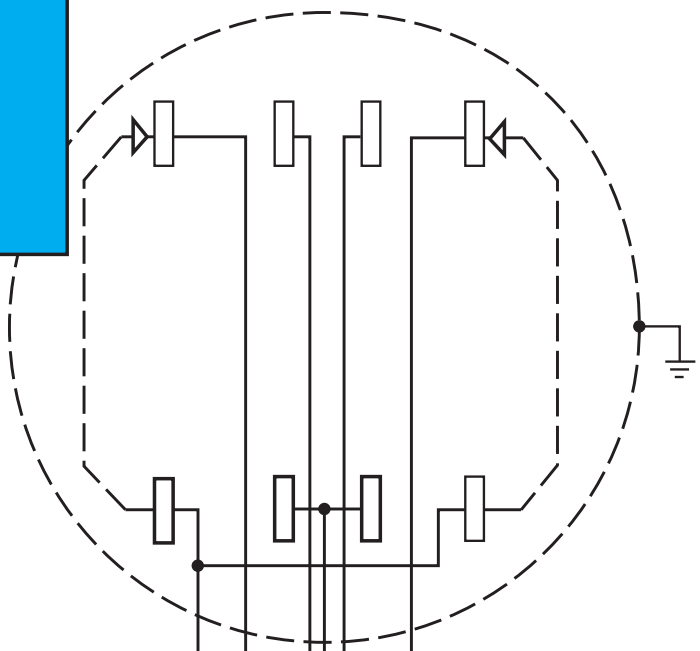
Metering
Program Catalog



MJTS

MERCHANT
Job Training & Safety

MJTS Program Overview

Merchant's Powerline Job Training & Safety Program is a distance-learning curriculum tailor-made for entry-level electric utility personnel. The program most commonly serves as related technical instruction for use in an apprenticeship program leading to journeyman certification when coupled with structured on-the-job training. It exceeds the U.S. Department of Labor's Office of Apprenticeship minimum requirement of 144 hours of related instruction per year. The program is also well suited for skill advancement of experienced employees with duties ranging from line personnel through management.

The Merchant Program is a four-year curriculum having a modular construction. Beginning at day one, MJTS core curriculum provides your employees with the practical key competencies critical to their on-the-job productivity and safety. The material is organized into blocks of information and presented in manageable units of instruction. The Merchant program is comprised of nineteen blocks, 13 of which are used in the metering program.

Block 1	The Electric System	Block 11	Power Use
Block 2	Basic Electricity	Block 12	Watt-Hour Meters
Block 3	Electrical Math	Block 13	Test Meters
Block 4	Safety	Block 14	Street Lighting
Block 5	Staking/Mapping	Block 15	Orientation
Block 6	Rigging	Block 16	Underground Distribution
Block 7	Transformers	Block 17	Substations
Block 8	Overvoltage/Overcurrent Protective Devices	Block 18	Equipment Safety
Block 9	Live Line Maintenance	Block 19	Equipment
Block 10	Voltage Regulation		

Each workbook is illustrated extensively with photographs and graphics to enhance the readability and understanding of technical material. Supplemental multimedia and video is available via our web site free of charge. If questions arise, trainees can contact our office 5 days a week by phone, e-mail, or fax during normal business hours (Monday - Friday, 8 AM - 5 PM CST).

Advantages of the MJTS Program

Individualized Learning

Design of the instructional material ensures that any trainee can successfully complete the program by self-study. Basic Concepts are presented for those who need remedial review, while others can accelerate through those materials quickly before moving on to the more advanced concepts. Your trainees have unlimited access to qualified instructors at MJTS who can accurately answer any questions that arise.

Proven Learning Methods

Dennis Merchant, an expert with the material who had many years of experience in the field and as a curriculum writer and teacher, designed the course content. MJTS presents the material to your employees using a time-tested format for vocational education. Since 1983 we have successfully helped advance and strengthen the careers of many thousands of trainees.

No Scheduling Problems

Distance learning is an ideal component of an apprenticeship program. The course is structured for self directed study. Your employees can study when its convenient for them. Training is portable, flexible, and cost effective. Your Employee's travel expenses and time off the job for training are eliminated.

Certifiable/Mastery Oriented

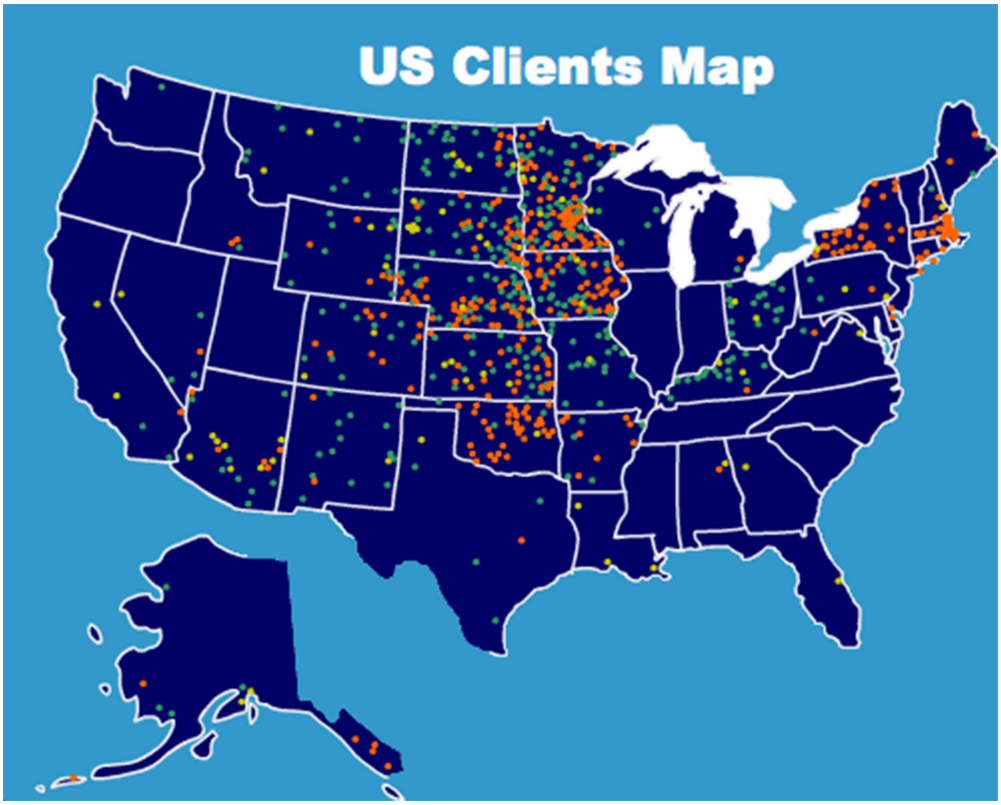
The training is consistent, measurable, and accountable for each of your trainees. They must demonstrate mastery in order to complete each section of the course. Our program exceeds the yearly 144 hours of related instruction required by the US Office of Apprenticeship, so your employees can earn national certification.

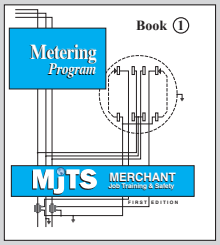
Permanent Records

Your employee's training records are permanently retained at our office. Employers can request records free of charge at any time.

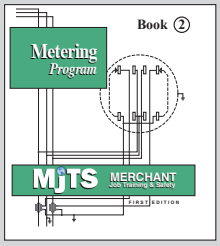
Centralized Control

Individualized study can be implemented at multiple locations, with all of your employees receiving the same quality instruction. Yet, centralized administrative control is maintained through our office. We summarize each employee's progress and mail them to your training coordinator each month.

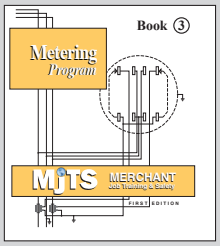




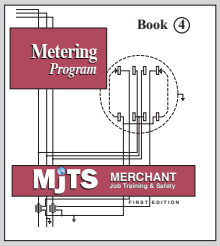
9 Section Tests
1st Year Final



9 Section Tests
2nd Year Final



9 Section Tests
3rd Year Final



9 Section Tests
4th Year Final

MJTS Certificate
Issued
at Completion

US Department of Labor
Certificate issued for Registered
Apprenticeship

Program Implementation

Training Coordinators

One or more employees at your company is appointed Training Coordinator. Training Coordinators are the main point of contact for your company with Merchant Job Training and Safety. This person faxes or e-mails Trainee applications to MJTS, receives workbooks and other required textbooks, distributes them to Trainees, has possession and control of tests, schedules test times for the Trainees, and receives grade reports and billing statements from MJTS. The Training Coordinator proctors the tests, administering them by "Closed Book," and then faxes them to MJTS for grading and recording of scores into the Trainee's permanent record. Commonly, employees appointed to be coordinators are crew leaders, safety/training staff, administrative staff, or superintendents.

