, the consumer shall ensure that there is no common neutral or phase or looping of neutral or phase of two or more consumers on consumer's side wiring. If such common neutral or phase or looping of neutral or phase comes to the notice of the licensee, he shall suitably inform the consumer through installation report or regular electricity bills or meter test report as applicable.

Consumer shall install the Earth Leakage Protective Device (ELPD) in accordance with the provisions of the rules or regulations in this regard.

Fig. 1.4 Earth Leakage Circuit Breaker

If the earth leakage indication is displayed in the meter, the licensees shall suitably inform the consumer through installation report or regular electricity bills or meter test report as applicable.

In case CTs and VTs form part of the meters, the meter shall be installed as near the instrument transformers as possible to reduce the potential drop in the secondary leads.

Operation, Testing and Maintenance of Meters

The operation, testing and maintenance of all types of meters shall be carried out by the generating company or the licensee, as the case may be.

Access to Meter

The owner of the premises where the meter is installed shall provide access to the authorised representative(s) of the licensee for installation, testing, commissioning, reading and recording and maintenance of meter.

Fig. 1.5 Concerned Person Checking the Meter

Sealing of Meters

Sealing Arrangements

All meters shall be sealed by the manufacturer at its works. In addition to the seal provided by the manufacturer at its works, the sealing of all meters shall be done at various sealing points as per the standards given in the schedule below:

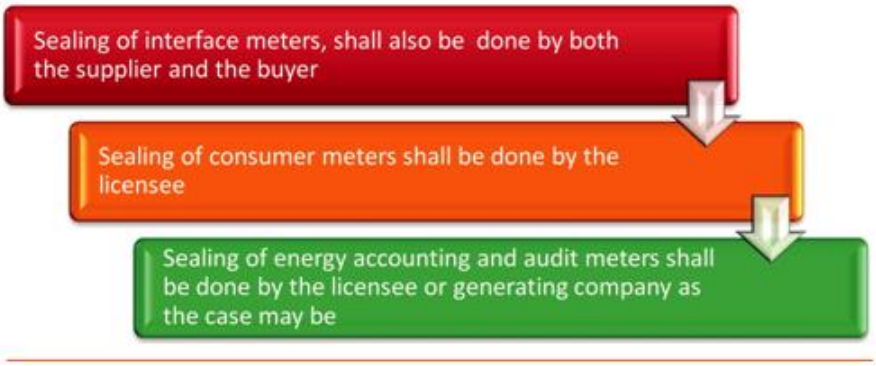


Fig. 1.6 Standards Followed for Sealing of All Meters

A tracking and recording software for all new seals shall be provided by the manufacturer of the meter so as to track total movement of seals starting from manufacturing, procurement, storage, record keeping, installation, series of inspections, removal and disposal.

Seal shall be unique for each utility, and name or logo of the utility shall be clearly visible on the seals.

Only the patented seals (seal from the manufacturer who has official right to manufacture the seal) shall be used.

Polycarbonate or acrylic seals or plastic seals or holographic seals or any other superior seal shall be used.

Lead seals shall not be used in the new meters. Old lead seals shall be replaced by new seals in a phased manner and the time frame of the same shall be submitted by the licensee to the appropriate Commission for approval.

Polycarbonate or acrylic seals or plastic seals or holographic seals or any other superior seal shall be used.

Removal and Installation of meters

Removal of meter is done when meter is replaced due to some discrepancy in meter, burnt of meter due to some reason and for testing purpose. Installation of meter is done for new connection and replacement of meter.

Removal of Seals from Meters

Seal of the consumer meter shall be removed only by the licensee. No consumer shall tamper with, break or remove the seal under any circumstances. Any tampering, breaking or removing the seal from the meter shall be dealt with as per relevant provisions of the Act.

Fig. 1.7 Sealing Meter

Safety of Meters

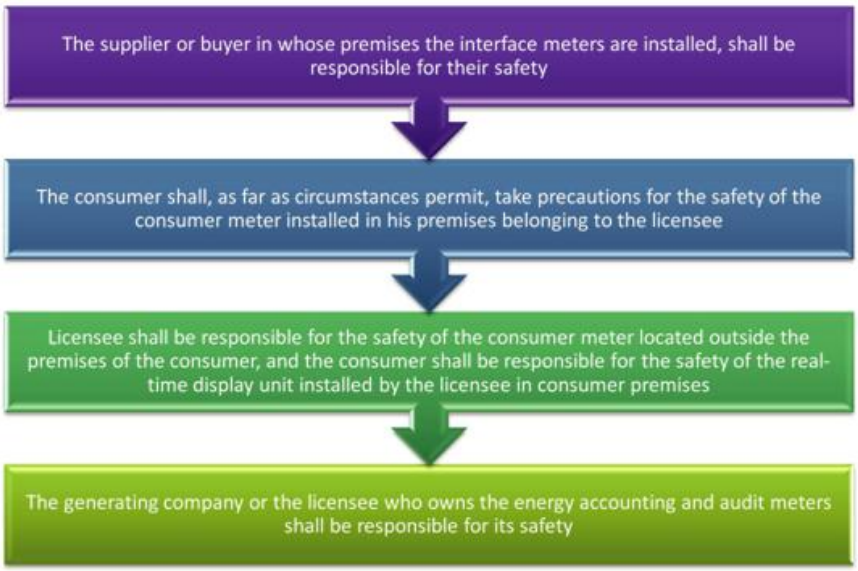


Fig. 1.8 Safety Standards to be Followed

Meter Reading and Recording

Consumer Meters

It shall be the responsibility of the licensee to record the metered data, maintain database of all the information associated with the consumer meters and verify the correctness of metered data.

The licensee shall maintain accounts for the electricity consumption and other electrical quantities of its consumers.

Brief history, date of installation and details of testing, calibration and replacement of meters shall be maintained by the licensee.

Fig. 1.9 Taking Reading From Electric Meter

Meter Failure or Discrepancies

In case the consumer reports to the licensee about consumer meter readings not commensurate with his consumption of electricity, stoppage of meter, damage to the seal, burning or damage of the meter, the licensee shall take necessary steps as per the procedures given in the Electricity Supply Code

of the appropriate Commission read with the notified conditions of supply of electricity.

Anti-tampering Features of Meters

The meters shall be provided with such anti-tampering features as per the Standards on Installation and Operation of Meters given in the Schedule.

Quality Assurance of Meters

The distribution licensee shall put in place a system of quality assurance and testing of meters with the approval of appropriate Commission.

The licensee shall set up appropriate number of accredited testing laboratories or utilise the services of other accredited testing laboratories. The licensee shall take immediate action to get the accreditations of their existing meter testing laboratories from NABL, if not already done.

The generating company or licensee shall ensure that all type, routine and acceptance tests are carried out by the manufacturer complying with the requirement of the relevant IS or BS or IEC as the case may be.

Calibration and Periodical Testing of Meters

fig. 1.16 Calibration of Electric Meters

Adoption of New Technol

The distribution licensee shall make out a plan for introduction and adoption of new technologies such as prepaid meters, time of the day meters (TOD), automatic remote meter reading system through appropriate communication system with the approval of the appropriate Commission or as per the regulations or directions of the appropriate Commission or pursuant to the reforms programme of the appropriate government.

SCHEDULE

(See Regulations 2, 5, 8, 12 and 16)

Part 1 Standards Common to All Types of Meters

These standards provide for specification of meters, immunity to external factors, sealing points and functional requirements that are required from regulatory perspective. Detailed technical specification shall be prepared by the purchaser of the meter.

2. Specifications of Meters

Standard Reference Voltage Voltage Range	As per IS As per IS
Standard Frequency	As per IS
Standard Basic Current	As per IS (Current range of consumer meters shall be so chosen as to record the load current corresponding to the sanctioned load)
Accuracy Class	Meters shall meet the following requirements of accuracy class:
- Up to 650 V	1.0s or better
- Above 650 V and up to 33 kV	0.5s or better
- Above 33 kV	0.2s
Starting Current and Maximum Current	As per IS
Power Factor Range	As per IS
Power Frequency Withstand Voltage	As per IS
Impulse Voltage Withstand Test for 1.2/50 micro sec	As per IS
Power Consumption	As per IS

Meter shall have downloading facilities of metered data through Meter Reading Instrument (MRI).

Immunity to External Factors

The meter shall be immune to external influences like magnetic induction, vibration, electrostatic discharge, switching transients, surge voltages, oblique suspension and harmonics; and necessary tests shall be carried out in accordance with relevant standard.

Sealing Points

Sealing shall be done at the following points (as applicable):

(a) Meter body or cover

(b) Meter terminal cover

(c) Meter test terminal block

(d) Meter cabinet

The accuracy class of current transformers (CTs) and voltage transformers (VTs) shall not be inferior to that of associated meters. The existing CTs and VTs not complying with these regulations shall be replaced by new CTs and VTs, if found defective, non-functional or as per the directions of the appropriate Commission. In case the CTs and VTs of the same accuracy class as that of meters cannot be accommodated in the metering cubicle or panel due to space constraints, the CTs and VTs of the next lower accuracy class can be installed.

The voltage transformers shall be electromagnetic VT or capacitive voltage transformer (CVT).

Standards for Consumer Meters

1. Measuring Parameters

(a) The consumer meter shall be suitable for measurement of cumulative active energy utilised by the consumer.

(b) The consumer meter may have the facilities to measure, record and display one or more of the following parameters depending upon the tariff requirement for various categories of consumers.

Fig. 1.11 Measuring Parameters

All parameters excluding instantaneous electrical parameters shall also be stored in memory.

These parameters are as follows:

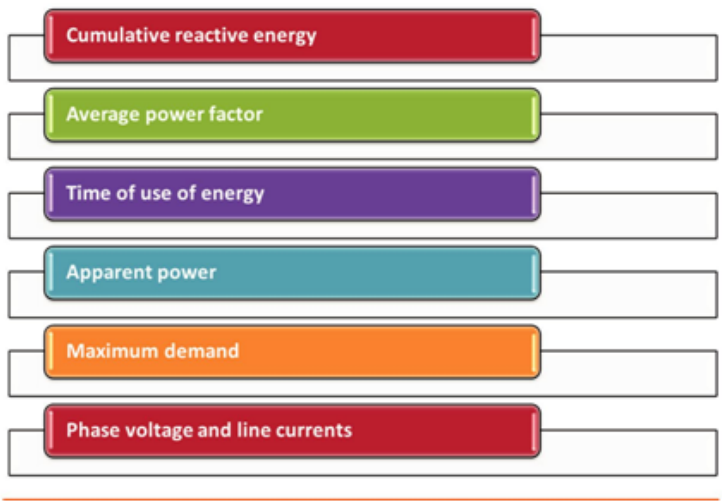


Fig. 1.12 Measuring Parameters

All the three phase meters shall have data storage capacity for at least 35 days in a non-volatile memory.

Anti-tampering Features

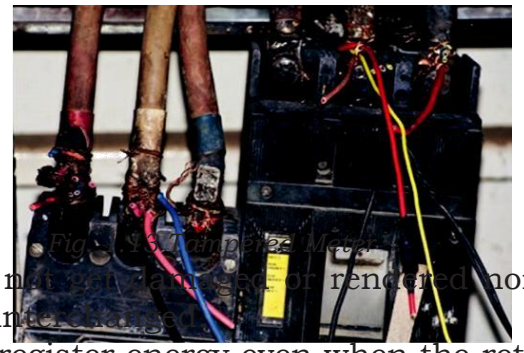


Fig. 1.13 Tampered Meter

(a) The meter shall not get damaged or rendered non-functional even if any phase and neutral are interchanged.

(b) The meter shall register energy even when the return path of the load current is not terminated back at the meter, and in such a case the circuit shall be completed through the earth. In case of metallic bodies, the earth terminal shall be brought out and provided on the outside of the case.

(c) The meter shall work correctly irrespective of the phase sequence of supply (only for poly phase).

(d) In case of 3 phase, 3 wire meter even if reference Y phase is removed, the meter shall continue to work. In the case of 3 phase, 4 wire system, the meter shall keep working even in the presence of any two wires, i.e., even in the absence of neutral and any one phase or any two phases.

(e) In case of whole current meters and LV CT operated meter, the meter shall be capable of recording energy correctly even if input and output terminals are interchanged.

(f) The registration must occur whether input phase or neutral wires are connected properly, or they are interchanged at the input terminals.

(g) The meter shall be factory calibrated and shall be sealed suitably before dispatch.

(h) The meter shall be capable of recording occurrences of a missing potential (only for VT operated meters) and its restoration with date and time of first such occurrence and last restoration along with total number and duration of such occurrences during the above period for all phases.

(i) Additional anti-tampering features including logging of tampers such as current circuit reversal, current circuit short or open and presence of abnormal magnetic field may be provided as per the regulations or directions of the appropriate Commission or pursuant to the reforms programme of the appropriate government.

These days, meters have technology to identify the theft and log the tamper with date and time stamping. Meter can keep record of large numbers of tampers, normally 200 tampers in three phase meters and 100 tampers in single phase meters. Meters are also programmed to record the energy at their maximum current rating under certain tamper condition to penalise the consumer or to discourage the consumer from attempting the theft.

Safety Precaution While Using Tools and Tackles during Installation

1. All insulated tools like screwdrivers, pliers, side cutter, etc., must be properly insulated.
2. Sharp edge tools like knife, chisel, poker, screwdrivers, etc., must not be kept open inside trouser pocket.

3. Keep a distance of hands with body while using knife or sharp edge blades.
4. Hammer must be fitted solidly with wooden handle and may not get loose during operation.
5. While using hacksaw, first make small cut at the particular point to avoid slip of blade. Your fingers may not be close to blade.
6. Keep the tool clean and place it at the right place after completion of work.
7. Always select proper size of proper tool to carry out the function.
8. In case of injury, get medical check-up immediately.

Session :3
Calibration and testing of meter

LEARNING OUTCOMES

On completion of this session the student will be able to:

- explain the procedure of calibration
- describe the meter testing report

Standard Meter Testing Instrument (Field Calibrator) Accuchek

Fig. 1.14 Standard Meter Testing Instrument (Field Calibrator) Accuchek

It is used to test energy meter on site without disturbing the meter connection. It

gives spot test results of LT energy meter (both single and three phase whole current and LTCT) as per available load provided.

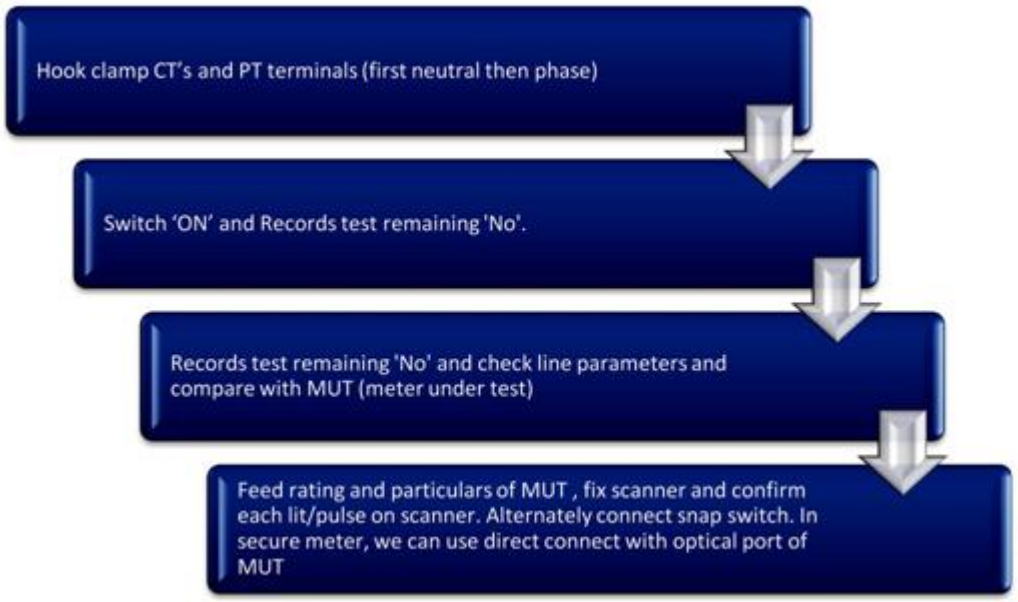


Fig. 1.15 Procedure for Meter Testing

Primary Injection Set

Primary injection set carries out the following tests:

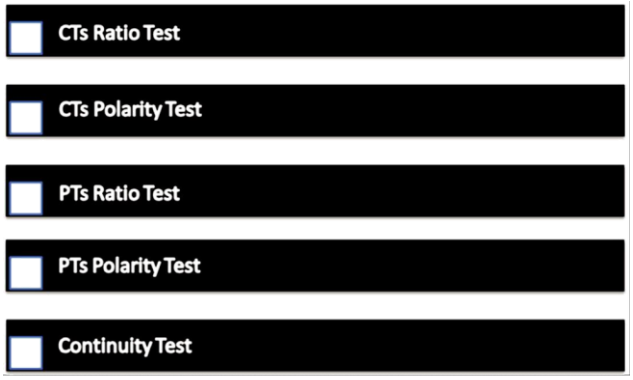


Fig. 3.41 Performance Check

This test is intended to verify that current transformation ratio as shown on the name plate is correct. Primary current injection test is not accuracy test; therefore, the result of this test to calculate ratio error is not acceptable.

