Hot Socket Issues

Causes and Best Practices

Notes from the Field
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with special thanks to L+G who sponsored much of the research presented here today

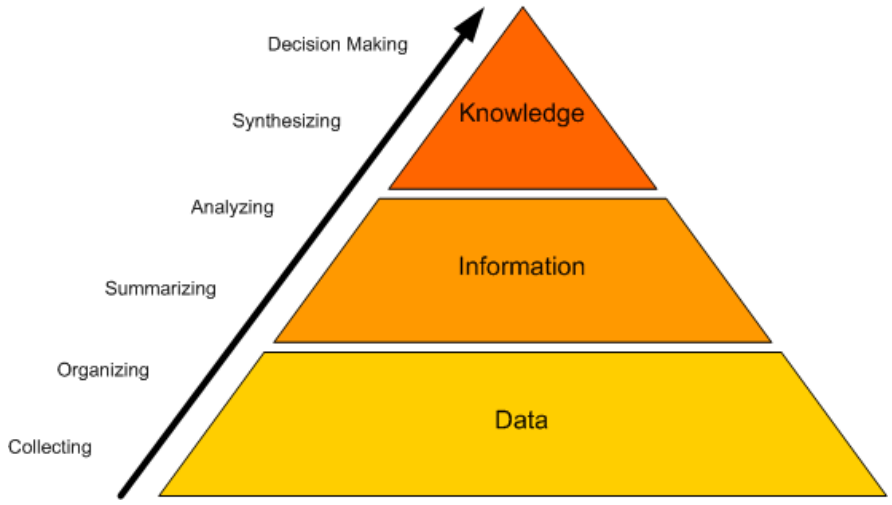
for the Southeastern Meter School & Conference 2014

The Issue

- Hot Sockets are not a new phenomenon. Virtually every meter man has either pulled a meter with a portion of the meter base around a blade melted and virtually every utility has been called to the site of a fire to assist in the investigation of a fire at a meter box.
- AMI deployments have helped to turn a spot light on this issue. The same deployments have also raised questions in the industry.
  - What causes a hot socket?
  - Are the meters ever the cause of a meter box failure?
  - What are the things to look for when inspecting an existing meter installation?
  - What are the best practices for handling potential hot sockets?
- This presentation will cover the results of our lab investigation into the sources for hot sockets, the development of a fixture to simulate hot sockets, the tests and data gleaned from hot sockets, and a discussion of “best practices” regarding hot sockets.

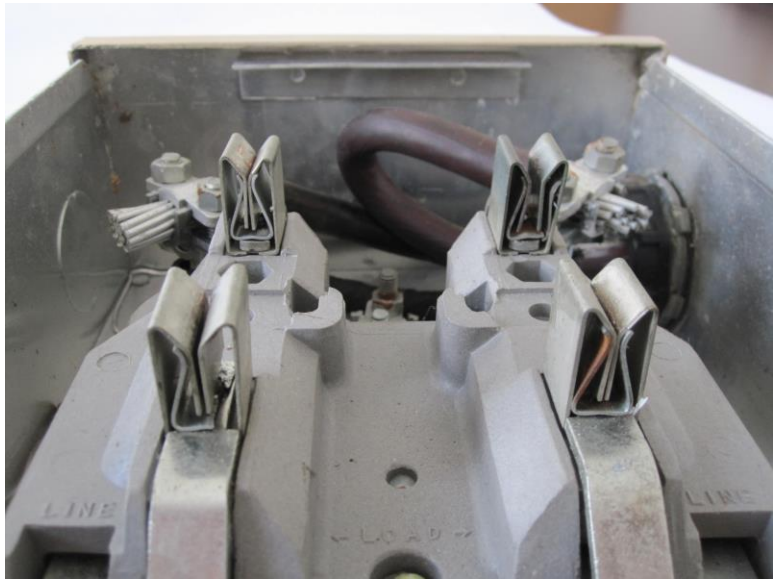
Why do we know anything about hot sockets?

