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METER SOCKET SAFETY CHECKS/HOT SOCKET DETECTION

TESCO's Meter School

TESCOOL ▶▶

June 11, 2023

10:00 AM – 11:00 AM

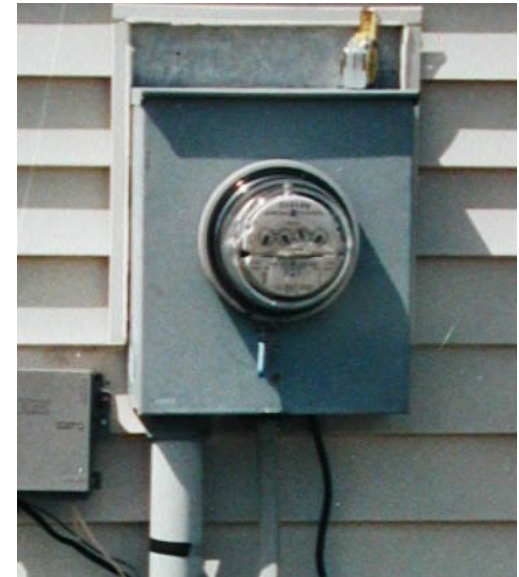
John Greenewald



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BASIC SINGLE PHASE SOCKET CHECKS

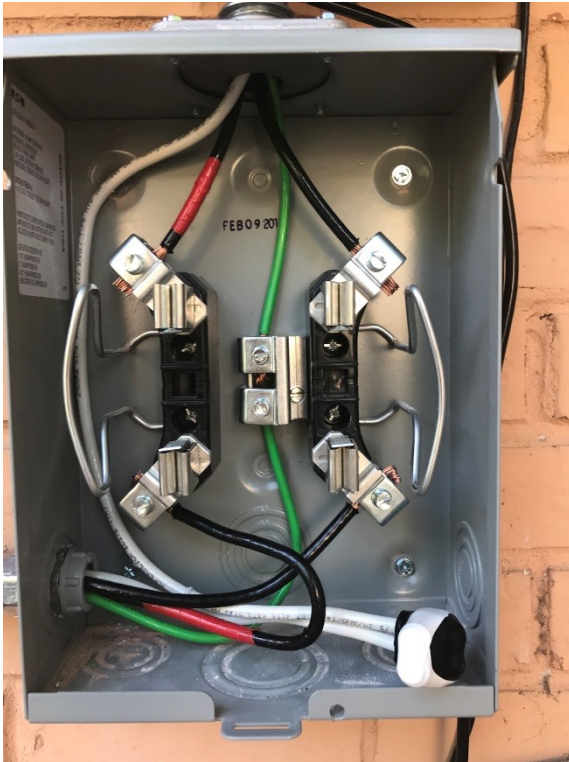
- Visual Inspection: Conduct a thorough visual inspection of the meter socket to check for any visible signs of damage, corrosion, or loose connections. Look for cracked or broken parts, frayed wires, or signs of overheating.
- Tightness of Connections: Ensure that all electrical connections within the meter socket are secure and tight. Loose connections can lead to arcing, overheating, and potential electrical hazards. Verify the tightness of terminal screws and lugs.
- Grounding: Verify that the meter socket is properly grounded. A reliable ground connection is crucial for diverting electrical faults and preventing electric shock. Ensure that the grounding conductor is securely connected and in good condition.
- Insulation: Inspect the insulation around the wires and terminals inside the meter socket. Look for any signs of damage, such as exposed or deteriorating insulation, which could lead to short circuits or electrical shocks.





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BASIC SINGLE PHASE SOCKET CHECKS



- **Proper Wire Sizing:** Check that the wires connected to the meter socket are appropriately sized and rated for the electrical load they are carrying. Improper wire sizing can lead to overheating and potentially cause a fire.
- **Meter Socket Cover:** Ensure that the meter socket cover is in place and properly secured. The cover protects against accidental contact with live electrical parts and shields the meter from environmental factors.
- **Weatherproofing:** If the meter socket is located outdoors, verify that it is adequately weatherproofed. This includes checking the integrity of seals, gaskets, or other weatherproofing elements to prevent moisture ingress and potential damage.
- **Compliance with Codes and Standards:** Ensure that the meter socket installation adheres to local electrical codes and standards. Verify that the socket type and specifications meet the requirements set forth by the utility and regulatory authorities.



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THE ISSUE

- Hot Sockets are not a new phenomenon. Virtually every meter tech 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 spotlight 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 self-contained meter installation?
 - What are the best practices for handling potential hot sockets?
- We 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.
- We will also cover new technology developed and patented by TESCO to use the meter to sense a hot socket and forward an alarm in near real time to the head end system.

