JCAA/JG-PP Lead-Free Solder Project: -20˚C to +80˚C Thermal Cycle Test

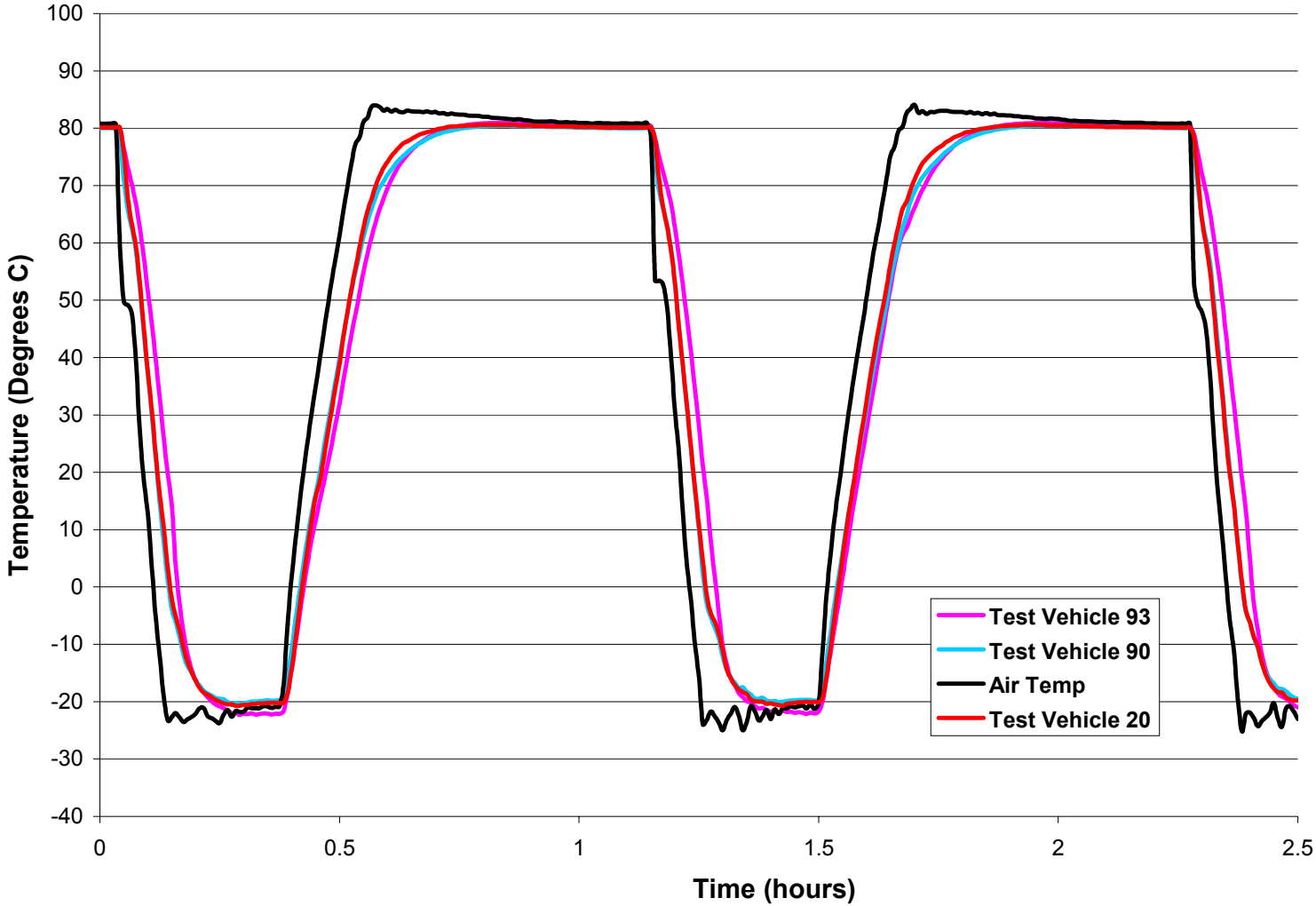
Tom Woodrow
Boeing Phantom Works
Seattle, WA

IPC APEX
Anaheim, CA
February 5 - 10, 2006

Thermal Cycle Testing

- **Test Vehicles**
  - **15 “Manufactured” Test Vehicles**
    - 5 – SnPb (reflow/wave)
    - 5 – SnAgCu (reflow/wave)
    - 5 – SnAgCuBi (reflow), SnCu (wave)