Fig. 1.16 Primary Current Injection Test

Test Circuit

Note: Ensure to short-circuit secondary terminal prior to conducting primary current injection.

Failing to do so will cause damage to current transformer.

Test Procedure

Following are the steps of test procedure which need to be followed:

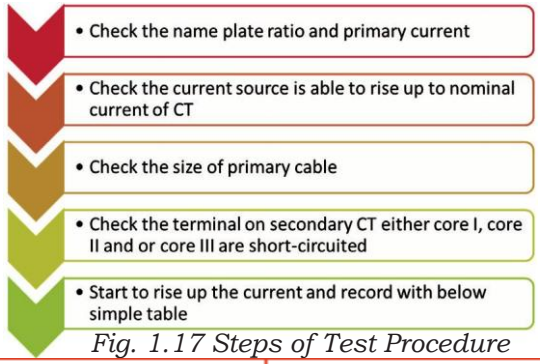


Fig. 1.17 Steps of Test Procedure

CT Specification:	Ratio:	Serial No:	Test Core No:
S. No.	Actual primary current (A)	Actual secondary current (A)	Actual ratio Calculated ratio
1.			
2.			

Fig. 1.17 'R' Phase Set (for Combined CT Ratio, PT Ratio and Polarity Test at Site)

Fig. 1.18 Phantom Load Testing

When the capacity of meters under test is very high, testing with actual loading method involves a considered loss of power and is not economical also. Therefore, to avoid wastage of power during testing, phantom loading method is adopted. In this method, pressure circuit is supplied from a circuit of normal voltage source and the current circuit from a separate low voltage source. Thus, total power consumed during testing becomes very small due to small pressure coil current at normal voltage plus load current at very less voltage for current circuit meter under test and RSS acts as a load on phantom loading kit.

Session 4

Meter installation practices

LEARNING OUTCOMES

On completion of this session the student will be able to:

1. Explain about meter installation practices

2. Discuss the points that should be followed while installing meter indoors in the consumer's premises
3. Discuss the types of overhead connections

Meter Installation Practices

The major cause of loss revenue is the lack of seriousness in ensuring effective installation practices, or inefficient/no maintenance practices. Some aspects to be considered for effective installation are:

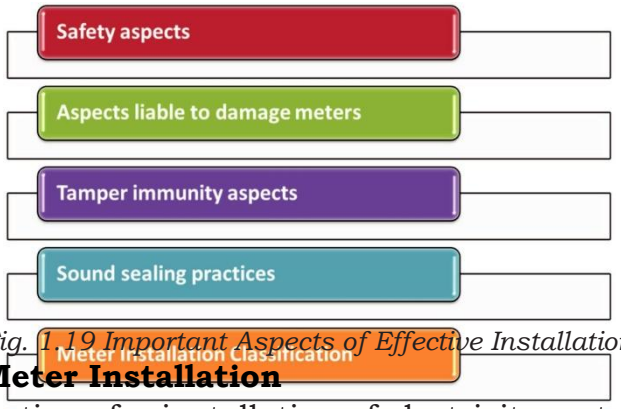


Fig. 1.19 Important Aspects of Effective Installation

Location of Meter Installation

Some potential locations for installation of electricity meters, and their respective benefits, are as follows:

Fig. 1.20 Some Locations for Installation of Electricity Meters with Their Respective Benefits

When installing meters indoor in the consumer's premises, ensure the following:

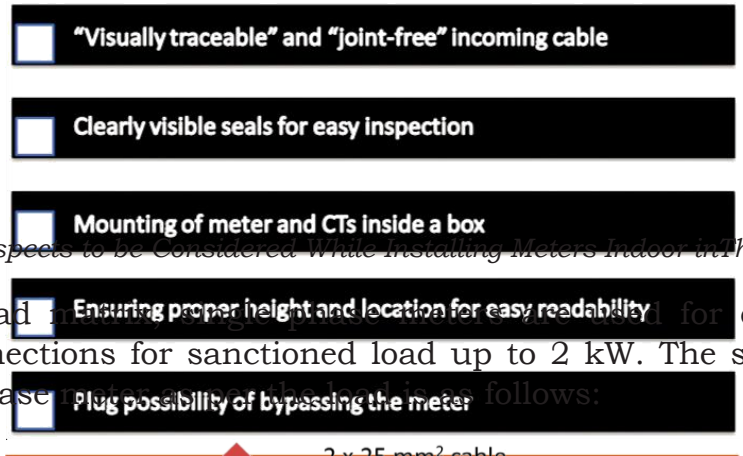


Fig. 1.21 Some Aspects to be Considered While Installing Meters Indoor in The Consumer's Premises

As per the load [illegible] for domestic and non-domestic connections for sanctioned load up to 2 kW. The size of service cable with single-phase meter as per the load is as follows:

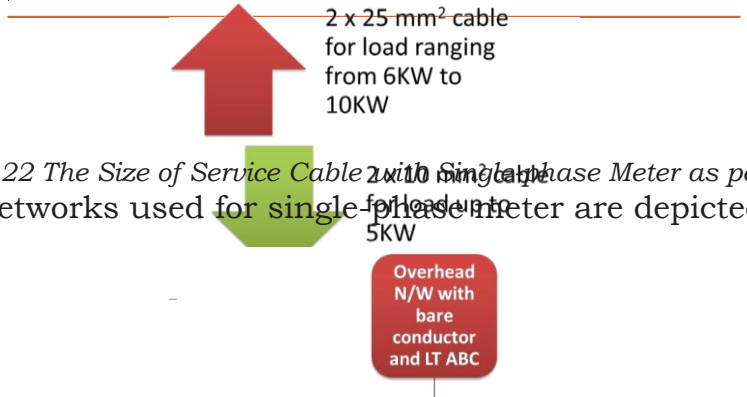


Fig. 1.22 The Size of Service Cable with Single-phase Meter as per the Load

The types of networks used for single-phase meter are depicted below:

Fig. 1.23 The Types of Networks Used for Single Phase Meter

For installation of single-phase meter against new connection/load enhancement request from consumer, installation of ELCB by consumer is a must for load equal to or greater than 5kW, as per clause 42 of CEA Regulations (measures related to safety and electric supply) 2010. Some examples of good practices for meter installation are as follows:

Fig. 1.24 Energy Meter Should Always be Installed in a Box of Utility Duly Sealed

Fig. 1.25 Incoming and Outgoing Lines from Energy Meter Box Should be Clearly Visible. Entry Holes Should be Solidly Plugged

Fig. 1.26 Clamping rrangement on MS Angle

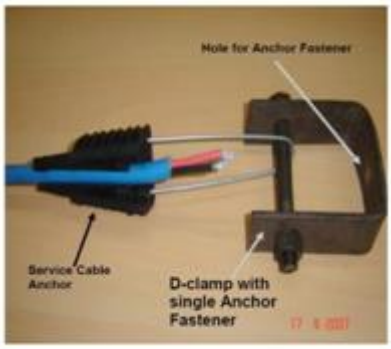


Fig. 1.27 'D' Clamp and Service Cable Anchor

Incoming supply to feeder pillar comes direct from local transformer. The same is further distributed to service pillars near metering points at the consumer's block or pockets, from where their service line emanates. Consumer service line from service pillar to energy meter is provided through an underground system.

Fig. 1.28 Group Metering-Feeder Pillar

Fig. 1.29 Group Metering-Service Pillar

Session 5

Planning of Installation of meter

LEARNING OUTCOMES

On completion of this session the student will be able to:

1. Discuss distribution box connections
2. Learn about HT Meter
3. Describe the type of meter and cable size
4. Analyse the details about earth leakage protected device

Distribution Box Connections

In electrical applications, a distribution box is a component that is used in a larger system that helps to regulate the flow of electricity through a distribution board.

Fig. 1.30 Distribution Box

Components and Features

The typical electrical distribution box is equipped with a solid case that is capable of keeping the equipment safe. The wiring and other parts that are contained within the box are usually mounted within the interior, helping to lessen the potential for the components to be damaged during any type of shifting that would otherwise create some type of abrasive action on wire coverings and other elements. Typically, the box is equipped with an airtight and watertight cover that allows for easy access to the interior components, making it easy to inspect and replace those components when and as necessary.

There are portable distributions boxes used for short term, such as at sites where new construction is taking place and an independent source of power is required during that construction.

Types of Connections

Fig. 1.31 Single Phase 2 Way

Fig. 1.32 Three Phase 3 Way

Fig. 1.33 Three Phase 8 Way

Whole Current Three-Phase Meter

Poly Phase meter is being installed for Domestic, Non-Domestic, Agriculture and Industrial connections.

Connection	**Poly Phase Meter**
For Domestic, Non-Domestic and Industrial connections	Poly phase meter of 20-100A rating is installed for the load from 11KW to 25KW and the size of service cable is 4x25sq.mm
For Agriculture	Poly phase meter is installed even for load less than 10 kW because 3-ph supply is required for water pumps and motors.

For installation of Poly Phase meters, the installation of ELCB (Earth Leakage Circuit Breaker) and earthling at consumer end is mandatory. For reading purpose, modem is used for AMR reading purpose.

LTCT Meter

LTCT meters are used for Domestic, Non-Domestic and Industrial connections. LTCT meters are used for the load from 26 kW to 99 kW with different size of cable as per the load, i.e.

100/5A LTCT meter is used with 4x95sq.mm cable for the load from 26kW to 57kW.

200/5A LTCT meter is used with 4x95 sq.mm cable for the load from 58 kW to 99 kW.

The CT ratio of LTCT meter and LTCT meter box remains the same to keep the MF 1.

For installation of LTCT meters, the installation of ELCB (Earth Leakage Circuit Breaker) and Earthing at consumer end is mandatory.

For reading purpose, modem is used for AMR reading purpose.

The type of Network used for LTCT meter is:-

- Overhead net work with bare conductor & LT ABC
- HVDS
- Underground net work through feeder pillar

Fig. 1.34 LT CT Meter with Box

Apart from consumer's LT meters in their premises, DT meters on distributions transformers on LT bushing sides are installed in theft-prone areas as check meter or energy audit meter to check the cumulative energy.

Fig. 1.35 DT Meter or Energy Audit Meter

HT meters are used for loads more than 100 kVA.

Load	
1. 100kVA to 500 kVA	at 11 kV
2. 501 kVA to 1000kVA	at 33kV
3. Above 1000kVA	at 132 kV or 220 kV

Ratio of CT-PT unit and metering cubicle are used as per the load matrix for 11 kV system:

Load	11 KV CT Ratio
Below 100 kW	5/5A
Up to 160 kW	10/5A
Up to 250 kW	15/5A
Up to 500 kW	30/5A
Up to 1000 kW	60/5A
Up to 1500 kW	100/5A
Up to 2500 kW	150/5A
Up to 5000 kW	300/5A

Fig. 1.36 Outdoor Type HT Metering

Planning for Meter Installation

The company shall ensure the selection of proper type of meter, with or

without meter box (as per the requirement) along with suitable cable and other accessories, as required for the installation of meter.

Fig. 1.37 Electrician Installing Energy Meter

Selection of Site

Unless specifically intended for outdoor installation, metering system shall be installed indoors. The site shall be accessible to the consumer as well as Utility's service providers for meter reading, installation, inspection and maintenance as the case may be. The meter shall not be located in inaccessible private areas, or areas that are unsafe, inconvenient or unsuitable for entry by service personnel or an area with uncontrolled or unrestrained access to animals, etc. the following shall be considered for selection of site and installation of meters:

Fig. 1.38 Smart Meter Installation within Premises

- Metering installation shall be protected from excessive dust and moisture, exposure to direct sunlight, rain and water seepage and vermin.
- Meters shall not be located at an elevated area or a depressed area that does not have access by means of a stairway of normal rise
- The height of meter display shall be between 750 mm to 1800 mm. In case the meter is provided with a secondary display unit, this requirement applies to the secondary display unit only
- A minimum clearance of 50 mm shall be maintained around the meter itself for better inspection. This includes the space between two meters, between meter and meter box and between two meter boxes
- For outdoor installations, the meters shall be protected by appropriate enclosure of level of protection IP 55 and ensuring compliance with above conditions

Size and Type of Service Cable Feeding the Meter

The size of the service cable for direct connected meters shall be suitably selected to carry the current according to sanctioned load as per relevant standard. Based on the length of the overhead and underground cables, the galvanised iron support wire shall be used for overhead cable and underground cable laying shall be in line with specification for LT cable laying works. The service cable shall be armoured and the armour shall be earthed.

Fig. 1.39 Armoured Service Cable

Type of meter and cable size to be used (with current rating in amperes) against various categories of consumers and load shall be as per the table below:

Connection Type/Load (Domestic/ Commercial)	1-5kW	6-10kW	11-25kW	26-57kW	58-100kW
Metertype	10-60A (1ph staticmeter)	10-60A (1ph staticmeter)	20-100A,3ph 4WWCT	3ph4W,LTCT Meter (100/5A)	LT CT 3ph 4W, Meter(200/5A)
Cable size	2c×10sq mm	2c×25sq mm	4c×25sq mm	4c×95sq mm	4c×150sq mm
Industrial	5-25kW			26-57kW	58-100kW
Metertype	20-100A,3ph4WWCT			3ph4W,LTCT Meter (100/5A)	LT CT 3ph 4W, Meter(200/5A)
Cable size	4c×25sq mm			4c×95sq mm	4c×150sq mm

Metering cables shall be laid in conduits and there shall be no access to cables and their joints. All service cable shall be without joint, with connector on line side and preferably overhead (not underground) and shall be visible to the open eye check up to the meter end at all times.

No cable other than the underground service cable shall be visible around the meter installation. Any cable from the back/other sides of the meter board, etc. shall be checked for possible sources of theft.

Types of cable used for meter installation shall be multi-strand cable for flexibility and ease of handling. Single cable length should be used for source side connection. There shall be no joint in the cable till it is terminated on the meter.

fig. 1.40 Flexible Multi- Stranded Cable

Wiring and Connections

The service provider shall provide phase(s), neutral and earth connection to the consumers. The service provider shall provide separate neutral to each consumer up to the metering point and same shall be used by the consumer. Whenever there is multiple meter installation bus bar arrangement shall be used for neutral, so that looping is avoided.

The neutral shall be used for carrying return current only. The neutral of one consumer shall not be connected to other consumers who have independent and separate supply connection. Consumer shall not earth the neutral after the metering point.

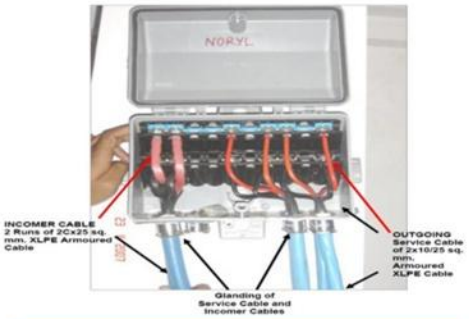


Fig. 1.41 Pole mounted Distribution Box

Terminations

In case of 1ph static meter and 3ph 4 wire whole current meters, the o/g cable from the distribution box shall be directly terminated to the terminals of respective meter. In case of 3ph 4 wire LT-CT meters, the service shall be connected to the CT terminal with the help of appropriate thimbles.

The terminals shall be made using proper tools and equipment so as to ensure complete tightening and stable connection. There are different types of terminals in an electric meter, such as tamper terminal, power terminal, etc.

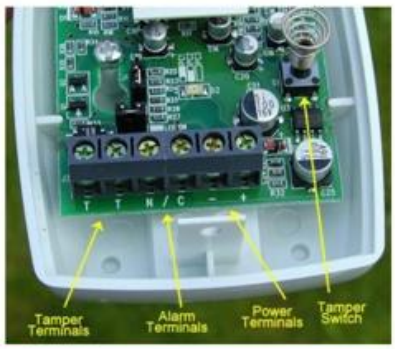


Fig. 1.42 LT Meter Terminals (L&T Meter)

Bus Bar Box

Whenever there is multiple meter installation, bus-bar arrangement shall be used for neutral to avoid looping. The bus bar box shall be installed towards the

top at a minimum height of 1800 mm from FGL

Fig. 1.43 Bus Bar Box

Meter Box

The meter shall be mounted inside the meter box, as applicable for 1 ph and 3ph, as per standard specifications and shall be sealed at multiple points. There shall be no access to the meters without breaking the sealing arrangement. The display of the meter shall be visible at a distance ranging between 750 mm to 1800 mm. The minimum clearance between any two meter boxes shall be 50 mm.

Fig. 1.44 Electric Meter Box

MCB (Miniature Circuit Breaker)

The O/G MCBs shall be mounted at top with identification arrangement. Minimum 40A DP and 40A TPN MCB shall be provided as O/G for all 1Ph/3Ph meters, respectively.