Trainees

Each workbook contains nine sections, most sections having four units of instruction. Trainees study the material and complete assignment sheets at the end of each unit, checking their answers in the back of the workbook. Trainees take a section test when they are ready, or on a schedule set by their training coordinator. The rate at which a trainee progresses through the material is completely at the discretion of the trainee and his employer. However, the program is designed so that one workbook is completed per calendar year. After successfully completing all nine sections, trainees take a final exam that covers material from the entire year. After completing the fourth year workbook, trainees take a comprehensive final exam that covers material from the entire four years.

MJTS encourages trainees to ask questions of journeyman linemen and other experienced personnel in their company. We also encourage them to contact our office any time with questions or comments.

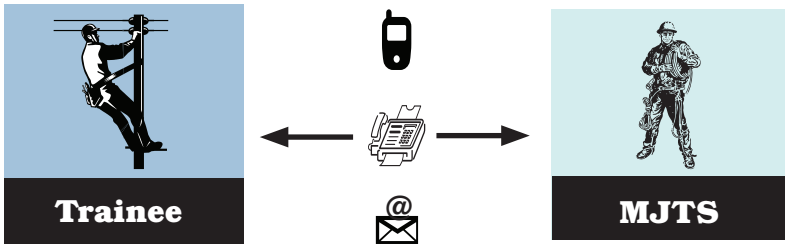
MJTS sets a minimum passing test score of 70%. Trainees who fail a test may retake an alternate test after reviewing and studying the material that they have missed. The original score and the retest are averaged. Trainees who fail a test are especially encouraged to contact our office for help.

Merchant Job Training and Safety

MJTS grades trainee tests and returns the results to the training coordinator, normally within minutes of receiving them. MJTS comments on all material or questions submitted by the Trainee and/or Training Coordinator, and issues certification of successful completion of the program.

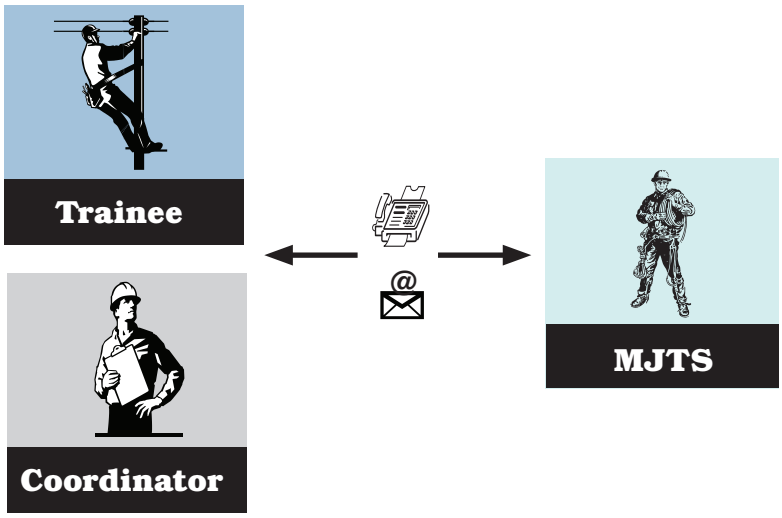
Trainees Study Material - One Unit at a Time

Trainees study units in a section. They complete assignment Sheets and check their answers with those in the answer key. If they have trouble they are encouraged to contact our office by phone, fax, or by e-mail. They can also find help at www.mjts.com.



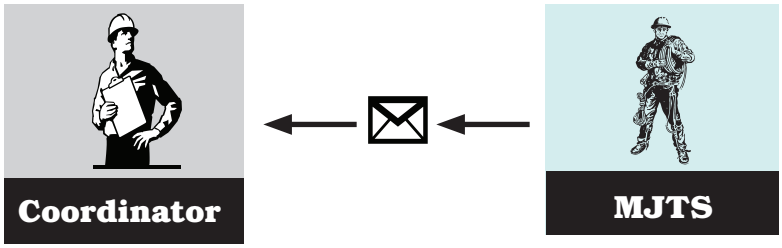
Coordinator Proctors Test by Closed Book Method

Training coordinators and trainees schedule a mutually agreeable test time. Trainees complete their tests by close book method and transfer their answers on to fax forms that MJTS provides as part of the test kit. When trainees finish, their coordinator faxes or emails the test to MJTS for grading. MJTS maintains several fax lines to assure a clear line when transmitting. Test results are faxed back to the training coordinator by MJTS staff, normally within minutes of receiving them.



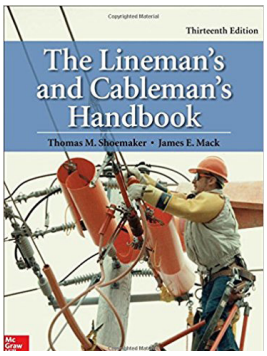
Coordinator Receives Grade Reports Monthly

At the first of each month, MJTS mails a grade report to the training coordinator, keeping them appraised of trainee progress. MJTS faxes or e-mails grade reports at any time to coordinators who request them. They can request reports by phone or by e-mail.

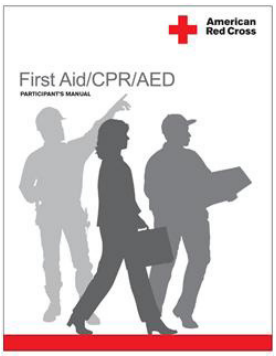


Required Textbooks

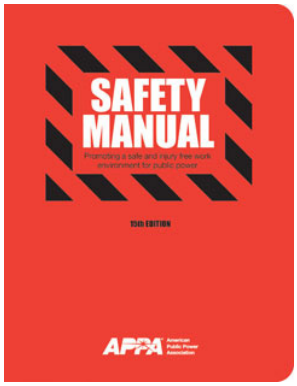
Lineman's & Cablemen's Handbook
13th edition
by Shoemaker



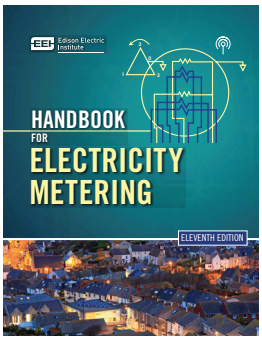
First Aid/CPR/AED Participant's Manual
The American Red Cross