Thermal Cycle (-20°C to +80°C; Actual Board Temperature)
30 min. dwell (hot); 10 min. dwell (cold)

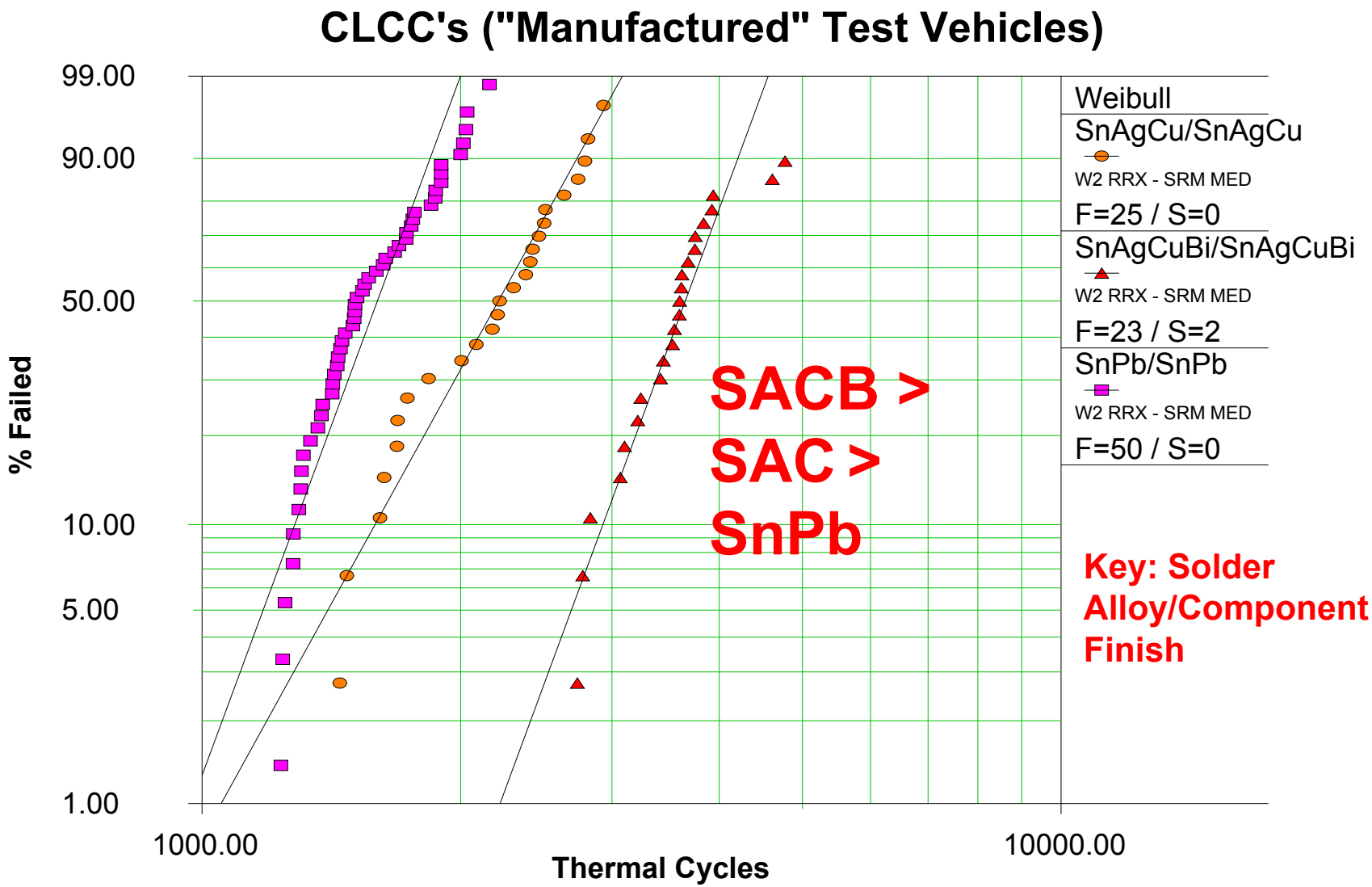


