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Site Verification for Self-Contained Hot Socket Detection

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The Eastern Specialty Company

for PREA

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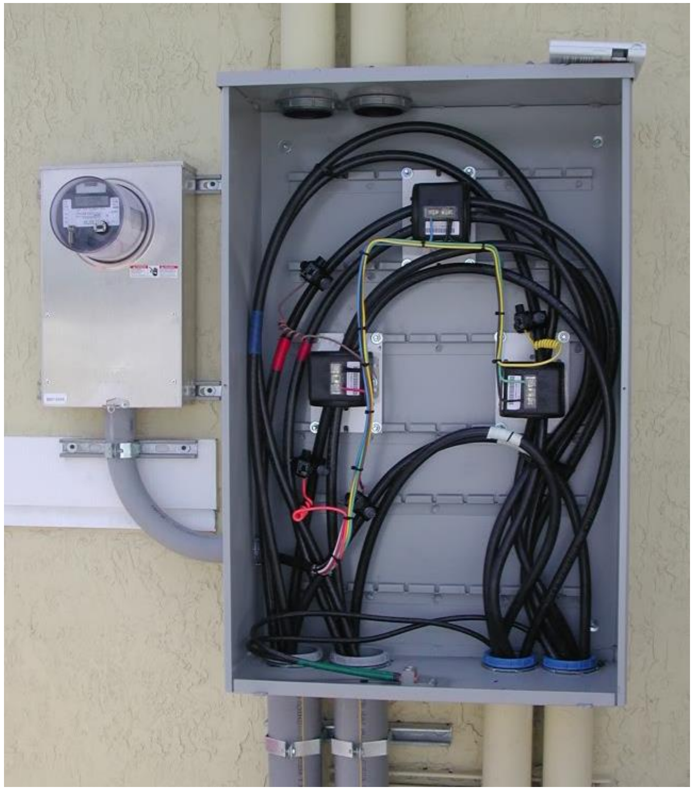
3:45 p.m. – 4:30 p.m.

Topics we will be covering

- The Basics- Differences Between Self Contained and Transformer or Instrument Rated Meter Sites
- Transformer Rated Meter Forms
- Test Switches and CT's
- Blondel's Theorem and why this matters to us in metering
- Meter Accuracy Testing in the Field
- Checking the Health of your CT's and PT's
- Site Verification and not just meter testing



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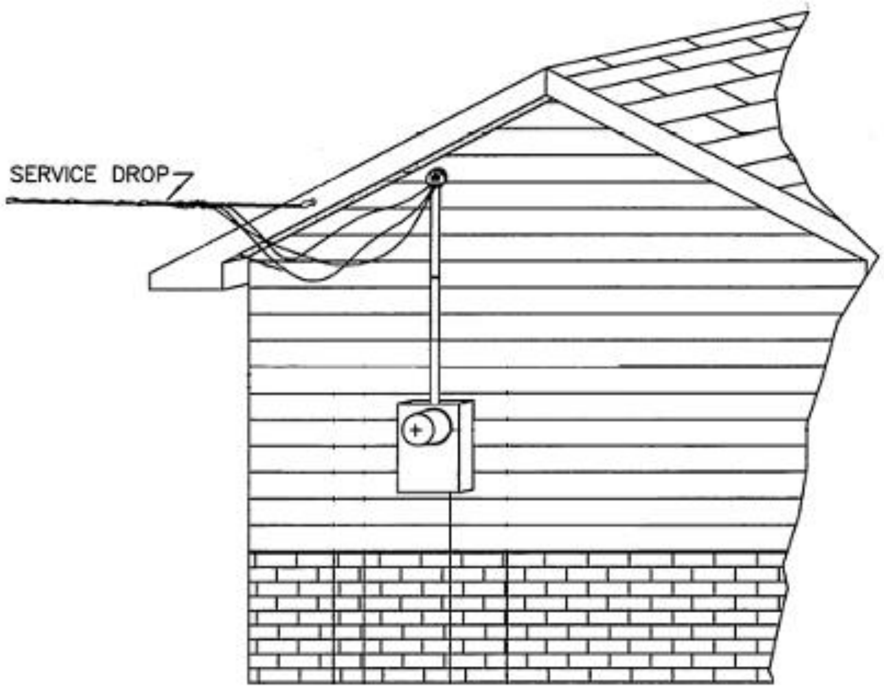
Self Contained Metering

- Typically found in residential metering
- Meters are capable of handling the direct incoming amperage
- Meter is connected directly to the load being measured
- Meter is part of the circuit
- When the meter is removed from the socket, power to the customer is interrupted



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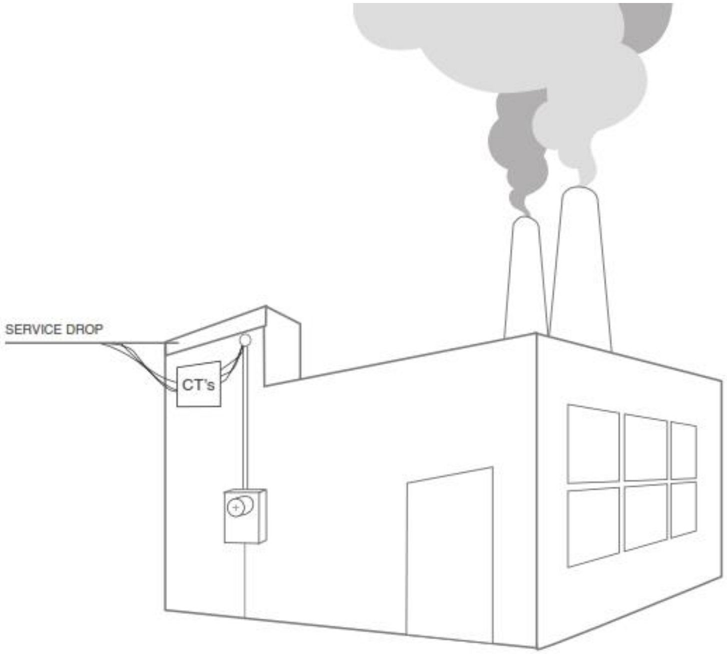
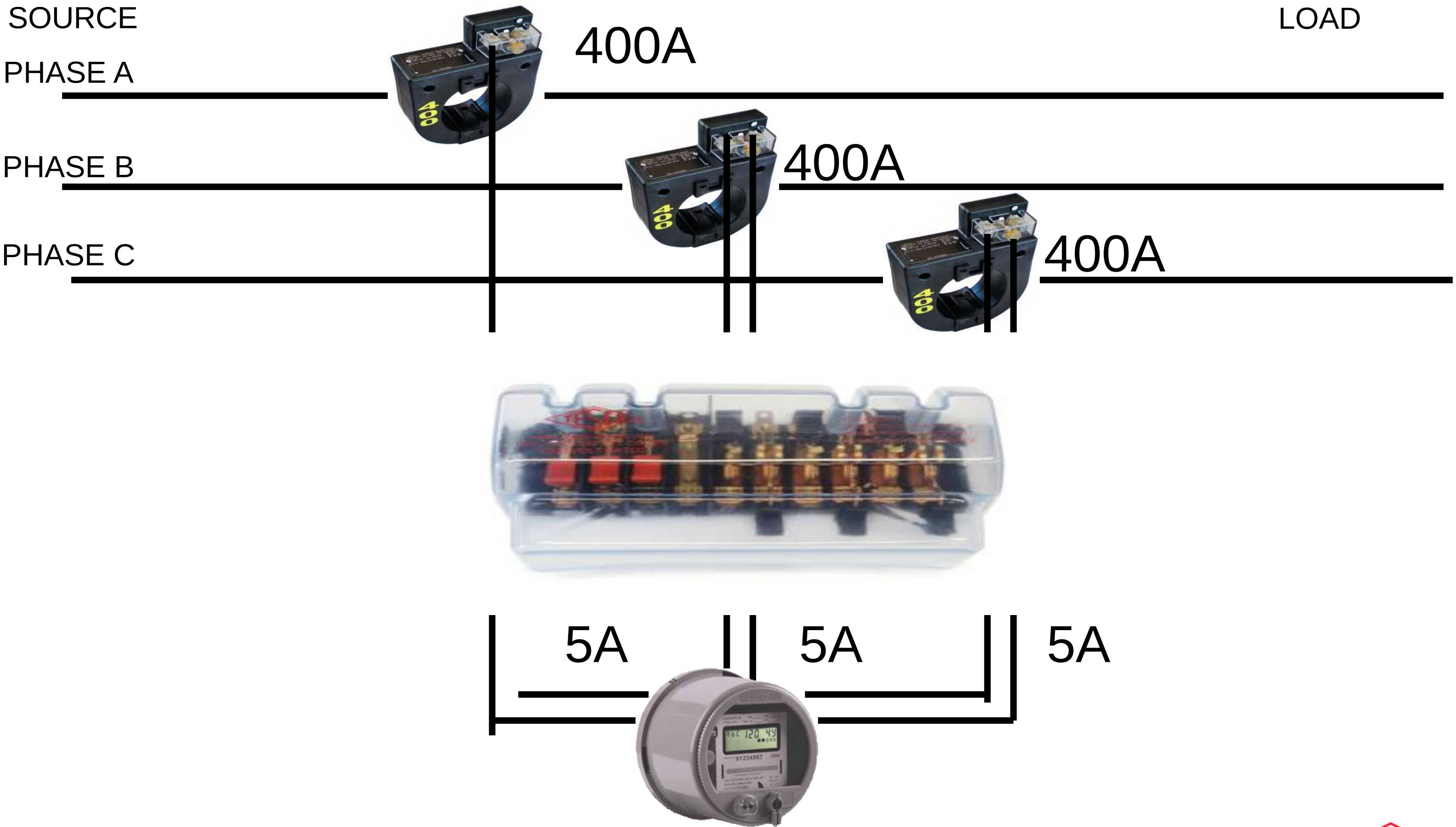
Transformer Rated Metering

