Voltage Drop Stability as a Method of Rating Power Contacts

Summary of Best Of Session Paper IICIT 2003
Voltage Drop Stability as a Method of Rating Power Contacts **R. Malucci & F. Ruffino**

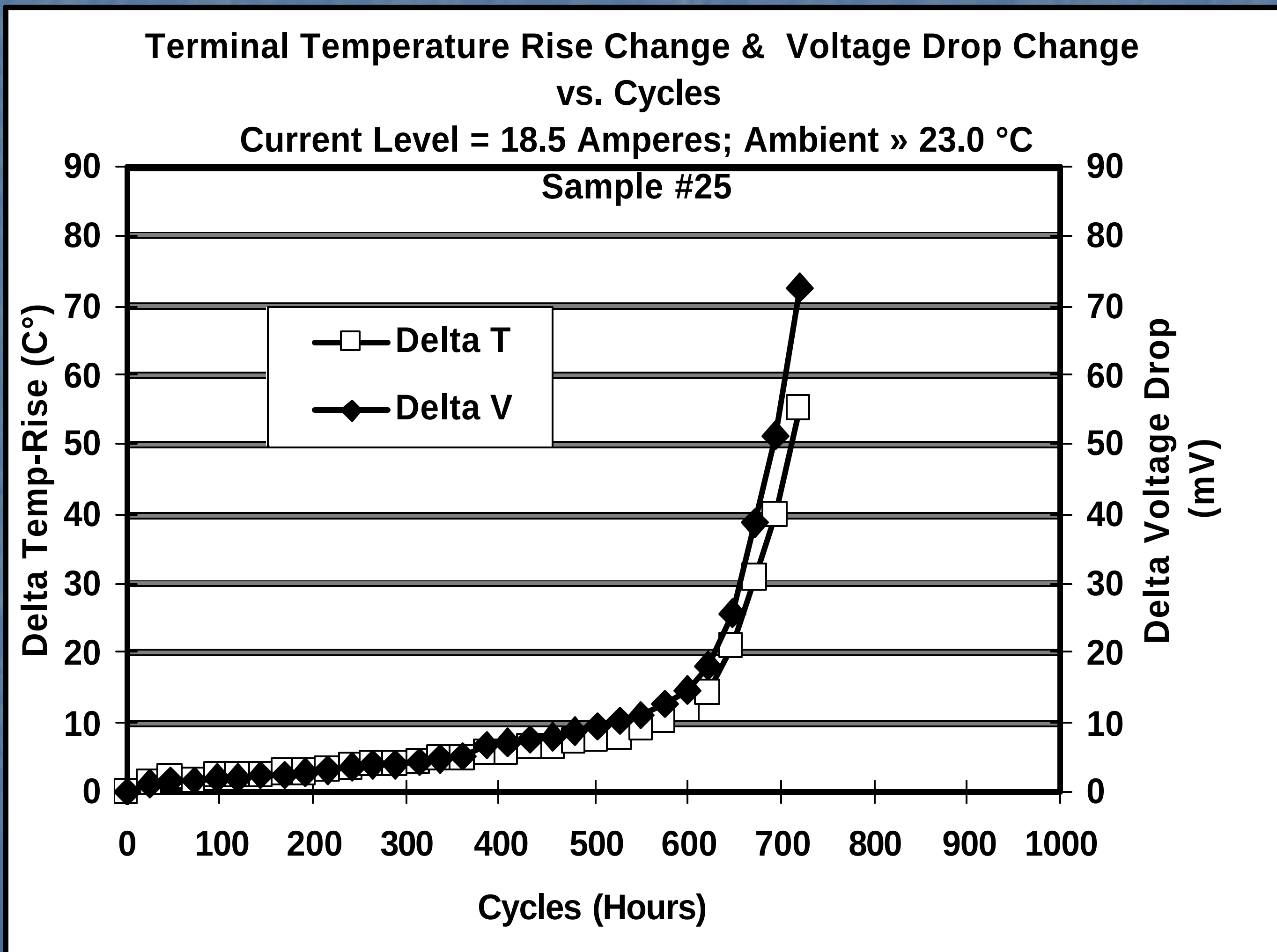
Typical Performance Criterion

- Signal Contacts
  - Monitor Contact Resistance
    - Resistance Stability
- Power Contacts
  - Monitor Temperature Rise
    - Thermal Stability
  - Measure Voltage Drop at Rated Current
    - Voltage Stability

