Hot Socket Issues

Causes and Best Practices

MINNESOTA ELECTRIC METER SCHOOL

Notes from the Field

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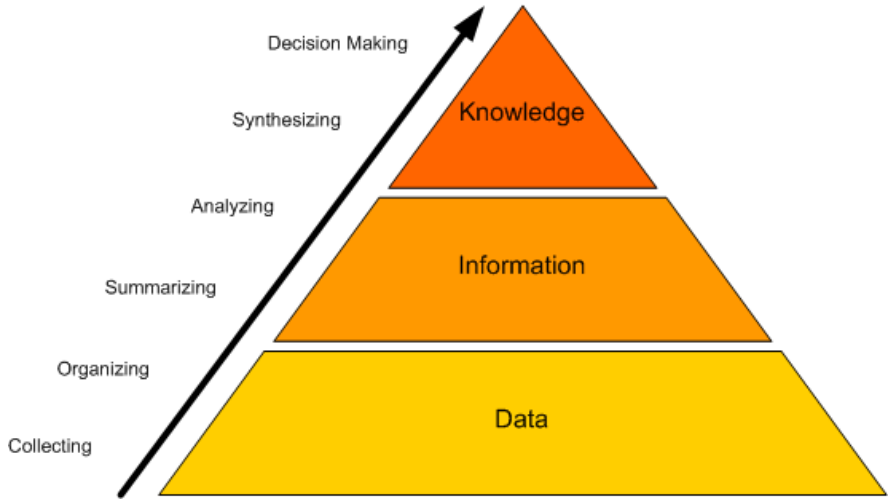
with special thanks to L+G who sponsored much of the research presented here today

The Issue

- Hot Sockets are not a new phenomenon. Virtually every meter man has pulled a meter with a portion of the meter base around a blade melted and virtually every utility has been called to assist in the investigation of a fire at a meter box.
- AMI deployments because of the volume of meters involved put a spot light on this issue.
  - 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.

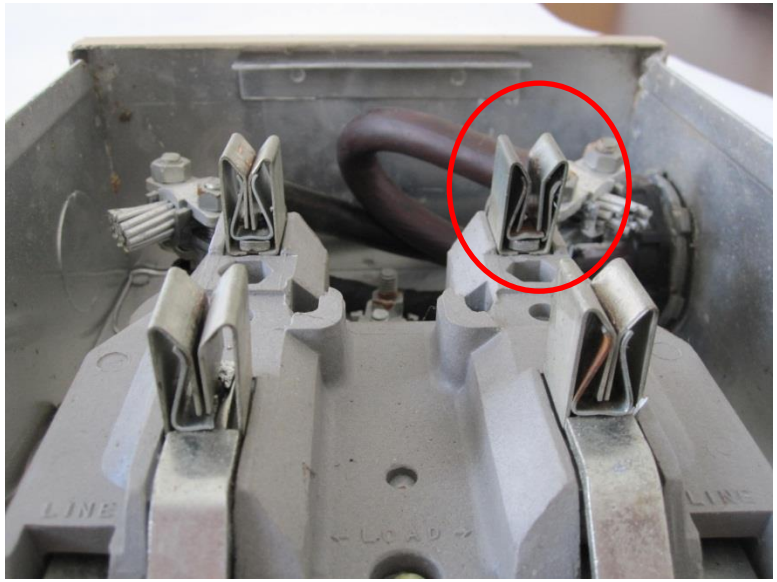
Why do we know anything about hot sockets?

- 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 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 since the 2013 Fall EEI 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.

