

# *Quality Switch Tapchanger Functional Life Tests*

*by Philip J. Hopkinson, PE 2/22/05*

**Objective: Demonstrate contact stability with de-energized tapchangers in FR3 Fluid**

**Requirement: Pass 30 day test of 2XN current in 130C bath for 8 hrs. on and 16 hrs. off (no heat to bath), with contact resistance stable and with no more than 25% increase.**

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Objective: Demonstrate contact stability with de-energized tapchangers in FR3 Fluid

First tests in FR3

Results

A. Silver plate on each contact

Passed

B. Silver plate versus plain copper contacts

Passed

Second Tests in FR

C. Plain Copper versus Plain Copper

Passed

**All contacts in FR3 passed the test !!**

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Photographs at Quality Switch: 2 Tanks and Power Supply



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Photographs at Quality Switch: Doug Senne, Phil Hopkinson and Donnie Meyers pointing at tank with Silver-Copper

Tank with silver-silver contacts



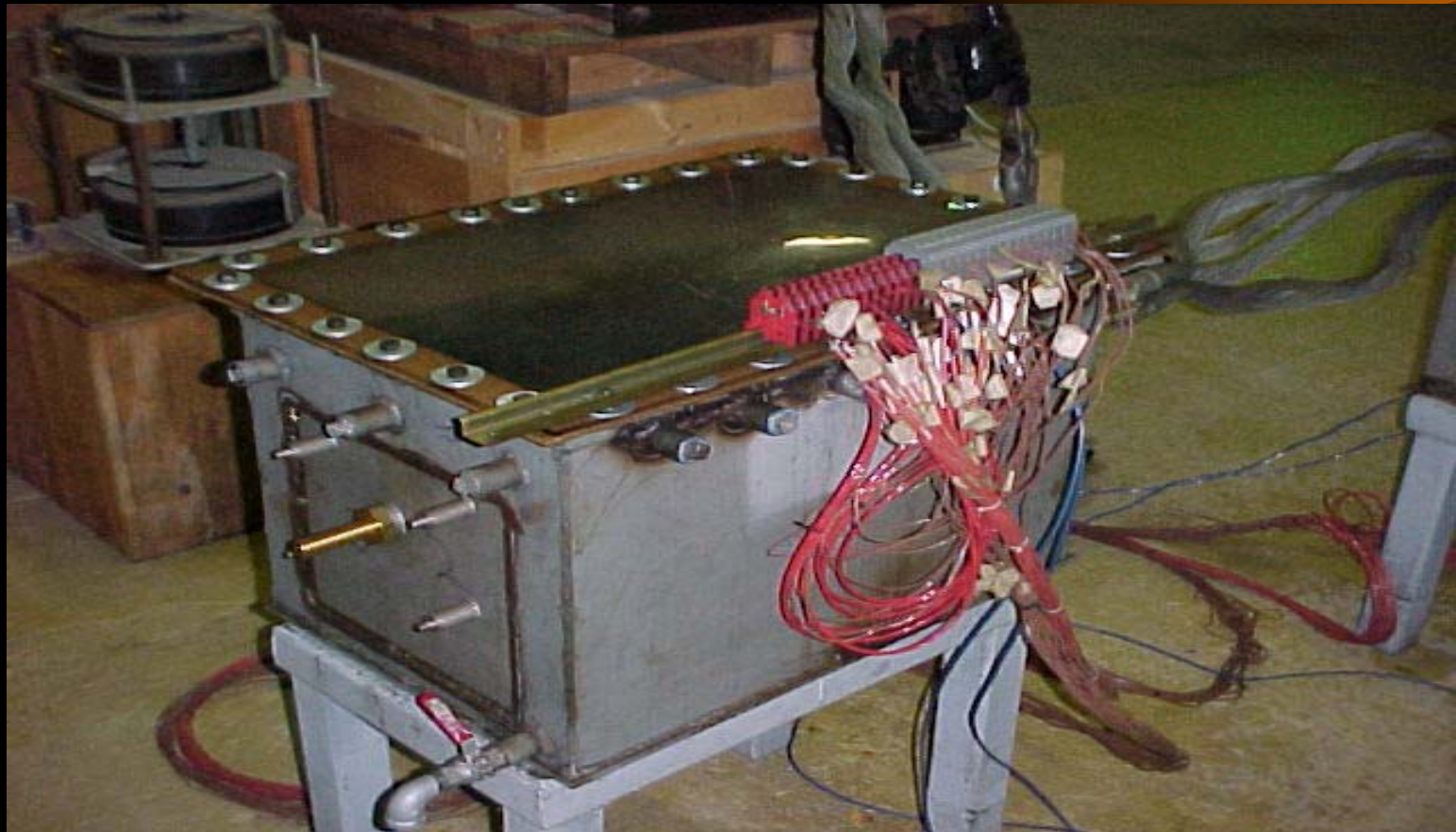
Tank with silver-copper contacts

Power supply

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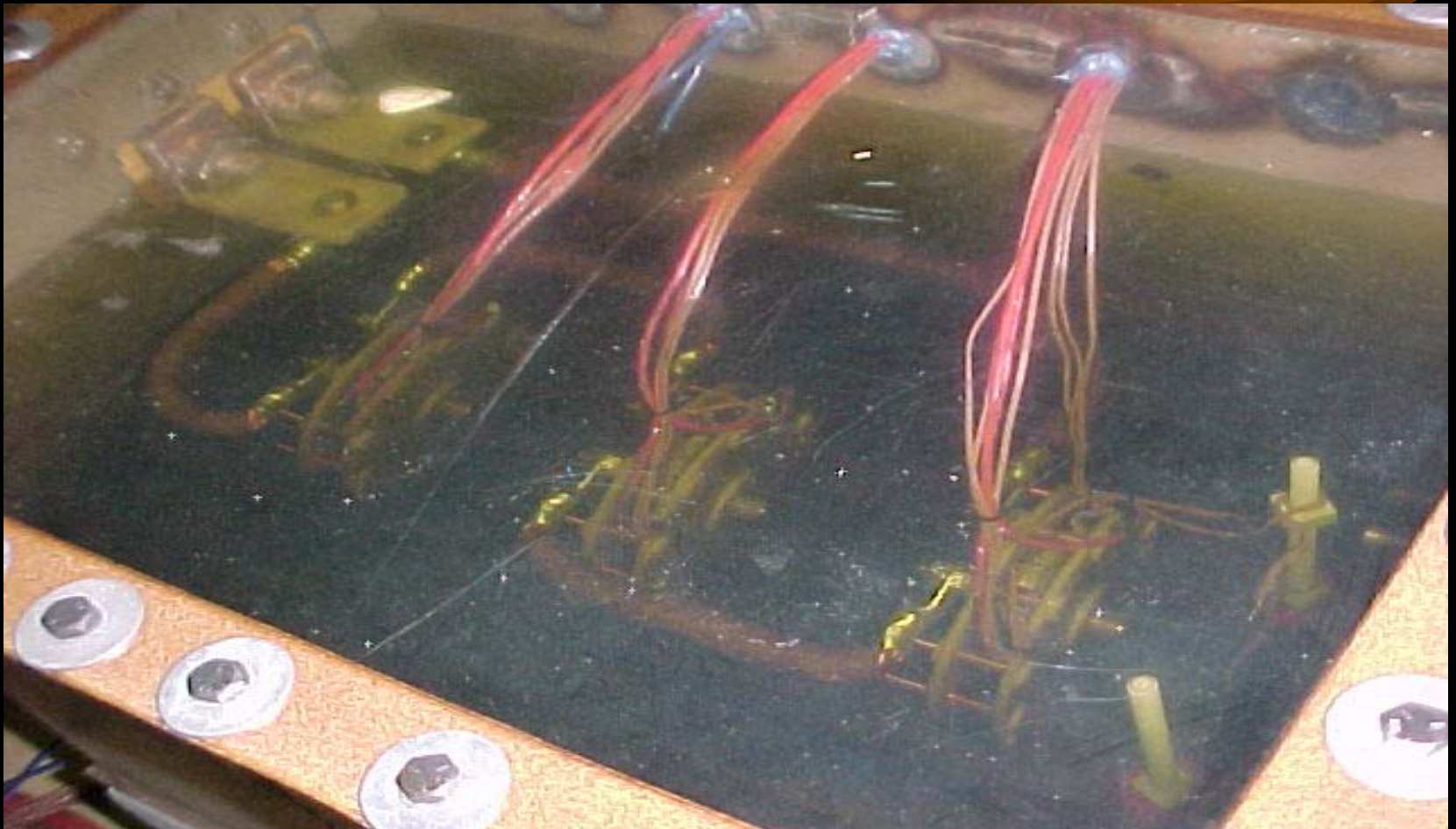
Photographs at Quality Switch: Cork gasketed plexiglass top, millivolt connector block on left and thermocouple block on right



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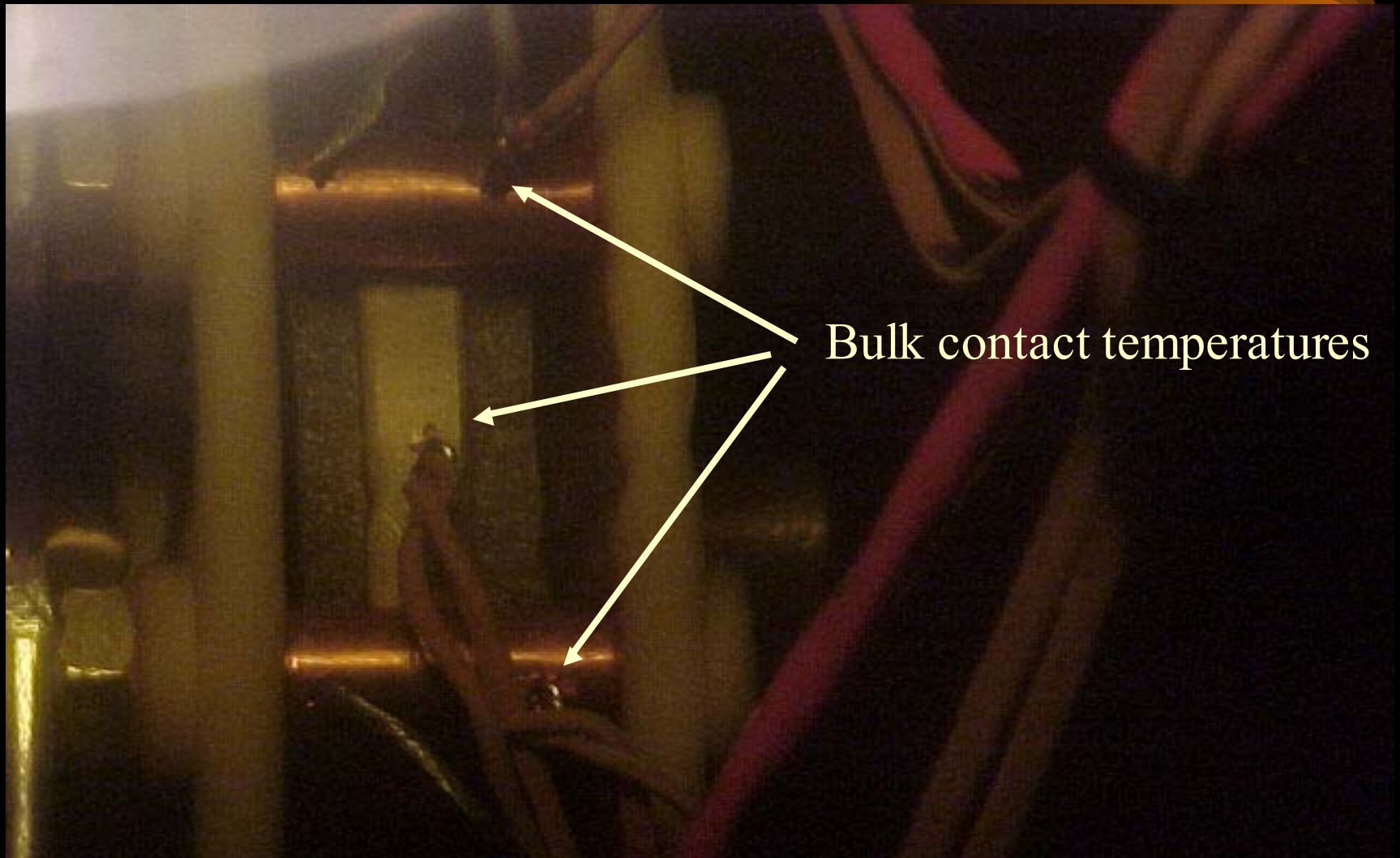
Photographs at Quality Switch: 3-ganged 3-phase switch with thermocouple and millivolt drop leads to data-logger



