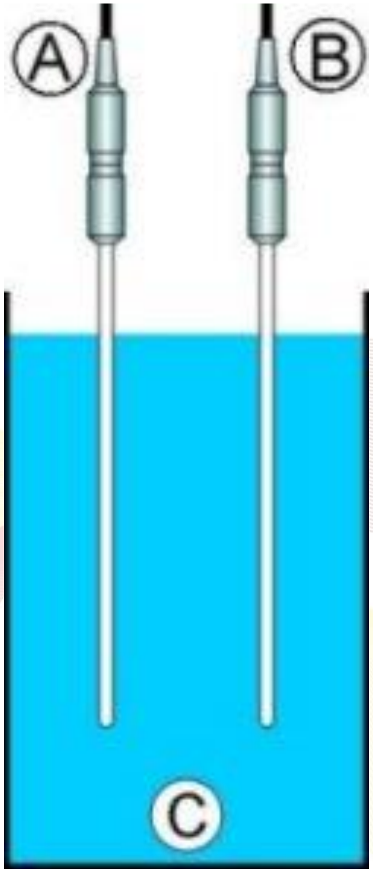
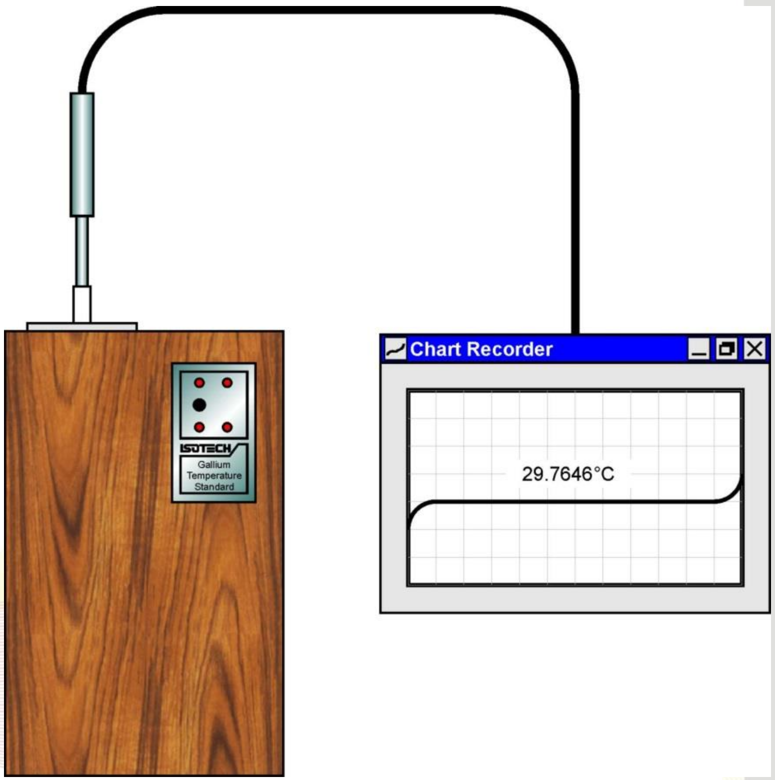
Introduction

- Most calibrations are performed by comparing the unknown characteristics of the thermometer under test to a calibrated reference thermometer
- But how are the reference thermometers calibrated?



Introduction

- The answer is, in a series of known and fixed temperatures where pure substances (usually metals) melt or freeze



Introduction

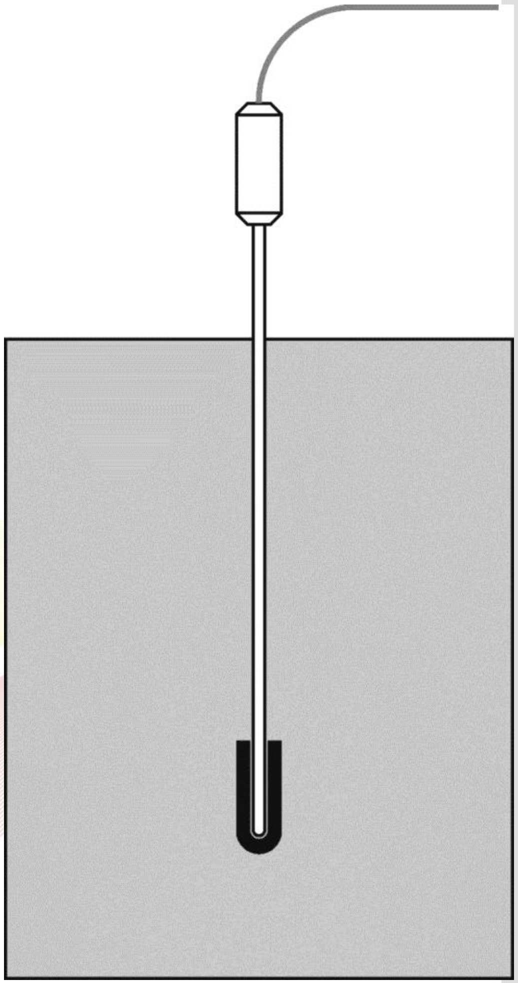
- Three things are required before a thermometer can be calibrated at a fixed point
  - A fixed point cell (an ingot of pure metal inside a specially shaped graphite crucible)
  - An apparatus or furnace to melt and freeze the ingot of metal uniformly
  - The thermometer must be sufficiently immersed so that the sensing element is at the cell’s temperature