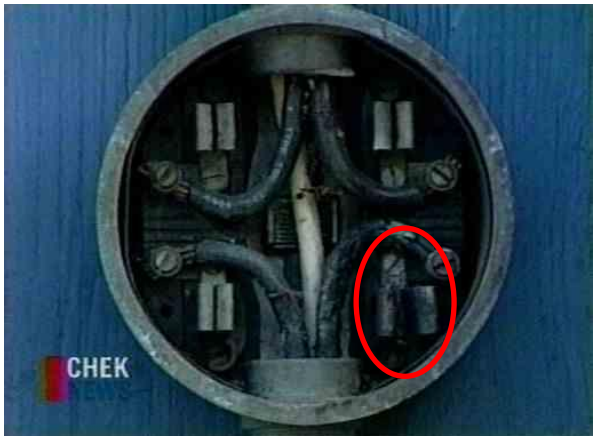


Searching for Hot Socket sources

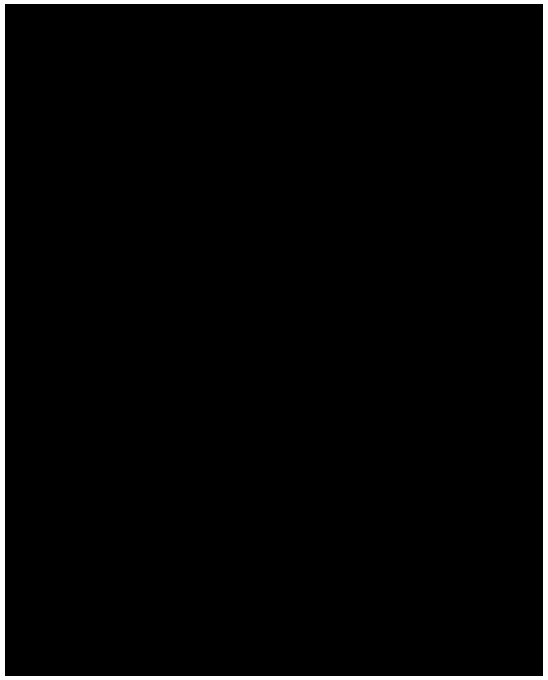
Common Features and Common Sources of Concern



- 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



Hot Socket Simulation Fixture



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Expected & Unexpected Results

Expected:

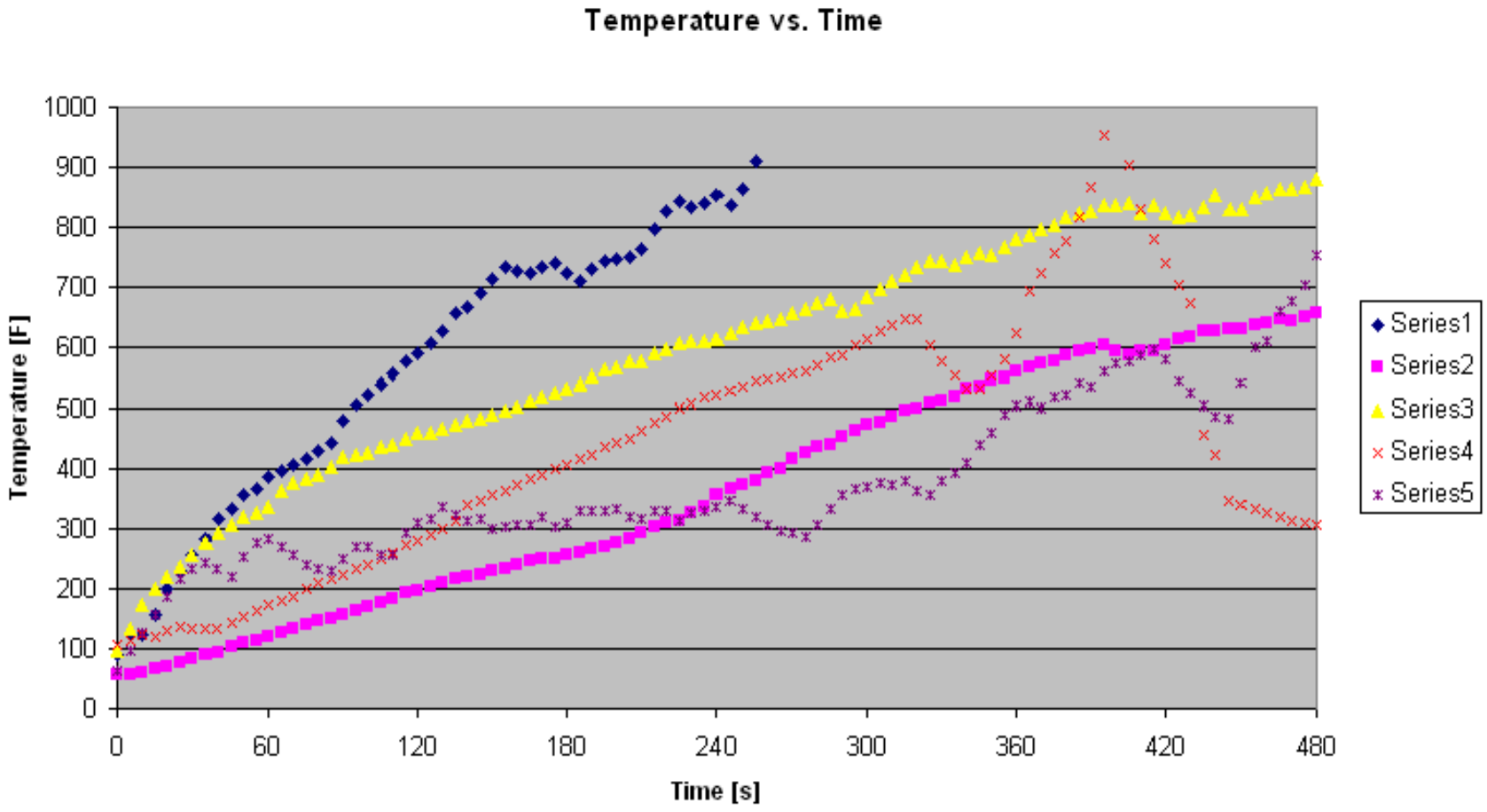
- Hot Sockets are exactly that – hot sockets. The hot sockets are the source of the problem and not hot meters.
- Electromechanical meters withstand hot sockets better than solid state meters