Fig. 1.45 MCB

Earthing

The utility's service provider shall maintain earth resistance as prescribed in IS 3043. The earthing connection shall not be used as return conductor and shall not carry neutral current. The utility's service provider shall provide the earthing connection at the consumer's metering point in accordance withthe Indian Electricity Rules, 1956. The consumer earth and supply neutral shall not be connected in the consumer premises after the metering point. The water supply pipe line or exposed iron structures shall not be used as earthing terminal. This shall be strictly avoided and no electrical circuit shall be connected to these metallic structures.

Fig. 1.46 Earthing in Electrical Meter

Provision of Earthing: The armour of the incoming service cable at the consumer end shall be earthed through gland if the meter box is metallic and in case the meter box is non-metallic, the jubilee clip with earth wire of 10 sq mm copper PVC cable shall be used to provide connection to the earth point of the box.

ELCB (Earth Leakage Circuit Breaker)

The flow of current through electrical facilities always involves risk. Poorly insulated apparatus, faulty wires or incorrect use of an electrical device cause current to flow through the wrong path (i.e. through the insulation) to the earth. This current is called the 'Leakage/Residual Current'.

Fig. 1.47 ELCB

As per CEA Regulations 2010 (Measures relating to Safety and Electric Supply), the details about earth leakage protected device are covered under Clause 42 detailed below:

Clause 42: Earth Leakage Protective Device: The supply of electricity to every electrical installation other than voltage not exceeding 250 V below 5 kW and those installations of voltage not exceeding 250 V which do not attract provisions of Section 54 of the Act, shall be controlled by an earth leakage protective device so as to disconnect the supply instantly on the occurrence of earth fault or leakage of current provided such earth leakage protective device shall not be required for overhead supply lines having protective devices which are effectively bonded to the neutral of supply transformers and conforming to regulation 73

Safety

The entire PMSS/HVDS installation shall be safeguarded against theft, nuisance and mis-usage by providing suitable IRC fencing arrangement as per the installation drawing.

ERC Fencing

- It extends up to 1000 mm in front of the installation, 400 mm on both sides and 2000 mm in height from FGL
- It is provided for installation of meter board/bus bar box with meters
- It has a single leaf door 800 mm (L)x2000 mm (H) which open towards road or open space.
- Safety norms shall be followed as per IS 732:198

Session 5

Practical Knowledge of Installation of meter

LEARNING OUTCOMES

On completion of this session the student will be able to:

- describe the installation of single phase meter
- describe the installation of three phase meter
- describe the CT operated meter

Installation of Different Energy meters

How To connect Single Phase Energy meter (1-phase,2 Wire) ? **(from the Supply to The Main Distribution Board (MDB)**

The Connection of Single-Phase (1-phase,2 Wire) kWh meter (Digital or Analog Energy Meter) from the Supply to The Main Distribution Board. The Red Wire shows the Live or Line or Phase and the Black shows the Neutral wire. This image shows the above idea in very simple way.

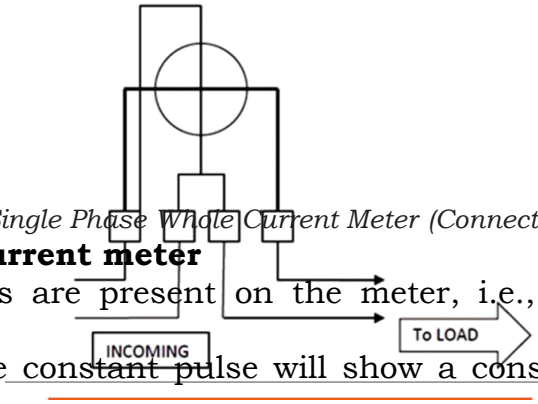


Fig. 1.48 Single Phase Whole Current Meter (Connection Diagram)

Single phase whole current meter

1. Various LED indicators are present on the meter, i.e., constant, pulse, ELT, REV.
2. If the power is ON, the constant pulse will show a constant indication, as the name suggests.
3. If the load is ON, the pulse indicator will be blinking. As specified on the meter box, a certain number of pulses will make a unit. For example, meters with 6400, 3400, 1200, etc., pulses per hour.

   For a typical meter having specifications of 3200 pulses, it will record 1 unit if 1 kW is used for 1 hour.
4. The ELT LED will be blinking in the tamper or unusual condition when there is a leakage of current through earth. This, additionally, indicates that the current is getting a separate return path through earth rather than the meter.
5. The LED indicating REV will be blinking in case of tamper or unusual conditions when there is a reverse current flowing through the meter. For example, if 5A is flowing through the phase wire, 8A is returning through neutral wire.

How To connect 3-Phase 4 wire Energy meter

Three phase or Poly Phase (3-phase,4 Wire) (Digital or Analog Energy Meter) from the Supply to The Main Distribution Board?

Below is The Connection of 3-Phase Three phase or Poly Phase (3-phase,4 Wire) Energy meter (Digital or Analog Energy Meter) from the Supply to The Main Distribution Board.

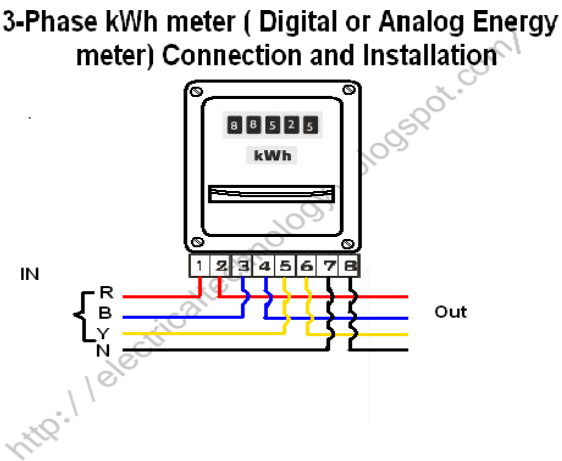


Fig. 1.49 Three Phase Whole Current Meter (Connection Diagram)

LT CT Meter (3 Phase 4 Wire Meters with CTs)

CTs are available in the ratio of 50, 100, 200, 300; 400/5 A. CT has to be accurately selected for consumer meter. Rating of CTs should fall within 50 to 80% of the maximum load current of the consumer. The polyphase meters are provided with maximum demand indicators (MDI), which are additional mechanisms attached to the meters to record the rate of consumption over a fixed period each time (30 minutes). Higher rating CTs say 800, 1000, 1200, 1500, 2000/5A are commonly used for energy audit as DT meters.

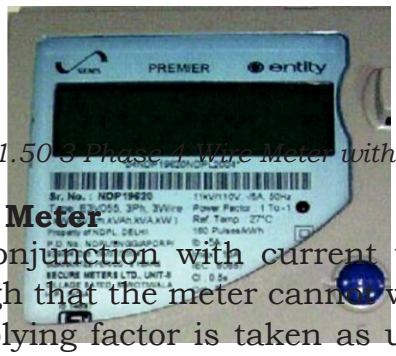


Fig. 1.50 3 Phase 4 Wire Meter with CT

Three Phase Whole Current Meter

These meters are used in conjunction with current transformers, as here the value of load current is so high that the meter cannot withstand it directly.

While calculating, the multiplying factor is taken as unity considering rating of CTs connected match with energy meter; in case different ratio CTs are used MF is additionally added.

Multiply Factor = Mains Capacity / Meter Capacity

$$\text{Multiply Factor} = \text{Reading} \times \frac{\text{Mains (Box) CTR}}{\text{Meter CTR}}$$

For example, if LT CT meters are rated CTR 60/5A, 100/5A and 200/5A and they are connected with identical CTs of ratio 60/5A, 100/5A and 200/5A, MF will always remain 1

Installation of LT CT Operated Meter

ENSURE ALL CURRENT TRANSFORMERS ARE INSTALLED AS PER WIRINGDIAGRAM (WHICH CAN ALSO BE FOUND UNDER THE TERMINAL COVER OF THE METER),THE CORRECT POLARITY OF CURRENT TRANSFORMERS IS ESSENTIAL ie (P1 FACING MAINS) and (P2 FACING LOAD) Check ALL S1 and S2 connections are correct as per wiring diagram otherwise problems will result with the REGISTER DISPLAYS For HEALTH & SAFETY reasons it should be noted that if a current transformer is operated with the secondary (S1 and S2) open circuited, DANGEROUS VOLTAGES may be generated at the secondary terminals or leads.

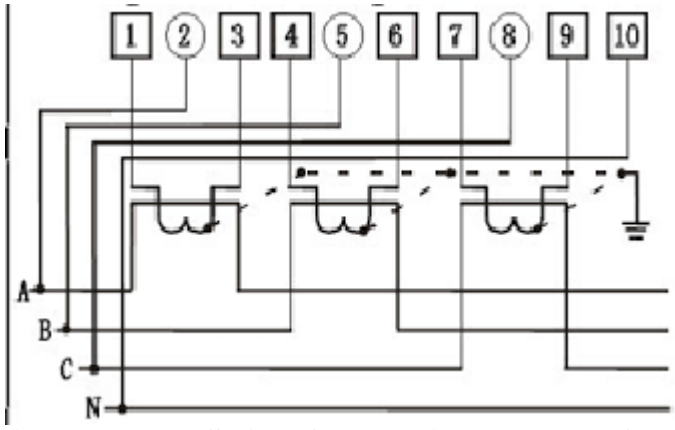


Fig. 1.51 3 Installation Phase 4 Wire CT Operated Meter

INSTALLATION NOTES To ensure that the meter reads correctly install as follows…..

1 Connect the meter according to above wiring instructions (which can also be found inside the terminal cover). Note the voltage inputs to the meter must be externally fused and terminal 11 is the neutral, tying down the three voltages

2 The CT cables should be kept as short as possible, use 2.5mm cable to maintain accuracy

3 CTs match the ratio of the meter being fitted (eg 200/5 amp meter = 200 amp CTs)

4 CTs must be fitted on to the cable the correct way round so that (P1) side is towards the MAINS and (P2) is facing the LOAD

5 The cables from the CTs must be connected the correct way round observing (S1) and (S2) markings on the meter and the CT

6 Always connect (S1) to the first terminal of the phase and (S2) to the third terminal. The smaller middle terminal is for a voltage connection from that phase

7 Check the RST indicator, this should be on – if it is off one or more phase voltages is missing – if it flashed the phases are in the wrong order, two will have to be swapped over (the CT wires will also have to be moved to keep them with the right voltage)

8 Check the meter is operating in the correct direction – the arrow symbol (or disk if disk driven) should show left to right. Open all the voltage fuses then try one phase on at a time and check each phase makes the meter go in the correct direction

9 Check the red light, this should flash if power is being measured

Exercise

(1) Fill in the blanks with suitable answers.

a. For punching cable sockets of cable end or end box termination at least _____

b. Primary current injection test is not accuracy test, therefore the result of this test to calculate ratio error is not _____.

c. The LED indicating REV will be blinking in case of tamper or unusual conditions when there's a _____ flowing through the meter.

d. It is mandatory for a Consumer Energy meter Technician to wear _____ and to prepare a safe Zone by cordon the area of electrical equipments taken under shut down.

e. Potential Transformer is used in electrical power system for stepping down the system voltage to a _____ which can be fed to low ratings meters and relays.

(2) Choose the correct answer from the following options.

1. For consumer meters:
   a. It is the responsibility of the licensee to record the metered data.
   b. The licensee shall maintain accounts for the electricity consumption.
   c. The licensee shall provide real time display unit at the consumer premises
      i. All of the above
      ii. Only (a) and (c)
      iii. Only (a) and (b)
2. Below mentioned are the characteristic of seal used:
   (a) Seal is not a lock
   (b) Seals are used to detect unauthorized entry
   (c) Seals are a means of security & safety for meters
   (d) Seals can be made of lead, metal, engineering plastic etc.
      i. All of the above
      ii. Only (a) and (d)
3. Why do people behave unsafe:
   (a) Lack of Knowledge
   (b) Job Dissatisfaction
   (c) Improper Motivation
   (d) Unsafe condition
      i. Only (a), (c) and (d)
      ii. Only (a), (b) and (c)

C. Match the elements of Group A with Group B

Group A	Group B
1. Green seals	(a) used by AMR for meter data downloading
2. Violet seals	(b) used by MMG team
3. Yellow seals	(c) used by Zone for Tyco box
4. Orange seals	(d) used by Zone for meters

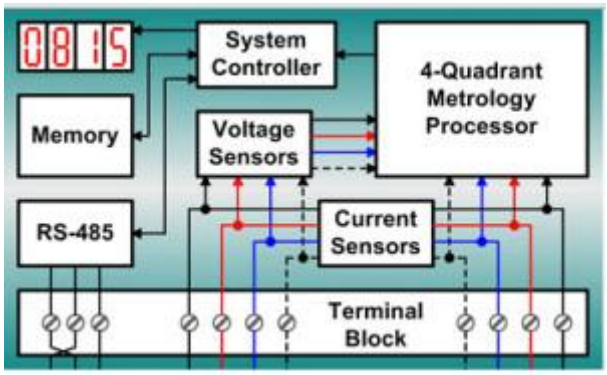
Practical Knowledge

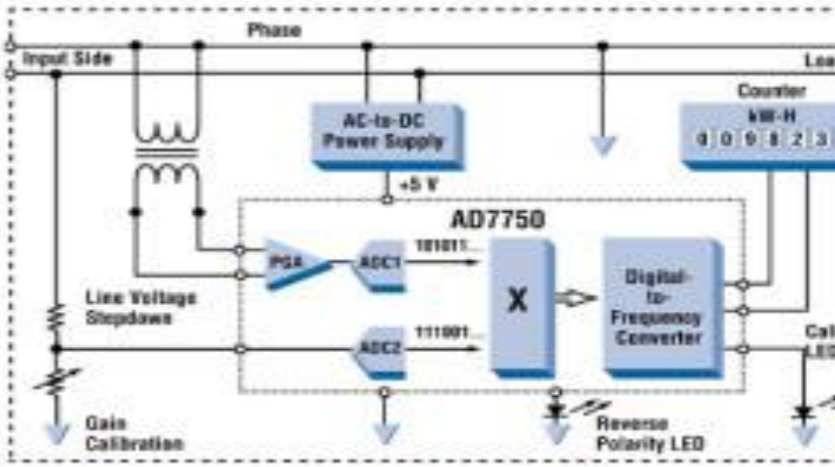
1. Indentifying various type of Meters

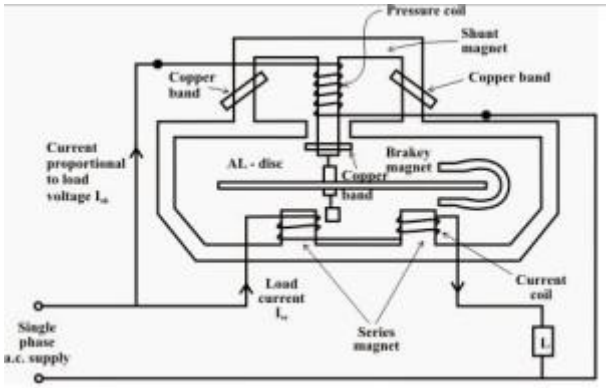
You can see various meters in Meter Testing Lab or Electrical store the various types of meters used for measuring the Electrical Energy installing in consumer's premises. Identify the types of meters some are given below.

2. Knowledge about components of various types of Meters

You can go in Meter Testing Lab where meters are tested by opening of meters. You can see various components of meters like Electro mechanical meter, Ana log Electronic meters, Digital Electronic Meters.







3. Practical procedure of Installation of Single Phase Energy Meter.

First inspect the site where the meter is to be installed and observe the following

a. Cable size is proper, or not, as per load and the cable is properly open from pole to meter box.
b. Meter box was placed at right place i.e. at the door step and proper visible height.
c. Proper earthing is provided or not and Earth wire is of proper size/gauge.
d. No any necked wire should be visible.

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Now fix the single phase meter in meter box and connect the outgoing phase and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire. Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for

energization, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

4. Practical procedure of Installation of Poly/3 Phase Energy Meter.

First inspect the site where the meter is to be installed and observe the following

a. Cable size is proper, or not, as per load and the cable is properly open from pole to meter box.
b. Meter box was placed at right place i.e. at the door step and proper visible height.
c. Proper earthing is provided or not and Earth wire is of proper size/gauge.

No any necked wire should be visible.

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Now fix the Poly/3 phase meter in meter box and connect the outgoing phase R, Y, B (three) and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire R, Y, B (three). Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect all the three (R, Y, B) phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

5. Procedure of Replacement of Single phase Energy Meter

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Firstly remove seals provided in terminal cover as well as meter box. Now unscrew the phase and neutral wire of incoming as well as outgoing from meter terminal now you remove cable connection from terminal. Now you can remove meter. If you have a meter for replacement then fix the single phase meter in meter box and connect the outgoing phase and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire. Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect.

