Meter Technician Career Development Program

Offered by
ElectriCities of North Carolina, Inc.
1427 Meadow Wood Blvd.
Raleigh, North Carolina 27604

Meter Technician Career Development Program Working Group

This program has been developed and implemented by representation from North Carolina members.

Active Members

Craig Batchelor, ElectriCities
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Kenny Roberts, ElectriCities
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Preface I

The Meter Technician Career Development Program (developed by the Meter Technician Career Development Working Group) is a video-based training program for electric meter technicians. The working group consists of electric meter technician supervisors selected by the ElectriCities Safety and Training Team.

Expert meter technicians contributed to the preparation of the instructional materials that were produced by the Alexander Publications. The Resource Guide includes program procedures, instructions on how to order, an index of modules (30), forms, and the three recommended levels of training. Each module includes a videotape, a student manual, and an instructor's guide. There are 30 module descriptions in the Resource Guide.

Recommended levels of training for electric meter technicians range from the entry level to the most advanced level: Basic – Meter Technician I, Intermediate – Meter Technician II, and Advanced – Meter Technician III.

Sections seven, eight and nine are the module descriptions recommended to enhance the student's job knowledge and ability within each training level.

Some modules are listed more than once. A lower training level often requires that you view a module as an overall introduction to the subject before covering that subject in depth at a higher training level. Some of the modules are taught in only one training level while others are repeated in higher training levels.

For example, Safety in Meter is covered in all three levels of the training program and is found in each training level. Therefore, when a student registers for the Meter Technician I, the Municipal Training Coordinator will receive the student manual and instructor's guide for that particular module. When the same student registers for the next two levels, he **will not** receive another student manual for Safety in Meter Work.

Save your student manual and instructor's guide. Records on file at ElectriCities will indicate that the registered student has the student manual and that the training coordinator has the instructor's guide.

Maintaining a library of student manuals provides not only a resource document but also study material for the Certification of Completion Examination.

The Certification of Completion Examination may include an evaluation of performance to assure the student has a working knowledge of the tasks usually required by a meter technician at that level in the industry. The instructor is strongly urged to include other hands-on training to complete the student's mastery of all tasks taught by the module.

Following are some comments, suggestions, and recommendations for administering the training program.

Training Coordinator

Each municipality is encouraged to select one of their staff members as a training coordinator for the program. The selection of one person will minimize the difficulties associated with communicating with more than one person about changes, interpretations, proposed meetings, and techniques to enhance training.

Teaching

Teaching techniques vary. However, a time-proven method to get your point across is by demonstration and hands-on experience. Simply stated, you can tell a person how and you can show them how, but you won't for sure what they have learned until they show you.

If possible, use demonstration models in concert with your modules. For example, when presenting a module on a single-phase meter, have a single-phase meter in the training room with you along with the disassembled parts of the meter.

Facility

Facilities will vary greatly. They must, however, include at least the following: space and seating for the anticipated group, a level place to write, a DVD player, a video monitor, and sufficient lighting.

To encourage maximum learning, use a chalkboard or flip chart and resource or reference publications. Periodic cleaning and servicing of the municipality's audiovisual equipment is recommended to maintain the videotapes in good working order.

Municipalities may consider using other town facilities such as fire stations, community centers, colleges, town halls, or the facilities of private organizations, e.g., Moose, Elk, Civitan.

Participants

Who will participate? Several municipalities will have all their electric meter technicians complete the program. It is more effective to have supervisors, foreman, instructors, and more experienced electric meter technicians attend first and separate them from the "green" or novice workers. This move assists in preventing embarrassment that may be associated with the mixing of the two groups. Of course, this procedure is not always necessary and is certainly at the discretion of the municipality. However, in some cases the program will be for the exclusive use of the new or inexperienced electric meter technician.

Instructors

It is a good idea for instructors to be familiar with and knowledgeable in the module they are scheduled to teach. This statement correctly infers that the same instructor does not need to instruct at all the sessions.

The training coordinator for the municipality needs to know the expertise and experience level of the proposed instructor in order to make a proper choice for maximum program effectiveness. It is recommended that these instructors be approved by the ElectriCities Safety and Training Team for teaching qualifications.

A municipality may reach out to the community or other participating municipalities for instructors to enhance their overall capabilities. You could properly conclude that a person with limited electric meter technician knowledge may be strong in a particular area of teach such as math concepts. When possible, involve your more experienced electric meter technicians in demonstrations when teaching subjects they have already mastered. This will allow you to keep their attention, refresh their knowledge on the subjects, and utilize their expertise in teaching others.

Instructor's Guide

An instructor's guide will be issued with each module. This guide is a complete explanation of content and includes suggested demonstration material, training techniques, and related instructional information. The guide is designed to minimize the instructor's preparation time that, in effect, could cut into the municipality's overall production time. A final quiz to be given at the conclusion of a module is also included in the instructor's guide.

Student Manual

A student manual that follows the videotape precisely is furnished to the student. This manual should be given to the student well in advance of the scheduled classes to allow the student sufficient preparation time. The videotape contains segments associated with the major subject. This time-proven method of learning, seeing, hearing, reading, and doing will assure a high percentage of comprehension.

The student manual contains a quiz for each segment to help assure the student's training progress. Questions that appear in each quiz are also contained in the test given by the instructor at the conclusion of each module.

Associated Training

Because the reading of the student manual and the viewing of the videotape does not guarantee your performance capabilities, the program strongly encourages sufficient hands-on training. Realizing that the program is highly task-oriented, hands-on training becomes even more critical to complete learning. Best results can be obtained while having students performs tasks on a module-by module basis.

Testing

Each module is divided into various subtopics called "segments". After each segment, the student manual offers a quiz to establish the student's comprehension of the subtopic in that segment. A comprehensive examination, located in the instructor manual, is available for the instructor to test the student's knowledge of the module subject after completing the total module.

Certification

Municipalities will keep records of students who participate in the program and the training level that they reach within a predetermined period of time. Record forms are included in the training level Sections 7, 8, and 9 to assist the municipality in tracking the progress of the class and each student. Promotion can be used as an incentive to participate in the program. Testing and certification and specifically covered in the Program Procedures Section.

Support

The ElectriCities staff is available to help you in making this program a success.

Definitions II

Confidential
Information that is not publicly posted nor accessible to the public to the extent permitted by law. The exact definition and procedures to insure confidentiality should be established by the municipality.

Coordinator
The person appointed by the municipality to administer the training and testing for the Meter Technician Training Program.

Employee
A person employed by a municipality.

Level
There are three levels into which the Meter Technician Training Program is divided and upon which a student is tested.

Meter Technician
A person whose job is to test, install, repair, and maintain electrical meter measurements.

Meter Technician Career Development Working Group
A committee under direction of the ElectriCities Safety and Training Team formed to develop, implement, and monitor the Meter Technician Career Development Program sponsored by ElectriCities.

Module
A "lesson" in the Meter Technician Training Program that consists of a videotape pertaining to a particular subject, the student manual for that videotape, and the instructor's manual for that tape.

Municipality

A municipality that is a member of ElectriCities of North Carolina, Inc. who participates in the Meter Technician Training Program.

Student

An employee registered in a Meter Technician Training Program level.

Section I
Program Procedures

Meter Technician Career Development Program

Purpose

The Meter Technician Career Development Program is a voluntary training program open to ElectriCities members and is designed to increase the skills and knowledge of meter technicians of all experience levels. The students will learn to test, install, repair and maintain customer watthour meters, and will gain an understanding of the basics of math as it relates to electricity and, in the more advanced levels, gain overall job knowledge of complex polyphase metering.

Each Municipality is encouraged to participate in the Meter Technician Career Development Program according to its needs and resources.

Method of Teaching

Three related approaches to training are used to ensure training of both the mind and the hands:

1. Module training - gives a basic understanding of the reasons why systems operate the way they do.

2. Hands-on task training - increases dexterity, develops safe work habits, and provides physical application of theories learned in Module training.

3. Testing - helps the meter technician identify areas that need improvement.

These three approaches reinforce each other to ensure that knowledge becomes practice.

Program Outline

Levels

The program consists of 30 training modules produced by Alexander Publications. The Meter Technician Career Development Program Working Group designated certain modules to be covered in each level of training. The modules are to be presented in a systematic order of presentation. as outlined in Exhibit I, pages 23, 24 and 25 of this Procedure Section, and at the beginning of Sections 7, 8 and 9.

The Meter Technician Career Development Program is divided into three training levels. Those levels are:

Level I — Basic — 14 modules

Level II — Intermediate — 15 modules

Level III — Advanced — 7 modules

The total number of modules to be viewed is 36. A module may be used as an introduction prior to in-depth study at a higher training level. Three of the 36 modules are listed in more than one level.

Additional Modules could be added to the program as they are made available by Alexander Publications.

Level Progression

Every student registering for the Meter Technician Career Development Program must begin with Meter Technician I and proceed to Meter Technician III. Each student is required to view and study every module in a level, perform the task requirements, and complete all other requirements.

Note: ElectriCities strongly recommends that each student be tested within two months of completion of all modules in a level.

Each student must pass a standard test for each training level before registering for the next level. This test contains both a written and a hands-on exam of task requirements. The minimum grade to pass both exams is 70 percent. Passing the hands-on exam is detailed later in this section.

After passing the tests, the student is encouraged to register for the next level within the next 90 days.

Time Limits

Both the Municipality and the student should progress steadily through the program. The intention should not be to see how fast the student or class can complete a certain level, but to thoroughly train the students in the knowledge and skills of meter technician work.
The Municipality should provide training for one module per month for each student. Therefore, if a Municipality has students registered in two levels, two training sessions must be provided each month.

The time required for a student to complete a training level is as follows:

Time in Program (Months)			
Training Level	**Minimum***	**Recommended**	**Maximum**
Meter Technician I Basic	3	12	24
Meter Technician II Intermediate	3	18	24
Meter Technician III Advanced	6	12	24

***Note**: Past experience as determined by the Municipal Coordinator.

For a substitute student, the time for level completion begins on the date the substitute was registered. (Note: See page 14 of this section under Substitutions.)

Future

To assure that the program is kept up to date and each student receives maximum benefit, the program will be monitored by the ElectriCities Safety and Training Team and Meter Technician Career Development Program Working Group.

Module Study

Module Sequence

The modules are self-contained and should be presented according to the order of presentation of the videos. See Exhibit I, pages 23, 24 and 25 in this procedure section and the beginning of sections 7, 8 and 9 covering level of training content.

Module

Modules are generally divided into four to six segments. After viewing each segment, the instructor may choose to stop and review the segment before proceeding to the next segment.

Module Ordering

A Module Request Form (see Section 4) listing the title and module I.D. number of the video desired must be sent to ElectriCities. No more than two videos may be requested at the same time.

A Module Packing List (see Exhibit II, page 26 in this procedure section) will accompany each videotape that ElectriCities sends out.

Time Limit - Module

The Municipal Coordinator is responsible for returning videotapes along with the Module Completion Certification Form (see Section 5) to ElectriCities within three weeks. Should additional time be needed, please call the ElectriCities Learning Coordinator to arrange a different return date.

Module Study (con't.)

Delivery of Videotapes

ElectriCities cannot guarantee the delivery of the desired videotape on the date requested. If delivery of the videotape to the Municipality is delayed, the ElectriCities Safety & Training Technician will call the Municipal Coordinator and arrange for an alternate date suitable to the Municipality. When delivery to the Municipality is delayed, return dates for the videotape will be adjusted accordingly.

Class Time Requirements

It is recommended that Municipalities schedule a minimum of four hours of uninterrupted classroom time for each module. Since some modules require more time than others, it may be necessary to review a particular segment, or the entire video, before going to the next module.

Regardless of the time it takes, no module should be considered complete until the students and instructor are satisfied that the module content is thoroughly understood.

Student module workbooks should be given to the student well in advance of the scheduled classes to allow the student sufficient preparation time.

Hands-On Training

Videotape training, by itself, will not develop a student's performance capabilities. Each Municipality must see that quality on-the-job training is provided to the student by a qualified, more experienced meter technician. If possible, such training should relate to the module being studied.

Certain hands-on task requirements approved by the ElectriCities Safety and Training Team are required for completion of each Meter Technician Career Development Program level.

Hands-On Training (con't)

For tasks requirements, see Sections 7, 8, and 9 at the beginning of each training level. When the student has gained the skills necessary, he will demonstrate to a qualified, more experienced meter technician his ability to perform the
hands-on tasks successfully, complying with all applicable safety rules.

Municipalities lacking the resources to train students for all task requirements are encouraged to coordinate with the Meter Technician Career Development Program Working Group and ElectriCities Safety & Training Specialist to coordinate training with a neighboring Municipality.

Training Suggestions

Some recommendations for the Municipal Coordinator to help the student get the maximum benefit from the Meter Technician Career Development Program are as follows:

- **Teaching** - Use demonstration equipment with your modules For example, when presenting a module on polyphase metering, have a polyphase metering installation in the training room with you.

- **Facilities** - Minimum facilities should include space and seating for the entire group, a level place to write, a DVD player, a video monitor, and adequate lighting.

- **Visual Aids** - Use a chalk board or flip .chart and reference publications for maximum learning.

- **Instructors** - The Municipal Coordinator will verify the instructor's qualifications for each module. A list of qualified instructors and those modules they are qualified to instruct will be provided by the Meter Technician Career Development Program Working Group. The instructors will be selected from the Municipal electric departments, the community, equipment vendors, manufacturing representatives, and other appropriate sources.

Module Completion

To complete a module, the student must:

1. View the module videotape.

2. Answer the questions in the student manual for each section.

3. Take the Instructor's Guide quiz. In all fairness to the student, it is imperative that this quiz be administered judiciously to assure the student is getting the full benefit of the training.

After the module is completed, a Module Completion Certification Form (see Section 5) listing names of registered students will be completed and returned to the ElectriCities Learning Coordinator.

Meter Technician Career Development Program Level Completion

To receive a Meter Technician Career Development Program Certificate of Completion for each level (see Exhibit III, page 27 of this procedure section), the student must:

1. Satisfactorily complete all modules of the level, including all recommended task requirements.

2. Pass the written and hands-on exam for the program level.

3. Have all records on file at ElectriCities.

Participation

Municipal Coordinator

Each Municipality with electric meter technician trainees in the Meter Technician Career Development Program shall appoint one Employee to coordinate the training. It is recommended that this person be a supervisor with the authority to register students, order modules, arrange instructors, schedule training meetings, certify module completion, request testing, and see that test results are reviewed with students.

