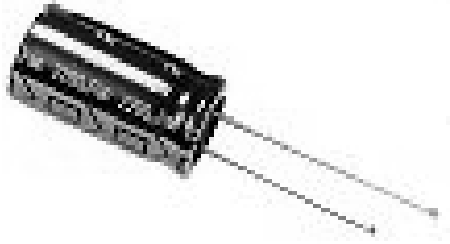
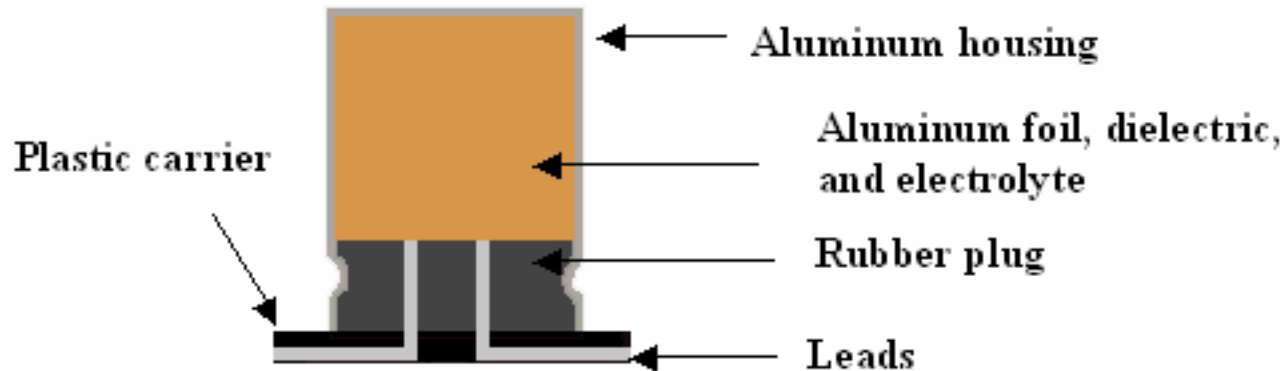


Electrolytic Capacitor (V-Chip Packaging)



Thru-hole electrolytic capacitors are not suitable for SMT and are not designed to handle reflow temperatures



SMT V-Chip is an adaptation of electrolytic capacitors to surface mount technology specifically designed to handle the high temperatures. Can they withstand the higher temperatures associated with SAC alloy Pb-free reflow?