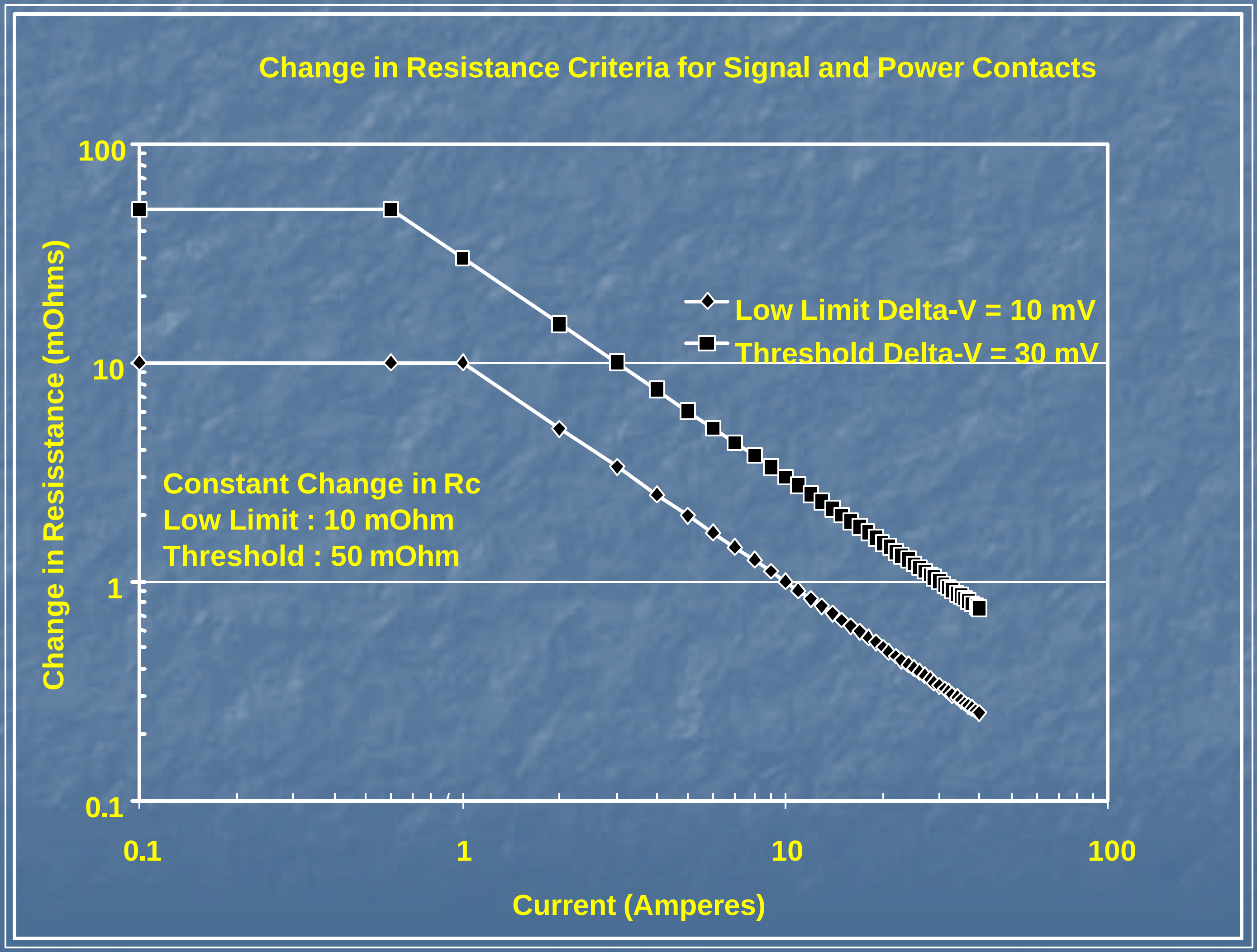
Proposed Performance Criteria

- Signal Connectors
  - Contact Resistance Change
    - $\Delta R <$ 0.01 to 0.05 ohms (for signal)
- Power Connectors – Tin Plated
  - Temperature Rise and Change
    - $\Delta T < 30\ ^{o}C$
  - Voltage Drop Change
    - $\Delta V = I\,\Delta R <$ 0.03 Volts (for power)
  - Tin Contact Interface Properties
    - Softening voltage ~ 0.07V
    - Melting voltage ~ 0.15V

