Temperature Monitoring Hot Sockets

Industry Update / EEI Presentation

October 2013

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SENSITIVE UTILITY INFORMATION

This document provides sensitive information concerning a utility's practices. Landis+Gyr provides this document upon request for utilities to facilitate thoughtful internal discussions and to help utilities discuss hot-socket concerns with local fire departments and answering media inquiries.

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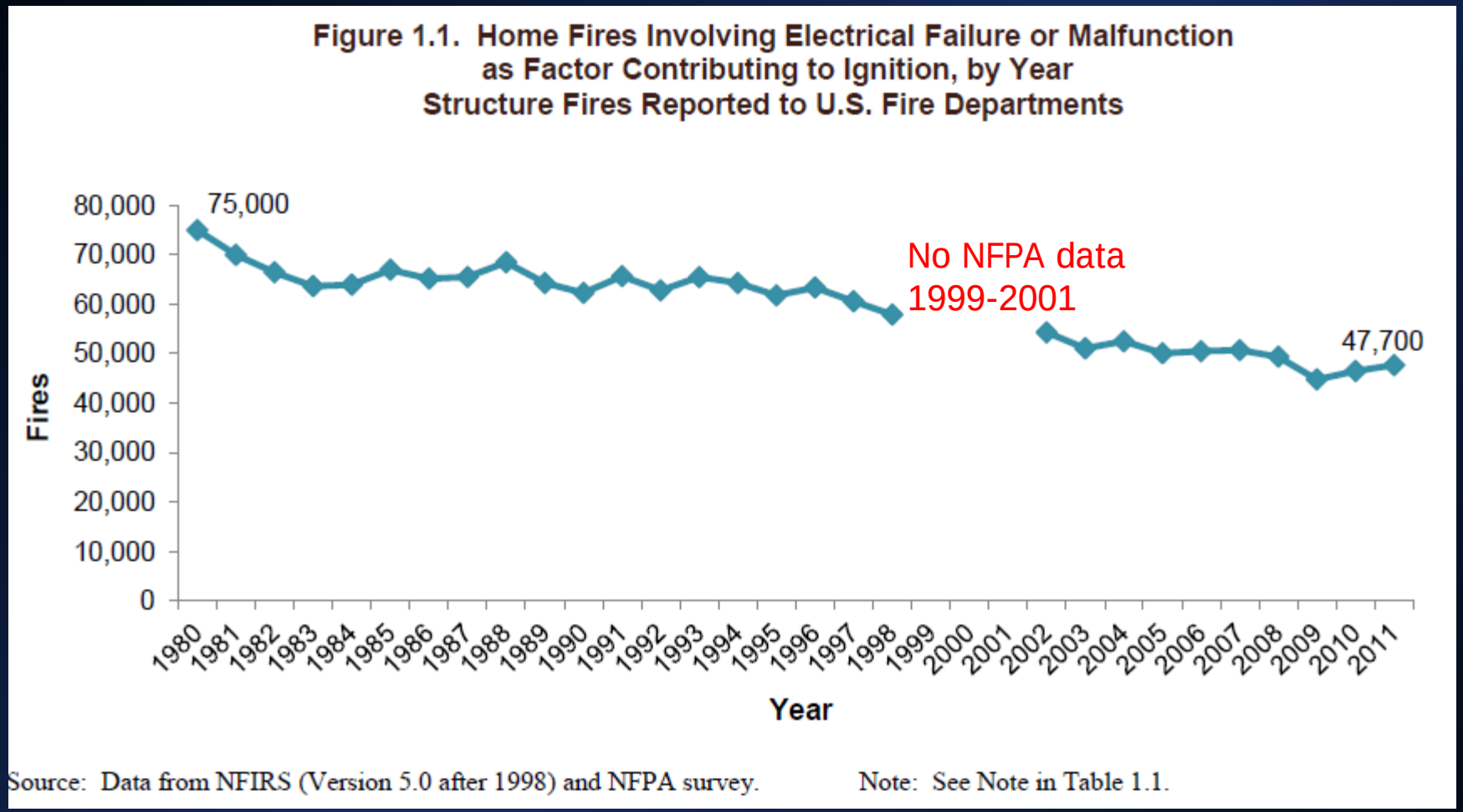
Overview of Hot Sockets

- Hot Socket Statistics
- Causes of Hot Sockets
- UL and ANSI C12.1 Meter Temperature Requirements
- Temperature conditions within a meter under lab conditions
- Temperature Monitoring Practices

Electrical Fires Generally Decreasing



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

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%)

No statistical change in fires in the vicinity of the Meter or Meter Box since 2003-2007 report

620/year 2003-2007

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 135 million electric meters installed in the US

