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INTRODUCTION TO WATTHOUR METER TESTING

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TESCO's Meter School

TESCOOL

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 vs Periodic Testing?
- What are regulatory tests?
- How do we know meter tests are good?
- What do we do with the test data?

WHY DO WE TEST?

- The meter is the “cash register” of the utility company and serves as a junction / interface between the utility and the customer
- Meter accuracy establishes “fair” transactions / billing between the utility company and customer
- Meter testing guidelines are taken from ANSI C12.1-2014 American National Standard for Electric Meters – Code for Electricity Metering
- Section 5 of C12.1 covers “Standards for New and In-Service Performance”
- ANSI provides guidance rather than enforces standards
- Final testing guidelines are established by the governing commission, local government, or the utility

ANSI
American National Standards Institute

Why Do We Test?

- Our regulatory commissions typically require us to test meters for accuracy
  - Regulatory commissions typically take their lead from ANSI C12.1 American National Standard for Electricity Metering
- State regulatory commissions focus on accuracy because they 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 good business practice
  - With the advent of AMI, functional testing has taken a high priority for the utility as well

ANSI
American National Standards Institute

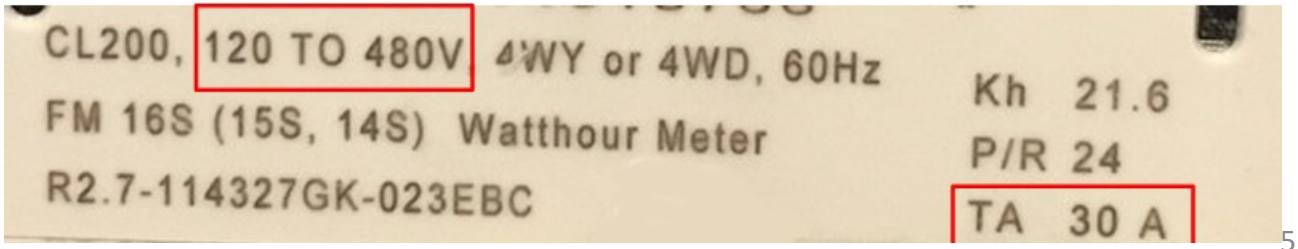
BASICS OF METER TESTING

- Equipment Needed for Testing
  - Reference Standard
  - Test Kit or Load Box
  - Test Jack or Test Switch
  - Multi-Meter
  - PPE & Safety Equipment

- Tests Performed

Test	Voltage	Current	PF
Full Load	Rated V	Rated Test Amps (TA)	1.0
Power Factor	Rated V	Rated TA	0.5
Light Load	Rated V	10% of TA	1.0

- Meter Characteristics - Test Amps, Class, Form, and Voltage are shown on the face of the meter as well as Kh (energy per pulse)



SHOP TESTING

- Shop or lab testing is considered to be done under ideal conditions
- The test machine contains the reference standard, meter socket interface, load circuit, and electronics
- The test machine is often connected to a PC and data management system
- The test machine may have an optical probe and other pickups to be able to sense a physical disc rotation, IR output, etc.
- Test machines are designed to test single phase and three phase meter forms as well as solid state and electro-mechanical meters

Field Testing

- Field testing can be performed with an adapter and site voltage from the meter socket or by removing the meter and testing in a piece of field equipment that may be contained in a utility vehicle nearby
- Voltage and current may by synthesized through electronics or the customer's meter socket may be used as a source
- Some commissions may require complaint & witness tests to be done in the field while others may allow to meter to be removed, secured(bagged), and tested in the shop with a witness
- Field testing and shop testing have various benefits to a utility
  - Quicker field procedure vs more back-office work
  - Longer field procedure vs less back-office work

COMPLIANT TESTING

- Customers always have the right to request a meter test
  - There may be limits to how often a test can be requested and there may be a cost to the end customer as well
- Some utilities and some jurisdictions allow for testing at the customer site(field), others require a test in a laboratory(shop) 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 within acceptable limits 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 Purchase Meters
  - Manufacturers tests
  - In-house tests on new shipments
- Recycled Meters
  - Return to Service Testing
- In-Service Meters
  - Periodic Tests
  - Selective, random, or statistical testing
- End of Life Meters
  - Retirement tests
- Testing of related metering equipment