The Municipal Coordinator will receive the test results and see that they are reviewed with each student. Although a student may make a passing grade, he may still need improvement in a particular area. The Municipal Coordinator should identify areas needing improvement for each student.

The Municipal Coordinator should make arrangements for the location of training and equipment needed.

Instructor

Each Municipal Coordinator needs to see that a qualified instructor is provided for each module.

Each instructor should be qualified and approved by the Meter Technician Career Development Program Working Group.

Registration

For a student to participate in the Meter Technician Career Development Program a Registration Form (see Section 2) signed by the Municipal Coordinator must be returned to ElectriCities and the tuition paid in full. A Registration Form is required for each of the three levels. Each student must be listed on the Registration Form.

Participation (con't)

Tuition

The current registration fee will be per level, payable prior to starting the course. Payment may accompany registration or may be billed to the Municipality.

Manuals

After receipt of registration and tuition, ElectriCities will see that all student manuals and instructor guides for the level are shipped to the Municipal Coordinator, i.e., one manual per module for each student and, if needed, one manual per module for each instructor.

Manuals are the property of the Municipality and may be controlled as they wish. Should the Municipality need additional manuals, they will be provided at the current price.

Decals and Patches

When a student first enters the Meter Technician Career Development Program, he will receive a hard hat logo decal and a cloth patch logo indicating he is in program training. As the student successfully completes each level, he will receive a cloth Level patch indicating the level completed. (See page 28 of this section for examples of patch and level recognition.)

Participation (con't)

Substitutions

Should the student withdraw from the program prior to completing the sixth module of Level 1, the Municipality may substitute another student. Module completion credit does not transfer from one student to another.
No additional tuition will be charged for this substitution if all of the following apply.

1. No additional student manuals are required.
2. No more than two months have lapsed between the withdrawal and the substitution.
3. The substitute is registered with ElectriCities prior to beginning the program.
4. ElectriCities is notified of the name of the student that withdrew.

Relocation

A student relocating to another Municipality retains credit for past module completions and may continue in the Meter Technician Career Development Program provided that:

1. The new Municipality requests re-registration.
2. Re-registration occurs within two months.
3. Pro-rated tuition is paid by the new Municipality.

If the relocated student was in a higher program level than the new Municipality, the period of time for re-registration will be extended to six months.

Participation (con't)

Testing

Tests after each Module in the Meter Technician Career Development Program helps provide feedback to the student on progress and needed improvement. These tests are administered under the direction of the Municipal Coordinator and the Instructor.

The ElectriCities Safety and Training Team strongly recommends that the final level written and hands-on exam be taken within two months after completing each level. These exams will be administered under the direction of ElectriCities staff. To register a student for testing, follow the steps listed in Pre-Testing Requirements. (See page 19 of this procedure.)

Pre-Testing Requirements

The Municipal Coordinator should notify ElectriCities staff 30 days in advance of the desired test date.

No student will be scheduled to take the test until the job task requirements have been performed. These tasks must be confirmed on the Task Requirements Forms (See Sections 7, 8 and 9). Completion of these forms requires that:

1. The student demonstrates the ability to perform all hands-on job tasks as listed by the Safety and Training Team.

2. The demonstration is witnessed by a qualified instructor.

3. The Task Requirements Forms for the student is completed, signed, and returned to ElectriCities.

The Module Completion Certification Forms (see Section 5) for a level must be completed, signed, and received by the ElectriCities Program Director at least two weeks prior to scheduling a test.

Prior to scheduling a test, ElectriCities staff will verify that the students have completed all requirements for the test. If any discrepancies are found, ElectriCities staff will discuss them with the Municipal Coordinator and resolve them prior to the scheduled test.

Module Additions to Level

If the Meter Technician Career Development Program Subcommittee adds a module to a level after a student has been enrolled in that level, the student will not be tested on its contents.

Test Coordination

The test consists of two parts: a written test and a hands-on exam. The written test is given by an ElectriCities staff member. The hands-on exam is given by examiners who are arranged by ElectriCities staff and approved by the Meter Technician Career Development Program Working Group.

A member of the ElectriCities Safety and Training staff and the selected field examiners will meet with the Municipal Coordinator to coordinate test details prior to the hands-on exam.

Ideally, both the written test and the field exam should be scheduled for the same day. When this is not possible, the ElectriCities staff will make arrangements suitable to the situation.

Level Certification Test Structure

Written Test

Normally, no more than four hours is required for written tests. There are several different tests made up of 100 questions for each level. A minimum grade of 70 percent is required to pass the written test.

Content

Written test questions are taken directly from the student manuals with some additional questions approved by the Meter Technician Career Development Program Subcommittee.

Procedures

The following procedures are used to ensure integrity during the testing of each level.

1. Written tests are administered and given by an ElectriCities staff member.
2. An ElectriCities staff member is present during the entire test.
3. Different tests are randomly distributed to the students.
4. Each completed test is returned to the ElectriCities staff member.
5. ElectriCities grades the test, prepares a test result form, and promptly sends the results to the Municipal Coordinator.
6. The Municipal Coordinator will be responsible to see that the results are discussed with the student, identifying areas needing improvement.

Level Certification Test Structure (con't)

Re-Testing

Should the student not pass the test on the first try, the Municipality may retest the student no sooner than two months and no later than six months after initial testing. The repeat test will be different than the first test.

Should the student not pass the re-test, the Municipality may withdraw the student from the Meter Technician Career Development Program or may re-register the student for the level at a 50 percent cost reduction.

Hands-On Test

The hands-on exam is comprised of detailed Task Requirements selected by the appointed examiners, ElectriCities staff, and the Meter Technician Career Development Program Working Group. A typical hands-on test form is illustrated in Exhibit V (page 29 of this procedure section). The hands-on Task Requirements will be filled in prior to the exam. The field examiners will check off whether the task requirement is completed satisfactory, needs improvement, or unsatisfactory. To successfully pass the hands-on exam, the student must complete 70 percent of the detailed task requirements satisfactory. If any task is checked unsatisfactory, this will result in the student repeating the exam. A student will not receive a Certificate of Completion until the hands-on field exam is passed.

Level Certification Test Structure (con't)

Procedures

The following procedures are used in administering the hands-on test.

1. Student is assigned to a field examiner and a location.
2. The Meter Technician Career Development Program Subcommittee, ElectriCities staff, and the field examiners will select the tasks student(s) will be required to perform.
3. Performance is graded by the field examiner.
4. Tests results are forwarded to the ElectriCities staff member present during the test.

Re-Testing

The student may be re-tested no sooner than two months and no later than six months after the original hands-on exam.

The repeat test of Detailed Tasks will consist of the tasks previously graded as unsatisfactory and needing improvement plus additional tasks to equal a consistent normal exam.

Students who pass both the written test and the hands-on exam will receive a Certificate of Completion (see Exhibit III, page 27 of this program procedure section) for each level of the Meter Technician Career Development Program and a cloth patch that indicates what level they completed.

Level Certification Test Structure (con't)

Records and Confidentiality

All information such as Task Requirement Forms, Field Exams, Module Certification Forms, and written tests are kept on file at ElectriCities.

This information is confidential and will not be released without a Release of Student Information Authorization Form. (See Section 6.) The Release of Student Information Authorization Form can be authorized three different ways:

1. Signature by the Student, Municipal Coordinator, and ElectriCities Program Director.
2. Signature by the Student and ElectriCities Program Director.
3. Signature by the Municipal Coordinator and ElectriCities Program Director.

Tape Handling

Damage Assessment

A damage fee of $100 will be assessed to a Municipality returning a videotape irreparably damaged by mishandling or negligence. Damage resulting from. normal viewing and defective DVD players will not be assessed a damage fee.

Level Certification Test Structure (con't)

Late Fee

The Municipality will pay a $25 late fee for the first day past the due date established by the Municipal Coordinator on the Module Request Form (only "week days" count for this calculation). For each additional day overdue, the Municipality will pay an additional $3 per day late fee. The late fee will never exceed $100.

Copyright Laws

The Municipality will abide by Federal Copyright Laws and not permit the videotape or any part of the manuals to be reproduced.

Support

For assistance or clarification Call the Manager, Safety & Training at (919) 971-2843 or the chairman of the Meter Technician Career Development Program Working Group.

Exhibit I

Meter Technician Level I
(14 Modules)
Video Order of Presentation

TITLE	MODULE ID NO
1. Principles of Magnetism	500
2. Basic Electrical Principles	510
3. AC Concepts	520
4. Introduction to Metering	530
5. Math for Metering I	540
6. Math for Metering II	550
7. Watthour Meter Principles I	560
8. Watthour Meter Principles II	570
9. Safety in Meter Work	580
10. Principles of Accuracy Testing	590
11. Watthour Meter Testing I	600
12. Watthour Meter Testing II	610
13. Energy Diversion	620
14. Customer Relations and High Bill Complaints	630

Exhibit I (continued)

Meter Technician Level II
(15 Modules)
Video Order of Presentation

TITLE	MODULE ID NO
1. Instrument Transformers	640
2. Testing Single-Phase, Transformer-Rated Meters	650
3. Polyphase Systems I	660
4. Polyphase Systems II	670
5. Self-Contained Polyphase Meter Testing	680
6. Polyphase Transformer-Rated Application	690
7. Safety in Meter Work (Review)	580
8. Polyphase Transformer-Rated Meter Testing	700
9. Demand Metering Concepts	710
10. Testing and Calibrating Demand Meters	720
11. Solid-State Meters and Associated Devices	730
12. Troubleshooting Techniques	740
13. Customer Relations and High Bill Complaints	630
14. Energy Diversion	620
15. Installation Checks and Inspections	750

Exhibit I (continued)

Meter Technician Level III
(7 Modules)
Video Order of Presentation

TITLE	MODULE ID NO
1. Reactive Metering Concepts	760
2. Reactive Metering Testing	770
3. "Q" Metering Concepts and Testing	780
4. Safety in Meter Work (Review)	580
5. Testing Totalizing Meters	790
6. Solid State Meters and Associated Devices (Review)	730
7. Energy Diversion	620

Exhibit II

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program
Module Packing List Form

Date _____

Shipped To _____

_____

_____

_____

Module I.D. No._____

Module Title _____

Package Contents
One Videotape**
One Module Certification Form**
One Self-Addressed Envelope**
One Module Request Form***

**Return via UPS or U.S. Mail by_____(This represents the postmarked date.)

***Return when you are ready to order your next module

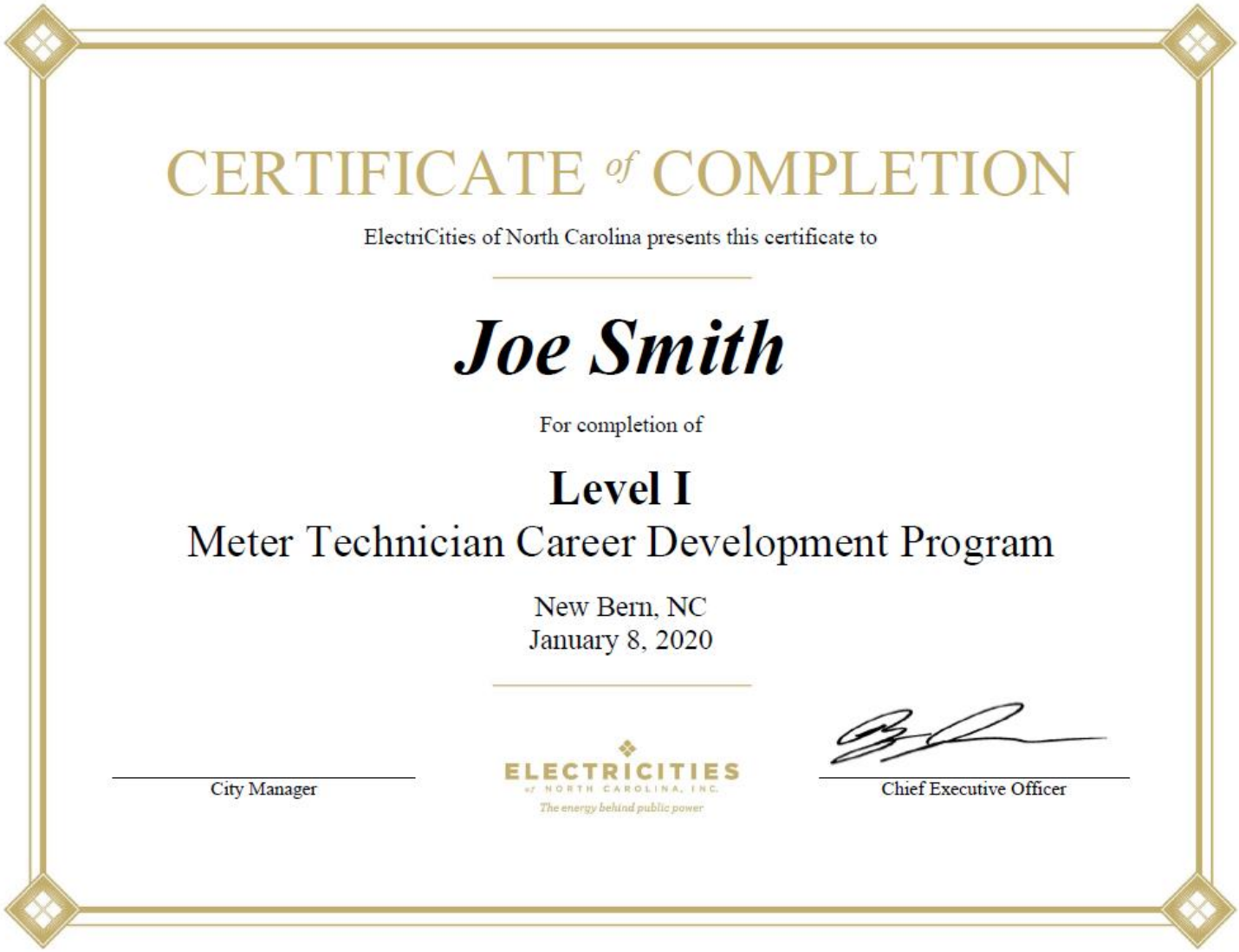
Notes:

1. Student Manuals and Instructor Guides for this module have been sent to you. Keep these for your employee's use.
2. Review this video before the training class to make certain that both video and equipment are working properly.
3. Please clean and service your videotape equipment regularly to keep videotapes in good condition.

