TESCO METERING

METER TESTING INTRODUCTION

44th Annual Mississippi Power and Meter School

Tuesday February 11, 2025 - 3:00 PM

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MISSISSIPPI STATE UNIVERSITY™
44TH ANNUAL ELECTRIC POWER & METERING SCHOOL

Questions to Answer

- Why do we test?
- How do we test?
- What types of meter tests are there?
- How do utility tests differ from customer request tests?
- What is In-Service Testing?
- How do we know meter tests are good?
- What do we do with the test data?

Why Do We Test?

- The first and most important reason is that this is the fundamental contract we have with our customers – we sell them electricity and they pay the agreed upon price. Our rate payers expect that we are charging them fairly and we make every effort to ensure that we are. So, we perform meter tests.

- Because of the importance of this, Utility commissions in every state also require some level of meter testing.

- But only for accuracy. State regulatory commissions want electric utilities to ensure that no customer is being billed unfairly, and that no subset of customers is being unfairly subsidized by the rest of the rate payers. Some states mandate only accuracy tests and others require demand and time of use accuracy tests.

- Any tests beyond accuracy tests are tests that are simply considered a “good business practice”. And even Utilities who do not have to abide by State Regulatory rules test for accuracy as their customers expect this of them.

ACCURACY TESTING

The basic accuracy tests puts energy through a meter and the same amount of energy through a traceable standard. That standard is considered 100.0% accurate for the sake of our accuracy test and the ratio of how much energy the meter sees to how much energy the standard sees is the meter accuracy.

Electric meters always come from the factory with a stated accuracy based on exactly this type of test. Typical accuracies might be 99.98% or 99.96%. Typical requirements for residential meters are +/- 2.0% so these meters are far better straight off the manufacturing line than required. Many utilities tighten up these requirements and will not let a meter into the field with any thing more than +/- 0.5%. These new meters are still more than an order of magnitude better than that.

COMPARING THE METER TO THE STANDARD

The basic watt hour meter is a marvel in simplicity. The old electromechanical meters can continue to accurately (with better than 99.90% accuracy) measure energy consumption after more than 30 years in an outdoor environment. And they were and continue to be relatively inexpensive ($20 to $30). This is pretty incredible.

With electromechanical meters, for every turn of the disk a certain amount of energy passing through the meter (Kh). Count the number of turns and you know how much energy is used over time.

For electronic meters, for every pulse there is a certain amount of energy passing through the meter. Count the pulses after the first one and you know how much energy is used over time.

Modern standards all have pulse outputs and most also provide the comparison with the meter under test.

Landis + Gyr Type MX
Electromechanical
(1994 to 2009)

BASIC ENERGY FORMULA

- The essential specification of a watthour meter's measurement is given by the value

  K_h [Watthours per disk revolution]

- The watthour meter formula is as follows:

$$E\left[\text{Watthours}\right] = K_h\left[\frac{\text{watthours}}{\text{disk revolution}}\right] * n\left[\text{disk revolutions}\right]$$

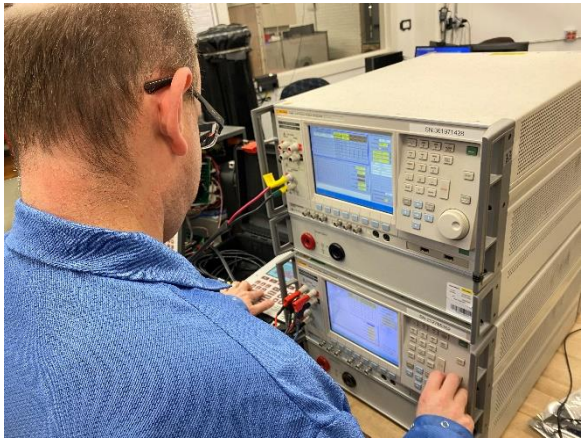
Traceability and Setup

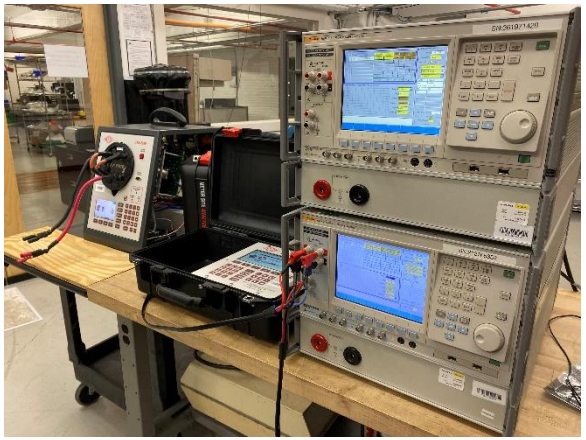
However, there is also the accuracy and traceability of the standard to consider as well as the set-up of the test and whether the test is in the meter lab, the meter shop or the field.