New Meter Testing Programs

- Utilities generally accept the manufacturer's test results then perform some type of test on their own
  - Statistical Sample Test of an incoming shipment
  - 100% test of an incoming shipment
- Utilities may opt for sample testing for residential and 100% testing for commercial shipments
- With consistent performance and accuracy of newer solid-state meters many utilities have moved to statistical sampling for all new purchases
- A utility may have more stringent guidelines than the commission
  - 98-102% vs 99.5-100.5% or even 99.7-100.3%

Return to Service Testing

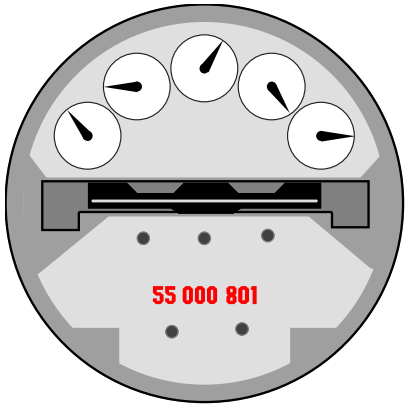
- Meters to be returned to service must always (virtually every utility commission requires this) be accuracy tested before being returned to service
- Best business practices also require that the meter is functionally tested as well
- With advances in AMI technology, many utilities may identify meters as End of Life (EOL) and simply “test and retire” OR they may perform accuracy testing, functional testing, and programming to return service and use in the field

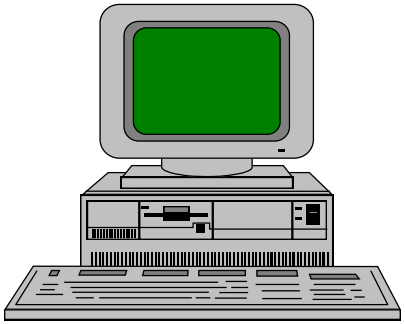
IN -SERVICE TESTING

- 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

Test Plans for Meters

- The most common test plans for in-service meters include periodic and statistical plans
  - Periodic plans may be based on a test every x number of years
  - This is more common with commercial meters
  - This may even be annually on interconnect meters and generation meters
    - Example ISO/RTO - PJM and 1 vs 2 years
  - Statistical plans generally are based on a subset of the population and broken out by groupings of the population





Periodic Test Plans

- Periodic
  - Varies by State / Jurisdiction
  - 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, an average of 12.5% of the population is tested per year
  - With AMI data and consistent performance, some utilities have moved their commercial populations to once every 12 or even 16 years

8 Years

16 Years

WHY USE A STATISTICAL TESTING 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

HOMOGENEOUS POPULATION(S)

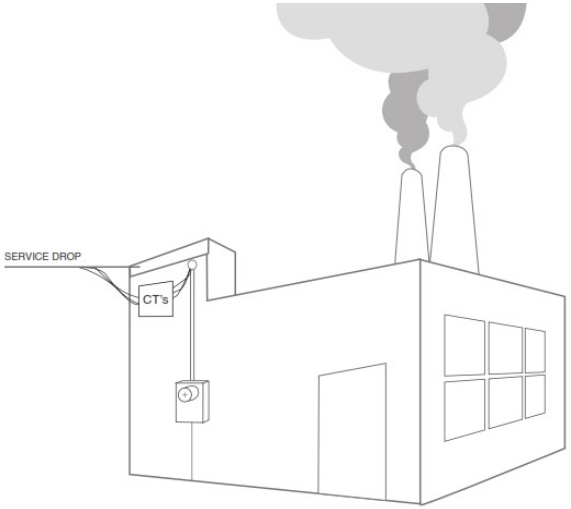
- The groups or populations being sampled and tested are made up of the same or similar items, items which operate in the same way and were made in the same manner
- For electric meters, this has traditionally been interpreted as being meters of a specific meter type from a manufacturer (IE AB1, J5S, 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
    - Some utilities may only have 4-5 groups now where they used to have 20+ groups to test
    - (IE Focus, i210+c, kv2c, centron, etc.)