For assistance or information, please call the ElectriCities Learning Coordinator at (919) 760-6301.

Exhibit III

Certificate of Completion



CERTIFICATE *of* COMPLETION

ElectriCities of North Carolina presents this certificate to

Joe Smith

For completion of

Level I

Meter Technician Career Development Program

New Bern, NC
January 8, 2020

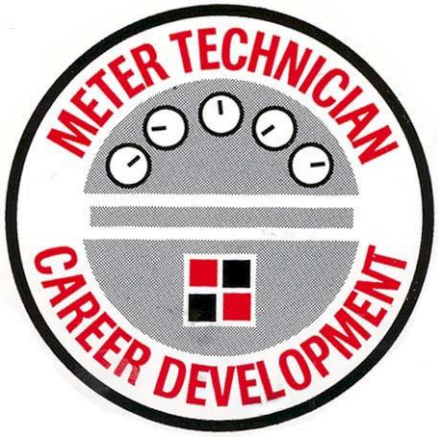
City Manager

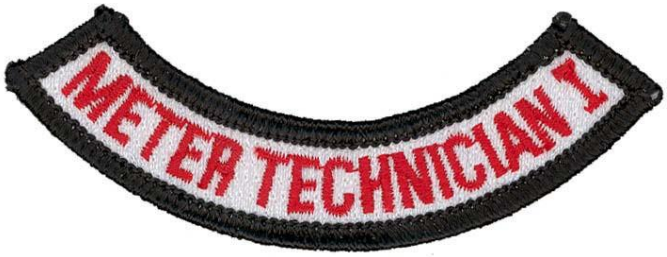
ELECTRICITIES of NORTH CAROLINA, INC.
The energy behind public power

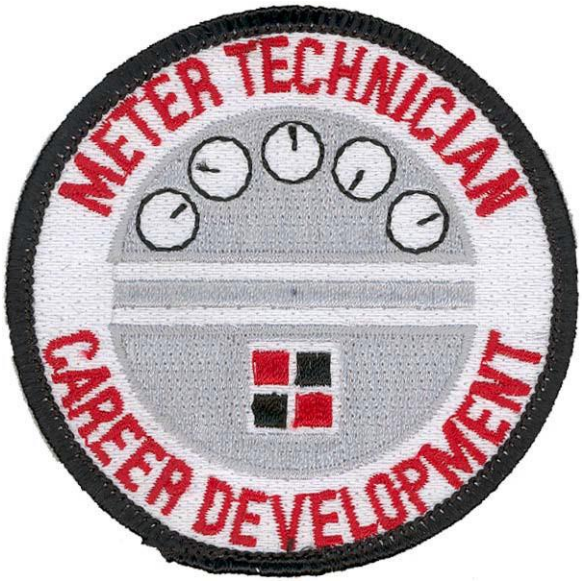
Chief Executive Officer

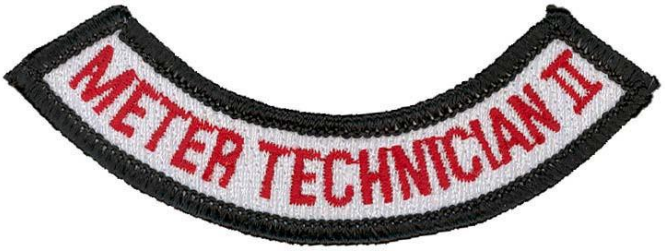
Exhibit IV

Decals and Patch Logo









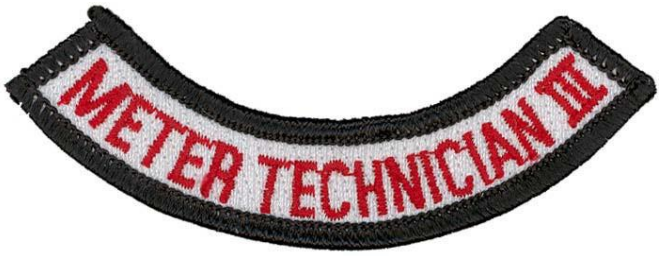


Exhibit V

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program - Level I
Hands-On Exam

Name:_____ Municipality:_____

Date:_____ Years *of* Service:_____

It is mandatory that the Meter Technician I be able to satisfactorily demonstrate and perform 70 percent
of the Detailed task requirements satisfactory. Any task (whether all or part) that is not performed and demonstrated in a safe and professional manner will be considered "needs improvement" or "unsatisfactory".

Hands-On Detailed Task Requirement	Satisfactory	Needs Improvement	Unsatisfactory
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			

NOTE (1): A TASK CHECKED "UNSATISFACTORY" WILL RESULTIN REPEATING THE FIELD EXAM.

NOTE (2): HAVING MORE THAN 30 PERCENT OF THE TASK REQUIREMENTS CHECKED "NEEDS IMPROVEMENT" WILL RESULT IN REPEATING THE FIELD EXAM PORTION OF THIS LEVEL.

Hands-On Examiner_____ Date _____

Place Out Procedure

In the event a student for the Meter Technician Career Development Program can document the required experience for the level in question, the student may be eligible to "Place Out" of the level and advance to the next level. A Place Out Test Request Form (see page 35) must be completed with the appropriate supervision verifying the student's experience and signed by the Municipality's Coordinator and then forwarded to ElectriCities prior to any testing. There is a fee for the test. The minimum Meter Technician experience requirements for each level are as follows:

Meter Technician Level I - Two years

Meter Technician Level II - Four years

Meter Technician Level III - Six years

Place Out Tests is based on per level, per student. If the student fails any level, the costs will be applied to the registration fee. All necessary requirements must be met according to the Meter Technician Career Development Program guidelines.

Once a student has demonstrated satisfactory completion of the prerequisites outlined above, the student can be tested beginning with the Meter Technician Level I examination. The minimum passing grade for all examinations in the Meter Technician Career Development Program is 70 percent correct. Following successful completion of each exam, the student may qualify to proceed to the next level. Each student will be given only one opportunity to place out of any level. Students must enter the Meter Technician Career Development Program at the level they fail to complete.

Place Out Procedure (con't)

The participating student, once enrolled for the Level I Place Out Test, will have thirty days upon successful completion to take each test. Example: If you have the time and experience to place out in all three levels, the following would apply: Thirty days for Level I, thirty days for Level II, thirty days for Level III, consecutively. For example: if you begin your Level I Place Out Test on January 1, 2010 you would have until April 1, 2010 to complete all three Place Out Tests. If you do not meet this time schedule you will remain enrolled in your current level.

Students who have been employed by another municipality may, at their manager's discretion, be approved for the place out procedure. The student must have his previous employer fill out the Verification of Employment Form on page 36. Under no circumstances will a student be allowed to test out of any level without providing the documentation described on page 36.

For example, if a student with six years of experience has appropriate documentation for (place out) testing of the Meter Technician Level III, the student must first successfully complete testing for Levels I and II, prior to placing out of Level III. Should the student be unsuccessful at any level of the testing, the student will enter the program at that level as a regular enrolled student.

Place Out Test Request Form

Name of Student: _____

Municipality: _____

_____ has been employed as a Meter Technician for our (student name)

municipality from _____ to _____ _____ _____
(month) (day) (year) (month) (day) (year)

for a total duration of _____ and _____
(years) (months)

The student also has been employed by other employers for a total duration of

_____ and _____
(years) (months)

(See page 36 - Verification of Employment Form.)

Registration Fee: based on per level per student.
Fee to be applied to the cost of the enrollment fee if the place out test is not successful.

Place Out Level Requested - Check Appropriate Box:

- ☐ Meter Technician-Level I
- ☐ Meter Technician-Level II
- ☐ Meter Technician-Level III

The above student has met the minimum Meter Technician experience requirements as outlined in the Place Out procedures on page 33 of the Program Procedures Manual.

Municipal Coordinator _____
(signature)

Municipal Supervisor _____
(signature)

Verification of Previous Field Experience/Employment Form

TO:_____(Previous Employment)

FROM:_____(Student Print)

DATE: _____

SUBJECT: Verification of Previous Field Experience/Employment

I,_____, am presently employed by
Student's Signature

_____
City/Town

Please verify my employment as a Meter Technician for your company, city or town:

from_____ to _____ _____ _____
(month) (day) (year) (month) (day) (year)

This form acknowledges the length of time employed, not the student's qualifications. Without an appropriate signature, this document is invalid.

_____
Previous Employer's signature

Name:

_____
Previous Employer (print name)

Title:_____ Date_____

A copy of this form must be made available to ElectriCities before the candidate can be given an opportunity to place out on the first level of the program.

Amount of years in service cannot substitute this form.

Registration Form
Section 2

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program
Registration Form

List names of students registering for this program and indicate training level. **Please Use Proper Name – No Nick Names**	
1.	7.
2.	8.
3.	9.
4.	10.
5.	11.
6.	12.
Level I ☐ **Level II** ☐ **Level III** ☐	

Name of municipality _____

Name of training coordinator _____

Telephone number (_____)_____

Registration Fee:

Registration fee is based on per level per student. Fee includes cost for student manuals, instructor's guide, DVDs/videotapes, and shipping costs.

☐ A check made out to ElectriCities of North Carolina, Inc. is enclosed.

☐ Please bill.

Training Coordinator Acknowledgment:

To the best of my knowledge the above information is accurate, and I agree to abide by the conditions of the Lineman Career Development Program.

Signature:_____Date_____

Municipal Training Coordinator

Mailing Instructions:

Return this form and payment to:

ElectriCities of North Carolina, Inc.
Learning Coordinator
1427 Meadow Wood Blvd.
Raleigh, NC 27604

Module Index
Section 3

	Module	Module ID. Number
1.	Principles of Magnetism	500
2.	Basic Electrical Principles	510
3.	AC Concepts	520
4.	Introduction to Metering	530
5.	Math for Metering I	540
6.	Math for Metering II	550
7.	Watthour Meter Principles I	560
8.	Watthour Meter Principles II	570
9.	Safety in Meter Work	580
10.	Principles of Accuracy Testing	590
11.	Watthour Meter Testing I	600
12.	Watthour Meter Testing II	610
13.	Energy Diversion	620
14.	Customer Relations of High Bill Complaints	630
15.	Instrument Transformer	610
16.	Testing Single-Phase Transformer-Rated Meters	650
17.	Polyphase Systems I	660
18.	Polyphase Systems II	670
19.	Self-Contained Polyphase Meter Testing	680
20.	Polyphase Transformer-Rated Application	690
21.	Polyphase Transformer-Rated Meter Testing	700
22.	Demand Metering Concepts	710
23.	Testing and Calibrating Demand Meters	720
24.	Solid State Meters and Associated Devices	730
25.	Troubleshooting Techniques	740
26.	Installation Checks and Inspections	750
27.	Reactive Metering Concepts	760
28.	Reactive Metering Testing	770
29.	"Q" Metering Concepts and Testing	780
30.	Testing Totalizing Meters	790

Module Request
Form Section 4

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program
Module Request Form

List Module Title and I.D. number requested and check appropriate training level.		
First Choice -		
Second Choice -		
Third Choice -		
Level I □	**Level II** □	**Level III** □

Date Needed:_____(allow at least two weeks from the date of this request).

Return Date:_____(mail module along with Certification of Module Completion Form within three weeks from date module is received).

Waiver:

I request the modules above and agree to adhere to the above scheduled dates. Further, I understand the "Conditions" for the Meter Technician Training Program and agree to abide by them.

Signature: _____

Training Coordinator

Mailing Instructions:

Return this form and payment to:

ElectriCities of North Carolina, Inc.
Learning Coordinator
1427 Meadow Wood Blvd.
Raleigh, NC 27604

Module Completion
Form Section 5

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program
Module Completion Certification

List names of students who have successfully completed modules in this program and indicate training level. **Please Use Proper Name – No Nick Names**	
1.	7.
2.	8.
3.	9.
4.	10.
5.	11.
6.	12.
Level I ☐	**Level II** ☐ **Level III** ☐

Date Completed: _____

Title of Module Completed:_____ I.D. No. _____

Certification:

I certify that the above information is correct to the best of my knowledge.

_____ Date:_____

Training Coordinator

Name of Municipality:

_____

Mailing Instructions:

Return this form and videotape to:

ElectriCities of North Carolina, Inc.
Learning Coordinator
1427 Meadow Wood Blvd.
Raleigh, NC 27604

*A module consists of a videotape, student manual, and an instructor's guide.

Test Results Authorization
Form Section 6

Release of Student Information Authorization Form

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program
Release of Student Information Authorization Form

Please forward a copy of my written exam, task requirements hands-on exam, and a list of modules I have completed.

Name		
Title		
Municipality		
Address		
City	State	Zip Code
Level I ☐	**Level II** ☐	**Level III** ☐

Waiver:

I understand that I cannot hold ElectriCities responsible for information released to a prospective employer.

Confidentiality:

I understand that this authorization form is considered confidential and photocopying is not permitted.

Authorization: (See Note)

_____ Date:____ Date: Date: _____

Student

_____

Municipal Coordinator

_____

ElectriCities Manager, Safety & Training

Mailing Instructions:

Return form:

ElectriCities of North Carolina, Inc.
Learning Coordinator
1427 Meadow Wood Blvd.
Raleigh, NC 27604

Note: This form can be authorized by (1) the student and the ElectriCities Manager of Member Services, (2) the Municipal Coordinator and the ElectriCities Manager of Member Services, or (3) by all three signatures. (Refer to Records and Confidentiality in the Program Procedures.)

Meter Technician

Level I Section 7

Overview

After the successful completion of Level I, the student has acquired the necessary math skills as it relates to electricity and watthour meter principles to safely install, test and calibrate single-phase, socket-type, self-contained watthour meters. The student will also begin to acquire skills in the areas of customer relations, high bill complaints, and energy diversion problems.

Recommend Task Requirements

Principles of Magnetism – Module ID #500

1. Demonstrate the right hand rule for a conductor and a coil.
2. Demonstrate the right hand rule for induced voltage.

AC Concepts – Module ID #520

1. Understand alternating current and voltage relationships.

Introduction to Metering – Module ID# 530

1. Be able to identify different types and forms of single-phase meters.
2. Demonstrate knowledge of single-phase meter parts, nameplate information, and demand register.
3. Identify different types of instrument transformers.

