SLIM QUARTZ &
METAL CLAD CELLS
User Maintenance Manual/Handbook

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This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical break-down or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuse.

In the event of failure covered by this guarantee, the instrument must be returned, carriage paid, to the supplier for examination and will be replaced or repaired at our option.

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INTRODUCTION

In the practical world of industrial temperature measurement, a large number of laboratories who normally make comparison calibrations need 1 or 2 fixed points to monitor their Standard Platinum Resistance Thermometers, or would like to calibrate shorter thermometers than the larger cells and apparatus can accept. For this group of users Isothermal have introduced 'slim' cells.

WHAT ARE SLIM CELLS?

The special requirements of immersion depth, plateau duration, etc. required for the calibration of SPRT's may not be necessary in laboratories charged with calibrating industrial resistance thermometers, thermocouples and thermistors, but mobility and cost may be more important. "Slim cells" is a name given to another category of cell, being somewhat slimmer, slightly shorter and lower in price than the standard varieties.

Slim cells are built using the same materials, techniques and purity of metal as the larger cells, but the uncertainties associated with them are somewhat larger, not because of the cells but precisely because their properties cannot be measured with SPRT's and transfer thermometers must be employed in qualifying them.

In consequence of their smaller size, smaller, lighter-weight apparatus (bench-top or cart-mounted furnaces) may be used to melt and freeze the metal in these cells. Sealed cells and associated apparatus, such as the Medusa and Oberon are available from Isotech.

Slim cells can be supplied in either quartz glass, or for Indium, Tin and Zinc, Isotech can safely encase the cells in a non-contaminating metallic housing.

INSTALLATION

If cell accessories have been purchased from Isotech, (comprising the inconel basket, insulation spacers, foil disc, inconel baffle and kaowool pad), these should be assembled in the furnace without the fixed point cell and pre-aged for a few hours 10°C above the fixed point cells transition temperature. This avoids possible contamination of the fixed point cell.

On arrival the cell should be inspected for damage.

One easy way to check if a cell is leaking is to plunge it into hot water. If it is leaking a stream of air bubbles will come out of the cell.

If the cell leaks it must be returned for a new glass or metallic housing.

If not, the cell can be assembled ready for installation into the apparatus.

Firstly the cell should be cleaned using a tissue and alcohol. This is especially important for the higher temperature cells of Aluminium, Silver and Copper.

Next the cell should be assembled according to the drawing in this manual and placed into the furnace to be used for melting or freezing the cell. If a lead cell has been purchased please refer to the special assembly drawing for this.

REALISING THE FOLLOWING FIXED POINTS: INDIUM, LEAD, ZINC, AND ALUMINIUM

These metals are characterised by a relatively short supercool (supercool is the characteristic of a freezing pure metal to remain liquid at a temperature below that at which the solid melts). The supercool of these metals can be expected to be less than 0.5°C.

The cell is placed in the furnace, suitable insulation and cover added and a monitoring thermometer inserted. The furnace controller is set 5°C to 10°C above the expected melt temperature. The temperature rise is monitored with a bridge and/or recorder connected to the thermometer.

Following the melt arrest, the temperature of the cell will rise to the controlled temperature. The metal in the cell is now entirely in the liquid phase and may be maintained in this condition for any desired period of time, for example, to accommodate to a calibration schedule.

To freeze, the furnace controller is set below the actual freeze temperature (for pure metals, melt and freeze temperatures are theoretically identical). The suggested setting is 1°C below the freeze temperature; this is, assuredly, below the bottom of the supercool. The furnace is allowed to cool to this new setpoint temperature, taking typically 30 to 45 minutes to do so.

When the monitor indicates that the cell is at, or below, its freeze temperature, the monitor is removed to a rack and replaced by a cold rod of quartz. This initiates nucleation. After 2 minutes the rod can be removed and replaced by the monitor again.

This procedure creates a radial freeze from the inside and outside walls of the cell towards the centre.