- TESCO has been fortunate enough to be involved in several meter deployments where we supplied full time and part time meter engineers and project managers to our customer's AMI deployment teams. In this capacity we have been involved in evaluating hot socket issues and helping to determine an appropriate response to actual or potential hot sockets.
- TESCO's meter lab has been contracted by utilities and meter manufacturer's to develop a laboratory fixture that would simulate the various features common to most hot sockets found in the field.
- TESCO developed and refined a fixture over the past year and we have spent most of that time running tests and gathering data on the effect of hot sockets on meters.
- TESCO has access to a large number of meters which have been exposed to hot sockets both before and after catastrophic failure.
- We have access to a limited number of sockets that were hot sockets and did not yet fail catastrophically.

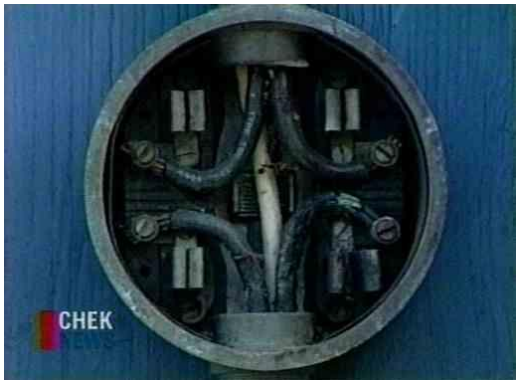


Searching for Hot Socket sources

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



The Initial Investigation

- Our Utility and our meter manufacturing customers had similar but different goals.
- Both wanted to make sure that the meters were not causing fires at the meter box. Neither expected that they were but they wanted an independent third party to help to determine the causes for the hot sockets, simulate these causes and prove that the meters were not the source.
- The meter manufacturers wanted to make this information public.
- The utilities wanted to understand the causes and see what else they could do to better identify hot sockets in the field. Legal counsel for the utility customers would not allow publication of any data linking their utility to this sort of research.

Expected & Unexpected Results

Expected:

- Hot Sockets are exactly that – hot sockets. The hot sockets are the source of the problem and not hot meters.
- Electromechanical meters withstand hot sockets better than solid state meters

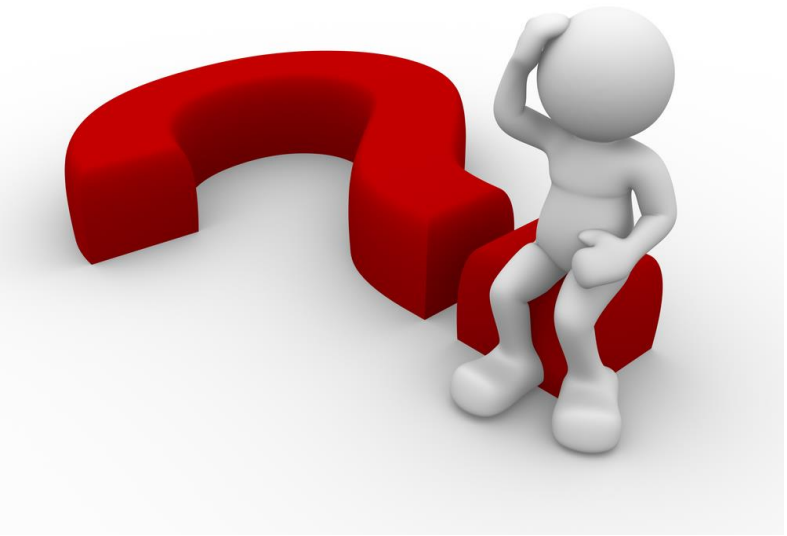
Unexpected:

- Current plays only a small role in how quickly a meter will burn up. Meters were burned up nearly as quickly at 3 amps, 30 amps, and 130 amps.
- Relatively small amounts of vibration can be the catalyst to the beginning and eventual catastrophic failure of a hot socket. Note: Other catalysts include but are not limited to power surges, debris, humidity.
- Contact resistance plays no role in creating a hot socket

What are the necessary ingredients for a hot socket?

