TESCO AMI Meter Services & Related AMI Equipment

Prepared by Tom Lawton
The Eastern Specialty Company

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Pre-AMI Meter Operations

Common Features and Common Sources of Concern

- Fewer meter techs in the field and in the shop than there were 25 years ago
- Fewer Field checks and site verifications due to lack of personnel, lack of experience and lack of expertise
- Significantly more features under glass in every AMR and AMI system being considered or being deployed
- Metering losses starting to be identified “by accident” as opposed to being “by design”.

The Pendulum Starts to Move

- Meter Operations. Prior to deployment many larger utilities take an attitude of “this is only metering – how hard can that be?”. Over the course of deployment Meter Operations gains a stature and a respect from the rest of the organization that was not previously accorded them – even if this is only begrudging respect.

- New tests for AMI meters (e.g. communication, disconnect) are identified

- The complexity and issues around high revenue metering are at least acknowledged by the rest of the organization

- Tests which have not been performed in years are suddenly back in vogue

The New Realities

- Electro-Mechanical Meters typically lasted 30 years and more. Electronic AMI meters are typically envisioned to have a life span of fifteen years and given the pace of technology advances in metering are not expected to last much longer than this.
- This means entire systems are envisioned to be exchanged every fifteen years or so. In the interim the meter population and communication network inherent in the infrastructure for each utility must be maintained.
- Meter communication and meter data management are becoming as important to metering operations as meter accuracy.
- Firmware upgrades, firmware stability and cyber security are becoming increasingly important to metering departments
- Meters are being replaced at a far faster pace than meter sockets, bringing Hot Socket issues to the forefront

Hot Socket Simulator

Click box to view video

Expected & Unexpected Trends at the End of Deployment

Expected:

- The AMI deployment team will declare victory at some point and move on. Clean-up will be left for the meter service department
- Change Management continues to be a tremendous challenge for every vendor through every deployment
- Meter Acceptance testing including far more than accuracy testing for every deployment
- Firmware upgrades must be checked and tested before mass deployment

Unexpected:

- Not all forms are available by the end of deployment and must be installed as part of normal operations by the meter service department
- Meter Certification Testing never slowed down over the course of any of the deployments

Why do AMI Meters Fail?

Looking back at various deployments – what are the chief causes to reject meter shipments?

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

Meter Qualification Boards

Meter Qualification Boards

Meter Qualification Boards

Lessons for the Future?

- Are these infant mortality issues or are these issues to be concerned about going forward?
- What was NEVER the reason for rejecting a shipment – meter accuracy.
- Which are the most difficult meters for every deployment – the transformer rated meters. Often these forms are not available until very late in the deployment and sometimes not until the deployment has officially ended.

Commercial and Industrial Metering Challenges

- Most AMI deployments utilize third party contractors to handle the residential and some self contained non-2S services. The balance are typically handled by the meter service department of the utility.
- No AMI deployment has used the AMI communication network to handle the communication with the largest customer meters. The risk from even a short term interruption of communication or loss of data far outweighs to benefit of meters which are already being communicated with daily or even several times a day.
- As these services are evaluated for new metering technology issues are being found at some accounts. These issues represent sometimes significant revenue losses (or overcharges) due to inappropriate metering schemes or partially failed metering components (e.g. transformers, electronic components).

How are these new realities starting to affect metering operations?

- Metering is becoming more about IT. Some metering departments have been reorganized after AMI as part of the IT department.
- Metering emphasis will shift strongly toward C&I customers and further and further away from residential meters
- Metering resources are being refocused on C&I accounts.
- There are fewer levels of meter tech. Every meter tech needs to be at the higher level as there is not enough lower level work to warrant full time employees
- Utility commissions are being less forgiving of allowing rate relief for project over runs and metering inaccuracies

New or expanded roles for metering departments of all sizes

- Responsible for either reviewing ANSI Tests or even performing some of these ANSI Tests
- Perform Meter Functionality testing on new and returned AMI meters
- Register and communication module energy measurement comparison
- Disconnect/Reconnect Functionality
- Outage Performance
- Meter Communications Performance
- Consumer safety and combating real and perceived issues
- Near continuous research into the “next” technology and the next deployment

Shop Testing

- Accuracy testing
- Meter Communications Performance
- Software and firmware verification
- Setting verification
- Functional testing
- Disconnect/reconnect Functionality and as left setting

AMI Services – Meter Reprogramming

Field Testing

- Accuracy Testing
- Meter Communications Performance
- Software & Firmware Verification
- Setting Verification
- Functional Testing
- Disconnect/Reconnect Functionality and as left setting
- Tamper Verification
- Site Audits appropriate to the type of meter