6. Procedure of Replacement of Poly/3 phase Energy Meter

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Firstly remove seals provided in terminal cover as well as meter box. Now unscrew the all phases and neutral wire of incoming as well as outgoing from meter terminal now you remove cable connection from terminal. Now you can remove meter. If you have a meter for

replacement then Now fix the Poly/3 phase meter in meter box and connect the outgoing phase R, Y, B (three) and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire R, Y, B (three). Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect all the three (R, Y, B) phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

Unit 2
Meter reading and post installation procedure

Introduction

Meter reading is very important activity in electric energy distribution. Revenue generation of a discom company is fully dependent on meter reading activity. Accuracy and time bound meter reading program is more important in meter reading activity. In past time meter reader visited door to door to take meter reading and the reading was processed and generate the electricity bill and again a bill distributor distribute the bill visiting door to door. At present these process has been changed. Now the meter reader visited a house and after taking meter reading he generated the bill through spot billing machine and hand over to consumer immediately. Even now automatic meter reading is also been taken by providing Smart meter in consumer premises through digital communication techniques and processed for generation of electricity bills.

Electrician Taking Meter Reading

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- explain Meter Reading Procedure
- describe parameter of post installation maintenance

Session 1

Meter reading process

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- Basic Meter Reading Procedure
- Maintain the log

Meter Reading

Profitability of a distribution utility depends upon metering, billing and collection efficiency. As the basic principles are: meter all that is used; bill all that is metered; and collect all that is billed. The move is from mechanical meters towards static (electronic) meters.

Fig. 2.1 Electrician Taking Meter Reading

The distribution systems are subject to important changes initiated by the electricity markets. Consumers have option of open access among multiple suppliers, bringing about a more complex and interactive control and billing scheme than in the previous situation with vertically integrated electricity companies. Another difference will be the ever more occurring bi-directionality of the electrical energy flow, due to the introduction of distributed generation units, in which a significant proportion of the electrical energy is produced on or near the consumer site. The excess energy can be supplied into the grid. Along with these changes, the power quality (PQ) has become very important, due to the large-scale use of power electronic based systems by both consumer and power suppliers.

Electricity meters Reading

There are a few different kinds of electricity meter and they are read in slightly different ways.

Fig 2.2 Meter reading

Simply enter all six numbers on your meter, including the number furthest to the right (usually, but not always red). If the number starts with a zero, include this too. The reading above is therefore 04267.3

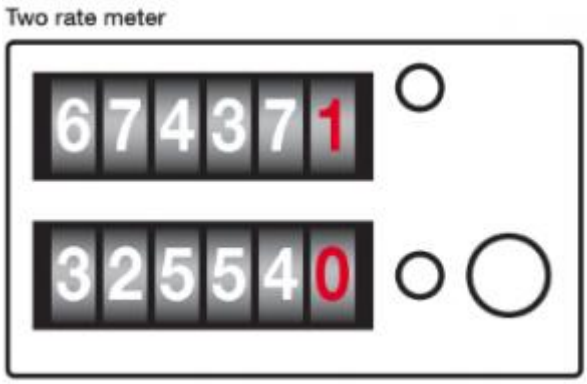


Fig 2.3 Meter reading

A two rate meter allows you to enter two different figures. You'll have this kind of meter if you're on an economy tariff. The Low rate is your night or economy rate. The Normal rate is your day or standard rate. Again, just provide us with the 6 digit number from left to right including the last number (usually in red). That means that the top reading here would be 67437.1 and the bottom reading would be 32554.0.

Fig 2.4 Meter reading

Sometimes, meters showing two rates are digital and only have one display. Different types of this kind of meter work in different ways. You'll see an identifier for the rate on the left hand side. This will usually be numerical – for example, rate 1 and rate 2. Rate 1 will be your low or night rate, rate 2 will be your normal or day rate. Either the display will change automatically every few seconds to show the two rates. Or you'll need to press the small button on the meter to see the rate that isn't currently showing. Then just read the number as it shows, including all the digits (although please exclude the rate identifier).

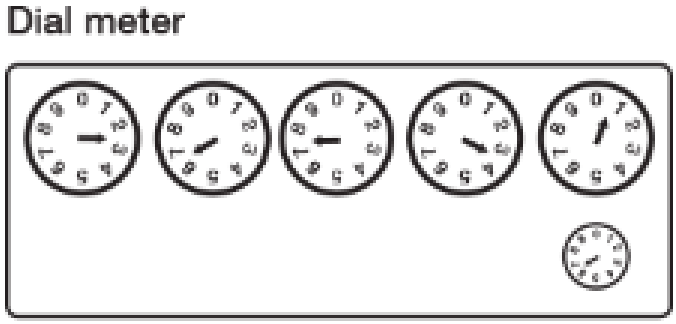


Fig 2.5 Meter reading

Dial meters need to be read left to right and each dial represents a separate number. Each dial actually turns in the opposite direction to the one before it. So if the pointer on the dial is turning clock wise the next dial should turn anti-clockwise. Every dial revolves from 0-1 and will pass through 9 before cycling round again. But whichever way they turn the numbers passed will always run in the same order – so the pointer will pass 1, then 2, then 3 and so on. If the pointer is between two numbers always record the lower number. If the pointer is directly on a number take that one. So in the picture the reading is 26730.6 (include the small dial) If the pointer falls between the 9 and the 0 make a record of 9 and reduce the reading you've already taken by one. So, for example if you've originally recorded 5 as the number reduce it to a 4.

Precaution during reading to be taken

- Read the dials from left to right
- If the pointer is between the two numbers, always take the lower number
- If the pointer is directly over a number, write down that one
- If the pointer falls between 9 and 0, write down 9 and reduce the reading you've already taken for the dial on it's left by one. For example, if you originally recorded 5, reduce it to 4
- Don't read the last dial on the right

Smart Meters: Smart meters are a new kind of energy meter. They use wireless technology similar to a mobile phone to send your meter readings to us automatically.

Smart meter send information about the energy used to a Smart energy display in consumer's home. This helps the consumer to see how much energy they are using and further allow them to get a good idea of what it's costing and helps to decide where they can use less.

Because the readings are sent to us automatically, it also means that one can say goodbye to those estimated bills and manual meter readings. Smart meters put consumers in control of their energy use, allowing them to adopt energy efficiency measures that can help save money on their energy bills and offset price increases.

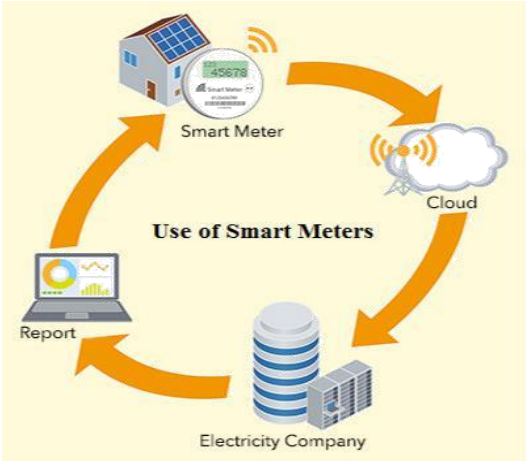


Fig. 2.6 Smart Meter Installation

Smart meters have been thoroughly tested for safety and reliability. These meters are also in use across the country, where they have undergone extensive tests by other utilities. Smart meters operate at a level that is much lower than the maximum permissible exposure limits for radio frequency.

Smart meters will ultimately make switching suppliers easier and quicker. It is important that smart metering devices work together (even if from different providers) and also that consumers can still use the meter on change of supplier.

Automatic Meter Reading (AMR) Technology

It is a technology for automating the process of energy measurement through digital communication techniques by bringing intelligence into the revenue cycle and managing it. The data can be transmitted from the meter to the utility company by telephone, power line, satellite, cable or radio frequency.

The main highlight of the AMR technology is that all types of meters in its installed base can be read through a single, seamless operation. The data from these meters is collected on a daily/fortnightly/ monthly basis and stored in a repository where all the analysis takes place automatically.

The AMR process flow is in the following sequence.

Fig. 2.7 AMR Process Flow

Common Meter Reading Instruments (CMRI or HHU)

The CMRI is a portable battery operated instrument applicable for viewing,

downloading, and uploading meter data to BCS. In the context of electricity metering applications, it is also referred as MRI or HHU. CMRI have been in use for more than a decade in the Indian power sector. The present CMRI's has a hardware/software that runs different communication protocols as provided by various manufacturers to download data from the meters of respective manufacturers, all of which are generally supplied with their own data exchange formats or protocols.

Fig. 2.8 Consumer Meter Reading Instrument

Spot Billing

Now a day's Meter reading instrument or HHU (Hand held unit) are being used to take meter reading by connecting energy meter through its optical port thus eliminates human error of recording. These instruments are also used for Spot billing. An inbuilt thermal printer on the HHU simultaneously generates the electricity bill as soon the meter reading is taken at consumer's premises. Each HHU are programmed according to tariff of each consumer in route if the consumer makes the payment at spot the same is also acknowledged through HHU. Thus a consumer does not need to go to cash collection centre of utility for electricity bill payment.

Fig. 2.9 Spot Billing (Electrician Giving Bill to Consumer)

Exercise

1. Write a short note on the following
   a. Spot billing
   b. AMR technology
   c. Importance of meter reading
2. Fill in the blacks
   a. Spot billing machine is known as .....
   b. Smart meter sent reading .....
   c. Energy billing is depend upon .....

Session 2

Post installation and maintenance

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- Measure the current and Voltage
- Verify power consumption

A multimeter or a multitester, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Digital multimeters (DMM, DVOM) have a numeric display, and may

also show a graphical bar representing the measured value. Digital multimeters are now far more common due to their cost and precision, but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value.
A multimeter 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.
Multimeters are available in a wide range of features

Fig 2.10 Multi meter

A multimeter is has three parts:

- Display
- Selection Knob
- Ports

The display usually has four digits and the ability to display a negative sign. A few multimeters have illuminated displays for better viewing in low light situations.
The selection knob allows the user to set the multimeter to read different things such as milliamps (mA) of current, voltage (V) and resistance (Ω).
Two probes are plugged into two of the ports on the front of the unit. COM stands for common and is almost always connected to Ground or '-' of a circuit. The COM probe is conventionally black but there is no difference between the red probe and black probe other than color.

Measuring Voltage

To start, let's measure voltage of line: Plug the black probe into COM and the red probe into mAVΩ. Set the multimeter to "250V" in the AC (Alternating current) range. Connect the black probe to the neutral or ground and the red probe to power or phase wire. Write down the reading of multimeter which is the voltage between phase and neutral.

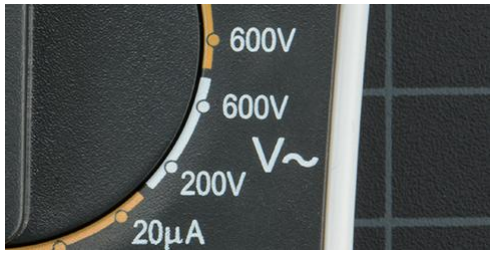


Fig 2.11 Range of multimeter

Measuring Current

Reading current is one of the trickiest and most insightful readings in the world of embedded electronics. It's tricky because you have to measure current in series. Where voltage is measure in parallel, to measure current you have to physically interrupt the flow of current and put the meter in-line. The first thing we'll need is an extra piece of wire. As mentioned, we'll need to physically interrupt the circuit to measure the current.

Digital Multimeter

fig. 2.12 Digital Multimeter

It measures all the basic electrical parameters required in meter testing such as:

1. Potential across line in Volt
2. Resistance of circuit conductor in Ohms
3. Fine value of current up to 1 Amp (1000 mA)
4. Continuity of control wiring
5. Frequency in Hz
6. Inductive reactance of circuit
7. Capacitive reactance

Clip-on Meter or Clamp-on Tester

Fig. 2.13 Clamp-on Tester

1. It measures on line current and voltage of AC circuit used in LT system.
2. The tong is made up of core material, when a live line conductor is clamped-in over insulation, it indicates the instant current flow in A (Ampere).
3. The tong of clamp meter acts as primary winding, and secondary winding calculates the current flow with its built-in multimeter.
4. Additional plugs are provided to check voltage and continuity.

7. Installation of Single Phase Energy Meter.

First inspect the site where the meter is to be installed and observe the following

e. Cable size is proper, or not, as per load and the cable is properly open from pole to meter box.
f. Meter box was placed at right place i.e. at the door step and proper visible height.
g. Proper earthing is provided or not and Earth wire is of proper size/gauge.
h. No any necked wire should be visible.

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Now fix the single phase meter in meter box and connect the outgoing phase and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire. Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

8. Practical procedure of Installation of Poly/3 Phase Energy Meter.

First inspect the site where the meter is to be installed and observe the following

i. Cable size is proper, or not, as per load and the cable is properly open from pole to meter box.
j. Meter box was placed at right place i.e. at the door step and proper visible height.
k. Proper earthing is provided or not and Earth wire is of proper size/gauge.
l. No any necked wire should be visible.

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Now fix the Poly/3 phase meter in meter box and connect the outgoing phase R, Y, B (three) and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire R, Y, B (three). Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect all the three (R, Y, B) phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

9. Procedure of Replacement of Single phase Energy Meter

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase

wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Firstly remove seals provided in terminal cover as well as meter box. Now unscrew the phase and neutral wire of incoming as well as outgoing from meter terminal now you remove cable connection from terminal. Now you can remove meter. If you have a meter for replacement then fix the single phase meter in meter box and connect the outgoing phase and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire. Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect

10. Procedure of Replacement of Poly/3 phase Energy Meter

Now first you wear the hand gloves and cut off the supply from the Distribution box and discharge the line using discharge rod and hang the discharge rod in phase wire. Put caution board also in distribution box before the starting the work. Now you have created a safe zone for work. Firstly remove seals provided in terminal cover as well as meter box. Now unscrew the all phases and neutral wire of incoming as well as outgoing from meter terminal now you remove cable connection from terminal. Now you can remove meter. If you have a meter for replacement then Now fix the Poly/3 phase meter in meter box and connect the outgoing phase R, Y, B (three) and neutral as per diagram shown in meter cover afterward first you connect incoming neutral wire in meter terminal and lastly the incoming phase wire R, Y, B (three). Please ensure proper tightening the screw of meter terminals. Now you put meter cover or box cover. Now premise is ready for energisation, now you connect the neutral wire of cable to supply neural conductor or neutral in distribution box and then you connect all the three (R, Y, B) phase wire to the line. Remove earthing rod and caution board before switch on the supply. Now you check the supply in consumer premise and if you are satisfy with the work man ship and proper working of meter then you seal the meter using seal pliers and lead seal or any other seal.

11. Taking Meter reading and recording in log book (preparation of log book)

Log Book of meter reading
Name of consumer
Meter No.
Address
Meter History No.

Capacity of meter

Make of Meter
Mobile no.
Date of Installation
Connected/sanction load.
M.F.

Date of reading	Reading	Consumption	Power factor	Max. Demand	Seal condition	Remarks

12. Measuring the Voltage and current through clamp on tester

To measure the current using clamp on tester, live line conductor is clamped-in over insulation, it indicates the instant current flow in A (Ampere).
To measure voltage clamp on tester's Plug the black probe into COM and the red probe into Phase. Set the multi meter to "250V" in the AC (Alternating current) range. Connect the black probe to the neutral or ground and the red probe to power or phase wire. Write down the reading of multi meter which is the voltage between phase and neutral.

Unit 3
Bus Bar and distribution box connected to the meter

Introduction

Now a day's multi storey buildings are a common feature of society and every city in India having so many multi storey building and commercial complex. For these type of buildings a special type of metering are being done. Panels are installed in one of the suitable place of building having bus bars, main protection arrangements and individual protection as well, there are enough space to work safely and space for fixing the meters.

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- describe the Multistory building bus bar and Meter Arrangements
- explain wiring drawing of control panel
- explain electro mechanical Assembly

Session 1

Multistory building bus bar and Meter Arrangements

LEARNING OUTCOMES

On completion of this session the student will be able to:

- explain installation of meters in multistory building
- explain distribution of lines and connection points

Multistory building bus bar arrangements

The requirements of the planning and execution of electrical works of an ordinary building having ground plus one or two floors housing are quite different from those of a multi storied or high rise building. A building is classified as 'High Rise', if it has more than Four floors (Ground + 3 Floors) or height more than 15 meters. It can be regarded as a miniature township requiring entire range of civic services such as electric power from the electricity board, standby / emergency power from diesel generator, water supplies for various applications, fire fighting system, elevator services and sanitation.