If the cell is left too long in the furnace without initiating the freeze as described above, nucleation will occur and the cell will begin to freeze from the bottom of the cell upwards.

This will result in a short, imperfect, plateau and, moreover, give an incorrect value of freeze point (typically 10mK below that expected).

At the temperatures of Indium, Tin and Zinc it is generally permissible to withdraw a thermometer, of type Isotech 909, directly into room temperature. At the Aluminium Point, the thermometer must be cooled slowly to 450°C. See 909 handbook.

FREEZING THE TIN CELL

Realisation of the Tin plateau is accomplished in a manner similar to those of Indium, and Zinc with the following exception.

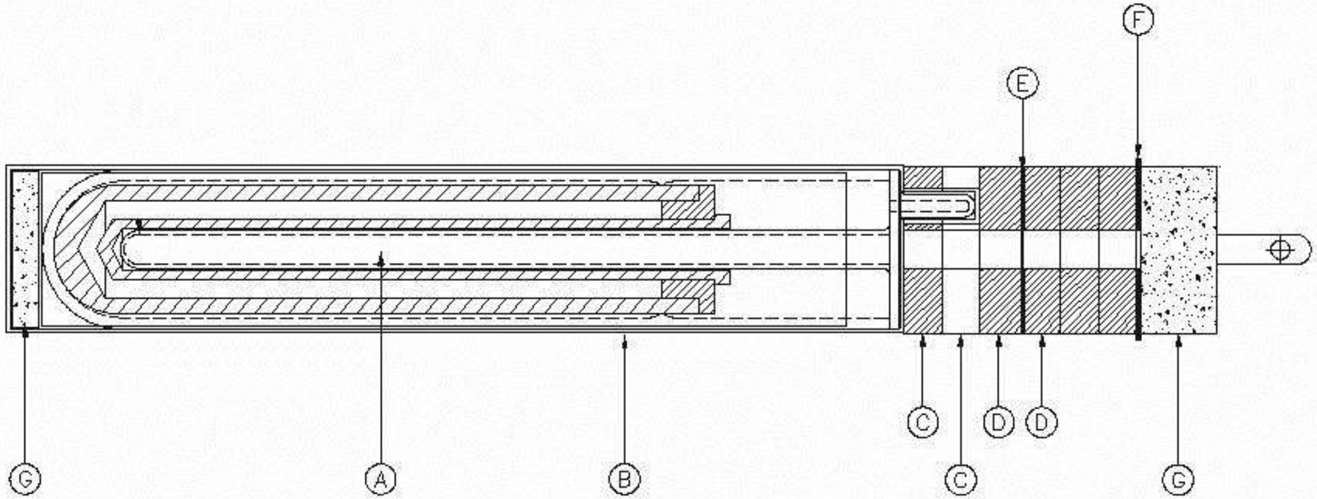
Tin can supercool as much as 10°C. If the furnace were allowed to cool to the nucleation point, it would probably not recover in time to realise the plateau.

Following melt; reduce the temperature of the furnace to a few tenths of a degree below the anticipated freeze plateau temperature. Prior to supercool, and with the thermometer still in place, withdraw the cell in its Inconel basket, from the furnace. Suspend the basket (with cell) in ambient air. Continue monitoring until the temperature begins to rise. Return the cell to the furnace, remove the monitor thermometer and replace with a cold quartz rod. After 2 minutes remove the rod and replace the thermometer. When the monitoring thermometer has shown no change for some minutes, the plateau has been achieved.

A USEFUL HINT

When first creating melts or freezes use large over or under settings - typically 3 to 5°C above or below the plateau. The result will be a shorter plateau time than ideal, but will engender confidence in establishing a plateau. Once familiar with the procedure using coarse settings, on subsequent exercises bring the setting of the controller closer to the known plateau temperature to increase the plateau length.