Introduction

- Fixed point systems to National Laboratory standards are very expensive and are also inconvenient if the thermometer is short. So shorter and smaller fixed point systems were developed
- The shorter, smaller and cheaper fixed points are approximations to those in National Laboratories and they seldom provide sufficient immersion for the thermometer being calibrated

Introduction

- To offer the customer small uncertainties the smaller cells are calibrated in large furnaces and the user must make allowance for the stem conductance of his thermometer
- This is not very satisfactory



A New Approach

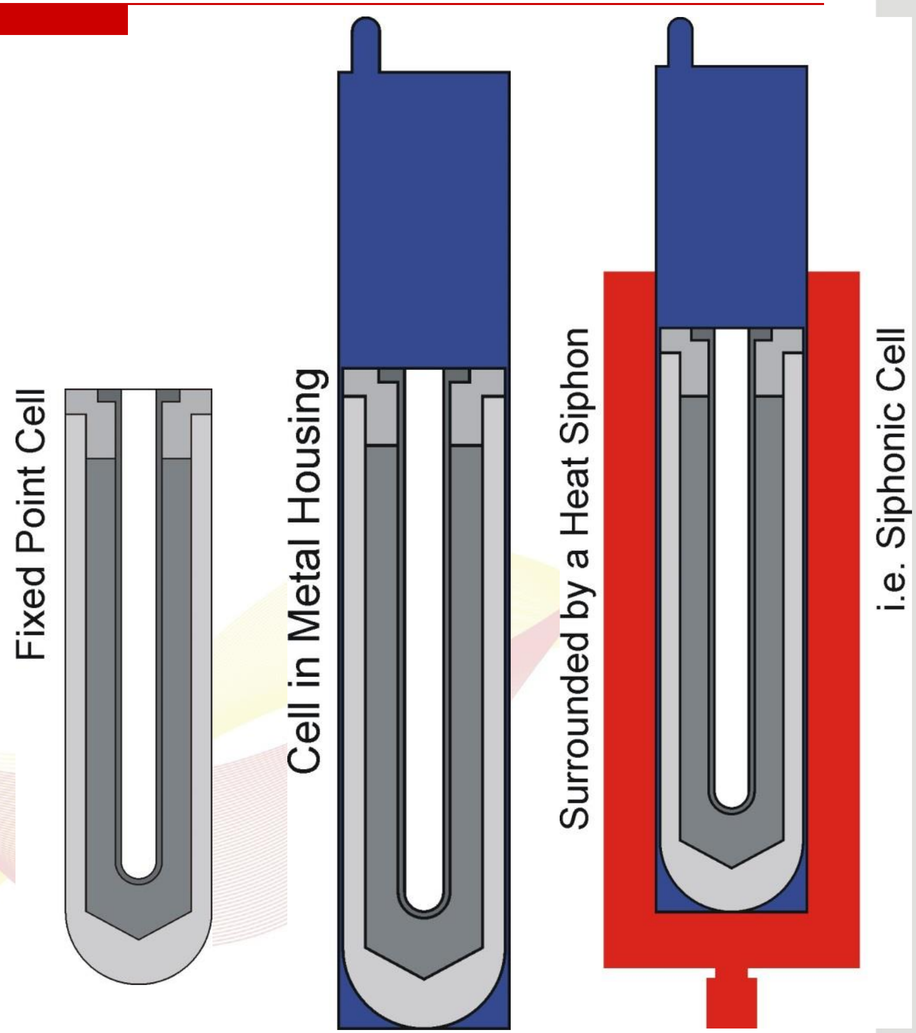
- **What if** we throw the existing ideas out of the window and start again?
- **What if** the cell and furnace become one and inseparable?
- **What if** the immersion necessary is calculated and compensated?
- Might we end up with a novel but improved solution to fixed point calibration?

New Design (Patented)

- The key to the new design is a heat siphon in the shape of a Dewar with elongated inner tube
- The key feature of the Siphonic Dewar is that it is gradient-free so a cell inside will melt and freeze uniformly
- Next the cell fits snugly inside and is sealed in place surrounded by 1 atmosphere of pure argon

Combining Cell and Apparatus

- The concept was patented and called a Siphonic Cell (S.C.)

