ANSI Standards Review

Prepared by Bill Hardy,TESCO

For North Carolina Electric Meter School
Thursday, June 29, 2017 at 8:00 a.m.

The Presenter

- Member of ANSI C12 since 2004
  - Voting member C12 Main, C12SC1, C12SC15, C12SC16; C12SC29
    - SC16 C12.20 (Vice-Chair)
    - SC29 Field Testing (Chair)
    - SC31 VA Measurement Standard (Chair)
    - SC46 Electricity Metering 0.1. 0.2, 0.5 Accuracy Classes for Measurement of Active, Apparent and Reactive Power (Chair)
  - Author: Power Measurements Handbook
  - Contributing Author: Handbook of Electricity Metering

ANSI

- American National Standard Institute, Inc.
  - Not a government agency
  - Standards do not have force of Law
  - All compliance is voluntary
  - ANSI doesn't actually generate any standards
  - Each standard is controlled by an industry organization as the "secretariat"
    - For C12 NEMA (National Electrical Manufacturer's Association) is the secretariat
    - Paul Orr is NEMA's secretary of C12

ANSI

- American National Standard Institute, Inc.
  - NEMA organizes committees to propose and review standards
  - Standards are republished approximately every 5 years
  - Standards codify consensus approaches in common practice
  - Generally, they do not break new ground or deal in controversial issues.
    - This is changing. Can't avoid issues any longer.

ANSI C12

- C12 Main Committee
  - General makeup has expanded slightly over last few years
  - 34 voting members with representation from three groups:
    - 12 - Manufacturers: Meter, Socket, Test Equipment, etc.
    - 13 - Users: Utilities
    - 9 - General Interest: PUC, UL, IEEE, Consultants, etc.
  - Usually meets twice a year in conjunction with EEI/AEIC

ANSI C12

- C12 Main Committee
  - Has final approval for all activities on any C12 family standard.
  - Establishes Subcommitties (SC) and Working Groups (WG) to address various standards and issues.
  - Meets twice a year in conjunction with EEI Transmission, Distribution and Metering Conference.

ANSI C12

- C12 Subcommittees
  - Various subcommittees have been organized to review specific standards
  - This is where the work is really done.
  - Each operates slightly differently
  - Each meets on a schedule of its own choosing
  - Most meet at EEI Biannual Transmission, Distribution and Metering Meetings
  - Communication WG meets more often and longer
  - Various subgroups meet frequently by teleconference.

ANSI C12 – Sub-Committees

Sub-Committee	Standards
C12 SC1	C12.1, C12.4, C12.5, C12.10
C12 SC15	C12.6, C12.7, C12.8, C12.9, C12.11
C12 SC16	C12.20
C12 SC17	C12.18, C12.19, C12.21, C12.22, C12.23, C12.26
C12 SC29	C12.29 Standard for Field Testing of Metering Sites
C12 SC31	C12.31 VA Measurement Standard
C12 SC46	C12.46 American National Standard for Electricity Meters - 0.1, 0.2 and 0.5 Accuracy Classes for the Measurement of Active, Apparent and Reactive Power

ANSI C12 SC 1

- C12.1 -2014 – Code for Electricity Metering
  - Published 6/30/2016
  - Changes in this Revision
    - Vector diagrams for balanced voltages are defined for common services.
    - Various definitions have been updated.
    - Bi-directional metering is added and tests updated to include bidirectional measurements.
    - Significant changes were made to the temperature rise section based on TRINIWOG tests

ANSI C12 SC 1

- C12.1 – Code for Electricity Metering
  - Changes in this Revision (continued)
    - Table 1b on maximum errors for reference standards was added.
      - Tightened to 0.05% and 0.02%
    - Accuracy Class 0.5 was added to the standard
    - A new column was added to all tables with tighter specs for AC 0.5
    - Section 5 on Standards for New and In Service Performance was completely rewritten
    - Appendix D was rewritten and simplified
    - A new Appendix F was added

ANSI C12 SC 1

- C12.1 – Code for Electricity Metering
  - Safety
    - Work is under way to move the safety related sections of C12.1 into C12.10
    - C12 is coordinating efforts with UL and its work on Subject 2735