Temperature and Voltage Stability



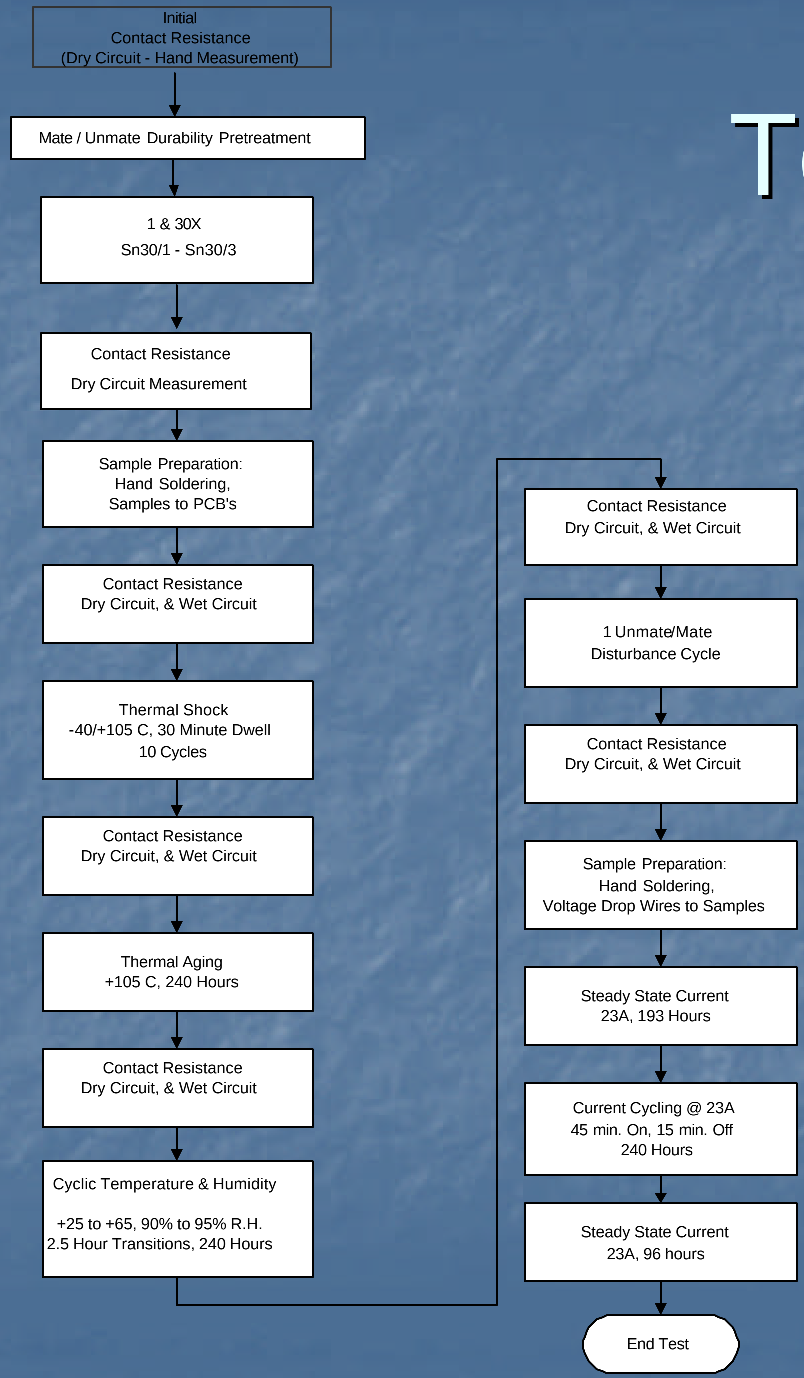
Universal Resistance Criteria



Samples

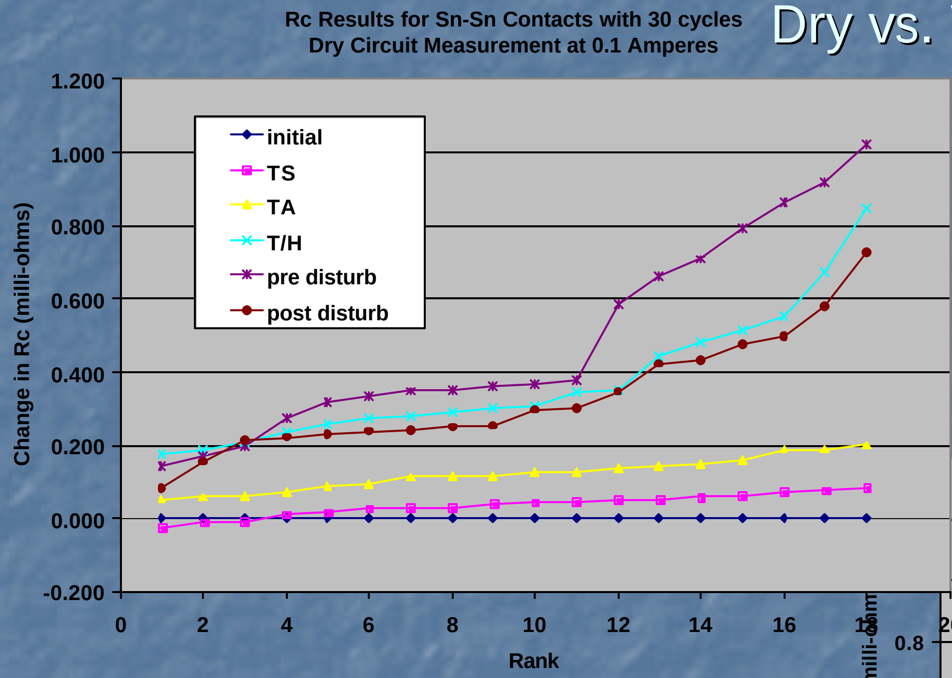
- Power connector in the development process – Tin Plated
- Design goal; 23 Amps, 10 mating cycles
- 1 Control sample
- 3 intentionally degraded samples

