New Challenges for the Meter Shop

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The Past

- Meters were simple energy measurement devices
- Meter shops concentrated on accuracy measurements
- New meter installations were “growth” related and proceeded at a “reasonable pace”

Oh my! Has that ever changed!

Today

- Meters are complex communications devices
- Meters have internal disconnect capability
- Loads are more complex and variable
- With massive AMI deployments we are installing 10’s of thousands if not 100’s of thousands of meters all at one time.
- The actual meter metrology may be the least of the issues for the deployment.

Compounding Issues

- Fewer meter techs in the field and in the shop than there were 25 years ago
- Acute shortage of experienced techs growing as industry experiences a wave of retirements
- Experienced “METER” techs may not be “COMMUNICATIONS” techs
- Significantly more features under glass in every AMR and AMI system being considered or deployed

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Why do AMI meters fail?

Looking back at various deployments
What are the failures that we see?

Meter functional test failures including but not limited to;

- Incorrect firmware
- Bad settings
- Alarms and errors that do not clear
- Communication test failures
- Bad tables
- Failed disconnect switches

What is the right approach to testing?

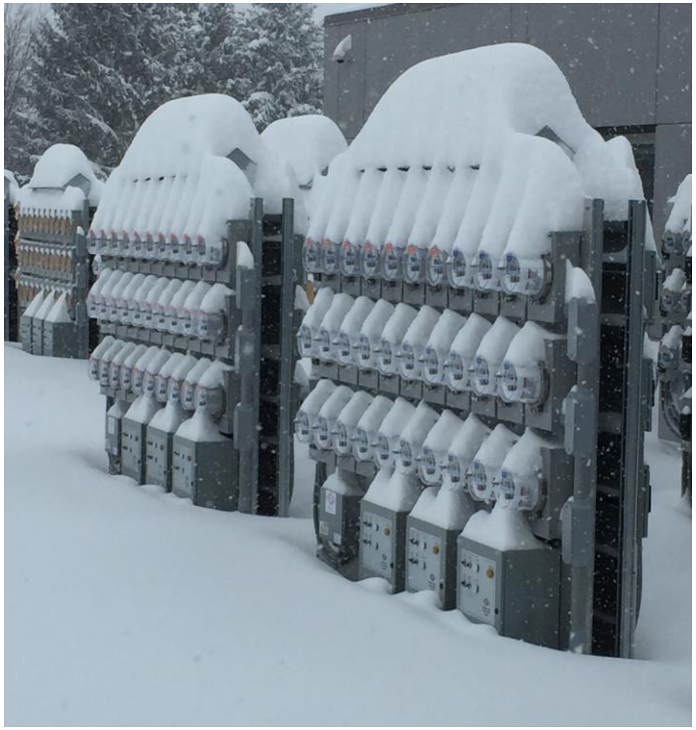
- ♦ Testing a small random sample of meters for accuracy is not a good solution for these problems
- ♦ New types of testing approaches address these issues more efficiently.

The Pendulum Starts to Move

- Over the last few years these challenges have clearly come into focus.
- Five years ago utilities were just starting to use "meter farms" for pre-deployment testing
- Here's a meter farm circa 2012
- The industry learned that testing significant numbers of AMI/AMR meters in controlled conditions was a valuable activity.

Meter Farms

- Today many companies are installing truly large scale meter farm facilities

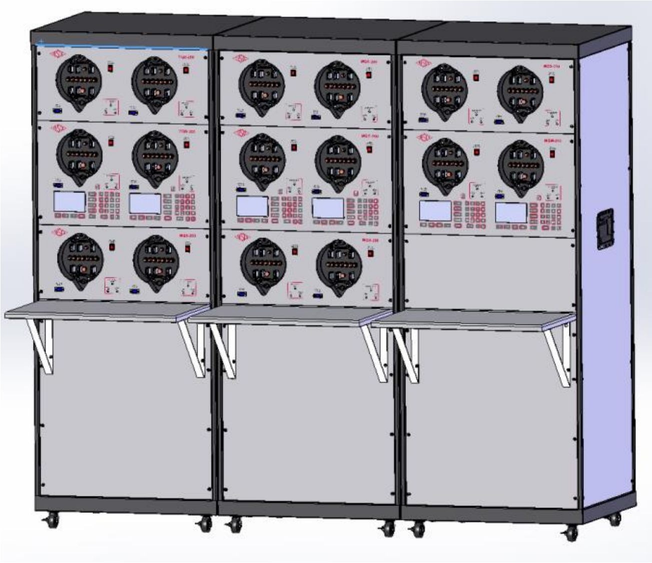


Meter Qualification Testing

- While meter farms provide large volume testing, their ability to control test parameters are fairly limited.
- In the real world, loads and operating conditions are growing more complex every day.
- One has to be sure that not only the metrology function but also the communications capabilities of meters function through these real world conditions.

