



Site Verification and Complex Metering



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Why a Manufacturer?

- We see a large cross section of Electric Utilities. Our goal is to visit every utility in North America each year, over 3,300 of them. We do not get to every one, every year, but we come pretty darn close.
- Over the past several years the things that we get asked about, the equipment people ask us for, new features they ask us for, new services they ask us for start fitting certain patterns.
- While there is definitely quite a bit of regionally specific needs and common practices, there are also some clear trends.
- One of these trends is Site Verification. This presentation will attempt to summarize the feedback we have received on this topic from Utilities large, small and everywhere in between over the past 36 months and where we believe the “best practices” are heading for Meter Service Departments regarding Site Verification.



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 the deployment of electronic AMR and AMI meters to the majority of the 155 Million connected customers in North America.
- The focus has now shifted from just the accuracy of the meter to also checking other features of the meter (e.g. communication and disconnect devices), the firmware versions and settings of the meter, and the overall meter installations for both residential and C&I customers.
- Incorrect or miscalculated site information or undetected problems can lead to an improperly metered customer not related to the meters accuracy and could also lead to potential safety issues.



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 electromechanical meters but differently

- Their overall life expectancy is not nearly the same
- Failure modes include drift (unexpected)
- Failure modes include catastrophic (expected)
- Power supply damage due to lightning surges or other causes
- LCD Display failures making a visual read impossible when required
- AMR/AMI communications module failures requiring a field visit to repair or replace meter/AMI module and get a read for billing purposes
- Failure modes include non-catastrophic but significant measurement error modes sometimes attributed to improper meter programming and in some cases meter firmware issues.
- Failure modes can include non-measurement issues which render the meter ineffective or inaccurate for billing purposes
- Clerical errors such as incorrect multipliers can do more damage than even the most catastrophic equipment failure in the field.



Best Practices

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



Why Site Verifications are a Valuable Utility Tool

- It is important to remember that with current systems it is not just the meter that can cause a major error in the measurement of a given service
- A meter test that indicates a meter is within the required accuracy parameters does not mean your service is being measured and billed accurately
- A meter test may not catch intermittent errors or identify errors with other equipment at the site, e.g. CT's & PT's
- A discrepancy between what is thought to be at a given site and what is actually at that site can cause a major billing error (either over or under billed)



How AMI can help us improve our metering infrastructure

- One of the typical components of any AMI business case is the opportunity to reduce the amount of time needed to support the metering for residential customers. This can happen in a number of different ways.
 - Better outage reporting systems
 - Better power quality monitoring
 - Ability to troubleshoot and identify issues using large scale data analysis
- One of the soft and rarely planned benefit of an AMI deployment is that the labor no longer required to support the residential side of the business can be focused on the Commercial and Industrial side where we have spent far too few resources as an industry over the past twenty years.



Why C&I and what should we invest our limited meter service resources here?

- Easy Answer: Money.
- These customers represent a disproportionately large amount of the overall revenue for every utility in North America.
- For some utilities the ten percent of their customers who have transformer rated metering services can represent over 70% of their overall revenue.
- While these numbers will vary from utility to utility the basic premise should be the same for all utilities regarding where Meter Services should focus their efforts – follow the money.



What are the opportunities that can be found in this work and what are our industry's "Best Practices" for this type of work?

- Most Utilities do not have a comprehensive and complete list of every instrument transformer on their system that is involved in providing the billing for the largest 10 to 20% of any utilities revenue.
- Most Utilities do not visit, document and verify these same services on any regular basis.
- Best practices call for the on-site verification of a Utilities "largest" customers on a periodic basis.
 - There is no definition of what this verification should entail
 - There is no definition of what "largest" means
 - There is no agreement on the frequency of this "periodic" inspection



Define “Largest” and what this may represent

- Largest should be defined by revenue.
- Lost metering revenue is no longer “recovered in the next rate case”, nor is recovered metering revenue necessarily “given back” in the next rate case.
- Utility Commissions are having less tolerance for new rate cases.
- Over billing of any customer has always been a public relations nightmare.
- A facility with an electric bill of \$10,000 per month would pay for a meter tech in two years if an error affecting the wiring of only one transformer (estimated lost revenue \$160,000 over a two year period). Does this mean that \$10,000 per month or more defines large?



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 - I would argue that this size customer is universally a “Large customer” and that from here each utility should decide how much smaller they should go in their definition of “Large”.



Define “Periodically” and how frequent this may be

- If changes in usage, equipment failures in the metering service, external damage to the service, or energy diversion at a single “large” customer can pay for a single meter tech in just two or three years, and a single meter tech can handle several of these inspections in a single day, then there is ample cost justification for inspecting these services at least once every year.



What should be done once on site to perform this inspection?

Potential list of tasks to be completed;

- Double check the meter number, the location the test result and the meter record
- 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 lightning 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.
- Burden test CTs and voltage check PTs.



Potential Site Check List (cont.)

- Verify service voltage. Stuck regulator or seasonal capacitor can impact service voltage.
- 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 CTs and VTs. Verify CTs and VTs not cross wired. Be sure CTs 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.
- 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.



Potential Site Check List (cont.)