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Photographs at Quality Switch: Silver-Copper Contacts



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Photographs at Quality Switch: Silver-Silver Contacts



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## Three types of graphical results

1. Contact volts at 2XN Load
2. Contact Super-temperatures
- 3. Contact resistance**

## Notes:

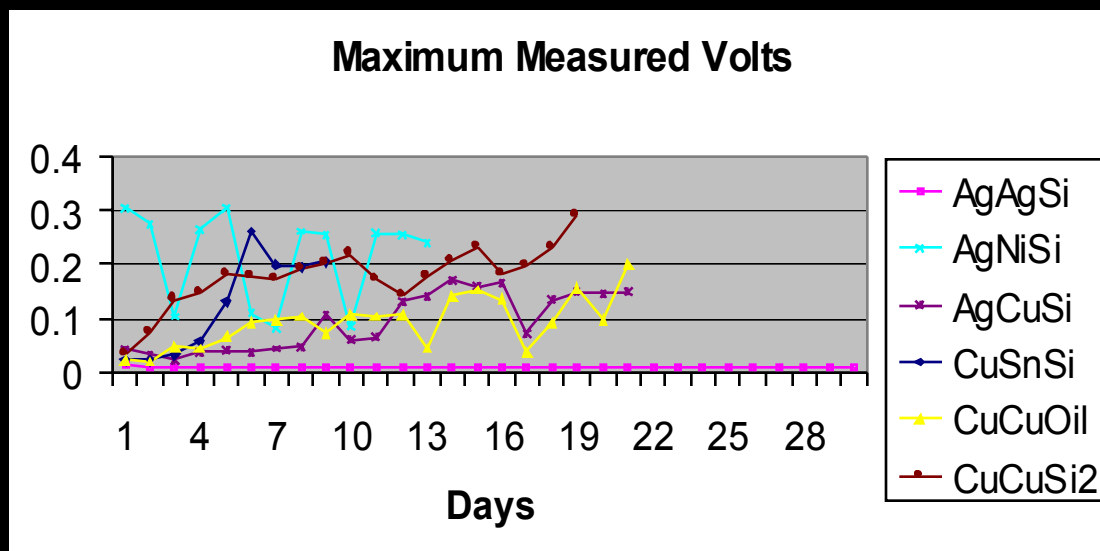
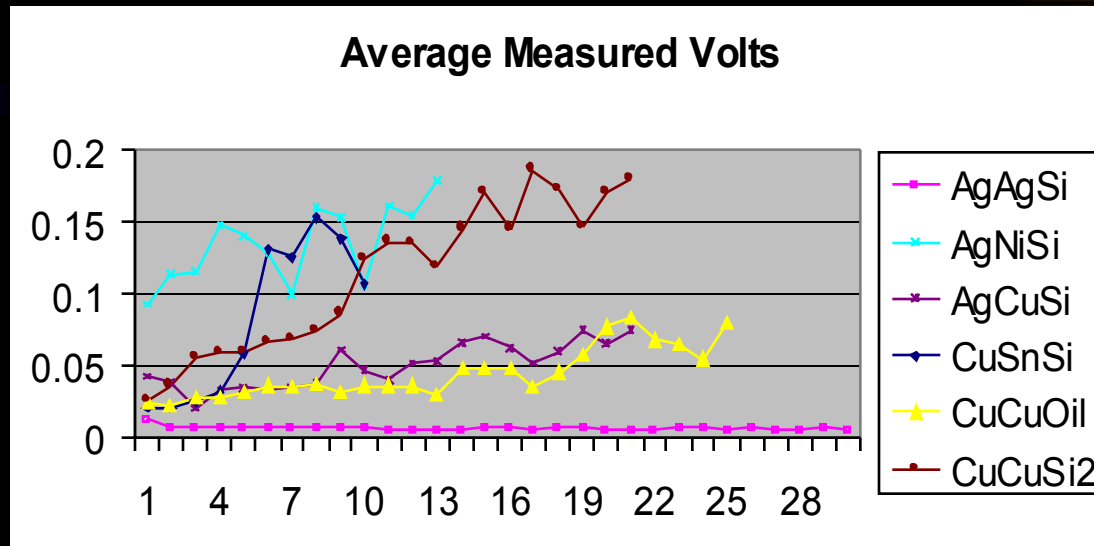
- 1. Supertemperature calculated per Slade =**