- SC 1 is in the process of being broken into two separate committees.
  - SC1 will focus on C12.1.
  - The new SC will focus on C12.10

ANSI C12 SC 1

- C12.10 – Physical Aspects of Watthour Meters – Safety Standards
  - Published C12.10 – 2011
  - New revision ready for ballot
    - Will add safety sections from C12.1
    - New safety requirements in development
    - Working with UL to achieve consistency with UL 2735C
    - New meter forms with auxiliary power pins have been added

ANSI C12 SC 1

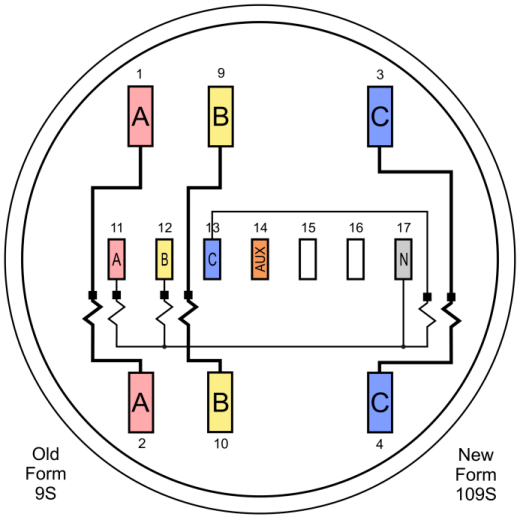
- New meter forms with Auxiliary Power
  - Seven new forms approved

Old Form	New Form	AUX Power Pin	AUX Neutral Pin
3S	103S	6	5, 5A
9S	109S	14	17
12S	112S	6	5, 5A, 10
35S	135S	14	17
36S	136S	14	17
45S	145S	14	17
66S	166S	14	17

ANSI C12 SC 1

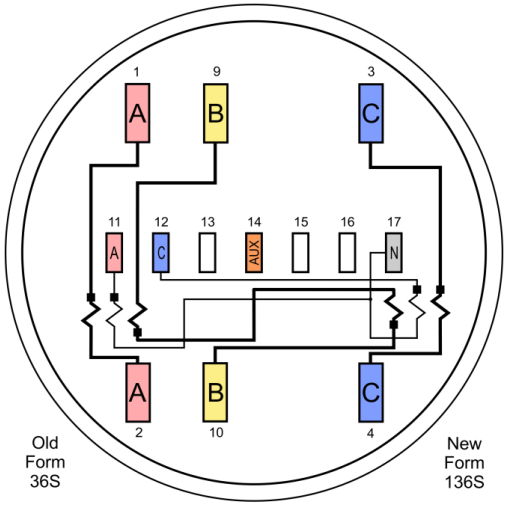
- New meter forms with Auxiliary Power
- Transformer Rated

Form 109



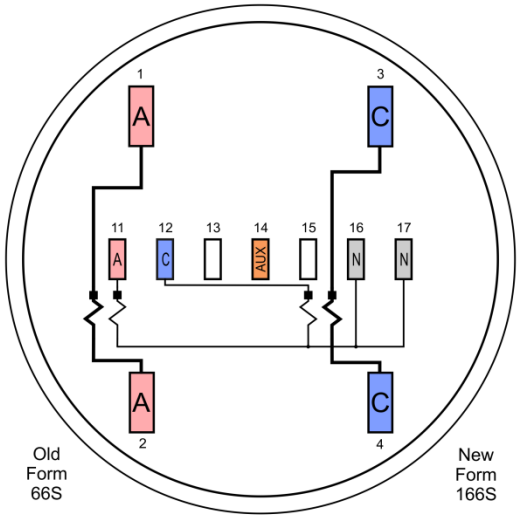
Meter power is between AUX and N.

Form 136



Meter power is between AUX and N.

