Site Inspections – Looking for Dangerous Installations or Incorrect Billing

Prepared by Tom Lawton, TESCO
The Eastern Specialty Company

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Premise

- Over much of the 20th century, utilities, regulators and customers each relied upon lab and field meter testing efforts which were primarily focused upon the accuracy of the watt-hour meter and demand register.

- This focus is now changing with overwhelming deployment of electronic meters and significant deployment of AMR and AMI meters throughout the installed base in North America.

- Meter Failure modes are changing. More meters are rejected for functional test failures than accuracy tests

- One of the benefits of AMI is that utilities can spend less time on residential metering and focus their meter techs on their more complex metering operations. More time can and should be spent inspecting and testing the Transformer rated installations in each utilities service territory.

Field Testing

Common Features and Common Sources of Concern

Electro Mechanical meters were subject to registration errors caused by mechanical issues with moving parts resulting in either the loss of revenue to the utility or over billing for the customer. Some of the more common problems were:

- Friction wear
- Gear mesh misalignment
- Retarding magnet failure
- Timing motors

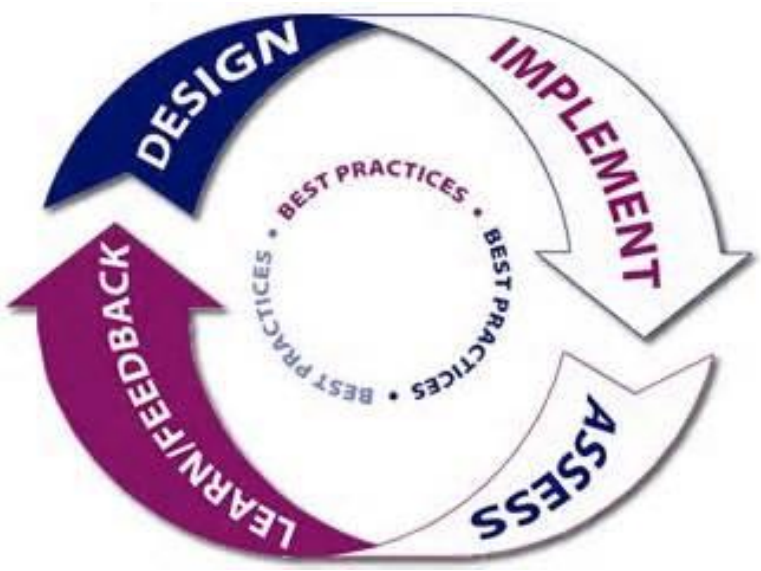
Electronic Meters – new failure modes require new testing and inspection methods

Electronic meters fail as do electro mechanical meters but differently

- Their overall life expectancy is not nearly the same
- Failure modes include drift and creep (unexpected)
- Failure modes with zero registration failures (expected)
- Failure modes include non-catastrophic but significant measurement error modes (unexpected)
- Failure modes can include non-measurement issues which render the meter ineffective or inaccurate for billing purposes.

Best Practices

- Residential vs Commercial
- Self-Contained vs Transformer Rated
- Follow the money and be as proactive as possible



Potential Site Check List

- Double check the meter number, the location the test result and the meter record.
- Double check the serial number of any attached device (e.g. communication module, disconnect device.
- Perform a visual safety inspection of the site. This includes utility and customer equipment. Things to look for include intact down ground on pole, properly attached enclosure, unwanted voltage on enclosure, proper trimming and site tidiness (absence of discarded seals, etc.)
- Visually inspect for energy diversions (intentional and not). This includes broken or missing wires, jumpers, open test switch, unconnected wires and foreign objects on meters or other metering equipment. Broken or missing wires can seriously cause the under measurement of energy. A simple broken wire on a CT or VT can cause the loss of 1/3 to 1/2 of the registration on either 3 element or 2 element metering, respectively.
- Visually check lightening arrestors and transformers for damage or leaks.
- Check for proper grounding and bonding of metering equipment. Poor grounding and bonding practices may result in inaccurate measurements that go undetected for long periods of time. Implementing a single point ground policy and practice can reduce or eliminate this type of issue.