- Meter measures scaled down representation of the load.
- Scaling is accomplished by the use of external current transformers (CTs) and sometimes voltage transformers or PTs).
- The meter is NOT part of the circuit
- When the meter is removed from the socket, power to the customer is not effected.



The Basic Components

9S Meter Installation with 400:5 CT's



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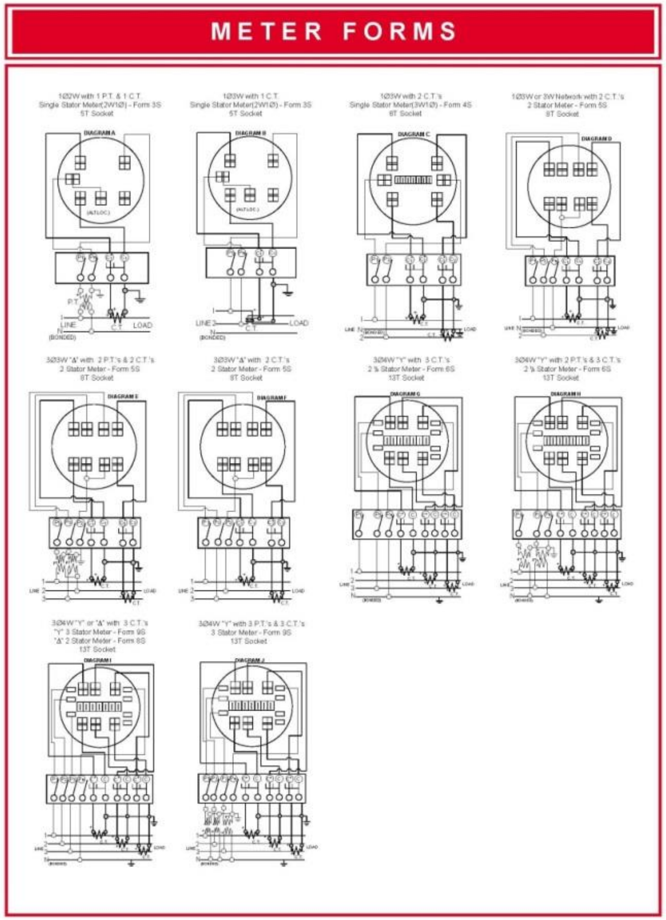
Typical Connections

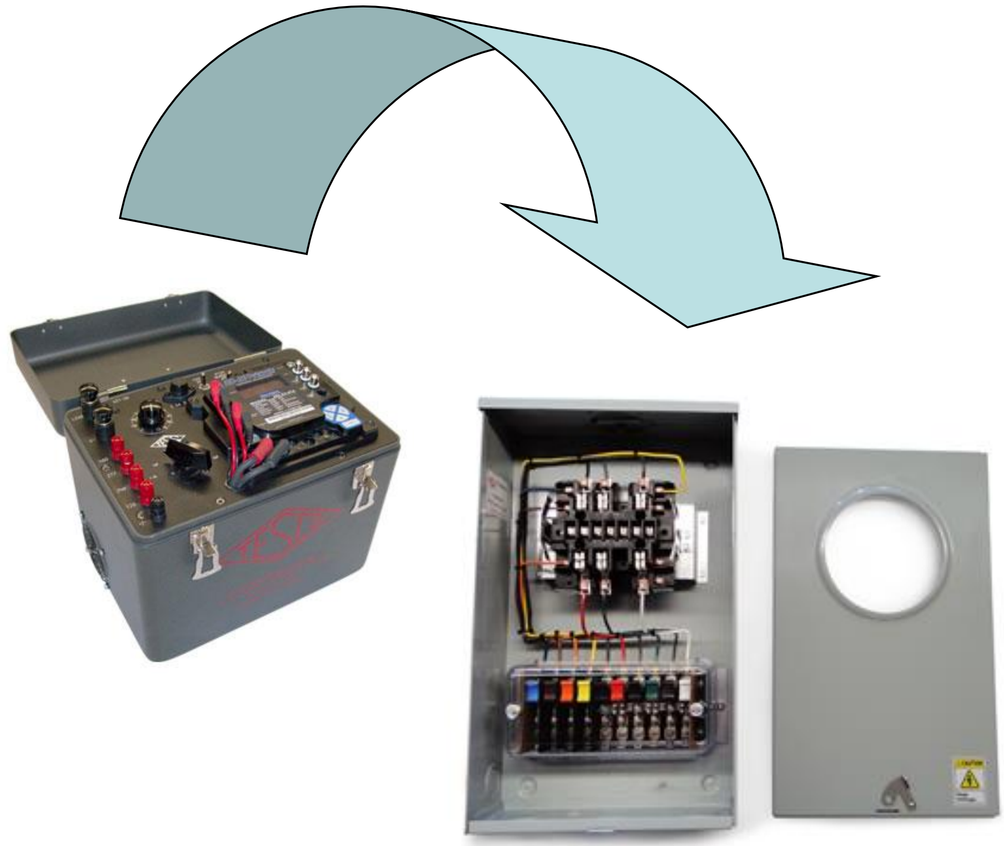


Typical Connections for Common Transformer (Instrument) Rated Meter Forms

Meter Accuracy Testing

Meter Accuracy Testing in a Nutshell

- ✓ Full Load
- ✓ Light Load
- ✓ Power Factor



The Importance of CT Testing in the Field

- One transformer in three wired backwards will give the customer a bill of 1/3rd the actual bill.
- One broken wire to a single transformer will give the customer a bill of 2/3rd 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 ½ 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.

The Importance of CT Testing in the Field (continued)

- 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

Testing at Transformer Rated Sites

- ✓Meter Accuracy
- ✓Full Load
- ✓Light Load
- ✓Power Factor
- ✓CT Health
- ✓Burden Testing
- ✓Ratio Testing
- ✓Admittance Testing
- ✓Site Verification