- 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. If present test/inspect isolation relays/pulse splitters for things like blown fuses to ensure they are operating properly.
- 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.
- Look for signs of excessive heat on the meter base e.g. melted plastic or discoloration related to heat



Tools that can be used

- Meter Field Test kits
- CT Burden and Ratio testers
- Low impedance volt meters
- Service ground test equipment
- Access to all system information regarding all information in the system of record from hardware information to billing information.
- The ability to verify all system information in the field and to input information found in the field for subsequent checking and updating of the system information (and handling any billing consequences).
- The ability to access previous work orders, pictures and engineering information about any particular site.
- The ability to easily and readily add pictures, GPS and access information to the record.



A Software Application that allows the Field Technician to take notes on the Equipment and Conditions at a given site is Extremely Valuable to the Utility!



Notes made by the Field Technician can be of great value for a myriad of reasons

Email to notify	<input type="text" value="DTJ@tesco.com"/>	<input type="button" value="..."/>
Notes	<input type="text" value="Noticed forward energy usage with bypass switches for all three phases of current open with CT's shorted"/>	



Periodic Site Inspections Can Prevent

- Billing Errors
- Detect Current Diversion
- Identify Potential Safety Issues
- Metering Issues (issues not related to meter accuracy)
- AMR/AMI Communications Issues
- The need for Unscheduled Truck Rolls due to Undetected Field Related Issues
- Discrepancies between what is believed to be at a given site versus the actual setup and equipment at the site



Periodic CT Burden and Ratio Testing are of Immeasurable Value to avoid Billing Errors on Large Power Customers

- Cross Phasing (wiring errors)
- Loose or Corroded Connections
- CT Mounted Backwards
- CT's with Shorted Turns
- Wrong Selection of Dual Ratio CT
- Detect Magnetized CT's
- Burden Failure in Secondary Circuit
- Open or Shorted Secondary
- Mislabeled CT's
- Ensures all Shorting Blocks have been Removed



Cost Savings Associated with a Good Site Verification System



- One transformer in three wired backwards will give the customer a bill of $\frac{1}{3}$ rd the actual bill.
- One broken wire to a single transformer will give the customer a bill of $\frac{2}{3}$ rd the actual bill
- One dual ratio transformer inappropriately marked in the billing system as 400:5 instead of 800:5 provides a bill that is $\frac{1}{2}$ of the actual bill. And the inverse will give a bill double of what should have been sent. Both are lose-lose situations for the utility.

Examples of Site Related Issues that resulted in an Over Billed Customer

- A utility in the western region of the country had a large resort in their service territory that expanded their resort and also added an additional 250 more guest rooms.
- A new electricity meter was temporarily installed on the service.
- Once the construction was completed a new metering cabinet and meter were installed as the permanent service for the addition to the resort.
- The final completed meter installation used new current transformers which had a lower ratio than the CT's used during the construction phase of the expansion.
- The ratio of the permanent CT's was updated in the Meter Service Department records, the information was passed onto the billing department and the work order was closed.
- However no one checked whether an update had been made to the CIS and the billing system. This update was not made as the CIS folks so no need to update anything.



Example #1 (cont)

No Need to bother Metering with billing information

- The result was that the resort was over billed by 25%.
- The customer complained about a substantially higher bill than anticipated.
- After several phone calls that went a bit too high in the organization, word went back to the Meter Services Department to roll a truck.
- This time the Meter Service Department was given all of the billing information as this had now escalated to a complaint by a large customer.
- This time the meter tech was able to do a complete site verification and found that the problem was a clerical issue.
- The meter tech explained the situation, reported everything back up the chain of command and the utility had to send an apology letter and a check for \$40,000 for just the first month of service and credited the current bill that had not been paid pending investigation.
- No one had ever done a complete site verification that included verifying everything back to (and including) the CIS/billing system records. Metering should not get involved with billing so why give them access?



Examples of Site Related Issues that resulted in an Over Billed Customer Cont.

- A utility in the Midwest had an older grocery store in their service area that wanted to close down the older store and build a newer larger and more modern store in an adjacent lot.
- The new store had more efficient baking ovens and HVAC system that were far more energy efficient than the older equipment.
- The grocery store had expected their consumption to go down and that the new equipment would help to pay for itself through the reduced gas bill.
- After the new installation was complete and the new store operational, the gas bill had not gone down, but had actually increased slightly.
- The store complained to the Utility and a field technician was sent out to the site.
- The field technician tested the meter and checked the installation and reported that everything was performing correctly.
- The grocery store went back and forth between the manufacturer of the equipment and the utility. The one insisted that their bill should be going down and not up and the other insisted that everything was correct on the metering and service side.
- Finally the grocery store requested an independent audit. The manufacturer supplied all of their information and the utility supplied all of the meter service department information and the billing information.



Example #2 cont

- The independent audit found that the utility had installed an unusual Dresser meter that used a fixed pressure correction factor for 10 PSI and the actual delivery pressure was 4 PSI. The utility had been applying a pressure correction factor in the billing calculation for 4 PSI. This utility did not have a Volume Corrector installed on this store with pressure and temperature sensors that would have performed the calculations onsite which would have averted this situation. The impact of the fixed correction factor resulted in an over billing of the actual gas volumes by 34%. Once the mistake was brought to the attention of the utility they promptly corrected the error and issued a refund to the customer of just over \$50,000.



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



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

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