APPA Safety Manual/OSHA Standards
16th edition
American Public Power Association



Handbook for Electricity Metering
11th edition
Edison Electric Institute

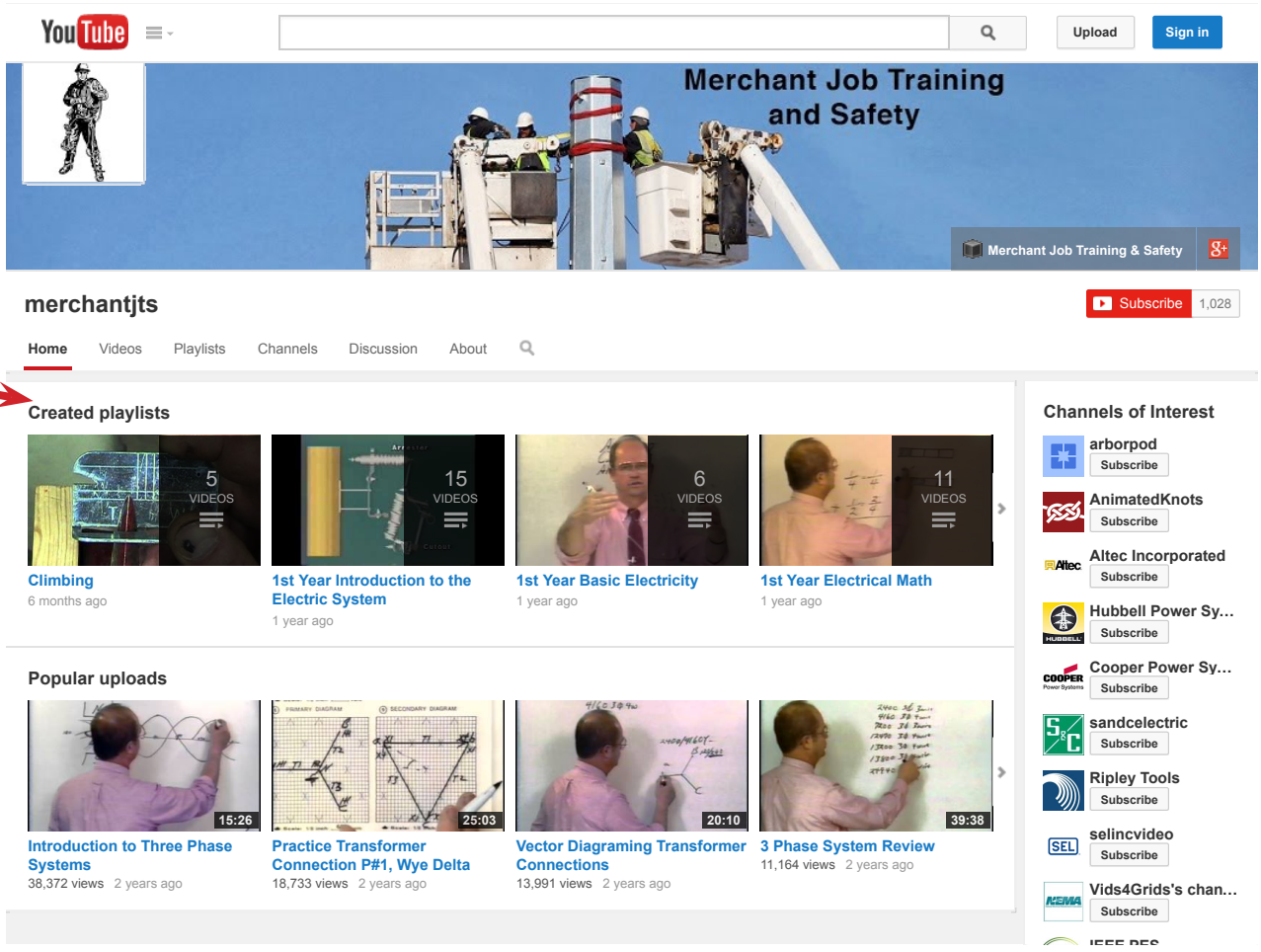


Streaming assistance over the internet from YouTube

Access Videos at:

www.youtube.com/merchantjts

Click on "Created Playlists"



Policies

Enrollment

-Trainees must be employed by a rural electric, municipal, contractor, or private utility.

-Trainees must be at least 18 years of age.

- Trainees must be high school graduates or they must posses a GED.

Testing for Advanced Placement

Due to the strong academic content of our program, we have found that it is a disadvantage for the Trainee to start at any point other than the 1st year of the program. Problems created from "Testing Out" prompted us to make this policy change over a decade ago. Trainees who are currently enrolled in another program and find it too frustrating to start over, we highly encourage completion of their current program. Trainees who transfer to our program can accelerate through the material provided they maintain acceptable scores on their section tests.

Department of Labor Registration

The Administrator's curriculum may be approved by The US Department of Labor, Office of Apprenticeship. If they wish to have a registered program, it is the prerogative of each utility, or their association, to have their program approved by the U.S. Department of Labor. Additional information is available in our Coordinator's Guide.

Tuition Payments

Tuition will be billed to the Employer on the first of the month after the Administrator processes the Application Form or Renewal Application, and ships required curriculum materials.

Tuition Refunds

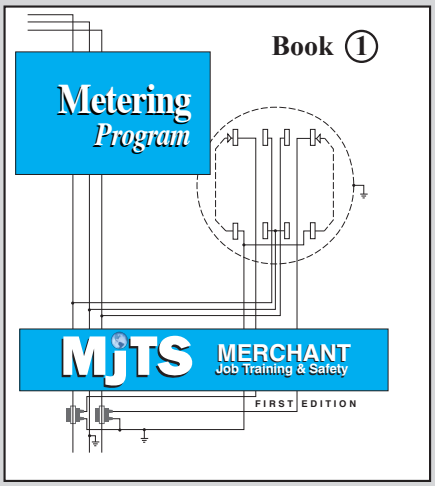
The Administrator will agree to a reimbursement of tuition in the event of a Trainees premature drop from training program by the following schedule:

1. Drop Enrollment date to 1st month - 80%
2. Drop 1 month to 2 months - 60%
3. Drop 2 months to 3 months - 40%
4. Drop 3 months to 4 months - 20%

Shipping

MJTS processes application forms and sends required curriculum materials, workbook and section tests for the program year, shipping by UPS. Shipping is free of charge. MJTS needs a physical address in order to ship material by UPS. Books going to Alaska are shipped by US mail.

Transmission Line exiting the Deer Creek Generating Station, Elkton South Dakota



First Year

Minimum Training Hours: 144
Sections: 9
Units of Instruction: 36
Tests: 9 Section Tests and a Final
Tuition: $550

Block 1 - Introduction to the Electric System

Introduction to the Electric System
Substations
The Transmission System
The Distribution System
Line Conductors

Block 2 - Basic Electricity

The Nature of Matter
Sources of Electricity
Circuit Fundamentals
Electromotive Force (voltage)
Current and Resistance
Ohm's Law
Power
Series Circuits
Parallel Circuits

Block 3 - Electrical Math

Introduction to Fractions
Fractions Addition & Subtraction
Fractions Multiplication & Division
Decimal/Exponent/Prefix
Advanced Math 1 Algebra
Percentage
Vectors
Ratio
Ratio & Proportion
Power & Square Root

Block 4 - Safety

OSHA Standards (part 1)
Specific Injuries
Shock

Block 7 - Transformers

Introduction to Transformers
Transformer Design
Polarity of Transformers
Insulating Liquid/Transformer Oil

Block 9 - Live-Line Maintenance

Protective Equipment

Block 11 - Power Use

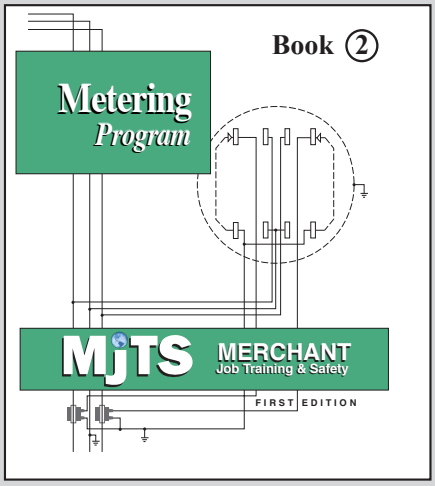
Batteries

Block 12 - Watt-Hour Meters

Reading Dial Meters
Meterman's Terms & Definitions

Block 15 - Orientation

How to Use this Course



Second Year

Minimum Training Hours: 144
Sections: 9
Units of Instruction: 35
Tests: 9 Section Tests and a Final
Tuition: $550

Block 2 - Basic Electricity

Combination Circuits
Magnetism
Fundamentals of AC Current
Inductance
Inductive Reactance
Capacitance
Capacitive Reactance
Series Reactance and Impedance

Block 3 - Electrical Math

Right Triangles
Advanced Math II (Trigonometry)

Block 4 - Safety

OSHA Standards (Part 2)
Electricity & the Human Body

Block 7 - Transformers

Transformer Rating
Primary System voltages
Introduction to Transformer Connections
Transformer Connections (Single-Phase)
Transformer Connections (Three-Phase)
Transformer Connections (Phase Displacement)
Transformer Connections (Wye-Delta)
Transformer Connections (Wye-Wye)
Transformer Connections (Delta-Wye)
Transformer Connections (Delta-Delta)
Transformer Fusing
Transformer Connections (Fusing Wye)

Block 9 - Live-Line Maintenance

Fault Currents

Block 10 - Voltage Regulation

Introduction to Voltage Regulators
Step Voltage Regulators

Block 11 - Power Use

Consumer's Service
Single-Phase Motors

Block 12 - Watt-Hour Meters

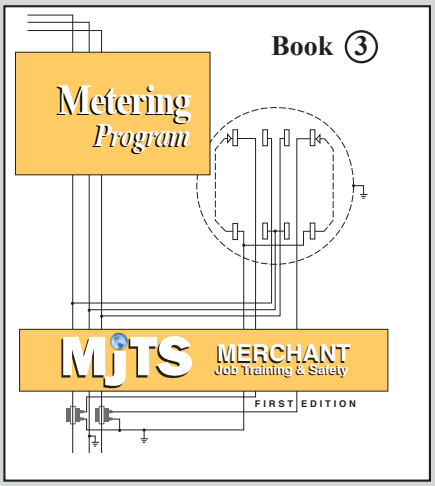
Introduction to Watt-Hour Meters
Polyphase Meters
Reading Dial Meters #2