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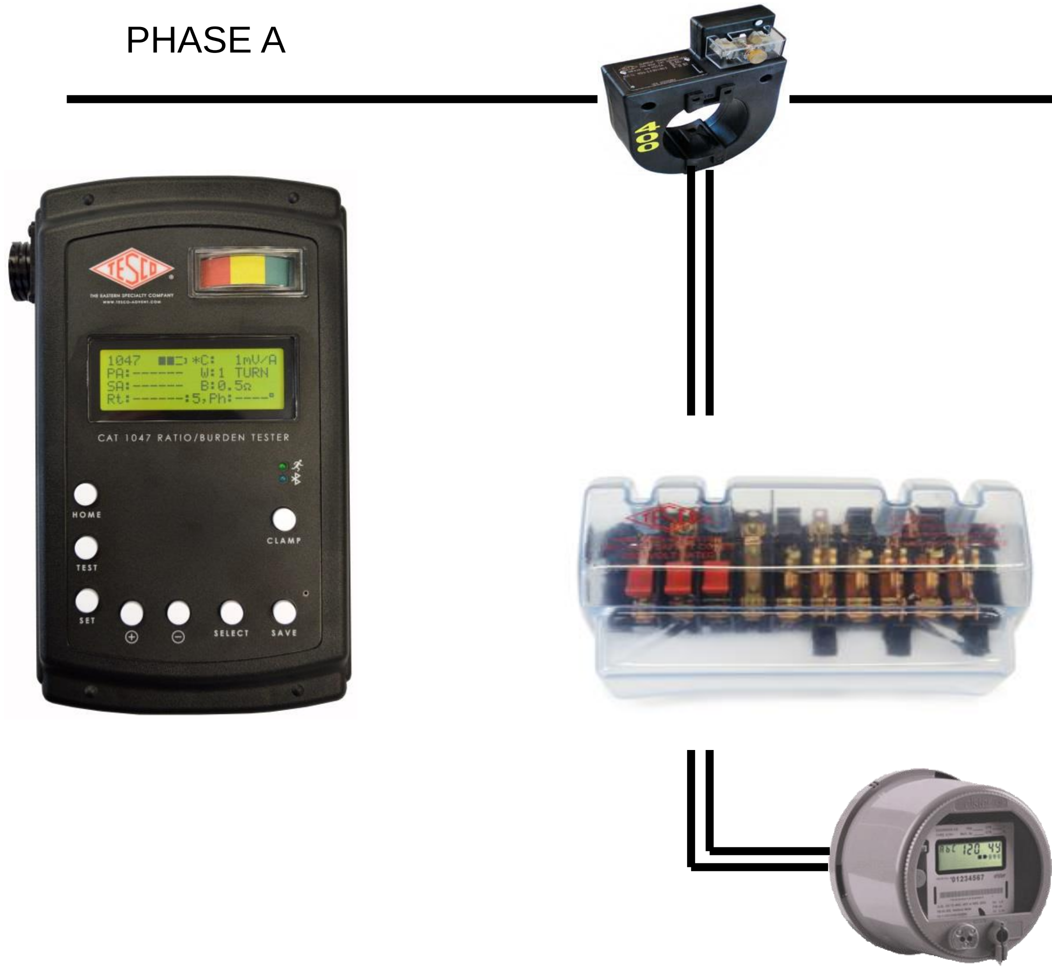
Fundamentals of Polyphase Field Meter Testing and Site Verification

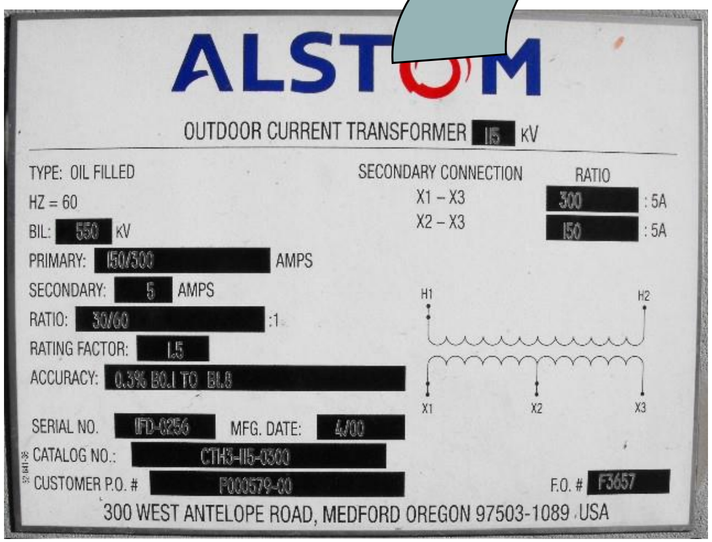
Functionality with Burden Present on the Secondary Loop



- Some burden will always be present – junctions, meter coils, test switches, cables, etc.
- CT's must be able to maintain an accurate ratio with burden on the secondary.

Fundamentals of Polyphase Field Meter Testing and Site Verification

Functionality with Burden Present on the Secondary Loop



Example Burden Spec:
0.3% @ B0.1, B0.2, B0.5

or

There should be less than the 0.3% change in secondary current from initial ("0" burden) reading, when up to 0.5 Ohms of burden is applied

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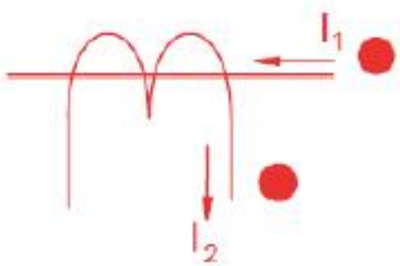
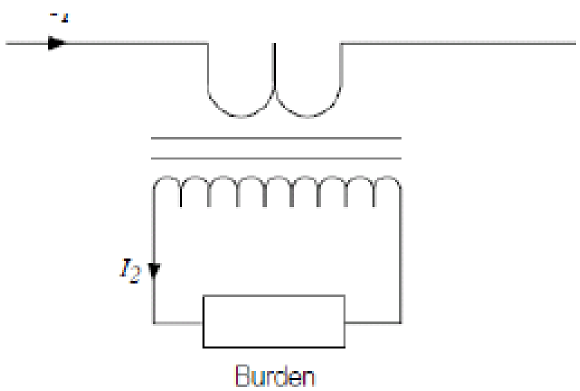
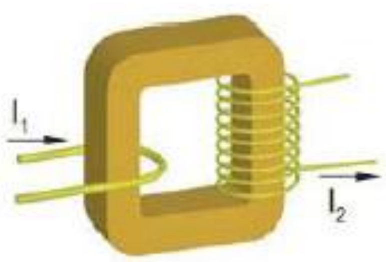
Current Transformers Conceptual Representation