SAMPLE TEST PLANS

- ANSI z1.4 and ANSI z1.9 are some of the more commonly accepted sampling plans
  - Z1.4 is more common and may be preferred as it is a sampling procedure based on attributes
    - Meters pass or fail
  - Z1.9 is more granular and may be preferred for aging population as it is a sampling procedure based on variables
    - Meters can fail but there is an average and statistical value calculated for the group
      - One abnormal test (33%) could be enough to fail an entire group
      - Utilities may denote abnormalities as “outliers”

Testing of a Meter vs Testing a Site

- ***Test an installation and site and not just the 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



Testing of a Meter vs Testing a Site

- Testing of CTs, PTs, and associated site equipment is often overlooked but many times is the key to lost revenue
  - Voltage & current checks may show a condition to cause concern
    - IE missing current on phase A or voltage on phase C
      - Site accuracy may be 66%!
  - Phase angle and phasor checks may show concern
    - IE current 180 degrees off – one CT wired in reverse
      - Meter tests at 100% but site accuracy is 33%!

METER TESTING TRACEABILITY

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

METER TESTING TRACEABILITY

- Traceability is defined as the 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

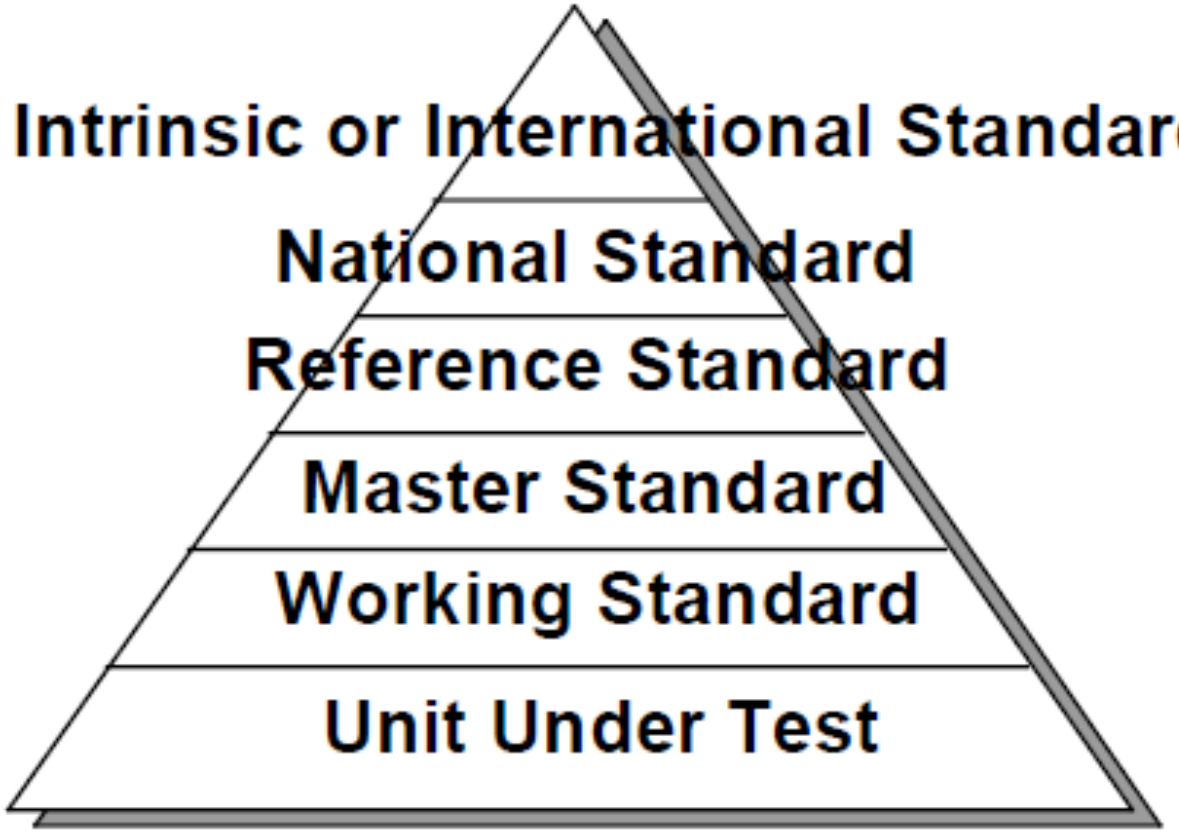
- Master standard (IE gages) are kept by National Measurement Institute (NMI) of each country