Traceability is the ability to trace the calibration of any one device back to an international standard.

Typical stated accuracies for standards are 0.04%, 0.02% and 0.01%. In the lab, these same standards typically measure better than 0.005%. That is 50 parts per million in accuracy.

Just because you have all the right equipment though, a bad setup can invalidate any test or calibration whether this is in the field or in a more controlled environment.





METER TESTING TRACEABILITY

PJLA
Calibration
Accreditation # 101105

- *Traceability is defined as ability to link the results of the calibration and measurement to related standard and/or reference (preferably national or international standard) through an unbroken chain of comparisons.*
- Calibration is typically performed by measuring a test unit against a known standard or reference.
- Master standard (i.e., gages) are kept by National Measurement Institute (NMI) of each country.

METER TESTING TRACEABILITY

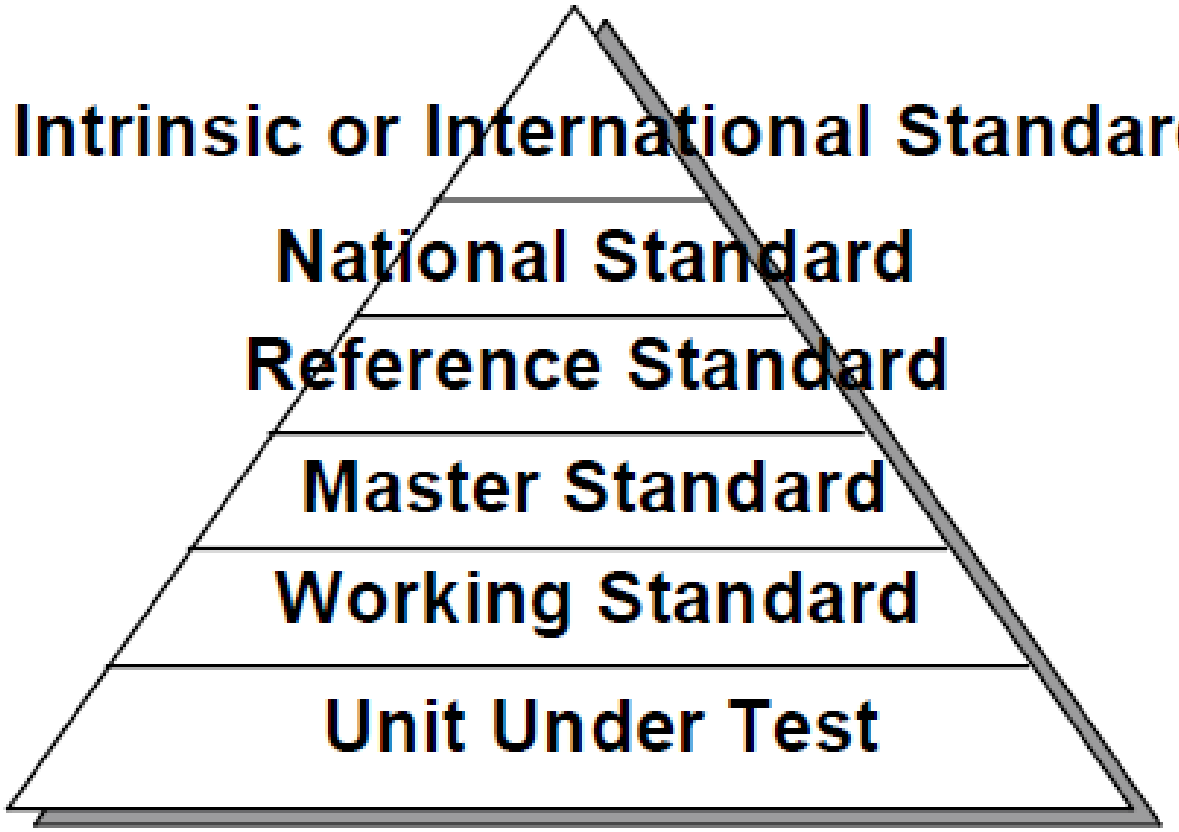
- National Institute of Standards and Technology (NIST) provides internal tracking numbers, which are often used as evidence of traceability.