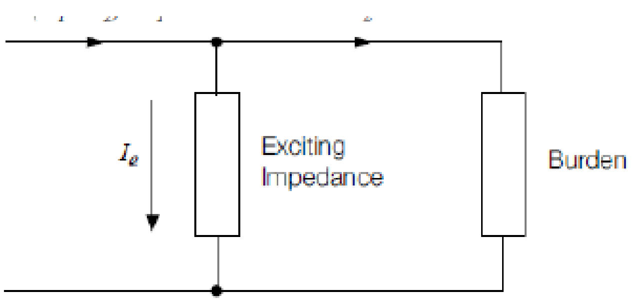


Ideal. No losses



$$I_2 = \frac{N_1}{N_2} \times I_1$$





$$I_2 = \frac{N_1}{N_2} \times I_1 - I_e$$

$$I_1 \times N_1 = I_2 \times N_2$$

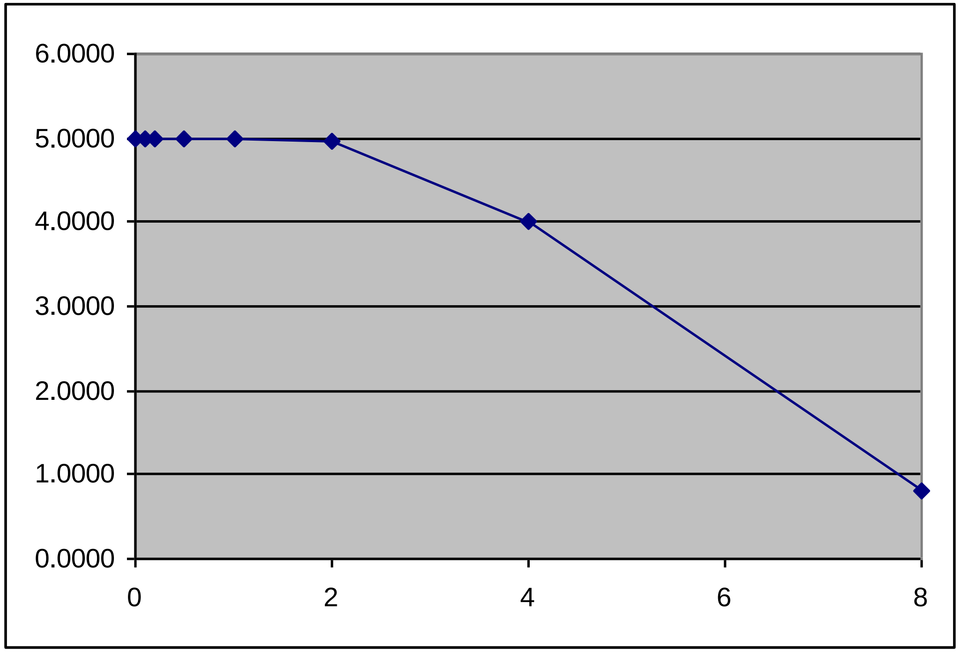
Real, with core losses

Fundamentals of Polyphase Field Meter Testing and Site Verification

Functionality with Burden Present on the Secondary Loop

0.3% @ B0.1, B0.2, B0.5

Initial Reading = 5Amps
0.3% x 5A = 0.015A
5A – 0.015 = 4.985A



Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

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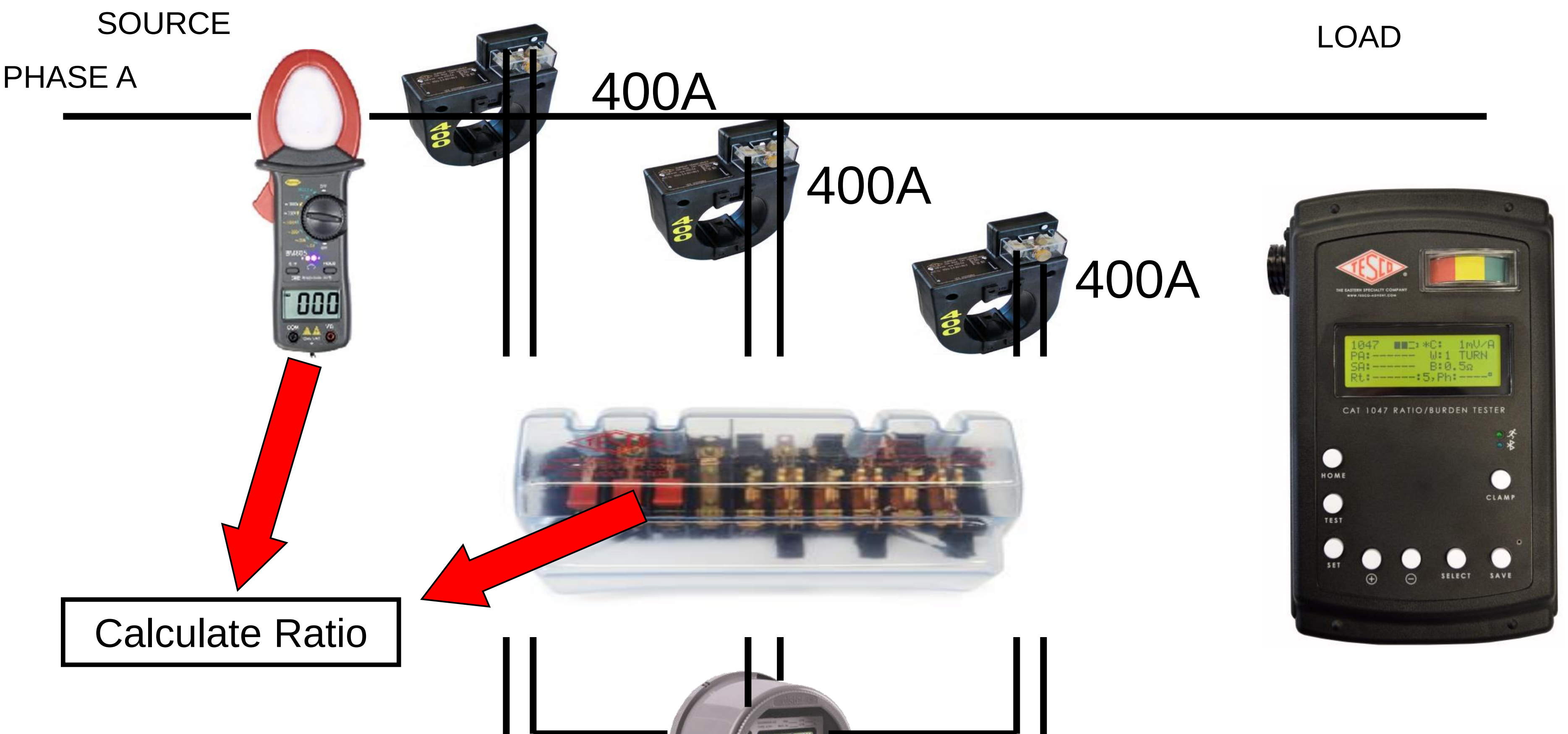
Fundamentals of Polyphase Field Meter Testing and Site Verification

Ratio of Primary Current to Secondary Current



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Three Phase Power
Blondel's Theorem

The theory of polyphase watthour metering was first set forth on a scientific basis in 1893 by Andre E. Blondel, engineer and mathematician. His theorem applies to the measurement of real power in a polyphase system of any number of wires. The theorem is as follows:

- *If energy is supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of the readings of N wattmeters, so arranged that each of the N wires contains one current coil, the corresponding voltage coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 wattmeters.*

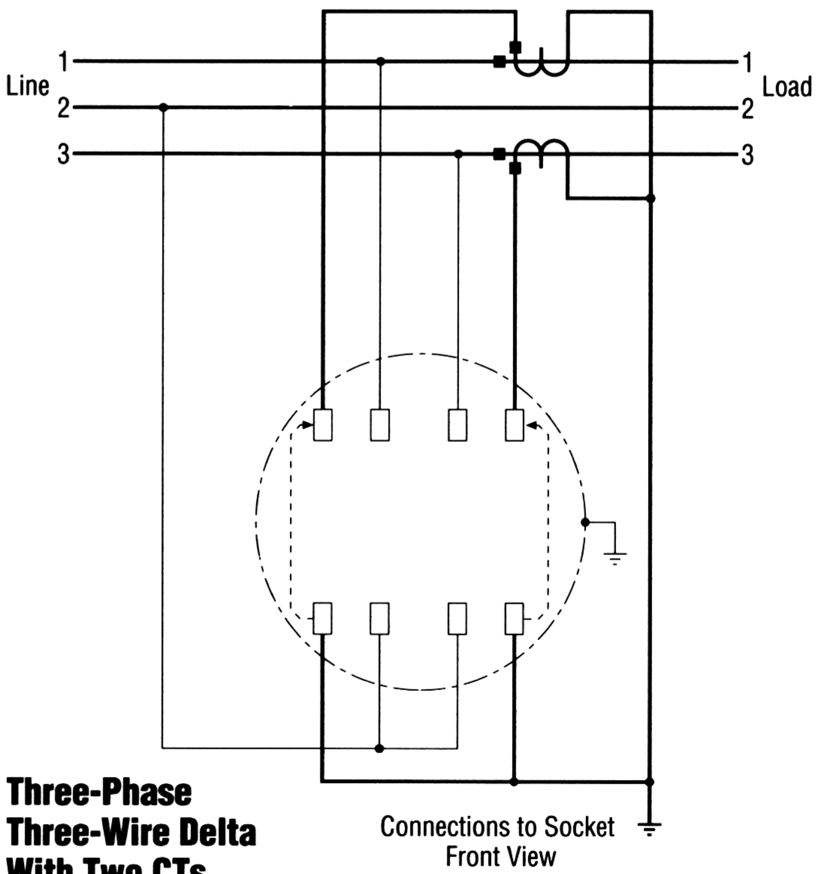
Three Phase Power
Blondel's Theorem

- Simply – We can measure the power in a N wire system by measuring the power in N-1 conductors.
- For example, in a 4-wire, 3-phase system we need to measure the power in 3 circuits.

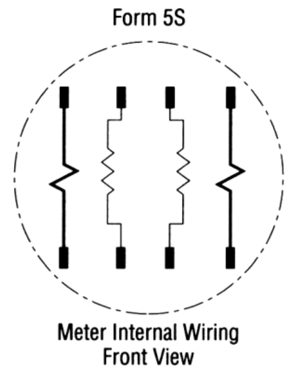
Three Phase Power
Blondel's Theorem

- If a meter installation meets Blondel's Theorem then we will get accurate power measurements <u>under all circumstances</u>.
- If a metering system does not meet Blondel's Theorem then we will only get accurate measurements if certain <u>assumptions are met</u>.

Blondel's Theorem



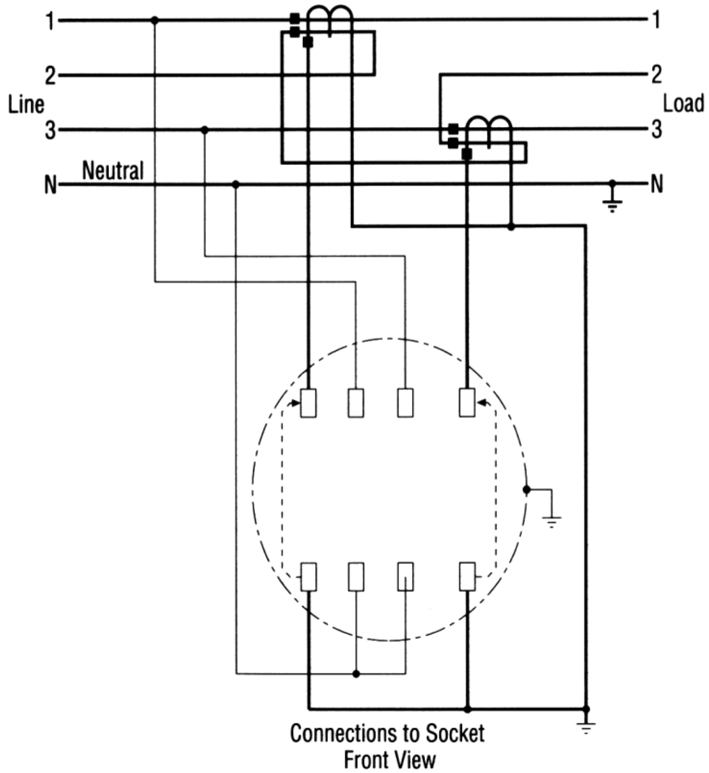
Three-Phase Three-Wire Delta With Two CTs



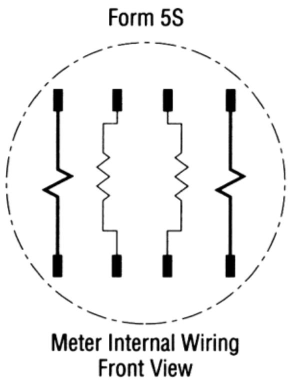
- Three wires
- Two voltage measurements with one side common to Line 2
- Current measurements on lines 1 & 3.