Block 13 - Test Meters

Basic Meters
Voltage Recorders

Block 17 - Substations

Introduction to Substations



Third Year

Minimum Training Hours: 144
Sections: 9
Units of Instruction: 30
Tests: 9 Section Tests and a Final
Tuition: $550

Block 2 - Basic Electricity

Parallel Reactance/Impedance
Electrical Terms (Review)
Impedance Calculations

Block 4 - Safety

OSHA Standards (Part 3)

Block 7 - Transformers

Transformer Connections (Fusing Delta)
Transformer Connections (Open)
Transformer Connections (Taps)
Autotransformers
Extra-ordinary Transformer Connections
Transformer Calculations
Transformer Connections/Unbalanced
Floated vs Grounded Wye
Unbalanced Loads
Phase Rotation/Transformers
Grounded Wye-Delta Transformers
Transformer Connections Review

Block 8 - Over-Voltage/ Over-Current Protective Devices

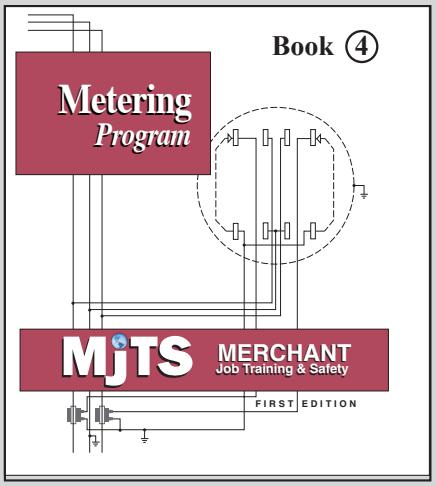
Introduction to Protective Relaying
Relay Operating Principles

Block 11 - Power Use

Power Factor
Power Factor Correction
Electrolysis
Capacitor Bank Application
Ferro-resonance
More Power Factor Correction
Power Factor Problems
Three Phase Motors

Block 12 - Watt-Hour Meters

Demand Factors
Instrument Metering
Application of Watt-Hour Meters
Reading Dial Meters Review



Fourth Year

Minimum Training Hours: 144
Sections: 9
Units of Instruction: 24
Tests: 9 Section Tests and a Final
Tuition: $550

Block 3 - Electrical Math

Advanced Vectors

Block 4 - Safety

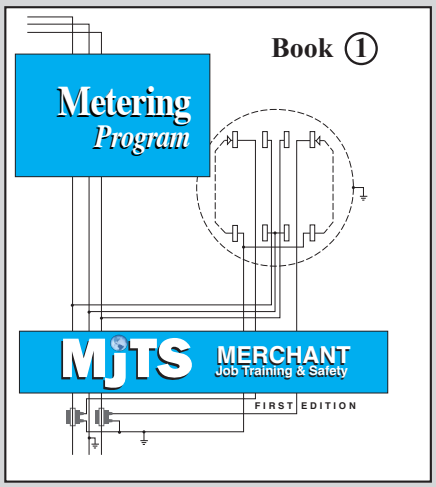
OSHA Standards (Part 4)
Portable Fire Extinguishers

Block 8 - Over-Voltage/Over-Current Protective Devices

Differential Protective Relaying/Applied

Block 12 - Watt-Hour Meters

Watt-Hour Meter Basics
Watt-Hour Meter Concepts
Meters & Associated Equipment
Demand Meters
Transformer Metering
Harmonics & Metering
Meter Connections/Single Phase
Meterman's Terms and Definitions Review
Introduction to Meter Testing
Meter Connections/Polyphase
Meter Connections/Four-Wire Wye
Summary of Meter Testing
Meter Connections/Four-Wire Delta
Introduction to Polyphase Meter
Testing Single-Phase Meters
Meter Connections/Network
Testing Polyphase Meters
Handling Meters
Reactive Power Metering
Solid-State Metering



First Year Unit Descriptions

Block 1 - Introduction to the Electric System

Introduction to the Electric System - Provides an overview of the electric system from the generating station to the customer service. Introduces common voltages, electrical devices, switches, and over-current and over-voltage devices.

Substations - Introduces transmission, distribution, & switching substations. Relates voltage and capacity. Surveys the function of equipment such as transformers, switches, breakers, potential and current transformers, relays, etc.

The Transmission System - Defines the transmission system and briefly survey system history. Introduces AC and DC transmission and pros and cons of each, and factors relating to capacity. Discusses three phase power, rights of way, magnetic and electric field effects, and corona.

The Distribution System - Defines distribution, single-phase, two-phase, and three-phase distribution. Introduces three-phase 3-wire & 4-wire, single-phase primary & secondary circuits, and the neutral conductor. Discusses harmonics, interference, neutral to earth voltage, stray voltage, and primary system isolation.

Line Conductors - Introduces relative advantages and disadvantages of copper and aluminum. Defines AWG wire sizes and circular mil areas, loading districts, and conductor code words. Trainees calculate weight and resistance from tables, introduce dampers, bundle spacers, and fiber-optic cables.

Block 2 - Basic Electricity

The Nature of Matter - Introduces the nature of matter, identifies atomic particles & the atomic structure and the relationships and effects that these particles have on one another. Defines the free electron, electron drift, characteristics of good conductors and insulators, and defines matter and its states - solid, liquid, and gas.

Sources of Electricity - Identifies the six sources of electricity - friction, pressure, heat, light, chemical, and magnetic. Describes thermocouples and thermopiles. Defines ions, ionization, and positive & negative ions.

Circuit Fundamentals - Explains how positive & negative particles attract an repel. Identifies diagrams and schematics, introduces direction of current flow in circuits, and states concepts involved in Ohm's Law.

Electromotive Force (voltage) - Introduces definitions of electrical terms such as the joule, the coulomb, potential difference, voltage, and polarity. Explains application of volt meters to electric circuits.

Current and Resistance - Explains the effect of applying voltage to a circuit, the direction of current flow, and the effect of resistance on current flow. Introduces resistivity, conductivity, and conductor dimensions and their relationship to conductor resistance.

Ohm's Law - States Ohm's Law and algebraically finds it's three forms. Introduces concepts of direct and inverse proportion as they relate to Ohm's Law. Demonstrates solving for an unknown parameter in Ohm's Law with the other two given, including solution of practical word problems.

Power - Defines energy, work, and power and their units of measure. Explores various forms of the power formula, introduces ratio and proportion and their application to electrical problems.

Series Circuits - Defines symbols and abbreviations used in series circuits. Explains rules pertaining to current, voltage, resistance, and power in series circuits. Looks at difference between open circuits, and partial and direct shorts.

Parallel Circuits - Surveys differences between series and parallel circuits, plus rules for current, voltage, resistance, and power in parallel circuits. Trainees calculate total resistance using the equal branch, unequal branch, and reciprocal methods.

Block 3 - Electrical Math

Introduction to Fractions - Introduces parts of fractions, common denominators, proper and improper fractions, and mixed numbers. Dividing and shading figures to represent fractions and solve simple problems by this method is detailed.

Fractions Addition & Subtraction - Trainees learn to add and subtract fractions and mixed numbers, expressing them in lowest terms. They apply these principles to practical word problems relating to everyday life and on the job.

Fractions Multiplication & Division - Trainees learn to multiply and divide fractions and express in lowest terms. They apply these principles to practical word problems relating to everyday life.

Decimal/Exponent/Prefix - Introduces writing mixed fractions and numbers given in words into decimal notation. Trainees learn to divide numbers with both positive and negative exponents, and to convert decimal numbers between metric prefixes.

Advanced Math 1 Algebra - Introduces combining like terms in equations and solving for variables in simple algebraic expressions. Trainees apply these concepts to simple practical word problems

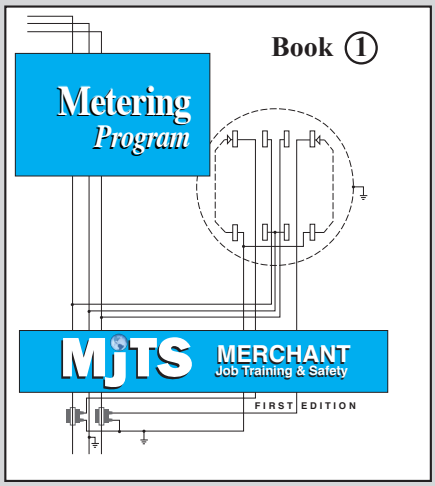
Percentage - Trainees learn to convert between decimal numbers and percentage. They apply the percentage formula to solve for base, rate, and the part, applying to practical word problems.