Reflow Sensitivity Analysis

Simulated Reflow



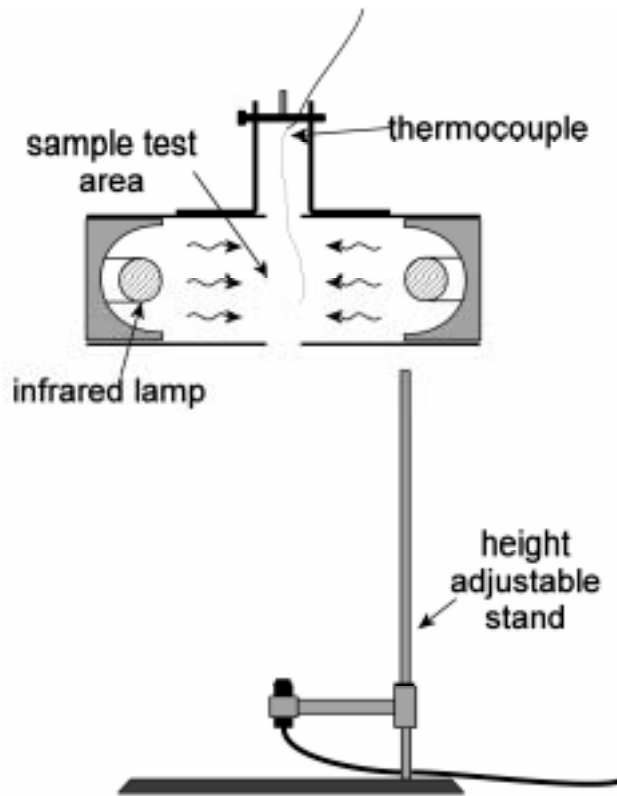
Pb-free

SnPb

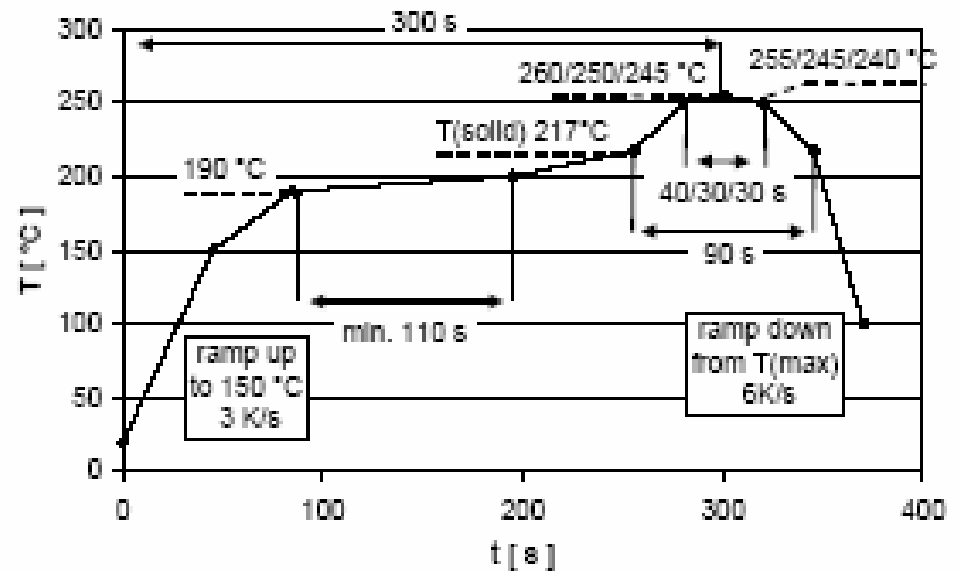
- Concern over the possibility of unknown reliability issues associated with Pb-free reflow profiles
- Observation of deformed electrolytic capacitors

- 1.) Do deformed capacitors represent a reliability issue?
- 2.) Is there the possibility of latent defects?

Test Setup



Infrared source and Omega temperature controller programmed to duplicate ramps of reflow profile



Temperature feedback from thermocouple mounted to specimen

Pb-free reflow simulation based upon J-STD-020C

Sample Population

NIC V-Chip Capacitors	Rating
• NACE100M16V3X5.5	2000 hrs at 85°C
• NACE1R0M50V4x5	2000 hrs at 85°C
• NACE100M50V6.3X5.5	2000 hrs at 85°C
• NACEW101M16V6.3X5.5	1000 hrs at 105°C
• NACEW102M6.3V6.3X5.5	1000 hrs at 105°C
• NACHL330M25V6.3X6.1	5000 hrs at 105°C
• NACE220M63V6.3X8	2000 hrs at 85°C
• NACE221M35V8X10.5	2000 hrs at 85°C
• NACT470M35V8X10.5	1500 hrs at 125°C