Details of electrical power requirements

The basic planning of the electrical works in high rise buildings starts with identifying the various requirements of the occupiers of the building, as well as the requirements of the statutory regulations. For this, one need the layout plan of each of the apartment, the activity planned in each room, the furniture layout, location of various electrical gadgets & their individual power requirement, plumbing needs etc. The requirements of apartments also largely vary depending on whether the occupier belong to high or low income group. Generally the high income group owner may prefer a large number of electrical outlets for lights, fans, table lamps, floor lamps, radio, T.Vs, music system, personal computers, fax machine, cordless telephones, air conditioners, washing machines, geysers, microwave oven, refrigerators, grinders, dish washer etc. This will not be the case with lower income group owners who may have one or two light points in each room, one or two sockets, a TV, a few fan points, refrigerator and a few kitchen appliances. Larger the income, higher is the power requirement & consumption. In addition to the individual requirements of the owners, there are also requirements for certain common areas, common facilities of the entire complex, such as common area and road lightings, elevators, water supply pumps, fire water systems, & fire fighting controls, recreation / swimming pool, communication system, security system etc. In the event of power failures, standby diesel generators need to take care of the common area lighting, drinking water pumps, fire water pumps, sewerage & storm water drainage pumps, elevators and a few lights for each apartment. This calls for laying of separate circuits for emergency lighting and change over facility for elevators, pumps etc. Based on these loads, total requirement of normal power as well as the emergency power with a provision for 15 to 20% future load growth & considering a Load factor of 0.6 to 0.8 depending on the type of load and one's experience in calculating the total demand.

Power distribution and safety devices

When once the estimated total demand has been arrived at, we have to decide how we are going to distribute it. In a simple 2/3 floor building it is fairly simple as there are only a few individual owners and their cumulative demand is also low. This low demand of power can be generally met by the utilities through a single phase supply to each owner and measured through independent energy meters. However, in the case of high rise buildings the requirement could be in terms of 1 to 2 mega watts depending on the number of apartments. Advance interaction with the electricity board with regard to the availability of catering such large power from their existing system is necessary. Otherwise the utility

has to plan necessary High Tension (HT) sub stations / feeders exclusively for the high rise complex. Such large power requirements are generally catered through High Tension supply, which could call for installation of a few step down substation inside the high rise complex. Each such substation has its own three phase + neutral, low tension power distribution boards. The electrical designer has to suitably plan the feeders and the out going cables in such a way that the loads or properly balanced on all the three phases and that each consumer gets proper voltage at his premises. Incoming supply to each consumer has to be protected by provision of an Earth Leakage Circuit Breaker (ELCB) to safeguard the persons against electrical shocks from faulty electrical gadgets. Further each circuit within the apartment is to be protected by Miniature Circuit Breakers (MCBs) to safely trip that particular circuit whenever there is an over load or short circuit. All power sockets need to be earthed through an earth conductor and ultimately connected solidly to earthed ground pits for safety of the personnel. With this provision any leakage current from a defective equipment will be directed to the ground and sensed by the ELCB, without harming the person coming in contact with it. Lightning arrestors provided at the top of the high rise buildings are connected to separate Earth pits through metallic conductors to safeguard the building against lightning.

Installation of Meter in Multi-Story building

The energization of Multi-story building is being done through panel box. A panel box consists of a bus bar arrangement, A Main MCCB (moulded case circuit breaker) space for premise wise meters to install and MCB for individual premise.

Bus Bar Arrangement

In electric power distribution, a busbar is a metallic (normally copper) strip or bar, typically housed inside switchgear, panel boards, and busway enclosures for local high current power distribution. They are also used to connect high voltage equipment at electrical switchyards, and low voltage equipment in battery banks. They are generally uninsulated, and have sufficient stiffness to be supported in air by insulated pillars. These features allow sufficient cooling of the conductors, and the ability to tap in at various points without creating a new joint.

The material composition and cross-sectional size of the busbar determine the maximum amount of current that can be safely carried. Busbars can have a cross-sectional area of as little as 10 square millimetres (0.016 sq in), but electrical substations may use metal tubes 50 millimetres (2.0 in) in diameter (20 square millimetres (0.031 sq in)) or more as busbars.

Busbars are produced in a variety of shapes such as flat strips, solid bars and rods typically copper, brass or aluminium in solid or hollow tubes.[1] Some of these shapes allow heat to dissipate more efficiently due to their high surface area to cross-sectional area ratio. The skin effect makes 50–60 Hz AC busbars more than about 8 millimetres (0.31 in) thickness inefficient, so hollow or flat shapes are prevalent in higher current applications. A hollow section also has higher stiffness than a solid rod of equivalent current-carrying capacity, which allows a greater span between busbar supports in outdoor electrical switchyards.

A busbar must be sufficiently rigid to support its own weight, and forces imposed by mechanical vibration and possibly earthquakes, as well as accumulated precipitation in outdoor exposures. In addition, thermal expansion from temperature changes induced by ohmic heating and ambient temperature variations, and magnetic forces induced by large currents must be considered.

Distribution boards split the electrical supply into separate circuits at one

location. Busways, or bus ducts, are long busbars with a protective cover. Rather than branching from the main supply at one location, they allow new circuits to branch off anywhere along the route of the busway.

A busbar may either be supported on insulators, or else insulation may completely surround it. Busbars are protected from accidental contact either by a metal earthed enclosure or by elevation out of normal reach. Power neutral busbars may also be insulated because it is not guaranteed that the potential between power neutral and safety grounding is always zero. Earthing (safety grounding) busbars are typically bare and bolted directly onto any metal chassis of their enclosure. Busbars may be enclosed in a metal housing, in the form of bus duct or busway, segregated-phase bus, or isolated-phase bus.

Busbars may be connected to each other and to electrical apparatus by bolted, clamped, or welded connections. Often, joints between high-current bus sections have precisely-machined matching surfaces that are silver-plated to reduce the contact resistance. At extra high voltages (more than 300 kV) in outdoor buses, corona discharge around the connections becomes a source of radio-frequency interference and power loss, so special connection fittings designed for these voltages are used.

Fig 3.1 Bus Bar Arrangement in a Electrical panel

Fig 3.2 Another type of bus bar arrangement in Electrical panel

Single-Phase/ Three Phase Electrical Wiring installation in a Multi-Story Building

Multistory building Distribution System

Requirements

- Three Phase Energy meter
- Two Pole MCCB, As per required capacity, 1 No
- Single Pole, As per required capacity , MCB,
- Distribution board cases, 3 Nos
- Bus bar Link for Neutral Cable Connections
- Cupper strips for MCB Common connection, 3 Nos

Step by Step Procedure

To do Electric wiring distribution system in a multi-storey building, follow the following steps.

1. First of all, connect the single-phase energy meter/ Three phase meter for each premise phase connecting from bus bar and meter out going to be connected to ingoing of MCB. Outgoing of MCB will be used as load point.
2. Connect the MCCB (Moulded Case circuit Breaker) incoming Phases from Electric pole or Transformer distribution box. Outgoing of MCCB will be connected to the main bus bar
3. Neutral wires from pole will be directly connected to neutral of bus bar and bus bar to meter's neutral.
4. Do not forget about earthing. So connect panel and all loads with Earth link and earth link must be connected to the earth electrode viva earth lead.
5. Use the main MCCB with proper rating i.e. which carry the total load current of all distribution boards.

General Precaution

- Disconnect the power source before servicing, repairing or installing electrical equipments and installation.
- Also use the proper cable in size with this simple calculation method (How to determine the suitable size of cable for Electrical Wiring Installation)
- Never try to work on electricity without proper guidance and care
- Work with electricity only in presence of those persons who has good knowledge and practical work to deal with electricity
- Read all instruction and cautions and follow them strictly.

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

Fig. 3.3 Normal distribution box

Distribution boxes are used to distribute the various load connected in the system. It is also useful to balance the connected load in 3 phase system. Advantage of installing the distribution box with MCB is that if any fault occurs in particular section the MCB trips and rest of supply will not 'OFF'

Fig. 3.4 Bus bar with MCB

Now a day bus bar with MCBs is used because it has very good protection system.

Exercise

1. Fill in the blanks
    a. ……. are used in busbar for protection.
    b. ……. metal is used in bus bar.
    c. ……..is used as secondary protection.
2. Write short note
    a. Multi storey building
    b. Bus bar arrangement.

Session 2

Wiring drawing of control panel

LEARNING OUTCOMES

On completion of this session the student will be able to:

- explain reading of wiring diagram
- explain method of making wiring diagram

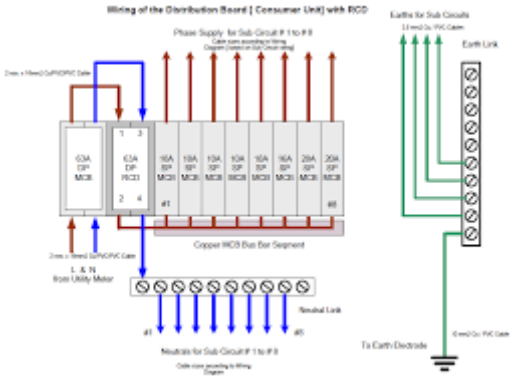


Fig. 3.4 Schematic diagram

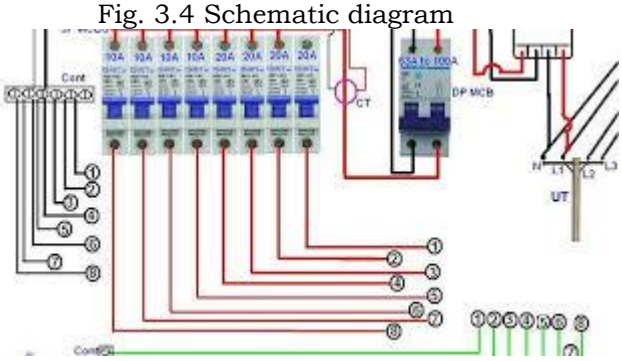


Fig. 3.5 Schematic diagram

Reading of wiring diagram is easy to learn. You should know the symbol, colour coding of wire, labelling procedure you can see the above two pictures and you can easily understand the diagram.

Wiring diagram is being made by using a soft ware called auto-cad. You can easily prepare the schematic diagram using the software.

Exercise:

1. What are the precautions taken during installation of meter in multi story building?
2. Fill in the blanks

d. In multistory building supply is given through .....

e. ..... and ..... Meters are used in multistory build.

f. .....is used as main switch in bus bar arrangement.

g. ..... metal is used for bus bar.

Session 3

Electro mechanical Assembly

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- explain importance of electromechanical assemblies and their componetents
- explain different types of electromechanical assemblies
- describe Wiring instruction and guidelines for wiring assemblies
- describe Labeling Methods for a control panel

In engineering, electro mechanics combines electrical and mechanical processes and procedures drawn from electrical engineering and mechanical engineering. Electrical engineering in this context also encompasses electronic engineering.

Devices which carry out electrical operations by using moving parts are known as electromechanical. Strictly speaking, a manually operated switch is an electromechanical component, but the term is usually understood to refer to devices which involve an electrical signal to create mechanical movement, or mechanical movement to create an electric signal. Often involving electromagnetic principles such as in relays, which allow a voltage or current to control other, usually isolated circuit voltage or current by mechanically switching sets of contacts, and solenoids, by which a voltage can actuate a moving linkage as in solenoid valves. Piezoelectric devices are electromechanical, but do not use electromagnetic principles. Piezoelectric devices can create sound or vibration from an electrical signal or create an electrical signal from sound or mechanical vibration.

Precision electro-mechanical assembly

Many complex mechanical assemblies are produced , which often feature a similar number of parts to a PCB assembly. These products demand high levels of skill, precision, accuracy and consistency. There is considerable in-house experience producing mechanical assemblies. They have such a high level of moving parts that we refer to them as "machines" rather than "products".

The awareness of critical engineering tolerances and the use of mechanical tools and gauges is key when producing moving mechanical assemblies of this complexity. Our skills-base also extends to testing mechanical and pneumatic assemblies. Following rigorous approval processes, our supply chain partners for custom parts - such as plastics, machined and fabricated metalwork, etc. - are monitored for quality and delivery performance. Tight control of the material supply chain ensures that, as with electronic parts, the availability of high-quality mechanical parts is maintained for timely production.

Electrical assembly

Many of the assemblies produced need wire and cable interconnection between boards and sub-assemblies. This can be via cable forms or point-to-point wiring.

As part of our electro-mechanical assembly service, we are often called on to produce machines that require critical cable routing, so that the moving parts may function. We also undertake electrical wiring of switch and instrument panels, as well as sophisticated control cabinets. These are all essential requirements for many of our customers. This activity reflects the same standards of accuracy and consistency as our PCB and mechanical assembly work.

The different circuit breakers and difference between MCB and MCCB, ELCB and RCCB are discussed below.

MCB-Miniature Circuit Breaker

MCB is an electromechanical device which guards an electrical circuit from an over current, that may effect from short circuit, overload or imperfect design. This is a better option to a Fuse since it doesn't require alternate once an overload is identified. An MCB can be simply rearranged and thus gives a better

operational protection and greater handiness without incurring huge operating cost. The operating principle of MCB is simple.

fig.3.6 Miniature Circuit Breaker

An MCB function by interrupting the stability of electrical flow through the circuit once an error is detected. In simple conditions this circuit breaker is a switch which routinely turns off when the current flows through it and passes the maximum acceptable limit. Generally, these are designed to guard against over current and overheating.

MCB is substituting the rewirable switch-fuse units for low power domestic and industrial applications in a very quick manner. In wiring system, the MCB is a blend of all three functions such as protection of short circuit, overload and switching. Protection of overload by using a bimetallic strip & short circuit protection by used solenoid.

These are obtainable in different pole versions like single, double, triple pole & four poles with neutral poles if necessary. The normal current rating is ranges from 0.5-63 A with a symmetrical short circuit breaking capacity of 3-10 KA, at a voltage level of 230 or 440V.

Characteristics of MCB

The characteristics of an MCB mainly include the following

- Rated current is not more than 100 amperes
- Normally, trip characteristics are not adjustable
- Thermal/thermal magnetic operation

MCCB-Moulded Case Circuit Breaker

The MCCB is used to control electric energy in distribution n/k and is having short circuit and overload protection. This circuit Breaker is an electromechanical device which guards a circuit from short circuit and over current. They offer short circuit and over current protection for circuits ranges from 63 Amps-3000 Amps. The primary functions of MCCB is to give a means to manually open a circuit, automatically open a circuit under short circuit or overload conditions. In an electrical circuit, the over current may result faulty design

Fig.3.7 Moulded Case Circuit Breaker

Fig. 3.8 Function of MCCB

The MCCB is an option to a fuse since it doesn't need an alternate once an overload is noticed. Unlike a fuse, this circuit breaker can be simply reset after a mistake and offers enhanced operator safety and ease without acquiring operating cost. Generally, these circuits have thermal current for over current and the magnetic element for short circuit release to work faster.

Characteristics of MCCB

The characteristics of an MCCB mainly include the following

- The range of rated current us up to 1000 amperes
- Trip current may be adjusted
- Thermal/thermal magnetic operation

Moulded Case Circuit Breakers - MCCB Components and Applications

Moulded case circuit breakers (MCCBs) are UL 489-approved circuit breakers whose current-carrying parts, mechanisms and trip devices are all completely contained within a moulded case of insulating material. MCCBs are available in various frame sizes with various interrupting ratings for each frame size. MCCBs are one of the two basic low voltage classes of circuit breakers.

Moulded Case Circuit Breakers are designed to provide circuit protection for low voltage distribution systems. They will protect connected devices against both overloads and short circuits. They are most-commonly-used in panel boards and switchboards where they are fixed mounted, though some of the larger MCCBs available may be available in a draw out mount design.

MCCBs are available with special features which make them suitable for the protection of motor circuits when used in conjunction with a separate overload protection device. When used in such applications, they are often referred to as motor circuit protectors (MCPs).

Molded Case Circuit Breaker Components

Molded Case Circuit Breakers are composed of five main components. These are: Molded case/frame, operating mechanism, arc extinguishers, contacts and trip units.

Frame: The Frame, also known as the moulded case, provides an insulated housing to mount to mount all of the circuit breaker components. This will often be made of a glass-polyester material or thermo set composite resin that combines ruggedness and high dielectric strength in a compact design. A frame designation is assigned to each different type and size of moulded case. This designation is used to describe the breaker's characteristics including maximum voltage and current ratings.

Operating Mechanism: The Operating Mechanism handles the opening and closing of the contacts. The speed that the contacts open or close is independent of how fast the handle is moved. This is known as "quick-make, quick-break". The breaker cannot be prevented from tripping by holding the handle in the on

position. This is known as "trip-free". The position of the handle indicates the status of the contacts - whether they are closed, open, or tripped. The handle will be in a midway position when the contacts are tripped, for example. In the event of a trip, the handle must first be moved to the off position from its center-tripped position, and then to the on position. When breakers are mounted in a group such as in a panel board, the distinct handle position will clearly indicate the faulted circuit. Some breaker designs may also incorporate a push-to-trip mechanism which allows for a manual means to trip the breaker and test the mechanism.

Arc Extinguisher: An arc is created whenever a circuit breaker interrupts a current flow. The Arc Extinguisher's job is to confine and divide that arc, thereby extinguishing it. Arc extinguishers are typically made of a stack of steel plates held together by two insulator plates. When an interruption occurs and the contacts separate, the current flow through the ionized region of the contacts induces a magnetic field around the arc and the arc extinguisher. The lines of magnetic flux created around the arc and its force drives the arc into the steel plates. The gas then goes through deionization and the arc divides, allowing it to cool. Standard MCCBs use a linear current flow through the contacts. Under short-circuit conditions, a small blow-apart force is created, which helps open the contacts. The majority of the opening action comes from the mechanical energy stored in the trip mechanism itself. This is because the current in both contacts are going in the same direction and attract each other. Newer design breakers use a reverse loop of current flowing in essentially opposite paths. This creates a repulsion action and results in a greater blow-apart force. This force assists with rapid arc extinguishing by causing the contact to open faster. The force is directly proportional to the size of the fault current. The greater the fault, the greater the force, and the faster the contacts open.