AMI Services – Cross Dock/Warehousing/Functional Testing/Sample Testing

AMI Services – Meter Retirement

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

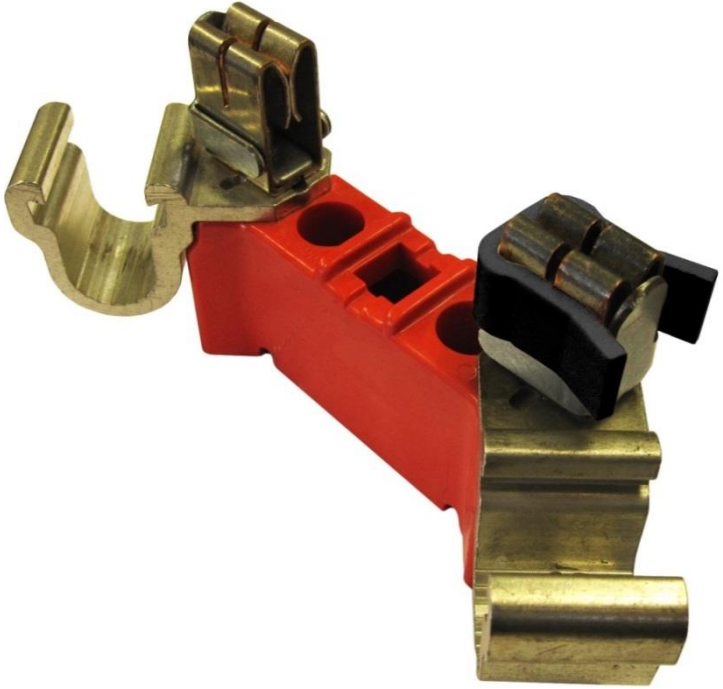
Who Sees Hot Sockets?

- Most AMI deployments utilize third party contractors to handle residential and some self contained non-2S services.
- After to or prior to AMI deployments, Utility personnel typically see these sockets
- Transformer rated meters typically handled by the meter service department of the utility.
- Hot socket concerns with lever by-pass sockets used on 3-phase meters are extremely rare.

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.)

Hot Socket Gap Indicator / Socket Safety Clips



Base Line Data Electro Mechanical meters vs solid state vs the latest generation of meters designed with hot sockets in mind

- At the start of our laboratory investigation the oldest electro mechanical meters withstood hot sockets the best
- The latest vintage solid state meters withstood hot sockets the least.
- Over the course of the past twelve months some meter manufacturers have begun to release 2S meters designed to withstand hot sockets and some have even begun to put temperature sensing closer to the meter blades instead of only on the metrology boards.
- One meter vendor's service switch meter has used high temperature base plate plastic since it was launched in 2008.)

Hot Socket 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.

RMA's, Root Cause Analysis and In Service Testing

No one knows the actual life of their AMI meter. To do this we must learn as much as we can from the failures and the performance of the meters we have deployed.

Opportunities to Learn:

- Meters returned from the field as bad or flagged on incoming inspection. These RMA's need to be tracked not only for warranty purposes but more importantly to understand the root cause of the issues.
- In Service Test programs need to be utilized to understand the overall performance of AMI meters and as failures are identified, these meters need to be dissected and the failure mode understood. If necessary, once the failure mode is understood the meter population may need to also be dissected to identify sub-groups of meter that may be similarly affected. This could be a group of meters…
  - from the same shipment.
  - that were deployed in the same geographic area.
  - that saw the same type of usage or environment.

AMI Services – RMA Processing

Post-Deployment Needs

- Once deployment is complete the certification and acceptance testing does not stop.
- Everyone understands the importance of acceptance testing, but future generations of a smart meter also require certification testing.
- New software and firmware needs to be tested and compared against the performance of older generations.
- New hardware must be tested and compared to older generations.
- Firmware upgrades need to be checked
- New head end systems or IT protocols need to be tested against a large group of meters before going live.