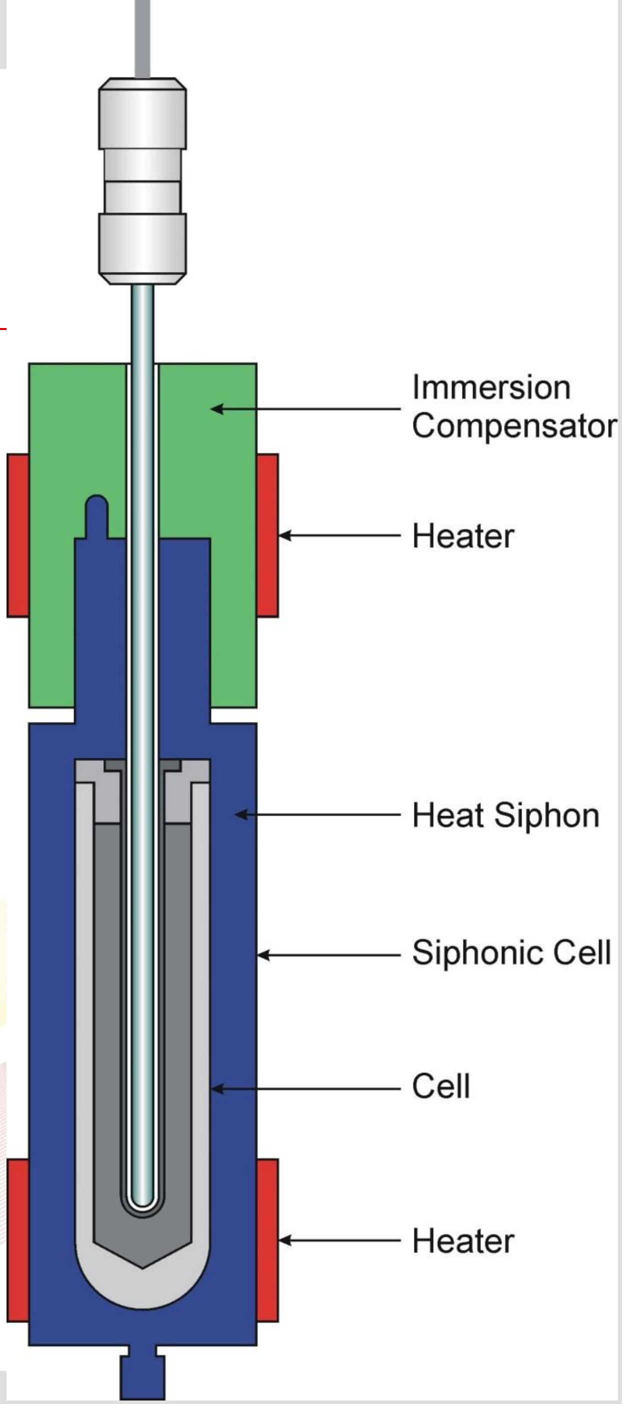


Combining Cell and Apparatus

- The ideal apparatus to surround a cell is a heat pipe or heat siphon. If the outer wall of a metal clad fixed point cell also becomes the inner wall of the heat siphon then a very simple structure of ideal thermal profile would result

How Does it Work?

- Two heaters are used, the main heater for the Siphonic Dewar, the second heats the immersion compensator to the same temperature as the cell

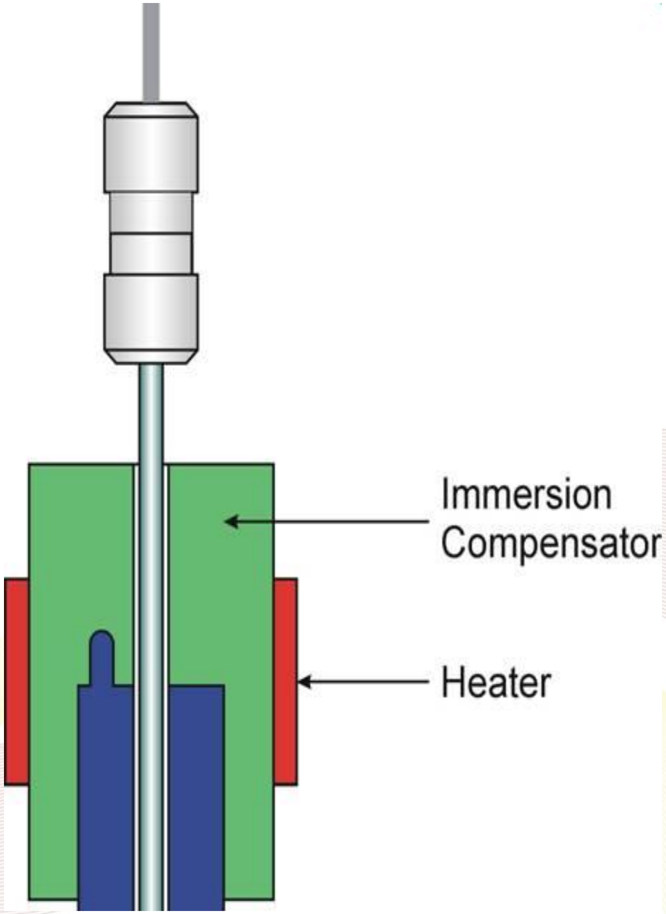


Immersion Compensator IC

- The depth from metal surface to the bottom of the re-entrant tube is 180mm and this is inadequate for most SPRTs
- The unit under test therefore needs to go through an isothermal zone above the cell set to the cell's transition temperature

Immersion Compensator IC

- The Immersion Compensator actively provides the Isothermal Zone
  - Patented



How Does it Work?

