Standards - Accuracy, Precision and Traceability

Notes from the Field

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Session Objectives

Discuss and gain an understanding about;

- What is ANSI C12.1 and why do we care
- What is suitable traceability according to the law
- The need for Meter Standards and traceability in electric metering
- The definition of metrology and the application of this science in electric metering
- The difference between accuracy and precision and why both are important
- The use of Standards in the test lab
- The use of portable Standards in the field

ANSI C12.1

ANSI C12.1-2015 is the current *American National Standard for Electric Meters, Code for Electricity Metering*. Most utility commissions use this Standard as a reference or the basis for their regulatory requirements for electric metering within their state.

ANSI C12.20-2010, *American National Standard for Electricity Meters, 0.2 and 0.5 Accuracy Classes*, provides different test tolerances and a few different or modified tests for higher accuracy meters.

ANSI develops voluntary Standards that are updated approximately every seven years by a volunteer group of users (utilities), manufacturers (manufacturers of meters and related metering equipment) and interested parties (metering professionals).

ANSI
American National Standards Institute

ANSI C12.1 – Why do we care?

- Electric Utilities in the United States are regulated by Utility Commissions within their individual State.
- Commission rulings and regulations are quite literally – THE LAW.
- Most commissions defer to ANSI C12.1 and codify part or all of this Standard as part of their individual state law regulating electric utilities.
- ANSI C12.1 is the Law for electric utilities. Every Electric Utility in the United States maintains traceability of their meter accuracy back to NIST (the accepted National Metrology Institute) as per ANSI C12.1 guidelines.

ANSI C12.1 and C12.20 Requirements for accuracy, precision and traceability

- ANSI C12.20 establishes aspects and acceptable performance criteria for 0.2 and 0.5 percent accuracy class meters meeting Blondel's Theorem. All other meters are covered under ANSI C12.1.
- Where there are differences between C12.20 and C12.1, ANSI Standard C12.20 takes precedence for meters covered by C12.20.
- Anything not covered under C12.20 reverts to ANSI C12.1 for meters covered by C12.20.

Current ANSI C12.1 Testing Requirements – there are others besides Accuracy

Table 3 – List of Tests

Tests (✓) Performed In Series	Descriptions Of Certification Tests	ANSI C12.1
	No Load	Test #1
	Starting Load	Test #2
	Load Performance	Test #3
	Effect of Variation of Power Factor	Test #4
	Effect of Variation of Voltage	Test #5 or 5a
	Effect of Variation of Frequency	Test #6
	Equality of Current Circuits	Test #7
	Internal Meter Losses	Test #8
	Temperature Rise	Test #9
	Effect of Register Friction	Test #10
	Effect of Internal Heating	Test #11
	Effect of Tilt	Test #12
	Stability of Performance	Test #13
	Independence of Elements	Test #14
✓	Insulation	Test #15
✓	Voltage Interruptions	Test #16
✓	Effect of High Voltage Line Surges	Test #17
	Effect of External Magnetic Field	Test #18
	Effect of Variation of Ambient Temperature	Test #19 or 19a
	Effect of Temporary Overloads	Test #20
	Effect of Current Surges in Ground Conductors	Test #21
	Effect of Superimposed Signals	Test #22
	Effect of Voltage Variation-secondary Time Base	Test #23
	Effect of Variation of Amb. Temp.-second. Time Base	Test #24
✓	Effect of electrical Fast Transient/Burst	Test #25
✓	Effect of electrical oscillatory SWC test	Test #25a
	Effect of Radio Frequency Interference	Test #26
	Radio Frequency Conducted and Radiated Emission	Test #27
✓	Effect of Electrostatic Discharge (ESD)	Test #28
	Effect of Storage Temperature	Test #29
✓	Effect of Operating Temperature	Test #30
✓	Effect of Relative Humidity	Test #31
	Mechanical Shock	Test #32
	Transportation Drop	Test #33
	Mechanical Vibration	Test #34
	Transportation Vibration	Test #35
	Weather Simulation	Test #36
	Salt-spray	Test #37
	Raintightness	Test #38

