



Smart Battery Validation ... an OEM's story ...

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Agenda

- Smart Battery Validation Methodology
- Results of Smart Battery Testing
- OEM's perspective on
 - Smart Battery validation
 - Smart Battery Specification Improvements
 - Additional design information
- Samsung call to action for the SBS-IF

Key messages to SBS-IF

- Smart Battery implementations today are not consistent
- Smart Battery validation testing needs to be addressed
- Smart Battery specifications may need clarification
- Samsung wants to work with the SBS-IF to enhance the Smart Battery

Smart Battery implementations today are not consistent

	Company A	Company B	Company C
Terminate_ Charge_Alarm	Set : Vdch \leq 4.19V/cell	Set : Vdch \geq 4.35V/cell Idch \geq 5A	Set : Vdch \geq 4.25V/cell Idch \geq 4A
	Reset : Charging Stop	Reset : Vdch \leq 4.15V/cell Battery Removed	Reset : Charging Stop
Terminate_ Discharge_Alarm	Set : Vdch \geq 2.6V/cell	Set : Vdch \geq 2.9V/cell	Set : Vdch \geq 3.32V/cell
	Reset : Discharging Stop	Reset : Vdch \leq 2.9V/cell	Reset : Discharging Stop

Smart Battery implementations today are not consistent

	Company A	Company B	Company C
Fully_Charged	Set : Vdch \leq 4.2V/cell & Idch \leq C/10	Set : Vdch \geq 4.15V/cell & Idch \leq C/20	Set : Vdch \geq 4.0V/cell Idch = 0.2~0.3A
	Reset : RSOC \leq 80%	Reset : RSOC \leq 90%	Reset : RSOC \leq 85%
CycleCount	Increment : ASOC has decreased by 15% or more from that base value	Increment : RSOC has decreased by 15% or more after Fully_Charged bit Set	Increment : RSOC has decreased by 40% or more after Fully_Charged bit Set

Smart Battery Validation Methodology

Test Setup

Capacity Test

- Capacity Test starts after 3 Cycles
- Full Charge to Full Discharge
 - Charge/discharge rate 0.5 C
 - 5 cycles
- Compare Vendor's spec with measured capacity during discharge
- Pass/fail criteria
 - Vendor's spec met

Accuracy Test (0.5C)

- Full charge to full discharge 3 times
- Full charge to 90% discharge 3 times
- 90% charge to full discharge 3 times
- 90% charge to 90% discharge 5 times
- Compare SB relative state of charge with measured state of charge
- Pass/fail criteria
 - +/- 3% for first 3 cases
 - +/- 5% for fourth case

Short Test

- Fully charged battery - short terminals for 5 seconds
- Full charge to full discharge battery
- Pass/fail criteria
 - Protection mechanism works
 - No fire/smoke
 - Protection mechanism resets itself
 - Battery returns normal data (CycleCount ,Design Capacity,ManufactureDate, etc..)
 - Note: expect Cycle Count will not reset

Voltage and Current Accuracy Test

- Voltage and Current - compare 5 1/2 digit DMM with battery reading
 - Conditions: Charging and discharging at 20ma, 0.5A, 1A, 1.5A, 2A, 3A
- Pass/fail criteria
 - Vendors spec or SB spec met

List of other tests

- Remaining Capacity Alarm
- Remaining Time Alarm
- Remaining Capacity
- Full Charge Capacity
- Average Time To Full
- Battery Status
- Cycle Count

Comparison of Smart Battery Implementations

Battery Comparison Data

Com pany	ACCURACY				SHORT TEST
	#1RSOC	#2RSOC	VOLTAGE	CURRENT	
A	4%	17%	50mV	40mA	Fail
B	1%	5%	60mV	31mA	Data Reset
C	3%	12%	600mV	14mA	Data Maintenance
D	2%	---	70mV	28mA	Data Maintenance
E	5%	---	300mV	44mA	Data Reset