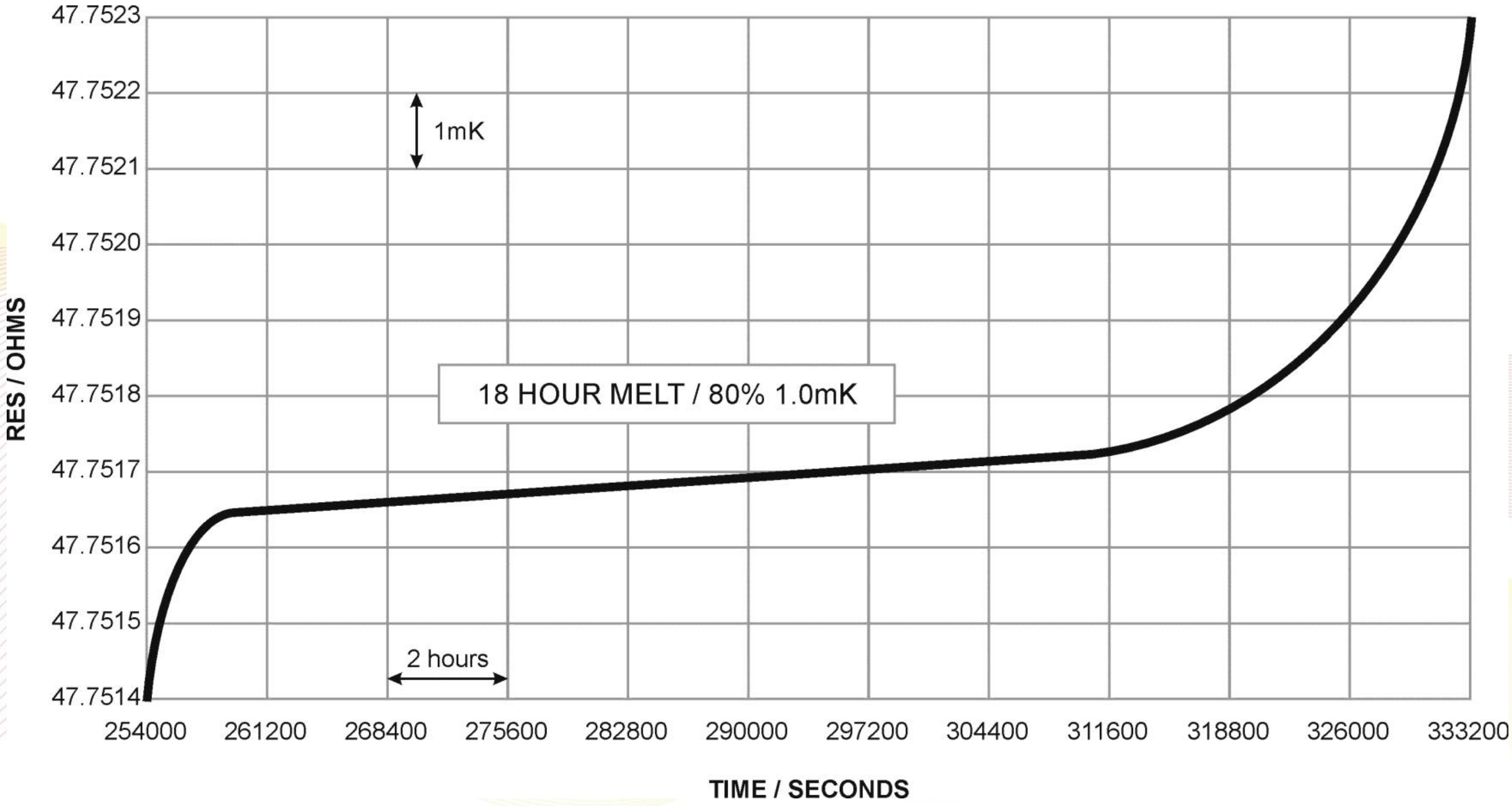
- The control temperature is set above the melt temperature – the cell melts. 0.1°C above yields a 30 hours melt. 0.2°C above 15 hours melt etc
- Setting the temperature 0.1°C below yields a 30 hour freeze etc