Case Volume

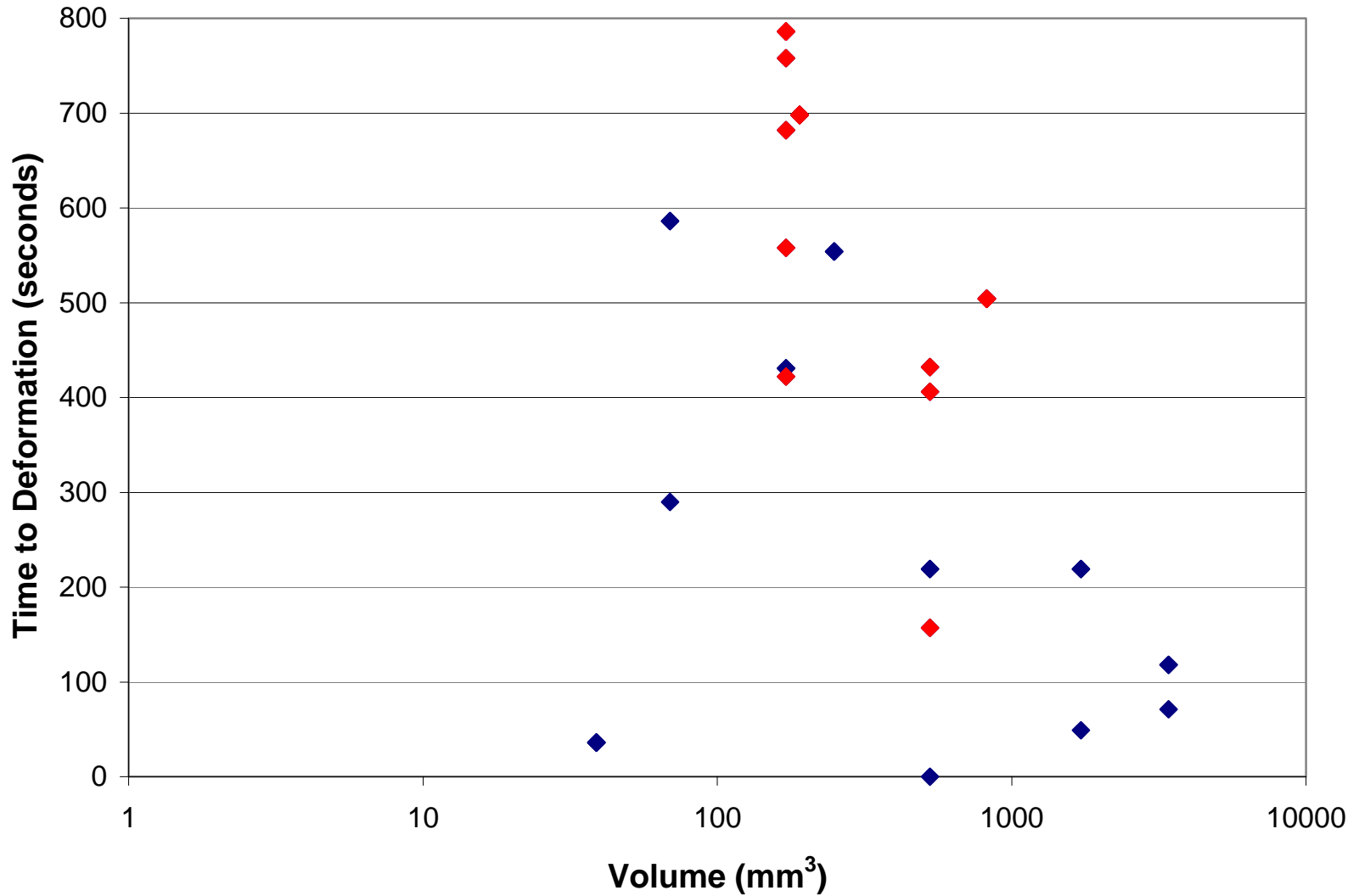
Size	Diameter	Height	Volume
3X5.5	3	5.5	39
4X5.5	4	5.5	69
6.3X5.5	6.3	5.5	171
6.3X5.5	6.3	5.5	171
6.3X5.5	6.3	5.5	171
6.3X6.1	6.3	6.1	190
6.3X8	6.3	8	249
8X10.5	8	10.5	528
8X10.5	8	10.5	528
10X10.5	10	10.5	824
12.5X14	12.5	14	1717
16X17	16	17	3416