ANSI C12.1-2008

American National Standard
for Electric Meters

Code for Electricity Metering

Current ANSI C12.20 Testing Requirements

Table 6 – List of tests

ANSI C12.20	Descriptions Of Certification Tests	Polyphase or Series-parallel loading	Tests (✓) Performed In Series	Precision or Nominal Source
Test #1	No Load	Either		P
Test #2	Starting Load	Either		P
Test #3	Load Performance	Either		P
Test #4	Effect of Variation of Power Factor	Either		P
Test #5a or 5b	Effect of Variation of Voltage	Either		P
Test #6	Effect of Variation of Frequency	Either		P
Test #7	Equality of Current Circuits	Either		P
Test #8	Internal Meter Losses	Either		N
Test #9	Temperature Rise	Either		N
Test #10	Effect of Register Friction	Either		P
Test #11	Effect of Internal Heating	Either		P
Test #12	Effect of Tilt	Either		P
Test #13	Stability of Performance	Either		N
Test #14	Effect of Polyphase Loading	Per Test		P
Test #15	Insulation		✓	NA
Test #16	Voltage Interruptions		✓	N
Test #17	Effect of High Voltage Line Surges		✓	N
Test #18	Effect of External Magnetic Field			P
Test #19	Effect of Variation of Ambient Temperature	Either		P
Test #20	Effect of Temporary Overloads			N
Test #21	Effect of Current Surges in Ground Conductors			N
Test #22	Effect of Superimposed Signals			NA
Test #23	Effect of Voltage Variation-secondary Time Base			NA
Test #24	Effect of Variation of Ambient Temperature -Secondary Time Base			NA
Test #25	Electrical Fast Transient/Burst		✓	N
Test #26	Effect of Radio Frequency Interference			N
Test #27	Radio Frequency Conducted and Radiated Emission			N
Test #28	Effect of Electrostatic Discharge (ESD)		✓	N
Test #29	Effect of Storage Temperature			N
Test #30	Effect of Operating Temperature		✓	N
Test #31	Effect of Relative Humidity		✓	N
Test #32	Mechanical Shock			NA
Test #33	Transportation Drop			NA
Test #34	Mechanical Vibration			NA
Test #35	Transportation Vibration			NA
Test #36	Weather Simulation			NA
Test #37	Salt-spray			NA
Test #38	Rain-tightness			NA

Correctly Billing the Customer – a Regulator's View

Every Utility Commission in the United States wants to ensure two fundamental things regarding the billing of customers within their State;

- That no one customer is being unfairly billed
- That no subset of customers is being unfairly subsidized by the rest of the rate payers

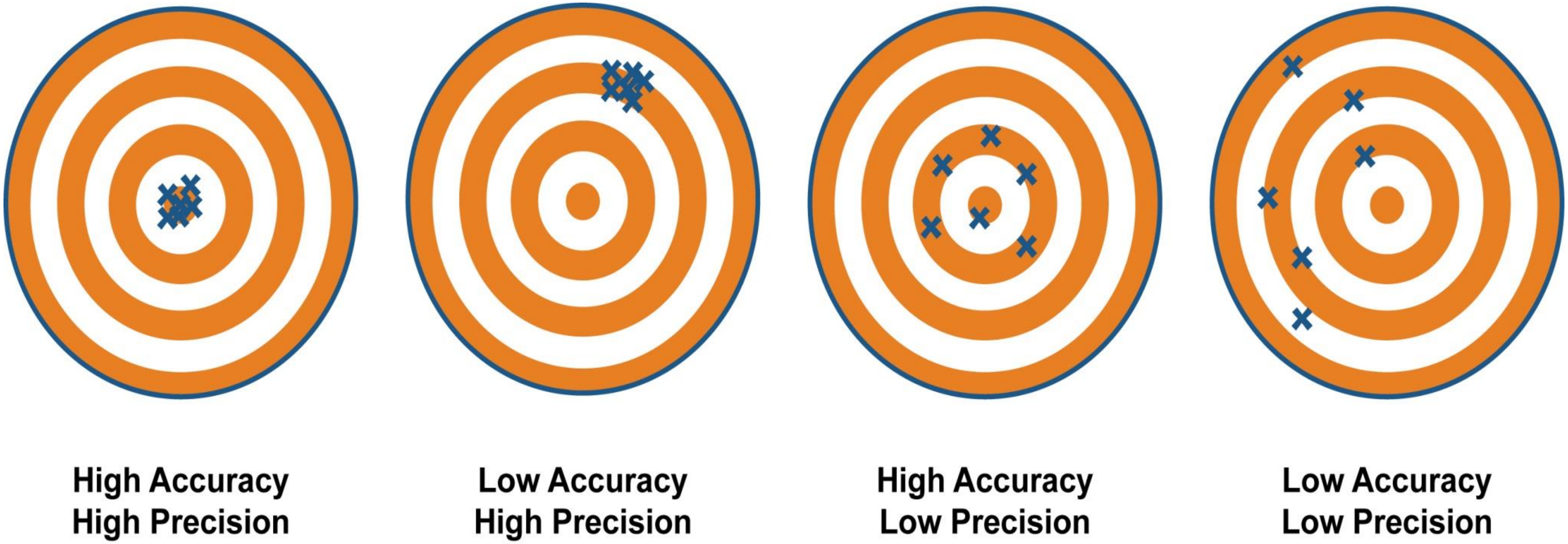
Accuracy vs. Functional Testing

- Today we will focus strictly on the traceability for accuracy testing. Once a meter passes the ANSI tests listed on the previous two slides there is no regulatory requirement to re-certify a meter in any way other than for accuracy.

- Electric Utilities are now finding that the functional testing of a meter must also be done every time a meter is returned to the shop and for higher end meters full site verifications must also be done periodically in the field to ensure accurate and reliable metering of customer energy usage. We will return to these two points briefly at the end of the presentation.