Vectors - Defines the vector and identifies its parts, introduces two graphical methods for adding and subtracting vector quantities. Trainees apply vectors to simple practical problems, measuring magnitude and angle or their results.

Ratio - Trainees set up ratios related to length, electrical units, money, liquid measure, and time. They solve word problems relating to gears, transformer turns ratio, efficiency, meter multipliers, and right triangles.

Ratio & Proportion - Introduces concepts of direct and inverse proportion. Trainees set up proportions and solve problems relating to weight, electrical circuits, and transformers.

Power & Square Root - Defines square, cube, and powers. Trainees calculate values of numbers raised to various powers.



First Year Unit Descriptions
(continued)

Block 4 - Safety

OSHA Standards (part 1) - Introduces terms and definitions related to safety rules pertaining to work at electric utilities and responsibilities for safety relating to every day activities of line personnel.

Specific Injuries - Introduces signs and symptoms of eye injury, cautions, and First Aid treatment for foreign bodies in eyes. Summarizes steps taken for chemical exposure to eyes and First Aid to be given. Finally, signs and symptoms of nose injuries are introduced. First Aid treatment for broken nose, nosebleeds, and follow-up to nose bleeds is detailed.

Shock - Defines shock, common causes of shock, signs and symptoms of shock, First Aid steps taken in treating and preventing shock, and fluid administration in the case of delayed medical attention.

Block 7 - Transformers

Introduction to Transformers - Surveys transformer history, application to AC current, its function in economical power delivery, transformer classifications, and mutual induction versus Autotransformers.

Transformer Design - Explains basic design considerations and construction of transformers, transformer losses, core and winding types, insulation, and insulating liquids.

Polarity of Transformers - Introduces testing transformers for polarity, terminal markings for additive versus subtractive transformers, and transformer coil voltage and kVA capacity as it relates to polarity.

Insulating Liquid/Transformer Oil - Explains the function of oil in electrical apparatus, impurities that contaminate oil, moisture detection, and standards for testing, filtering, and replacing transformer oil.

Block 9 - Live-Line Maintenance

Protective Equipment - Explains rubber glove specifications, use and care of rubber goods, rubber sleeves, rubber insulating line hose, hoods, and blankets. Discusses polyethylene covers, conductor covers, insulator covers, cross arm covers, and pole covers.

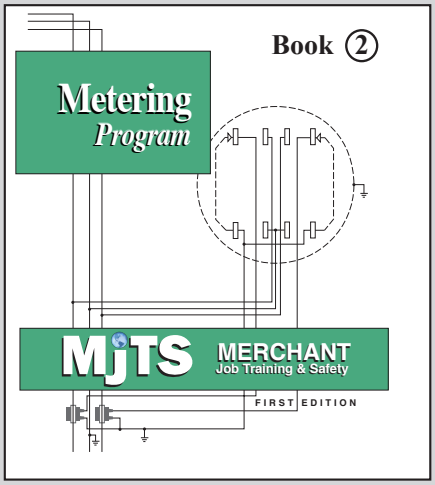
Block 11 - Power Use

Batteries - Trainees learn about primary and secondary batteries, wet and dry cells, rejuvenation of dry cells, indications of "used up battery," lead-acid cell charging, testing and specific gravity, and electrode potential and the ion.

Block 12 - Watt-Hour Meters

Reading Dial Meters - Introduces reading four and five dial meters, calculate actual monthly consumption from present and previous meter readings, using register constant and the register reading.

Meterman's Terms & Definitions - Introduces terms and definitions relating to watt-hour meters.



Second Year Unit Descriptions

Block 2 - Basic Electricity

Combination Circuits -Trainees trace current flow paths and identify points where current divides and recombines. They simplify and redraw combination circuits. They also demonstrate effects of opens and shorts in various parts of combination circuits.

Magnetism - Introduces magnetic poles, lines of force, permanent magnets, magnetic domains, and electromagnetism. Explains the left hand rule, and explores field interaction between current carrying conductors and resulting force exerted on those conductors.

Fundamentals of AC Current - Compares AC and DC current properties. Reviews induction as a source of electricity, and explains operation of AC generators. Defines the sine wave, peak voltage, the cycle, frequency, the period, instantaneous values, and average & effective values of voltage and current. Explains phase difference between voltages by utilizing two generators that are 90˚ out of phase.

Inductance - Defines inductors, inductance, induction, and counter electromotive force. Introduces air core and iron core inductors. Reviews four factors affecting inductance, introduces the henry, coefficient of coupling, and transformer ratios. Trainees solve for total inductance in series an parallel circuits.

Inductive Reactance - Defines inductance, reactance, inductive reactance, impedance, reactive power, true power, frequency, and angular velocity. Trainees calculate inductive reactance from inductance and frequency, define the inductive time constant, introduce phase relationship between voltage and current, apply Ohm's Law in AC inductive circuits.

Capacitance - Defines capacitance, dielectric, and describes the electrostatic field within a capacitor. Explains physical factors affecting value of capacitance, and computing total capacitance in series and parallel. States relationships between farads, volts, electric charge, and voltage.

Capacitive Reactance - Differentiates between inductance and capacitance in AC circuits. Defines capacitive reactance and the formula for computing capacitive reactance from frequency and capacitance. Introduces phase relationship between voltage and current in capacitive circuits Trainees compute impedance in a series capacitive circuit and a series RC circuit. They also calculate power factor in RC circuits.

Series Reactance and Impedance - Defines impedance and the series RLC circuit. Introduces representing impedances in an RLC circuit as vectors, finding net reactance, drawing the impedance triangle, and solving for the hypotenuse to find impedance. Trainees calculate component voltage, represent voltages as vectors, find net reactive voltage, represent voltages as a right triangle, and find the total voltage with Pythagorean's Theorem.

Block 3 - Electrical Math

Right Triangles - Defines the right triangle and equilateral triangle. Identifies the hypotenuse, altitude, and base. Trainees apply Pythagorean theorem to solve right triangles for their missing side.

Advanced Math II (Trigonometry) - Trainees review the right triangle and Pythagorean's Theorem. The sine, cosine, and tangent functions are introduced as ratios of two sides of the right triangle. Trig tables are introduced, along with the concept of the ratio of sides being dependent on the angle. Trainees solve practical word problems using right triangle trigonometry.

Block 4 - Safety

OSHA Standards (Part 2) - APPA Safety Manual, Section 1 - General Rules. Topics include employee responsibility for safety, reporting employee injuries, reporting utility vehicle accidents, reporting hazardous conditions, taking chances, practical jokes, guards, hazardous energy control/ lockout-tagout, warnings, intoxicating beverages and drugs, housekeeping, smoking, clothing, eye and face protection, supplemental breathing equipment, fall protection, life jackets, head protection, wearing apparel, hand tools, portable electric tools, pneumatic tools, hydraulic tools, power lawn mowers, edgers, etc., power-actuated tools, safe supports and scaffolds, ladders, straight ladders, step ladders, material handling and storage, explosives, compressed gasses, welding and cutting, and acids and caustics.

Electricity & the Human Body - Introduces factors that affect current flow through the body, effects on the body versus current magnitude, critical difference between pathways through the body, and hazards of working on electrical equipment in wet conditions.

Block 7 - Transformers

Transformer Rating - Transformer nameplates, kVA ratings, and high & low side ratings are reviewed, along with standard nameplate symbols used to state voltage ratings. Formats are covered for stating voltage ratings of grounded-wye, delta-only, and delta-wye application. Additionally, low side ratings for transformers with series parallel capability, 3-phase 4-wire capability, and dual voltage center tap connections are reviewed. Transformer ratings are given for transformers with three bushings and internal connections, and four bushing transformers using external connections.

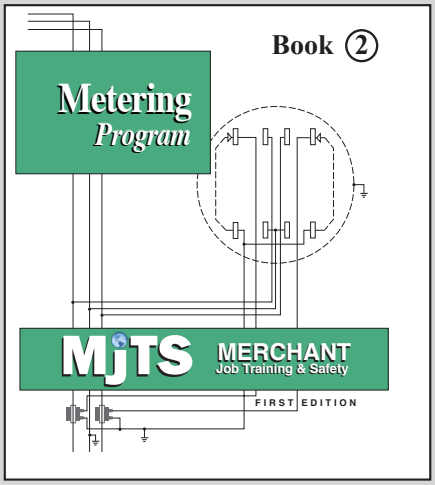
Primary System voltages - Trainees draw vector diagrams of delta and wye systems, using a protractor and ruler and they identify phase and line voltage values. They determine the three phase constant to calculate line voltages from phase values, and survey standard primary system voltages.