Thermal Cycle Chamber

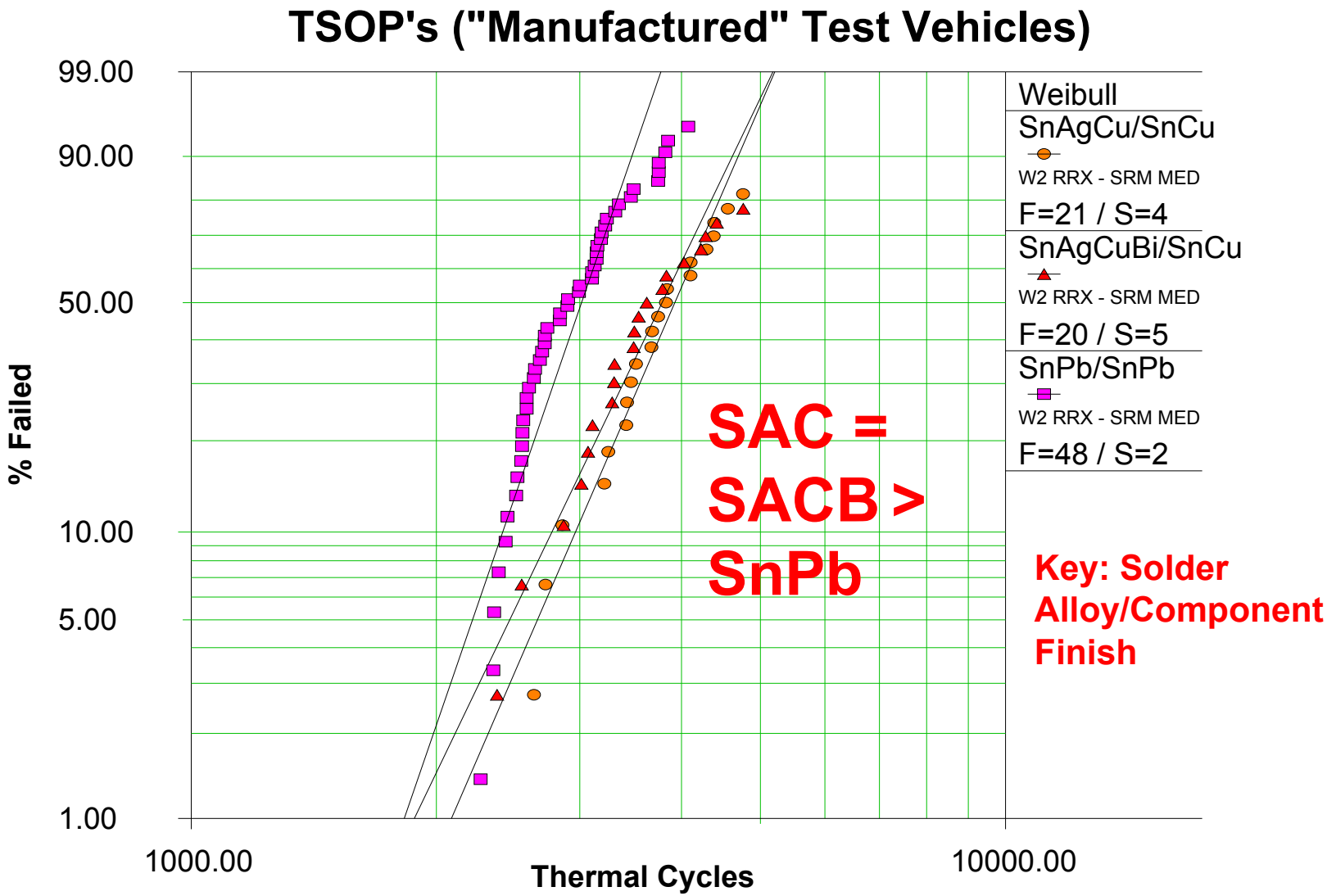
Thermal Cycling Status

- Approx. 8900 cycles completed. 3000+ cycles to go.