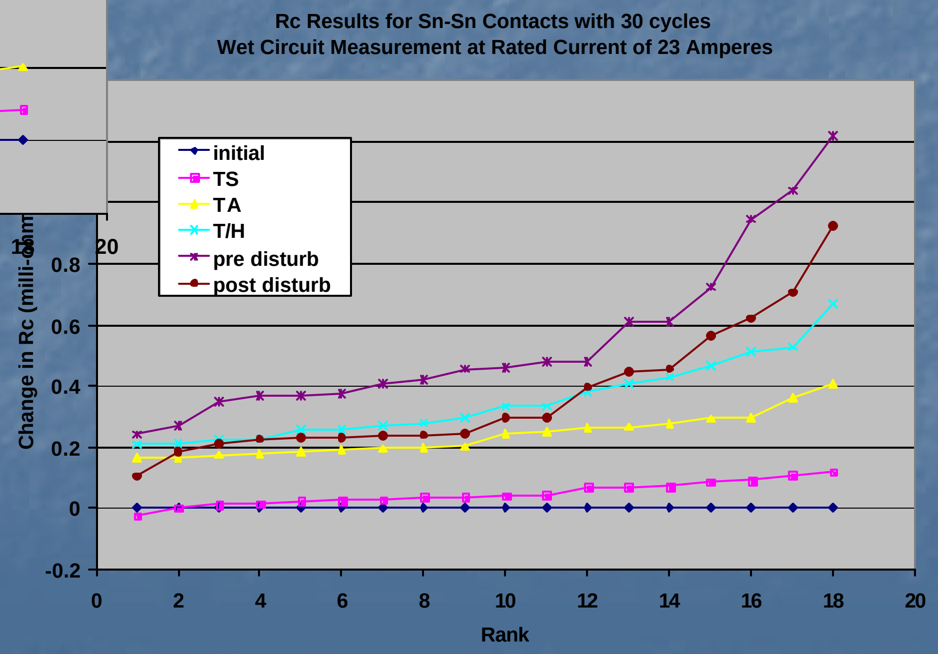
Test Sequence



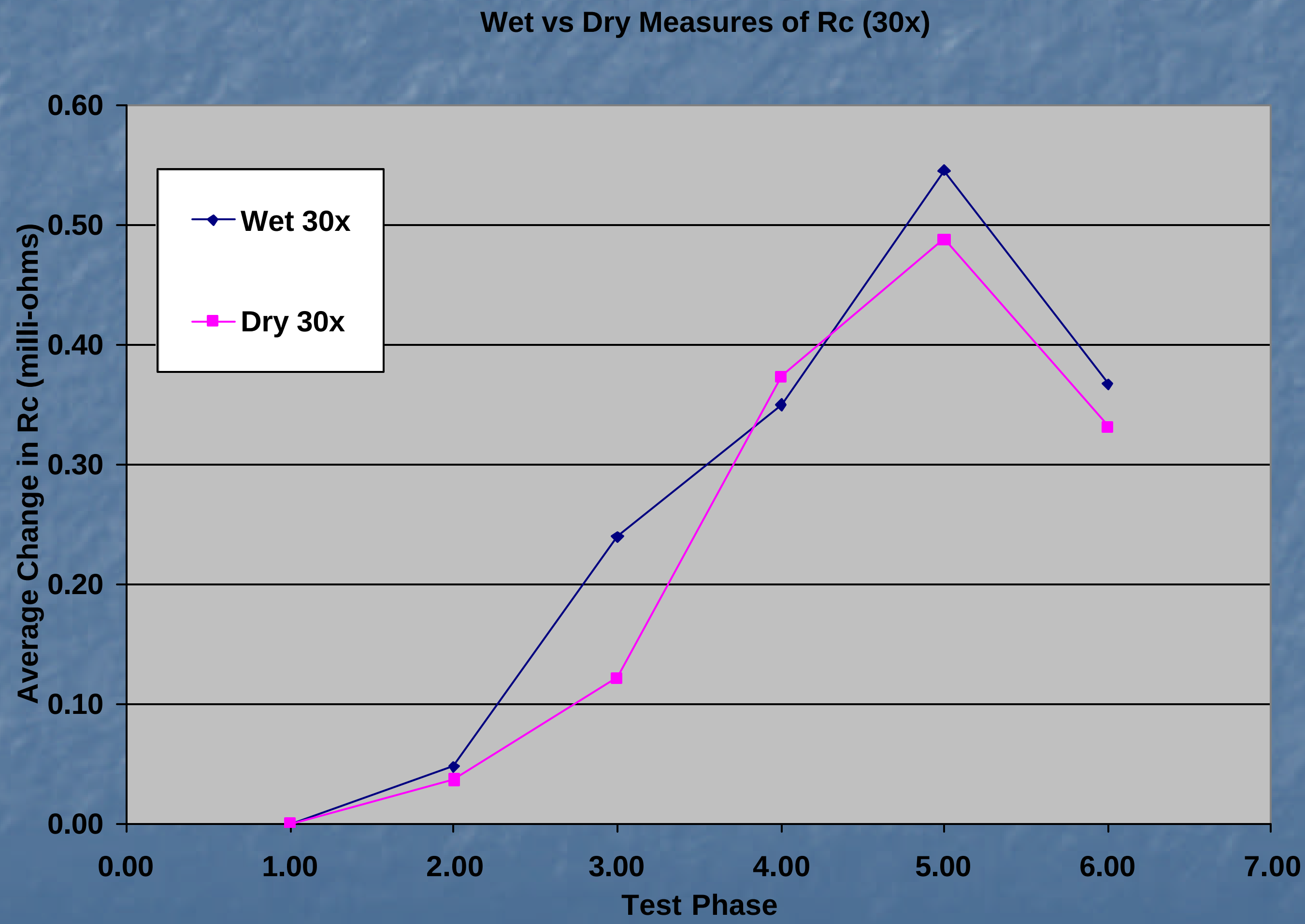
Change in Resistance Distributions

Dry vs. Wet