#1 : Full charge to full discharge

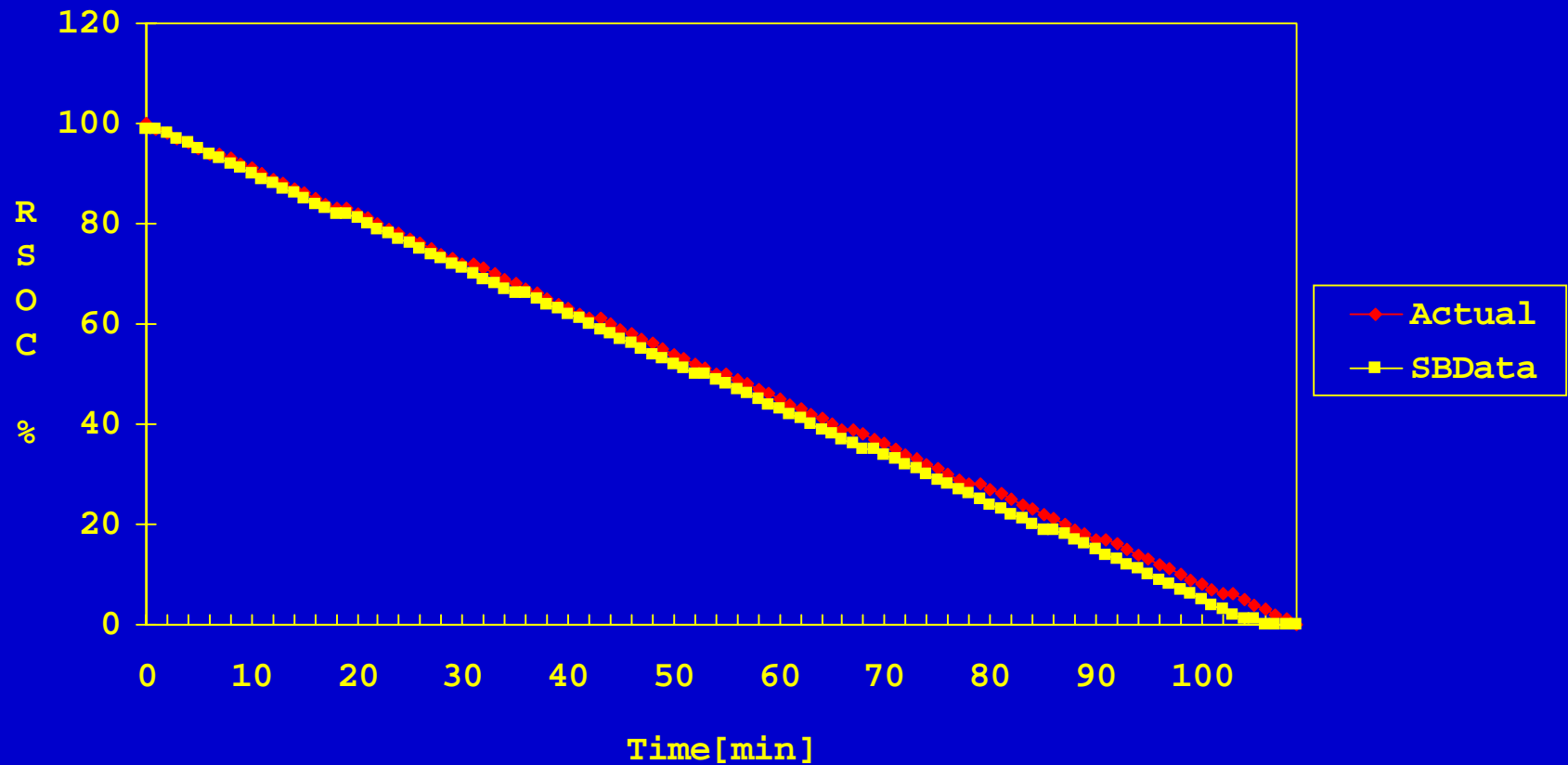
#2 : 90% charge to 90% discharge

Accuracy Test(1) Results

- Test Condition
 - Full charge to full discharge
 - Charge/discharge rate 0.5 C
 - 3 cycles
- Charge
 - C-C Mode (0.5C) => C-V Mode
- Discharge
 - C-C Mode (0.5C)
 - End Point : Voltage (Vendors spec)