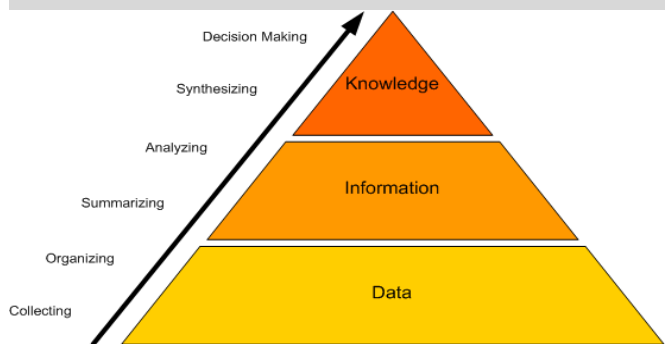




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WHY DO WE KNOW ANYTHING ABOUT HOT SOCKETS?

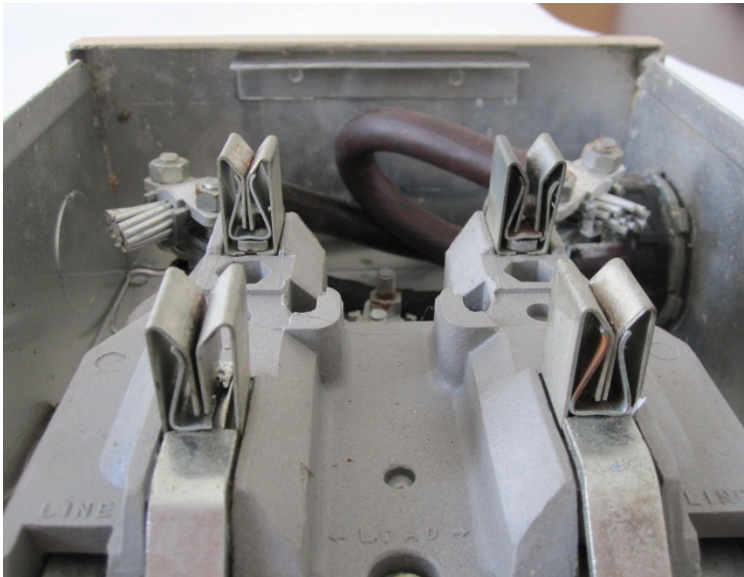
- TESCO has been fortunate enough to be involved in several meter deployments where we supplied full time and part time meter engineers and project managers to our customer's AMI deployment teams. In this capacity we have been involved in evaluating hot socket issues and helping to determine an appropriate response to actual or potential hot sockets.
- TESCO's meter lab was contracted to develop a laboratory fixture that would simulate the various features common to most hot sockets found in the field. TESCO was also contracted to develop test protocols, gather data and benchmark various conditions and meters.



- TESCO has access to a large number of meters which have been exposed to hot sockets both before and after catastrophic failure as well as a limited number of sockets that were hot sockets and did not yet fail catastrophically.

SEARCHING FOR HOT SOCKET SOURCES

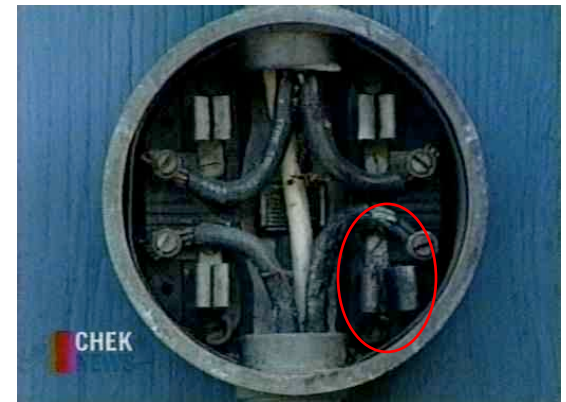
Common Features and Common Sources of Concern