This satisfies Blondel's Theorem.

Blondel's Theorem



Three-Phase
Four-Wire Wye
With Two Equal-Ratio CTs



- Four wires
- Two voltage measurements to neutral
- Current measurements on lines 1 & 3. How about line 2?

This DOES NOT satisfy Blondel's Theorem.

Blondel's Theorem

- In the previous example:
  - What are the "ASSUMPTIONS"?
  - When do we get errors?
- What would the "Right Answer" be?

$$P_{sys} = V_a I_a \cos(\theta_a) + V_b I_b \cos(\theta_b) + V_c I_c \cos(\theta_c)$$

- What did we measure?

$$P_{sys} = V_a [I_a \cos(\theta_a) - I_b \cos(\theta_b)] + V_c [I_c \cos(\theta_c) - I_b \cos(\theta_b)]$$

Blondel's Theorem

- Phase B power would be:
  - $P = Vb\ Ib \cos\theta$
- But we aren't measuring Vb
- What we are measuring is:
  - $IbVa\cos(60 - \theta) + IbVc\cos(60 + \theta)$
- $\cos(\alpha + \beta) = \cos(\alpha)\cos(\beta) - \sin(\alpha)\sin(\beta)$
- $\cos(\alpha - \beta) = \cos(\alpha)\cos(\beta) + \sin(\alpha)\sin(\beta)$
- So

Blondel's Theorem

- $Pb = Ib\ Va \cos(60 - \theta) + Ib\ Vc \cos(60 + \theta)$
- Applying the trig identity
  - $IbVa(\cos(60)\cos(\theta) + \sin(60)\sin(\theta))$
    $IbVc(\cos(60)\cos(\theta) - \sin(60)\sin(\theta))$
  - $Ib(Va+Vc)0.5\cos(\theta) + Ib(Vc-Va)\ 0.866\sin(\theta)$
- Assuming
  - Assume $Vb = Va = Vc$
  - And, they are exactly 120° apart
- $Pb = Ib(2Vb)(0.5\cos\theta) = IbVb\cos\theta$

Blondel's Theorem

- If Va ≠ Vb ≠ Vc then the error is
- %Error =

$$-Ib\{(Va+Vc)/(2Vb) - (Va-Vc)\ 0.866\sin(\theta)/(Vb\cos(\theta))$$

How big is this in reality? If

Va=117, Vb=120, Vc=119, PF=1 then E=-1.67%

Va=117, Vb=116, Vc=119, PF=.866 then E=-1.67%

Blondel’s Theorem

Power Measurements Handbook

Condition	% V	% I	Phase A				Phase B				non-Blondel
	Imb	Imb	V	ϕvan	I	ϕian	V	ϕvbn	I	ϕibn	% Err
All balanced	0	0	120	0	100	0	120	180	100	180	0.00%
Unbalanced voltages PF=1	18%	0%	108	0	100	0	132	180	100	180	0.00%
Unbalanced current PF=1	0%	18%	120	0	90	0	120	180	110	180	0.00%
Unbalanced V&I PF=1	5%	18%	117	0	90	0	123	180	110	180	-0.25%
Unbalanced V&I PF=1	8%	18%	110	0	90	0	120	180	110	180	-0.43%
Unbalanced V&I PF=1	8%	50%	110	0	50	0	120	180	100	180	-1.43%
Unbalanced V&I PF=1	18%	40%	108	0	75	0	132	180	125	180	-2.44%
Unbalanced voltages PF≠1 PFa = PFb	18%	0%	108	0	100	30	132	180	100	210	0.00%
Unbalanced current PF≠1 PFa = PFb	0%	18%	120	0	90	30	120	180	110	210	0.00%
Unbalanced V&I PF≠1 PFa = PFb	18%	18%	108	0	90	30	132	180	110	210	-0.99%
Unbalanced V&I PF≠1 PFa = PFb	18%	40%	108	0	75	30	132	180	125	210	-2.44%
Unbalanced voltages PF≠1 PFa ≠ PFb	18%	0%	108	0	100	60	132	180	100	210	-2.61%
Unbalanced current PF≠1 PFa ≠ PFb	0%	18%	120	0	90	60	120	180	110	210	0.00%
Unbalanced V&I PF≠1 PFa ≠ PFb	18%	18%	108	0	90	60	132	180	110	210	-3.46%
Unbalanced V&I PF≠1 PFa ≠ PFb	18%	40%	108	0	75	60	132	180	125	210	-4.63%

Site Verification: Why should we invest our limited meter service resources here

- 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

- This is perhaps one of the larger benefits that AMI can provide for our Utilities – more time to spend on C&I metering and less on residential

Easy Answer: Money.

Potential list of tasks to be completed during a Site Verification of a Transformer Rated Metering Site

- 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.

Site Verification Checklist (continued)

- 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.
- Confirm we have a Blondel compliant metering set up
- 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.

Site Verification Checklist (continued)

- 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, 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

Periodic Site Inspections…..

….Can Discover or Prevent:

- Billing Errors
- Bad Metering set-up
- 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

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HOT SOCKETS

Disclaimer – Sensitive Utility Information

This document provides sensitive information concerning a utility's practices and is intended to facilitate thoughtful internal discussions and to help utilities discuss hot-socket concerns with local fire departments and answering media inquiries.

DO NOT provide this document directly to the public or media to avoid the contents being misused or taken out of context.

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?

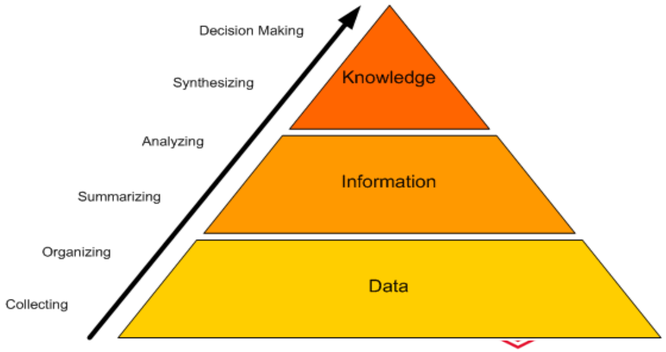
  - What are the best practices for handling potential hot sockets?

- 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.

- We will also cover new technology developed and patented by TESCO and L+G to use the meter to sense a hot socket and forward an alarm in near real time to the head end system.

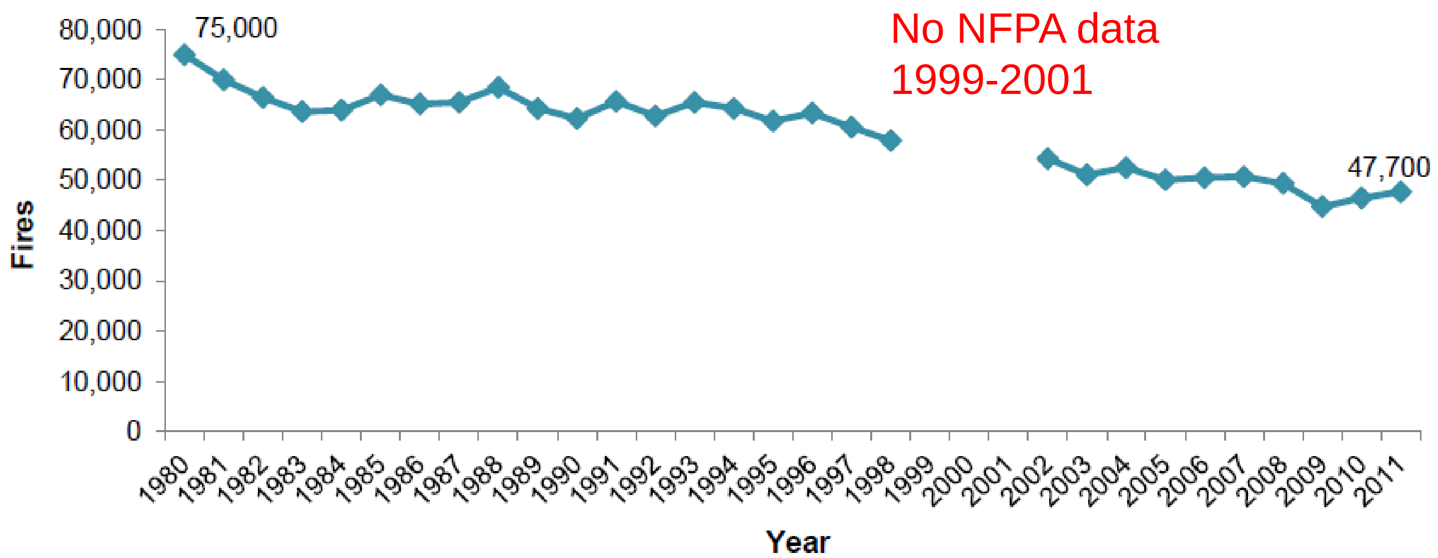
Why do we know anything about hot sockets?