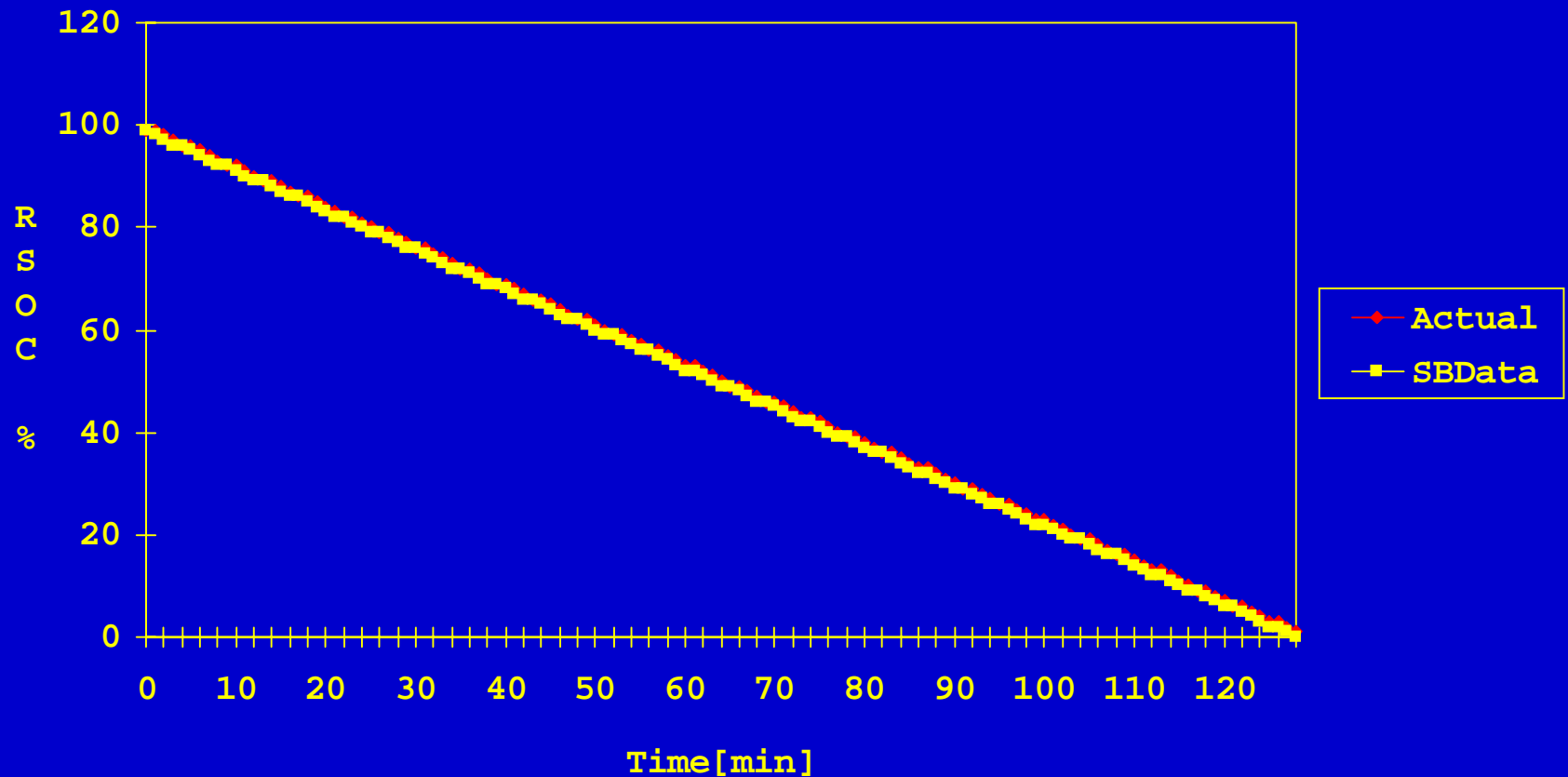
Company A

Discharging (RSOC)