Form 166

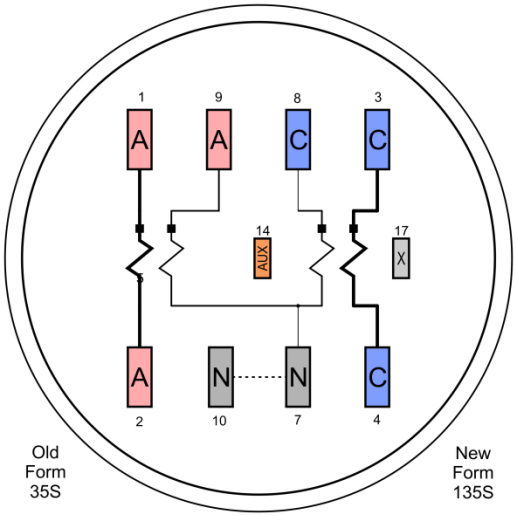


Meter power is between AUX and N.

ANSI C12 SC 1

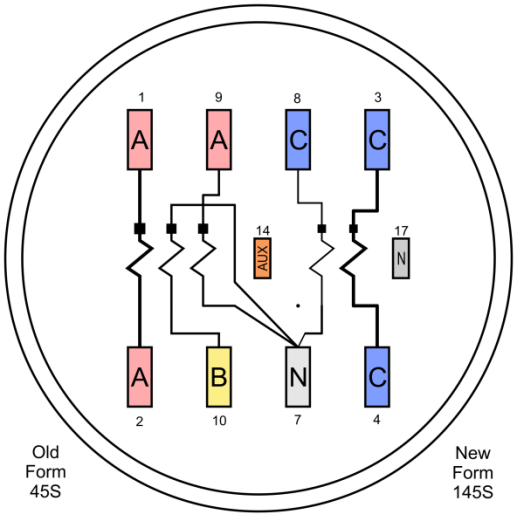
- New meter forms with Auxiliary Power
  - Transformer Rated

Form 135



Meter power is between AUX and N.

Form 145

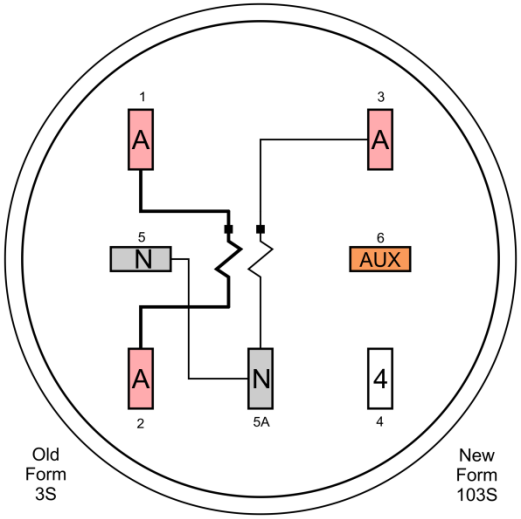


Meter power is between AUX and N.

ANSI C12 SC 1

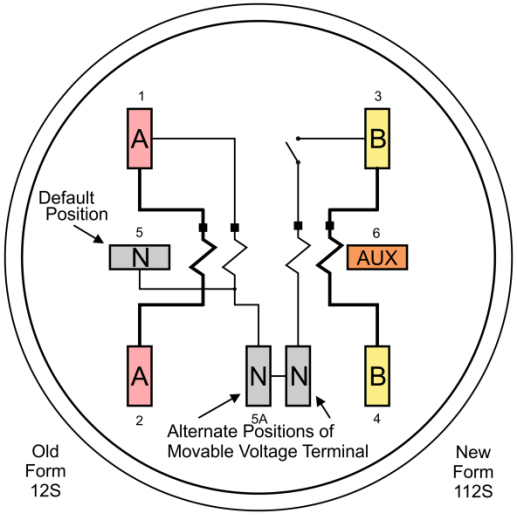
- New meter forms with Auxiliary Power
  - Self contained

Form 103



Meter power is between AUX and N.

Form 112



Meter power is between AUX and N.