- **WARNING!** NIST does not certify or guarantee that calibration and measurements are correct, nor does it provide any kind of certification of accuracy and calibration. NIST only provides certifications for the work performed by them.

- NIST is the US National Lab but using NRC out of Canada or any other national lab is also acceptable. We need traceability to an international standard and all these national labs do this.

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

METER TESTING TRACEABILITY - STANDARDS



METER TESTING TRACEABILITY - STANDARDS

- *National Standard*
  In the US, this is maintained by NIST, in Canada by NRC. Not all countries have a National Standards group and even the US does not have a group for every item of interest to an electric utility (e.g., voltage transformers)

- *Reference/Master Standard*
  Item of highest metrological quality located at a site where calibration is being conducted.

  Transfer Standard
  Lower level of Reference Standard and used for calibration of lower-level calibration requirements measuring devices.

- *Working Standard*
  Lower level of Reference Standard and used for calibration of lower-level calibration requirements measuring devices. Should be compared to Master Standard or Reference Standard on regular basis; used for daily checks comparisons of the calibrated devices.

TEST EQUIPMENT CALIBRATION

Primary Requirement: Traceable to an International Standard

- Meter Test Boards, Field Test Kits calibrated to a known master standard maintained at Meter Shop.
  - ✓ Some periodicity such as monthly or quarterly
- Reference or Master standard calibrated by outside vendor traceable to a national lab (e.g., NIST, NRC) or directly by a national lab.
  - ✓ Usually annually for metering

METER SHOP AND FIELD ACCURACY TESTS

Typical Test Setups for Shop and Field

- True Three phase boards – multi position and single position
- Series Parallel Boards – multi position and single position
- Field Test kits

Typical Test Setups for Shop and Field

True Three Phase Boards
Multi-position and Single Position

With true three phase Test Boards the tester can apply true three phase voltage and current to electric meters, enabling the meters to be tested under all possible conditions that may be encountered in the field.

These types of test boards can also be used for a variety of other functional testing and operational tasks.

- New AMI/AMR meters settings check-out
- Meter program updates
- Software revision checking for both the meter and the communications module
- Communications module troubleshooting
- Checking of problem meters for open/shorted elements

Typical Test Setups for Shop and Field

Series Parallel Boards
Multi-position

Power-up and apply load to electric watt-hour meters for functional and accuracy testing. These types of boards can also assist with AMI Meter Certification process and AMI meter qualification and communication testing.

Typical Test Setups for Shop and Field

Series Parallel Boards
Single Position

These types of boards are the same as the multi position boards and off the same functionality. They are transportable and can be moved between locations or located in meter testing vans.

These types of boards are ANSI compliant and newer versions have waveform generator, providing all of the waveforms called out by ANSI C12. These boards typically have a single voltage and three isolated current sources.

Is the Meter Test All About Accuracy?

Once upon a time…….
…….meter testing was only about accuracy. AMI has changed that completely.

We have always tested the functionality of the meter, but when all the meter did was measure energy, this meant all we were interested in was an accuracy test.

Today's AMI meters typically

- Have a disconnect device under the cover
- provide a variety of distribution related information including direct voltage and current measurements that can be provided back to the head end
- Have two way communication to meter and the meters can be upgraded over the air.
- Have a variety of alerts and alarms. The meter can have
    - temperature alerts
    - tamper alerts
    - micro arc detection (hot socket) alerts
    - last gasp alerts among other alarms.
- Wave forms can be recorded, and a host of distribution specific data collected and transmitted.

All this functionality is now becoming part of "meter testing".

TYPICAL TEST SETUPS FOR SHOP AND FIELD

Field Test Kits

As a utility, most revenue comes from large customers who have transformer-rated services. At transformer rated sites the opportunity for something to go wrong is much greater than at a self-contained site. Studies have shown that at transformer-rated sites, most issues are related to wiring, CTs, PTs and other issues. If you want to be sure that the customer is billed correctly and you are not losing revenue, you must test the whole site, not just the meter.