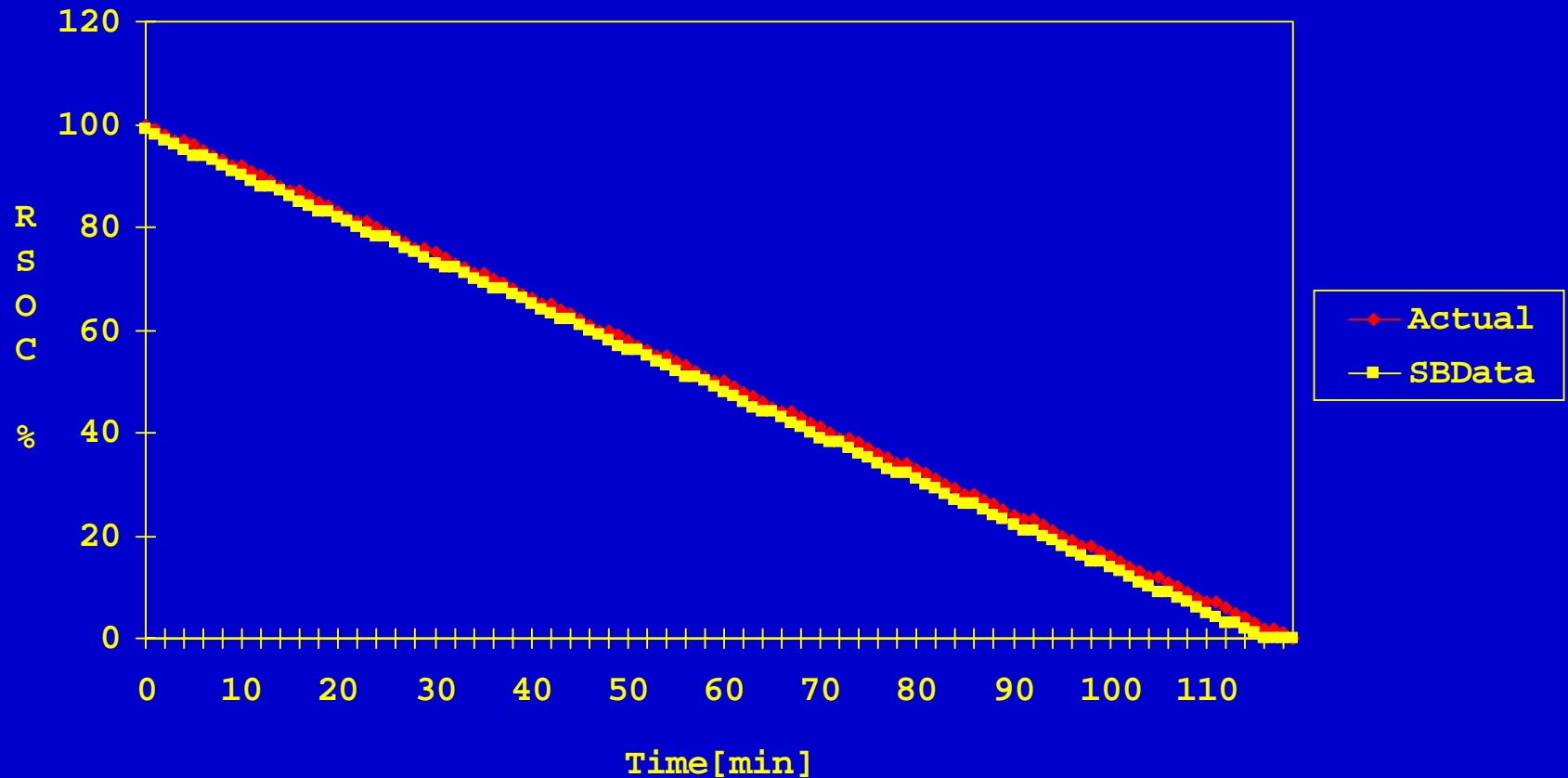
Company B

Discharging (RSOC)