ANSI C12 SC 15

- C12.6 – Marking and Arrangement of Terminals for Phase-Shifting Devices used in Metering
  - Re-Published without change Sept 2012
- C12.7 – Requirements for Watthour Meter Sockets
  - Published – Feb 2015

ANSI C12 SC 15

- C12.8– Test Block and Cabinets for Installation of Self contained “A” Base Watthour Meters
  - Published without change Dec 2012
- C12.9 – Test Switches and Plugs for Transformer Rated Meters
  - Extensive Revision just completed
  - Specifications for test plugs added
  - Published – March 2015

ANSI C12 SC 15

- C12.11– Instrument Transformers for Revenue Metering, 10kBIL through 350 kBIL
  - Revised to parallel C57.13
  - Published – July 2014

ANSI C12 SC16

- C12.20-2015 – 0.1, 0.2 and 0.5 Accuracy Class Metering
  - Published April 27, 2017
  - 0.1 Percent Accuracy Class Added
    - New column added to all accuracy test tables
  - Section 4.6 Added to provide specifications for test outputs
    - Type B port specifications were made “informative” due to last second objections from a meter manufacturer

ANSI C12 SC16

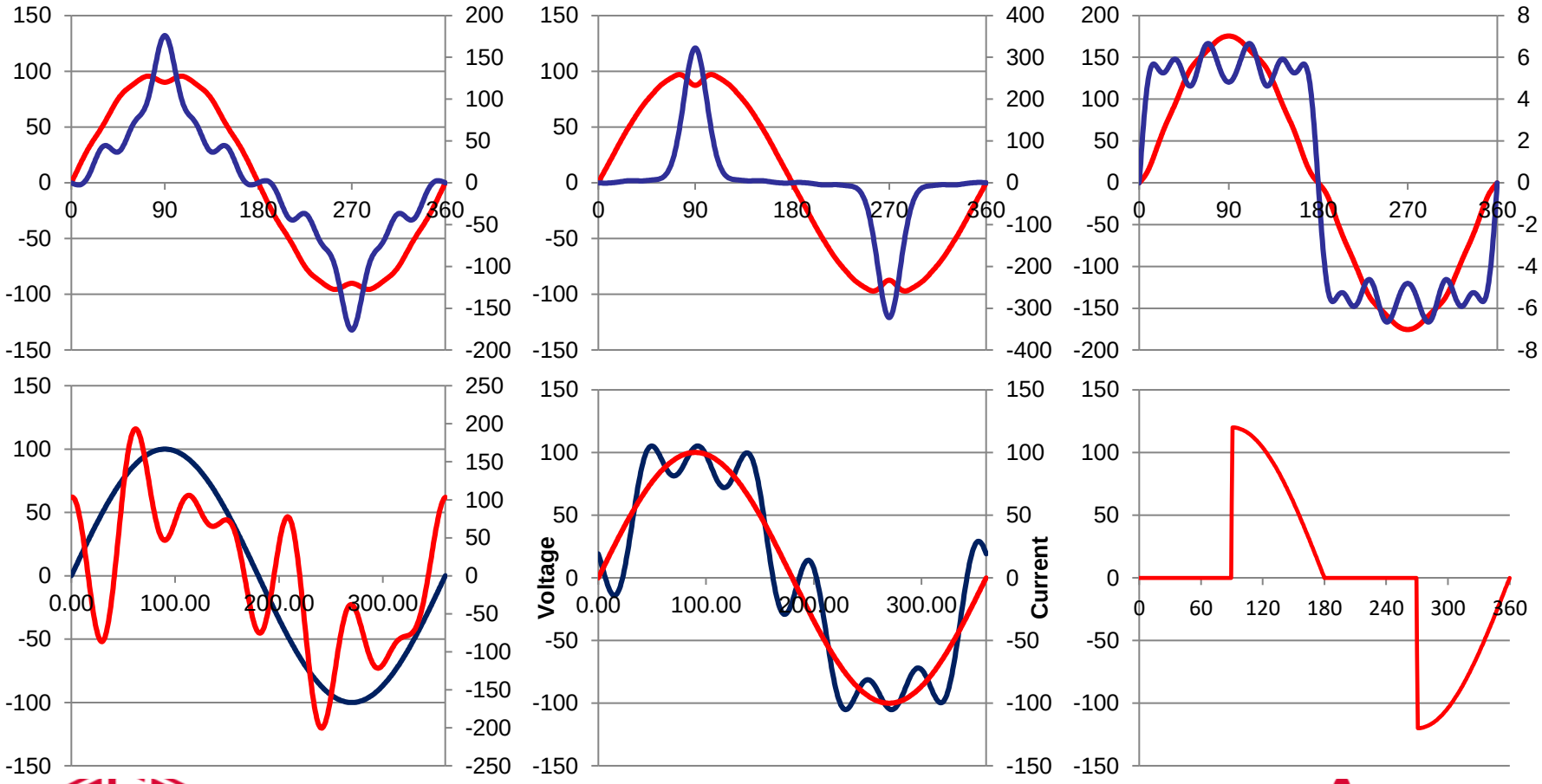
- C12.20 – 0.1, 0.2 and 0.5 Accuracy Class Metering
  - Tighter performance at reference conditions was specified
  - Table 2 updated to make clear which forms and applications are Blondel compliant.
  - Table 2A added to make clear which forms and applications are NOT Blondel compliant