Introduction to Transformer Connections - Trainees draw a vector diagram of a 3-phase 4-wire system to scale and label phases and neutral conductor, calculate phase voltage and line voltage. They give the ratio of line-to-phase voltage. They determine transformer coil voltage from system voltage and the transformer connection. Transformer ratings are reviewed.

Transformer Connections (Single-Phase) - Reviews the distribution system, voltage vectors, consumer's service, transformer rating, and primary system voltages. Introduces a 12-step method used to diagram 1-phase transformer connections. Trainees draw vector diagrams of primary system voltages, determine line and phase voltage. They make common transformer connections using the 12-step procedure.

Transformer Connections (Three-Phase) - Reviews common voltage ratings for residential services. Describes the wye and delta connection. Trainees determine high & low side connections based on transformer rating & system voltage.

Transformer Connections (Phase Displacement) - Defines transformer phase displacement. Gives the possible phase displacements given the four possible three phase connections for both standard and alternate displacements. Trainees construct a "vector guide" to assist trainees in manipulation of vectors and phase displacement.



Second Year Unit Descriptions
(continued)

Transformer Connections (Wye-Delta) - Defines the floating high side connection and advantages & disadvantages of floated and grounded wye high side. Gives examples of secondary service ratings that require delta low side, make wye-delta connections by the vector method.

Transformer Connections (Wye-Wye) - Gives advantages and disadvantages of wye-wye connection and requirements of grounding wye-wye connection. Reviews customer service that requires a secondary wye connection. Trainees make wye-wye transformer connections by the vector method.

Transformer Connections (Delta-Wye) - States biggest advantage of low side wye connection. Introduces the connection required to test a transformer for percent impedance. Trainees calculate impedance from high side voltage required to produce rated low side current. They demonstrate the ability to make delta-wye connections by the vector method.

Transformer Connections (Delta-Delta) - Introduces importance of impedance to delta high side connections, the effect of differences in the relative impedance of delta connected transformers, and the effect of high circulating currents within the delta. Trainees demonstrate the ability to make delta-delta connections by the vector method.

Transformer Fusing - Trainees are introduced to fusing considerations for high side connections; wye, delta, open-wye, and open-delta. Trainees determine coil voltage based on system voltage and the high side connection, calculate coil current from coil voltage, and transformer kVA rating, they determine line current based on the transformer connection, and then calculate the current value to use in sizing transformer fuses.

Transformer Connections (Fusing Wye) - Trainees work out high side wye connections by the vector method and then calculate coil currents, line currents, and line current value to be used for sizing transformer fuse size.

Block 9 - Live-Line Maintenance

Fault Currents - Defines fault current and primary factors governing value of fault current on a circuit. Compares fault current on open wire and underground cable, and the effect inductance has on changes in current flow. States precautions to take in selecting arrestors. Identifies features of cutouts that allow its use on high fault current circuits. Relates problems with CSP transformers on high fault current circuits.

Block 10 - Voltage Regulation

Introduction to Voltage Regulators - Introduces TCUL transformers, step regulators, induction voltage regulators, auto-boosters, booster transformers, and capacitor banks.

Step Voltage Regulators - Transformer classifications - mutual induction & autotransformers are discussed. Covers double throw switches as they apply to voltage regulators, regulator control mechanisms, and determination autotransformer output based on turns ratio and step setting. Considerations for bypassing regulators are reviewed.

Block 11 - Power Use

Consumer's Service - Trainees identify consumer system ratings from diagrams and voltages available phase-phase & phase-neutral. Outlines distribution services, ground clearance, and maximum service drop span by NESC. Details service entrances, grounding, temporary service, and farmyard poles.

Single-Phase Motors - Explains right and left had rule and torque production. Gives a brief history of motors, and how 3-phase motors have simpler construction but more expensive regarding availability of 3-phase at the service entrance.

Block 12 - Watt-Hour Meters

Introduction to Watt-Hour Meters - Details how the potential coil and voltage coil are connected into the circuit, how torque is produced on a disk to produce rotation, and what determines how fast it turns. Names principle parts of a meter. Defines power, watt, energy, watt-hour, register, watt-hour constant, stator and rotor

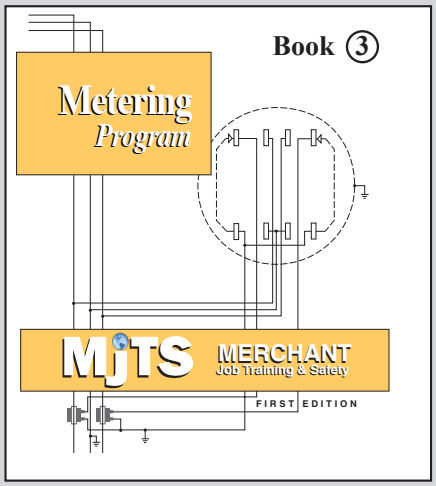
Polyphase Meters - Trainees compare construction of single-phase and polyphase meters. They learn the advantages of metering polyphase as one circuit instead of metering each phase seperately. They are introduced to the advantages and disadvantages of single vs. double disk on a single shaft. They apply Blondel's Theorem to the polyphase system, and determine methods to reduce interference between different stators on one disk. They will also relate to the magnetic load braking comparison of milti-phases, and the control and compensation for temperature changes.

Reading Dial Meters #2 - Trainees read dial meters for both four and five dial meters. They calculate actual monthly consumption by giving the present and previous meter readings. They calculate montlly consumption using the register constant and register readings.

Block 13 - Test Meters

Voltage Recorders - Surveys strip type and paperless voltage recorders.

Basic Meters - Identifies basic meter movements, explains how variation in current effects magnitude of meter readings. Explains operation of electromagnetic and thermal meter movements. Discusses linear and non-linear meter scales. Introduces basics of electronic meters.



Third Year Unit Descriptions

Block 2 - Basic Electricity

Parallel Reactance/Impedance - Defines the parallel RLC circuit. Introduces finding current through each parallel component, representing the branch currents as vectors, finding net reactive current, drawing the current triangle, and solving for total current by solving for the hypotenuse. Explains finding total impedance by the unequal branch method in RC or RL circuits and by Ohm's Law using total applied voltage and total current.

Electrical Terms (Review) - Trainees review electrical terms from the four years of the program and test their memory by working out a crossword puzzle.

Impedance Calculations - Trainees learn circuit calculations that have resistors and inductors in both series and parallel configurations. They apply these concepts to their understanding of how the line-drop compensator enables the voltage regulator to "see out" to remote parts of the system and correct voltage conditions to that point in the line.

Block 4 - Safety

OSHA Standards (Part 3) - Trainees review safety standards specific to health and environmental control, vehicle operations, work area protection, and fire protections. Trainees sharpen their recollection of the standards by working crossword puzzles.

Block 7 - Transformers

Transformer Connections (Fusing Delta) -Trainees work out high side delta connections by the vector method, then calculate coil currents, line currents, and line current values to be used for sizing transformer fuses.

Transformer Connections (Open) - Trainees are introduced to open wye-open delta connections, vector diagrams of the open wye-open delta connection, and limitations placed on use of open wye connections. Given system voltage, transformer rating, secondary system, and phase displacement, trainees use the vector method to work out transformer connections. They determine primary coil voltage, primary coil current, primary line current, and determine the current value needed to size transformer fuses.

Transformer Connections (Taps) - Given system voltage, transformer rating, secondary system, and phase displacement, trainees use the vector method to work out various transformer connections. They use system voltage and transformer rating to calculate necessary tap settings. They calculate primary coil voltage, primary coil current, line current, and the current value need to size transformer fuses.

Autotransformers - Trainees review the differences between mutual induction and autotransformers, and are introduced to advantages and limitations of autotransformers. They calculate output voltage of autotransformers given input voltage and turns ratios, as well as primary and secondary currents. They explain kVA rating of mutual inductance transformers and autotransformers.

Extra-ordinary Transformer Connections - Trainees are introduced to two phase systems, 2-phase 4-wire systems, 2-phase 3-wire systems, 2-phase 5-wire systems. Conversion from 3-phase to 2-phase using conventional and the Scott Connection is presented. Also presented is the connection for 120/208 3-phase 3-wire & 120/240 1-phase 3-wire. A connection to provide 120/208 3-phase 4-wire when only two primary phases and a neutral are available is introduced. Finally, balancing large single-phase loads onto a three-phase feeder using 120/208 Network 3-wire service is presented.