- L+G has been investigating hot sockets and how to make their meters withstand hot socket conditions for longer periods of time so the socket has a greater likelihood of being repaired prior to catastrophic failure.
- L+G has also been investigating ways to utilize AMI communication to possibly alert head end systems of hot socket incidences.
- 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.



Electrical Fires Generally Decreasing

Figure 1.1. Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Year Structure Fires Reported to U.S. Fire Departments



Source: Data from NFIRS (Version 5.0 after 1998) and NFPA survey. Note: See Note in Table 1.1.

National Fire Prevention Association (NFPA) tracks sources of home electrical fires - 2013 report.

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Sources of Electrical Fires

Annualized Rate of Occurrence 2007-2011

Equipment Involved in Ignition	Fires	
Electrical distribution or lighting equipment	**20,700**	**(48%)**
Unclassified wiring	6,590	(15%)
Outlet or receptacle	2,590	(6%)
Branch circuit wiring	2,200	(5%)
Fuse or circuit breaker panel	1,350	(3%)
Extension cord	1,330	(3%)
Service supply wiring from utility	690	(2%)
Meter or meter box	610	(1%)
Unclassified lamp, light fixture or sign	560	(1%)
Incandescent light fixture	560	(1%)
Wiring from meter box to circuit breaker	530	(1%)
Surge protector	480	(1%)
Unclassified cord or plug	430	(1%)
Power (utility) line	380	(1%)

610 fires/year in the vicinity of the Meter or Meter Box

Electrical Fires Near the Meter

Annualized Rate of Occurrence 2007-2011

Service supply wiring from utility	690	(2%)
Meter or meter box	610	(1%)
Unclassified lamp, light fixture or sign	560	(1%)
Incandescent light fixture	560	(1%)
Wiring from meter box to circuit breaker	530	(1%)

- Approximately 141 million connected customers in the United States with approximately 170 Million installed electric meters. Using 610 fires at or near the meter per year yields 3.6 fires per million meters per year without AMI deployments.

Electrical Fires Near the Meter

Annualized Rate of Occurrence 2007-2011

- 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.

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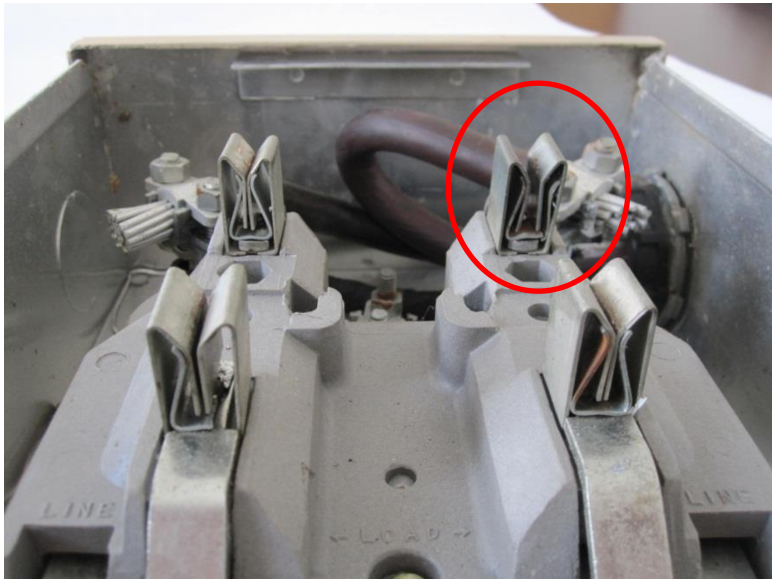
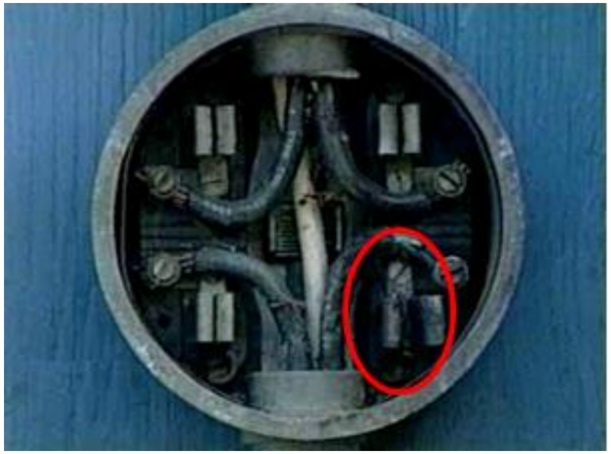
Searching for Hot Socket sources

Common Features and Common Sources of Concern



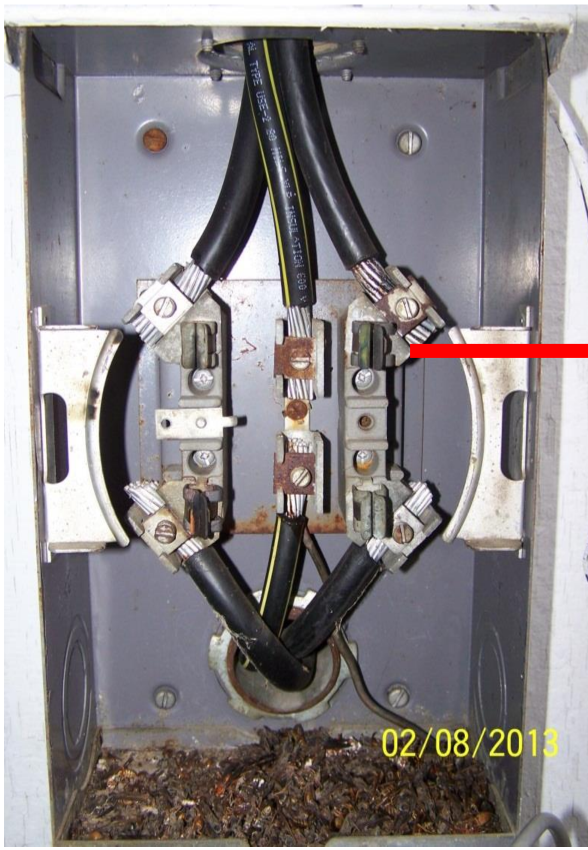
- Pitted and discolored meter blades
- Melted plastic around one or more of the meter stabs (typically the plastic around one stab is where the deformation starts)
- Pitted and discolored socket jaws
- Loss of spring tension in the socket jaws

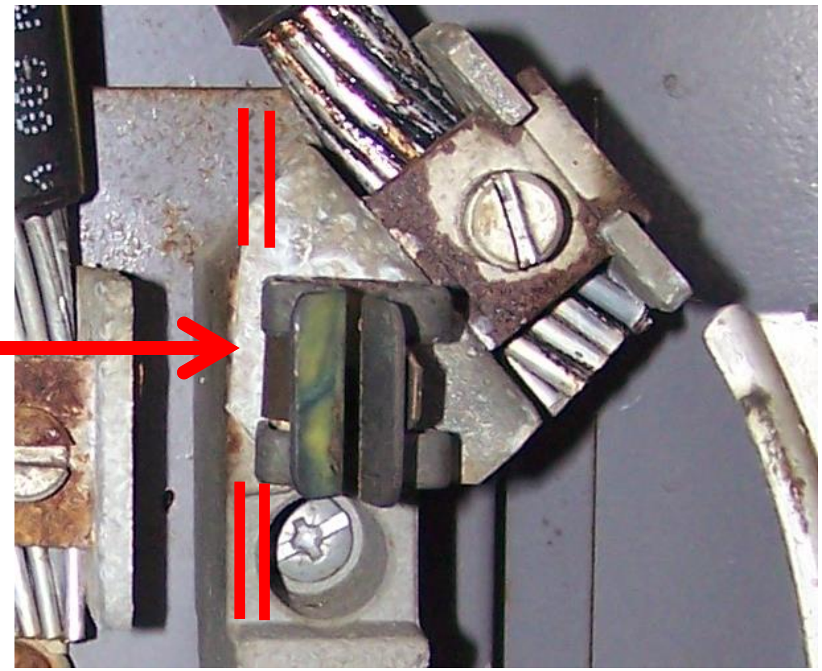


What are Likely Socket Concerns?