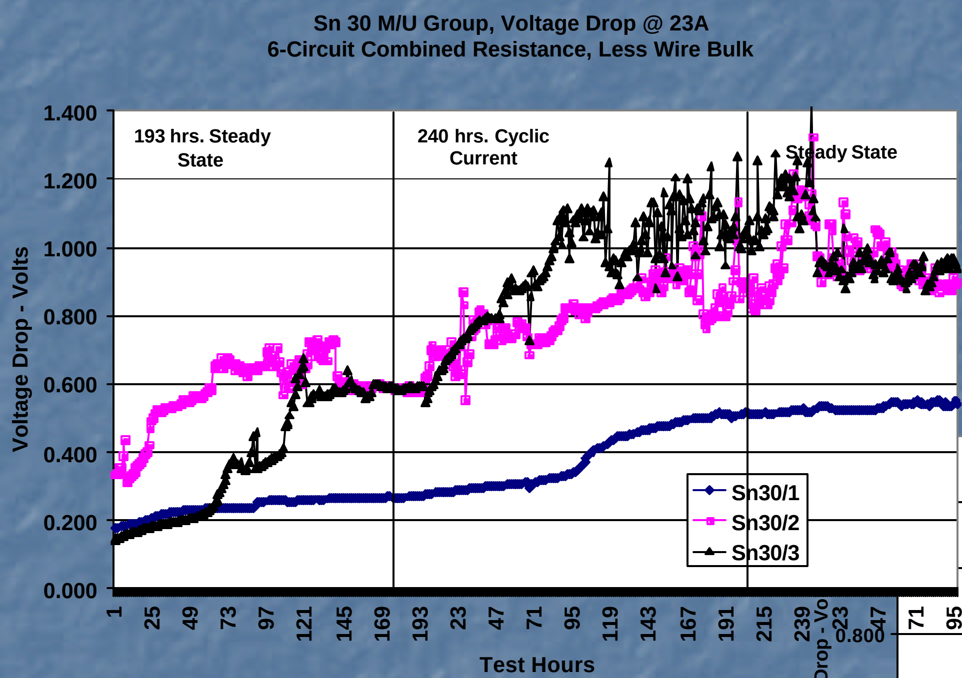


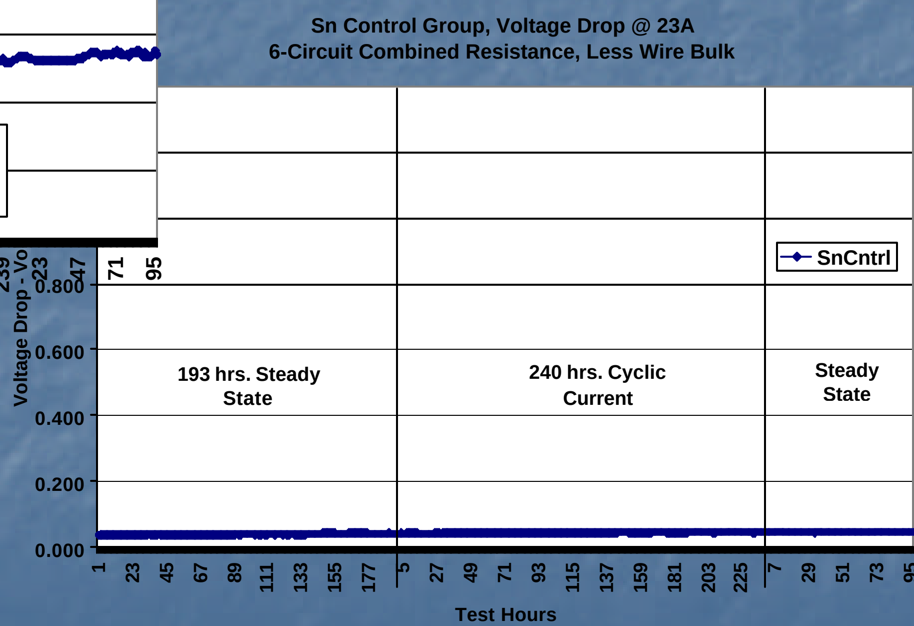


Wet and Dry Circuit Test Results



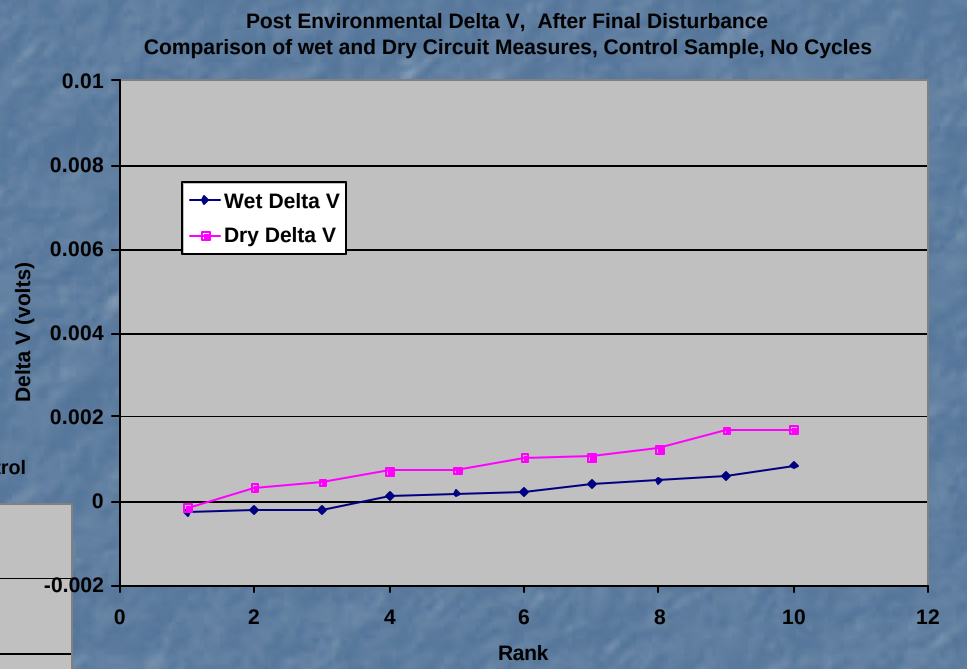