Math for Metering I – Module ID #540

1. Demonstrate knowledge of square roots, fourth roots, etc., and powers of numbers.
2. Understand current transformers (CT's) and how to calculate secondary and primary currents.
3. Solve algebraic equations and mathematical formulas.

Math for Metering II – Module ID #550

1. From graphs, be able to solve angular relationships between current, voltage, and power.

Watthour Meter Principles I – Module ID #560

1. Identify and point out the six main components of a simple watthour meter and explain each component's function.
2. Describe in electrical terms what causes a meter disk to rotate.

Watthour Meter Principles II – Module ID #570

1. Understand the functions of electro-mechanical meter compensations and adjustments.

Safety in Meter Work – Module ID #580

1. Demonstrate the ability to recognize when proper personal safety equipment is required.
2. Identify physical and electrical hazards of a job site.
3. Safely replace a single-phase meter in service.
4. Demonstrate field testing of rubber protective personal equipment (rubber gloves and sleeves).

Principles of Accuracy Testing – Module #590

1. Identify meter accuracy test equipment and state the function of each piece of equipment.
2. Connect test equipment to simulate in-service conditions for accuracy testing and how test results are interpreted.
3. Identify test connection diagrams for some typical watthour meters.

Watthour Meter Testing I – Module ID #600

1. Demonstrate procedures for testing a typical single-phase meter with various types of test equipment in the field.
2. Identify the connections and controls of a watthour standard and explain their uses.

Energy Diversion – Module ID #620

1. Demonstrate what to look for when inspecting a meter base for energy diversion.
2. Describe at least three methods of internally altering a meter and at least five methods of tampering with meter seals.

Customer Relations and High Bill Complaints – Module ID #630

1. Explain how to use the watt-load check method to determine the accuracy of a watthour meter.

ElectriCities of North Carolina, Inc.
Electric Meter Technician Career Development Program - Level I
Task Requirements Form

Name_____

Municipality_____

To apply for certification at this level, a student must be able to demonstrate the ability to perform the tasks below.

Task	Date Performed	Witnessed By (Please Initial)
1. Demonstrate the right-hand rule for a conductor and a coil.		
2. Demonstrate the right-hand rule for induced voltage.		
3. Understand alternating current and voltage relationships.		
4. Be able to identify different types and forms of single-phase meters.		
5. Demonstrate knowledge of single-phase meter parts, nameplate information, and demand registers.		
6. Identify different types of instrument transformers.		
7. Demonstrate knowledge of square roots, fourth roots, etc. and power of numbers.		
8. Understand current transformers (CTs) and how to calculate secondary and primary currents.		

9. Solve algebraic equations and mathematical formulas.		
10. From graphs, be able to solve angular relationships between current, voltage, and power.		
11. Identify and point out the six main components of a simple watthour meter and explain each component's function.		
12. Describe in electrical terms what causes a meter disk to rotate.		
13. Understand the functions of the electro-mechanical meter compensations and adjustments.		
14. Demonstrate the ability to recognize when proper personal safety equipment is required.		
15. Identify physical and electrical hazards of a job site.		
16. Safely replace a single-phase meter in service.		
17. Demonstrate field testing of rubber protective personal equipment (rubber gloves and sleeves).		
18. Identify meter accuracy test equipment and state the function of each piece of equipment.		
19. Connect test equipment to simulate in-service conditions for accuracy testing and how test results are interpreted.		

20. Identify test connection diagrams for some typical watthour meters.		
21. Demonstrate procedure for testing a typical single-phase meter with various types of test equipment in the field.		
22. Identify the connections and controls of a watthour standard and explain their uses.		
23. Demonstrate what to look for when inspecting a meter base for energy diversion.		
24. Describe at least three methods of internally altering a meter and at least five methods of tampering with meter seals.		
25. Explain how to use the watt-load check method to determine the accuracy of a watthour meter.		
26. Computer Training.		
27. NCSU Meter School – Polyphase (recommended).		

ElectriCities of North Carolina, Inc.

Meter Technician Career Development Program – Level I

Student List

Municipality: _____

Date Course Started: _____ (Date first module started)

Date Course Ended: _____ (Date final module instructor administered)

Coordinator: _____ Phone No: _____

Student Name	Municipality	Job Classification	Telephone Number

Meter Technician Level I
Class Attendance Report

Municipality _____ Coordinator_____ Phone No. _____

Date Course Started_____ Date Course Completed _____

Student Name→ Module Attended ↓												
Date_____Instructor _____ Principles of Magnetism												
Date_____Instructor _____ Basic Electrical Principles												
Date_____Instructor _____ AC Concepts												
Date_____Instructor_____ Introduction to Metering												
Date_____Instructor _____ Math for Metering I												
Date_____Instructor _____ Math for Metering II												
Date_____Instructor _____ Safety in Meter Work												
Date_____Instructor _____ Principles of Accuracy Testing												
Date_____Instructor _____ Watthour Meter Testing I												
Date_____Instructor _____ Watthour Meter Testing II												
Date_____Instructor _____ Energy Diversion												
Date_____Instructor _____ Customer Relations and High Bill Complaints												

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program – Level I
Progress Report

Student's Name:_____ **Municipality:** _____

Job Classification:_____ **Telephone:** _(____)_____

Date Course Began:_____**(First Module Presentation)**

Date Course Completed:_____**(Final Module Presentation)**

Module ID Number	Module Title	Student Manual Date of Issue	Date Class Held	Module Instruct or Quiz %	Overall Grade Average To Date	Instructor
500	Principles of Magnetism					
510	Basic Electrical Principles					
520	AC Concepts					
530	Introduction to Metering					
540	Math for Metering I					
550	Math for Metering II					
560	Watthour Meter Principles I					
570	Watthour Meter Principles II					
580	Safety in Meter Work					
590	Principles of Accuracy Testing					
600	Watthour Meter Testing I					
610	Watthour Meter Testing II					
620	Energy Diversion					
630	Customer Relations and High Bill Complaints					

Principles of Magnetism – Module ID No. 500

Overview

Principles of Magnetism examines various aspects of magnetism and how it occurs naturally in the world as well as how it can be reproduced in electromagnets. This unit also demonstrates the characteristics of magnets, electromagnets, and their function in electric metering.

Objectives

Magnetism

- Define permanent magnet, magnetic field, lines of force, and flux density.
- Identify and describe four characteristics of magnets.

Electromagnetism

- Define electromagnetism.
- Describe an electromagnet.
- Identify and describe characteristics of electromagnets.
- Demonstrate the right-hand rule for a conductor and for a coil.

Induction

- Define induction and identify the requirements for induction.
- Identify two factors that determine the direction of an induced voltage.
- Demonstrate the right-hand rule for induced voltage.

Motor Action

- Define motor action and describe the principle of motor action.

Subjects

Magnetism

Electromagnetism

- Electromagnetism and electromagnetic fields
- Characteristics of electromagnets

Induction

- Principles of induction
- Induction from the motion of a conductor
- Determining the direction of induced voltage
- Induction in a meter from a moving conductor
- Induction form the motion of a magnetic field
- Determining the direction of induced voltage
- Induction in a meter from moving magnetic fields

Motor Action

- Principles of motor action
- Motor action in a meter

Basic Electrical Principles – Module ID No. 510

Overview

This unit gives trainees a foundation of basic electrical theory and circuit analysis on which to build an understanding of meter principles. The unit begins with a review of Ohm's Law and Kirchhoff's laws and progresses to an explanation of power and energy in DC circuits.

Objectives

Ohm's Law

- Identify the three basic parts of a simple electrical circuit and the electrical property associated with each.
- Using Ohm's law, describe the relationship between current, voltage, and resistance in a circuit.
- Calculate the current, voltage, or resistance of a simple circuit when the other two quantities are known.

Series Circuits

- Identify the characteristics of a series circuit and explain the principles of series circuits relating to current, total resistance, and Kirchhoff's voltage law.

Parallel Circuits

- Identify the characteristics of a parallel circuit and explain the principles of parallel circuits relating to voltage, branch currents, Kirchhoff's current law, and total resistance.

Power and Energy

- Define electric power.
- Explain how power, current, or voltage can be calculated for a DC circuit when the other two quantities are known.
- Define energy and explain how energy is calculated.

Subjects

Ohm's Law

- Parts of a DC circuit
- Using Ohm's Law

Series Circuits

- Characteristics of a series circuit
- Principles of series circuits

Parallel Circuits

- Characteristics of a parallel circuit
- Principles of a parallel circuits

Power and Energy

- Power
- Energy

Ac Concepts – Module ID No. 520

Overview

This unit examines various aspects of AC power. After completing this unit, trainees should know the relationships between AC generator operation and sine wave and phaser representations of AC voltage and current. They also should be able to explain the effects of inductance and capacitance in an AC circuit and how these effects may be shown using sine waves and phaser diagrams. In addition, trainees should be able to describe the relationship between active power, reactive power, and apparent power by explaining the use of power factor in calculating active power in AC circuits.

Objectives

Magnitude, Direction, and Time

- Describe how a basic AC generator works to produce voltage and current.
- Describe how the magnitude and direction of AC voltage and (in-phase) current can be plotted against time using sine waves and how current can be shown for a given point in time using phasers.

Inductance

- Define inductance and inductive reactance.
- Describe how an inductor works to oppose changes in AC current.
- Explain the effects of inductance and capacitance an AC voltage and current using sine waves and phasers.

Capacitance

- Define capacitance and capacitive reactance.
- Describe how a capacitor works to oppose changes to AC voltage.
- Explain the effects of capacitance an AC voltage and current using sine waves and phasers.

AC Power

- Differentiate between active power, reactive power, and apparent power.
- Explain how power factor is used in calculating active power in AC circuits.

Subjects

Magnitude, Direction, and Time

- AC generator operation
- Sine Waves
- Phasers

Inductance

- Effects of an inductor in an AC circuit.
- Effects of inductance on AC voltage and current.

Capacitance

- Effects of a capacitor on an AC circuit.
- Effects of capacitance on AC voltage and current.

AC Power

- Active power
- Reactive power
- Apparent power
- Power factor

Introduction to Metering – Module ID No. 530

Overview

This unit presents trainees with an overall view of what is meant by electric metering and electric meter training and introduces them to some of the main subject areas that are covered in detail in later units. The unit offers a brief history of electric energy measurement, which includes a simplified look at watthour meter construction and operating principles. In addition, the unit offers descriptions of several areas of concern to the trainee, in a sequence from the least complex to the most complex. Also presented is a brief explanation of meter testing and calibration.

Objectives

Basic Concepts of Metering

- Identify several early types of elctro-mechanical watthour meters.
- Identify the basic parts and describe the operating principles of a modern electro-mechanical watthour meter.

Self-Contained Meter Application

- Explain the difference between self-contained meters and transformer-rated meters.
- List and explain some of the information typically found on watthour meter nameplates.
- Identify the characteristics of a typical three-phase delta service and typical three-phase wye service.

Transformer-Rated Meter Application

- Explain how an instrument transformer is connected to a transformer-rated meter.
- Identify the two main classifications of instrument transformers.
- State the function of a test switch.

Meter Testing

- Describe the basic steps for conducting a comparison test on a single-phase watthour meter.
- Explain the function of a standard and describe how a standard is used to conduct accuracy tests.

Electric Meter Technician Responsibilities

- Describe some of the tasks and responsibilities commonly associated with being an electric meter technician.
- Identify some typical installation checks performed by electric meter technicians and explain how they are done.
- Identify several forms of power theft.

Subjects

Basic Concepts of Metering

- Early watthour meters
- Watthour meter design and operation

Self-Contained Meter Application

- Meter Types
    - Self-contained meter applications
    - Single-phase services
    - Three-phase meter services

Transformer-Rated Meter Application

- Types of instrument transformers
    - Current transformers
    - Voltage transformers
- Transformer-rated meter applications

Meter Testing

- Meter test connections
- Meter test procedure
    - Full load test
    - Light load test
- Determining meter accuracy

Electric Meter Technician Responsibilities

- Installation checks
- Industrial reads
- Handling customer complaints
- Verifying meter tampering

Math for Metering I – Module ID No. 540

Overview

This unit introduces trainees to the concepts of ratios, percents, squares, and square roots. Also included are demonstrations of how to manipulate simple algebraic equations.

Objectives

Roots and Powers

- Define root, square root, power, and exponent.
- Describe what powers are and how they are indicated.
- Explain how to add, subtract, multiply, and divide numbers taken to various powers.
- Explain how powers of 10 are related to place values.

Number Relationships

- Define ratio, direct proportion, inverse proportion, percentage, and average.
- Describe how rations may be expressed in mathematical terms.
- Explain how to convert between percents, fractions, and decimal numbers.
- Explain how averages are calculated.

Equations

- State the basic difference between arithmetic operations and algebraic operations.

- Describe two rules for solving equations.

- Explain how the components of an equation can be rearranged to solve for a desired value.

- Explain the terms combining like terms and distribution.

Metering Examples

- Describe several ways in which math can be used for day-to-day metering applications.

Subjects

Roots and Powers

- Roots

- Powers

- Powers and math operations

- Powers of 10

Number Relationships

- Ratios
- Proportions
- Percentage
- Number conversions
- Averaging

Equations

- Arithmetic and algebraic equations
- Working with equations
- Rearranging equations
- Combining like terms
- Grouping symbols

Metering Examples

- Accuracy tests
- Register and gear ratios
- Customer relations
- Trigonometry

Math for Metering II – Module ID No. 550

Overview

Math for Metering II introduces trainees to the rectangular coordinate system, phaser analysis and basic trigonometric principles that apply to metering.

Objectives

Basic Graph Characteristics

- Identify characteristics of a basic X-Y graph.
- Describe or demonstrate how values can be located and plotted on an X-Y graph.
- Describe how some of the characteristics of a basic X-Y graph are related to sine wave graphs and certain phaser diagrams.

Phasers and Phaser Diagrams

- Explain what a phaser is, identify phasers commonly used in electrical applications, and explain how a phaser can be used to represent the magnitude and direction of a quantity.
- Describe or demonstrate three methods of phaser addition.

Basic Trigonometric Principles

- Describe characteristics of a right triangle.
- Explain how the Pythagorean theorem can be used to calculate the value of one side of a right triangle when the values of the other two sides are known.
- Explain how to determine the sine, cosine, and tangent of an angle.