630 fires/year / 135m = **4.5 average per year over 1,000,000 meters**

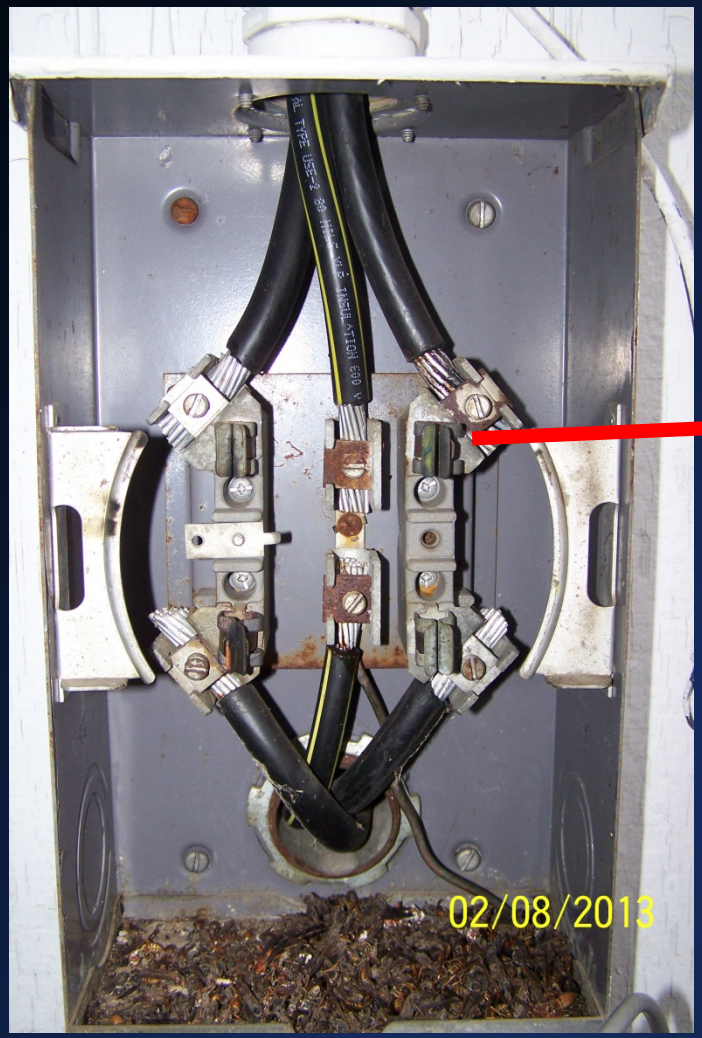
Taking into account wiring into/out of socket may increase the rate:

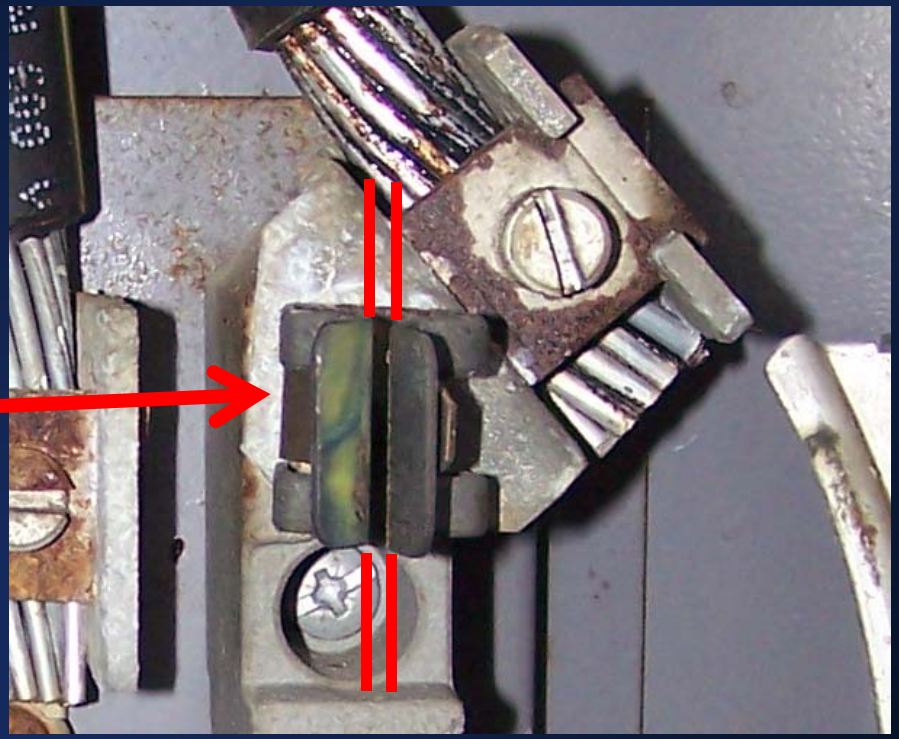
(690+610+530)/ 135m = **13.5 average per year over 1,000,000 meters**

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 loads exceeding socket capacity – lots of older 100 amp services in the field

Hot Socket Causes – Sprung Jaws



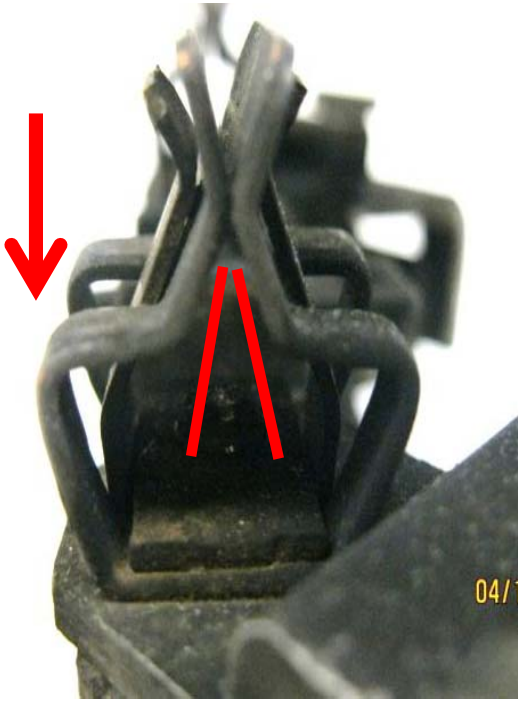


Tin plating on jaw “cooked”

Heat accelerates oxidation on lug wire

Note: Tin Melts at 232ºC (450ºF)

“Bent Jaw” Connection (Continued)



Jaws are bent and do not meet parallel in the center.