$$18700 * V^2 + \text{Bulk/Oil} + \text{Oil Temperature}$$

- 2. Contact Resistance = Volts / Amps**

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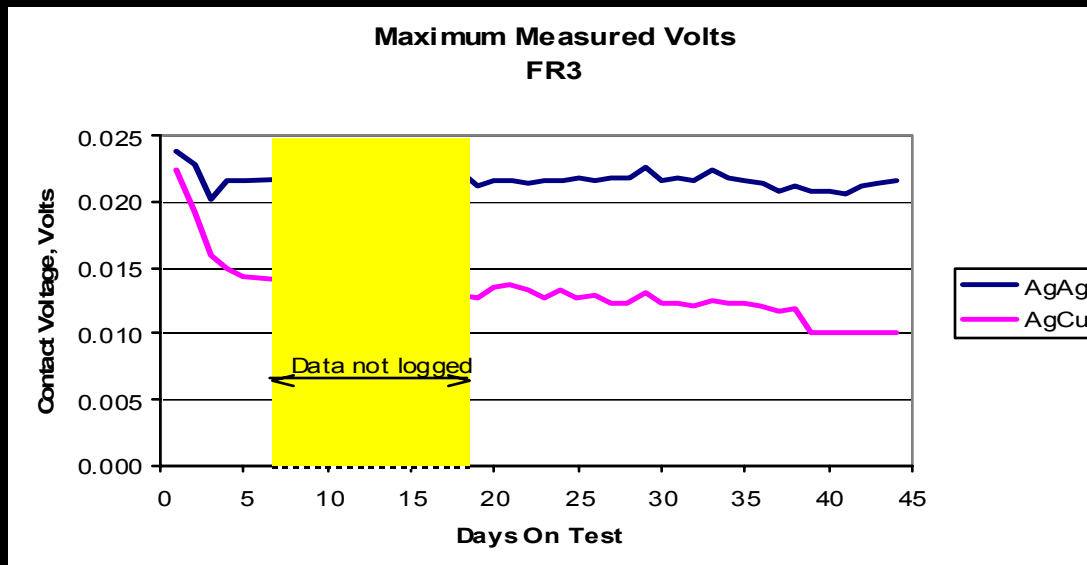
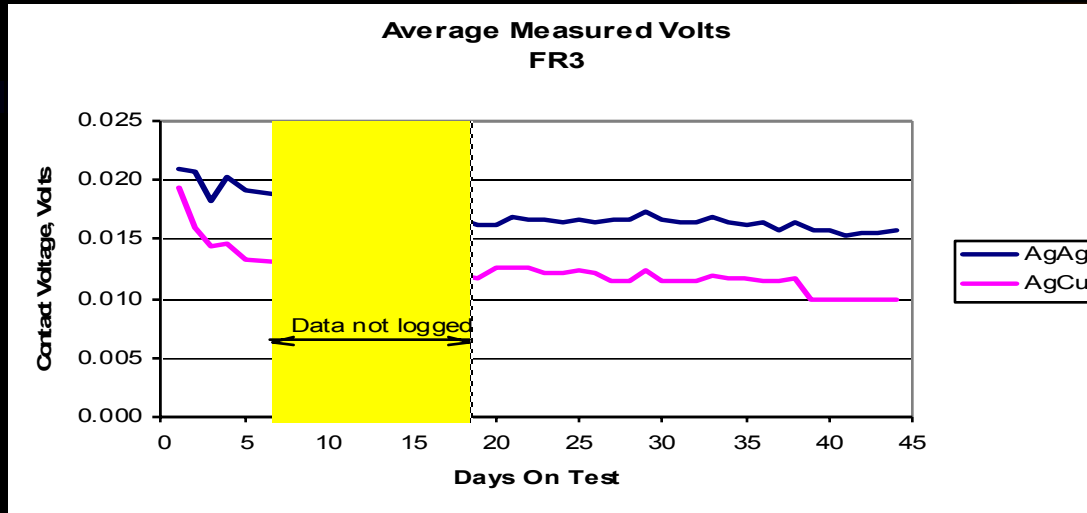


Typical Data

Millivolts drop across the contacts is a measure of the contact resistance and is used to determine the hottest spot, the Super-Temperature

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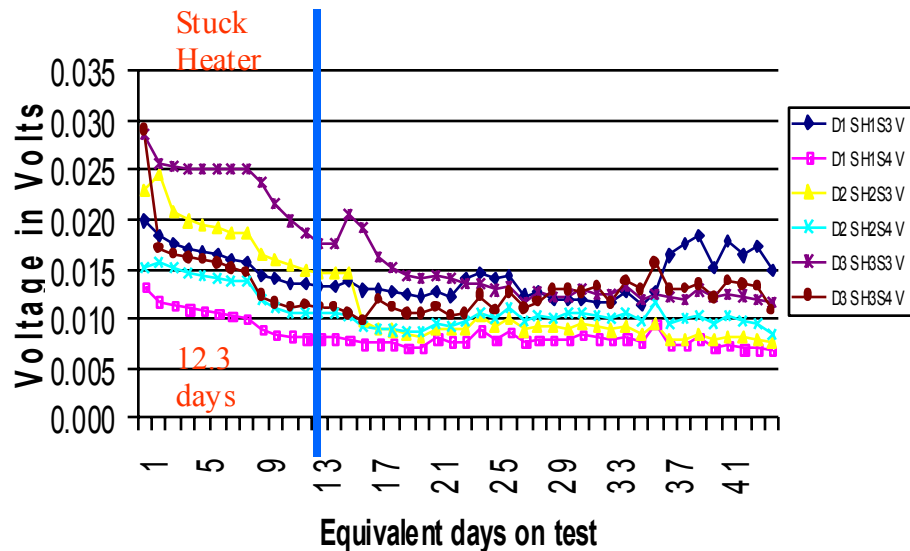
Typical Data

Millivolts drop across the contacts is a measure of the contact resistance and is used to determine the hottest spot, the Super-Temperature