Applying Math to Metering

- Explain how to use current and voltage values to determine the power drawn by a circuit.
- Explain how to determine the power factor for a circuit using the cosine function.
- Explain how to use a power triangle to determine the apparent power drawn by a circuit.

Subjects

Basic Graph Characteristics

- X-Y graphs
- Other graphs and diagrams

Phasers and Phaser Diagrams

- Basic phaser characteristics
- How phasers are used
- Phaser addition

Basic Trigonometric Principles

- Right triangle characteristics
- The Pythagorean theorem
- Trigonometric functions

    Sine Function

    Cosine Function

    Tangent function

Applying Math to Metering

Example 1: Using current and voltage values to determine power

Example 2: Using a power triangle to determine apparent power

Watthour Meter Principles I – Module ID No. 560

Overview

This unit covers the operating principles and physical construction of electromechanical watthour meters. Magnetic principles and their relationship to current flow are examined to show what makes the meter disk turn.

Objectives

Basic Components

- Identify the basic components of a typical electro-mechanical watthour meter.
- Identify the function of each component in a typical electro-mechanical watthour meter.

Fluxes

- Identify the fluxes at work in a watthour meter and describe where each flux originates.
- Describe how watthour meter fluxes are distributed in a meter.
- Identify the direction of each flux at given points in time.

Driving the Disk

- Identify the four driving fluxes that cause a meter disk to rotate.
- Describe the relationship of the fluxes at four points in time.
- Explain how the fluxes interact in a watthour meter to drive the disk.

Lagging the Potential Coil Flux

- Explain why the potential coil flux must be lagged behind the current coil flux and by how much.
- Identify the components in a watthour meter that cause the potential coil flux to lag the current coil flux, and briefly explain, using phasers, how this is done.

Controlling Disk Rotation

- Explain why it is necessary to control the rotation of a meter disk.
- Identify the component in a watthour meter that controls the rotation of the disk, and briefly explain its operation.

Subjects

Basic Components

Fluxes

- Current coil flux
- Potential coil flux
- Flux produced by current coil flux
- Flux produced by the potential coil flux
- Permanent magnet flux
- Flux produced by the permanent magnet flux

Driving the Disk

- Driving fluxes
- Flux interactions

Lagging the Potential Coil Flux

- Flux relationships and power factor
- Lagging

Controlling Disk Rotation

- Reasons for controlling disk rotation
- Controlling disk rotation

Watthour Meter Principles II – Module ID No. 570

Overview

After completing this unit, trainees should be able to explain why a meter disk turns in proportion to the power being used. The theory and functions of electro-mechanical meter compensations and adjustments are also discussed.

Objectives

Meter Design Characteristics

- Identify basic operating principles and design characteristics that relate directly to a meter's accuracy.
- Define design speed and disk constant and explain how design speed is related to a meter's accuracy.
- Describe how meter manufacturers control a meter's design speed.

Overload Compensation

- Identify four compensations used to maintain watthour meter accuracy.
- Explain why an uncompensated meter will run slow in an overload condition.
- Describe how a watthour meter can be compensated during overload condition by an overload plate.

Voltage, Temperature, and Frequency Compensations

- Describe a voltage compensation.
- Describe a temperature compensation.
- State why variation in a system's frequency are not a major concern.

Full Load Adjustment

- Identify three common watthour meter adjustments.
- Explain why a full load adjustment may be needed to maintain a meter's accuracy.
- Describe three ways in which a full load adjustment can be made.

Light Load and Power Factor Adjustments

- Explain why a light load adjustment may be needed to maintain a meter's accuracy.
- Describe how a light load adjustment can be made.
- Explain why a power factor adjustment might be needed and how it can be made.

Subjects

Meter Design Characteristics

- Basic meter operating principles and design characteristics
- Design speed and disk constant characteristics

Overload Compensations

- Watthour meter compensations
- Overload compensation

  Effects of an overload condition on an uncompensated meter Overload plate

Voltage, Temperature, and Frequency Compensations

- Voltage compensation
- Temperature compensation
- Frequency compensation

Full Load Adjustment

- Watthour meter adjustments
- Full load adjustments

Light Load and Power Factor Adjustments

- Light Load adjustment
- Power factor adjustment

Safety in Meter Work – Module ID No. 580

Overview

This unit points out some of the major safety concerns associated with meter work and explains how safety hazards can be minimized. The unit examines single-phase and polyphase self-contained meter installations, pointing out where high fault current may be present. Also discussed are safety practices associated with working in instrument transformer cabinets and hazards related to open current transformer secondaries. In addition, safety concerns related to bypassing, replacing, and installing self-contained meters are described.

Objectives

Safety Guidelines

- State three basic safety guidelines that apply to meter work.

Physical Hazards

- Identify physical hazards associated with material handling and associated with conditions at a job site.

Electrical Safety

- Describe the effects of current flow on the human body.
- Describe the dangers of flash burns.
- Identify safety gear normally used for protection against electrical hazards.

Single-Phase Meter Replacement

- Describe safety procedures associated with a typical single-phase replacement job.

Three-Phase Meter Installation

- Describe safety procedures associated with a typical three-phase meter installations job.

Subjects

Safety Guidelines

- Knowing the requirements for the job
- Planning the job carefully
- Using the proper work methods
- Safety awareness

Physical Hazards

- Material handling
  - Using the proper safety equipment
  - Using the proper lifting techniques
  - Maintaining good housekeeping
- Conditions at the job site

Electrical Safety

- Electrical hazards

    Current flow

    Flash burns

- Safety gear for electrical hazards

Single-Phase Meter Replacement

Three-Phase Meter Installation

Principles of Accuracy Testing – Module ID No 590

Overview

This unit presents trainees with the basic theory and principles of watthour meter accuracy testing. First, trainees are introduced to typical test equipment and how that test equipment is connected to simulate in-service operating conditions for accuracy testing. Second, trainees are show how to interpret test results. Finally, trainees are shown test connection diagrams for some typical watthour meters.

Objectives

Principles of Meter Operation

- Briefly state why meters are tested.
- Briefly state what a meter test consists of.
- List the general types of information needed to test meters.
- Briefly describe how a typical watthour meter works.

Meter In-Service Connections

- Describe the source and load connections for a typical single-phase meter and typical polyphase meter.
- Describe the flow of current through the current and potential coils of a typical single-phase meter and a typical polyphase meter.

Test Equipment

- Describe the overall purpose of test equipment.
- Identify the equipment typically used to test meter accuracy in the field and state the function of each piece of equipment.

Test Connections and Comparisons

- Describe the principles for connecting test equipment to a typical single-phase meter.
- Describe the principles for connecting test equipment to a typical polyphase meter using the separate stator test approach.
- Describe the principles for connecting test equipment to a typical polyphase meter using the series test approach.
- Define watthour constant (K_h).
- Describe how a typical single-phase meter is compared to a standard when the K_h of the meter is different from the K_h of the standard.
- Describe how a typical polyphase meter is compared to a standard when the K_h of the meter is different from the K_h of the standard.

Test Connection Diagrams

- Identify meter, phantom load, standard, current circuit connections, potential circuit connections, and meter current coil jumper connections on a typical meter test connection diagram.
- Identify meter form number, current coils, and potential coils on a typical meter internal diagram.
- Identify jumper connections, phantom load potential connections, and current connections on a typical test jack diagram.

Subjects

Principles of Meter Operation

- Meter testing basics
- Basic principles of watthour meter operation

Meter In-Service Connections

- Single-phase meter
- Polyphase meter

Test Equipment

- Purpose of test equipment
- Comparison method test equipment

    Reference standards

    Phantom loads

    Test jacks and test switches

Test Connections and Comparisons

- Single-phase meter test connections
- Polyphase meter test connections
    - Separate stator test approach
    - Series test approach
- Performance comparison

Test Connection Diagrams

- Meter test connection diagram
- Meter internal diagram
- Test jack diagram

Watthour Meter Testing I – Module ID No. 600

Overview

This unit covers the basics of meter testing. The concepts of comparison testing are explained, and solid-state and mechanical reference standards and several types of loading devices are examined. Procedures for field testing a typical single-phase residential meter are demonstrated.

Objectives

Accuracy Testing Methods

- Describe the time-watt method of testing a watthour meter's accuracy.
- Explain how to use the time-load method to estimate a watthour meter's accuracy.
- Describe the comparison method of testing a watthour meter's accuracy.

Portable Watthour Standards

- Describe a rotating standard.
- Describe a solid-state standard.
- Describe the resistance-load method of supplying a load to a standard and meter under test.
- Describe how a phantom load can be used to supply a load to a standard and a meter under test.

Meter Field Test Connections

- Describe test jacks and test leads used to field test a socket-type watthour meter.
- Explain how various types of test equipment can be connected to a socket-type watthour meter in the field.

Subjects

Accuracy Testing Methods

- The time-watt method
- The comparison method

Portable Watthour Standards

- Rotating standards
- Solid-state standards
- Providing loads

    Resistance load method

    Phantom load method

Meter Field Test Connections

- Test jacks
- Test leads
- Field test connections

Watthour Meter Testing II – Module ID No. 610

Overview

This unit examines typical accuracy limits and standards set by utilities and regulatory agencies. Field testing procedures including bypassing the meter, installing and connecting test equipment, and the adjustments necessary to bring the meter within specified limits are demonstrated.

Objectives

Watthour Meter Tests

- Identify and describe two categories of watthour meter accuracy tests.
- Identify and describe three basic types of testes for single-phase, self- contained meters.
- Describe documentation typically associated with meter accuracy testing.

Meter Test Formulas

- Describe how the standard revolutions formula is used to determine the number of revolutions that should be registered by a standard during an accuracy test.
- Describe how the accuracy formula is used in testing the accuracy of a watthour meter.

Field Testing and Calibration

- Describe how to field test and calibrate a socket-type, self-contained, single-phase watthour meter.

Subjects

Watthour Meter Tests

- Types of tests
- Meter test documentation

Meter Test Formulas

- Standard revolutions formula
- Accuracy formula

Field Testing and Calibration

- Test preparations and equipment
- As-found tests
- As-left tests

Energy Diversion – Module ID No. 620

Overview

This unit examines methods that residential and commercial customers have used to seal electrical service. The unit starts with some very basic techniques and moves on to the more complex forms of diversion that might go undetected without close examination. Emphasis is on detection techniques and verification procedures.

Objectives

Methods of Energy Diversion – Part I

- Define revenue protection and energy diversion.
- Identify two basic types of energy diversion.
- Explain how a meter can be bypassed.

Methods of Energy Diversion – Part II

- Describe common methods of exploiting a meter's vulnerable points and explain how this type of tampering can be detected by meter personnel.
- Describe three common methods of altering a meter.

Diversion Protection

- Describe methods that utilities use to avoid energy diversion.
- Describe three basic methods that are commonly used to detect energy diversion.

Proving Diversion

- Describe how electronic tap detection can be used to provide evidence of energy diversion.
- Describe how series metering can be used to provide evidence of energy diversion.

Subjects

Methods of Energy Diversion – Part I

- Terms
- Types of energy diversion
- Methods of bypassing a meter

Methods of Energy Diversion – Part II

- Exploiting a meter's vulnerable points
- Methods of altering a meter
    - Adding an on/off switch
    - Altering the gear train
    - Tampering with transformer-rated meter circuits

Diversion Protection

- Avoiding diversion
- Detecting energy diversion
    - Computer checks
    - Individual awareness
    - Periodic tests

Providing Diversion

- Electronic tap detection
- Series metering

Customer Relations and High Bill Complaints – Module ID No. 630

Overview

This unit examines common situations encountered when dealing with customer complaints (usually related to high bills). Emphasis is placed on communication techniques used during problem resolution and on common causes of a bill being higher than normal. Typical high bill complaints are used as examples and attention is focused on how to leave the customer satisfied.

Objectives

Customer Relations – Part I

- Describe ways in which an electric meter technician can achieve a proper on-the-job appearance.
- Describe some of the ways that an electric meter technician can help ensure a proper level of job preparedness.

Customer Relations – Part II

- Explain what job awareness is and why it is important for electric meter technicians.
- Describe a proper attitude for an electric meter technician.
- Explain why it is important to be knowledgeable about the equipment and procedures used on the job.

High Bill Complaints

- Identify causes of high electrical bills.
- Explain how to use the watt-load check method to determine if a meter reading is accurate.
- Describe a procedure for troubleshooting a high bill complaint at a single-phase residential meter installation.

Subjects

Customer Relations – Part I

- Dealing with the public
- Appearance
- Preparedness

Customer Relations – Part II

- Awareness, attitude, and knowledge
- Awareness, attitude, and knowledge on-the-job

High Bill Complaints

- Causes of high electric bills
  - Incorrect meter readings
  - Meter problems
  - Increased energy demand
- Troubleshooting a high bill complaint

Meter Technician
Level II Section 8

Overview

Upon completion of Level II, the intermediate training level, the student will have acquired the skills necessary to understand polyphase distribution systems and the general metering of these systems. This includes the installation, maintenance, testing, and calibration of transformer-rated meter applications. The student will review customer relations and high bill complaints, energy diversion and safety.

Recommended Task Requirements

Safety in Meter Work – Module ID #580

1. Demonstrate the ability to recognize when proper safety equipment is required.
2. Identify physical and electrical hazards of a job site.
3. Safely replace a three-phase meter in service.
4. Demonstrate field testing of rubber protective personal equipment (rubber gloves and sleeves).

Instrument Transformers – Module ID #640

1. Determine when an instrument transformer service is necessary.
2. Distinguish the difference between bar type CTs and window type CTs.
3. Identify the main components of a typical current transformer and the polarity marks.
4. Identify the CT ratio from the nameplate and reduce it to its lowest ratio.
5. Connect up single-phase metering equipment using two CTs.
6. Know and identify components of a voltage transformer.
7. Understand, know and explain how VTs are connected in a three-phase, four-wire service.

Testing Single-Phase, Transformer Rated Meters – Module ID #650

1. Identify and describe the functions of a transformer-rated meter, current transformer, voltage transformer and a test switch.
2. Identify and describe the use of equipment needed to test single-phase transformer rated meters.
3. Know and understand the Standard Revolutions formula.
4. Set up and field test a single-phase transformer rated meter.