Trip Unit: The Trip Unit is the brain of the circuit breaker. The function of the trip unit is to trip the operating mechanism in the event of a short circuit or a prolonged overload of current. Traditional molded case circuit breakers use electromechanical trip units. Protection is provided by combining a temperature-sensitive device with a current sensitive electromagnetic device, both of which act mechanically on the trip mechanism. Electronic trip units are now available and they can provide much more sophisticated protection and monitoring. Most molded case circuit breakers utilize one or more different trip elements to provide circuit protection for different applications. These trip elements protect against thermal overloads, short circuits and arcing ground faults. Conventional MCCBs are available with either a fixed or interchangeable electromechanical trip unit. If a new trip rating is required for a fixed trip breaker, the entire breaker must be replaced. With an interchangeable trip unit, only the trip unit needs to be changed up to the maximum current rating of the breaker frame. Interchangeable trip units are also often called rating plugs. Some breakers offer inter-changeability between electromechanical and electronic trip units within the same frame.

ELCB -Earth Leakage Circuit Breaker

The ELCB is used to protect the circuit from the electrical leakage. When someone gets an electric shock, then this circuit breaker cuts off the power at the time of 0.1 secs for protecting the personal safety and avoiding the gear from the circuit against short circuit and overload.

Fig. 3.9 Earth Leakage Circuit Breaker

ELCB is a security device used in electrical system with high Earth impedance to avoid shock. It notices small stray voltages on the metal fields of electrical gear, and interrupt the circuit if an unsafe voltage is detected. The main principle of Earth leakage protectors is to stop injury to humans and nature due to electric shock.

This circuit breaker is specialized kind of latching relay that has structures incoming mains power connected through its switching contacts so that this circuit breaker disconnects the power supply in an unsafe condition.

The ELCB notices fault currents from live to the ground wire inside the installation it guards. If enough voltage emerges across the sense coil in the circuit breaker, it will turn off the supply, and stay off until reset by hand. A voltage-sensing earth leakage circuit breaker doesn't detect fault current from exist to any other ground body.

Characteristics of ELCB

The characteristics of an ELCB mainly include the following

- This circuit breaker connects the phase, earth wire and neutral.
- The working of this circuit breaker depends on current leakage.

RCCB (Residual Current Circuit Breaker)

A RCCB is an essential current sensing equipment used to guard a low voltage circuit from the fault. It comprises of a switch device used to turn off the circuit when a fault occurs in the circuit RCCB is aimed at guarding a person from electrical shocks. Fires and electrocution are caused due to the wrong wiring or any earth faults. This type of circuit breaker is used in situations where there is a sudden shock or fault happening in the circuit.

Fig. 3.10 Residual Current circuit Breaker

For instance, a person suddenly enters in contact with an open live wire in an electrical circuit. In that situation in the absence of this circuit breaker, a ground fault may occur and an individual is at the hazardous situations of receiving a shock. But, if the similar circuit is defended with the circuit breaker, it will tour the circuit in a second therefore, avoiding a person from the electric shock. Therefore, this circuit breaker is good to install in an electrical circuit.

Characteristics of RCCB

The characteristics of an RCCB mainly include the following

- Both wires phase and neutral are connected through RCCB
- Whenever there is any ground fault occurs, then it trips the circuit.

- The amount of current supplies through the line should go back through neutral.
- These are a very effective type of shock protection.

Wires and terminal numbering (Labelling)

In any electrical control panel, there are wires to which various electrical devices are connected.

It is important that electrical devices in a circuit are connected accurately through wires with proper voltages and polarity.

To ensure proper connections of wires, devices as well as terminals (through which they are routed) are given unique numbers.

This practice is followed for designing, assembling, and maintenance. This helps in identifying the devices, wires, and terminals during troubleshooting.

In an electrical panel, terminals are used to connect the wires. Generally, they are grouped together and called 'Terminal Block'. They are grouped either as per their functional use or as per the device connected.

Each terminal block consists of a group of terminals with an assigned 'Terminal Block Number'. Each terminal on the block is assigned a unique 'Terminal Number'.

In a panel, usually one side of the terminal is used for connecting internal wires from the devices inside the panel, and the other side is used for field or external connections.

In electrical panels, wires and cores of multi-core cables are used for interconnections. Wires and cable cores are terminated on device terminals and terminal blocks. Wires and cable cores used for interconnection are numbered. Alphabetical symbols and numbered ferrules are used on each wire or core of the cables.

The numbering of wires should consist of the following details:

• Cable number
• Wire or core number of the multi-core cable
• Terminal block number
• Terminal number on which the wire is to be terminated.

As a wire is connected at two ends, it is quite useful to use a cross-referencing method for numbering the wires. Cross-referencing of wires or cable cores include the details of the other end of the wire where it is terminated. Details such as 'Panel Number', 'Terminal Block Number', and 'Terminal Number' of the other end of the wire are also included apart from the above-mentioned details of the termination end.

Cross-reference wire numbering and terminal numbering is shown in Figure 2.13.

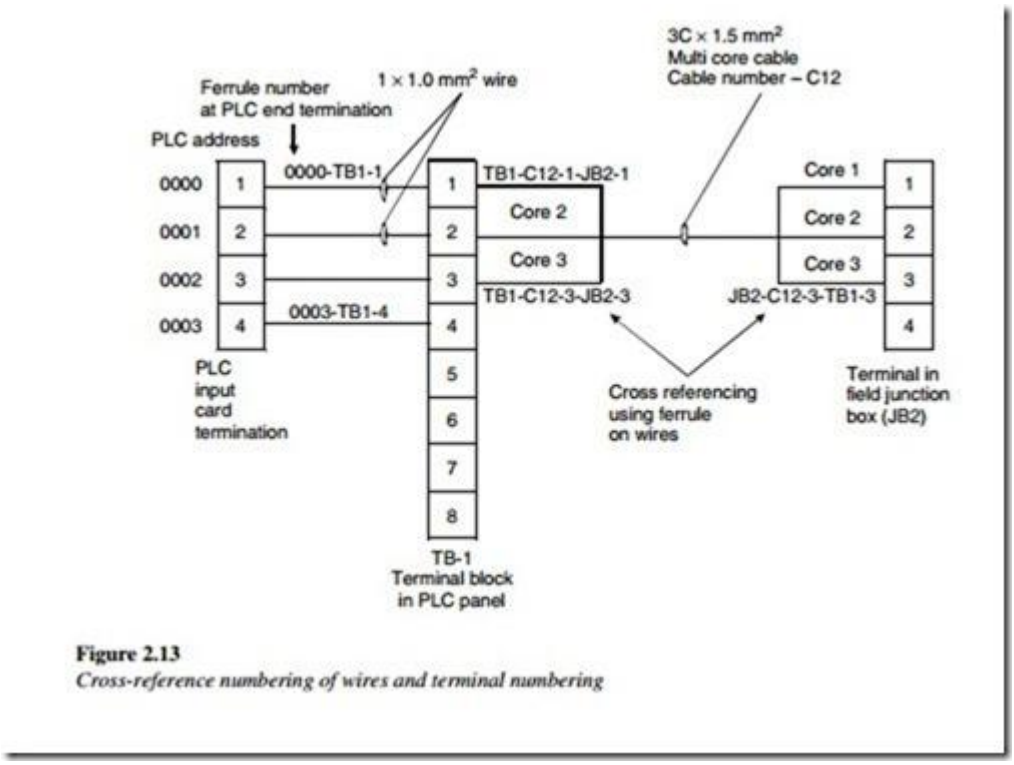


Figure 2.13
Cross-reference numbering of wires and terminal numbering

Fig. 3.11 labelling

Though the wire numbering and terminal numbering shown in the figure is typical, in practice, there are many ways and methods of numbering wires and terminals that may be adopted. A cross-referencing number is one of the methods found useful during cable laying and termination, continuity testing, and troubleshooting.

As shown in Figure 2.13, cross ferruling is used between TB1 and JB2 terminal blocks for cable C12 cores. The ferrule at TB2 terminal block gives an idea of where the other end of the core is connected.

For example, as shown in the Figure 2.14, a PLC panel wiring along with cross-reference ferruling, PLC address information is also included. It is quite useful to include the PLC address in the wire ferrule number apart from the cable number, core number, terminal number, and cross-reference detail for troubleshooting.

In Figure 2.14, cross-referencing ferruling is used for field devices and terminal block wiring, as well as inter-terminal block wiring. Although this kind of ferruling involves lengthy ferrule numbers, the practice is certainly worth the effort while troubleshooting.

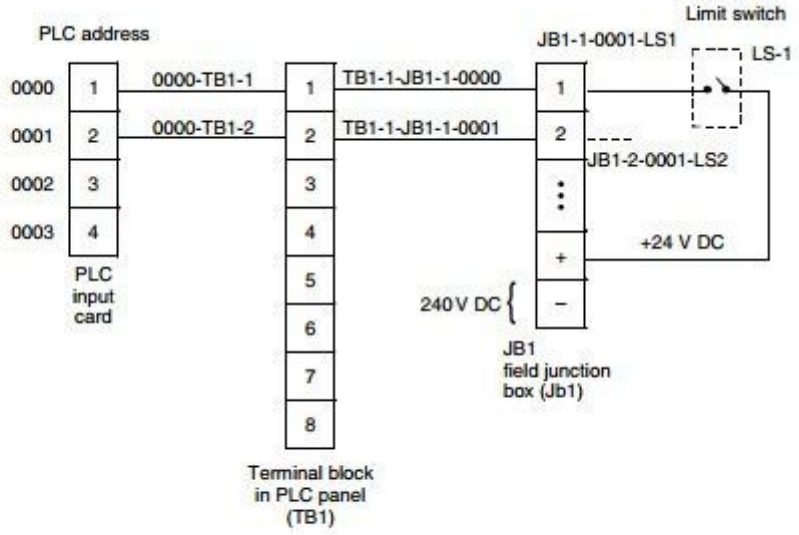


Figure 2.14
Wire numbering in a PLC panel with additional details such as PLC addresses

Exercise

1. Write the Characteristics of RCCB?
2. What is Labeling?
3. Write main component of molded case circuit breaker?
4. Mark True or false
    a. The ELCB is used to protect the circuit from the electrical leakage.
    b. Electrical devices are not connected properly through labeling.
    c. Main use of MCCB is trip the whole circuit.

Unit 4

Safety Precautions for electrical work

Introduction

Safety precaution is a for most thing to be adopted in a electrical system. Man working on live line as well as dead line should adhere of rules and regulation of safety precaution. Man working on line should have all the safety tools and got tested periodically. Man should know to create the safety zone before starting the allotted work. He also know the procedure for artificial respiration and basic first aid also.

LEARNING OUTCOMES

On completion of this unit the student will be able to:

- explain safe working practices
- describe basic First Aid procedures

Session 1

Safe Working Practices

LEARNING OUTCOMES

On completion of this session the student will be able to:

- Illustrate the importance of safety at workplace.
- List the safety equipment used at heights.
- Compare the working of various electrical equipment.
- Appreciate importance of using PPE.

What is Safety?

Safety means condition or state of a person free from injury, accident, risk or any kind of hazard.

Fig. 4.1 Safety Comes First

Some fundamental knowledge that every electrical worker should imbibe:

- Operating instruction
- Line clear approach
- NBFC (No Back Feed Certificate)
- Earthing arrangement
- Deployment of proper tools
- Authorisation to work on power equipment and lines
- Proper approach while withdrawing line clear
- Withdrawal of any tools or equipment lying on the line, while returning line clear should be ensured
- Earth rods are to be withdrawn before returning line clear
- To ensure that effective opening or closing of all AB switch blades as the case may be

Where to Find Health and Safety Equipment

Normally all the general health and safety equipment are available with the concerned sub-division in-charge in a construction sub-division. Moreover, all the linemen construction is provided with safety tools and equipment and PPEs for their personal use.

Fig. 4.2 Safety Tools for Electrical Workers

Safety Equipment Used at Heights

Portable Ladders

Portable ladders are normally one of three types:

- Straight
- Extension
- Step-ladders

Portable ladders are normally constructed on one of the three materials:

- Wood
  - ◊ Difficult to maintain
  - ◊ Have a limited service life
  - ◊ Are used less now
- Aluminium
  - ◊ Light-weight and maintenance-free
  - ◊ Strong for their weight
  - ◊ Bend before they break
  - ◊ Are good general service ladders unless exposure to heat or electricity is expected
- Fibreglass
  - ◊ Strong and durable
  - ◊ Relatively stable to heat and electricity
  - ◊ Good general service ladders, but are somewhat heavy

For all their apparent simplicity, two primary hazards are associated with the use of ladders. These hazards are:

- Falls (sudden stop at the bottom!)
- Electrical hazards
  - ◊ Electrocution
  - ◊ Shocks (often with resulting falls with sudden stops at the bottom!)

The correct way of leaning a ladder is to place it about 1 m out for every 4 m in height i.e. at an angle of 75 degrees. There should be sufficient space behind the rung to provide a proper footing.

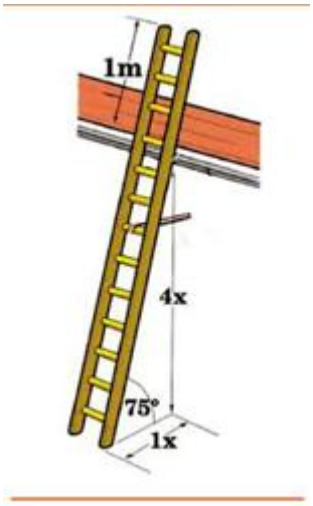


Fig. 4.3 Correct Way of Leaning a Ladder

The lineman should understand that portable ladders (of any type) and electricity truly do not mix. Portable ladders are difficult to handle and can easily or sometime accidentally break lighting and other power fixtures. The worst part is, portable ladders used outdoors can contact elevated high tension supply lines accidentally resulting in electrocution. In many cases, conductive ladders do not have to contact the line – they can merely come sufficiently close to it to cause a short circuit through the ladder to ground.

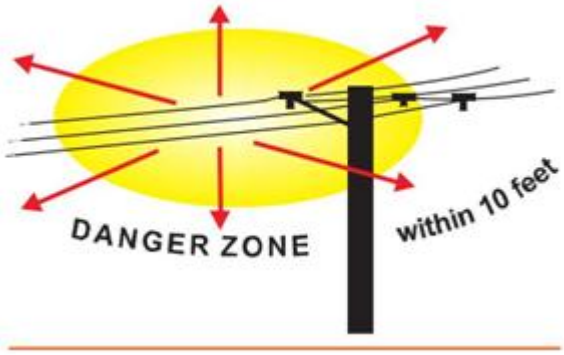


Fig. 4.4 Danger Zone

Tips

Many workers believe that they have time to regain their balance before they fall. However, this belief is usually untrue. The following table shows how far you can fall in different time spans:

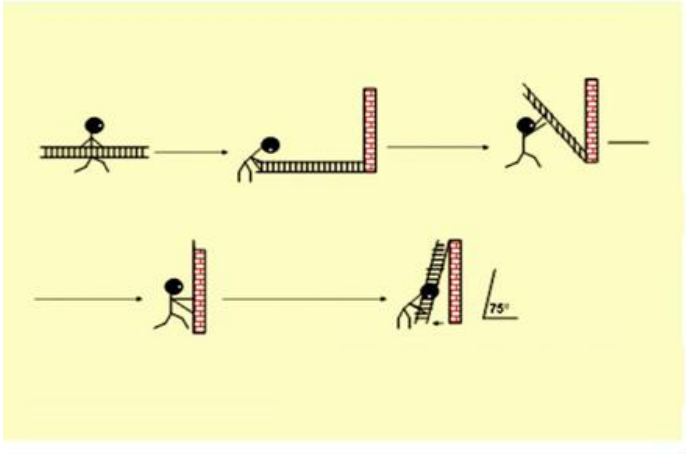
Time (Seconds)	Distance (Feet)
0.5	4
1.0	16
1.5	36
2.0	64
2.5	100
3.0	144
4.0	256

Table 4.1 Distance Covered in Different Time Span

If a 70 kg person falls from 64 feet height, he will receive impact of more than 2 ton (force of 2180 kg) more than enough to break a lot of otherwise healthy bones! Makes you appreciate the seriousness of the "sudden stop at the bottom"!