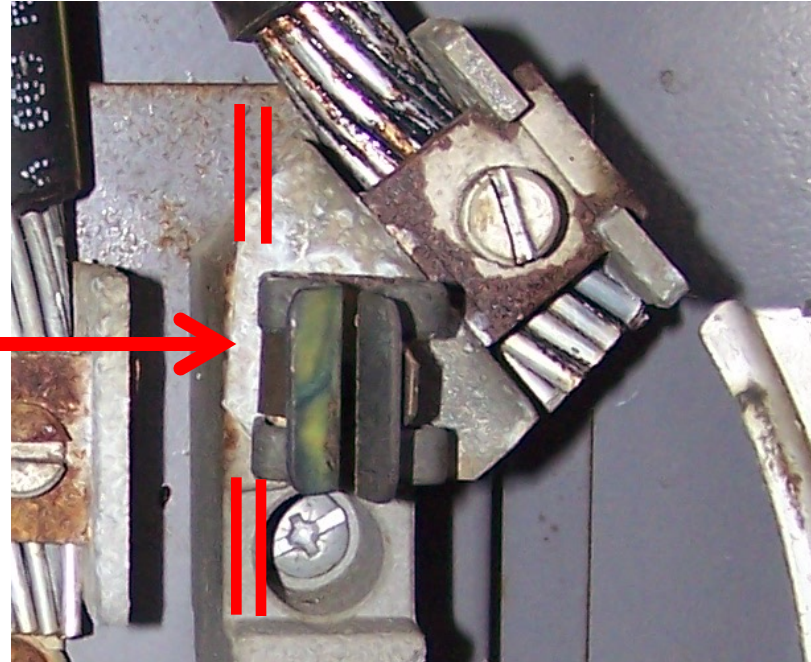
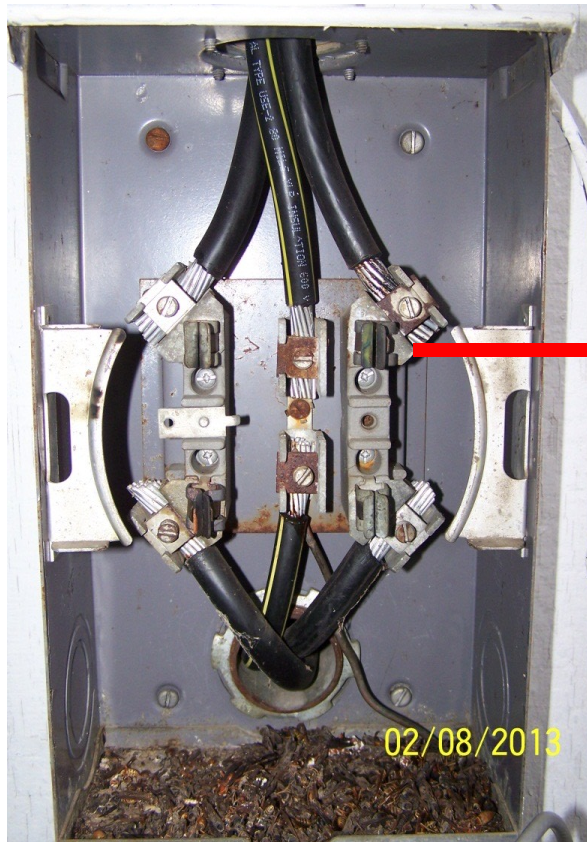
- Pitted and discolored meter blades
- Melted plastic around one or more of the meter stabs (typically the plastic around one stab is where the deformation starts)
- Pitted and discolored socket jaws
- Loss of spring tension in the socket jaws

WHAT ARE LIKELY SOCKET CONCERNS?

- Sprung/damaged jaw
- Loose wire termination at line or load side jaw
- Meter blade beside and not into socket jaw
- Worn line/load wire insulation arcing over to grounded mounting box
- Total load exceeding socket capacity – lots of older 100 amp services in the field