High Current Test Results

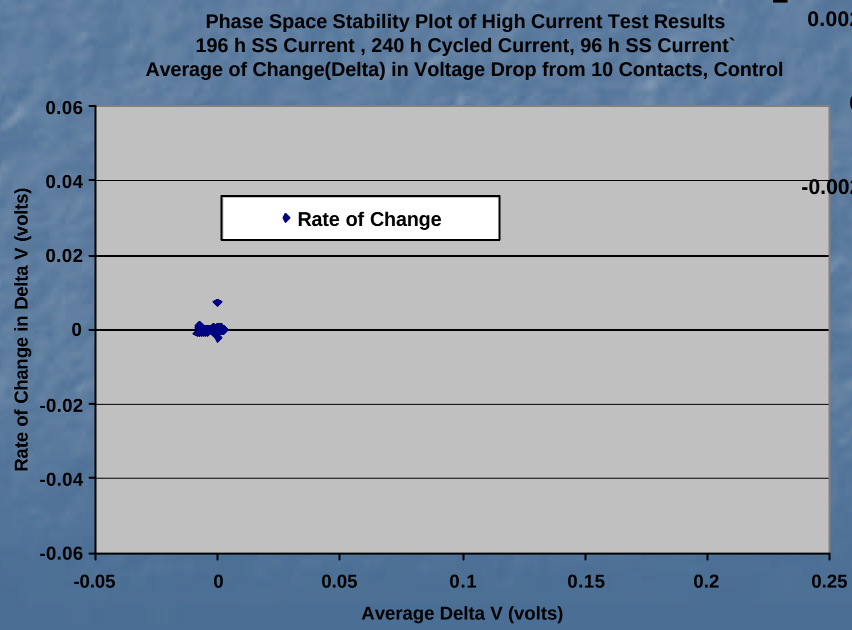




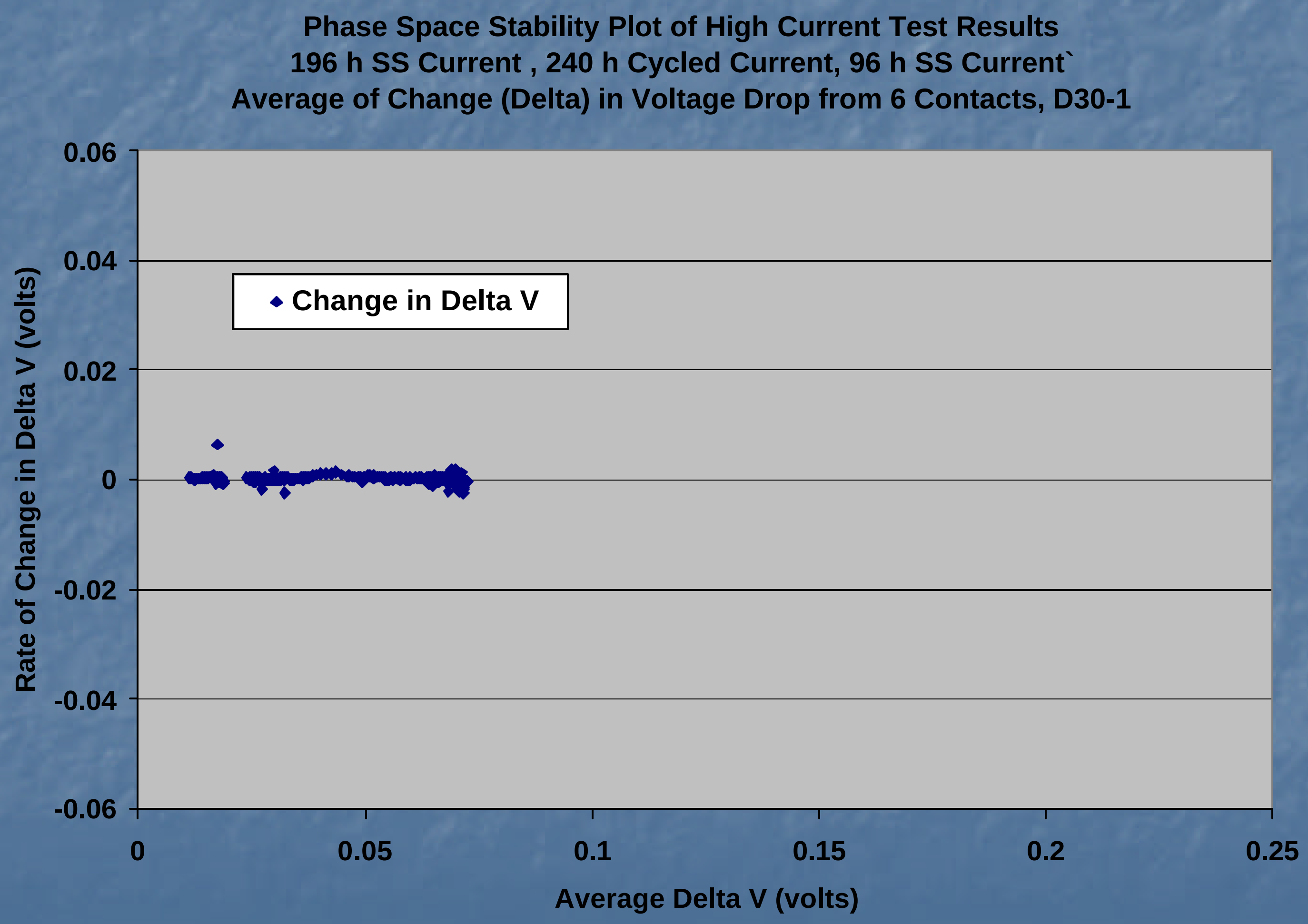
Note: Measurements are based on 6/10ths of a 10