Time to deformation
measured at two
temperatures

- 235°C
- 260°C

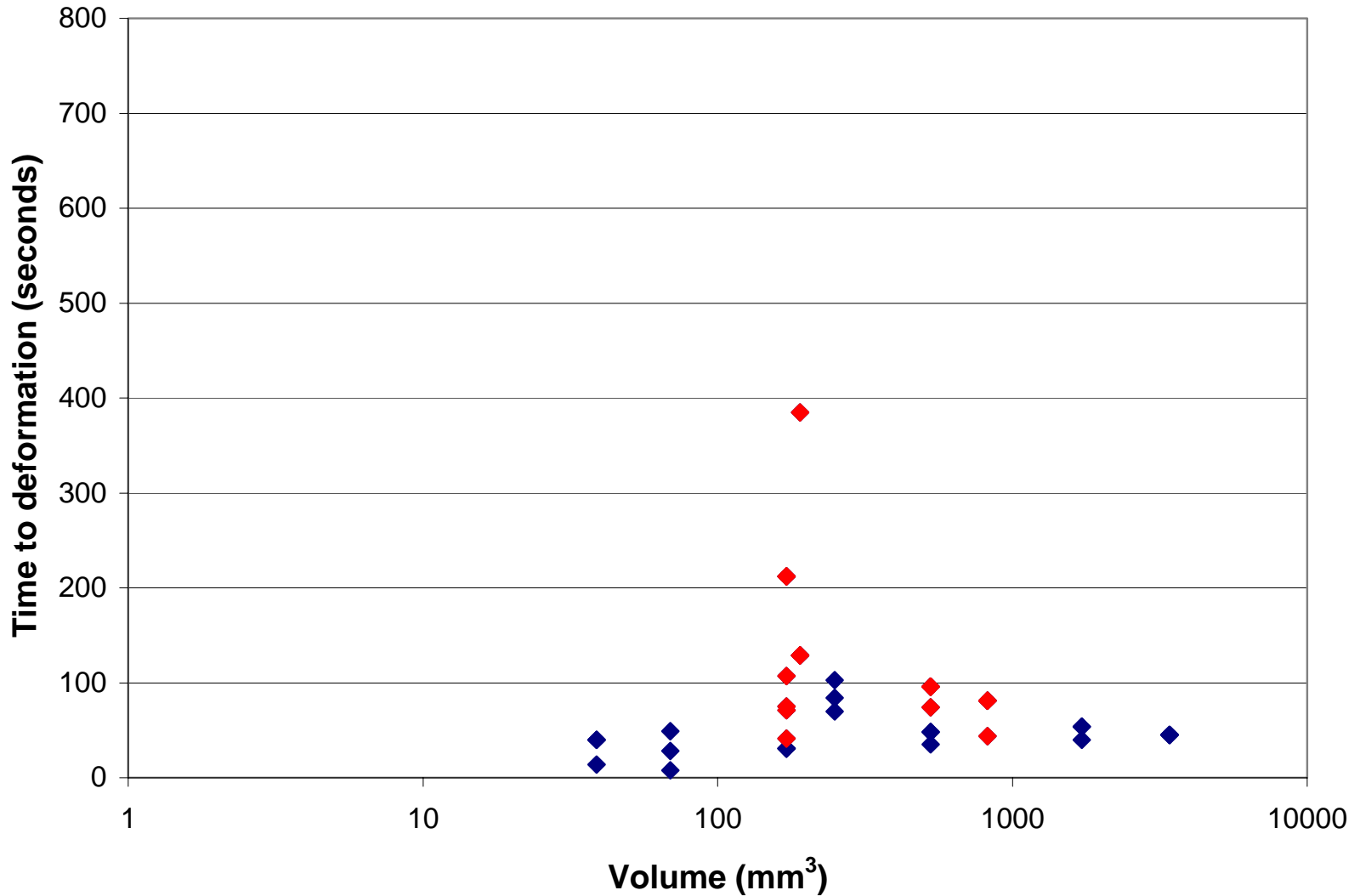


Time to Deformation



Time to deformation at 235°C

Time to Deformation



Time to deformation at 260°C

Reflow Sensitivity Results

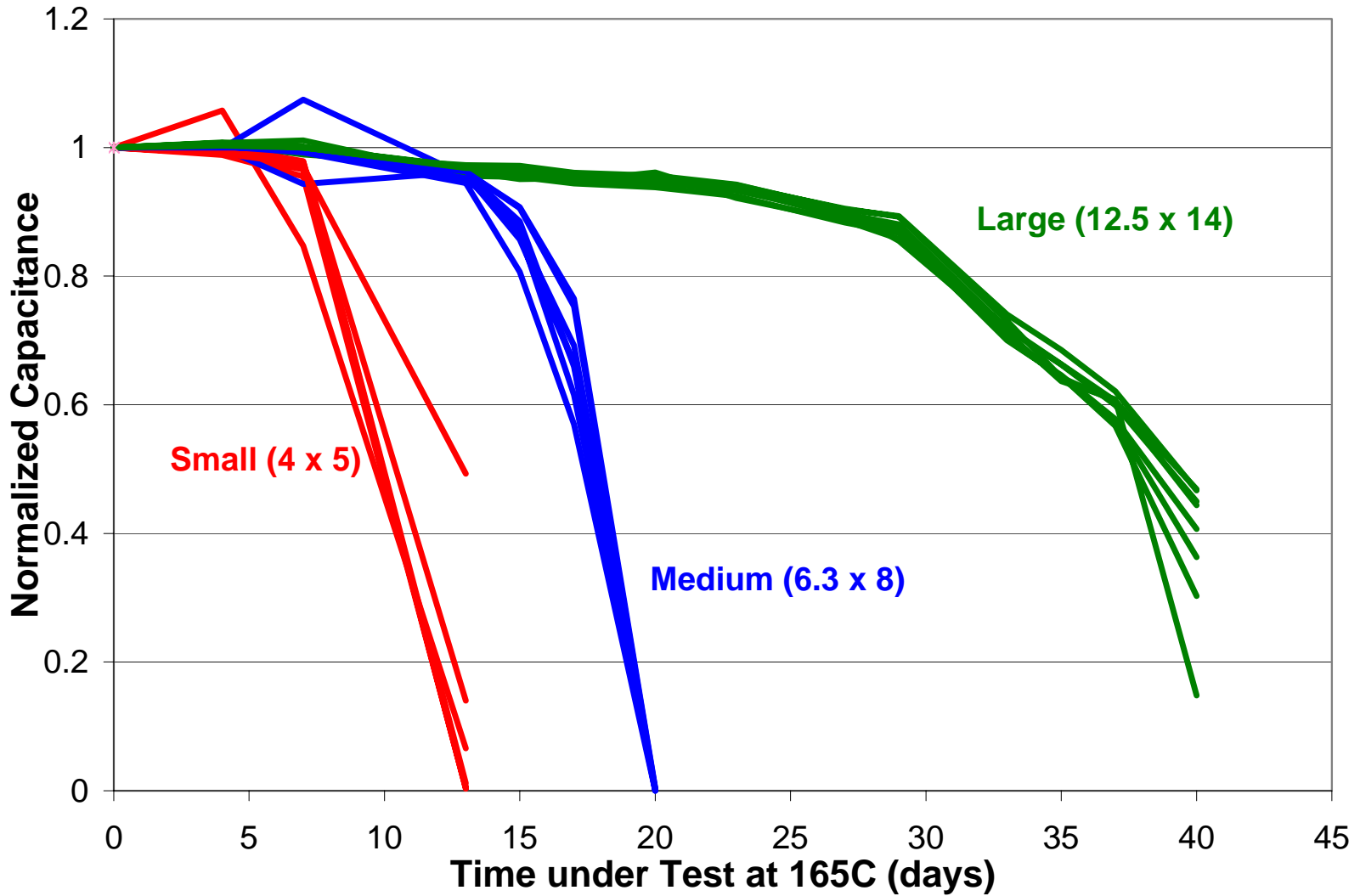
- Time to deformation strongly dependent on capacitor volume
- Smallest and largest more susceptible to deformation
- Moderate volume capacitors
 - 100 – 500 mm³
 - More robust
- Some capacitors experienced deformation before the 40 second hold time defined in J-STD-020C