HOT SOCKET CAUSES – SPRUNG JAWS

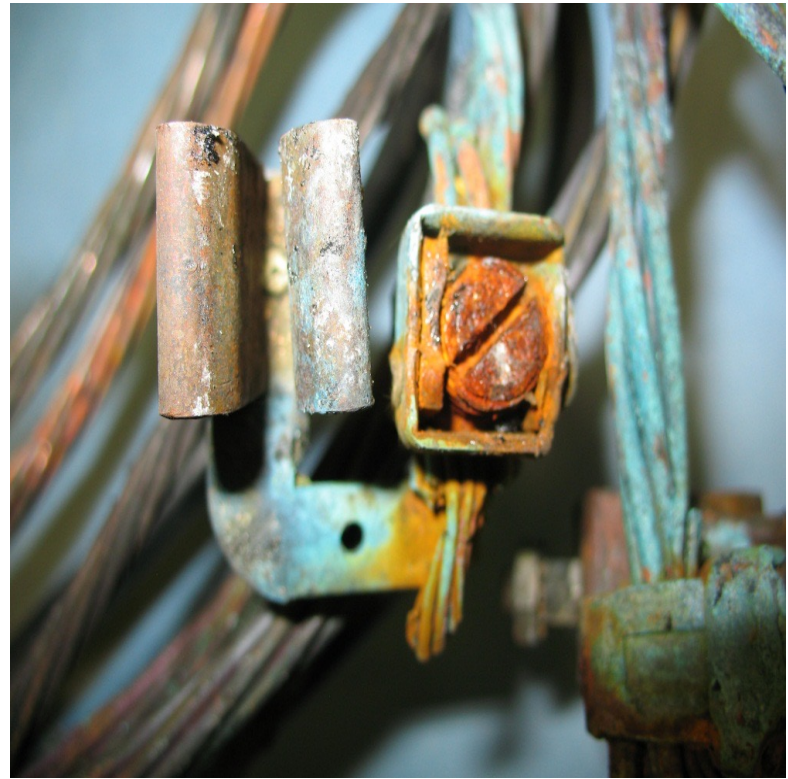


Tin plating on jaw “cooked”

Heat accelerates oxidation on lug wire

Note: Tin Melts at 232°C (450°F)

Jaw completely separated - large gap resulting in poor connection



AMI DEPLOYMENTS AND HOT SOCKETS

- Replacing a meter in an existing meter socket will weaken the socket and if performed enough times this action will create a hazardous condition.
- **AMI deployments** will increase the incidence of hot sockets and meter fires unless precautionary steps are taken as part of the meter deployment.
- How many meters have been installed and removed in meter box that's 50 or even 60 years old?
- How old is the infrastructure at your utility's service area?

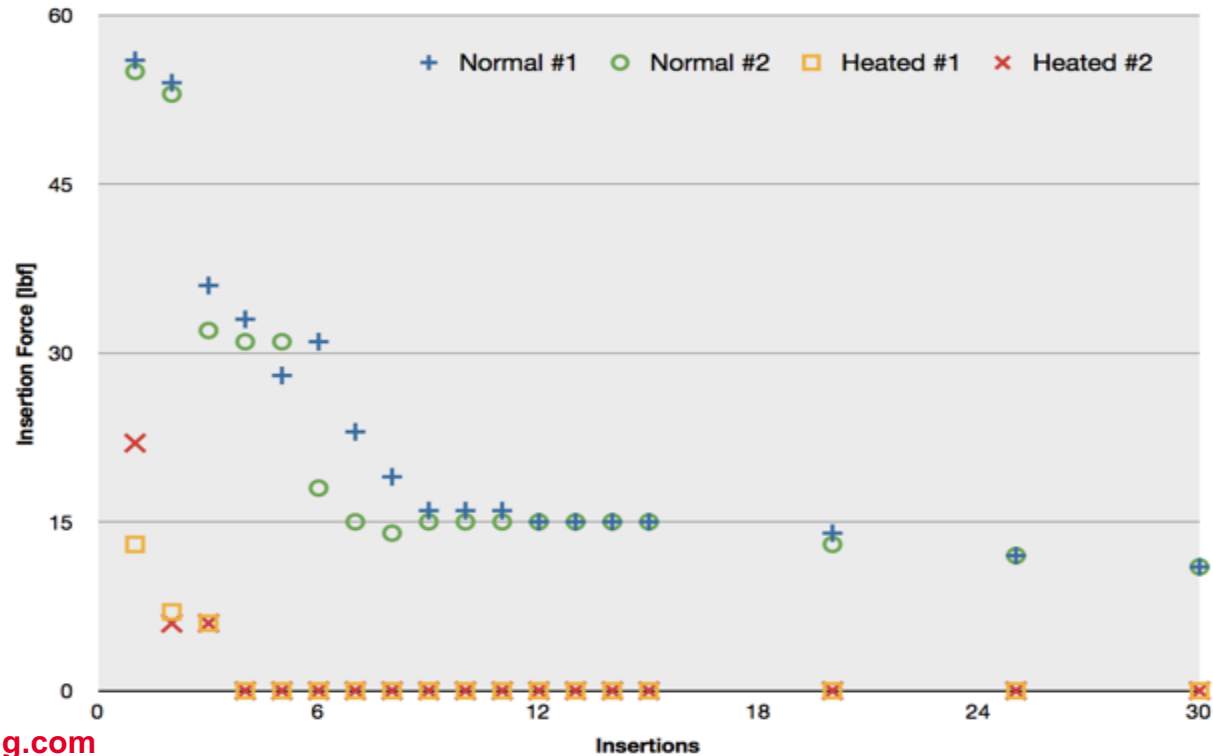




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Insertions	Normal #1	Normal #2	Heated #1	Heated #2
1	56	55	13	22
2	54	53	7	6
3	36	32	6	6
4	33	31	0	0
5	28	31	0	0
6	31	18	0	0
7	23	15	0	0
8	19	14	0	0
9	16	15	0	0
10	16	15	0	0
11	16	15	0	0
12	15	15	0	0
13	15	15	0	0
14	15	15	0	0
15	15	15	0	0
20	14	13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