SLIM CELL (477) ASSEMBLY TO FIT MEDUSA 1
SUITABLE FOR IN, SN, ZN, PB, SLIM QUARTZ OR METAL CLAD CELLS



MOD#	DESCRIPTION
-1-	DETAILS ALTERED
-2-	INSULATION ALTERED
-3-	INSULATION ALTERED
-4-	INSULATION ALTERED
-5-	LEAD TYPE (PB) ADDED
-6-	LEAD TYPE (PB) REMOVED
-7-	LEAD TYPE (PB) ADDED
-8-	'G' PART # CORRECTED

HOLE	DESCRIPTION

- (A) SLIM CELL (IN, SN, OR ZN) 477-00-00 OR 480-01-00
- (B) CELL CAGE (855-05-01 X1, PRE-AGED)
- (C) INSULATION SPACER (426-04-04B X2)
- (D) INSULATION SPACER (426-04-04A, 4 X GLASS, 5 FOR METAL CELLS)
- (E) FOIL DISC (PLATINUM 935-40-09 X1)
- (F) INCONEL BAFFLE (426-04-03 X1)
- (G) KAOWOOL BLANKET PAD (FROM 932-20-52 X2)

FOR In, Sn, Zn & Pb CELLS

GENERAL TOLERANCES
+/-0.1mm LINEAR DIMS
+/-0.1mm HOLE CENTERS
+/-0° 30' ANGLES

MATERIAL
SEE INDIVIDUAL COMPONENTS

FINISH
PLEASE REFER TO INDIVIDUAL COMPONENTS

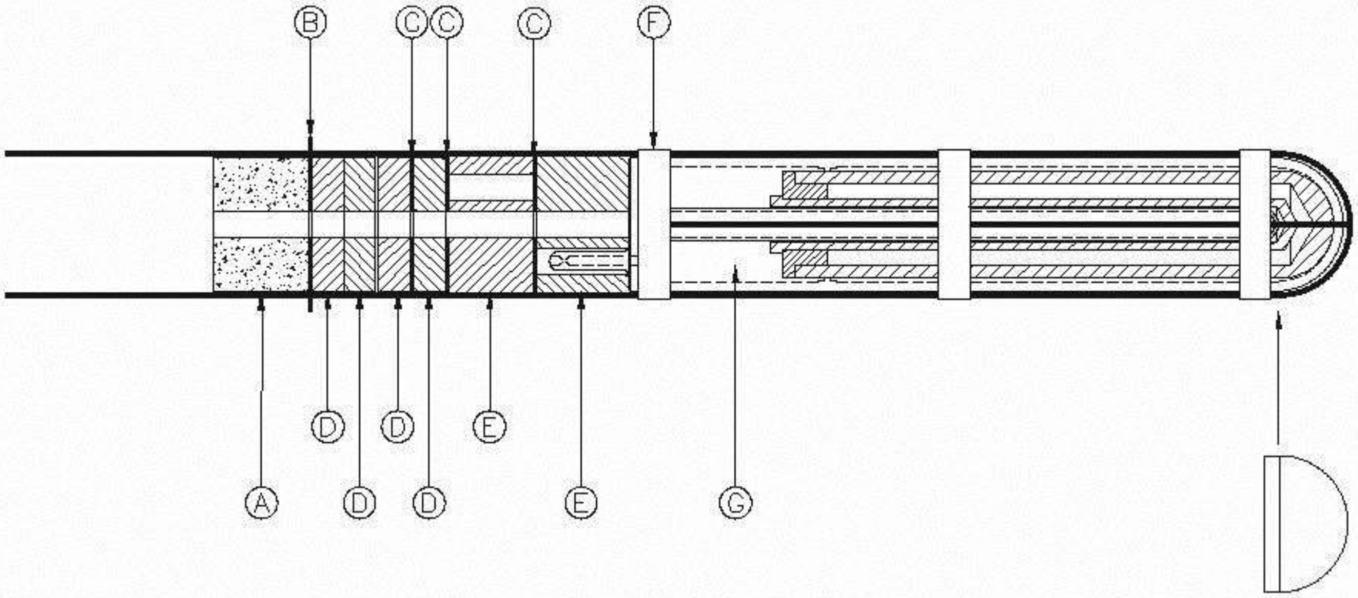
DO NOT SCALE TO DRAWING

THIRD ANGLE PROJECTION

ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, U.K.