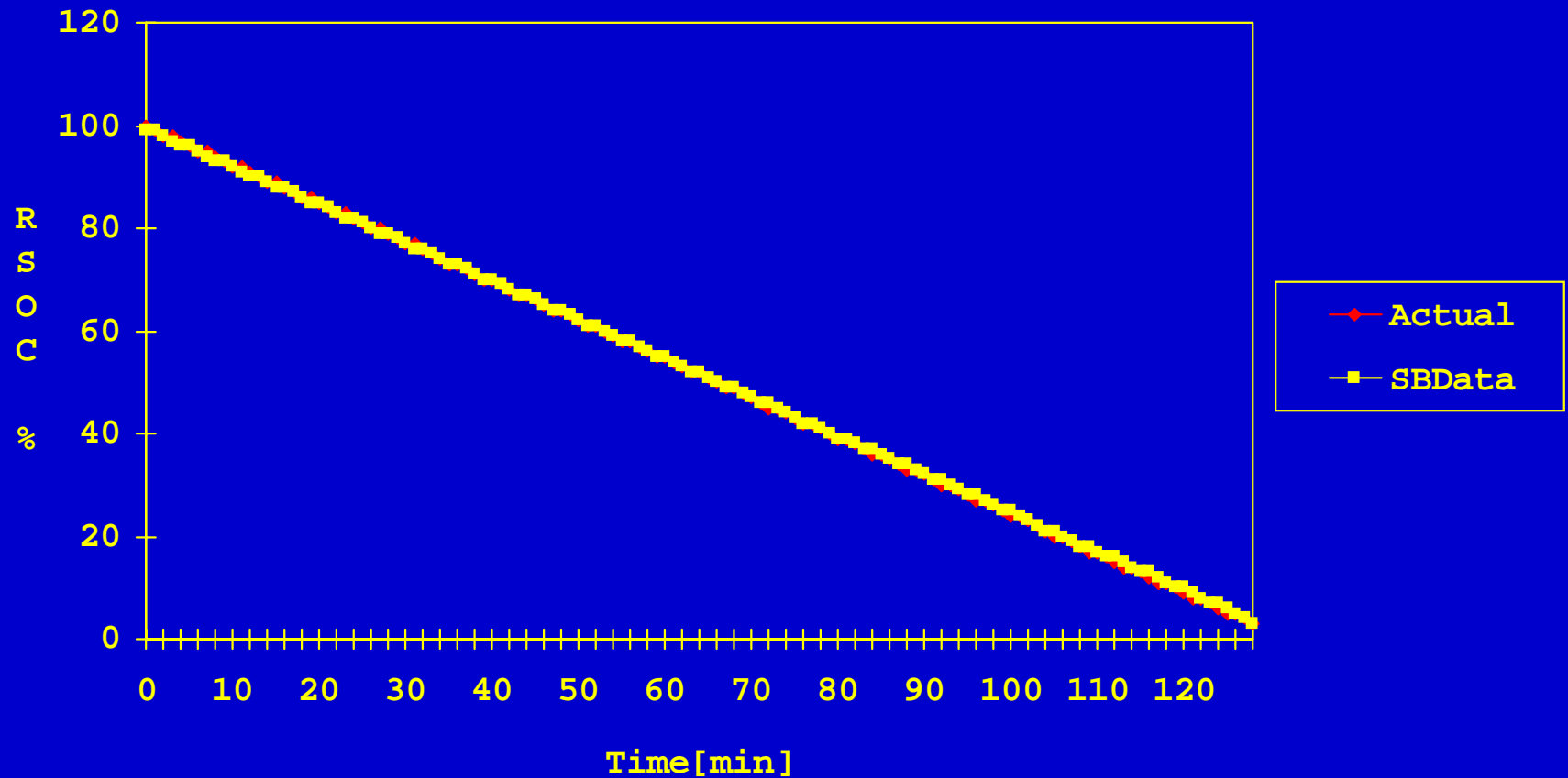
Company C

Discharging (RSOC)