Long-Term Degradation

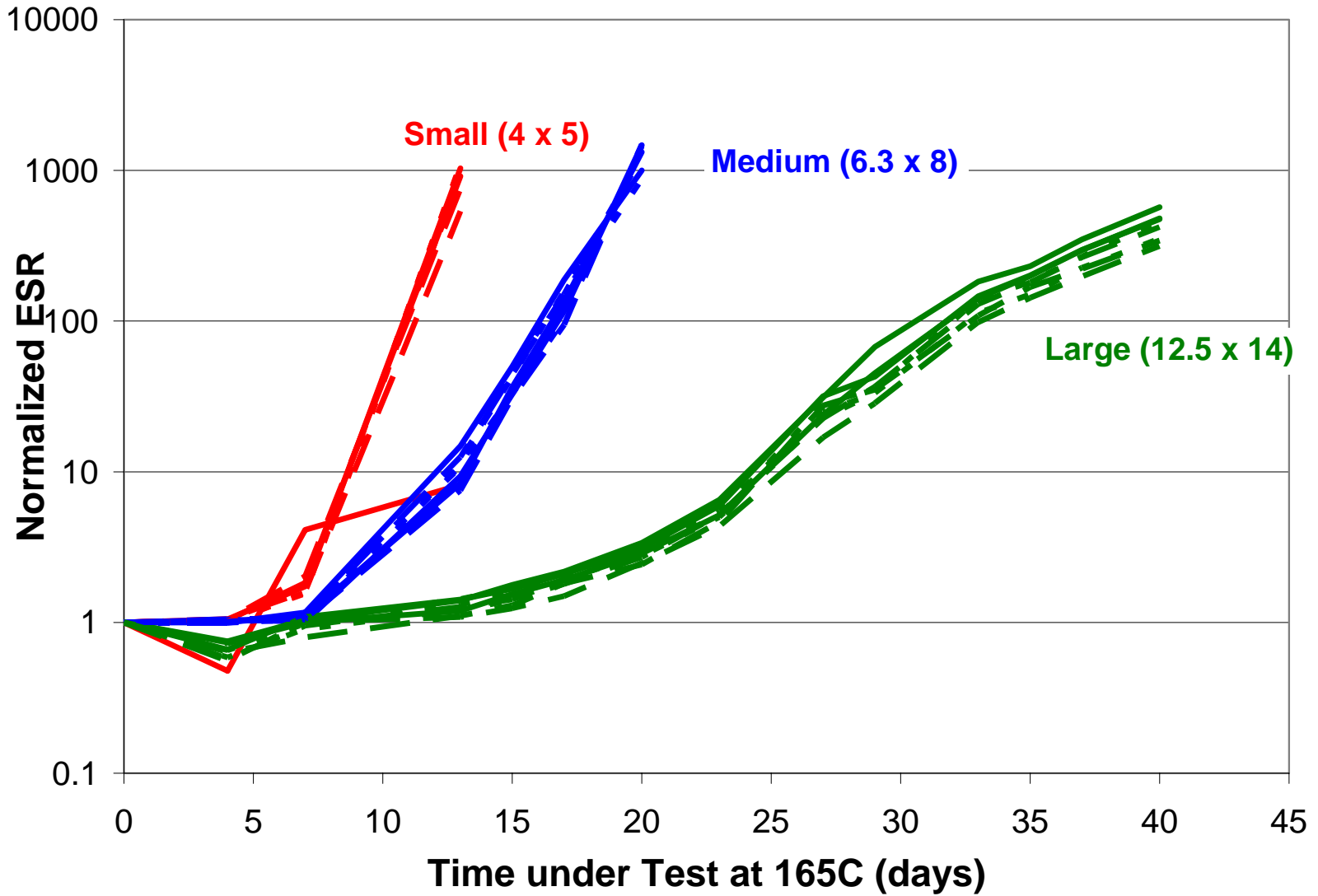
Sample Set	Part Number	Reflow Conditions		
		Benign	J-STD-020C	Severe
Volume < 350 mm ³	NACE1R0M50 V4x5	235°C / 30 sec	250°C / 30 sec	260°C / 30 sec
	NACE220M63V 6.3X8		250°C / 40 sec	
Volume > 350 mm ³	NACE331M50V 12.5X14	235°C / 30 sec	245°C / 30 sec	260°C / 30 sec
			245°C / 40 sec	
Extended Lifetime (NACHL)	NACHL330M25 V6.3X6.1	N/A	N/A	260°C / 20 sec