# Quality Switch Tapchanger Functional Life Tests

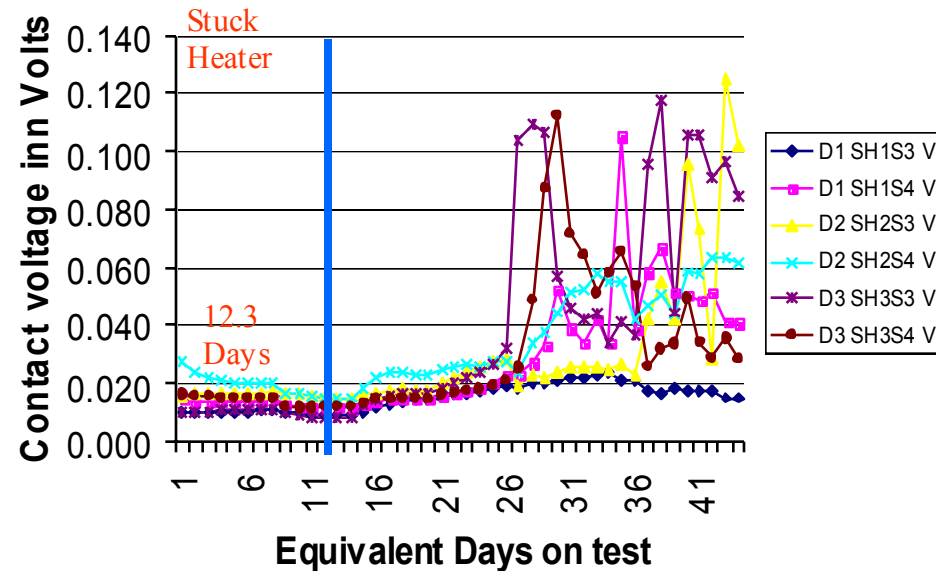
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CU-CU FR3 Contact Voltage with days adjusted for stuck heater relay (+12.3 days)



Pass

AG-CU Mineral Oil contact voltage with days adjusted for stuck heater relay (+12.3 days)



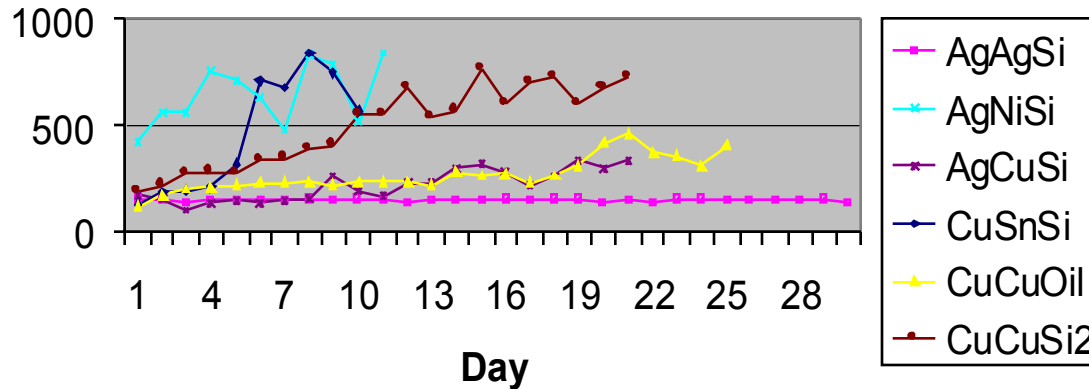
Fail

Contact Voltage used to determine Super-temperature and resistance

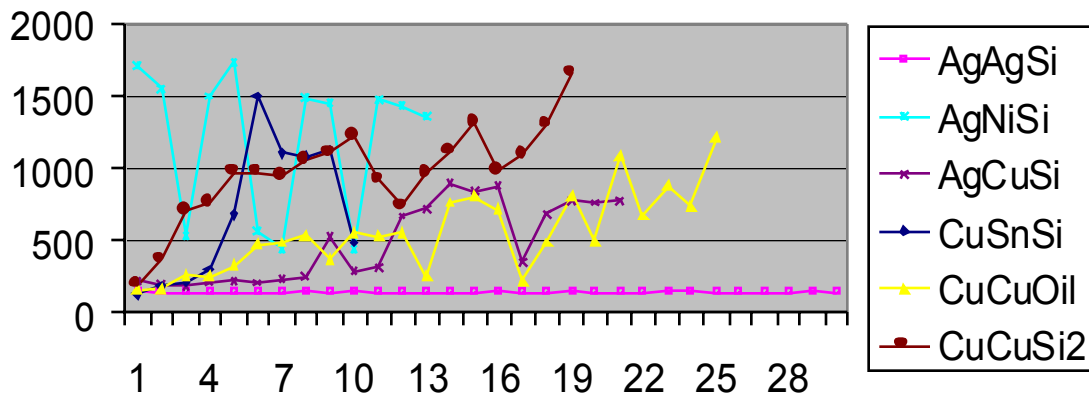
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### Super Temperatures - Averages