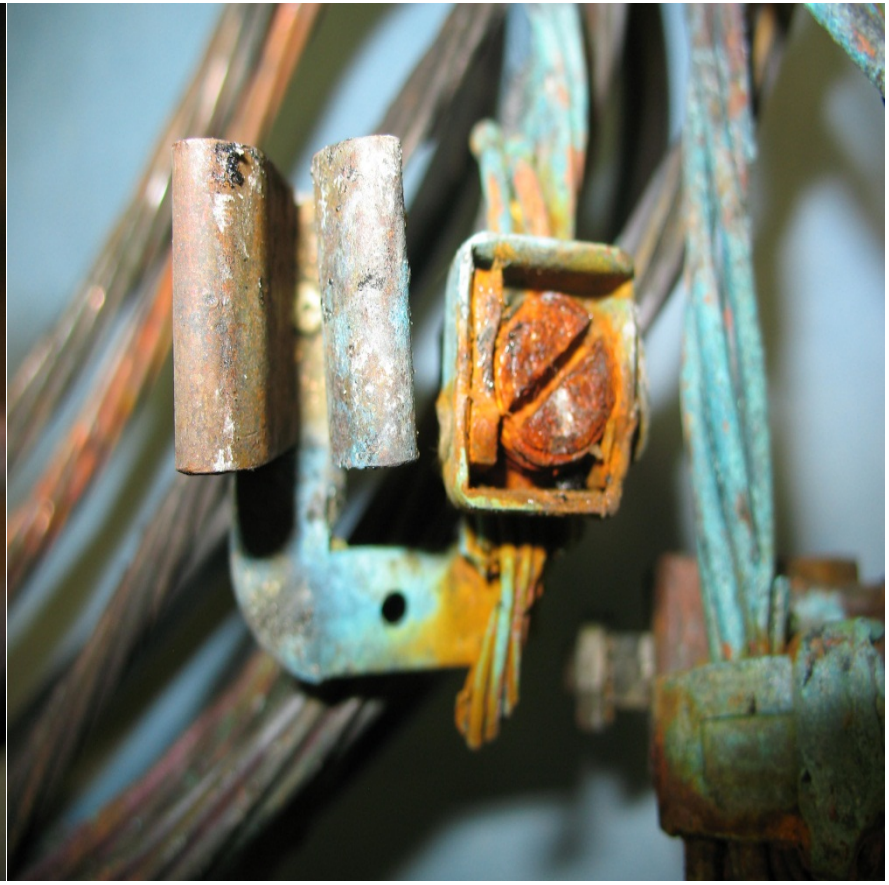
Jaws appear bent down and splayed apart.

Good Jaws are almost parallel in the center, flat contact area.

This jaw/blade exhibited minimal if any thermal damage.

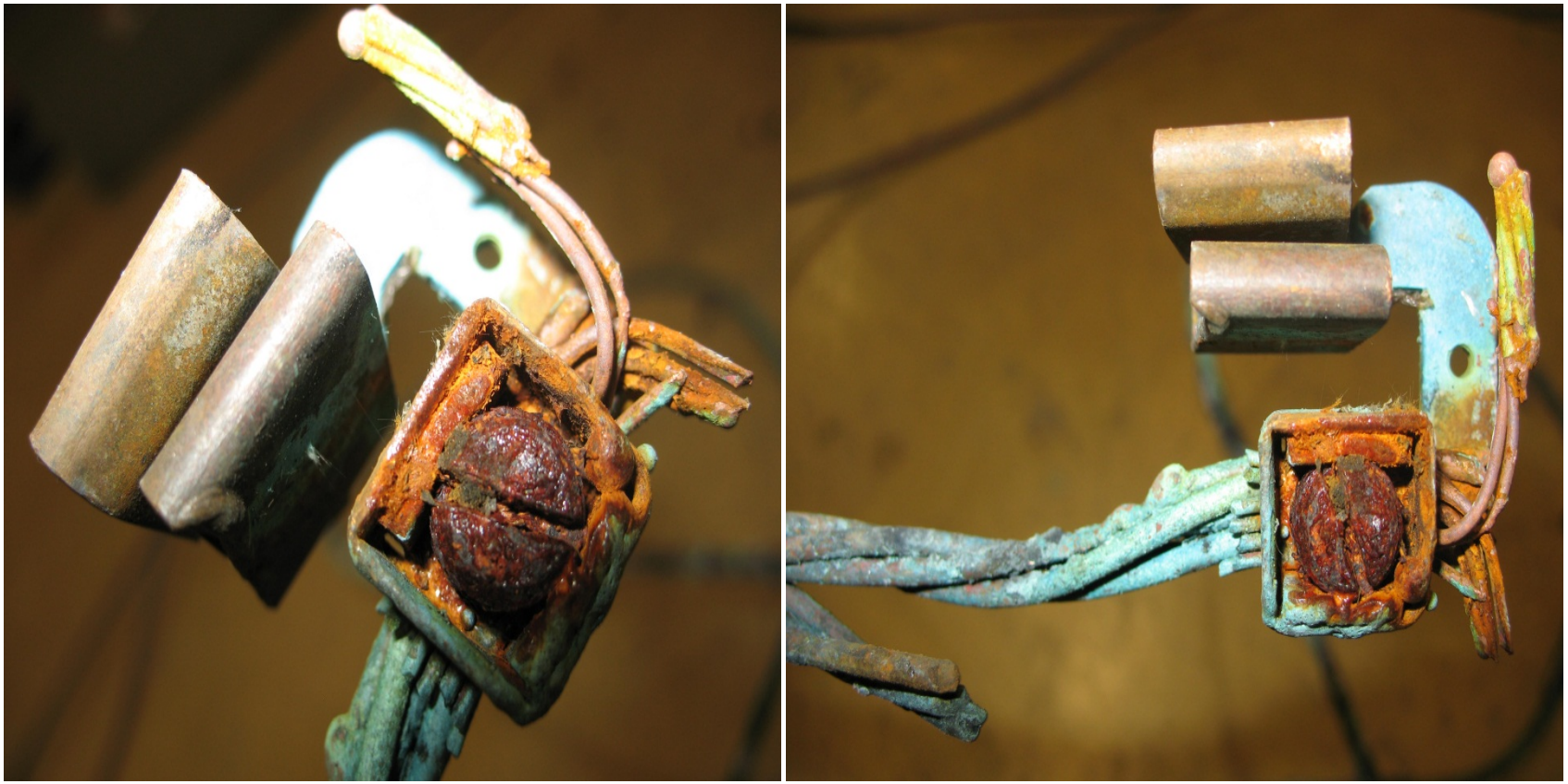
Example – “Sprung Jaw”