Insertions, Heated Jaws vs Normal, Heated at 700°F for 5 minutes





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HOT SOCKET SIMULATION FIXTURE



Carbon Pitting and Base Melting



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

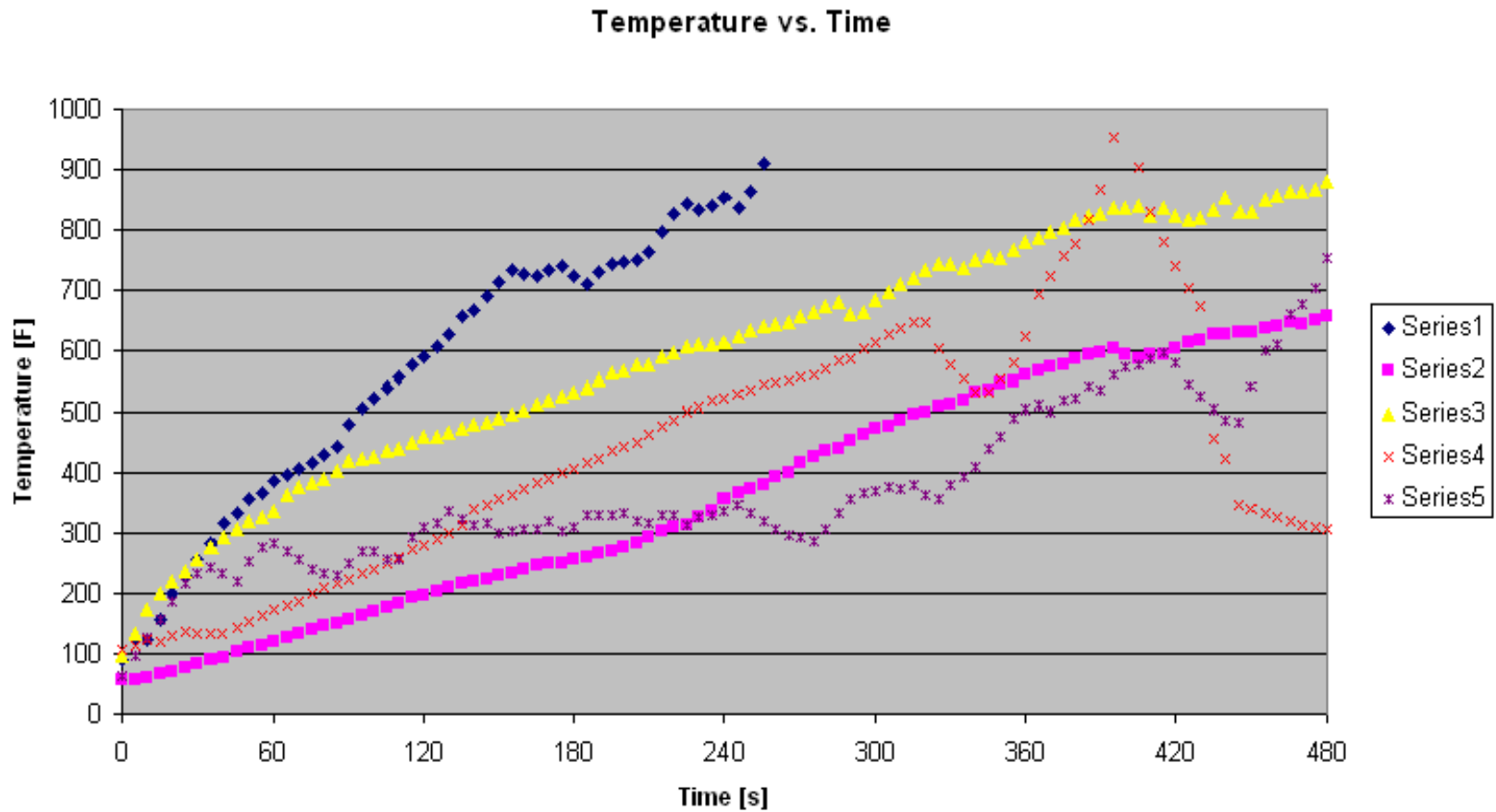


And some newer solid state meters are better than electromechanical meters.