### Super Temperatures - Maximum

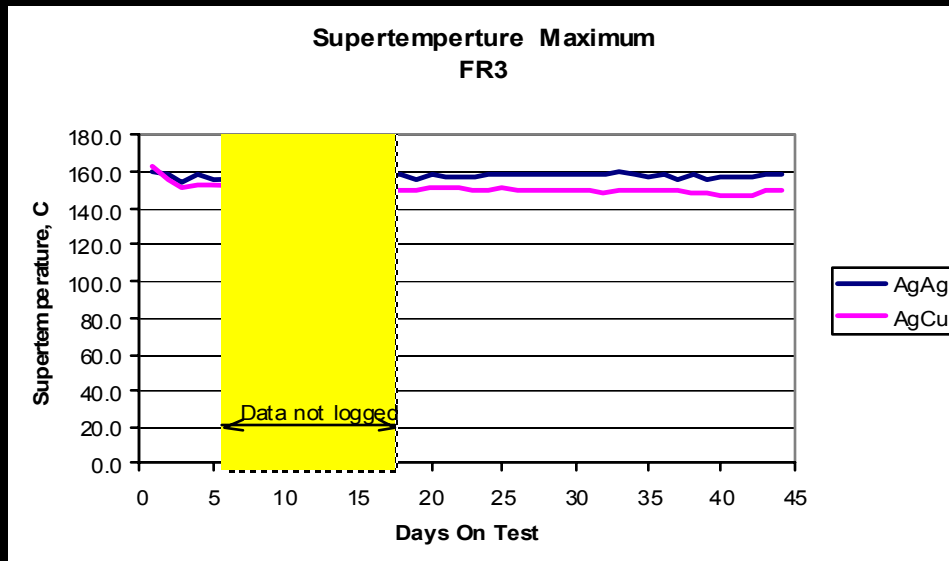
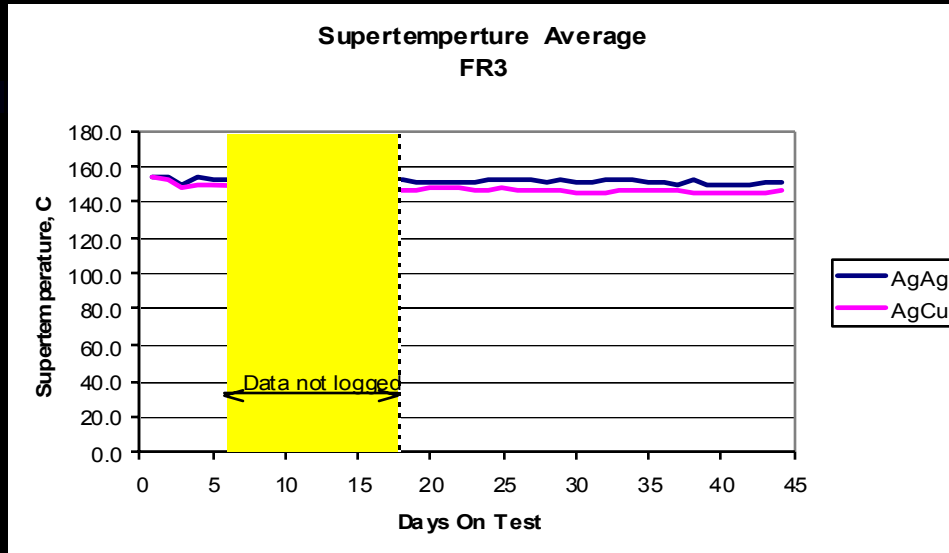


Typical Data

Super-temperature is a measure of the temperature at the actual point of contact

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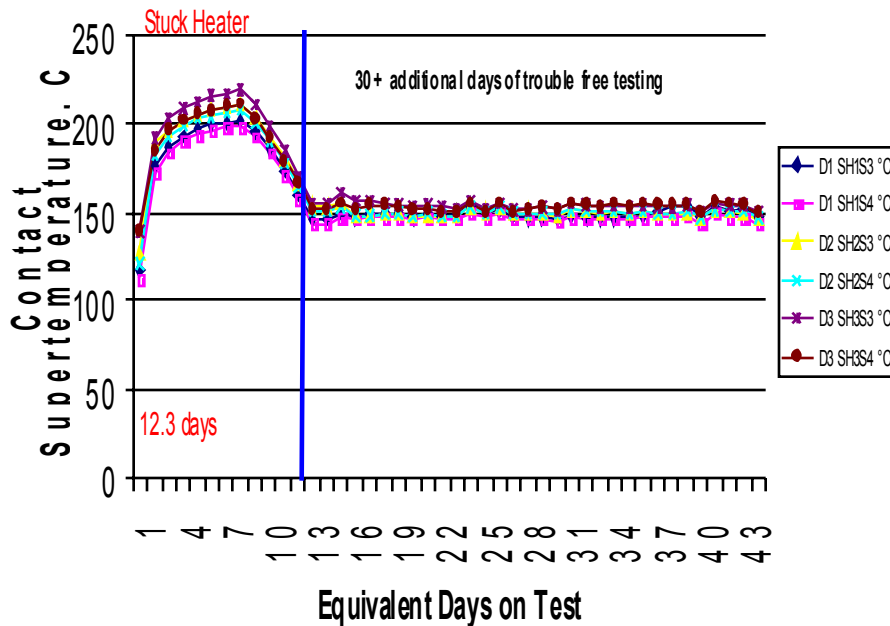
Typical Data

Super-temperature is a measure of the temperature at the actual point of contact

# Quality Switch Tapchanger Functional Life Tests

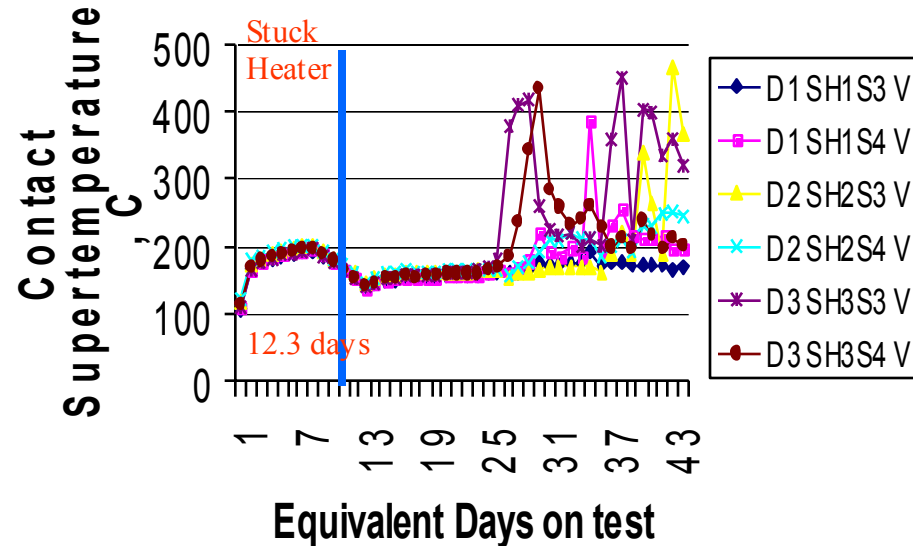
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CU-CU-FR3 Contact Supertemperature with days adjusted for heater stuck relay (12.3 days added to front end of test)