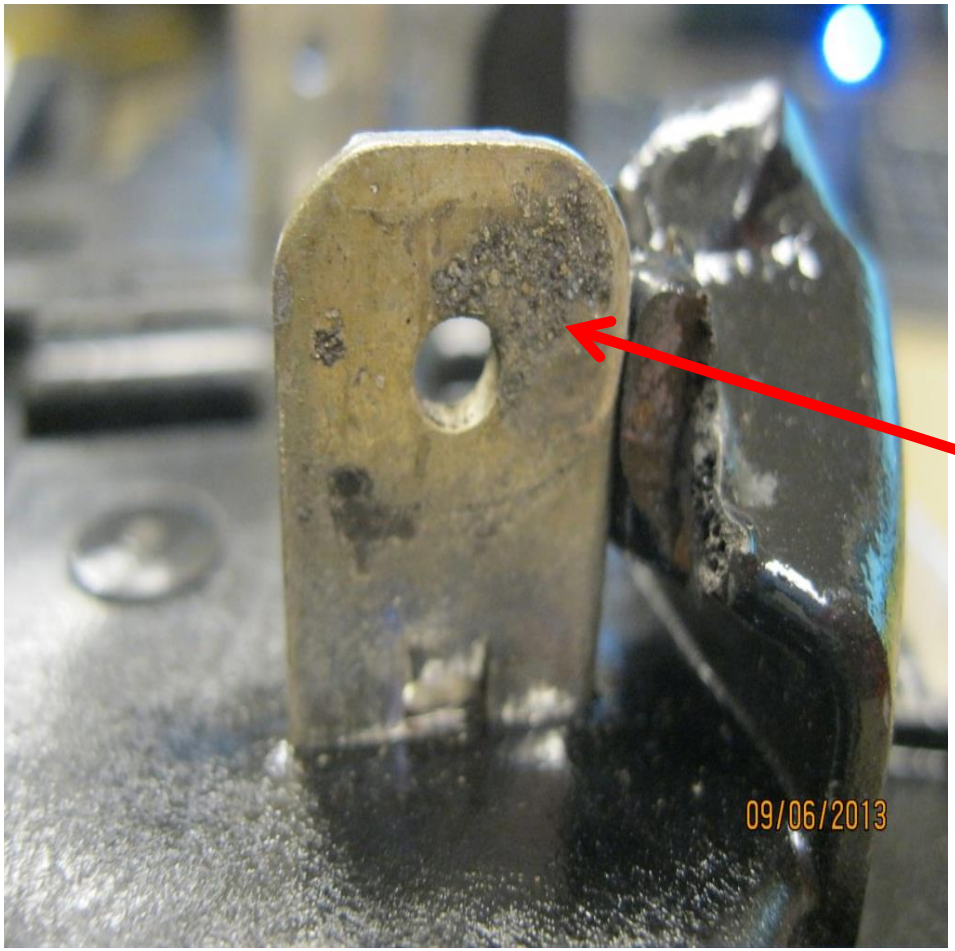
Field Inspection of Sockets
Best Practices

- Example field check list
  - Gaps in meter socket jaws
  - Discoloration of one jaw vs. the other three
  - Signs of melted or deformed plastic on meter base
  - Pitting of either meter blade or socket jaw
  - Loss of tension in meter socket jaws
  - Check condition of wire insulation and connections to meter jaws
  - Check the overall condition of the box, socket, meter and how they attach to each other and the building.
  - Look for signs of tampering
  - Look for signs of water or debris inside of the meter can

Reviewing the data and learning from the data

- Repeated meter insertions degrades the tension in the socket jaws (see graph), but not to dangerous levels
- Exposure to elevated temperatures rapidly degrades the socket jaw tension to dangerous levels (see graph)
- Visual inspection will catch some but not all dangerous socket jaws
- Arcing creates the heat
- Exposure to elevated temperatures has a cumulative effect on the meter socket jaw
- Relatively small vibration can initiate arcing