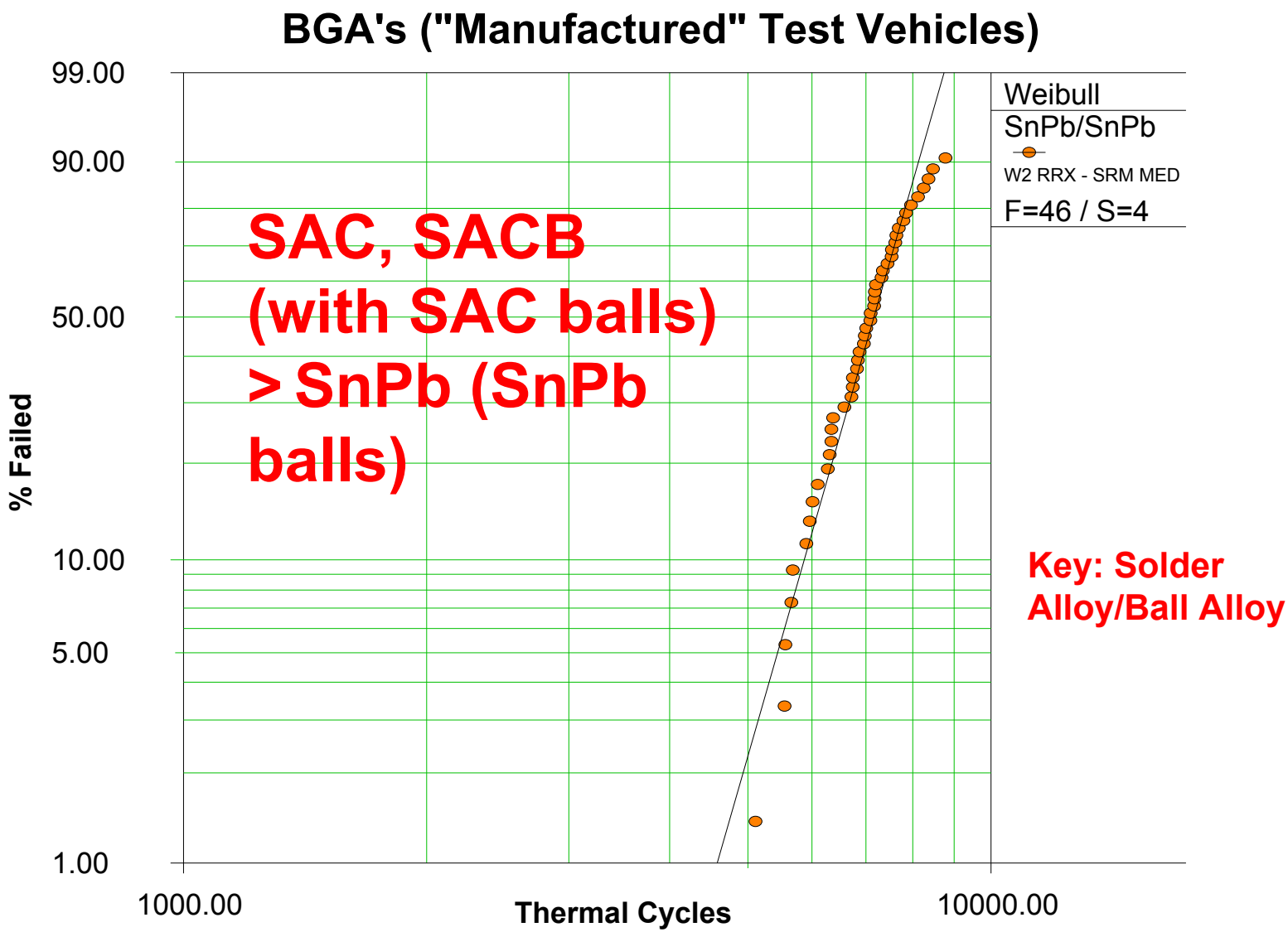
Event Detectors/Data Collection



$\beta 1=5.6953$, $\eta 1=2360.2202$, $\rho=0.9746$
$\beta 2=8.5259$, $\eta 2=3813.6398$, $\rho=0.9434$
$\beta 3=8.4987$, $\eta 3=1670.8514$, $\rho=0.9358$