Transformer Calculations - Trainees calculate three-phase transformer bank rating for given closed delta and open delta banks. They calculate the power load from given values of system voltage load current. They use charts to calculate the relationship between given values of average KWHr in a peak month, transformer demand in kVA, and the number of customers who can be served from a transformer. They calculate voltage drop for a given kVA load over a given secondary lenth using charts. They will determine necessary secondary wire size to yeild a desired maximum voltage drop. They calculate and recommend transformer ratings for given loads, utilizing open delta and closed delta configurations.

Transformer Connections/Unbalanced - Trainees fuse high side wye and delta transformer banks. They complete conventional transformer connections as outlined earlier in the program. Trainees identify coil voltage, coil current, line current, and fuse sizes for unbalanced systems.

Floated vs Grounded Wye - Trainees learn the meaning of the term, floating. They learn the effect of losing a phase on both grounded and floated wye-delta systems. They calculate the transformer bank capacity after the loss of a transformer on a grounded wye-delta bank. Trainees demonstrate their skills at diagraming transformer connections by redrawing transformer vector diagrams after losing one phase of a three phase system.

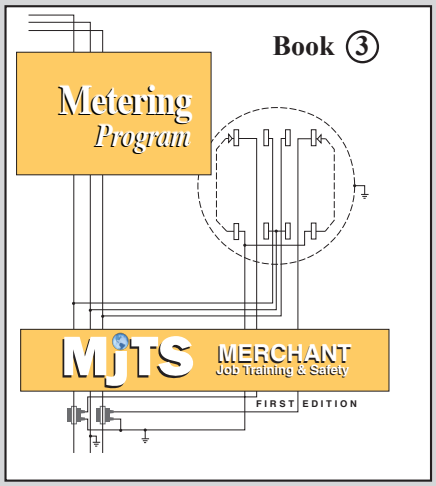
Unbalanced Loads - Trainees learn to calculate loads on transformer banks and specify transformer sizes required for the bank. Trainees are required to calculate transformer sizes by the mathematical method, and then graphically calculate the same bank for comparison.

Phase Rotation/Transformers - Trainees learn general information regarding phase rotation and the Open Wye - Open Delta connection. They learn the effect that phase sequence has on direction of rotation of three-phase motors. The learn three alternatives of achieving 3-phase power from single-phase and V-phase systems.

Grounded Wye-Delta Transformers - Trainees demonstrate their skills with grounded Wye-Delta and Delta-Delta transformer connections. They complete transformer connections showing high side and low side diagrams, phase displacement and rotation, required transformer sizes, and necessary fuse sizes.

Transformer Calculations & Review - Trainees learn to calculate transformer bank rating for given closed delta and open delta banks. They draw vector diagrams for system voltages, and label the vectors the diagrams for the system voltages. They are introduced to calculating power loads from given values of system voltage and load current. They determine residential transformer capacity and calculate transformer voltage drop and secondary conductor voltage drop. Finally, they learn to size transformers for an unbalanced 3-phase bank such as the 120/240 V 3-phase 4-wire with large single phase load.

Transformer Connections Review - In this unit, trainees review transformer connections and calculations and demonstrate their abilities with the more common transformer connections.



Third Year Unit Descriptions
(continued)

Block 8 - Over-Voltage/Over-Current Protective Devices

Introduction to Protective Relaying - Trainees learn the definition and primary funciton of a protective relay. They familiarize themselves with the various abnormal conditions detected by protective relays. They explain undesirable effects of overlapping protection zones and why despite these undesirable effects, it is desirable to overlap protection zones. Trainees learn probable causes of relay failure and why it is desirable to have back-up relaying systems. They are introduced to the advantages gained with microcomputer relay systems.

Relay Operating Principles - Trainees learn the difference between open and closed contacts, and normally open or closed contacts. They familiarize themselves with symbols for electrical devices and number systems relating to relays. They learn the difference between “pickup” and “reset” quantities of current, along with the principles ralating to the operation of electromagnetic attraction type and induction type relays.

Block 11 - Power Use

Power Factor - Power factor, apparent power, true power, and reactive power are defined. Trainees are introduced to representing these powers as vector quantities, determining net reactive power, and constructing the power triangle. They calculate power factor in RC, RL, and RLC parallel circuits and are introduced to the concept of power factor correction.

Power Factor Correction - Trainees learn to calculate power factor from given loads. They draw the power triangle and determine phase angle and power factor using a ruler and protractor. They calculate the capacitor bank rating necessary to correct a given load to 100% power factor.

Electrolysis - Trainees are introduced to a voltaic cell and how this cell relates to electrolysis of metals. The term electrode potential is defined, as well as calculating the voltage generated from the combination of various metals. Trainees learn variables that determine the rate of oxidation-reduction and why using sacrificial metals for grounding is dangerous. Sacrificial anodes are introduced, along with proof-testing sacrificial anodes. Trainees learn oxidation-reduction and various corrosion problems related to overhead and underground systems.

Capacitor Bank Application - Units of measure for real, reactive, and apparent power are reviewed, as well as formulas for calculating power factor. They are given a method for determining the best location and size of a permanent capacitor bank. They are introduced to proper application of capacitors relating to proper connections and grounding of capacitor banks. They calculate power factor of circuits and correct them to a given power factor. They calculate capacitor fuse sizes and review safety requirements for disconnecting and removing capacitors from service.

Ferro-resonance - Trainees are introduced to the mechanisms behind ferro-resnance. They learn variables affecting ferro-resonant situations, along with two transformer connections that are resistant to ferro-resonance. They are also given procedures protecting a system against ferro-resonance.

More Power Factor Correction - Trainees identify units of measure for true, reactive, and apparent power. They learn the most efficient location for placement of capacitor banks within the electric system, and where on the system they are likely to find highly reactive loads. They familiarize themselves with two applications for use of oil circuit breakers on switched capacitor banks. They learn the advantages and disadvantages of capacitor bank use compared to the step voltage regulator in regulating system voltages. They calculate power factor from given situations on the electric system, and calculate power factor corrections for three different applications.

Power Factor Problems - Trainees calculate true power, reactive power, and total or apparent power, and percent power factor for a variety of RL and RLC circuits. They then calculate capacitor bank kVAR rating necessary to iimprove power factor to a given desired value. Capacitor bank fuse sizes are also calculated.

Three Phase Motors - Trainees are introduced to the major types of three phase motors in use today, and their basic construction. They learn basic operation of synchronous, squirrel-cage, and wound-rotor three phase motors, and the procedure for reversing the rotation of a three phase motor. They are also introduced to wye and delta motor winding connections.

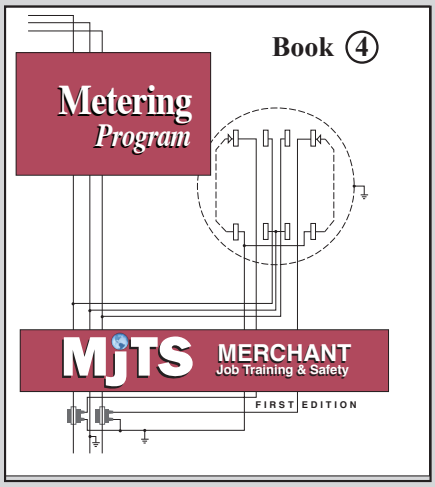
Block 12 - Watt-Hour Meters

Demand Factors - Terms relating to demand metering are defined. Trainees are introduced to the types of demand registers and which are most accurate. They learn the difference between primary, secondary, and universal metering. They calculate load factor given maximum demand and average demand, and learn why load factor is critical to economic distribution of power.

Instrument Metering - Trainees are introduced to potential and current instrument transformers, their purpose, their terminal markings, and their polarity. They calculate potential, current, and watt-meter multipliers. They calculate the value of voltage at the meter of a substation meter. They learn ratings for capacity, voltage, and error for potential transformers, as well as secondary ratings of both the current and potential transformers and their application to metering situations.

Application of Watt-Hour Meters - Trainees review definitions of metering terms. They review the units of measure for energy and the time period for recording maximum demand. They learn capacity limitations placed on self contained meters, and the full load current and voltage of transformer rated meters. They are introduced to advantages of the S base meter compared to the A base meter. They learn to apply meters to 1-phase 2-wire service, 1-phase 3-wire service, 3-wire network service, 3-wire 3-phase grounded phase delta service, 3-wire 3-phase ungrounded delta service, 4-wire 3-phase delta service, and 4-wire 3-phase wye service.