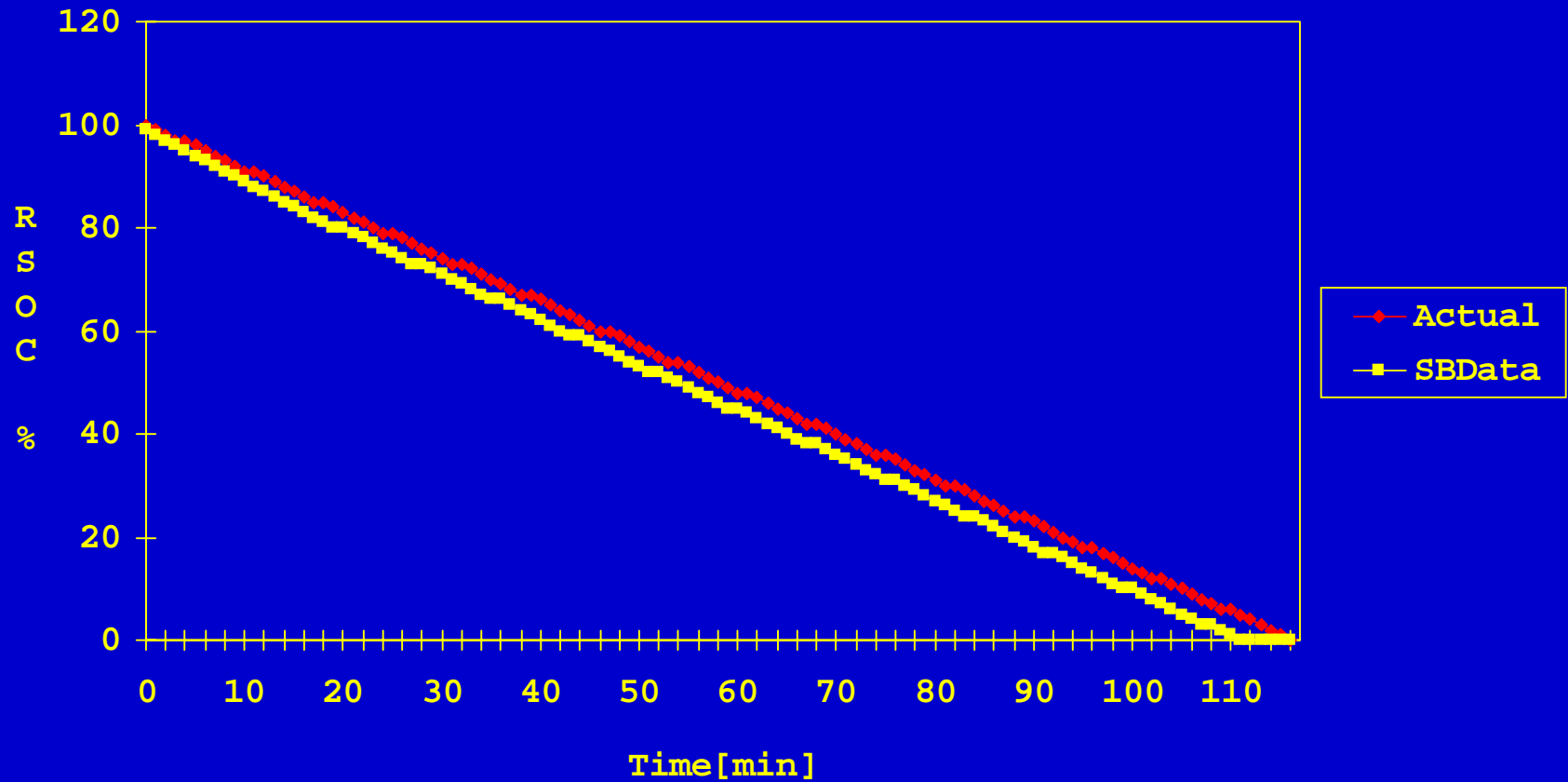
Company D

Discharging (RSOC)



Company E

Discharging (RSOC)

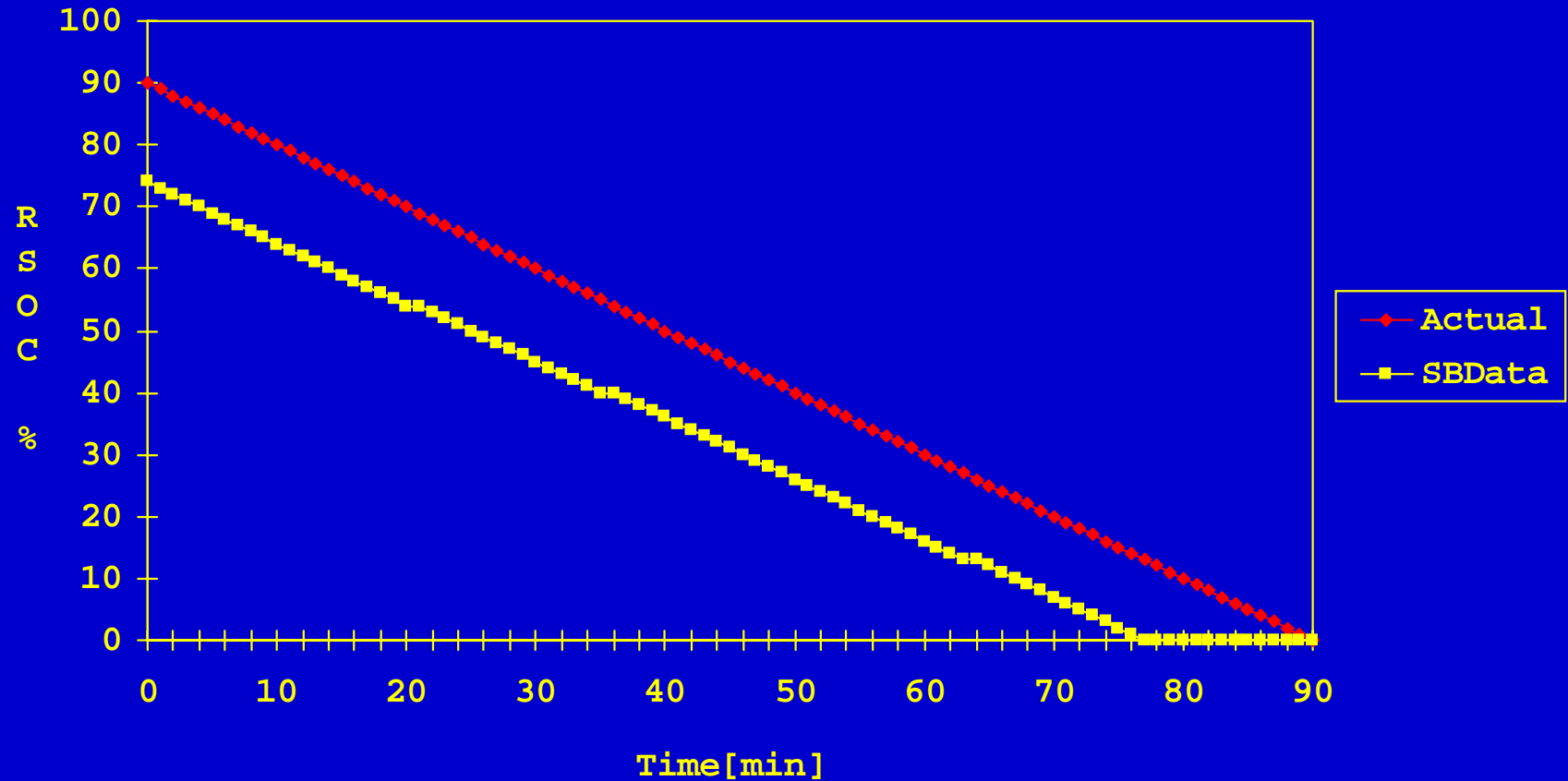


Accuracy Test(2) Results

- Test Condition
 - 90% charge to 90% discharge
 - Charge/discharge rate 0.5 C
 - 5 cycles
- Charge
 - C-C Mode (0.5C) => C-V Mode
- Discharge
 - C-C Mode (0.5C)