Unexpected:

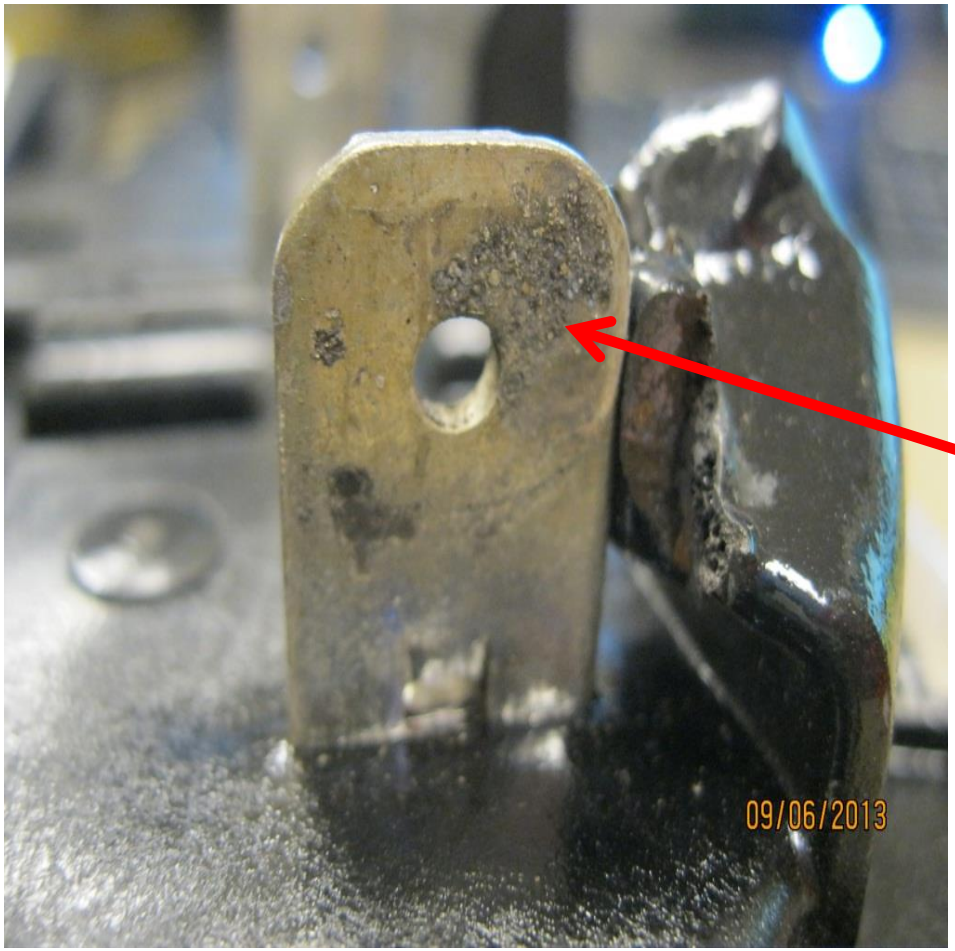
- Current plays only a small role in how quickly a meter will burn up. Meters were burned up nearly as quickly at 3 amps, 30 amps, and 130 amps.
- Relatively small amounts of vibration can be the catalyst in the beginning and eventual catastrophic failure of a hot socket. Note: Other catalysts include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