-8-	ISSUE#	DESCRIPTION	
-8-	MOD#	CELL CAGE ASSEMBLY	
12/2/14	DATE		

DRAWN: A.J.Land
CHECKED BY: A.Blundell
DRAWING NUMBER: 510-05-00



LOWER INSULATION
DRAWING NUMBER 426-04-06
METAL CLAD SLIM CELLS ONLY

- (A) KAOWOOL PAD (FROM 932-20-52)
- (B) INCONEL BAFFLE (426-04-03 X1)
- (C) PLATINUM FOIL DISCS (X3) 935-40-09
- (D) INSULATION SPACERS (426-04-04A)
- (E) INSULATION BLOCK (426-04-05 X2)
- (F) CELL BASKET (426-04-01, pre-aged)
- (G) SLIM CELL (AL, AG or CU) 477-00-00 OR 480-01-00

MOD#	DESCRIPTION
-1-	INSULATION CHANGED
-2-	DETAILS ALTERED
-3-	INSULATION CHANGED
-4-	INSULATION CHANGED
-5-	INSULATION CHANGED
-6-	NOTE ADDED M.C.S.C.
-7-	'A' WAS 932-20-15

HOLE	DESCRIPTION

GENERAL TOLERANCES

+/-0.1mm LINEAR DIMS
+/-0.1mm HOLE CENTERS
+/-0°30' ANGLES

MATERIAL
SEE COMPONENT DETAILS

FINISH
SEE INDIVIDUAL COMPONENTS

DO NOT SCALE TO DRAWING

THIRD ANGLE PROJECTION

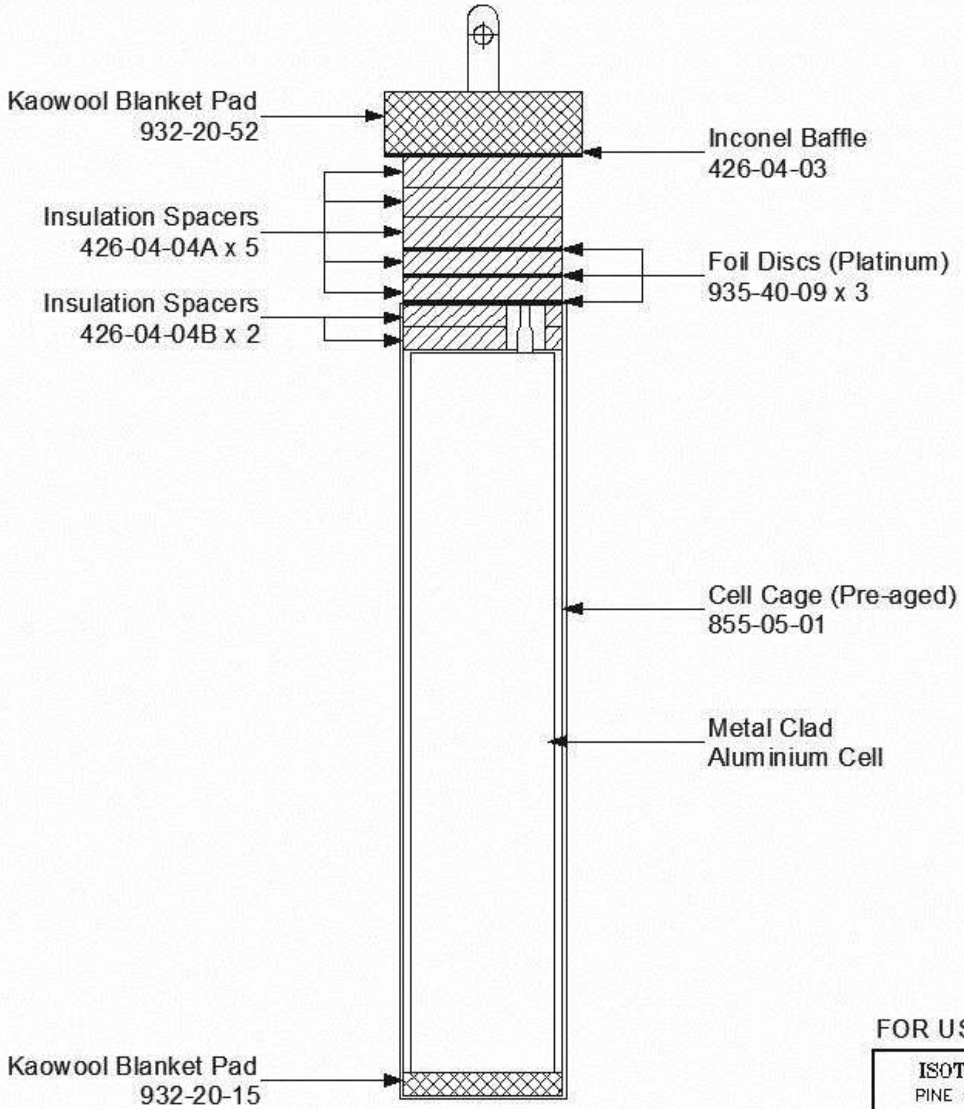
ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, U.K.