There are three necessary ingredients to create a hot socket (Note: We are not suggesting that we have simulated or even understand all causes for all hot sockets and meter related fires, but rather that we have simulated and understand the causes behind most hot sockets and meter related fires);

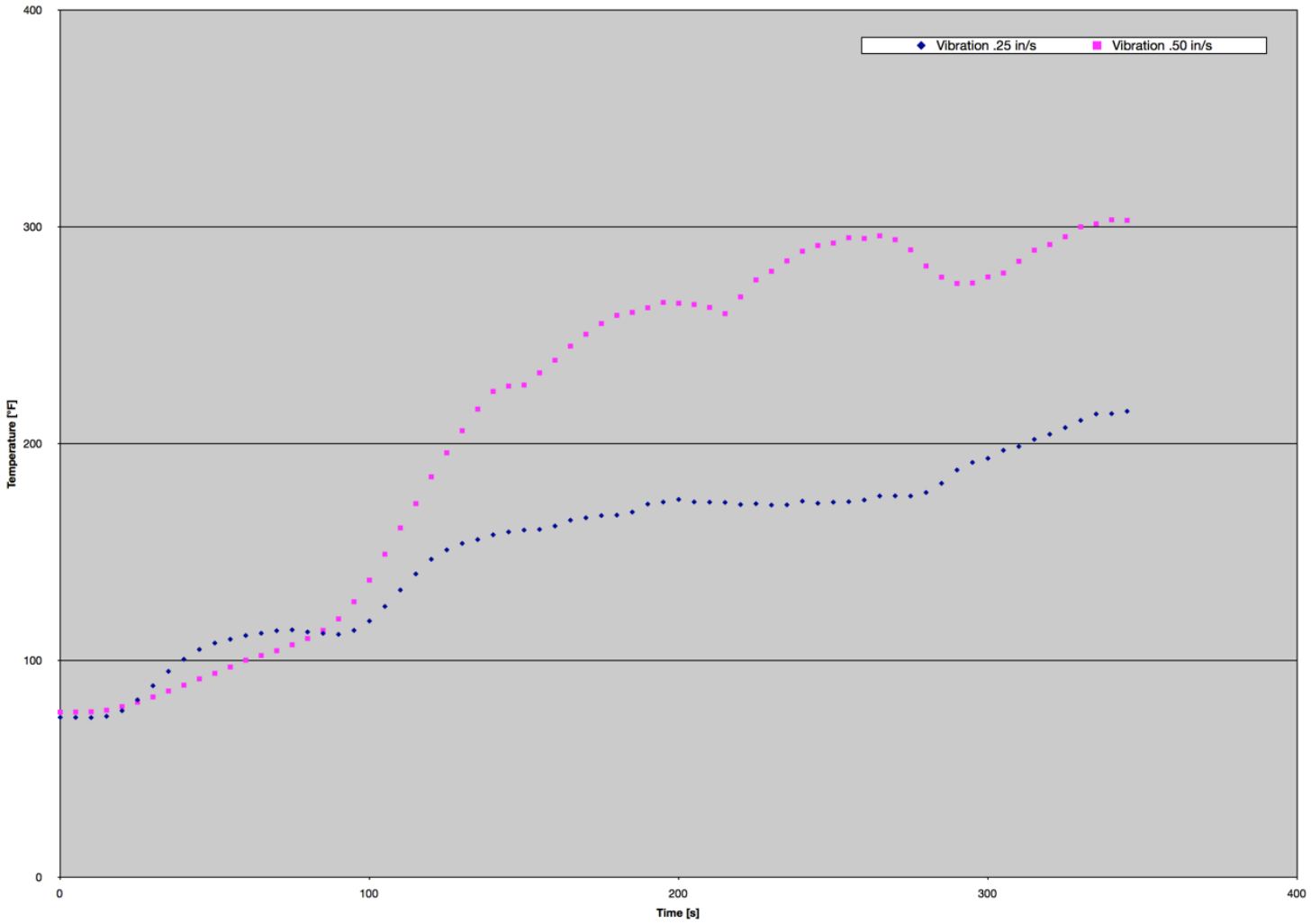
- Loss of jaw tension in at least one of the socket jaws.
- Vibration (or other catalyst to initiate arcing)
- Power