Polyphase Systems I – Module ID #660

1. Know and describe the parts of a polyphase system.
2. Know and describe the characteristic of a wye-connected system.
3. Know and describe the characteristics of a four-wire delta system.
4. Show how to parallel a transformer secondary coil.
5. Show how a bank of three transformers is connected in a three-phase wire closed delta system.

Polyphase Systems II – Module ID #670

1. Draw a line diagram of a 240 volt, three-phase, three-wire open delta system and describe it characteristics.
2. Physically wire a seven terminal meter socket for installation of a form 15 meter.
3. Draw a line diagram of a 120/208 volt three-phase, four wire wye system and describe its characteristics.
4. Connect the source and load for a three-phase, three-wire meter.
5. Connect the source and load for a four-wire wye meter.

Self-Contained Polyphase Meter Testing – Module ID #680

1. Calculate the revolutions that a standard should display using the Standard Revolutions formula.
2. Set up and test a poly phase meter in the field and calculate the percent of accuracy using the corrected accuracy formula.
3. Perform an individual element test on a polyphase meter.
4. Adjust a polyphase meter to + or – 0.2%.

Polyphase Transformer-Rated Application – Module ID #690

1. Identify four items of information found on a VT nameplate.
2. Using a sample CT, identify the primary and secondary polarity. Also, describe the direction of current flow.
3. Design a proper meter installation for a closed delta, three-phase, three-wire service.
4. Have knowledge of polyphase secondary transformer rated schematic wiring diagrams.

Polyphase Transformer – Related Meter Testing – Module ID #700

1. Point out switches for potential wiring using a ten-pole test switch.
2. Determine the accuracy of a three-phase, four-wire meter after performing a series element test.

Demand Metering Concepts – Module ID #710

1. Identify the components of a mechanical demand register.
2. Properly reset a demand register.
3. Demonstrate the ability to read and calculate the demand from a demand register.
4. Understand and define the term "demand" in Electric Power Metering.

Testing and Calibrating Demand meters – Module ID #720

1. Test the timing function (interval) of a mechanical demand register (in Meter Shop).
2. Test the demand indication function (pull up) of a solid state or mechanical demand register (in Meter Shop).

Solid State Meters and Associated Devices – Module ID #730

1. Read and program a solid state/electronic meter.
2. Remove and replace electronic module on a solid stat/electronic meter.
3. Identify the shutter and photo-optic assembly on an electro-mechanical meter.

Trouble Shooting Techniques – Module ID #740

1. Troubleshoot a single-phase, low consumption meter.
2. Name three basic types of meter complaints.
3. Troubleshoot a polyphase transformer rated meter installation.

Installation Checks and Inspections – Module ID #750

1. Describe non-electrical checks and inspections on a polyphase transformer rated meter installation.
2. Perform a voltage check on a polyphase transformer rated meter installation.
3. Check circuit continuity on polyphase transformer rated meter installation using ammeter, and when customer has a load.
4. Perform a complete follow-up inspection on a polyphase transformer rated meter installation.

ElectriCities of North Carolina, Inc.
Electric Meter Technician Career Development Program – Level II
Task Requirements Form

Name _____

Municipality _____

To apply for certification at this level, a student must be able to demonstrate the ability to perform the tasks below.

Task	Date Performed	Witnessed By (Please Initial)
1. Hook up a single-phase metering equipment using two CTs.		
2. Explain how VTs are connected in a three-phase, four-wire service.		
3. Set up and field test a single-phase transformer rated meter from start to finish, including calculations for revolutions.		
4. Physically wire a seven terminal meter socket for installation of a form 15 meter.		
5. Connect the source and load for a three-phase, three-wire meter.		
6. Connect the source and load to a four-wire Wye meter.		
7. Perform an individual element test on a polyphase meter.		
8. Using the sample CT, identify the primary and secondary polarity. Also, describe the direction of the current flow.		
9. Safely replace a polyphase meter in service.		
10. Point out switches used for potential wiring in a ten-pole test switch.		

Task	Date Performed	Witnessed By (Please Initial)
11. Demonstrate the accuracy of a three-phase, four Wye meter after performing a series element test.		
12. Demonstrate the ability to read and calculate the demand from a demand register.		
13. Test the demand indication function (pull up) of a solid state or mechanical demand register (in meter shop).		
14. Test the timing function (interval) of a mechanical demand register (in meter shop).		
15. Read and program a solid state/electronic meter.		
16. Troubleshoot a single-phase, low consumption meter.		
17. Troubleshoot a polyphase transformer rated meter installation.		
18. Describe non-electrical checks and inspections on a polyphase transformer rated meter installation.		
19. Perform a voltage check on a polyphase transformer rated meter installation.		
20. Check circuit continuity on a polyphase transformer rated meter installation using ammeter, and when customer has a load.		
21. NCSU Meter School – Polyphase (recommended).		

Recommended Task Requirements:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____

ElectriCities of North Carolina, Inc.
Electric Meter Technician Career Development Program – Level II
Task Requirements Form

Name _____

Municipality _____

To apply for certification at this level, a student must be able to demonstrate the ability to perform the tasks below.

Task	Date Performed	Witnessed By (Please Initial)
1.		
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16.		

ElectriCities of North Carolina, Inc.
Electric Meter Technician Career Development Program – Level II
Student List

Municipality: _____

Date Course Started: _____ (Date first module started)

Date Course Ended: _____ (Date final module instructor quiz administered)

Coordinator: _____ Phone No.: _____

Student Name	Municipality	Job Classification	Telephone Number

Meter Technician Level II
Class Attendance Report

Municipality:_____ Coordinator:_____ Phone No.: _____

Date Course Started:_____ Date Course Completed: _____

Module Attended	Student Name											
Date_____ Instructor_____ Instrument Transformers												
Date_____ Instructor _____ Testing Single-Phase Transformer-Rated Meters												
Date Instructor_____ Polyphase Systems I												
Date_____ Instructor_____ Polyphase Systems II												
Date_____ Instructor _____ Self Contained Polyphase Meter Testing												
Date_____ Instructor_____ Polyphase Transformer-Related Application												
Date_____ Instructor_____ Safety in Meter Work (Review)												
Date_____ Instructor_____ Polyphase Transformer Rated Meter Testing												
Date_____ Instructor_____ Demand Metering Concepts												
Date_____ Instructor_____ Testing and Calibrating Demand Meters												
Date_____ Instructor _____ Solid State Meters and Associated Devices												
Date_____ Instructor _____ Troubleshooting Techniques												

Date_____Instructor _____ Customer Relations and High Bill Complaints (Review)												
Date_____Instructor _____ Energy Diversion (Review)												
Date_____Instructor _____ Installation Checks and Inspections												

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program – Level II
Progress Report

Student Name:_____ Municipality: _____

Job Classification:_____Telephone: (___)_____

Date Course Began:_____(First Module Presentation)

Date Course Completed:_____(Last Module Presentation)

Module I.D. Number	Module Title	Student Manual Date of Issue	Date Class Held	Module Instructor Quiz %	Overall Grade Average To Date	Instructor
640	Instrument Transformers					
650	Testing Single-Phase, Transformer Rated Meters					
660	Polyphase Systems I					
670	Polyphase Systems II					
680	Self-Contained Polyphase Meter Testing					
690	Polyphase Transformer-Rated Application					
580	Safety in Meter Work					
700	Polyphase Transformer-Rated Meter Testing					
710	Demand Metering Concepts					
720	Testing and Calibrating Demand Meters					
730	Solid-State Meters and Associated Devices					

Module I.D. Number	Module Title	Student Manual Date of Issue	Date Class Held	Module Instructor Quiz %	Overall Grade Average To Date	Instructor
740	Troubleshooting Techniques					
630	Customer Relations and High Bill Complaints					
620	Energy Diversion					
750	Installation Checks and Inspections					

Instrument Transformers – Module I.D. No. 640

Overview

After completing Instrument Transformers, trainees should be able to explain what instrument transformers are and how they are typically used. Trainees should also be transformers (VTs) in single-phase and polyphase services.

Objectives

Instrument Transformer Applications

- Describe the main functions of instrument transformers.
- Identify factors that determine when instrument transformers are required.

Current Transformers

- Distinguish between bar-type current transformers and window-type current transformers.
- Identify how a current transformer's fixed current ratio can be determined and indicated.
- Describe how a current transformer's polarity can be indicated.

Current Transformer Connections

- Describe how two CTs can be connected in a single-phase, three-wire service.
- Describe how one CT can be connected in a single-phase, three-wire service.
- Describe how three CTs can be connected in a three-phase, four-wire service.

Voltage Transformers

- Identify the components of a voltage transformer.
- Define burden and accuracy class.

Voltage Transformer Connections

- Describe how a voltage transformer can be connected with a single-phase primary service.
- Describe how voltage transformers can be connected with a three-phase primary service.

Subjects

Instrument Transformer Applications

- Meter installations
- Types of instrument transformers

Current Transformers

- Types of current transformers
- Current ratio
- Polarity

Current Transformers Connections

- Single-phase, three wire service: two CTs
- Single-phase, three-wire service: one CT
- Three-phase, four-wire service

Voltage Transformer

- Components of a voltage transformer
- Voltage transformer nameplate information

Voltage Transformer Connections

- Connection with a single-phase primary service
- Connections with a three-phase service

Testing Single-Phase Transformer-Rated Meters – Module I.D. No. 650

Overview

This unit shows how single-phase, transformer-rated meters can be tested on the customer's property. The purpose of the test switch is explained, and the connection of test equipment to a test switch is demonstrated. Also, demonstrated are accuracy tests and adjustments made on single-phase transformer-rated meter installations.

Objectives

Meter Installation Review

- State the functions of a transformer-rated meter installation.
- Identify and describe the functions of the following transformer-rated meter installation components, i.e., transformer-rated meter, current transformer, voltage transformer, and test switch.
- Describe how the components of a transformer-rated meter installation can be connected.

Equipment, Tests, and Calculations

- Identify and describe equipment used to field test single-phase, transformerated meters.
- Identify and describe tests typically used to field test single-phase, transformer-rated meters.
- Identify and describe calculations needed to field test a single-phase, transformer-rated meter.

Field Test Connections

- Describe preparations for making field test connections to a single-phase, transformer-rated meter.
- Describe how to conduct a creep check on a single-phase, transformer-rated meter.
- Describe how to connect a standard, a phantom load, and a test switch to field test a single-phase; transformer-rated meter.

Field Testing and Calibrating

- Describe how to field test and calibrate a single-phase, transformer-rated meter.

Subjects

Meter Installation Review

- Meter installation components
- Meter installation connections

Equipment, Tests, and Calculations

- Equipment
- Tests
- Calculations

    Standard revolutions formula

    Accuracy formula

Field Test Connections

- Field test preparations
- Field test connections

Field Testing and Calibrating

- Obtaining information
- Conducting as-found tests
- Calibrating the meter
- Conducting as-left tests

Polyphase Systems I – Module I.D. No. 660

Overview

This unit explains what polyphase systems are and how wye and delta systems differ. Various transformer bank connections and illustrated using phaser diagrams and typical voltages are explained. Examples of polyphase transformer banks and their external connections are shown.

Objectives

Polyphase System

- Define polyphase and describe how the parts of a polyphase system are distinguished from one another.
- Describe how a polyphase system is different from a single-phase system.
- Give examples of where polyphase systems exist in a utility's operating system.

Wye Systems

- Using diagrams, describe the characteristics of a wye-connected system.

Delta Systems

- Using diagrams, describe the characteristics of a delta-connected system.

Transformer Connections

- Describe a three-phase, four-wire wye-connected polyphase system.
- Describe a three-phase, three-wire closed delta-connected polyphase system.
- Describe a three-phase, four-wire closed delta-connected polyphase system.
- Describe a three-phase, three-wire open delta-connected polyphase system.
- Describe a three-phase, four-wire open delta-connected polyphase system.

Subjects

Polyphase Systems

Wye Systems

Delta Systems

Transformer Connections

- Three-phase, four-wire wye-connected polyphase system
- Three-phase, three-wire closed delta-connected system
- Three-phase, four-wire closed delta-connected system
- Three-phase, three-wire open delta-connected system
- Three-phase, four-wire open delta-connected system

Polyphase Systems II – Module I.D. No. 670

Overview

This unit discusses when and where various meters should be used. Blondel's theorem is introduced and used to show how a polyphase system is accurately metered. Both balanced and unbalanced loads in polyphase meter installations are examined.

Objectives

Metering Polyphase Systems

- State the characteristics of delta systems and wye systems.
- State Blondel's theorem and describe how it can be applied to meter a three-phase, four-wire wye system and a three-phase, three-wire delta system.

Polyphase Meters

- Describe the features of a three-phase, three-wire socket-type meter, and describe how it can be connected to meter a three-phase, three-wire delta system.
- Describe the features of a three-element meter, and describe how a three-element socket-type meter can be connected to a meter a three-phase, four-wire wye system.

Balanced and Unbalanced Loads

- Define balanced load and unbalanced load
- Describe how a balanced load and an unbalanced load on a polyphase system can be accurately metered.

Subjects

Metering Polyphase Systems

- Polyphase system characteristics
    - Delta Systems
    - Wye Systems
- Polyphase system metering

Polyphase Meters

- Metering a three-phase, three-wire service
- Metering a three-phase, four-wire wye service

Balanced and Unbalanced Loads

- Metering a balanced load
- Metering an unbalanced load
- Two and one-half element meters

Self-Contained Polyphase Meter Testing – Module I.D. No. 680

Overview

This unit demonstrates accuracy tests on a three stator, self-contained polyphase meter and a two-and-a-half stator (Split element) self-contained polyphase meter in the field. This demonstration includes details on bypassing the meter and connecting test equipment for both individual element and series element testing. In addition, a procedure for bringing the meter into acceptable accuracy limits is demonstrated.

Objectives

Basic Meter Testing

- Describe accuracy tests typically performed on a self-contained, polyphase meter.
- Identify the basic test equipment used for testing a self-contained, polyphase meter.
- Describe how a self-contained, polyphase meter and the appropriate test equipment are connected to perform each type of accuracy test.

Testing a Polyphase Meter

- Describe basic preparations for testing a polyphase meter.
- Describe how series element tests may be performed on a three-phase, four-wire, three-stator meter.
- Describe how individual element tests may be performed on a three-phase, four-wire, three-stator meter.
- Describe the basic layout of a three-phase, four-wire, two-and-a-half-stator meter (text only).
- Describe how series element tests may be performed on a three-phase, four-wire, two-and-a-half stator meter (text only).
- Describe how individual element tests may be performed on a three-phase, four-wire, two-and-a-half-stator meter (text only).