Jaw completely separated - large gap resulting in poor connection

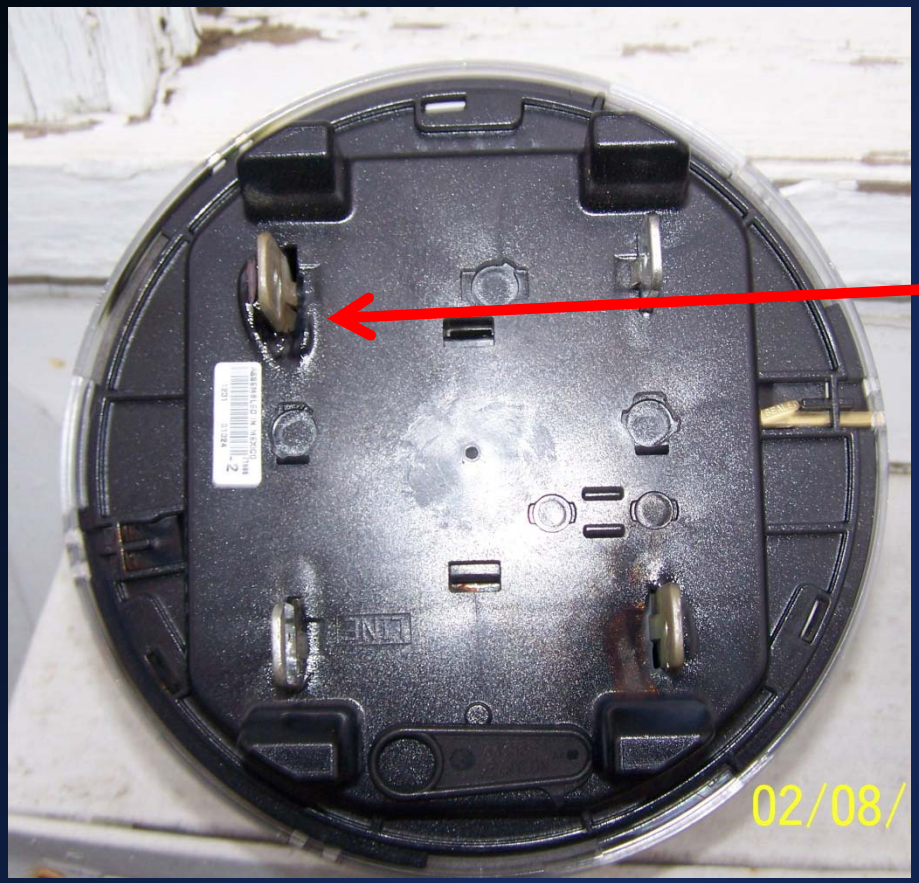


Example - “Skewed Jaw”

Screwdriver or other tool inserted and twisted to reduce the force necessary to insert / install the meter by spreading the jaws apart