Results

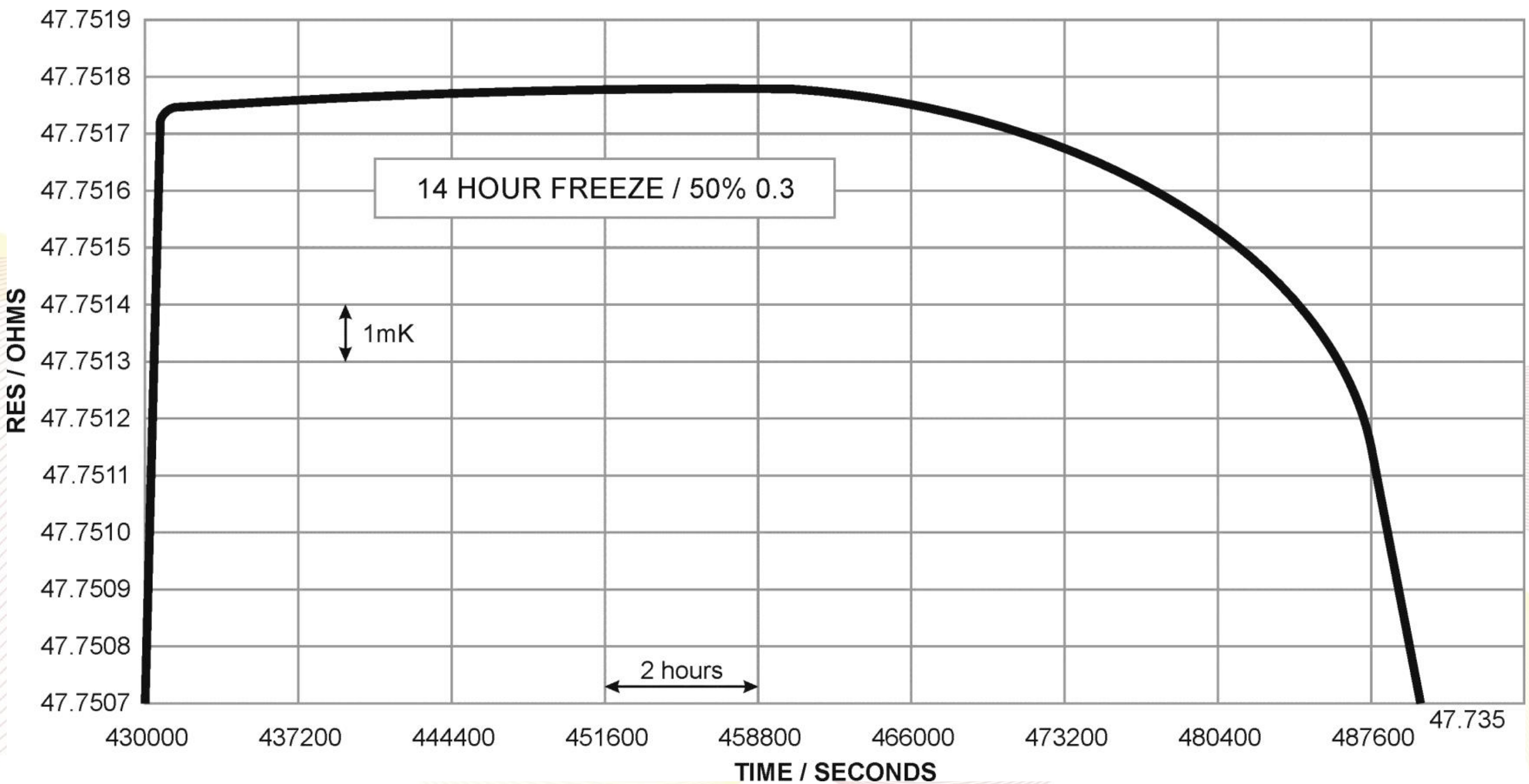
- A series of melt and freeze plateau graphs follow

Slide 14

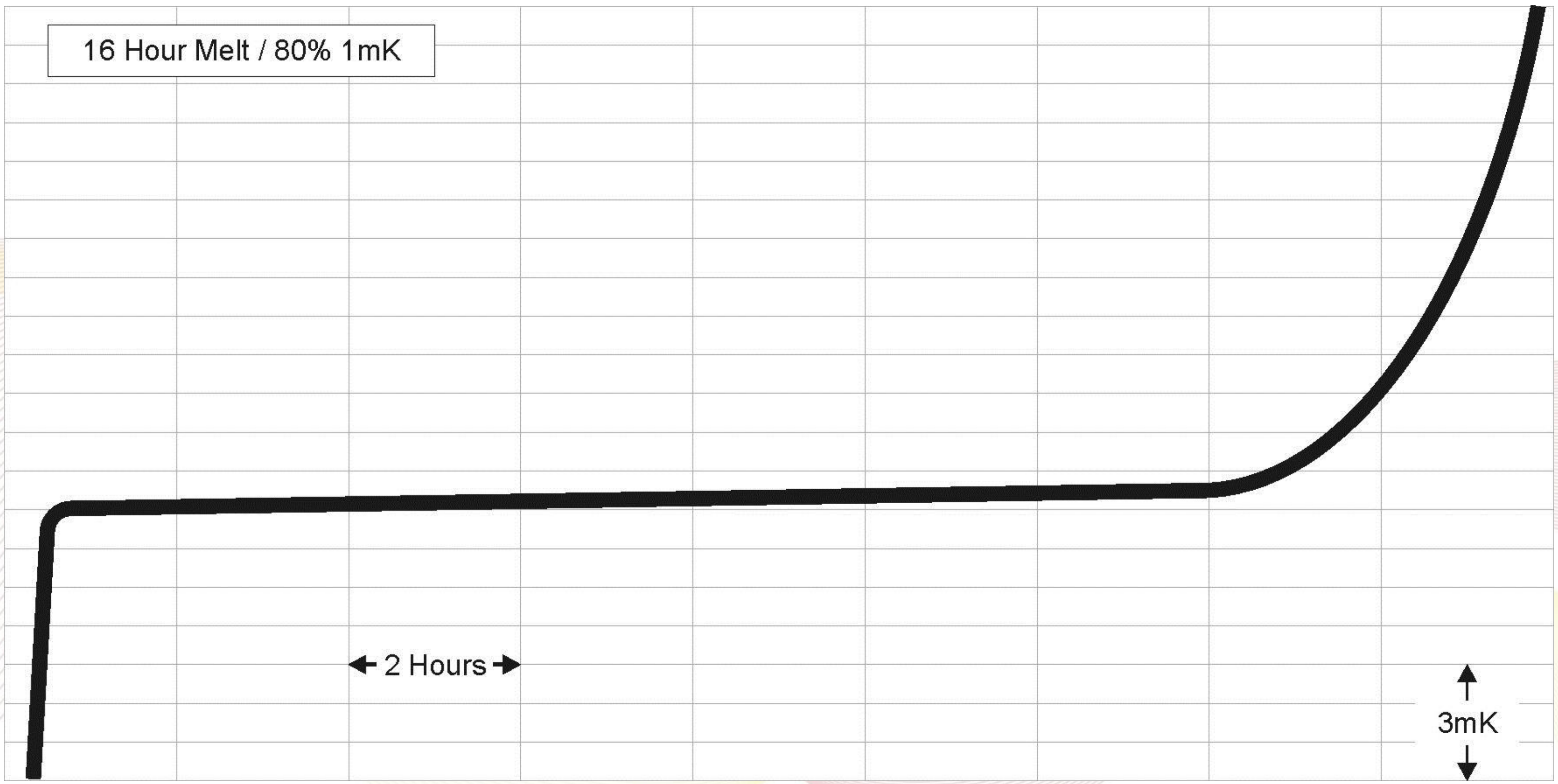
Siphonic Sn Fixed Point Cell Melt Plateau