Meter Farms

Meter Farms

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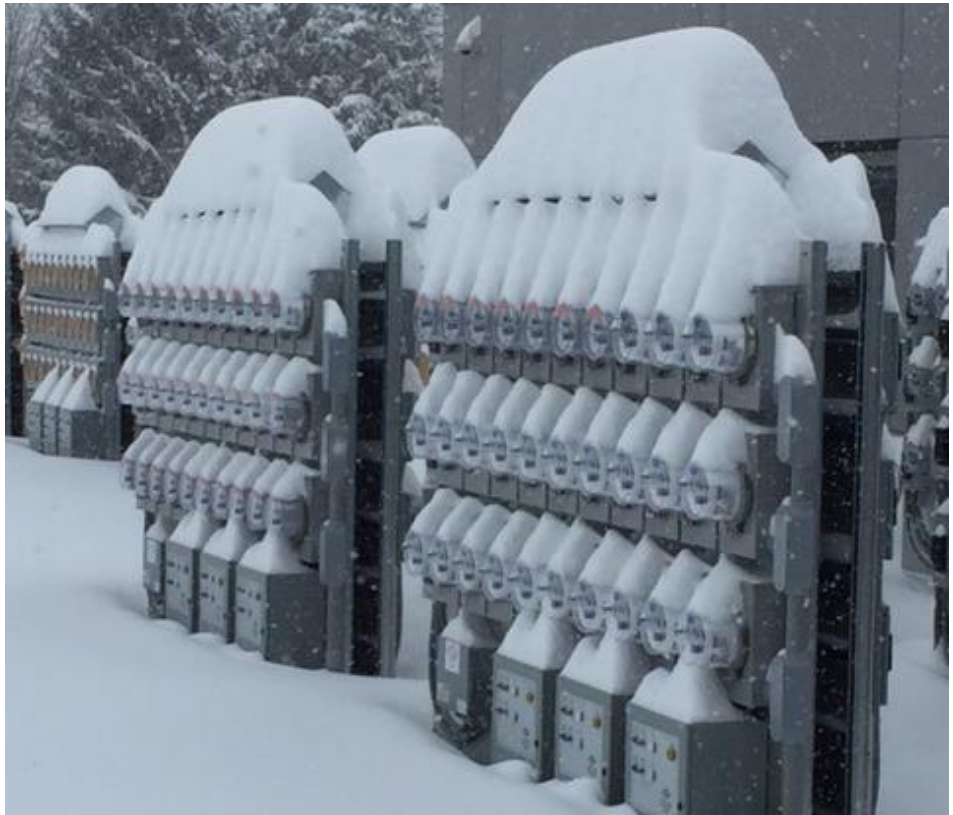
Meter Farms



TESCO Meter Manager Software Modules

- **Meter Shop** – ordering, receiving, testing, acceptance, retirement, tracks test board standards, calibration date, required test schedule, tested by, traceability to NIST and tracking of other test equipment and required calibrations
- **Meter Inventory** – tracking of meters not installed in the field and includes RMA tracking as a part of this module
- **Meter Records** – all meter attributes as well as ancillary devices associated with a meter e.g. AMR/AMI modules
- **In Service Testing** – Random sample testing
- **Site Verification** – stores site specific equipment information, manages tasks and appropriate resource allocation, maintains site/premise specific information such as GPS coordinates, equipment attributes such as CT's & PT's etc.
- **Personal Protective Equipment** – PPE & Tool Tracking and scheduling of calibration/test dates
- **RMA Processing & Tracking** – for the tracking of hardware sent back to the various vendors/manufacturers for meters and ancillary equipment both in and out of warranty

TESCO Meter Manager Software Modules- Meter Life Cycle

New Meter Purchase

- Purchase Order
- Vendor File
- Meter Receiving
- Acceptance Testing
- Device Creation in customer system of record e.g. CIS
- Device Release to Stock

Used Meter Processing

- Meter Check-in
- Meter Testing
- Device Restocking

Asset Management

- Track Inventory within shops / warehouses / storerooms, down to the container and/or shelf
- Track Inventory to the person or truck
- Meters are assigned to the person / truck
- As meters are set, they are removed from inventory
- Used meters are tracked from removal to meter shop
- Physical inventory counts may be performed at any time

Quality management

- Detailed analysis of meter performance
- In-service random sample and periodic test plans
- Full RMA tracking

Real Life Examples of Change Management in Action

- Issues in the system not the components – what is the definition of a meter and when did the meter change?
  - Meter and communication device interface
- Feature Creep – every manufacturer wants to differentiate themselves – sometimes this works in unanticipated ways
  - Recovery from power outages
  - Short and long demand periods
- But we only changed….lessons we should have learned from Microsoft
  - Over the air upgrades
- Thank Goodness for test plans – right?
  - Half closed disconnect devices
  - Disconnect devices of unknown state
  - Meters with incorrect firmware

Summary

- The focus is on far more than accuracy
- The meter man of the future knows not only metering but they are communication experts and are involved with handling, reporting and analyzing far more customer and system data
- There are fewer “routine jobs” in the field and many of the standard tasks are no longer required. This will lead to fewer classifications of meter techs going forward and the need for a more highly trained tech.
- Each Utility must take a far more active role as part of checking, certifying, and rechecking the functionality of their meters.
- Metering will be in a near constant cycle of looking for the next technology, evaluating those technologies, planning for deploying these technologies, and cleaning up the aftermath of the deployment of
  these technologies.

Questions and Discussion

Tom Lawton

TESCO – The Eastern Specialty Company

Bristol, PA

1-800-762-8211

www.tesco-advent.com