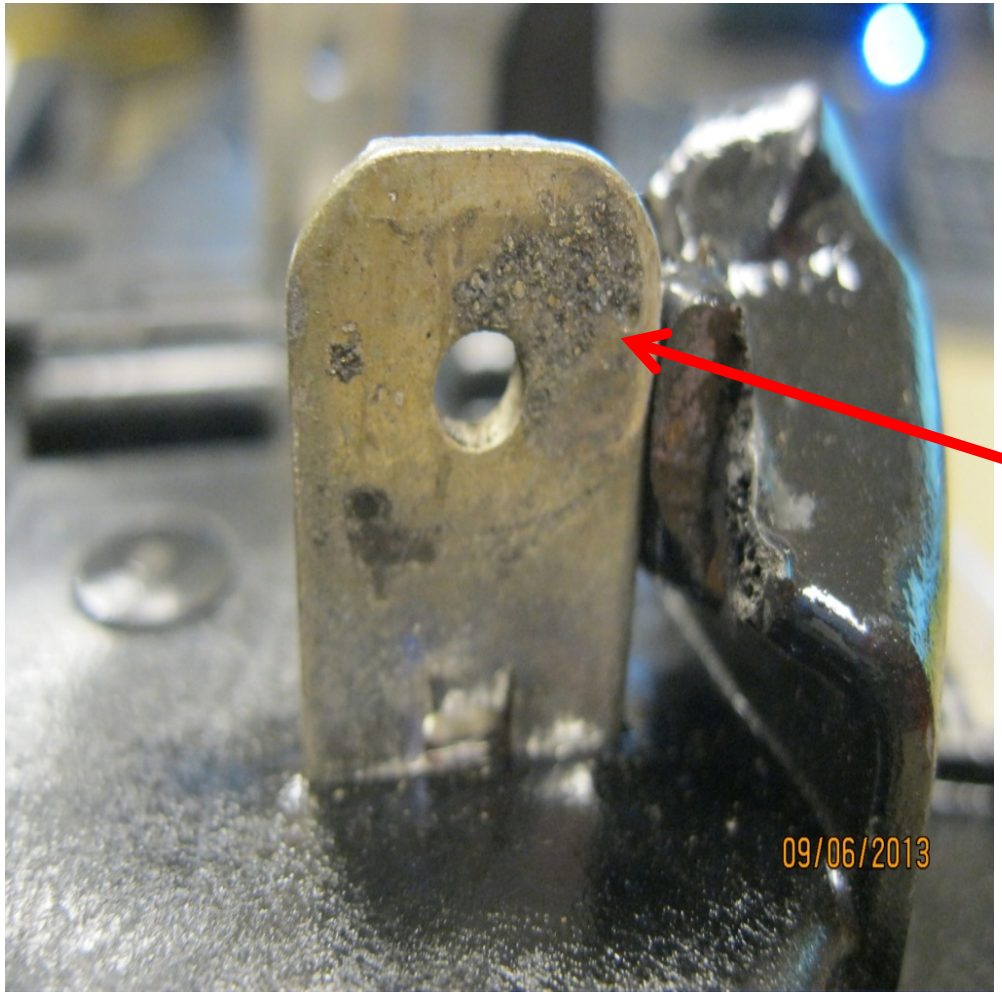
Hot Socket – Sprung Jaws
Localized Heating On Meter Blade



Heat from poor jaw connection flows through meter blade.

FOCUS AL and FOCUS AX non-disconnect base plastic has 350ºC (660ºF) melting point.

Jaw to Blade Arcing

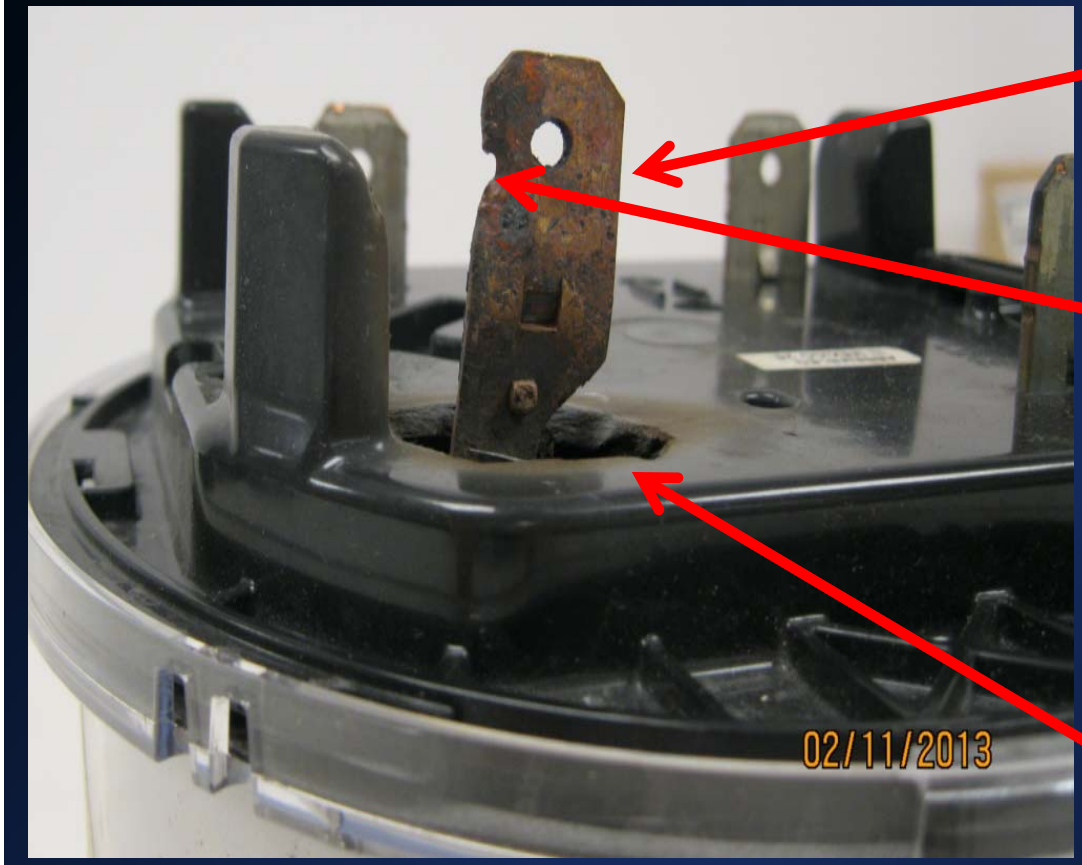


Jaws with intermittent connections will arc to the meter blade resulting in pitting on the blade.