ANSI C12 SC16

- C12.20 – 0.1, 0.2 and 0.5 Accuracy Class Metering
  - Polyphase loading for accuracy testing is allowed and details provided
    - As of Jan 1, 2020 polyphase loading will be **REQUIRED**
  - Non-Sinusoidal Performance Testing
    - Extensive performance testing using non-sinusoidal waveforms was added

Harmonic Load Waveforms

ANSI C12.20 now addresses harmonic waveforms as well as sinusoidal.



ANSI C12 SC 17

- C12.18 – Protocol Specification for ANSI Type 2 Optical Port
  - Reaffirmed and published 3/16/2017
- C12.19 -2015– Utility Industry End Device Data Tables
  - Major additions in process.
- C12.21 – Protocol Specification for Telephone Modem Communication
  - Published 3/21/17

ANSI C12 SC29
Field Testing of Metering Installations

- Field Testing of Metering Accuracy
  - Nearly ready for publication
  - New approach to testing
    - Perform the test in any of several approaches
    - If test is within the specified window then it is acceptable

ANSI C12 SC29
Field Testing of Metering Installations

Table 1 – Temperature ranges

Low Temperature Range (LTR)	**Tmin < T < 0°C**	**where Tmin is the lowest operating temperature certified by the manufacturer**
Normal Temperature Range (NTR)	**0°C ≤ T ≤ 50°C**	**Range over which performance is expected to match the "Nominal" requirements**
High Temperature Range (HTR)	**50°C < T < Tmax**	**where Tmax is the highest operating temperature certified by the manufacturer**

Table 2 Voltage Quality (Harmonic content)

Normal Harmonic Distortion (NHD)	**THD ≤ 30%**	**Range over which harmonic distortion on the voltage is expected to have no significant effect.**
High Harmonic Distortion (HHD)	**THD > 30%**	**Range over which harmonic distortion on the voltage may have an effect outside of normal accuracy expectations.**

ANSI C12 SC29
Field Testing of Metering Installations

Table 3 – Current ranges by current class

Current Class	Low Current	Normal Current
2	I < 0.025	0.025 ≤ I ≤ 2
10	I < 0.25	0.25 ≤ I ≤ 10
20	I < 0.25	0.25 ≤ I ≤ 20
100	I < 1.5	1.5 ≤ I ≤ 100
200	I < 3.0	3.0 ≤ I ≤ 200
320	I < 5.0	5.0 ≤ I ≤ 320

Table 4 – Current ranges by harmonic content

Low Harmonic Content (LHC)	**THD ≤ 100%**	**Range over which harmonic distortion on the current is expected to have no significant effect.**
High Harmonic Content (HHC)	**THD > 100%**	**Range over which harmonic distortion on the current may have an effect outside of normal accuracy expectations.**

ANSI C12 SC29
Field Testing of Metering Installations

Table 1 – Field Test Equipment Accuracy

Meter Accuracy Class	Minimum Test Equipment Accuracy	Preferred Test Equipment Accuracy
0.1%	0.025%	0.01%
0.2%	0.05%	0.02%
0.5%	0.05%	0.05%
1.0%	0.05%	0.05%

ANSI C12 SC29
Field Testing of Metering Installations

Table 2 – Expected Test Accuracy

Meter Accuracy Class	Maximum Expected Error
0.1%	0.25%
0.2%	0.5%
0.5%	1.0%
1.0%	2.0%