- Complete Site Verification
- CT Testing (ratio with Burden, burden, admittance)
- Meter Testing
- Accuracy, Demand, Timed Register, Timed Run, Energy Delivery

Site Inspection Vs. Meter Testing

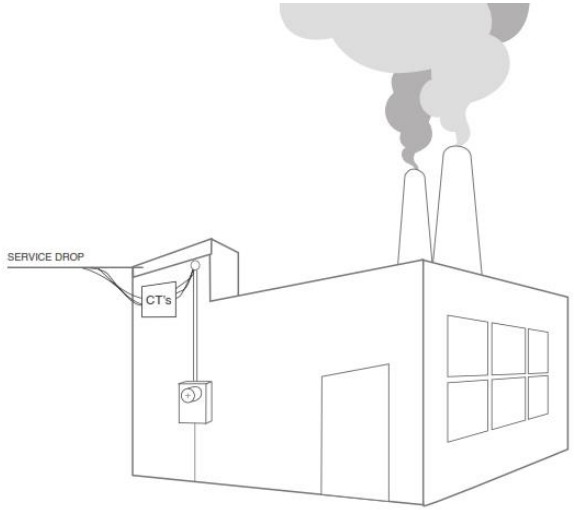
For transformer rated services the site inspection and verification is far more important than just the meter test. The meter test is only one component of this work and is often the least important of all the steps on the check list.

We are interested in single phase meter testing in this presentation but even at self-contained residential services performing a visual inspection of the site often determines what the issue or issues may be with the site that have nothing to do with the accuracy of the meter.

Testing a Meter Vs. Testing a Site

Test an installation and system and not just a meter!

Test programs may need to involve testing and checking the meter performance as well as checking and testing the installation. This more extensive test check list needs to be done especially for the higher revenue C&I customers.



COMPLIANT TESTING

Customers always have the right to request a meter test.

Some utilities and some jurisdictions allow for testing at the customer site, others require a test in a laboratory environment.

Some allow the customer to witness the test and others require the utility commission to witness the test.

Utilities must show that the meter tests well and must demonstrate that they have a test program in place to ensure the meters in service are performing well.

General Meter Testing Requirements

- New Meters
  - Manufacturers tests
  - In-house tests on new shipments
- Return to Service Testing
- In-Service Meters
  - Periodic Tests
  - Selective, random, or statistical testing
- Retirement tests
- Testing of related metering equipment

New Meter Testing Programs

- Accept the Manufacturer's Test results
- Perform a Statistical Test of an incoming shipment
- Perform a 100% test of an incoming shipment

RETURN TO SERVICE TESTING

- Meters to be returned to service must always (virtually every utility commission requires this) be accuracy tested before being returned to service.
- Best business practices also require that the meter is functionally tested as well.

IN-SERVICE TESTING

Meter Testing for new and in-service meters is specified in ANSI C12.1-2015, *American National Standard for Electric Meters, Code for Electricity Metering*. Most utility commissions use this Standard a reference or the basis for their meter testing requirements.

Periodic Test Plans

- Periodic
  - Varies by State
  - Example provided by ANSI C12.1:
    - Each Electromechanical meter is tested once every 8 years
    - All other Meters are tested every 16 years
    - Appendix D provides details for other meters & devices
    - No guidance for AMI meters
  - Generally, average of 12.5% of population tested per year

8 Years

16 Years

STATISTICAL PLANS: THE BEST APPROACH

ANSI C12.1-2001 Code for Electricity Metering Guidance

Paragraph 5.1.4.3.3 Statistical sampling plan

"The statistical sampling plan used shall conform to accepted principles of statistical sampling based on either variables or attributes methods. Meters shall be divided into homogeneous groups, such as manufacturer and manufacturer's type. The groups may be further divided into subdivision within the manufacturer's type by major design modifications."

NOTE - Examples of statistical sampling plans can be found in ANSI/ASQC Z1.9, the ANSI version of MIL-STD-414 and ANSI/ASQC Z1.4, the ANSI version of MIL-STD-105.

Why Use a Statistical Test Plan?