-8-	ISSUE#	DESCRIPTION: Slim Cell (477) assembly to fit Oberon
-7-	MOD#	For Al, Ag and Cu Slim Quartz or Metal Clad Cells
07/02/13	DATE	

DRAWN: A.J.Land

CHECKED BY:

DRAWING NUMBER: 426-04-00



FOR USE IN MEDUSA 3

MOD#	DESCRIPTION
-1-	932-20-52 UPDATED

HOLE	DESCRIPTION

GENERAL TOLERANCES

+/-0.1mm LINEAR DIMS
+/-0.1mm HOLE CENTERS
+/-0° 30' ANGLES

MATERIAL

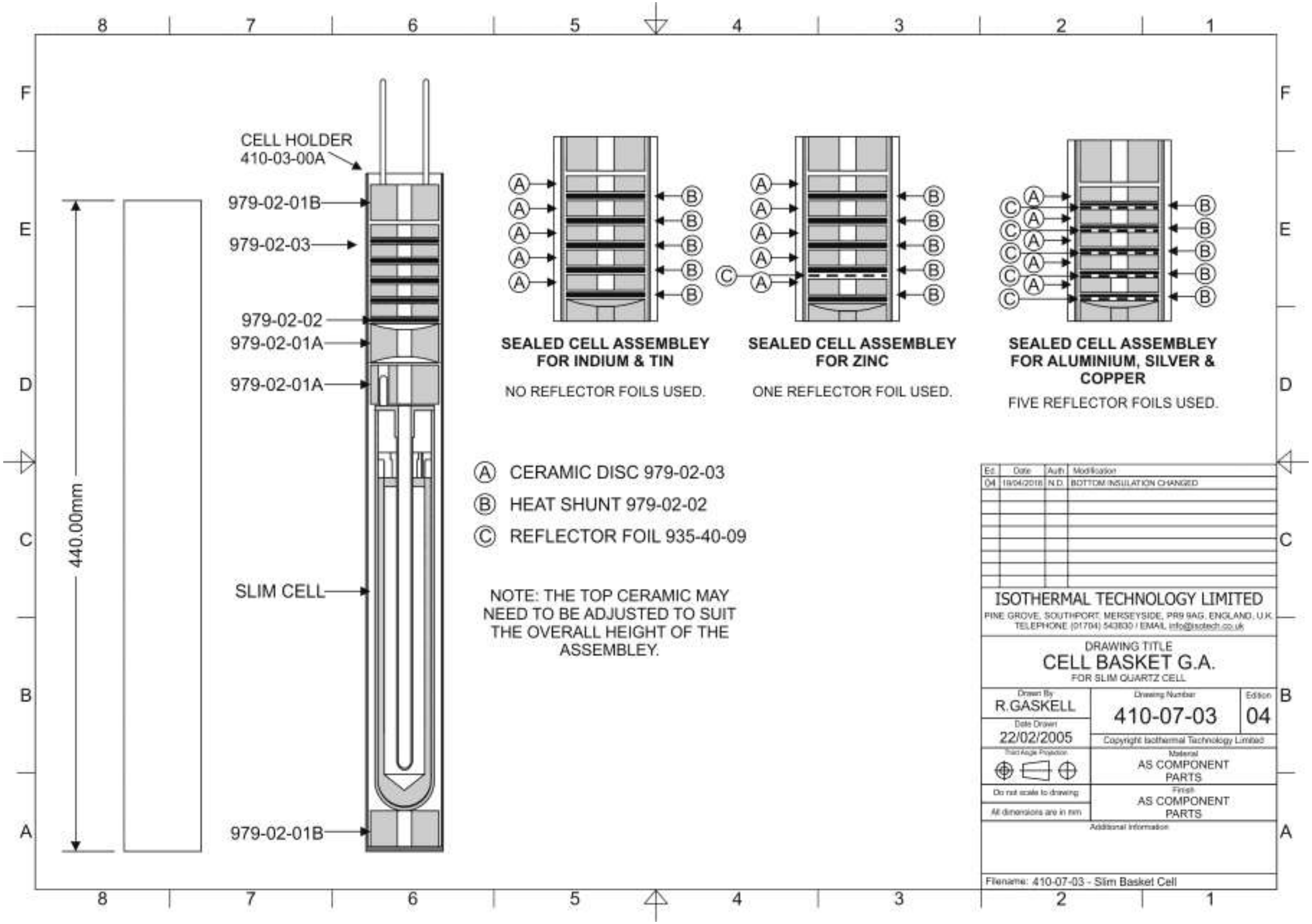
FINISH

ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, U.K.

DO NOT SCALE TO DRAWING
THIRD ANGLE PROJECTION

-2-	ISSUE#	DESCRIPTION: Cell Cage General Assembly for Metal Clad Slim Aluminium Cell
-1-	MOD#	
12/2/14	DATE	

DRAWN: A.J.Land
CHECKED BY: A.Blundell
DRAWING NUMBER: 511-05-01


CELL HOLDER
410-03-00A
979-02-01B
979-02-03
979-02-02
979-02-01A
979-02-01A
SLIM CELL
979-02-01B
440.00mm
SEALED CELL ASSEMBLEY FOR INDIUM & TIN
NO REFLECTOR FOILS USED.
SEALED CELL ASSEMBLEY FOR ZINC
ONE REFLECTOR FOIL USED.
SEALED CELL ASSEMBLEY FOR ALUMINIUM, SILVER & COPPER
FIVE REFLECTOR FOILS USED.
Ⓐ CERAMIC DISC 979-02-03