And some newer solid state meters are better than electromechanical meters.

Temperature Rise Data



Jaw to Blade Arcing

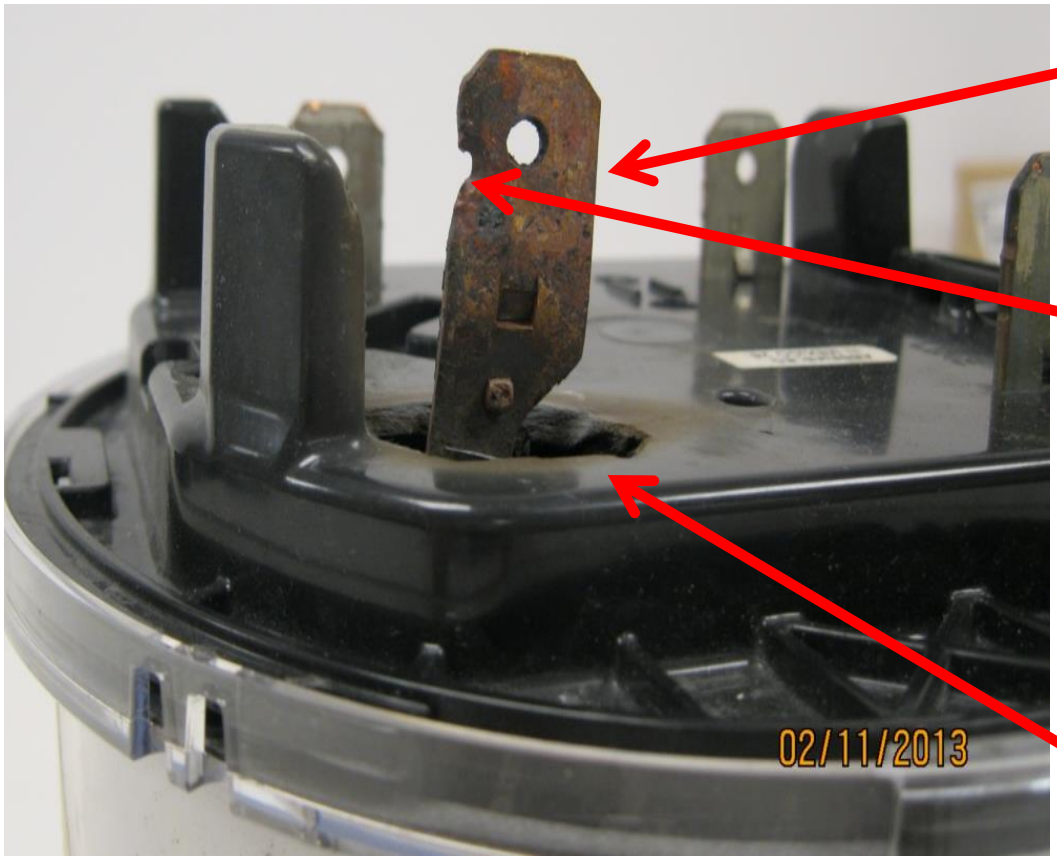


Jaws with intermittent connections will arc to the meter blade resulting in pitting on the blade.

Blade shows early signs of arcing.