Blade shows early signs of arcing.

Tin Melts at 232ºC which is lower than the 350ºC baseplate 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)

UL Materials for Baseplate and Service Switch

UL 94 5VA is the most stringent UL plastic requirement

- **5** repeated applications of a **5** inch flame
- Flame applied at 20 degree angle for **5** seconds
- Plastic sample mounted **Vertically**
- Material may not burn longer than 1 minute with no flaming particles given off after 5th application

UL 2735 Standard for Safety – Electric Utility Meters

Section 16 Flammability - Calls out UL 94 5VA test - Applied to external baseplate surface as well as internal surfaces of the meter through a hole in the base:

When testing complete assemblies, if the flame extinguishes due to oxygen starvation during one or more of the 5 second applications, the burner is to be withdrawn, re-ignited, and testing shall be continued until five applications of the test flame (including any application that self-extinguishes) are conducted.

UL 2735 – Temperature Ratings at Maximum Current

Table 15.1
Surface temperature limits in normal condition

	Part		Limit
			°C
1	Outer surface of enclosure (unintentional contact)		
	a)	metal, uncoated or anodized	65
	b)	metal, coated (paint, non metallic)	80
	c)	plastics	85
	d)	glass and ceramics	80
	e)	small areas (<2 cm^2) that are not likely to be touched in NORMAL USE	100
2	Knobs and handles (NORMAL USE contact)		
	a)	metal	55
	b)	plastics	70
	c)	glass and ceramics	65
	d)	non-metallic parts that ir	70

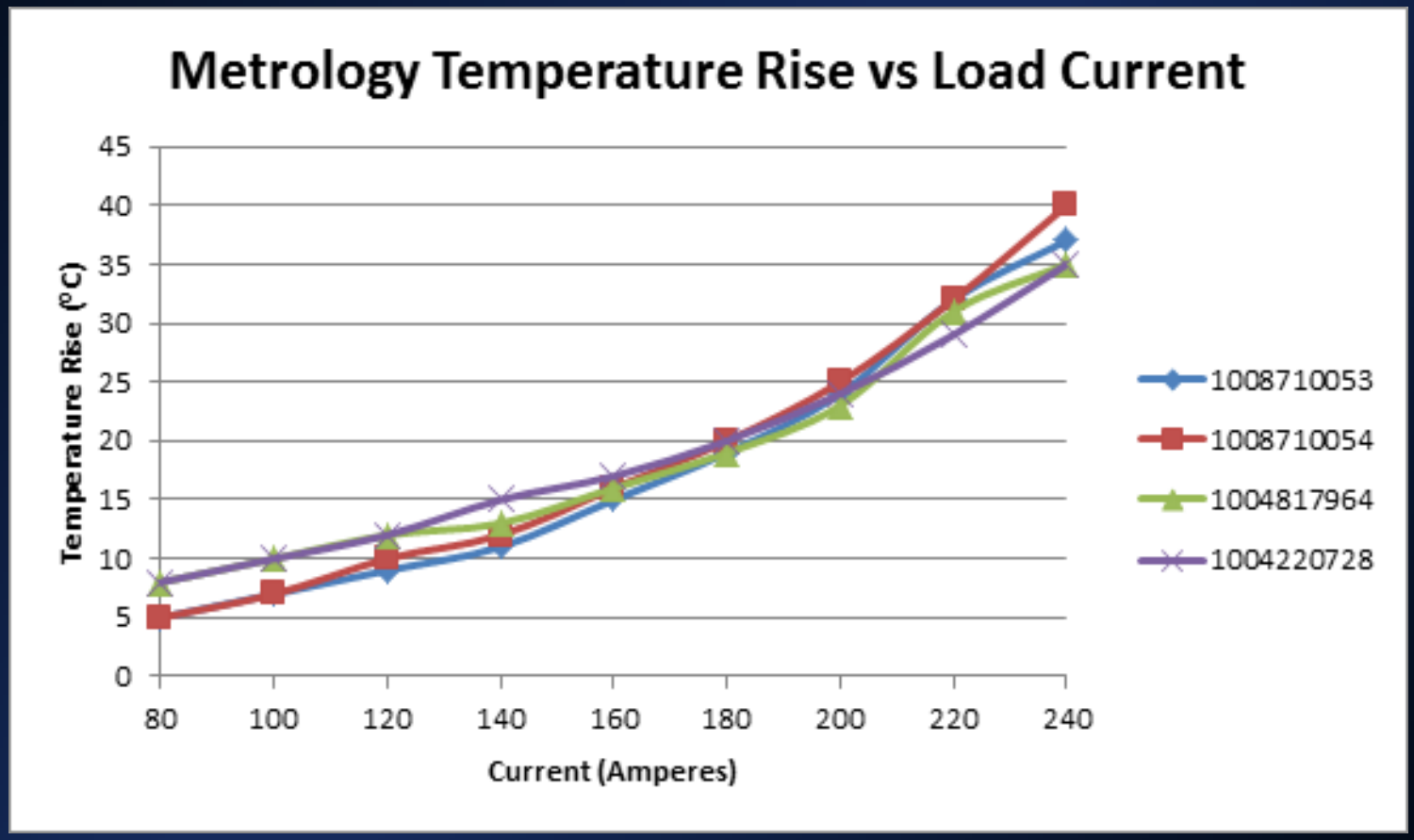
For Comparison:
ANSI C12.1 Test No. 9 Temperature Rise
55°C added to 40°C ambient = 90°C max