Ⓑ HEAT SHUNT 979-02-02
Ⓒ REFLECTOR FOIL 935-40-09
NOTE: THE TOP CERAMIC MAY NEED TO BE ADJUSTED TO SUIT THE OVERALL HEIGHT OF THE ASSEMBLEY.
Ed. Date Auth Modification
04 N.D. BOTTOM INSULATION CHANGED
ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, PR9 9AG, ENGLAND, U.K.
TELEPHONE (01704) 543830 / EMAIL info@isotech.co.uk
DRAWING TITLE
CELL BASKET G.A.
FOR SLIM QUARTZ CELL
Drawn By
R.GASKELL
Drawing Number
410-07-03
Edition
04
Date Drawn
22/02/2005
Copyright Isothermal Technology Limited
Third Angle Projection
Material
AS COMPONENT PARTS
Do not scale to drawing
Finish
AS COMPONENT PARTS
All dimensions are in mm
Additional Information
Filename: 410-07-03 - Slim Basket Cell

INSTALLATION OF THE SLIM CELLS INTO THE MEDUSA AND OBERON APPARATUS

The diagrams in this manual show the assembly of the slim cell into the Inconel basket ready for insertion into the Medusa or Oberon apparatus. With the Medusa apparatus a small pad of kaowool is placed into the concave portion of the Medusa well. The cell assembly is then placed on top of this.