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

Severe Arcing Jaw to Blade



Tin burned off

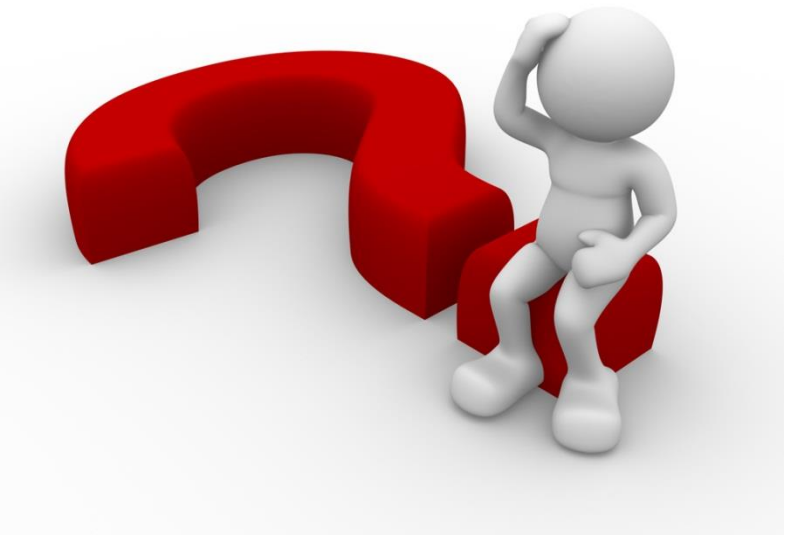
Blade hole due to arcing to jaw – Copper melts at 1040ºC (1900ºF)

AX-SD base thermoset plastic melts at 960ºC (1760ºF)

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);

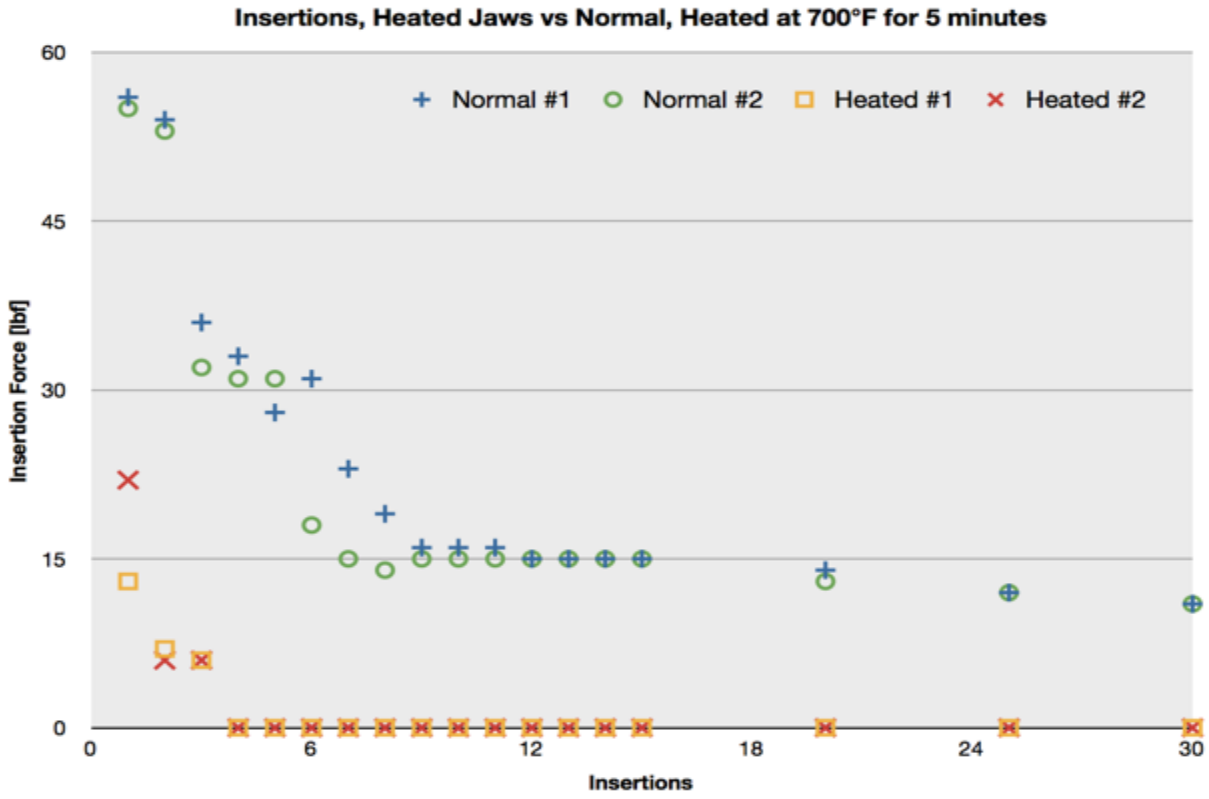
- Loss of jaw tension in at least one of the socket jaws.
- Vibration (or other catalyst to initiate arcing)
- Minimal load present