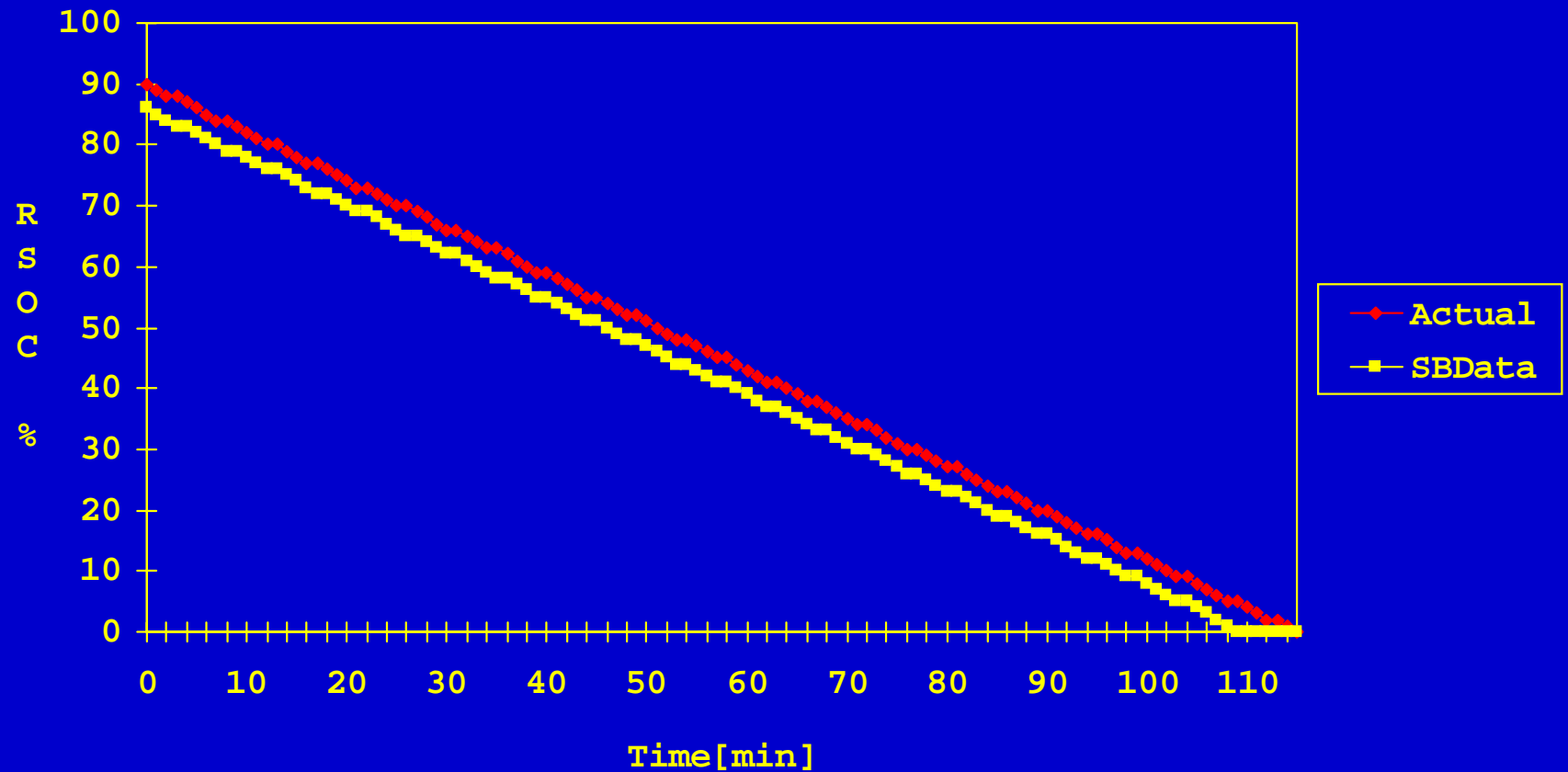
Company A

Discharging (RSOC)