Once inside the apparatus the top of the well is insulated with a pad of kaowool.

If the user has not purchased a specially designed Inconel basket with the cell, they should bear in mind that the use of a solid housing for the cell, that sticks out of the Medusa or Oberon well, is not suitable. This would form a thermal shunt to ambient and distort the freeze and melting curves of the cell.

Article taken from Isotech Journal of Thermometry Vol. 7 No. 2, entitled 'FREEZING AND MELTING POINTS IN SLIM CELLS'

FREEZING AND MELTING POINTS IN SLIM CELLS

by Michael Trim and Anne Blundell

INTRODUCTION

The most accurate temperatures available to us for the calibration of thermometers are those at which pure substances exist in eqilibrium in the phase-transition state. Pure metals (e.g., gallium, indium, tin, zinc, aluminium, silver) melt and freeze at specific and defined temperatures which are invariant during transition. Artifacts called "cells" have been designed to contain these metals and protect their purity, and apparatus exists in which to heat or cool the cells so that they may be melted or frozen slowly. During the melt or freeze transition there is, ideally, no change in temperature, permitting the International Temperature Scale (ITS-90) to be realized directly by these phenomena. National Laboratories maintain at least one set of standard cells and appropriate operating apparatus to support and to realize ITS-90. The fixed points of interest above 0°C are these:

The triple point of water	0.01°C
The melting point of gallium	29.7646
The freezing point of indium	156.5985
The freezing point of tin	231.928
The freezing point of zinc	419.527
The freezing point of aluminium	660.323
The freezing point of silver	961.78

In contrast to National Laboratories, industry conventionally calibrates temperature sensors by comparing them to standard thermometers which have been calibrated at the fixed points. However a simpler, more accurate and more direct approach to calibration exists between the very high accuracy of an ITS-90 realization and the lower accuracy of comparison calibration. This article describes simplified equipment for realizing fixed points and simplified procedures which still allow accurate calibration temperatures to be achieved.

TO FREEZE OR MELT?

In a paper published in 1982 [1] John McAllan of the National Standards Laboratory of Australia (CSIRO) discussed the relative merits of calibration in fixed point cells ranging from indium through aluminium in both the melting and in the freezing modes. Freezing points, in general, have been preferred for measurements of the highest precision, since most impurities affect freezing points less than they do melting points. However, where uncertainties of a few mK are sufficient, the use of melting points has certain distinct functional advantages. McAllan pointed out some of these advantages:

- Using the melt avoids the problems and delays of undercool and of establishing freezing nucleation.

- In freezing, the furnace throat temperature is below the equilibrium temperature, whilst in melting it set higher. This may partially offset errors due to the stem conduction losses, especially of metal-sheathed secondary thermometers.

- When many thermometers are to be cycled through a freezing point cell, heat extraction by the thermometer advances the freeze and so shortens the usable freeze duration. Used as melting points, the thermometers do not drive the temperature away from the correct value so long as they are preheated to prevent severe chilling of the melting metal. Instead, the melting process retraces the same melting curve, and prolongs the usable duration of the melt.

The melting mode of pure metals has received consideration in the past, usually not as a calibration equilibrium but for the purpose of estimating the purity of the metal in the cell. The sharper the transition from solid to liquid metal, and the closer the melt temperature is to the ITS-90 defined temperature, the purer the metal is considered to be. McAllan's paper is interesting in that it discusses a simplified technique for calibrating a thermometer at ITS-90 fixed points using inexpensive equipment, and allowing relatively high calibration through-put, at some slight reduction in absolute accuracy. The accuracy advantage of melting-point calibration, as opposed to comparison calibration, is clearly shown in Chart 1.