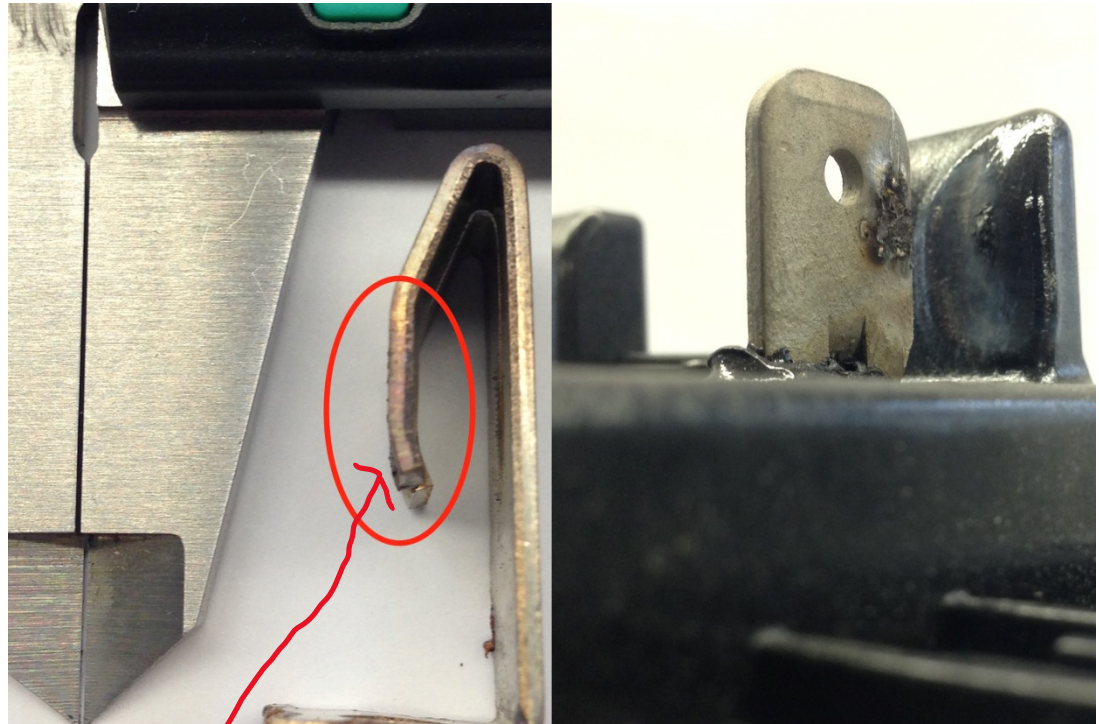
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TEMPERATURE RISE DATA



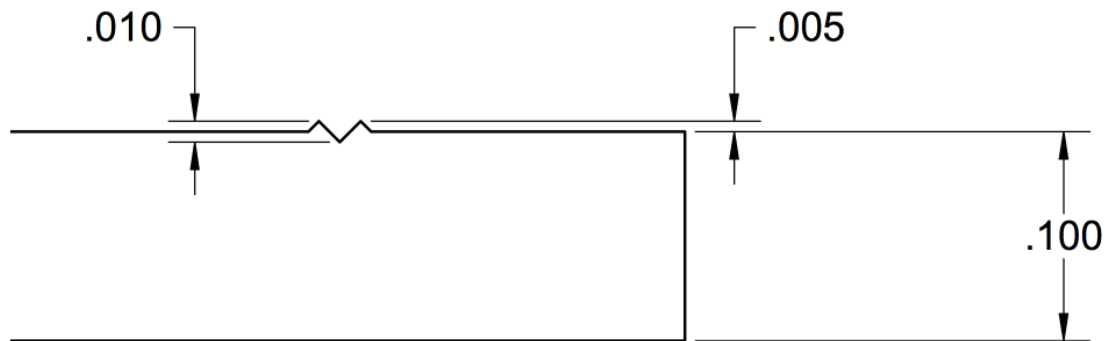
GAP EVALUATION

- 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.