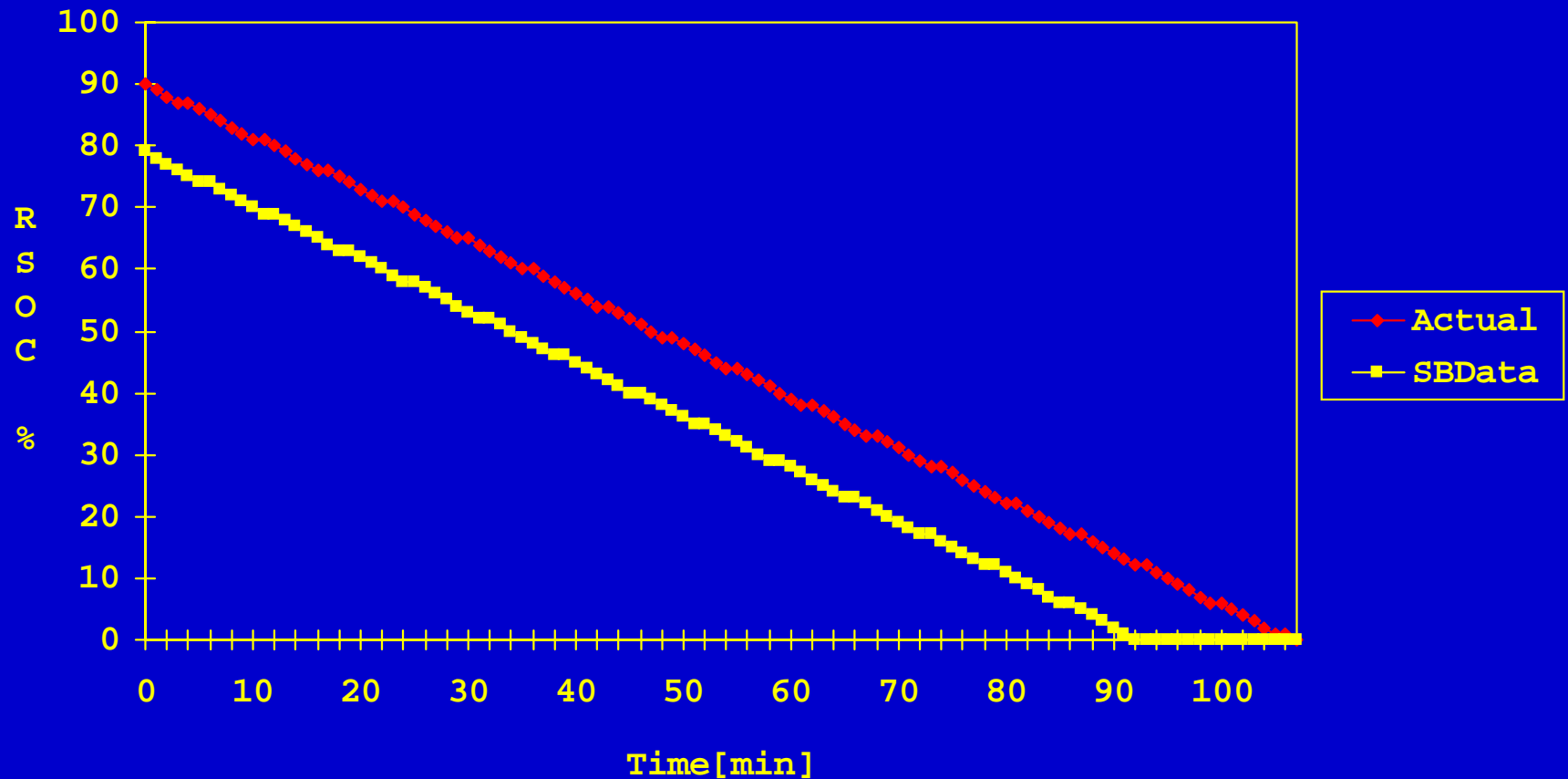
Company B

Discharging (RSOC)



Company C

Discharging (RSOC)



Predicted Remaining Battery Capacity

- Full Charge to Full discharge Accuracy is Good
- 90% Charge to 90% discharge Accuracy is not good
- The Actual User Condition is Random
- Difficult to Predict remaining Battery Capacity by Temperature, Rate, Cycle Life , Self Discharge etc

Smart Battery Improvement's problems

- The Smart battery specification good, but today's batteries don't meet the Specification
- Smart Battery's Predictive data accuracy can't be trusted
- Each vendor has a different Smart battery implementation
- Conditioning Cycle request periodically
- System Protection from Pirated Smart battery

SAMSUNG Smart Battery Improvements

- Smart Battery + CM Battery
- End of Charge :
SBData FullyCharged bit 'set' &
Actual Battery Charging Current
- End of discharge :
SBData RSOC & Battery Voltage

OEM's Perspective

- A battery which meets the Smart battery specification will present as the Improvement of Battery application technology
- Smart Battery Implementation should be standardized
- Smart Battery Certification Mark Institution should be executed

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