Polyphase Meter Adjustments

- Describe preliminary steps that are often taken before adjustments are made to a polyphase meter.
- Describe how adjustments can be made to a three-phase, four-wire, three-stator meter.

Subjects

Basic Meter Testing

- Types of meter tests
- Basic test equipment
- Basic test connections
    - Series element test connections
    - Individual element test connections

Testing a Polyphase Meter

- Meter testing preparations
- Testing a three-phase, four-wire, three-stator meter
    - Series element tests
    - Individual element tests
- Testing a three-phase, four-wire, two-and-a-half stator meter
    - Testing preparations
    - Series element tests
    - Individual element tests
- "As-found" and "as-left" tests

Polyphase Meter Adjustments

- Preliminary steps
- Adjusting a three-phase meter

Polyphase Transformer-Rated Application – Module I.D. No. 680

Overview

This unit examines transformer-rated installations and discusses when and why instrument transformers are used. Instrument transformer basics are reviewed, their polyphase connections are shown, and the most common polyphase transformer-rated installations are examined. Installation procedures are discussed, and close attention is given to transformer polarity markings. Also included is a discussion of sizing and proper selection of Cts and VTs to verify those issued for a given job.

Objectives

Polyphase Transformer-Rated Metering

- Describe the functions of the two basic types of instrument transformers commonly used in metering.
- Identify variables that affect the installation of current transformers and meters.

Delta Transformer-Rated Meter Installation

- Describe a typical three-phase, three-wire, delta transformer-rate meter installation.
- Describe a typical three-phase, four-wire, delta transformer-rated meter installation.
- Describe one way to determine the instrument transformer requirements for a given delta transformer-rated meter installation.

Wye Transformer-Rated Meter Installation

- Describe a typical three-phase, four-wire, wye transformer-rated meter installation.
- Describe one way to determine the transformer requirements for a typical wye transformer-rated meter installation.

Instrument Transformer Verification

- Describe problems that can develop with instrument transformers.
- Describe how some of the electrical properties of instrument transformers can be checked.
- Describe how a meter on a polyphase installation can be checked to ensure proper registration.

Subjects

Polyphase Transformer Rated Metering

- Instrument transformers
  - Voltage transformers
  - Current transformers
- Variables that affect CT installation

Delta Transformer-Rated Meter Installations

- Characteristics of a three-phase, three-wire delta system
- Characteristics of a three-phase, four-wire delta system
- Determining instrument transformer requirements

Wye Transformer-Rated Meter Installation

- Characteristics of a three-phase, four-wire wye system
- Determining instrument transformer requirements

Instrument Transformer Verification

- Instrument transformer problems

  Burden

  Ratio and phase angle errors

  Polarity

- Polyphase meter installation checks

Safety in Meter Work – Module I.D. No. 580

Overview

This unit points out some of the major safety concerns associated with meter work and explains how safety hazards can be minimized. The unit examines single –phase and polyphase self-contained meter installations, pointing out where high fault current may be present. Also discussed are safety practices associated with working in instrument transformer cabinets and hazards related to open current transformer secondaries. In addition, safety concerns related to bypassing, replacing, and installing self-contained meters are described.

Objectives

Safety Guidelines

- State three basic safety guidelines that apply to meter work.

Physical Hazards

- Identify physical hazards associated with material handling and with conditions at a job site.

Electrical Safety

- Describe the effects of current flow on the human body.
- Describe the dangers of flash burns.
- Identify safety gear normally used for protection against electrical hazards.

Single-Phase Meter Replacement

- Describe safety procedures associated with a typical single-phase replacement job.

Three-Phase Meter Installation

- Describe safety procedures associated with a typical three-phase meter installation job.

Subjects

Safety Guidelines

- Knowing the requirements for the job
- Planning the job carefully
- Using the proper work methods
- Safety awareness

Physical Hazards

- Material handling
    - Using the proper safety equipment
    - Using the proper lifting techniques
    - Maintaining good housekeeping
- Conditions at the job site

Electrical Safety

- Electrical hazards
    - Current flow
    - Flash burns
- Safety gear for electrical hazards

Single-Phase Meter Replacement

Three-Phase Meter Installation

Polyphase Transformer-Rated Meter Testing – Module I.D. No 690

Overview

This unit demonstrates field accuracy tests of four-wire, transformer-rated meters. Isolating the meter and making test connections to a test switch are demonstrated in detail. These demonstrations also include calibration of a typical polyphase four-wire meter.

Objectives

Testing Considerations and Installation Layout

- Describe accuracy tests commonly performed on polyphase, transformer-rated meters.
- Describe the layout of a typical polyphase, transformer-rated meter installation.
- Describe basic safety considerations associated with testing polyphase, transformer-rated meters.

Basic Test Connections

- Describe connections needed to perform individual element tests on a polyphase, transformer-rated meter.
- Describe connections needed to perform series element tests on a polyphase, transformer-rated meter.

Testing a Three-Phase, Four-Wire, Three-Stator Meter

- Describe preliminary steps that are normally taken before a polyphase, transformer-rated meter is tested.
- Describe how individual element tests may be performed on a three-phase, four-wire, three-stator, transformer-rated meter.
- Describe how series element tests may be performed on a three-phase, four wire, three-stator, transformer-rated meter.

Basic Meter Adjustments

- Describe preliminary steps that are often taken before adjustments are made to a polyphase, transformer-rated meter.
- Describe how adjustments can be made to a three-phase, four-wire, three stator, transformer-rated meter.

Subjects

Testing Considerations and Installation Layout

- Types of meter tests
- Basic system layout
- Safety considerations

Basic Test Connections

- Example meter and test equipment
- Individual element test connections
- Series element test connections

Testing a Three-Phase, Four-Wire, Three-Stator Meter

- Preliminary steps
- Individual element tests
- Series element tests

Basic Meter Adjustments

- Preliminary steps
- Adjusting the meter

Demand Metering Concepts – Module I.D. No. 700

Overview

Demand Metering Concepts discusses the need for demand metering and basic metering concepts. Examples of power demand by various types of customers are shown. Mechanical, thermal, and solid-state types of demand registers are examined and the principles of demand registration for each type are explained.

Objectives

The Demand Concept

- Explain why demand is metered.
- Define demand.
- Identify three common types of demand registers.

Demand Metering Methods

- Explain the block interval method of metering demand.
- Explain the lagged method of metering demand.

Mechanical Demand Registers – Part I

- Describe a mechanical sweep pointer demand register.
- Identify the main components of a mechanical sweep pointer demand register and briefly describe their operation.

Mechanical Demand Registers – Part II

- Describe the parts and operation of a mechanical dial readout indicating register and a cumulative demand register.

Electronic Demand Registers

- Describe the basic operation of an electronic demand register.
- Explain how pulses can be generated to operate an electronic demand register.
- Describe features that can be programmed in a typical electronic demand register.

Subjects

The Demand Concept

- Demand metering
- Demand registers

Demand Metering Methods

- Block interval method
- Lagged Method

Mechanical Demand Registers – Part I

- Indicating registers
- Register classes and operation

Mechanical Demand Registers – Part II

- Dial readout indicating registers
- Cumulative demand registers

Electronic Demand Registers

- Overview and operation
- Electronic demand register features
    - Interval programming
    - Register mode

Testing and Calibrating Demand Meters – Module I.D. No. 710

Overview

In this unit trainees are presented with ways of performing accuracy tests on kWh meters equipped with various types of demand registers. Also presented is testing a demand register independent of a kWh meter. In addition, testing of the timing function and the registration function of both electro-mechanical and solid-state demand registers is covered.

Objectives

Testing and Calibrating a Mechanical Demand Register – Part I

- Explain what a typical demand meter indicates.
- Identify and describe several types of demand registers.
- Describe the basic procedures for testing a demand register.
- Describe one way to field test a mechanical demand register.

Testing and Calibrating a Mechanical Demand Register – Part II

- Describe how to field test the timing function of a mechanical demand register.
- Describe how to shop test a mechanical demand register.
- Describe how mechanical demand register problems can be dealt with.

Testing and Calibrating a Solid-State Register

- Describe some basic characteristics of a solid-state register.
- Describe how accuracy tests are performed on a solid-state register.
- Describe how a solid-state register can be programmed.

Subjects

Testing and Calibrating a Mechanical Demand Register – Part I

- Demand meter indications
- Types of demand registers
- Basic testing procedures
- Field testing the demand indication function

Testing and Calibrating a Mechanical Demand Register – Part II

- Field testing the timing function
- Shop testing a demand register
- Common demand register problems

Testing and Calibrating a Solid-State Register

- Basic solid-state register characteristics
- Field testing a solid-state register
- Reprogramming a solid-state register

Solid-State Meters and Associated Devices – Module I.D. No. 720

Overview

This unit examines many of the solid-state devices used in, or in conjunction with, electric metering. The devices are identified and described and their functions demonstrated. In addition, an example of a totally solid-state metering system is presented and its associated components identified.

Objectives

Solid-State Devices Used With Electro-mechanical Meters

- Identify and describe devices used to convert information provided by an electro-mechanical meter.
- Identify and describe devices that receive electronic information from a meter.

Solid-State Meters

- Describe the basic operation and characteristics of a solid-state meter.
- Describe some of the features of interchangeable electronic register modules.

Solid-State Meter Systems

- Identify and describe devices used with solid-state meters.
- Describe an example of a solid-state meter system that provides two-way communications.

Subjects

Solid-State Devices Used with Electro-mechanical Meters

- Devices that convert information
- Devices that receive electronic information
    - Solid-state registers
    - Solid-state totalizers
    - Magnetic tape recorders
    - Electronic recorders

Solid-State Meters

- Operation of a solid-state meter
- Solid-state meter characteristics
- Interchangeable register modules

Solid-State Meter Systems

- Components of solid-state meter systems
- Two-way communication system

Troubleshooting Techniques – Module I.D. No. 730

Overview

This unit examines techniques commonly used to locate problems in various types of meter installations. For self-contained installations, basic problems such as low consumption, zero consumption, and abnormally high usage are examined. For commercial and industrial installations, more complex problems are described and the uses of instruments and devices to help locate the problems are explained.

Objectives

Meter Complaints

- Describe some basic guidelines for troubleshooting a meter installation.
- Describe conditions that can cause high bill complaints.
- Describe conditions that can cause low consumption or no consumption meter readings.

Troubleshooting Single-Phase Meter Installations

- Describe a procedure for troubleshooting a single-phase meter installation.

Troubleshooting a Three-Phase, Self-Contained Meter

- Describe a procedure for troubleshooting a three-phase, self-contained meter.

Troubleshooting Transformer-Rated Meter Installations

- Describe a procedure for troubleshooting a transformer-rated meter installation.

Subjects

Meter Complaints

- Basic troubleshooting guidelines
- Types of meter complaints

  High bill complaints

  Damaged equipment
- Low consumption or no consumption readings

Troubleshooting Single-Phase Meter Installations

Troubleshooting a Three-Phase, Self-Contained Meter

Troubleshooting Transformer-Rated Meter Installations

Customer Relations and High Bill Complaints – Module I.D. No. 630

Overview

This unit examines common situations encountered when dealing with customer complaints (usually related to high bills). Emphasis is placed on communication techniques used during problem resolution and on common causes of a bill being higher than normal. Typical high bill complaints are used as examples and attention is focused on how to leave the customer satisfied.

Objectives

Customer Relations – Part I

- Describe ways in which an electric meter technician can achieve a proper on-the-job appearance.
- Describe some of the ways that a meter technician can help ensure a proper level of job preparedness.

Customer Relations – Part II

- Explain what job awareness is and why it is important for electric meter technicians.
- Describe a proper attitude for an electric meter technician.
- Explain why it is important to be knowledgeable about the equipment and procedures used on the job.

High Bill Complaints

- Identify causes of high electrical bills.
- Explain how to use the watt-load check method to determine if a meter reading is accurate.
- Describe a procedure for troubleshooting a high bill complaint at a single-phase residential meter installation.

Subjects

Customer Relations – Part I

- Dealing with the public
- Appearance
- Preparedness

Customer Relations – Part II

- Awareness, attitude, and knowledge
- Awareness, attitude, and knowledge on-the-job

High Bill Complaints

- Causes of high electric bills
  - Incorrect meter readings
  - Meter problems
  - Increased energy demand
- Troubleshooting a high bill complaint

Energy Diversion – Module I.D. No. 620

Overview

This unit examines methods that residential and commercial customers have used to steal electrical service. The unit starts with some very basic techniques and moves on to the more complex forms of diversion that might go undetected without close examination. Emphasis is on detection techniques and verification procedures.

Objectives

Methods of Energy Diversion – Part I

- Define revenue protection and energy diversion
- Identify two basic types of energy diversion
- Explain how a meter can be bypassed

Methods of Energy Diversion – Part II

- Describe common methods of exploiting a meter's vulnerable points and explain how this type of tampering can be detected by meter personnel.
- Describe three common methods of altering a meter.

Diversion Protection

- Describe methods that utilities use to avoid energy diversion.
- Describe three basic methods that are commonly used to detect energy diversion.

Proving Diversion

- Describe how electronic tap detection can be used to provide evidence of energy diversion.
- Describe how series metering can be used to provide evidence of energy diversion.

Subjects

Methods of Energy Diversion – Part I

- Terms
- Types of energy diversion
- Methods of bypassing a meter

Methods of Energy Diversion – Part II

- Exploiting a meter's vulnerable points
- Methods of altering a meter

  Adding an on/off switch

  Altering the gear train

  Tampering with transformer-rated meter circuits

Diversion Protection

- Avoiding diversion
- Detecting energy diversion

    Computer checks

    Individual awareness

    Periodic tests

Proving Diversion

- Electronic tap detection
- Series metering

Installation Checks and Inspections – Module I.D. No. 740

Overview

This unit uses common test equipment to demonstrate typical methods of verifying the correct wiring of a meter installation. Verifications are made on installations to determine conditions such as open coils and matched phasing of potential and current. Checks are made for shorted current transformers and wiring.

Objectives

Non-electrical Checks and Inspections

- Describe general non-electrical checks and inspections that can be made to a meter installation.
- Describe non-electrical checks and inspections that can be made inside a transformer cabinet and inside a meter box.