Some safety pointers when working with ladders:

- Do not use metal (or wet) ladders when working near power-lines.
- Keep all ladders at least ten feet away from residential power-lines and much further away from larger power-lines.
- Never hand carry loads up a ladder. If tools or supplies are required, carry them in your pocket, in a tool belt, or lift them from the ground in a line.
- Never stand on the ladder's top three rungs. It is easy to overbalance and fall off.
- Never use a ladder that is damaged or weakened.
- Never "walk" a ladder into position while you are on it. Climb down and re-position the ladder from the ground.
- Use care around electrical fixtures. You can get an electrical shock on any ladder, but dry fibreglass and wood ladders do not normally conduct electricity. Using aluminium ladders around electrical fixtures can result in electrocution.
- Never carry a ladder in the vertical position. Carry a ladder in the horizontal only.
- Never jump from a ladder.
- Be certain you are in good enough physical condition to climb. This includes that person should not be under the influence of alcohol or drugs that make you dizzy, drowsy or subject you to fainting.
- Make sure ladders are kept free of oils, greases or other contaminants that may cause slipping.
- Use ladders only for their intended purpose!
- Ensure the ladder is in good condition and can handle your weight.



Tips

Theoretically, a ladder is strongest when it is in the vertical (90°) position relative to the surface it is on. However, vertical ladders are not safe to climb, unless they are secured in some manner. So, a stable angle is used to weight-rate ladders; 75-76° relative to the support surface – a slope of 4/1. Therefore, the most stable angle for a portable

ladder is approximately 75° or a 4/1 slope.

Working with Electrical Equipment

Work permit system and creation of safety zone:

- Proper and safe operations on the electric system are the qualifications of the people who are responsible for performance of the work.
- It is important that people in charge of jobs be knowledgeable of the hazards and means for providing safe conditions to accomplish the necessary work.
- For this reason, only authorised workers will be permitted to request permits to work on sub-station premises or to perform work on circuits.

How to make safety zone for working in sub-station?

- Check the supply at HT&LT terminals of DT with Neon Tester.
- Test the supply at LT ACBs incoming and outgoing terminals with Neon Tester.
- Discharge it with discharge rods.
- Short the HT/LT bushings of DTs with chain and connect with Earth.
- Short the LT out going feeders with chain to prevent back feed from consumer.

Rules regarding permit and important notices/information:

- Unless line clear permit is issued by the authorised person, worker should not climb on pole or apparatus. No one should go in the vicinity of bare conductor and work.
- Only shift engineer or operation in-charge is authorised to issue permit.
- The line clear permit should only be issued to person duly authorised for said work.
- The only competent authority to authorise a worker is the Executive Engineer of that division or Superintending Engineer. They should issue authorisation order in writing.
- The permit can only be issued or obtained by these authorised persons for the work and jurisdiction as prescribed in the written authorisation order of Competent Authority.
- The written order of the Competent Authority should invariably be displayed on notice board at the concerned sub-station, power house and distribution centres in specific format.
- The consolidated authorisation should be kept at office of the concerned Superintending Engineer.
- The Superintending Engineer or Chief Engineer of Circle/Zone can authorise person other than stated above such as E.E. (Testing) or Testing Staff (or any other person who is competent to work in the views of concerned SE/CE).
- The Area Authority should include the names of such authorised persons in their list. The Area Officer should obtain the list of authorised persons of bulk consumers and area in the vicinity and also handover his list to them.

- Generally, the Line Inspector or persons of equivalent post are authorised for working on H.T. line/installations. However, Division Engineer may authorise the person/persons of below rank, if he is confident about his skills.

Method for issuing/obtaining and returning the permit:

- For obtaining line clear permit, only authorised person should apply. He should apply for line clear permit to the authorised person only and such authority will issue the permit accordingly.
- Where it is not possible to obtain permit in writing then permit can be obtained on telephone. In such case, the permit obtaining authority should confirm by repeating the matter with permit issuing authority on phone. The same should be noted in the permit book by both the persons. The duplicate copy of line clear permit after cancellation shall be sent to each other by post/ in person as early as possible for record. This register should be inspected by Area/Divisional Officer from time to time.

- The permit book is an important record and should be preserved properly. The pages of permit book should be numbered serially. Pages from this book should not be taken out or torn out or used for any other work. In case any page is torn-out or taken-out by some person due to any reason, then the concerned person should sign on the same and make dated entry in the logbook of sub-station/Power House with signature.
- The person, who has taken the permit, should return it. In case where the permit issuing and obtaining authority is same, the self-permit should be taken in his name and cancelled after completion of work. This procedure should be followed strictly.
- In case the permit is taken in person, same can be returned on phone.
- While issuing or returning permit on phone, the code words should be used.

Precautions to be taken while issuing permit:

It is the duty of the Shift Engineer or person issuing the line clear permit to ensure that the sub-station/ feeder/equipment for which the permit is being issued, should be made dead, i.e., equipment/ feeder should be discharged and properly earthed. First, he should switch off the equipment/feeder as per the instructions laid down. Thereafter, he should follow the following instructions regarding grounding and locking of equipment:

- Power T/F should be opened (off position) and locked, at S/stn, respectively.
- Warning boards with following instructions should be tagged on handles of isolators/breakers:
    - ◊ "Do not charge. Workers are working."
    - ◊ "The line/equipment under permit - Don't charge."
    - ◊ "Attention - work in progress - Do not change the line/equipment."
- The same type of warning boards should be tagged on handles of control switchgear. The control circuit fuse of control panel

should also be taken out and kept in the custody of permit issuing authority.

- The L.V. side breaker of the T/f should be pulled out from the breaker - panel.
- The H.T. and L.T. Terminals of the T/F should be permanently discharged using discharge rods and earth rods should be kept as it is until cancellation of permit.
- High voltage potential T/f and LAs, if erected on ground level, shall be discharged from outside the fencing and then earthed perfectly.
- Outdoor type circuit breakers should be first discharged from all six terminals and then perfectly earthed. Both sides of the isolator circuit breakers should be locked in off condition and warning board should be tagged to its handle.
- In case of indoor type H.T. panels, P.Ts should be made off, discharged and perfectly earthed before permit is given.

- Outdoor Bus Bar, isolators, etc. and switchgear or complete section of Bus Bar where line clear permit is to be issued, should be first isolated from all equipment and perfectly earthed. The isolated portions or parts should be brought to the notice of person to whom permit is being issued and accordingly noted in the permit. It is possible that some part of isolated switch may remain live; the same shall be brought to the notice of person whom permit is being issued and noted in the permit. While doing maintenance work above the ground level, the live parts or conductors may come in the vicinity of the worker. Such possibilities should be brought to the notice of person whom permit is being issued and in such cases, temporary screening arrangements should be made.
- At some places, the transformers, isolators are associated with the structure. In such cases, the climbing on the fuse structure is not advisable. The ladder should be used for replacement of fuses.
    - **Outdoor H.T. (Kiosk):** The O.C.B. must be switched off in case of outdoor H.T. (Kiosk). The incoming and outgoing links of OCB, PT and CT should be removed using operating rod and discharged. The bus isolators are in live condition and this point should be kept in mind.
    - **Indoor Cubical Gears:** The OCB should be switched off. Use operating rod to open links and earth. The isolating chamber or incoming cable may be live and such cases should be brought to the notice of person whom permit is being issued.
    - **H.T. Overhead Line:** The Circuit/ conductor on which work to be carried out, should be isolated by opening the CB and line links. In case of double feeding circuit, switches of both the ends should be opened and the earth switches of either end closed, if provided or line should be earthed locally before issue of line clear permit. If the feeders are controlled through trunk type metal clad gears, then gear must be separated from each other. Where earthing switch is not provided, conductors should be discharged and earthed perfectly.

- **H.T. Underground Feeders:** The same procedure as H.T. Overhead Lines is also applicable here. Further before taking work in hand it should be discharged and earthed at specific points. The low/medium pressure circuits, apparatus, equipment, control switches should be opened and made electrically dead. If circuit fuses are provided, they should be separated or breaker units should be racked down. The switches should be locked in off position and warning boards should be tagged on it. Where apparatus/or switches are remotely controlled, the control circuit fuses should be removed and kept in the custody of permit issuing authority and handed over to the person of next shift.

Fig. 4.45 Danger Signboard

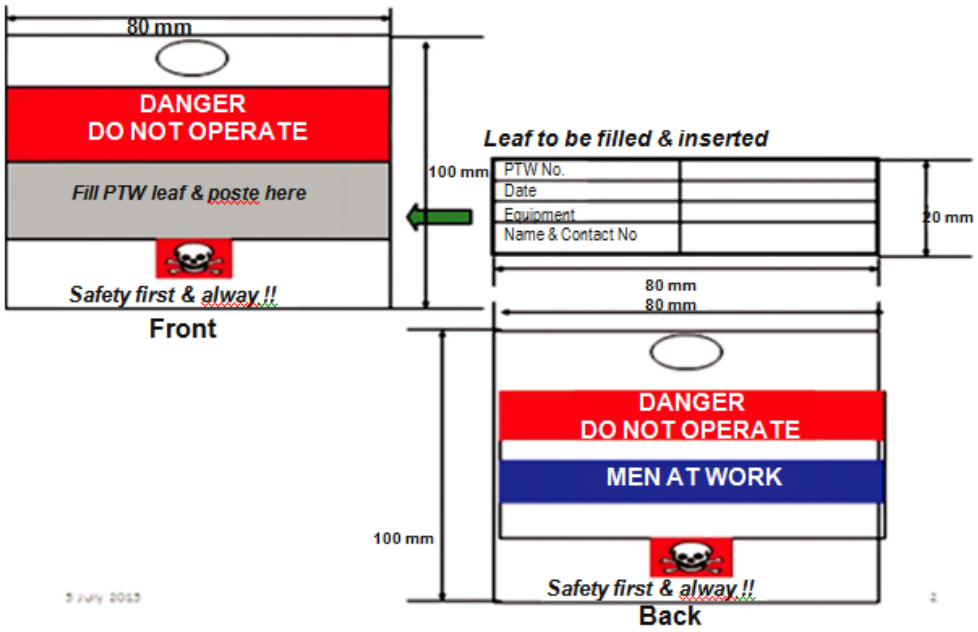


Fig. 4.46 Tagging Placed on Switchgear Handle after Getting Shut Down and PTW

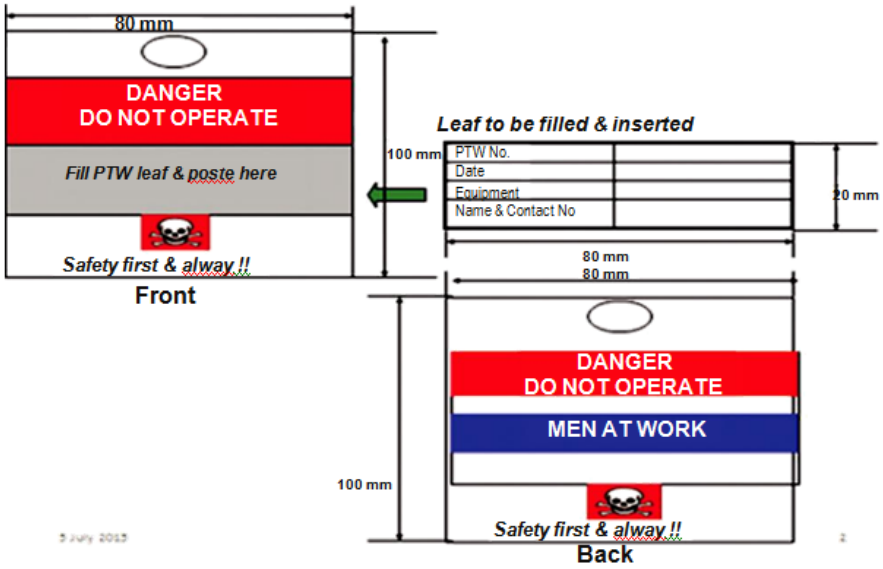


Fig. 4.46 Tagging Placed on Switchgear Handle after Getting Shut Down and PTW

Permit log in, issue and return permit:

- All the operations carried out should be logged in the substation log book as per the sequence of operations.
- All operations carried out at Down Substation/up substation/other end person should be logged in.
- The last operation regarding issue of/return of permits should be entered in the log-book with red-ink.
- During shift change, the outgoing operator/engineer should give the oral information about pending line permits and logged in the logbook by red ink along with other important information about pending permit.
- The incoming operator/engineer should also note about the balance work and note in the log-book about permit.
- All the sub-station operators concerned should follow the above practice.
- Equipment/line should not be charged unless permit is returned and cancelled.
- The person who has taken the permit should himself return the permit to the person from whom the permit is taken or to the next duty operator if shift changes.

Precautions to be taken during the work by permit holder:

- The permit holder should ensure before taking the work in hand that equipment/lines, switchgear, etc. on which permit is taken, are duly earthed. If it is not earthed properly, then the permit holder should not permit his staff to touch the equipment/switchgear.
- Information regarding specific places where one should not climb, the dead equipment, limit switches and structures, etc. should be brought to the notice of the co-workers/staff.
- The no entry warning boards should be tagged on line portion or on places where climbing is not permitted. The rope or red-flag can also be used at such places.
- When one has to climb on any structure or equipment, which are in the vicinity of live portion, then permit holder himself should be present there and proper guidance be given to the workers.

Exposure to Toxic Material

The worker may get exposed to flux or molten lead. Exposure may be due to ingestion, contact with skin, or inhalation. The following preventive and remedial actions should be taken in case of exposure to toxic material like solvents:

- Provide immediate first aid.
- Drink lots of water and vomit to dilute the effect.
- Report exposure to supervisor for medical help.
- Wear mask and get the surrounding ventilated.

Importance of Using PPE

In this section, you will learn about the importance of Personnel Protective Equipment (PPE) while carrying out any electrical work of switching operation, repair and maintenance. Let us look at some basic PPE for electrical workers.

Neon (Power) Tester

It is a protective instrument that gives alarm indication of live H.V. and L.V. lines at a distance of 5 meter. It is fitted in a PVC conduit pipe (50 mm) of 2 meter length with extension rod of 3 meter. It has an LED indicator and audio alarm speaker to produce beep sound when its point is brought near the live line. It has three modes – 'ON', 'OFF' and 'Test' mode operated through inside battery backup. No beep sound and no indicator lamp light shows that power supply is dead at that point.

Fig. 4.6 Neon (Power) Tester

Precaution and maintenance of Neon (Power) Tester:

- Always ensure battery status by switching in Test mode to confirm the Neon Tester is functioning before checking any line.
- Keep the tester in 'OFF 'mode when not in use and to avoid battery unusual discharge.
- Always keep the tester in its gunny bag to protect from dust and moisture. Handle carefully.

Discharge Rod

It is an insulated rod (with extension rod) having Resistance/Corona capsule in its edge connected with earthing lead. The discharge rod shall be used to discharge the static and induction charge of the power line after opening it. The discharge rod is a prime importance safety tool, which can safeguard from unforeseen dangers and even fatal accident. The line should be treated charged until the neutral or earth wire is discharged. There is possibility of charging of line due to static charge, induction or fault current. Hence, first discharge the line by using discharge rod.

fig. 4.7 Discharge Rods

The use of a discharge rod can safeguard against all types of back feeding cases/eventualities such as follows:

- Consumer may start his generator set.
- The line is charged by some mischievous or unknown person not having adequate knowledge.
- The area of T/F under shutdown due to fault, the line is charged from other source.
- Power swing may cause charging line if the guarding is not provided at line crossing.
- Line clear permit is given, but the person forgets to open the line.
- Operator may forget that the line is under permit and he may charge the line for testing, etc.
- The change in status of line feeding is not known to the operator after returning from long leave, etc.
- The use of discharge rod safeguards from the above types of eventualities.

Maintenance of Discharge Rod:

- The rod should not be kept in wet condition.
- Ensure that the continuity of all wires of discharge rod is intact.
- Carbon deposited on hook of the rod should be cleaned regularly.
- The continuity of wires should be tested regularly.

How to work safely with discharge rod:

- Confirm the cleanliness of the wire ends/lugs provided before use. Make firm connection of wires with earth point by nut-bolt. Where use of nut-bolt is not possible then after rubbing the earth wire wrap it firmly to earthing. Confirmation of the continuity and good condition of earthing is a must.
- Hand gloves shall be used while discharging the line by discharge/earth rod.
- While working on L.T. line first discharge the neutral and then phases. Thus, the wire of discharge/ earth rod shall be connected to earthing first and then discharge the phases one by one.
- The line should be discharged at one pole before and one pole after the pole where to attend work.
- The rods shall be kept on line till the work is completed.
- After completion of work and climbing down the pole, discharge rods should be removed one by one using hand gloves invariably. After removing all rods, earthing shall be removed.

- After this, if we notice that some work is still balance or some T&P, etc. is still left on the line, then do not climb on line unless the line is discharged again. The eventuality often occurs within seconds; hence don't take risk or don't be hasty, and work calmly and with concentration, without any disturbances.

Fig. 4.8 Working with Discharge Rod

Chain

Metallic chains (minimum 5 meters) are placed over the each phase of line and made earth to protect from accidental restoration or back feed of supply while attending break down or planned shutdown.

Mask

It is mandatory to place two masks at prominent place (easily accessible) in the substation or generating station to protect from gas and smoke.

Rope

It is used to give tools and tackles to the lineman who climbs on pole. One portion of rope is tied on the waist of the lineman.