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

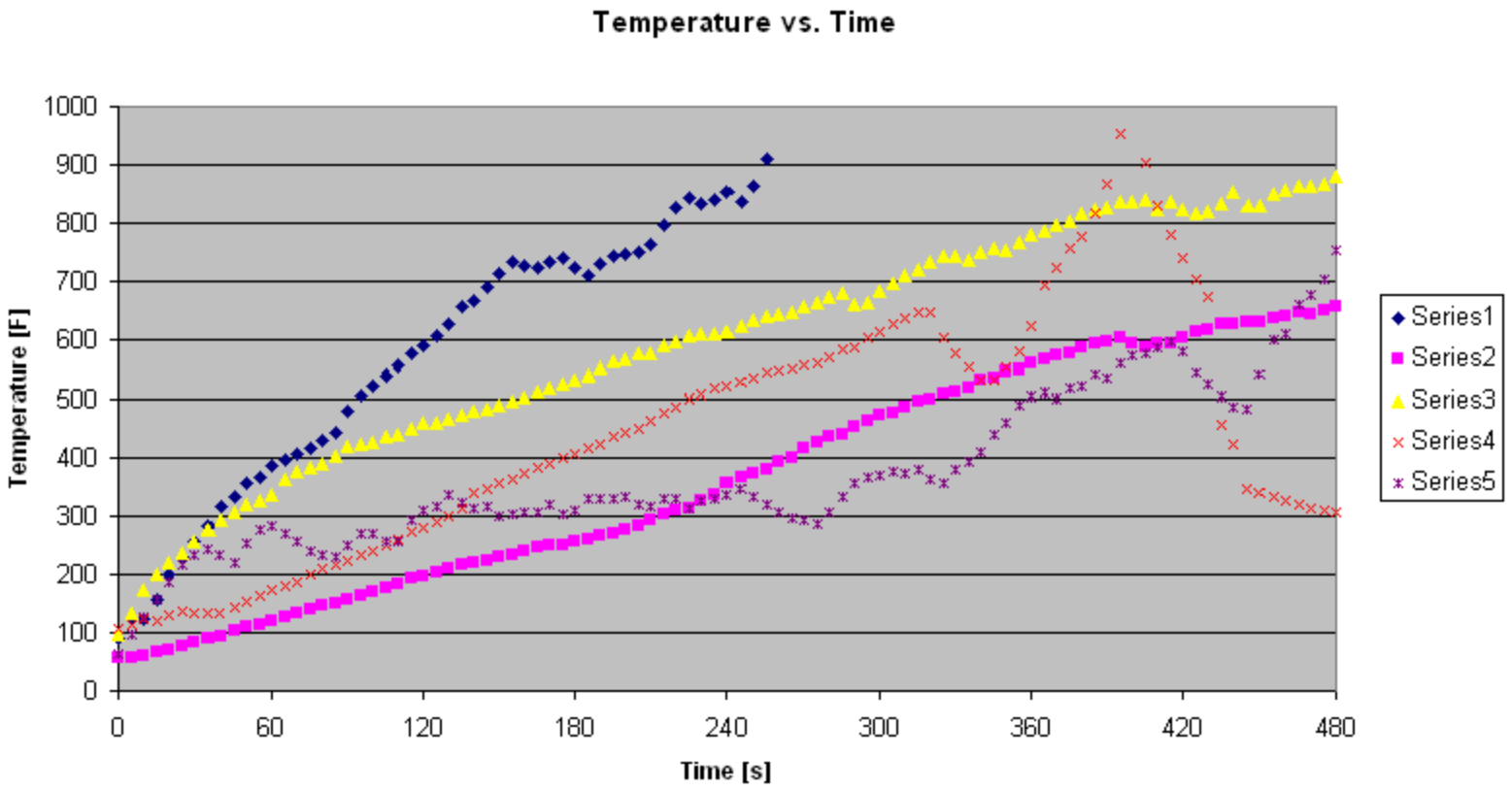
Reviewing the data and learning from the data



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 revenue losses due to inappropriate metering schemes or partially failed metering components (e.g. transformers, electronic components).