- 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





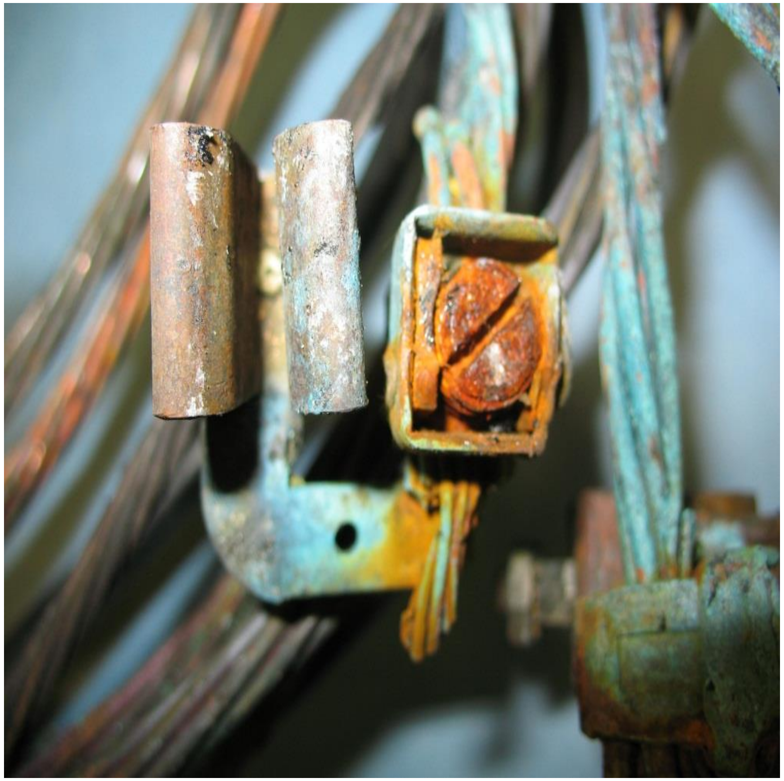
Tin plating on jaw “cooked”

Heat accelerates oxidation on lug wire

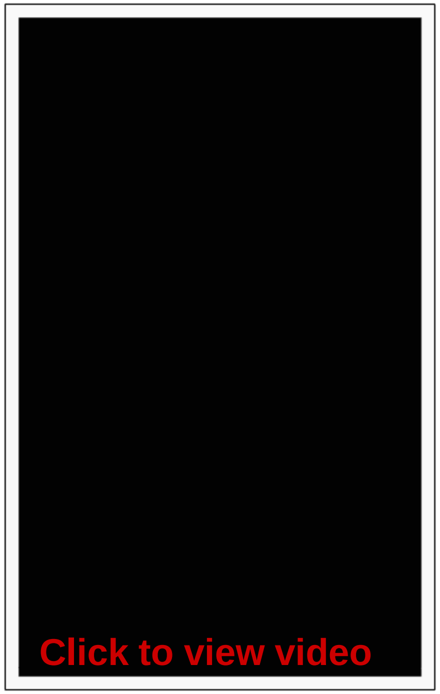
Note: Tin Melts at 232ºC (450ºF)

Example – “Sprung Jaw”

Jaw completely separated - large gap resulting in poor connection



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.

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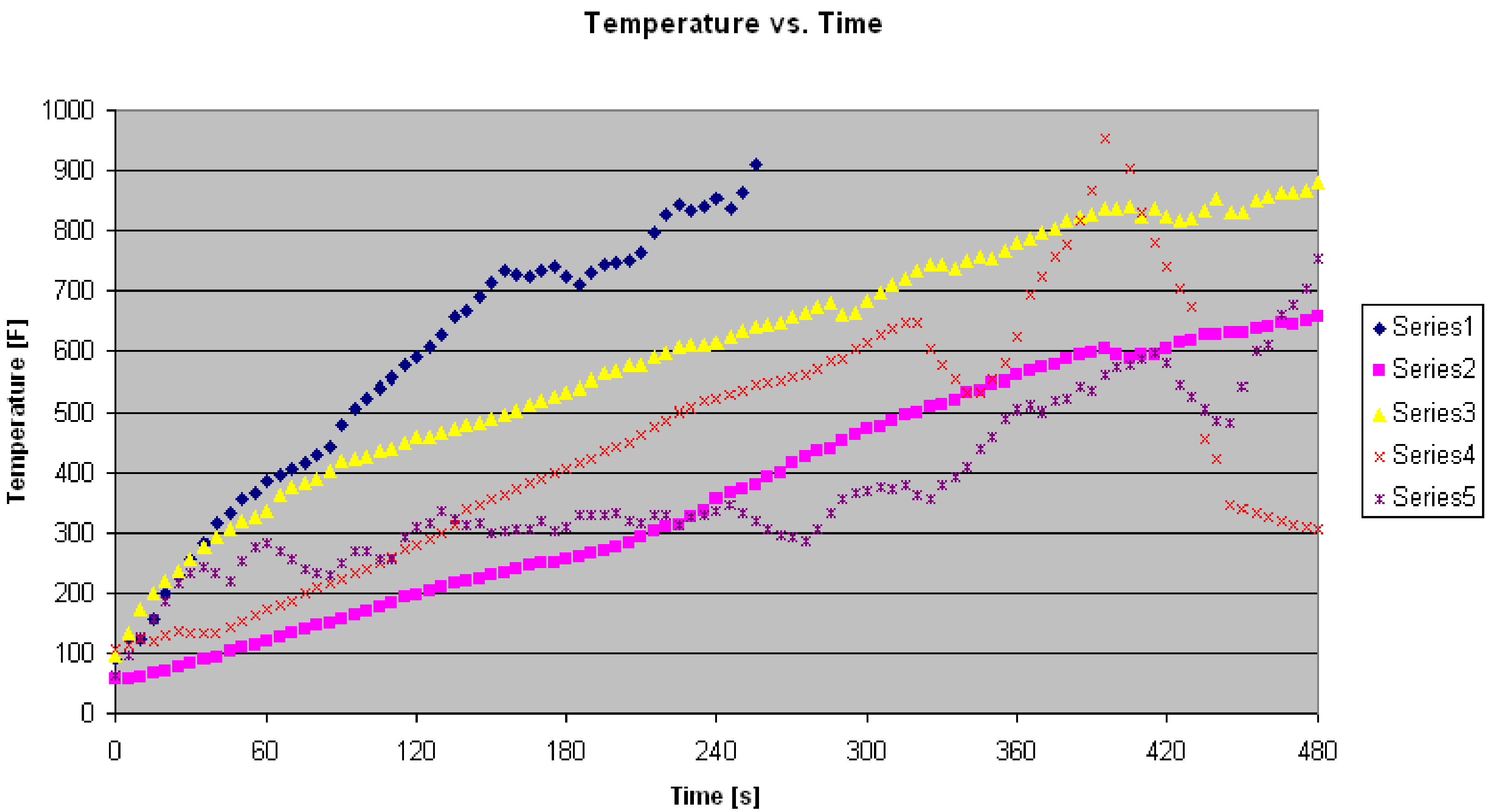
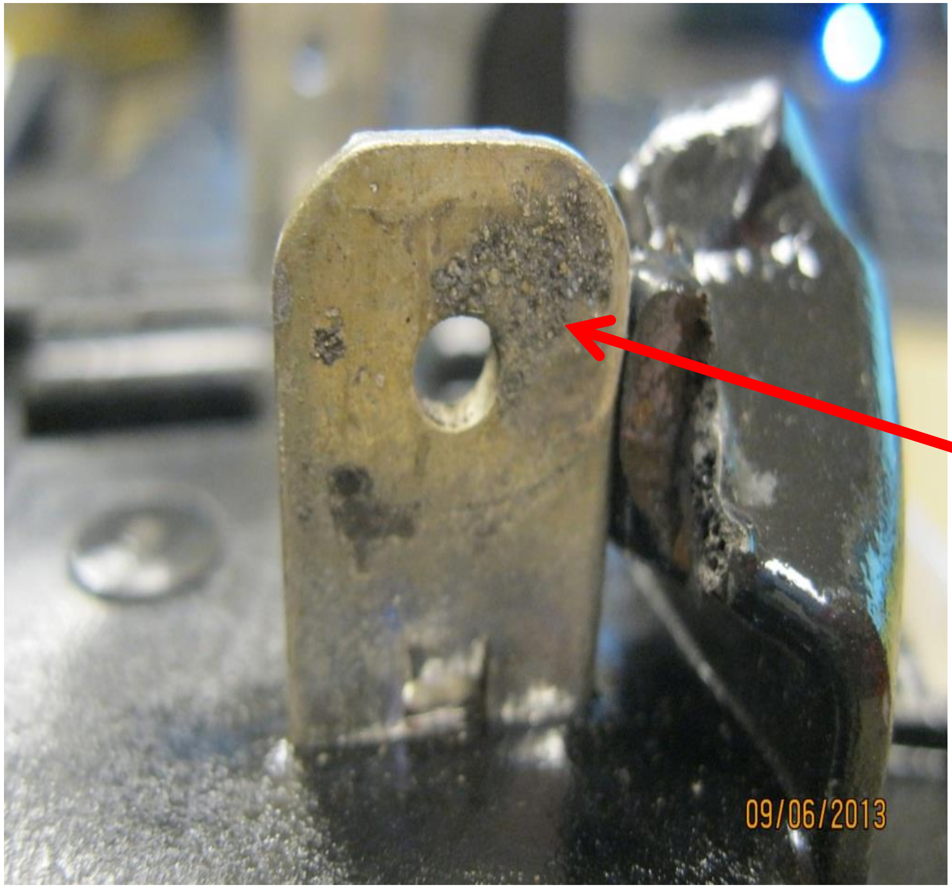
Temperature Rise Data