- Focuses testing on the proper meters
- Minimizes number of meters to be tested; usually requires less than 30% of what a periodic testing plan requires
- Provides data and analysis tools for use in understanding what is happening with installed meters or for use in the purchasing of new meters

HOMOGENOUS POPULATION(S)

- The groups or populations being sampled and tested are made up of the same or similar items, items which operate in the same way and were made in the same manner.
- For electric meters, this has traditionally been interpreted as being meters of a specific meter type from a manufacturer (i.e., AB1, J5S, MX, etc.).
- AMR & AMI programs have helped to make the overall populations more homogenous. This makes a utility with AMR & AMI meters better prepared to take advantage of a statistical sampling plan.

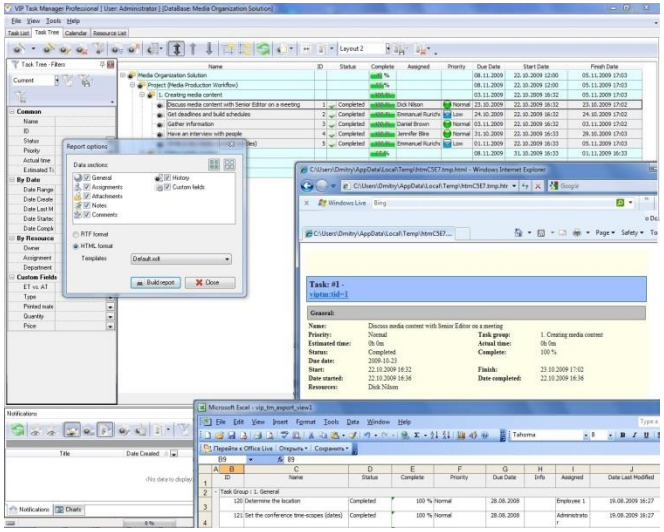
TRACKING METER RECORDS

- AMI programs help to update and overhaul meter record systems.
- Having the records for the entire meter population updated allows for a better chance that test data is available to answer questions and that any meter may be selected as part of the sample for testing.

METER TEST DATA TRACKING

Test data should be tracked throughout meter life
  – Certification testing, first article, acceptance testing, in-service (field & shop), retirement

- Meter test data should be linked to meter record data such as meter form, amps, voltage, display type, etc.
- Best time to start to develop the program is before the meters are being installed.
- Accuracy test data is usually collected automatically as new meters are tested in meter shops or cross docks.

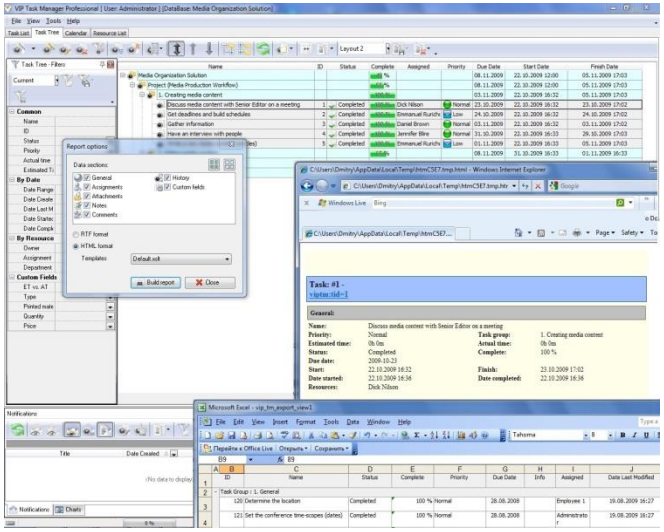


METER TEST DATA TRACKING

- Need to consider tracking non-accuracy functional testing (meter software configuration, service disconnect testing, voltage, etc.)

- Use installation reports to determine if there is any initial concerns about the meters being installed.

- Typical reports that should be available:
  - Failed Meter Report, Project to Date
  - Electric Meters on Network Report



METER TESTING TRACEABILITY

- Test equipment to an International standard
- Tracking number of meters to be tested per State Commission requirements
- Tracking meter test data
  - Meter Records
  - Meter Data Management System (MDMS)

METER TEST DATA TRACKING SYSTEM

- System should track meter test results for ease of future reference or for response to public or Utility Commission inquiries.
- Maybe part of Meter Data Management System (MDMS) or a separate Meter Records system.
- Requires discipline in collecting & entering data, especially field tests.

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Questions and Discussion

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