Jaw to Blade Arcing



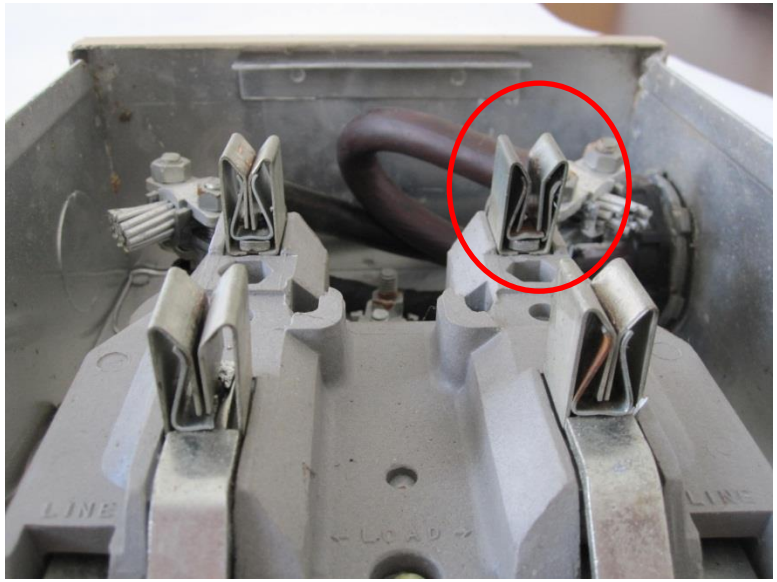
Jaws with intermittent connections will arc to the meter blade resulting in pitting on the blade.

Blade shows early signs of arcing.

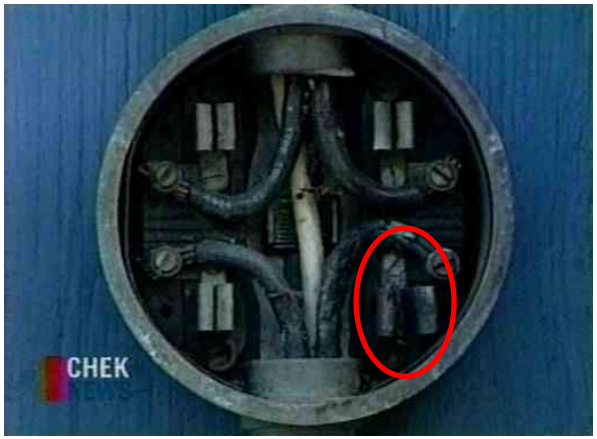
Tin Melts at 232ºC which is lower than the 350ºC base plate plastic.

Searching for Hot Socket sources

Common Features and Common Sources of Concern

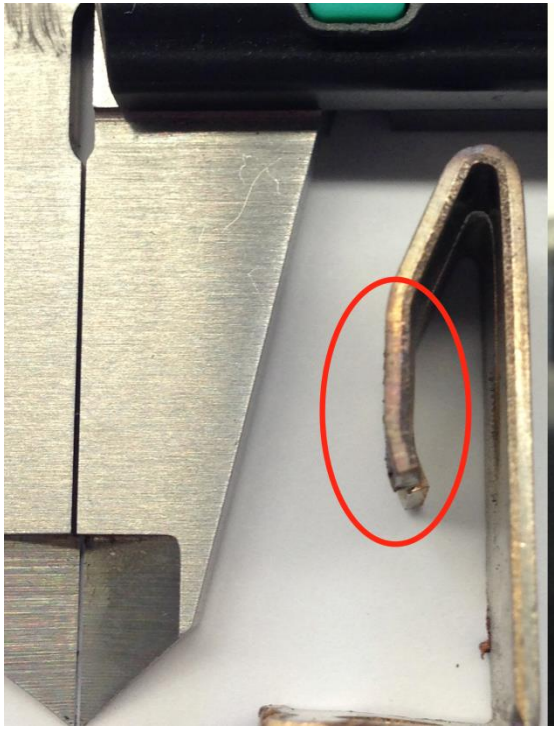


- Pitted and discolored meter blades
- Melted plastic around one or more of the meter stabs (typically the plastic around one stab is where the deformation starts)
- Pitted and discolored socket jaws
- Loss of spring tension in the socket jaws



Service Degradation

- Calipers show a .01” gap, with that size gap between jaws and stabs we were able to heat meter stabs over 1000 degrees Fahrenheit in a few minutes.
- The rough spots you see on the post-test jaw next to the calipers are over .005” high. This surface degradation appears on the stab as well.
- Between the two surfaces you can have large gaps, along with insulating by-product of the arcing, that can sustain heavy arcing in a solid state.