Jaw to Blade Arcing

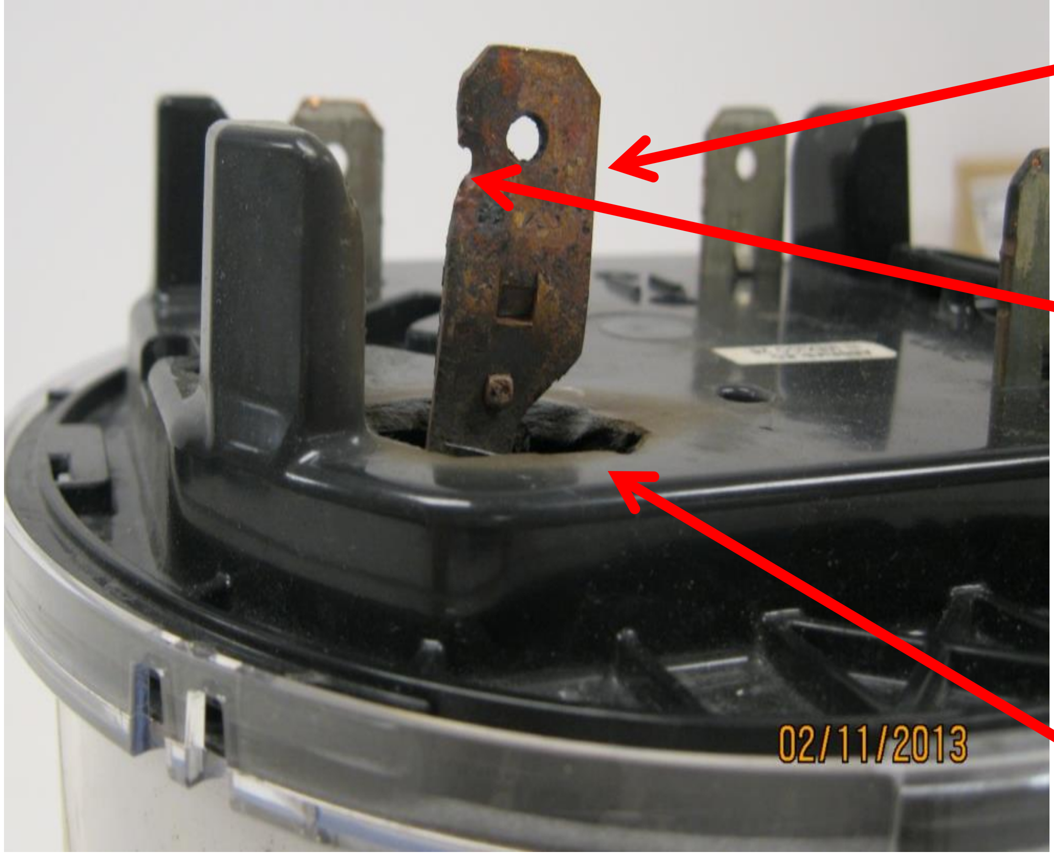


Jaws with intermittent connections will arc to the meter blade resulting in pitting on the blade.

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 (1984ºF)

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);

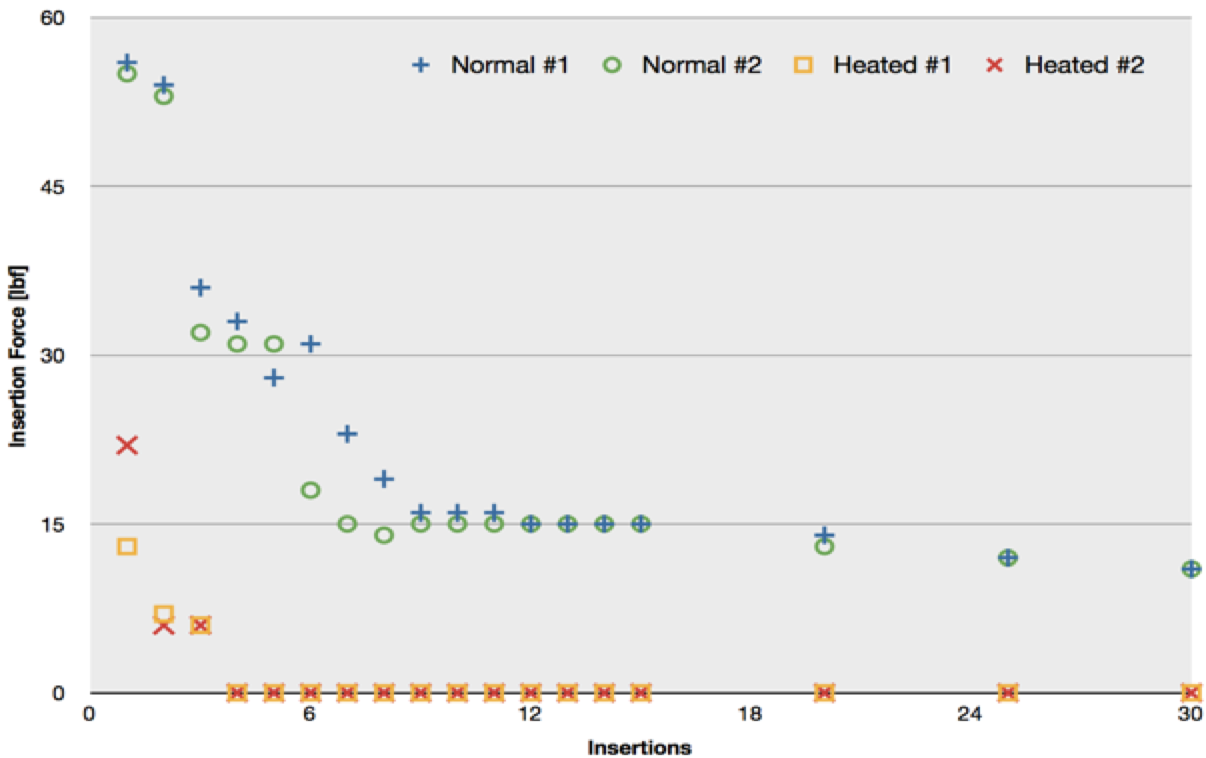
- Loss of jaw tension in at least one of the socket jaws.
- Vibration (or other catalyst to initiate arcing)
- Minimal load present

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

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



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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

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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.

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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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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 twenty four months virtually every meter manufacturer has begun to release 2S meters designed to withstand hot sockets.

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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.

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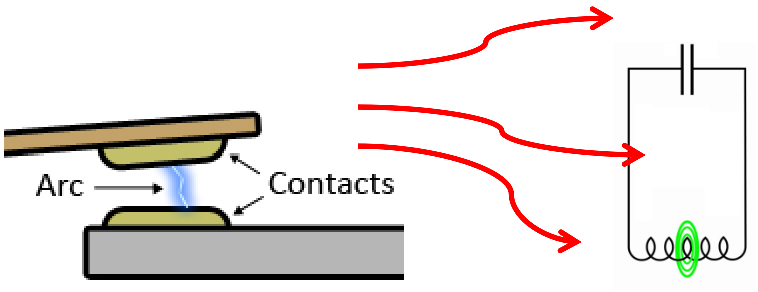
Finding a Hot Socket with a meter – What is known and Keys to these new technologies

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).



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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

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.
- In 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.

Questions and Discussion

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

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