**Pass**

AG-CU Mineral Oil Contact Supertemperature with days adjusted for stuck heater relay (12.3 days)



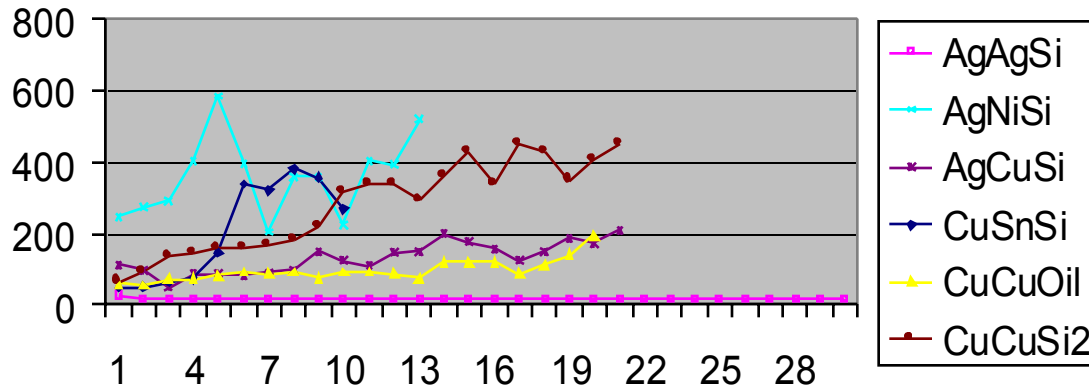
**Fail**

Super-temperature is a measure of the temperature at the actual point of contact

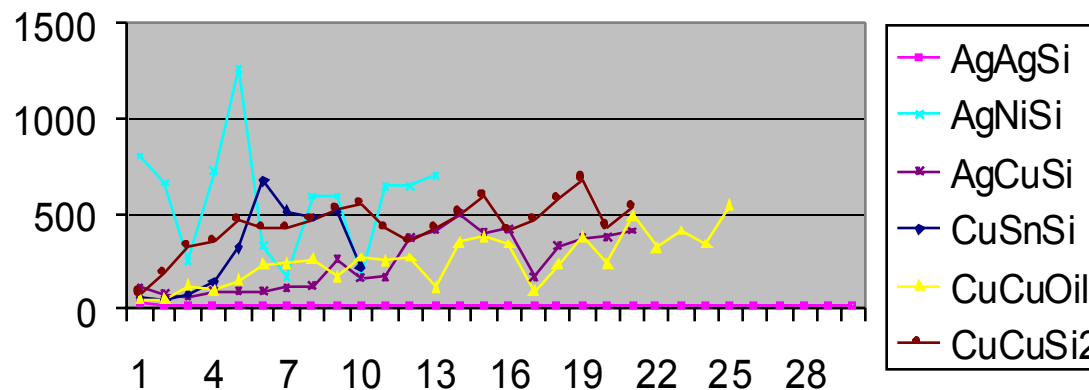
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### Contact Resistance in Micro-Ohms; Averages



### Contact Resistance in Micro-Ohms; Maximum



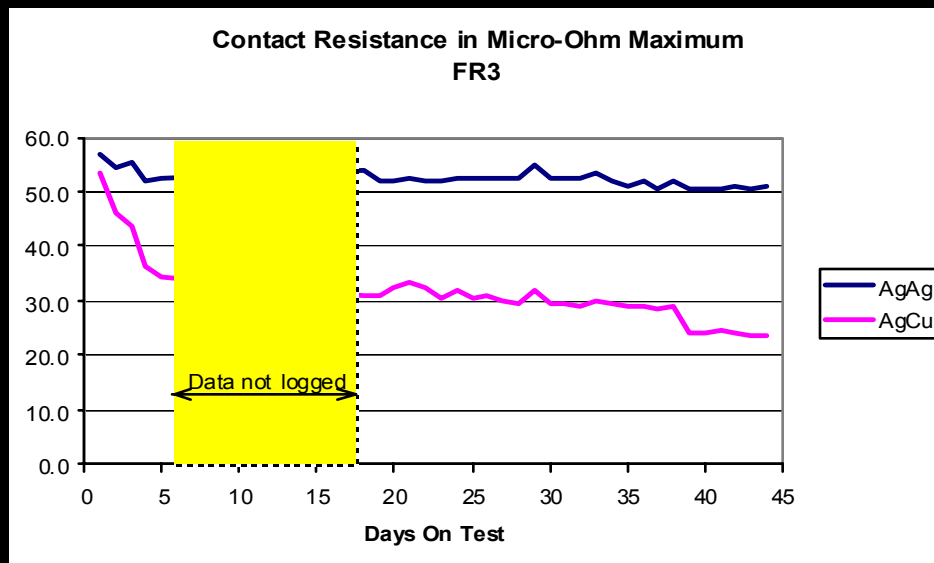
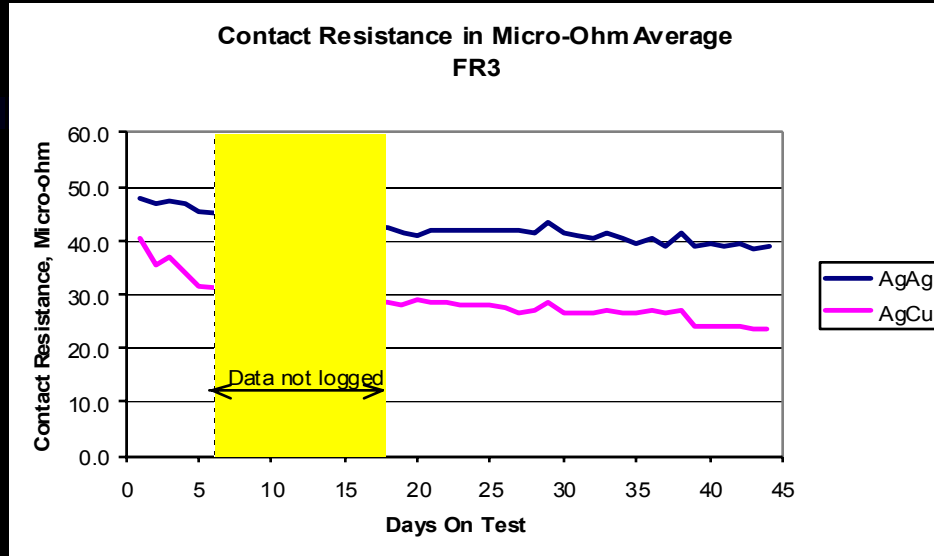
Typical Data