Meter Qualification Testing

- What is qualification testing?
  - Test that the meter functions completely.
  - Program the meter with the latest firmware.
  - Validate communications functionality.
  - Run the meter under widely varying conditions
    - Vary voltage
    - Vary current
    - Generate transients
    - Generate dropouts



New Energy Definitions

- 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

Time Domain

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

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

Eq. 4.2.3.3
$$P = \frac{1}{2}\sum_n \left|\vec{V}_n \bullet \vec{I}_n\right| = \frac{1}{2}\sum_n (a_n c_n + b_n d_v)$$
$$= \frac{1}{2}\sum_n V_n I_n \cos(\theta_n)$$
Frequency Domain

New Definitions

Apparent Power

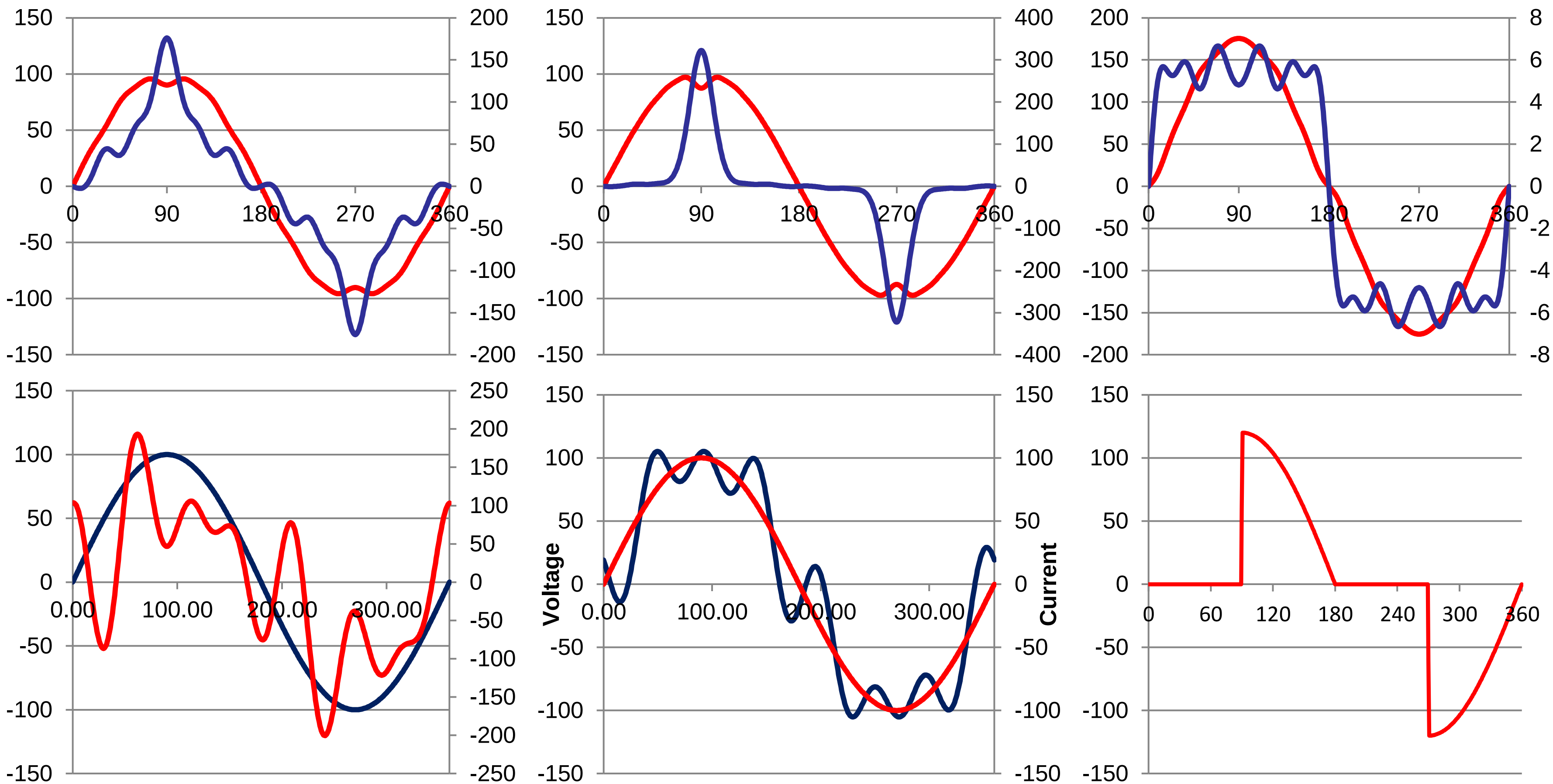
Eq. 4.2.3.1 $$S = \sqrt{\frac{1}{T}\int_0^T V^2(t)dt}\,\sqrt{\frac{1}{T}\int_0^T I^2(t)dt}$$ Basic Definition

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

Harmonic Load Waveforms

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



Test waveforms being proposed for ANSI C12.20.

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