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

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 a utility (IE 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 NIST Standards

- 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 NIST or directly by NIST
  - ✓ Usually annually

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

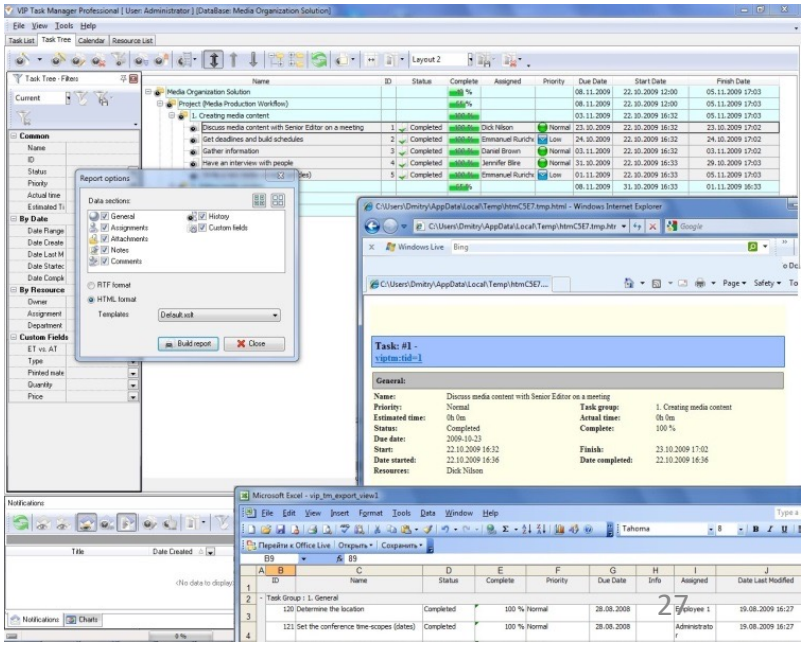
METER TEST DATA TRACKING

- 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

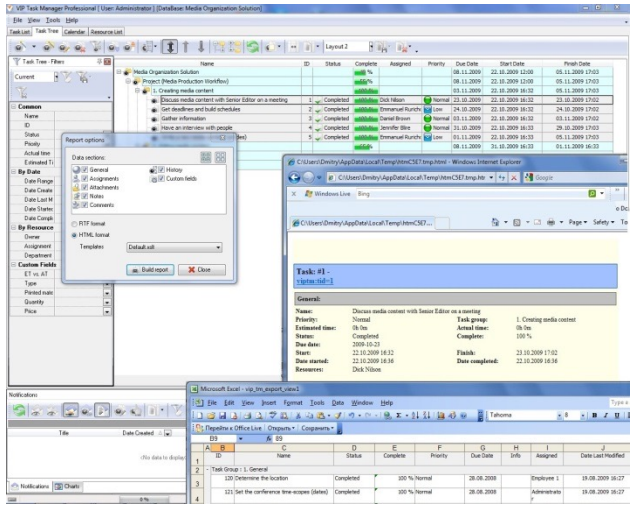


METER TEST DATA TRACKING

- 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 TEST DATA TRACKING SYSTEM

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

QUESTIONS?

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- What is In-Service Testing?
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QUESTIONS AND DISCUSSION

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