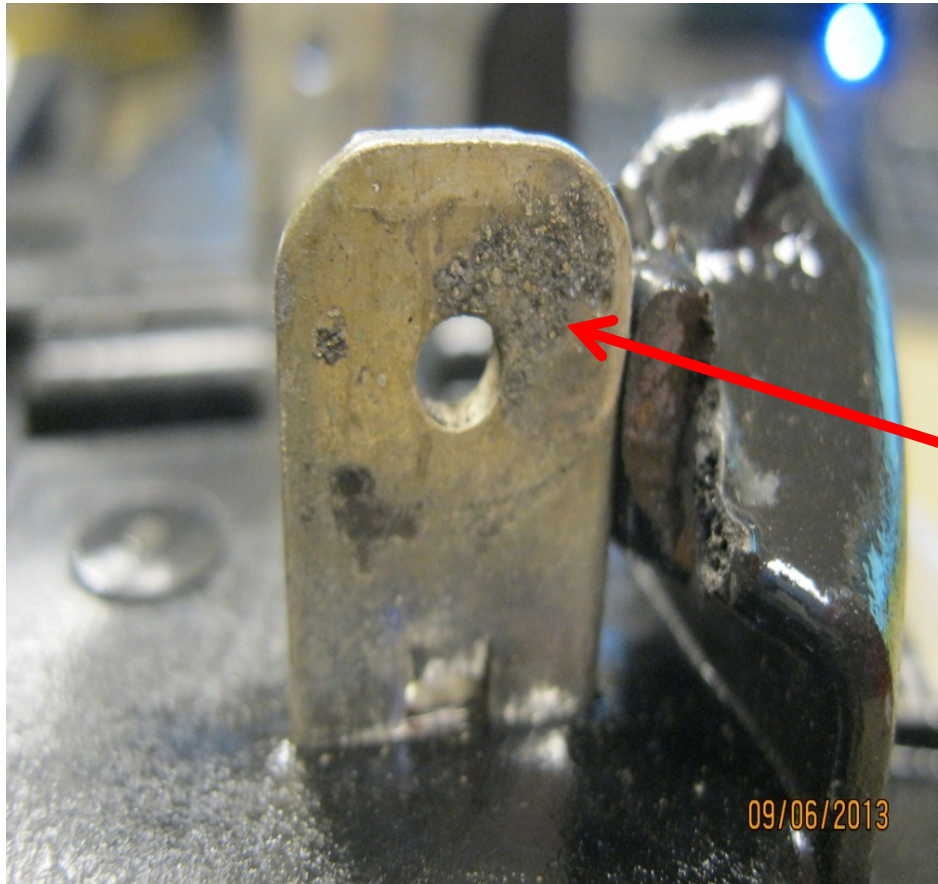


Carbon Pitting

- In a representative side view of a 0.100" 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.