Table 15.2
Maximum temperatures for insulation material of windings

Class of insulation	Normal condition	SINGLE FAULT CONDITION
	°C	°C
Class A	105	150
Class B	130	175
Class E	120	165
Class F	155	190
Class H	180	210

Metrology Temperature Rise with Current

Linear temperature rise rate of 2-3ºC for every 20 Amps increase until 160 Amps. Above 160 Amps, metrology temperature increases exponentially.

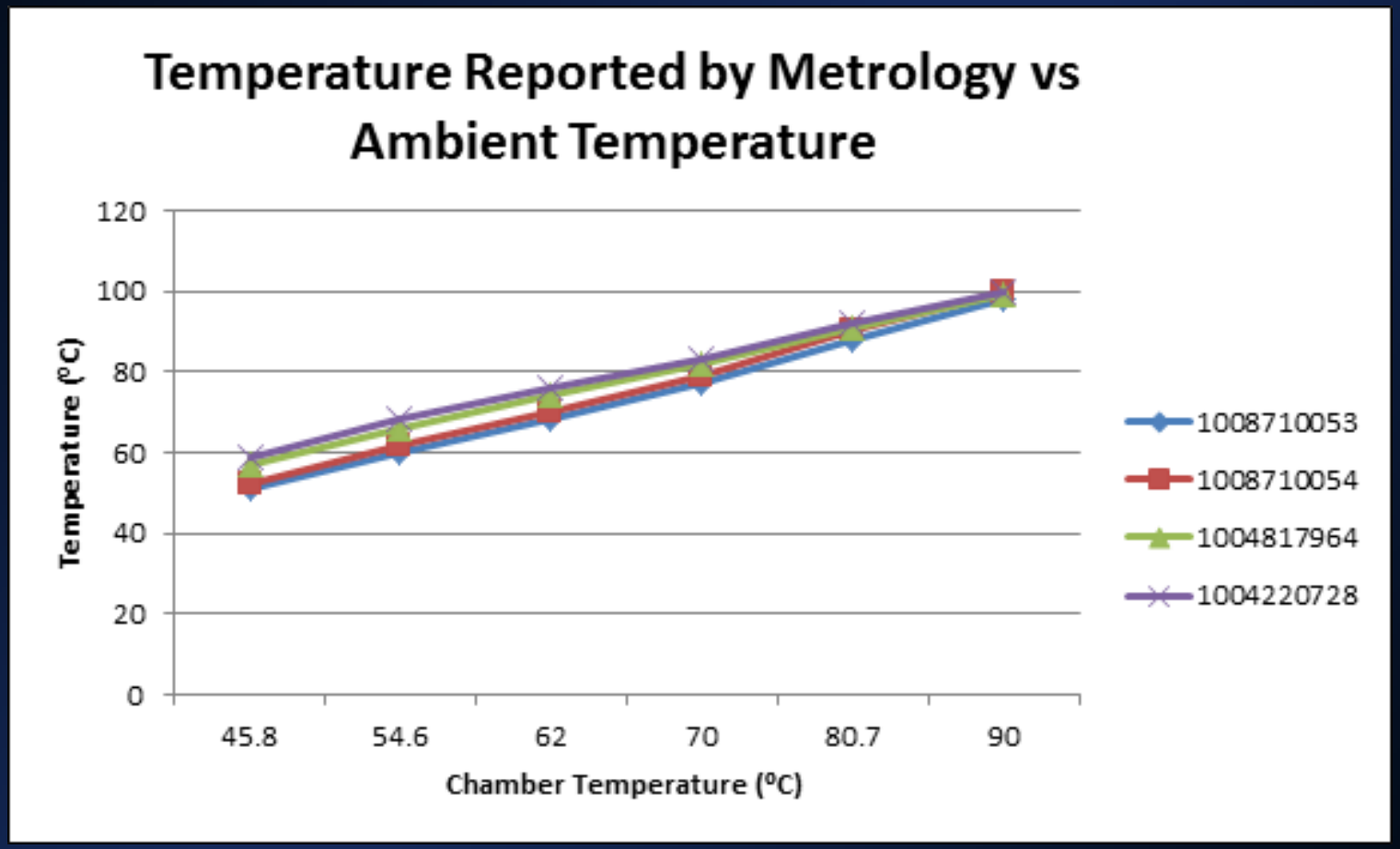


Conditions: FOCUS AX-SD form 2S – Ambient 23ºC +/-2ºC

Metrology Temperature Rise with Ambient

Metrology temperature 15ºC higher than ambient at lower temperatures.

Metrology temperature 10ºC higher than ambient at elevated temperatures.