Electrical Checks and Inspections – Part I

- Describe how voltage checks may be made on a polyphase, transformer-rated meter installation.
- Describe how circuit continuity checks may be made on a polyphase, transformer-rated meter installation.

Electrical Checks and Inspections – Part II

- Describe how circuit continuity can be checked on a meter installation that has a connected customer load.
- Describe how a phase check can be performed on a polyphase, transformer-rated meter installation.
- Describe how the accuracy and balance of a meter in a polyphase, transformer-rated meter installation can be checked.

Subjects

Non-electrical Checks and Inspections

- General checks and inspections
- Transformer cabinet checks and inspections
- Meter box checks and inspections

Electrical Checks and Inspections – Part I

- Voltage checks
- Continuity checks

Electrical Checks and Inspections – Part II

- Checking circuit continuity
- Checking phase rotation
- Accuracy and balance checks

Meter Technician

Level III Section 9

Overview

In Level III, the most advanced training level, the student will acquire the skills of reactive metering, "Q" metering, totalizing metering applications, and polyphase metering systems. After completing this level, the student will be qualified to address all metering applications as they apply to the electric utility distribution system.

Recommended Task Requirements

1. Draw a phasor diagram of a parallel circuit consisting of resistive, inductive, and capacitive loads.
2. Write a formula used to calculate the reactive power in a balanced three-phase system.
3. Properly test and calibrate a kilovarhour meter that is in service or simulated to be in service and individual test.
4. Be able to explain what cross phasing is in relation to Q-hour metering.
5. Perform a series element test on a Q-hour meter.
6. Identify the basic components of a split-element totalizing meter.
7. Explain pulse or solid-state metering.

ElectriCities of North Carolina, Inc.
Electric Meter Technician Career Development Program – Level III
Task Requirements Form

Name_____

Municipality_____

To apply for certification at this level, a student must be able to demonstrate the ability to perform the tasks below

Task Requirements	Date Performed	Witnessed By (Please Initial)
1. Draw a phasor diagram of a parallel circuit consisting of resistive, inductive, and capacitive loads.		
2. Write a formula used to calculate the reactive power in a balanced three-phase system.		
3. Properly test and calibrate a kilovarhour meter that is in service or simulated to be in service for a series and individual test.		
4. Be able to explain what cross phasing is in relation to Q-hour metering.		
5. Perform a series element test on a Q-hour meter.		
6. Identify the basic components of a split-element totalizing meter.		
7. Explain pulse or solid-state metering.		
8. NCSU Meter School-Advanced (Recommended)		

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program Level III
Student List

Municipality: _____

Date Course Started:_____(Date first module started)

Date Course Ended:_____(Date final module instructor quiz administered)

Coordinator:_____Phone No.:_____

Student Name	Municipality	Job Classification	Telephone Number

Meter Technician Level III
Class Attendance Report

Municipality_____Coordinator_____Phone No._____

Date Course Started_____Date Course Completed_____

Student Name→ Module Attended ↓												
Date_____Instructor_____ *Reactive Metering Concepts*												
Date_____Instructor_____ Reactive Metering Testing												
Date_____Instructor_____ "Q" Metering Concepts and Testing												
Date_____Instructor_____ Safety in Meter Work (Review)												
Date_____Instructor_____ Testing Totalizing Meters												
Date_____Instructor_____ Solid State Meters and Associated Devices (Review)												
Date_____Instructor_____ Energy Diversion (Review)												

ElectriCities of North Carolina, Inc.
Meter Technician Career Development Program – Level III
Progress Report

Student's Name:_____ Municipality: _____

Job Classification:_____ Telephone: _(___)_____

Date Course Began:_____(First Module Presentation)

Date Course Completed:_____(Last Module Presentation)

Module ID Number	Module Title	Student Manual Date of Issue	Date Class Held	Module Instructor Quiz %	Overall Grade Average To Date	Instructor
760	Reactive Metering Concepts					
770	Reactive Metering Testing					
780	"Q" Metering Concepts and Testing					
580	Safety in Meter Work (Review)					
790	Testing Totalizing Meters					
730	Solid State Meters and Associated Devices (Review)					
620	Energy Diversion (Review)					

Reactive Metering Concepts – Module I.D. No. 760

Overview

This unit used the power triangle to illustrate the relationships between active power, apparent power, and reactive power. The concept of metering reactive power is explained. In addition, this unit explains how a phase shifting device can be used to produce the phase relationships needed to meter reactive power with conventional kWh meters.

Objectives

Power Relationships

- Define reactive power and explain why reactive power consumption is measured.
- Using phaser diagrams, explain the relationship between active and reactive power.
- Explain how net reactive current flow is determined.
- Using the parallelogram method of phaser addition, explain how to determine total current flow in a circuit.

Determining Power In a Circuit

- Explain how the Pythagorean theorem and the power triangle can be used to determine power values.
- Using mathematical functions, explain how to determine the power factor of a circuit.
- State the formulas that can be used to calculate active power, reactive power, and apparent power in a balanced three-phase system.
- Describe how reactive power can be metered using two kilowatt-hour meters and a phase shifting transformer.

Reactive Metering Connections

- Describe how two-kilowatt hour meters and two-phase shifting transformers may be connected to a meter reactive power in a three-phase, three wire system.
- Explain how the 90-degree phase shift is accomplished in a reactive meter installation.

Subjects

Power Relationships

- Reactive power concepts
  - Resistive circuits
  - Inductive and capacitive circuits
  - Reactive load components
- Determining apparent power

Determining Power in a Circuit

- The Pythagorean theorem
- Determining power factor
- Determining power in three-phase systems
- Typical three-phase reactive meter installation

Reactive Metering Connections

- Basic connections
- Phase shifting

Reactive Meter Testing – Module I.D. No. 770

Overview

This unit demonstrates accuracy tests on typical three-wire and four-wire reactive meter installations. Isolating a meter from a phase shifting device and making test connections, as well as test procedures and determining accuracy for two reactive meter installations are shown.

Objectives

Reactive Meter Testing Connections

- Describe the layout of a typical reactive meter installation.
- Identify and describe the accuracy tests normally performed on a kilovar-hour meter.
- Describe how a typical kilovar-hour meter and the test equipment are connected so that series element tests can be performed.

Testing a Two-Stator Meter

- Describe how series element tests are performed on a three-phase, three-wire, two-stator kilovar-hour meter.
- Describe how the meter and test equipment are connected for individual element testing.
- Describe how individual element tests are performed on the meter.

Testing a Two-and-a Half Stator Meter

- Describe the basic layout of a three-phase, four-wire, two-and-a-half stator kilovar-hour meter.
- Describe how the kilovar-hour meter and test equipment are connected for series element testing.
- Describe how series element tests are performed on the kilovar-hour meter.
- Describe how the kilovar-hour meter and test equipment are connected for individual element testing.
- Describe how individual element tests are performed on the kilovar-hour meter.

Subjects

Reactive Meter Testing Connections

- Installation layout
- Tests and test equipment
- Series element test connections

Testing a Two-Stator Meter

- Series element tests
- Individual element tests

Testing a Two-and-a-Half Stator Meter

- Basic meter layout
- Series element test connections
- Series element test procedures
- Individual element test connections
- Individual element test procedures

"Q" Metering Concepts and Testing – Module I.D. No. 780

Overview

In this unit, trainees are introduced to the concept and theory of "Q" meters. The power factor range associated with "Q" meters is compared to kWh and kvarh meters. Also included in this unit is an explanation of how "Q" relates to active power, reactive power, and apparent power.

Objectives

Measuring the Electrical Quantity "Q"

- Describe what the electrical quantity "Q" is.
- Identify the components of a typical Q-hour meter installation.
- Explain how power is measured by a kilowatt-hour meter, a kilovar-hour meter, and a Q-hour meter.

Relating "Q" to Active Power, Reactive Power, and Apparent Power

- Identify the mathematical formulas that can be used to describe the basic function of a kilowatt-hour meter, a kilovar meter, and a Q-hour meter.

- Identify the Q-hour meter formula that can be used to determine the reactive power in a circuit based on a Q-hour meter reading.

- Describe some general rules that can be applied to the Q-hour meter formula to determine the type of power factor that exists for a circuit.

Q-Hour Meter Connections and Testing

- Explain what cross-phasing is.

- Explain how a 60-degree shift in the voltage applied to a Q-hour meter can be accomplished by cross-phasing and reversing the polarity on the potential coils.

- Explain how a 60-degree shift in the voltage applied to a Q-hour meter can be accomplished by cross-phasing and reversing the polarity on the current coils.

- Describe basic principles that apply to testing Q-hour meters.

Subjects

Measuring the Electrical Quantity "Q"

- The electrical quantity "Q"
- Why different meters measure power over different power factor ranges

  Kilowatt-hour meter power measurement

  Kilovar-hour meter power measurement

  Q-hour meter measurement

Relating "Q" to Active Power, Reactive Power, and Apparent Power

- The mathematical function of a kilowatt-hour meter
- The mathematical function of a kilovar-hour meter
- The mathematical function of a Q-hour meter
- Power factor determination

Q-Hour Meter Connections and Testing

- Cross-phasing to shift voltage
- Q-hour meter testing

Safety in Meter Work – Module I.D. No. 580

Overview

This unit points out some major safety concerns associated with meter work and explains how safety hazards can be minimized. The Unit examines single-phase and polyphase self-contained meter installations, pointing out where high fault current may be present. Also discussed are safety practices associated with working in instrument transformer cabinets and hazards related to open current transformer secondaries. In addition, safety concerns related to bypassing, replacing, and installing self-contained meters are described.

Objectives

Safety Guidelines

- State three basic safety guidelines that apply to meter work.

Physical Hazards

- Identify physical hazards associated with material handling and with conditions at a job site.

Electrical Safety

- Describe the effects of current flow on the human body.
- Describe the dangers of flash burns.
- Identify safety gear normally used for protection against electrical hazards.

Single-Phase Meter Replacement

- Describe safety procedures associated with a typical single-phase replacement job.

Three-Phase Meter Installation

- Describe safety procedures associated with a typical three-phase meter installation job.

Subjects

Safety Guidelines

- Knowing the requirements for the job
- Planning the job carefully
- Using the proper work methods
- Safety awareness

Physical Hazards

- Material handling
  - Using the proper safety equipment
  - Using the proper lifting techniques
  - Maintaining good housekeeping
- Conditions at the job site

Electrical Safety

- Electrical hazards
  - Current flow
  - Flash burns
- Safety gear for electrical hazards

Single- Phase Meter Replacement

Three-Phase Meter Installation

Testing Totalizing Meters – Module I.D. No. 790

Overview

This unit examines the principles of operation of four-element, six element and eight-element electro-mechanical totalizing meters. Test equipment connections and test procedures for testing an eight-element meter are demonstrated.

Objectives

Introduction to Totalizing Meters

- Identify two common applications for totalizing meters.
- Identify the basic components of a totalizing meter and describe how the meter works.
- Identify other types of metering equipment that can be used for the same purpose as a totalizing meter.

Totalizing Meter Tests and Test Procedures

- Describe accuracy tests normally performed on totalizing meters.
- Identify the basic test equipment used for testing totalizing meters.
- Describe how a totalizing meter and the appropriate test equipment are connected to perform each type of accuracy test.

Totalizing Meter Adjustments

- Describe preliminary steps that are often taken before adjustments are made to a totalizing meter.
- Describe how adjustments can be made to a split-element totalizing meter.

Subjects

Introduction to Totalizing Meters

- Common applications
- Totalizing meter parts and operation
- Alternative metering equipment

Totalizing Meter Tests and Test Procedures

- Types of meter tests
- Basic test equipment
- Basic test connections
    - Individual element test connections
    - Series element test connections
- Basic Testing Procedures

Totalizing Meter Adjustments

- Preliminary steps
- Adjusting a totalizing meter

Solid-State Meters and Associated Devices – Module I.D. No. 730

Overview

This unit examines many of the solid-state devices used in, or in conjunction with, electric metering. The devices are identified and described and their functions demonstrated. In addition, an example of a totally solid-state metering system is presented and its associated components identified.

Objectives

Solid-State Devices Used with Electro-mechanical Meters

- Identify and describe devices used to convert information provided by an electro-mechanical meter.
- Identify and describe devices that receive electronic information from a meter.

Solid State Meters

- Describe the basic operation and characteristics of a solid-state meter.
- Describe some features of the interchangeable electronic register modules.

Solid-State Meter Systems

- Identify and describe devices used with solid-state meters.
- Describe an example of a solid-state meter system that provides two-way communications.

Subjects

Solid-State Devices Used with Electro-mechanical Meters

- Devices that convert information
- Devices that receive electronic information
    - Solid-state registers
    - Solid-state totalizers
    - Magnetic tape recorders
    - Electronic readers

Solid-State Meters

- Operation of a solid-state meter
- Solid-state meter characteristics
- Interchangeable register modules

Solid-State Meter Systems

- Components of solid-state meter systems
- Two-way communication system

Energy Diversion – Module I.D. No. 620

Overview

This unit examines methods that residential and commercial customers have used to steal electrical service. The unit starts with some very basic techniques and moves on to the more complex forms of diversion that might go undetected without close examination. Emphasis is on detection techniques and verification procedures.

Objectives

Methods of Energy Diversion – Part I

- Define revenue protection and energy diversion.
- Identify two basic types of energy diversion
- Explain how a meter can be bypassed.

Methods of Energy Diversion – Part II

- Describe common methods of exploiting a meter's vulnerable points and explain how this type of tampering can be detected by meter personnel.
- Describe three common methods of altering a meter.

Diversion Protection

- Describe methods that utilities use to avoid energy diversion.
- Describe three basic methods that are commonly used to detect energy diversion.

Proving Diversion

- Describe how electronic tap detection can provide evidence of energy diversion.
- Describe how series metering can provide evidence of energy diversion.

Subjects

Methods of Energy Diversion – Part I

- Terms
- Types of energy diversion
- Methods of bypassing a meter

Methods of Energy Diversion – Part II

- Exploiting a meter's vulnerable points
- Methods of altering a meter

  Adding an on/off switch

  Altering the gear train

  Tampering with transformer-rated meter circuits

Diversion Protection

- Avoiding diversion
- Detecting energy diversion

    Computer checks

    Individual awareness

    Periodic tests

Proving Diversion

- Electronic tap detection
- Series metering