What can be done once a hot socket is identified?

- Easiest resolution is to replace the damaged jaw.
- **Never** try and repair a damaged jaw. The tension in the damaged jaw will not return simply by taking a pair of pliers and closing the jaw tighter.
- Either the entire box should be replaced or the damaged jaw (assuming the wiring and other jaws are deemed safe through the rest of the inspection.)

Summary

- Hot sockets start with a loss of tension in at least one of the meter socket jaws. This loss of tension can be from a variety of sources that start as early as improper installation or even “tight sockets”.
- Loss of tension is necessary to create the initial micro-arcing conditions.
- Sockets with repeated meter exchanges observed to have higher incidence of hot socket issues and “booting” a meter may spring jaws even more.
- Vibration appears to be the most common catalyst to the micro-arcing that creates the initial heat in a “hot socket”.
- The meter must have some power, but current is not a significant factor in how quickly or dramatically a hot socket occurs
- The effects of vibration and weakened jaw are cumulative
- Meter Manufacturers have all been working on the design of their meters to better withstand a hot socket. These new meters have better baseline performance than even the older electro mechanical meters, but a hot socket will eventually burn up even the most robust meter.

Potential Site Check List (cont)

- Burden test CTs and voltage check PTs.
- Verify service voltage. Stuck regulator or seasonal capacitor can impact service voltage. Voltage differential between phases can also indicate theft of service.
- Verify condition of metering control wire. This includes looking for cracks in insulation, broken wires, loose connections, etc.
- Compare the test switch wiring with the wiring at the CT's and VT's. Verify CT's and VT's are not cross wired. Be sure CT's are grounded in one location (test switch) only.
- Check for bad test switch by examining voltage at the top and bottom of the switch. Also verify amps using amp probe on both sides of the test switch. Verify neutral connection to cabinet (voltage).
- Check rotation by closing in one phase at a time at the test switch and observing the phase meter for forward rotation. If forward rotation is not observed measurements may be significantly impacted as the phases are most likely cancelling each other out.
- Test meter for accuracy. Verify demand if applicable with observed load. If meter is performing compensation (line and/or transformer losses) the compensation should be verified either through direct testing at the site or by examining recorded pulse data.

Potential Site Check List (cont)

- Loss compensation is generally a very small percentage of the overall measurement and would not be caught under utilities normal high/low checks. However, the small percentages when applied to large loads or generation can really add up overtime. Billing adjustments can easily be in the $million range if not caught early.

- Verify metering vectors. Traditionally this has been done using instruments such as a circuit analyzer. Many solid state meters today can provide vector diagrams along with volt/amp/pf and values using meter manufacturer software or meter displays. Many of these desired values are programmed into the meters Alternate/Utility display. Examining these values can provide much information about the metering integrity. It may also assist in determining if unbalanced loads are present and if CTs are sized properly. The vendor software generally has the ability to capture both diagnostic and vector information electronically. These electronic records should be kept in the meter shop for future comparisons.

- If metering is providing pulses/EOI pulse to customers, SCADA systems or other meters for totalization they also should be verified vs. the known load on the meter.

- Verify meter information including meter multiplier (rework it), serial number, dials/decimals, Mp, Ke, Primary Kh, Kr and Rate. Errors in this type of information can also cause a adverse impact on measured/reported values.

- Verify CT shunts are all opened.

Shop Testing

- Accuracy Testing
- Meter Communications Performance
- Software & Firmware Verification
- Setting Verification
- Functional Testing
- Disconnect/Reconnect Functionality
  and as left setting

Testing Frequency & Cost

- Tools (hardware and software)
- Personnel
- Frequency
- Test
- Report
- Analyze
- Learn, Share, Adapt

Questions and Discussion

Tom Lawton

TESCO – The Eastern Specialty Company

Bristol, PA

215-688-0298 (cell)

1-800-762-8211

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

www.tesco-advent.com