Temperature Rise Data



Insertions	Normal #1	Normal #2	Heated #1	Heated #2
1	56	55	13	22
2	54	53	7	6
3	36	32	6	6
4	33	31	0	0
5	28	31	0	0
6	31	18	0	0
7	23	15	0	0
8	19	14	0	0
9	16	15	0	0
10	16	15	0	0
11	16	15	0	0
12	15	15	0	0
13	15	15	0	0
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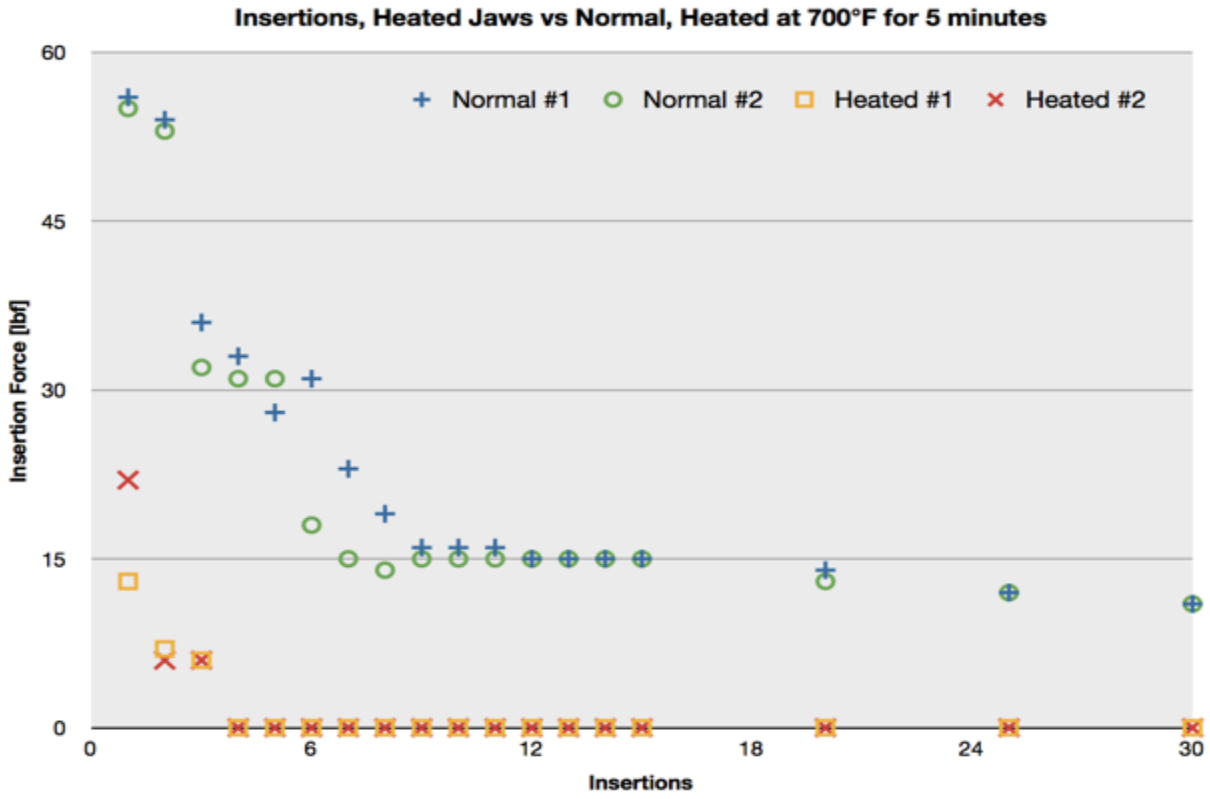
20	14	13	0	0
25	12	12	0	0
30	11	11	0	0



Field Inspection and Sensing Hot Sockets Best Practices

- Use a check list
- An example of a meter box inspection checklist (not intended to be all inclusive, but a good starting point)
  - Gaps in the meter socket jaws
  - Discoloration of one jaw vs. the other three
  - Signs of melted or plastic deformation on the meter base
  - Pitting of either the meter blade or the socket jaw
  - Loss of tension in the meter socket jaws
  - Check the condition of the wire insulation
  - Check the condition of the wire connections to the meter socket
  - 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
- Physical Inspection
- Use AMI temperature sensing with field inspection and statistical analysis to create filters that allow for better determination of when your AMI system may be telling you about a hot socket event. These events occur over time and can be sensed in advance
- Easiest resolution is to replace the damaged jaw. This is a policy decision that is often made during AMI deployments but rarely made outside of AMI deployments. This is a decision to be made by the Utility as a whole in how best to respond to defective customer equipment discovered in the field.
- Never try and repair a damaged jaw. The tension in the dmaaged 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.

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 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.

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”. This loss of tension is necessary to create the initial micro-arcing conditions.
- 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 this vibration and weakened jaw are cumulative
- Utilities are in a quandary as the meter socket typically belongs to the customer
- 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.

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

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