Contact resistance is the basis of pass-fail of the functional life test.

Resistance after 30 days must be stable and total increase must be <25%

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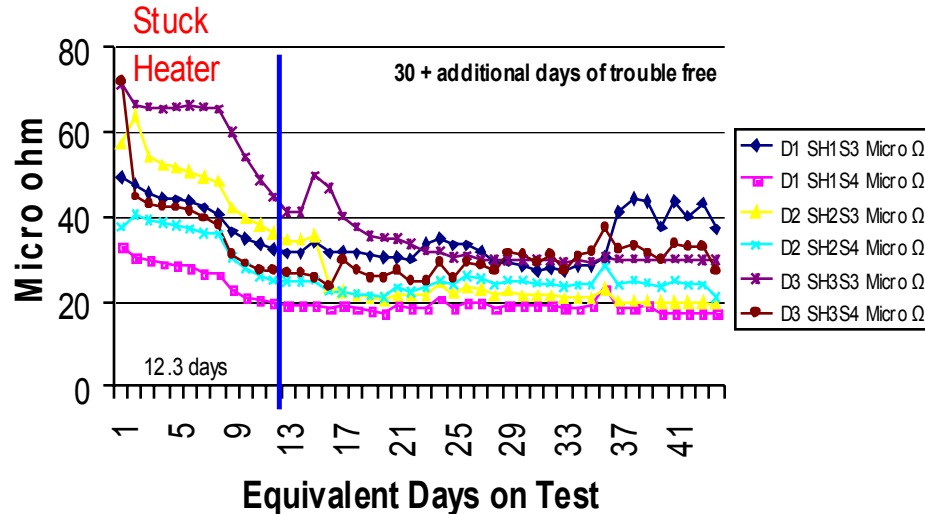
## Typical Data

Contact resistance is the basis of pass-fail of the functional life test. Resistance after 30 days must be stable and total change must be  $<25\%$

# Quality Switch Tapchanger Functional Life Tests

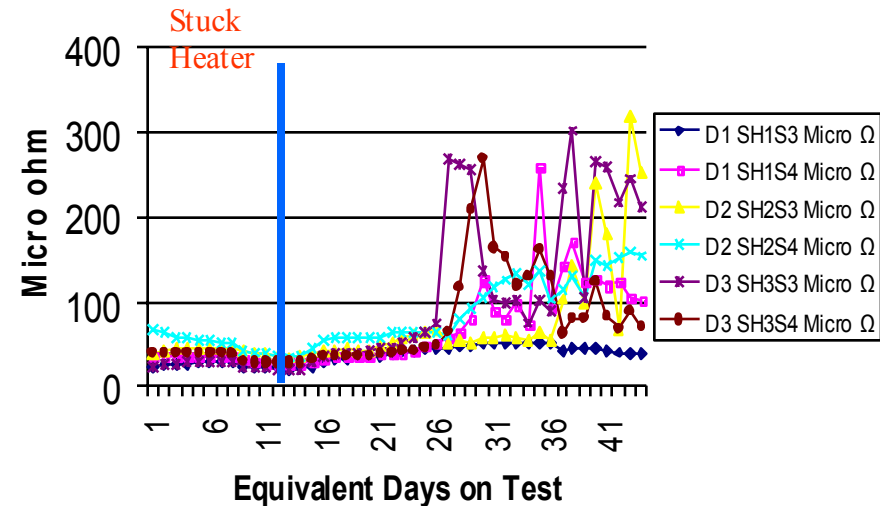
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CU-CU-FR3 Contact Resistance in Micro ohm,  
Days Adjusted for stuck heater relay (+12.3 days  
added to front end of test)



Pass

AG-CU Mineral Oil Contact Resistance in  
Micro ohm, days adjusted for stuck heater  
relay (+12.3 days to front end)



Fail

Contact Resistance is the Basis of Pass-Fail

After 30 days, the increase must be <25% and be stable

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## **Conclusions to Date:**

1. FR 3 Stable with Silver-Silver, Silver-Copper, and Copper-Copper Contacts.
2. Mineral Oil and Silicone only stable with Silver-Silver Contacts, with Silicone the most aggressive fluid.
3. FR 3 appears to prevent or minimize contact corrosion.

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## Summary to Date:

### Contacts

(in order of stability)

### Fluid

Most Stable

Least Stable

	FR3	Mineral Oil	Silicone
Silver-Silver	Pass	Pass	Pass
Silver-Copper	Pass	Fail	Fail
Copper-Copper	Pass	Fail	Fail
Tin-Copper	??	Fail	Fail

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## **Future Tests Planned:**

1. Due to run-a-way heaters at the start of the last test, **repeat FR 3 with Copper-Copper Contacts and repeat Mineral oil with Silver-Copper contacts.** The outcome is not likely to be different, but the defective heater influence would be eliminated.
  
1. **Long Shot look at FR 3 Tin-Copper.** Now that Copper-Copper in FR3 has passed, perhaps even Tin plated copper vs. plain copper will also pass??