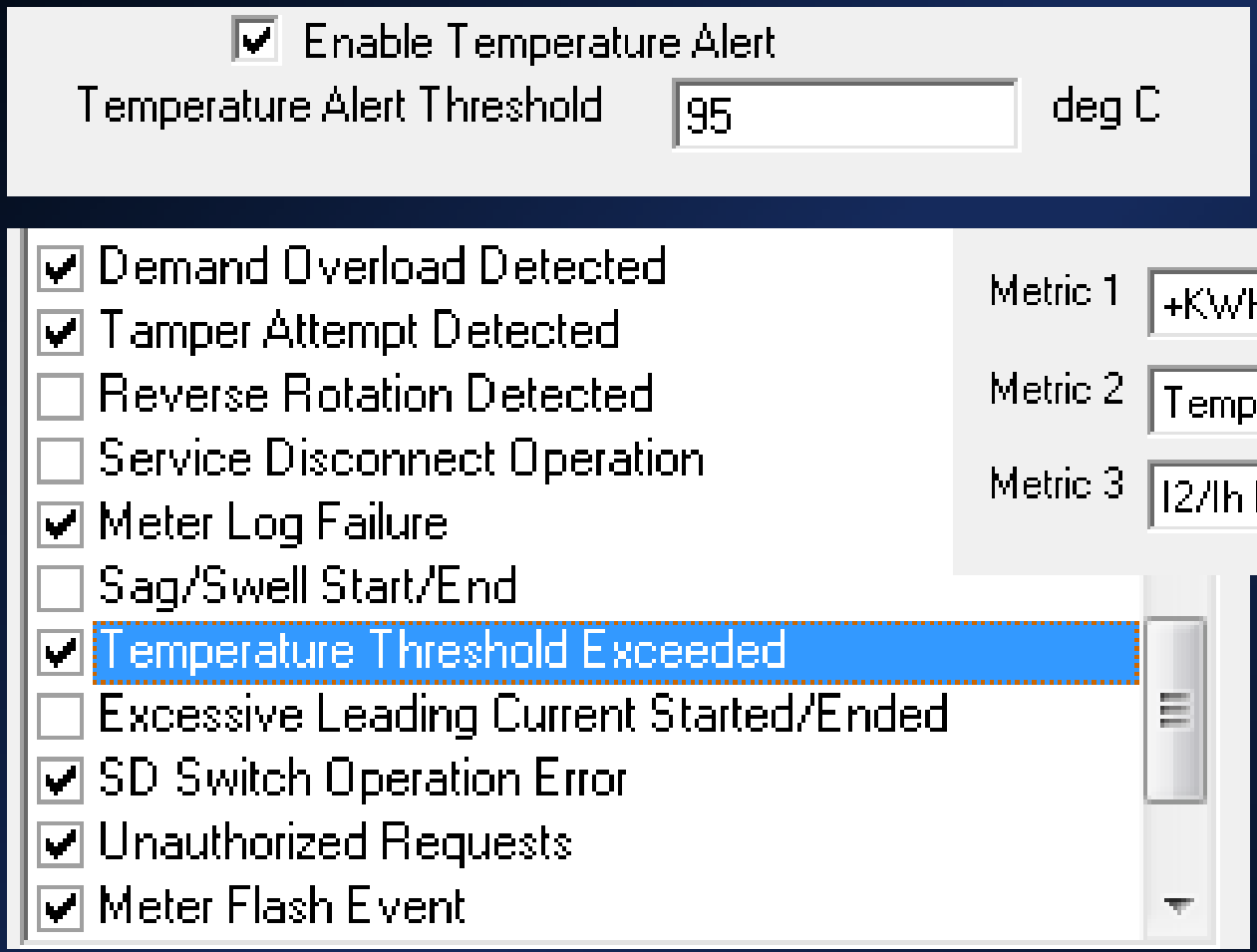
Conditions: FOCUS AX-SD form 2S with 30A load

Summary of Meter Temperature Monitoring

- Modest temperature differences found between radios on FOCUS AX-SD (+/-5ºC)
- Metrology temperature is consistently higher than ambient, but the differential narrows to 10ºC at elevated ambient temperatures which are of interest for “hot socket” detection.
- Heat radiating off of the meter’s current coils increases under-cover temperatures exponentially as load current exceeds 160 Amps.
- Heat due to a severe “hot socket” condition that can cause a melted baseplate will radiate through the meter’s current coils and cause an exponential temperature rise compared to ambient.
- Many radio transmitters will thermally shut down at elevated temperatures in the 90-100ºC range, however metrology will log the event for later reporting when radio has cooled off.

Meter Temperature Profiling and Alarm Capabilities

FOCUS AX and S4x provides instantaneous temperature, temperature alarm, logging alarm, and profiling of temperature



Hot Socket Monitoring– Utility Best Practices

- Some utilities recording temperature in load profile on sample of meters to understand ambient conditions
- If temperature threshold alert used – L+G recommends a value of 95-100^{o}C depending on utility environmental conditions. Utility may choose to ignore events occurring during sunny parts of the day.
- Some utilities taking temperature read coincident with current reading in middle of night
  - Night time read has no solar heating to influence temperature read
  - Night time typically has lower current (under 160 Amps) so load is less likely to cause false hot-socket events.
  - Comparison of temperature extremes with respect to the average has good correlation – Benchmark average, review those that are 5-6^{o}C degree's above average (deviation) and assess for potential risk

Future Areas of Research

- Simulate hot socket conditions – Not an easy task. Many attempts have been made to simulate hot sockets
- Once hot socket conditions can be simulated, monitor metrology temperature to confirm understanding and refine “best practice” recommendations

Questions?

Thank you

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