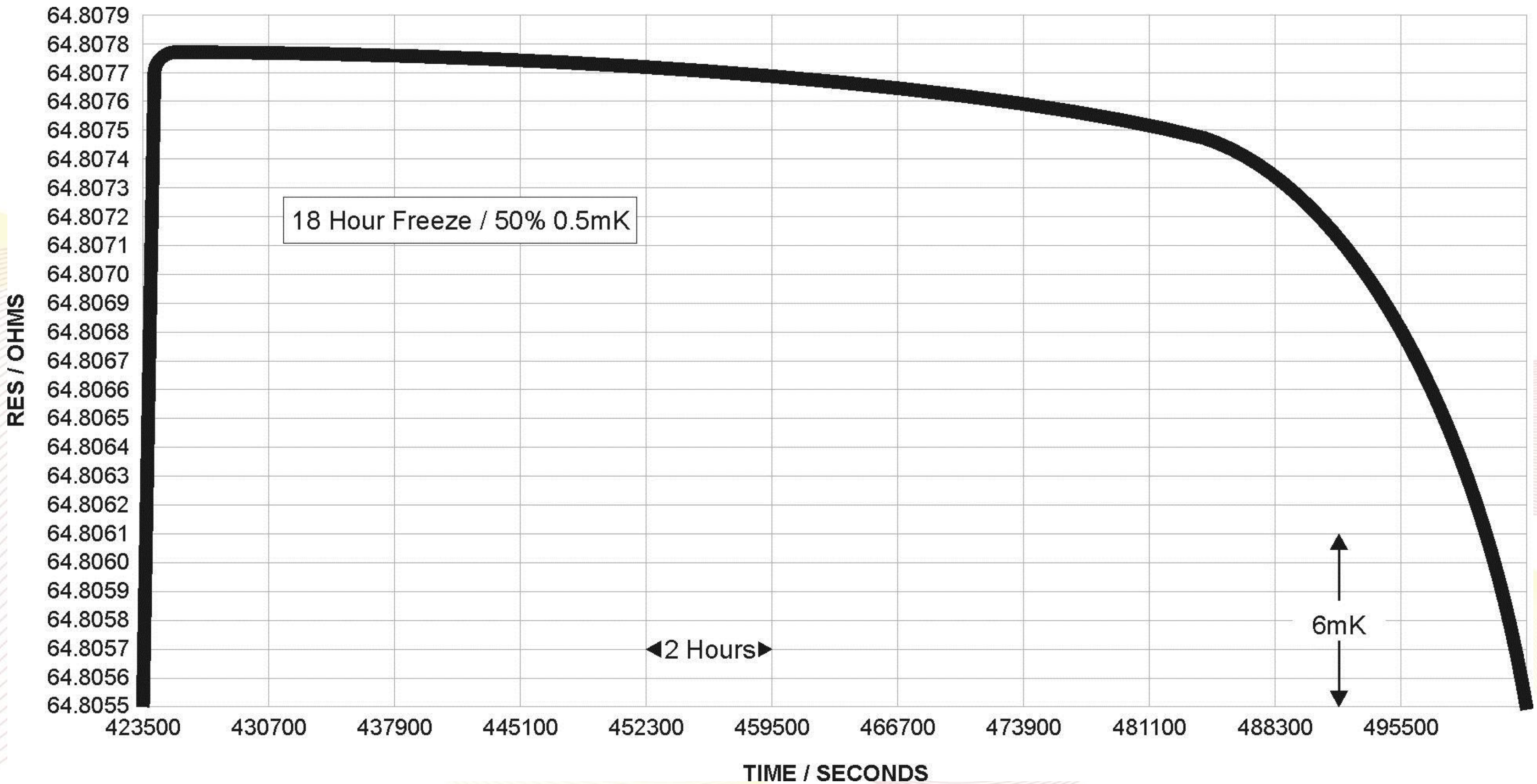
Siphonic Sn Fixed Point Cell Freeze Plateau