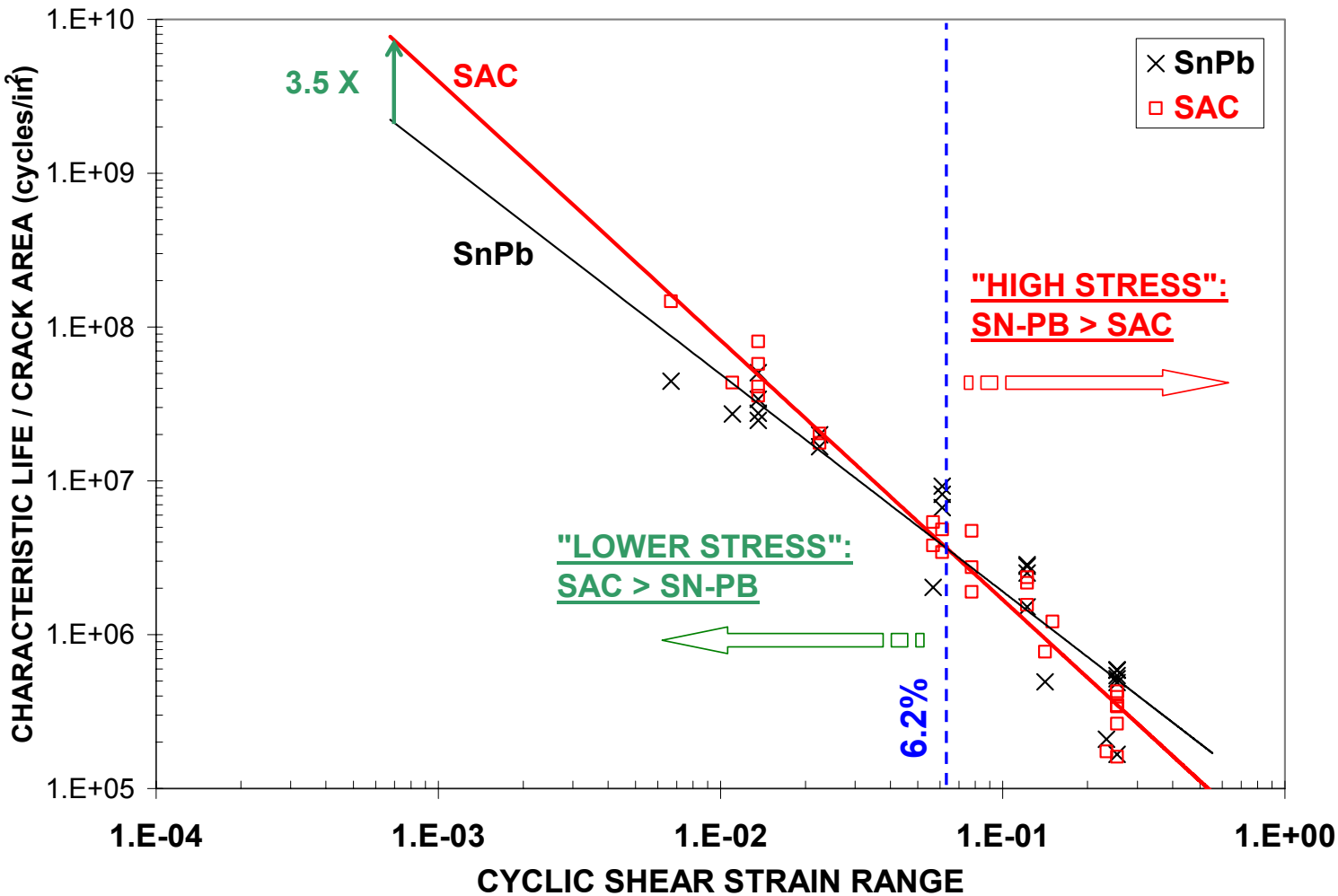


$\beta 1=6.6998$, $\eta 1=4147.7846$, $\rho=0.9789$
$\beta 2=6.0405$, $\eta 2=4024.6482$, $\rho=0.9738$
$\beta 3=8.4423$, $\eta 3=3150.0693$, $\rho=0.9215$



β=9.4729, η=7447.2133, ρ=0.9792

Ranking of Alloys Depends Upon Thermal Cycle Used



Reference: Clech, Jean-Paul, “Lead-Free and Mixed Solder Joint Reliability Trends”, Proceedings of the IPC Printed Circuits Expo, APEX and Designers Summit 2004, February 24-26, Anaheim, CA (on CD).

Preliminary Conclusions

- **The results of the -20 to +80˚C thermal cycle should give a realistic ranking of solders as it is close to field conditions (low stress conditions)**
- **Pb-free will probably outperform SnPb in all cases**
- **A model will be needed to predict field lifetimes (which is what we really want).**
- **The JCAA/JG-PP thermal cycle data will be needed to validate the model**