Reading Dial Meters (Review) - Trainees practice reading dial meters on progressively difficult examples.



Fourth Year Unit Descriptions

Block 3 - Electrical Math

Advanced Vectors - Trainees build on the their knowledge of vectors by learning addition and subtraction of vectors by mathematical methods in addition to graphical methods they learned earlier in the program. They familiarize themselves with common terms used in measurements such as scaler, vector. polar coordinates, rectangular coordinates, and pathagoreaon theorem.

Block 4 - Safety

OSHA Standards (Part 4) - Trainees review safety standards specific to overhead distribution and transmission, tree trimming, underground lines and equipment, underground residential distribution, generating stations, communication facilities, and office safety.

Portable Fire Extinguishers - Introduces common fire extinguishers used by electric utilities. Associates combustibles with classes of fire. Emphasizes the hazards of fire fighting. Gives safety precautions to be taken before starting work where fire hazards exist. Surveys tools recommended for fire fighting.

Block 8 - Over-Voltage/Over-Current Protective Devices

Differential Protective Relaying/Applied - Trainees learn the basics of differential protective relaying as it applies to bus protection and transformer protection schemes. Trainees work out currents and current transformer ratings for a substation three-phase wye-delta transformer.

Block 12 - Watt-Hour Meters

Watt-Hour Meter Basics - Trainees learn the basic components and operating principles of an induction watt-hour meter. They learn terms and definitions to understanding the basic watt-hour meter. Trainees match electrical systems to given power totalization formulas.

Watt-Hour Meter Concepts - Trainees learn the basics of measuring parameters related to electrical energy use. They get an overview of applying various types of meters, particularly the watt-hour meter. Trainees are introduced to reactive loads and power factor of systems, and terms and definitions relating to meter personnel using crossword puzzles.

Meters & Associated Equipment - Trainees receive general information regarding the design of kilowatt-hour meters. Information pertains to accurate measurement of energy in the form of kW-hours. Trainees are introduced to both mechanical and electronic meters, and relate to the key parts of the meter. They identify and label the symbols used on a meter, and learn eight variables that must be considered before installation of a kW-Hr meter.

Demand Meters - Trainees learn the basics of demand metering, and advantages of demand metering for both the utility and the consumer. They they gain appreciation for how the utility absorbs the cost in the form of energy to produce electricity and the cost of equipment to supply high demand consumers. Trainees list the various types of demand meters and how the kilowatt hour meter can also measure the maximum kW demand. They learn the three common registers used by utilities and the advantages and disadvantages of each.

Transformer Metering - Trainees are familiarized with straight or self-contained metering, as-well-as the application of transformer rated metering. They are introduced to the capacity of single and polyphase services, and the recommended ratings of each. Trainees will deal with the various types of meters and their application. They will learn about the hazards of working with dangerously high voltages and currents, and why the CT must be handled with care when installing or removing them from service. Trainees must identify symbols used in diagramming meters and the use of form designations.

Harmonics & Metering - Trainees learn general information regarding system interference from harmonic line losses. They work with the perfect waveform, and waveforms that are distorted by loads known to distort current or voltage waveforms. They will be exposed to harmonic distortions from earlier times, as well as modern day losses due to electronic equipment.

Meter Connections/Single Phase - Trainees will complete metering situations by filling in form standards showing external wiring, meter socket, and meters for applications involving single-phase circuits. They diagram self-contained as well as transformer-rated meter connections. The first six assignment sheets are completed by transferring circuits to the meter as practice for application to electrical services.

Meterman's Terms and Definitions (Review) - Trainees review terms and definitions relating to Metermen. They complete a crossword puzzle from given terms. The terms and definitions will familiarize trainees with the definitions of terms of particular interest, along with their spelling.

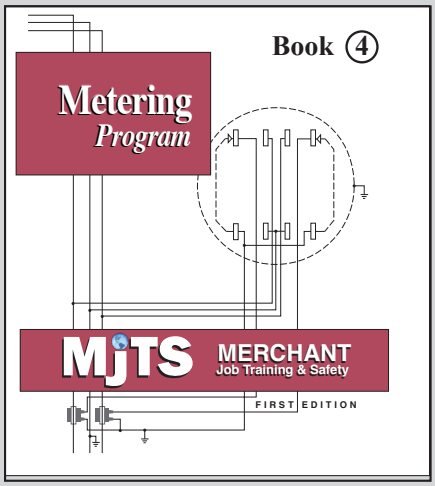
Introduction to Meter Testing - Trainees learn such terms as; "as-found" and "as-left" in reference to meter testing. They are given formulas for testing single-phase, 3-wire meters such as the function of meters, finding the load placed on a meter, accuracy, and percent error of a meter. They also learn the location of adjustments of a meter, and the three adjustments done to a meter under test. Trainees are given tips used for inspecting a meter that may require testing. These inspection suggestions may save the Meterman valuable time by eliminating the need for testing.

Meter Connections/Polyphase - Trainees learn general information regarding poly-phase metering. They connect the Network meter connection that by definition is a poly-phase meter. Trainees also connect a meter containing 2-PTs and 2-CTs. They also connect a 3-phase meter with 2-CTs for a circuit having low voltage, but high current.

Meter Connection/Four-Wire, Wye - To give the trainee practical experience, they will complete on paper the following connections.

1. Transformer-rated 2-stator meter with three CTs.
2. Transformer-rated 2-stator meter with three CTs and PTs.
3. Transformer-rated 3-stator meter with three CTs and three PTs.

Summary of Meter Testing - Trainees use the "Power-Time Meter Testing" formula to test meters for accuracy. They are given values to first calculate time from given power loads. Then, give power loads, they calculate time necessary for the number of turns of the disk. Trainees answer general questions relating to rotating standard ratings such as normal currents and voltage ratings. Then, they calculate the multiplier, which will match the rotating standard to the meter under test.



Fourth Year Unit Descriptions
(continued)

Meter Connections/Four-wire, Delta - Trainees perform on paper the following connections:
1. Three CTs for 4-wire delta.
2. Two CTs, for 4-wire delta.
3. Two-stator meter with one 2-wire and one window-type CT, for 4-wire delta.

Introcuction to Polyphase Metering - Trainees are introduced to general information regarding poly-phase metering. They learn to take into consideration the location of the meter as well as considerations necessary to assure accuracy of watt-hour meters. Trainees consider such basics as proper protection from surge voltages and application of a detent added to the meter. Application of instrument transformers is also reviewed. Cautions taken in the maintenance of watt-hour meters such as keeping magnetic materials from meter braking system and refraining from the use of lubricants.

Testing Single-phase Meters - Trainees learn general information regarding testing of single-phase meters. This involves reviewing the meter and preparing for meter testing. They work with principle meter parts, and review effects of an eddy-current simultaneously interacting with the magnetic field. Trainees learn how the stator works like an induction motor. Testing involves adjustment of the Full-Load, LIght-Load, and the Lag-Load. Problems from ambient heat on braking magnets and disk creep are discussed.

Meter Connections/Network - Trainees learn general information relating to Network Connections. They replicate Network connections for self-contained and transformer-rated 2 and 3-wire connections. They work with single-stator Network meter connections that will show the changes in phase angle for proper metering of a 3-wire Network connection.

Testing Polyphase Meters - Trainees learn general information regarding the testing of polyphase watt-hour meters. They explain proper stator coil connections. They learn procedures for the “as found” checks given to meters that are removed from service. They learn important calibration checks performed on meters as well as the adjusting of the torque screws made before major calibrations are made. They are given formulas used for comparing a meter under test with a known rotary standard. The constant that refers to the number of current coils will be used.

Handling Meters - Trainees learn safe work practices dealing with energizing and de-energizing meters and their associated electrical components. They relate to the use of transformer-rated meters and the safe use of potential and current transformers.

Metering Reactive Loads - Trainees work with units of measure for power loads, and reference transformer sizing. They gain an understanding of reactive loads and what is required to meter reactive loads. Trainees work with a 3-wire system, a 4-wire system, and a phase-shifting transformer for measuring reactive loads. They explain the Q-Meter and its function, along with the system of Cross-Phasing simplifies the necessary equipment required for metering reactive loads.

Solid State Metering - Trainees gain an understanding of how current and voltage are multiplied to measure power, and how by the use of microprocessors, solid-state meters can measure energy. They learn functions of a solid-state meter that can be performed electronically, but are not possible with an electromechanical meter. Trainees learn and work with four different methods used by manufacturers to multiply current and voltage. They describe in particular the method used by the Hall Effect to multiply the current and voltage

Notes

Notes

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