Control Samples

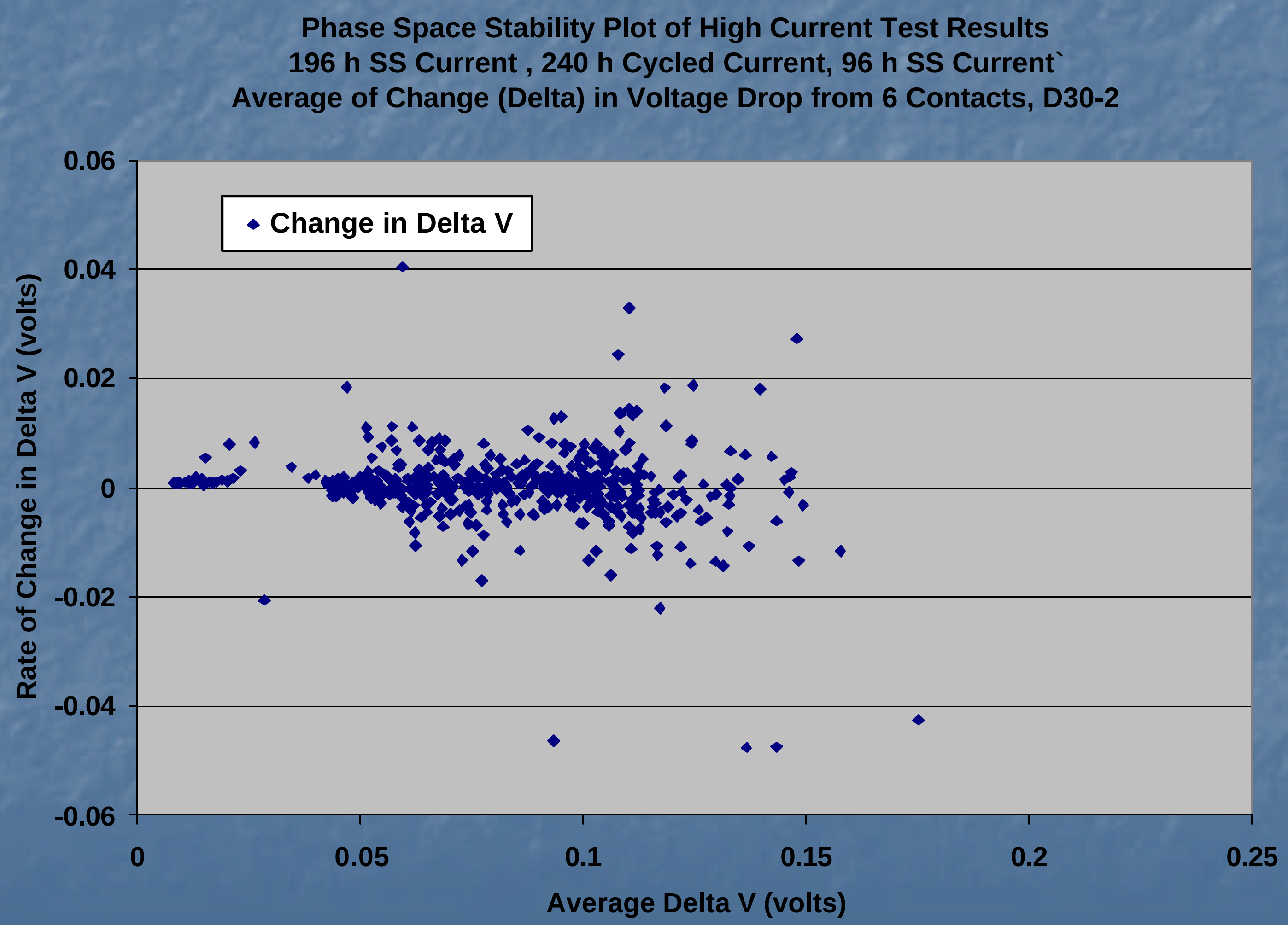




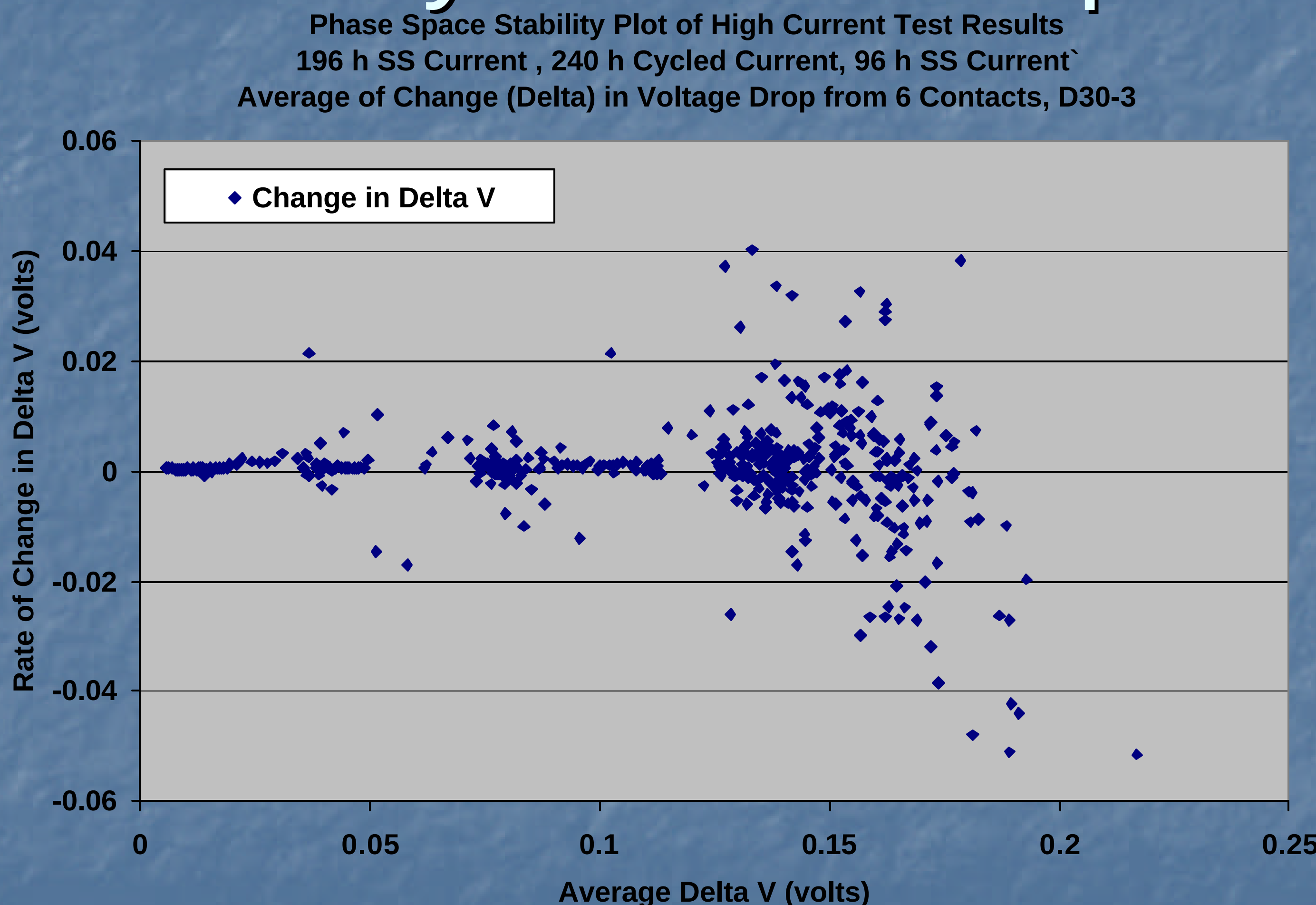
Stability Analysis of Sample 1



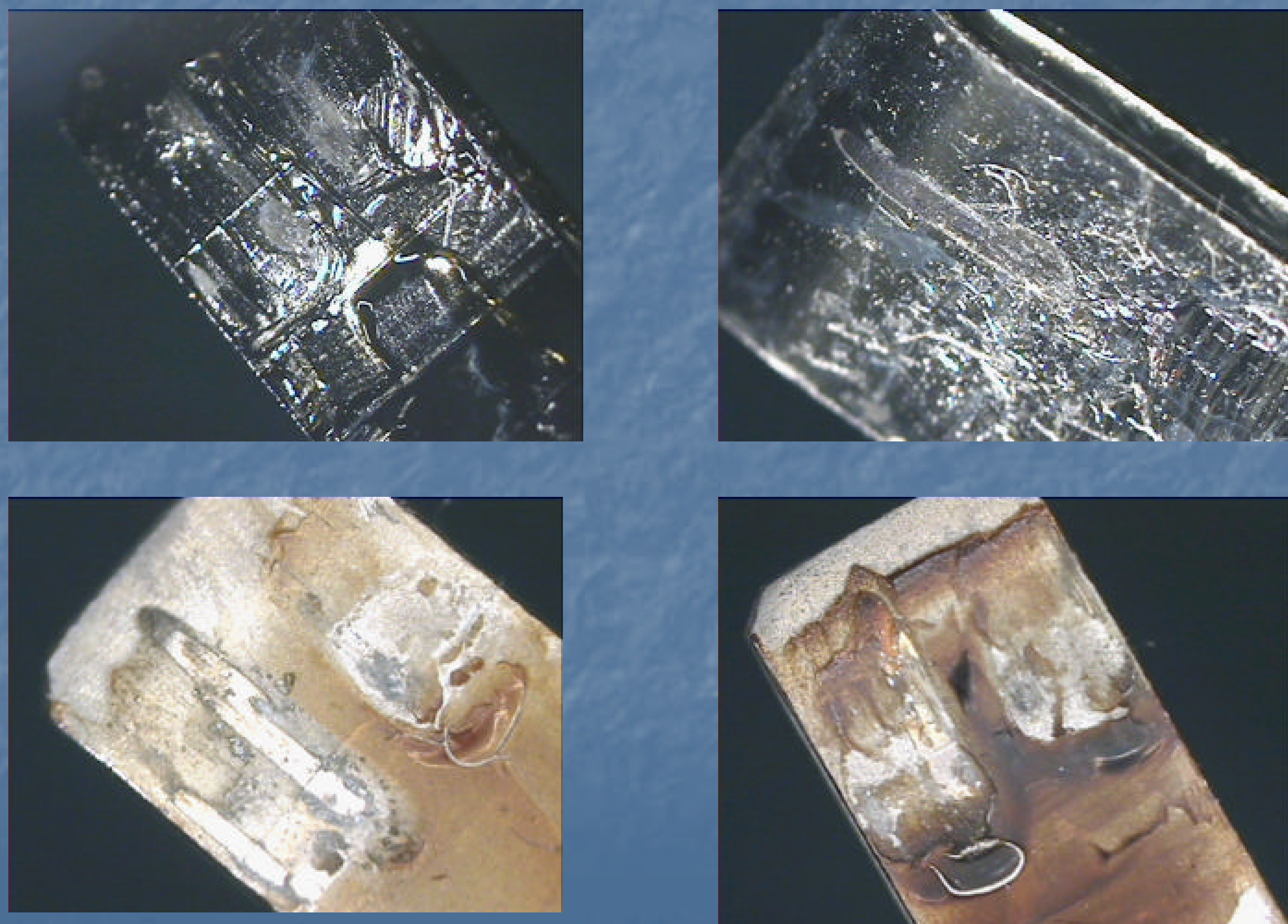
Stability Plot of Sample 2



Stability Plot of Sample 3



Typical Good and Degraded Contact Surfaces



Summary

- Below ΔV Threshold (< 0.03 volts)
  - Control Sample Stable
- Above ΔV Threshold (> 0.03 volts)
  - Sample 1 stabilized at softening voltage (0.07 v)
  - Sample 2 instability up to melting voltage (0.15 v)
  - Sample 3 instability past melting voltage (> 0.15 v)

Conclusions

- Change in Voltage Drop
  - Can be used to Monitor performance
  - Can be used to judge thermal stability
- Power Rating
  - Use T-rise on control samples to define I_{max}
    - Short term test & small sample size
  - Monitor ΔR through the appropriate aging tests to simulate application end of life
  - Use $\Delta V = I_{max} \Delta R$ to assess stability (dry)
  - Determine max current rating $I \Delta R <= .03$ at end of life simulation test
  - Monitor ΔV at I_{max} during high current test (SSCCSS) or LLCR after the test

Benifits

- Excessive voltage drop increases at the contact interface are the fundamental cause of thermal run-a-way. P = IE
- Measuring contact resistance in relatively non-intrusive and a more accurate assessment of contact interface degradation vs. thermocouples.
- Sample preparation is more efficient and straight forward.
- Much larger sample sizes can be accommodated for statistically significant data.
- Criteria based and science vs. 30C rise rule of thumb