Fig. 4.9 Using Safety Gear

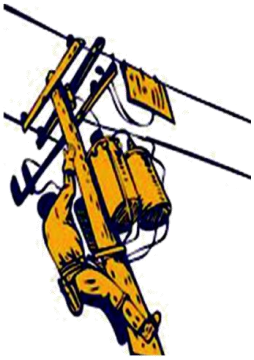


Fig. 4.10 Lineman Responsibilities

Fig. 4.11 Safe Condition

Fig. 4.12 Unsafe Condition

Fig. 4.13 Lineman Working with Rope

Rubber Mat

For operating any switch gear, it is mandatory to place a rubber mat in front of panel. Nowadays, synthetic rubber mats with very low thickness of 2 to 5 mm and light weight are available.

Rubber base PVC Sole Shoes

The worker should use rubber base PVC sole shoes without nails. Proper shoe should be used to work on over head line protection (not sport/tennis shoes) from electric shock.

Fig. 4.14 Safety Boots

Fig. 4.15 Safety Harness

Gloves and Helmet

Rubber insulating gloves are commonly used in L.T. line system to protect from head injury and prevent from electrocution.

Fig. 4.15 Safety Gloves

Fig. 4.16 Safety Helmet

3.1.7 Safety Requirements Applicable at Work

The linemen are supposed to brave all weather conditions such as heat, sleet and snow. They are expected to report for duty at odd places and in odd situations. Keeping in view the nature of their job, the linemen are generally physically and mentally trained. However, they are required to follow certain guidelines to avoid any mishap and ensure safety at work. Some important safety tips for the linemen are as follows:

- Wear personal protective equipment.
- Follow a strict discipline, and invariably follow the instruction of the supervisors.
- Identify the hazards.
- Use tools in a proper manner.

Always follow safety procedures

•Follow strictly the CEA Regulations 2010 for measures related to safety and electric supply.

•The third safety level is the use of an external disconnect switch, which is essentially a lever that a utility lineman can use to shut down a homeowner's PV system, and physically isolate it from the grid while doing maintenance or repair work.

Fig. 4.17 Lineman at Work

Clean and Safe Environment

Cleanliness and safety of the workplace is of paramount importance. Workers must comply with the instructions and follow the policies and procedures relating to health and safety at workplace.

Workplaces and facilities should be cleaned on a daily or weekly basis. The cleaning programme of the facilities and equipment should be designed taking into account the work shifts, the work type, the likelihood of

contamination and the number of workers using them.

Fig. 4.18 Working in a Risky Condition

Tips

Lightning Arresters are the most effective means of protecting electrical lines against lightning and switching.

Activity

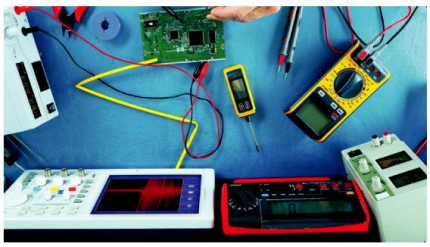
In the exercise shared below, identify and tick the correct precautions to be observed by the linemen before starting work.

The work area should be spacious

There should be proper lighting at

The linemen should be properly trained, or work under supervision of their senior

The linemen should possess safety equipment



The linemen must wear protective gear

The equipment should be calibrated

The linemen should work in group

Proper equipment in hand

Work Area Responsibilities

The tasks to be performed by a lineman, light and power include:

- Erecting and maintaining overhead electric power lines to conduct electricity from the power plant to the place of use.
- Erecting poles and small towers at specified distances with the assistance of other workers.
- Climbing poles and towers, fixing insulators, lightning arresters, cross-brass, etc. and other auxiliary equipment at proper heights.
- Stringing and drawing cables (wires) through insulators fixed on cross bars.
- Exercising great care to leave a proper sag in wires to avoid breakage under changing atmospheric conditions.
- Joining the cable by various methods, fixing joint-boxes at specified places, replacing fuses and faulty components as necessary and testing for electrical continuity.
- Checking overhead lines in the allotted section as necessary and maintaining them for transfer of electricity.
- Maintaining proper repairs of defective electricity lines, poles, towers and auxiliary equipment as per the given instructions.
- Installing and repairing overhead power lines for electric trains, trams or trolley buses.
- Working on high tension or low tension power lines.

Fig. 4.19 Linemen at Work

Fig. 4.20 Lineman Checking the Problem

Tips

"Basic Safety Precaution" is the inherent characteristic that any person should keep in view while working on power equipment. Never should we forget that "Electricity is an obedient servant and dangerous master".

Exercise

1. Write any 5 work perform by a lineman?
2. Write a short note on discharge road.
3. Write any 5 personnel protective equipments?
4. Fill in the blanks

a. Lineman should fallow ..... for measures related to safety and electric supply.
b. ..... is used for earthing the line.
c. ..... should be taken before starting the work on line.
d. ..... protective instrument that gives alarm indication of live H.V. and L.V. lines

Session 2

Basic First Aid Procedures

LEARNING OUTCOMES

On completion of this session the student will be able to:

- Arrange basic first aid in case of accidents.
- Provide basic understanding of electrocution.
- Discuss about artificial respiration (cardiopulmonary resuscitation).
- Interpret the types of bleeding which is caused by an injury.

Basic First Aid

First aid is of prime importance in the event of an accident. Hence, everybody should know the basic methods of first aid:

- Bring the affected person at peaceful and airy place and care should be taken that he should not get suffocated.
- All the parts of body of affected person be kept in straight position and should be laid down on even spot.
- In case of head injury, lay down the affected person in such a way that his head rests in upward position.
- If he is having trouble in proper respiration, then he should be kept in sitting position.
- If he is in the epileptic condition, then lay him down ensuring that his head is below the level of his body.
- If he is having wounds, then take water in one small bucket and add 4 drops of Iodine in it to make it anti-bacterial and wash the wounds neatly and carefully and dry it. Then apply the iodine on wounds and wrap it by medicated/antibacterial cotton.

Fig. 4.21 Giving Basic First Aid

Tips

When faced with an emergency, try to remain calm and controlled so that you can act effectively. Before assessing the victim's condition and carrying out the appropriate first aid, make sure that you are not putting yourself in danger. You will not be able to help anyone else if you become a victim yourself.

The following medicines/items should be kept in first-aid box:

- Small size dressing cotton/patti
- Medium size dressing patti
- Large size dressing patti
- Yellow patti or dressing pad for burn injuries
- Clean and sterilised cotton pads
- Tincture - iodine
- Potassium permanganate
- Sol-violate spirit (for smelling of unconscious person)
- Adhesive plaster
- Eye drops
- Boric powder
- Tourniquet
- Three angle bandage (in case of broken bone)
- Safety pins
- Soda-Bi-Carbon
- 2 or 3 wooden plaques.
- Aspirin tablets
- Bottle of Dettol or Savlon liquid
- Bottle of spirit
- Scissor, knife, etc.

Bleeding

There can be four types of bleeding through injuries:

1. Minor bleeding
2. Bleeding through artery or main blood circulatory system
3. Bluenen or bleeding from vein
4. Internal bleeding

If bleeding is of (1) or (3) type, then first tightly wrap the part of body before and after of wound so as to stop the bleeding. Internal bleeding, such as in stomach, from brain or lungs, etc. cannot be seen. However, it can be seen in the vomiting or spiting of injured person. Internal bleeding is very dangerous rather than external bleeding. In such situations, give the injured person cold water or ice and arrange for immediate medical help. Excessive bleeding after injury may cause death rather than bleeding from wounded spot. Hence, medical help should be arranged without any delay.

Injuries to Bones

In the event of accidents, sometimes the bones of the body may break, and the tip of the broken part may come out along with wound. In such cases, first try to stop bleeding without touching the wounded part. Then try to join the broken bones by pushing from both the sides of wound and broken point. Whether it is effective or not always wrap the broken body part resting on wooden plank and take the injured to hospital as early as possible, and if the bones of legs are broken then the injured person

should be taken on stretcher.

Unconsciousness

If the person loses consciousness, open his airways by tilting his head slightly and monitor his breathing. If breathing becomes difficult for him, call other people to move the victim into recovery position. Put your hands over his ears to keep his head align and working as a team, roll him over gently making sure that you keep the neck and back align at all time making the hands of all team member as stretcher.

Fig. 4.22 Lying Unconscious

Injuries due to Burning

A burn that affects all the layers of the skin or covers a large area of the body is a severe burn. The aim of first-aid treatment is to cool down the affected area rapidly to minimize damage and loss of body fluids, and therefore reduce the risk of developing shock. Any burn larger than the palm of the victim's hand, whatever the depth, needs hospital treatment.

If the victim's clothing is on fire, force him/her to the ground and use a wool or cotton blanket, rug, or coat to smother the flames. Immerse the burn in cool water, douse it with water, or cover it with cold, wet towels for at least 10 minutes. If the burn injuries are due to acid action then we should first wash and clean the wound using baking soda water. If burn injury is due to carbolic acid, it should be cleaned and washed by spirit.

Fig. 4.23 Burn Injury

Tips

Don'ts:

Do not apply any ointments to the burns.

Do not touch the burns or burst any blisters.

Do not put ice or iced water on the burns.

Do not apply iodine on such wounds.

Electrocution

When a worker is electrocuted, the following measure should be taken:

- First disconnect the power supply and if possible send somebody else for disconnecting the supply.
- If the person is under contact of live wires/equipment, do not isolate him by hands or don't try to isolate him away by standing on wooden planks. Because even if we are on wooden plank, the circuit is completed through body of person getting electric shock and there is possibility that you may get electrocuted.
- If a person came into contact with low or medium voltage line/equipment then using rubber gum-boots and hand gloves, the electrocuted person can be isolated from line contacts. However, confirm that the things used for such operations are dry and insulated one. If the shock is through H.T. Line then the safety equipment/items used for separation should be of that much voltage capacity, i.e., H.T. Voltage capacity; otherwise don't try to isolate the person under shock.
- After removing/isolating the electrocuted person from live line/equipment, first loosen his clothes. Then take out the pant, tobacco, betel nuts or artificial teeth from his mouth. If the respiration system has failed, try to give him artificial respiration immediately.
- If the electrocuted person becomes unconscious, do not give him any drink, water, etc.
- Apply Burnol or Soframycin type creams to burnt part of body of electrocuted person and do the bandage. The wound should not come into contact of air.
- Keep the person warm by wrapping blanket or coat. Do such things that his body should remain warm enough. If possible, both his feet should be kept in warm water.

After the person gains consciousness, do the following things:

- Arrange immediately to call doctor and continue with artificial respiratory system.
- Enough quantity of water mixed with sodium bicarbonate should be given to the electrocuted person.

- Give him table-salt to inhale.
- If his throat is injured or he has pains in throat, no any drink/water be given unless otherwise advised by doctor.
- If the person passes urine, keep the urine sample for pathological tests.
- Don't try to do anything which can cause mental/physical stress till the doctor is available.
- If the person becomes normal then allow him to take rest. Tea can be given.

Tips

In case of electrocution:

- Take remedial measures immediately without delay.
- Passing of time may cause into death of the shocked person.
- Though all electric shocks are of fatal tendency, timely aid and remedial measures may save the life of the shocked person. Otherwise delay may cause into certain death.
- The heart muscles remain live up to 1/2 hour time after shock. Hence, the artificial respiration may save the life of the shocked person.
- Start artificial respiration. Continue it till doctor or medical help arrives.

Artificial Respiration (Cardiopulmonary Resuscitation)

Artificial respiration is given when a person's respiration fails. There are following types of methods used for artificial respiration:

Mouth to Mouth Procedure

In this system, first stand up near the head of electrocuted person or sit on his knee. His head should be kept in down position by one hand and by other hand lift his lower jaw. Inhale the deep breath and keep your opened mouth on the mouth of electrocuted person. Close both nostrils of his nose by one hand and exhale your breath into the lungs of subject person slowly. By doing so, see whether his chest get expanded or not.

Fig. 4.24 Mouth to Mouth Respiration

Keep your mouth away and again inhale deep breath in your lungs and repeat the procedure as mentioned above. Try to repeat such artificial respiration about 10 to 12 times in a minute. If there is some difficulty in doing so, try to push the persons head and again pull the lower jaw. If again you find it difficult to give him this treatment, then see whether the lips of the person are open and try to see if the teeth are jammed, if so, then use the nose to mouth method.

Nose to Mouth System

If the above procedure is not possible, try to use nose to mouth system. In this process, stand near the head of person or sit on your knees. Push his head fully to down side and pull up the lower jaw of person. Then inhale deep breath and after opening the lips cover the nose of person completely. By other hand close the mouth of the person tightly and exhale the breath from your mouth into the nose of person slowly so that air enters his lungs. See if his chest gets expanded. The same procedure should be repeated 10 to 12 times in a minute.

When the person starts breathing on his own, then give him such breathing in a synchronous way and see if his chest gets expanded. When person comes to comfortable position, allow him full rest. Put him on a stretcher and see that no any difficulty comes in his respiratory system. His body should be wrapped in a blanket and keep him warm. The unconsciousness position due to electric shock may cause damage to his heart. Thus every worker/engineer should know this method and try to get training of such procedures.

Fig. 4.25 Mouth to Nose Respiration

Tips

Things to remember:

- If the practice of nose to mouth is required to be done, then the air will go slowly, to the electrocuted person. Hence this system is safer and in case when the nose of the electrocuted person is very narrow then the system of mouth to mouth should be adopted.
- If it is observed that the throat of person is very narrow or closed due to some object, then the same should be cleaned by fingers.
- In case, the teeth of the person are tightly closed, then use the nose to mouth system.
- If possible, keep a thin handkerchief on the mouth of the person for using mouth to mouth procedure.
- For infant or young children, if affected, then use the blow of air from our mouth. Send at least 20 times per minute respiration of which respiration should be done.
- In case, when we have to use this artificial respiration on pole, then first safeguard yourself from the live parts and also from coming into the contact of electrocuted person, if he is still under shock. Stand carefully in such a way on pole by using safety belt so that we place our mouth on the mouth/nose of electrocuted person.

Sometimes, artificial respiration can be done by way of muscular movement or with help of some equipment. These are described below.

Holger Nelson System

In this procedure, first lay down the

person in downward position and keep his hands on back in crossed position and on that hand, keep his neck in one-sided position and give pressure lightly. Keep our right side knee near the head of the person and the feet near the elbow of affected person. Put our palms on the back of affected person in such a way that our thumbs of both hands rest on back-bone of person and the other portion of palms rests on balance portion of back side of person. Then start giving light pressure by both the palms on back of affected person and keeping this position for 2.5 seconds duration and then start releasing pressure slowly from back. Now hold the arms of crossed-hands of person and put his hands in upward position and pull them forward. In this way the procedure should be repeated 10 to 12 times per minute till the person starts breathing on his own.

Fig. 4.26 Defibrillator in Use

Sheffer System

Exhale air outside: In this system also, lay down the person in downward position and keep some pillow/or clothes below his head and put his neck on one side. Now, lay the knees and on the back side of waist, bring the thumb of hands in such a way that both the thumbs are near to each other. Place your fingers of hands on back side of person's fore-arm from both sides. Bow down on person slowly. While doing so, give the constant pressure on back of person.

Inhaling the breath: Give a tilt to back side of person in such a way that your hands remain on his back. For exhaling the breath keep your hands on back of person in the same position. Keep doing both the works simultaneously. This simultaneous procedure is to be done with rate of 15 times per minute. The reason behind this is to keep the respiration process of electrocuted person continued through the expansion and contraction of lung muscles. The person doing this function should breathe slowly for exhaling and inhaling action by pushing/pulling the electrocuted person and he can see the effects of this action and amount of pressure will maintain and will result into synchronisations of breathing of affected person. This procedure should keep continued till the person electrocuted starts breathing on his own.

This exercise may take 1/2 hour or more to get proper effect of respiration. The subject system described above is considered as best system. The pressure should be 20 to 25 pound magnitude.

Silverester's System

Lay down the electrocuted person in upward position. Loosen the

clothes on his chest and stomach. A pillow should be placed below his shoulders in such a way that the neck and head of the affected person will be in somewhat downward position. Then pull his tongue outside. The person giving treatment should sit on his knees near the affected person. Keep the hands of the person below the elbow and pull his hands till it becomes parallel to earth. This treatment should be given for 3 seconds. After that, bring both hands of the person below his chest and press the chest to inside position. This action should be given for 2 seconds. Thus the procedure is repeated 10 to 12 times per minute. In this system since the head of the affected person remains in upward position, the effect or action of artificial respiration can be seen immediately.

Tips

For a man, give 20 to 25 pound pressure for 10 to 12 times. In case of women and child, the pressure should be 10 to 15 pounds for 10 to 12 times per minute. For very young child or infant, the pressure should be 15 times per minute. This procedure should be kept continued till the affected person starts taking breath of his own.

Exercise

1. Write down note on basic first aid?
2. What is Silverester's System?
3. What precaution to be taken during mouth to Nose Respiration?
4. What is Artificial Respiration?