- This presentation will focus on accuracy and the traceability of this testing back to the International System of Units (SI).

Accuracy vs Precision



Metrology and why this word matters to us

Metrology is defined by the International Bureau of Weights and Measures (BIPM) as “the science of measurement, embracing both experimental and theoretical determinations at any level of uncertainty in any field of science and technology”.

How do we apply this in metering?

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ANSI C12.1 Meter Standard Definition and Requirements

3 Standards and standardizing equipment

3.1 General

The purpose of this section is to outline an appropriate chain of intermediate steps between the national standards and watthour meters.

3.2 Traceability paths to the International System of Units, SI

It is the responsibility of the utility to establish and maintain the traceability of the watthour standard to the SI. This traceability plan shall document the relationship between the revenue meter and the SI. Described below are some common methods for establishing this traceability.

ANSI C12.1 Meter Standard Definition and Requirements (cont)

3.2.1 Direct transfer

A watthour transport standard is sent directly to a National Metrology Institute (NMI) for comparison with the representation of electrical energy maintained at the NMI. The NMI must be a signatory to the CIPM Mutual Recognition Arrangement * and be listed in the BIPM Key Comparison Database (KCDB) indicating Calibration and Measurement Capabilities (CMC) for AC Power.

3.2.1.2 Independent laboratory

An independent standards laboratory able to document traceability to the SI may be used by a utility that does not carry out the entire chain of sequential measurements between the national standards and the local energy standard. An independent laboratory may include another utility with a qualified laboratory.

Transfer/Transport Standards

3.5.2 Transport standards

- Transport standards are standards of the same nominal accuracy class as the basic reference standards of a laboratory. Such standards are regularly intercompared with the basic reference standards to maintain a history of their behavior. The main purpose of the transport standard is to establish traceability from outside the utility and transfer traceability within the utility.

3.6 Periodic verification of reference standards

- Watthour meters used as reference standards to maintain the unit of energy shall be intercompared at appropriate intervals.

Every Utility handles their Transfer Standards in a way that suits their operation , their budget, and the equipment that they have available

  – Radian 703's or their equivalents from Fluke or other manufacturers
  – Portable Transfer Standards
  – Outside contractors

ANSI C12.1 Meter Standard Definition and Requirements (cont)

3.2.1.3 Meter laboratory transport standard comparison to a NMI

The utility selects a transport standard which is sent to the NMI or an independent laboratory for intercomparison to the national standard. When the transport standard is returned to the utility, it is intercompared with the basic reference standards to provide traceability to the SI.

Meter Labs

3.3 Meter laboratory

The meter laboratory is concerned with two functions:

a) Maintaining standards whose calibration values are traceable to national standards.

b) Assigning calibration values (correction factors) to working standards.

It may be equipped and staffed to make calibration tests at some or all of the sequential steps intermediate between the national standards of resistance, EMF, and time interval, and a local reference standard of energy measurement (such as a group of watthour meters).

3.5 Laboratory standards

Laboratory standards are those standard meters that are used to verify the accuracy of working standards. The standards in the laboratory are the basic reference standards and the transport standards.

3.5.1 Basic reference standards

Basic reference standards are those standards with which the accuracy of the watthour is maintained in the laboratory. Ideally, the basic reference standards of a laboratory should be maintained in groups of three or more separate individual units that can be intercompared readily. Three standards are the minimum for which a change in one can be both detected and located by intercomparison.

Working Standards

3.7 Portable/field/working standard watthour meters

Portable/field/working standards are commonly used interchangeably. These standard watthour meters are in constant use and accuracy should be verified at least annually.

3.8 Performance records

Historical records should be kept of the performance of each standard. Where this record shows excessive variation between tests, the standard should then be subjected to special investigation to determine the cause of the variation. If the cause cannot be determined and corrected, use of the standard shall be discontinued.

Meter Shop Testing

3.4 Meter shop

The meter shop is concerned with the routine testing, repair, and calibration of meters, auxiliary devices and equipment essential to the metering of electric energy and power.

- Watthour Test Boards are used to test electric meters in traditional meter shops.
- These boards must be “calibrated”.
- What is meter test board calibration and how frequently must this be done
- Best practices and “golden meters”
- How do we maintain traceability for new meters?

Field Testing

- How is this covered in ANSI C12.1 and ANSI C12.20?
- How do we maintain traceability for these tests?
- How do we ensure the overall accuracy of all of the meters installed on our system?

New ANSI C12.29 for Field Testing Metering Devices

Is Accuracy testing alone good enough?

ANSI C12.29 will establish recommended field testing for metering devices and should eventually be referenced in C12.1 and C12.20. The new standard is expected to have three Sections:

- Meter Testing
- Instrument Transformer Testing
- Site Wiring and Auxiliary Devices

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Questions and Discussion

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This presentation can also be found under Meter Conferences and Schools on the TESCO web site: www.tesco-advent.com