JAW TO BLADE ARCING

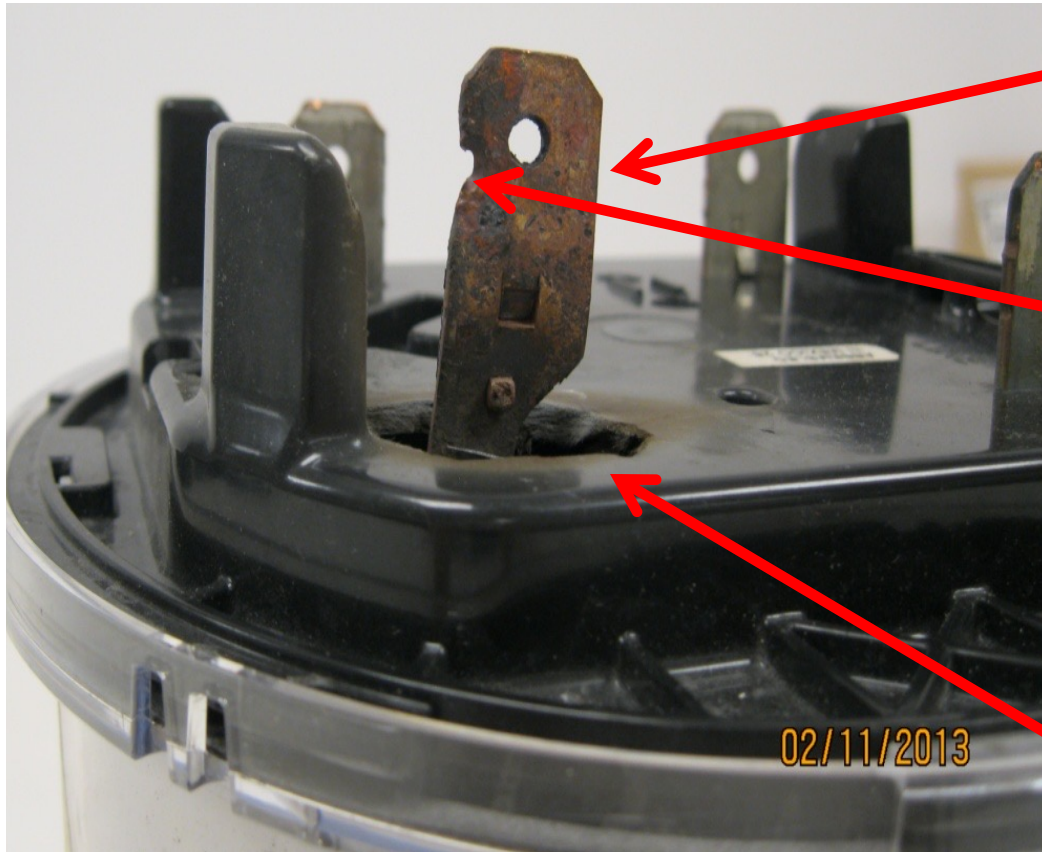


Jaws with intermittent connections will arc to the meter blade resulting in pitting on the blade.

Blade shows early signs of arcing.

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

SEVERE ARCING JAW TO BLADE



Tin burned off

Blade hole due to arcing to jaw – Copper melts at 1040°C (1984°F)

AX-SD base thermoset plastic melts at 960°C (1760°F)



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





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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



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 by simply “squeezing” the damaged jaw with a pair of pliers or other tool. The metallurgical properties of the jaw will not magically return and the jaws will simply spread again as soon as a meter is put into the socket.
- If the other jaws are deemed to be in good repair, the box and wiring are in good condition and appropriate Socket Blocks are available to effect a repair, then replacing the damaged socket block with a new one is the most expedient and cost effective solution. If any of these conditions do not exist then replacing the box is the best solution.



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HOT SOCKET EQUIPMENT



Top: **Cat. 300 Hot Socket Gap Indicator**; Right: **Hot Socket Repair Kit** (Cat. 304-Basic; Cat. 305-Pro);
Below, left: Cat. 301 **Socket Safety Clip**; Below, right: Cat. 302 **Hot Socket Gap Indicator Calibration Fixture**



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 several years every meter manufacturer has released 2S meters designed to withstand hot sockets.



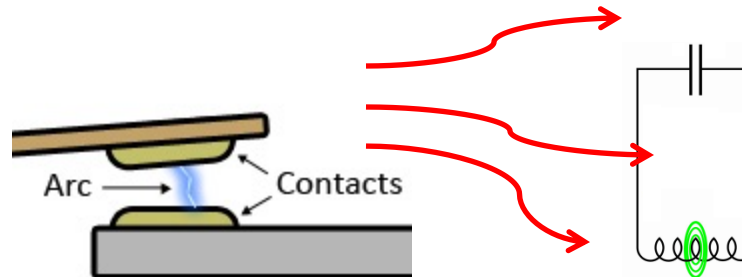
IN SEARCH OF HOT SOCKETS

- The meter manufacturer's and various electric utilities have also been looking at a variety of ways to better sense hot sockets.
- Utilities who have deployed are looking for a set of alarms that when taken together may give them a better idea that there is a hot socket
- Meter Manufacturers have worked on evaluating a variety of temperature levels to send an alarm, disconnecting the meter if there are sustained elevated temperatures, using increased impedance to signify a hot socket, improving the temperature sensors and putting additional temperature sensors on the blades of the meters.



FINDING A HOT SOCKET WITH A METER – WHAT IS KNOWN AND KEYS TO THESE NEW TECHNOLOGIES

1. Temperature Sensing – sensing the temperature at the metrology board and at the meter stab(s).
2. Impedance Sensing – detecting a change in impedance in the meter circuit.
3. Detecting the RF signature of a micro Arc with a near field sensor - Arcing emits broadband energy in the form of radio waves. Launching radio waves requires a disturbance in the electric and magnetic fields near where the arc occurs (the near-field space).





SUMMARY OF THE PROBLEM

- 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



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SUMMARY OF THE POTENTIAL SOLUTIONS

- 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.
- Thorough visual inspections of all services when replacing a meter whether for AMI or not
- Hot Socket Indicator inspection for all jaws. This is a non-invasive way to check that the minimum safe holding force or greater is present in all socket jaws.
- Hot Socket clips. Allows for the meter tech to leave the service as safe or safer than when the problem jaw has been identified.
- Hot Socket detection circuit incorporated into the Meter circuit for near real time detection and alarm to the head end allows the utility to identify compromised jaws before they damage the meter and before they become dangerous to the rate payer or tenant. This feature is just now becoming available and can be specified when requesting meters.

FIELD INSPECTION OF SELF CONTAINED 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



QUESTIONS AND DISCUSSION

John Greenewald

Senior VP of Sales

john.greenewald@tescometering.com



TESCO – The Eastern Specialty Company

Bristol, PA

215.228.0500

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