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

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
14	15	15	0	0
15	15	15	0	0
20	14	13	0	0
25	12	12	0	0
30	11	11	0	0



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?

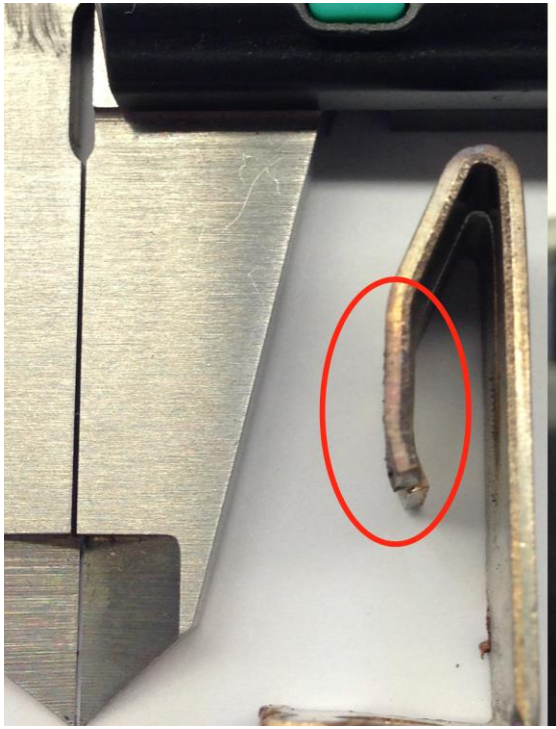
- Easiest resolution is to replace the damaged jaw.
- **Never** try and repair a damaged jaw. The tension in the damaged jaw will not return simply by taking a pair of pliers and closing the jaw tighter.
- Either the entire box should be replaced or the damaged jaw (assuming the wiring and other jaws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

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.)

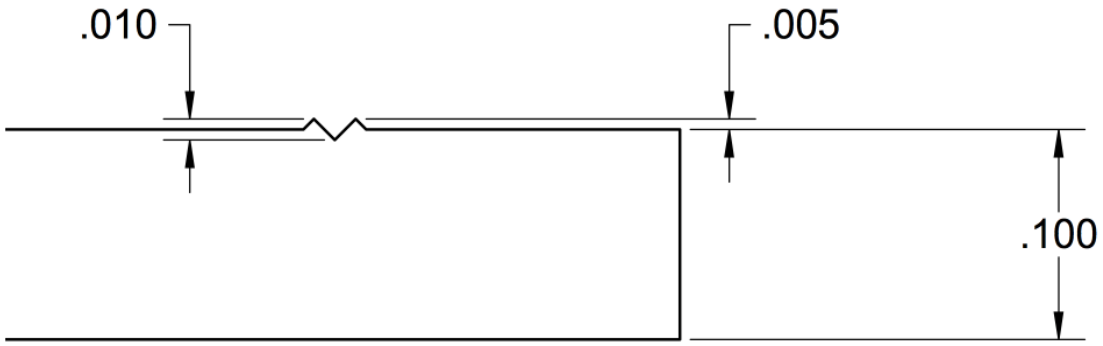
Service Degradation

- 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.



Service Degradation

- In a representative side view of a .1” thick standard meter stab, you can see how small these distortions appear relative to the thickness of the stab, while creating an air gap large enough for significant arcing.



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.

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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