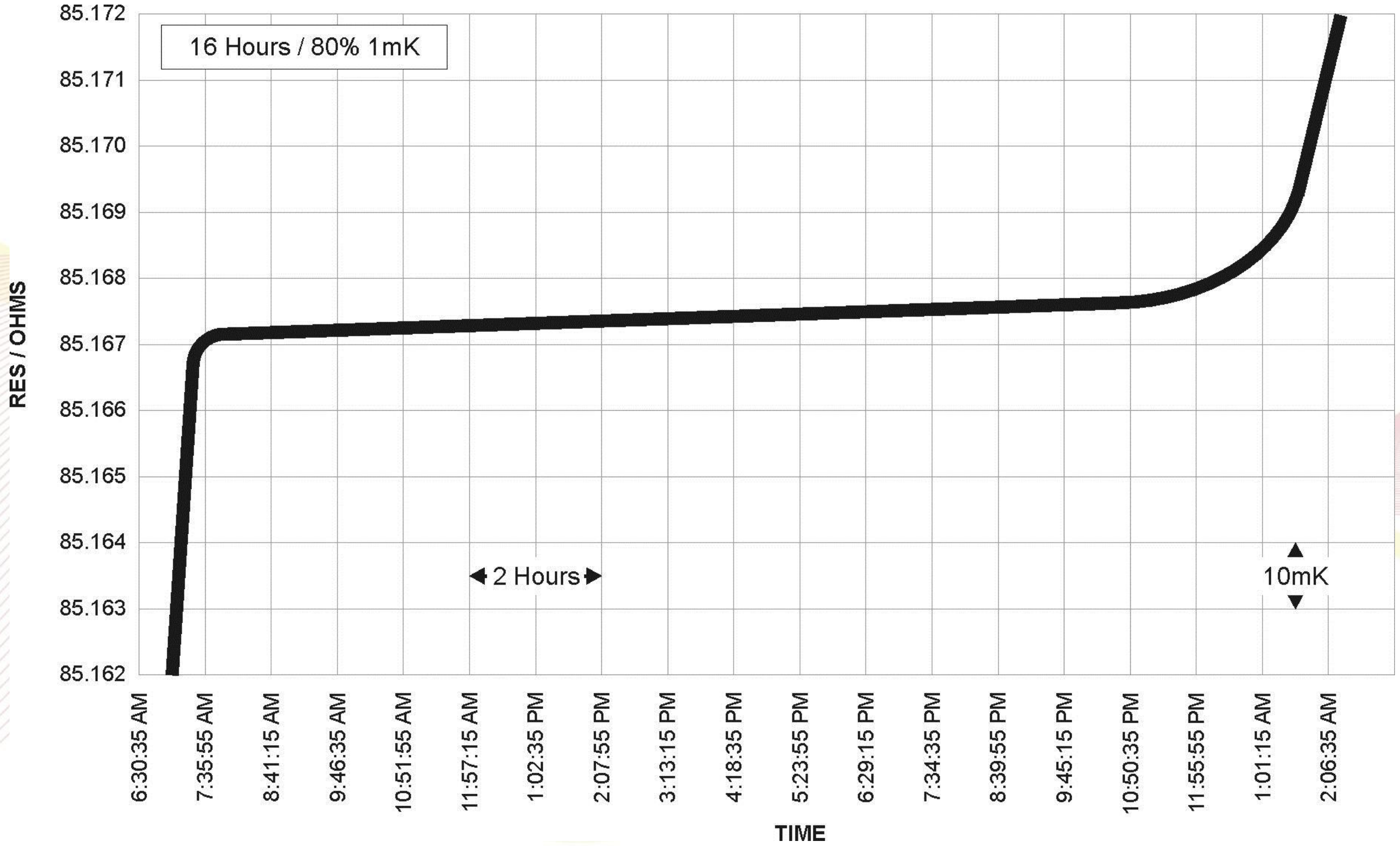
Siphonic Zn Fixed Point Cell Melt Plateau