Test conditions set at 165°C at 25 VDS

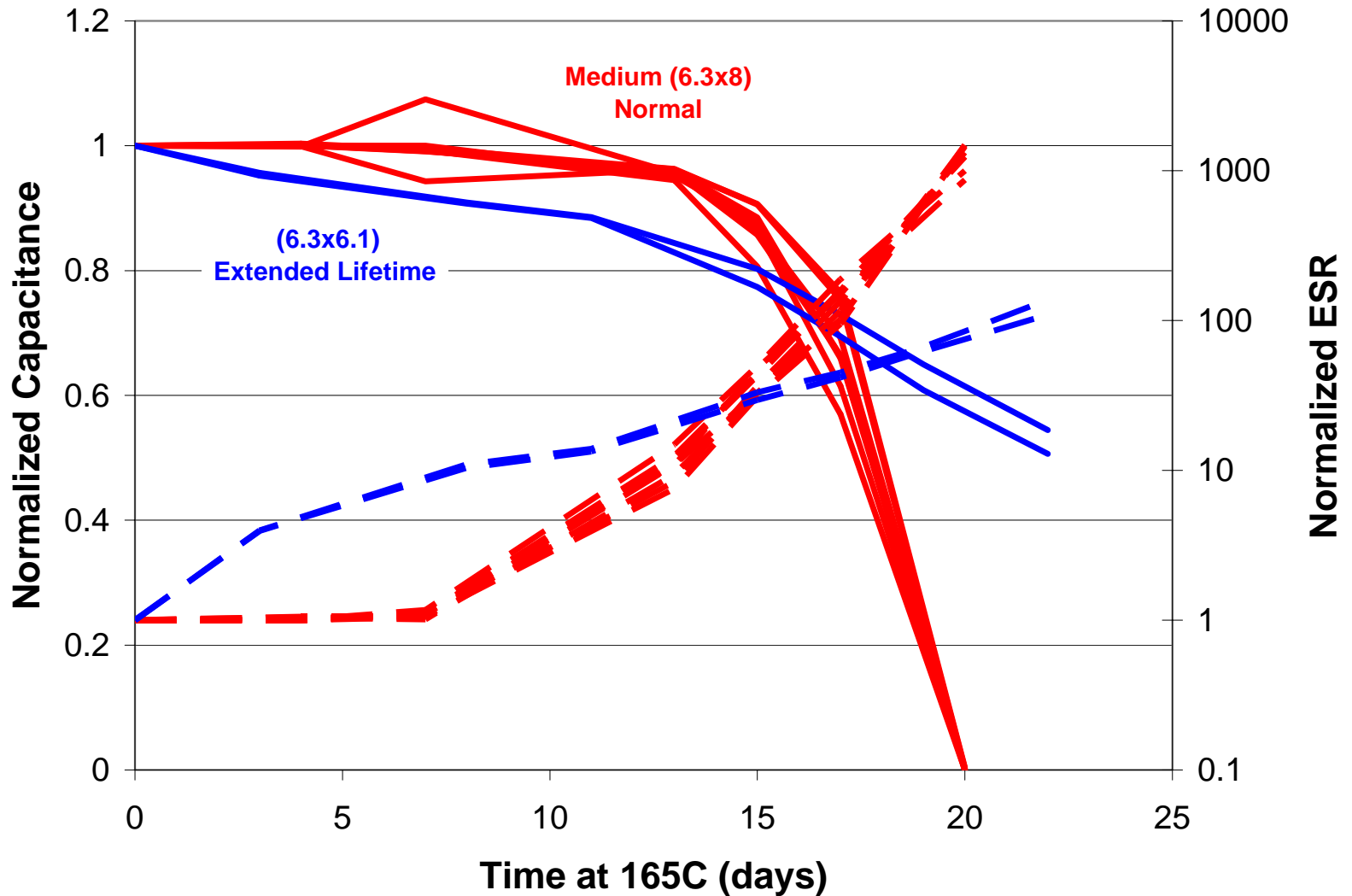
Capacitance



ESR



Extended Lifetime Capacitors



Conclusions

- Case distortion mainly dependent on the volume of the capacitor
 - Small capacitors $<100 \text{ mm}^3$ and large capacitors $>1000 \text{ mm}^3$ susceptible to case distortion
 - Medium capacitors, less susceptible
- Case distortion did not influence capacitor life
 - No evidence of latency in any sample
- Extended temperature or extended lifetime capacitors are more robust