ANSI C12 SC29
Field Testing of Metering Installations

- Issues still to be addressed
  - Field Testing of Current Transformers in the Metering Circuit
    - Ratio Testing
    - Ratio Testing with Applied Burden
    - Admittance Testing
  - Field Testing of Potential Transformers in the Metering Circuit
    - Ratio Testing
    - Ratio Testing with Applied Burden
  - Validation of Wiring

ANSI C12.31

- At the moment there is no non-sinusoidal definition for VA
- New ANSI Standard coming very soon

C12.31

American National Standard

for Electricity Meters—
Measurement of VA and Power Factor

New Definitions

RMS Voltage

Eq. 4.1.4.1 $$V(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} \left(a_n \cos(n\omega_0 t) + b_n \sin(n\omega_0 t) \right)$$ Waveform

Eq. 4.2.4.1 $$V = \frac{1}{T} \int_0^T V^2(t)\,dt$$ Basic Definition

Eq. 4.2.4.2 $$V = \sqrt{\frac{1}{N} \sum_n V_n^2}$$ Time Domain

Eq. 4.2.4.3 $$V = \frac{1}{\sqrt{2}} \left[\sum_n (a_{vn}^2 + b_{vn}^2) \right]^{1/2}$$ Frequency Domain

New Definitions

RMS Current

Eq. 4.1.4.2 $$I(t) = \frac{c_0}{2} + \sum_{n=1}^{\infty} \left(c_n \cos(n\omega_0 t) + d_n \sin(n\omega_0 t) \right)$$ Waveform

Eq. 4.2.2.1 $$I = \frac{1}{T} \int_0^T I^2(t)\, dt$$ Basic Definition

Eq. 4.2.2.2 $$I = \sqrt{\frac{1}{N} \sum_n I_n^2}$$ Time Domain

Eq.4.2.2.3 $$I = \frac{1}{\sqrt{2}} \left[\sum_n (c_{vn}^2 + d_{vn}^2) \right]^{1/2}$$ Frequency Domain

New Definitions

Active Power

Eq. 4.2.3.1

$$P = \frac{1}{T}\int_0^T V(t)I(t)dt$$

Basic Definition

Eq. 4.2.3.2

$$P = \frac{1}{N}\sum_{i=0}^{i=N-1} V_i I_i$$

Time Domain

$$P = \frac{1}{2}\sum_n \left|\vec{V}_n \bullet \vec{I}_n\right| = \frac{1}{2}\sum_n (a_n c_n + b_n d_v)$$

Eq. 4.2.3.3

$$= \frac{1}{2}\sum_n V_n I_n \cos(\theta_n)$$

Frequency Domain

New Definitions

Apparent Power

Eq. 4.2.3.1 $$S = \sqrt{\frac{1}{T}\int_0^T V^2(t)dt}\sqrt{\frac{1}{T}\int_0^T I^2(t)dt}$$ Basic Definition

Eq. 4.2.3.2 $$S = VA = \sqrt{\frac{1}{N}\sum_{i=0}^{i=N-1} V_i^2 \bullet \frac{1}{N}\sum_{i=0}^{i=N-1} I_i^2}$$ Time Domain

Eq. 4.2.3.3 $$S = \frac{1}{2}\left[\sum_n (a_n^2 + b_n^2)\sum_n (c_n^2 + d_n^2)\right]^{1/2}$$ Frequency Domain

ANSI C12.46

- New Sub-Committee to Develop a Replacement for C12.1 and C12.20
  - Adopts the structure of OIML IR-46
  - Addresses 0.1, 0.2, and 0.5 Accuracy Classes
  - Addresses Active, Reactive, and Apparent Energy
  - Will be biggest change to metering standards in 100 years
  - Review and editing of draft in process
  - Expected Publication 2020

Questions and Discussion

Bill Hardy, CTO

TESCO – The Eastern Specialty Company

Bristol, PA

865-279-1090 (cell)

215-785-2338 (office)

This presentation can also be found under Meter Conferences and Schools on the TESCO website:

www.tesco-advent.com