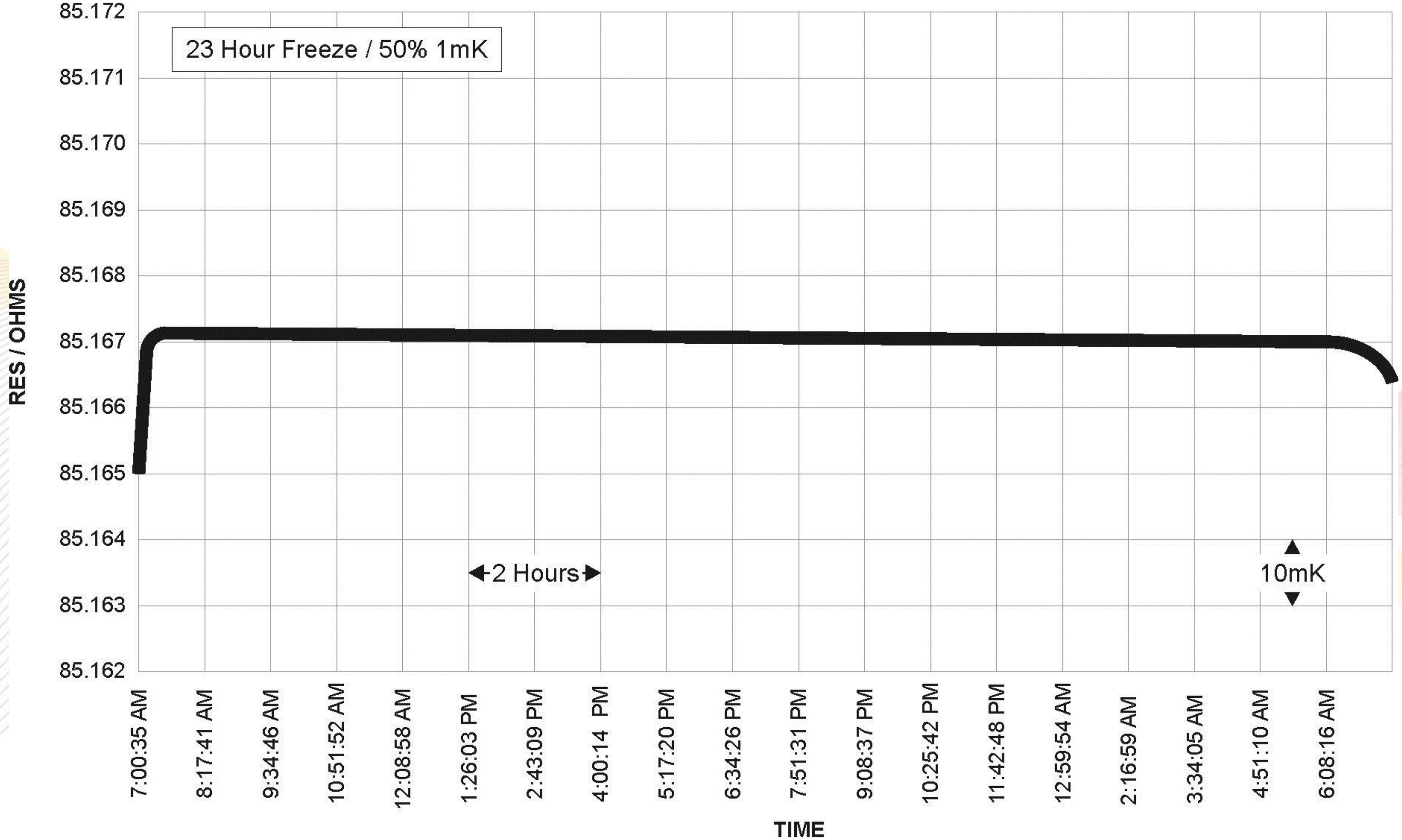
Siphonic Zn Fixed Point Cell Freeze Plateau



Siphonic Al Fixed Point Cell Melt Plateau



Siphonic Al Fixed Point Cell Freeze Plateau



German Laboratory Invested in ISOTowers

- KK set up a laboratory based on ISOTowers

ISOTowers in Germany

- Achieved Daaks (formerly DKD accreditation
- Tin 3mK
- Zinc 3mK
- Aluminium 5mK

DAKKS Accreditation

Widerstands-thermometer (auch SPRT) und direktanzeigende Widerstands-thermometer-Messeinrichtung	−189,3442 °C	Argontripelpunkt	5 mK	Kalibrierung an Temperatur-fixpunkten
	−38,8344 °C	Quecksilbertripelpunkt	3,5 mK	
	0,01 °C	Wassertripelpunkt	2,5 mK	
	29,7646 °C	Galliumschmelzpunkt	2,5 mK	
	156,5985 °C	Indiumschmelzpunkt	5,5 mK	
	231,928 °C	Zinnerstarrungspunkt	3,0 mK	
	231,928 °C	Zinnschmelzpunkt	7,0 mK	
	419,527 °C	Zinkerstarrungspunkt	3,0 mK	
	419,527 °C	Zinkschmelzpunkt	12 mK	
	660,323 °C	Aluminium-erstarrungspunkt	5,0 mK	
	660,323 °C	Aluminium-schmelzpunkt	20 mK	
Thermoelemente Typ Au/Pt	0,01 °C	Wassertripelpunkt	0,2 K	Kalibrierung an Temperatur-fixpunkten
	419,527 °C	Zinkschmelzpunkt	0,2 K	
	660,323 °C	Aluminium-schmelzpunkt	0,2 K	
	961,78 °C	Silbererstarrungspunkt	0,2 K	
Typ Au/Pt	0 °C bis 962 °C	3-Zonen-Ofen	0,4 K	Vergleich mit Au/Pt-Thermoelementen
Typ R, S	0 °C bis 962 °C		0,8 K	