To make clearer the difference in the freezing and melting techniques, we will describe each:

THE FREEZE TECHNIQUE

Fixed point cells are normally used in the freeze mode when the highest accuracy and precision are required, and to appreciate the simplification obtained by using the melt mode, it is first necessary to understand the freeze mode technique.

In establishing the freeze-point equilibrium, it is first necessary to assure that the entire ingot of metal in the cell is molten. This is done by heating the cell in a furnace set about 5°C higher than the melt temperature for the specific metal. The molten state can be assured either (a) by monitoring the cell internal temperature with a thermometer, as it passes through the rise to the melt plateau, the dwell at the plateau, and the rise from the plateau to the setpoint temperature, or (b) more customarily, having the cell in the furnace at the +5°C setpoint temperature overnight.

With the ingot molten, the temperature of the furnace is then set about 1°C below the freeze temperature, and the cell temperature monitored with an SPRT. (A method for auto-calibrating the controller set point with respect to the freezing point of the metal is given in [2]). Reducing the furnace temperature allows the outer shell of the metal to solidify, but we also require the inner shell, next to the thermometer well, to freeze. This is achieved by removing the SPRT and replacing it with quartz rods at room temperature for 2 minutes, then replacing the SPRT. This is called "cold-rodding" and it is usually done twice.

The SPRT is then returned to the cell and observed until it is certain that the freeze plateau has been reached and the indicated temperature is stable. (For the tin point, an additional operator action is required, to accommodate the deep (~10°C) supercool of this metal. When the furnace controller has been set below the freeze temperature, the entire cell must be lifted from the furnace into ambient temperature. The cell temperature will be seen to drop and then, as nucleation occurs, to rise again. At this point the cell is returned to the furnace and cold-rodded. The freeze plateau will then soon be observed by the monitoring thermometer.

In the freeze mode, it is wise always to preheat the thermometers which are to be calibrated. Inserting a cold thermometer into the well advances (and shortens) the freeze.

THE MELT TECHNIQUE

Our discussion of the melt technique of calibrating thermometers will emphasize Isotech "slim" cells. Later in this paper we will go into detail about what "slim" cells are, and the advantages they possess for calibration where the highest accuracy is not required, but where economy of apparatus, and high calibration through-put, are important. Slim cells are somewhat smaller in diameter and in length than the cells used in primary laboratories, but are built using the same materials, techniques and purity of metal as the larger cells. The uncertainties associated with them are slightly larger, due mostly to shorter immersion depth. They are excellent devices for calibrating semi-standard and some industrial resistance thermometers.

Using a fixed-point cell in the melting mode simply requires setting the furnace temperature slightly above the freeze temperature; typically 1.5°C, and observing on a monitoring thermometer when the melt plateau has been achieved. Indeed, the melt can be initiated by a timer before the Laboratory day begins.

ISOTECH "SLIM" CELLS

Isotech "slim" cells are smaller in diameter and somewhat shorter than standard cells used in primary laboratories. They contain about 70% as much metal as cells designed to fully realize ITS-90. By reducing the size, price can be reduced, since the high-purity metal is a large fraction of the cost of a cell. Also, the slim cell can be fitted into smaller pieces of furnace apparatus, which cost less. The negative side is that the thermometers being calibrated cannot be as deeply immersed, which may or may not affect the accuracy of the sensed temperature. Slim cells may be used in the melt or the freeze mode.

For convenience, slim cells may be classified (quite arbitrarily) into three functional groups:

GROUP I CELLS

Group 1 comprises the triple point of water and the slim gallium cell. A single piece of apparatus can be used to realize the equilibrium condition of either substance. Isotech's equipment for this is called "Hyperion", and its useful range is from -15° to +110°C.

THE TRIPLE POINT OF WATER (0.01°C)

The temperature of the triple point of water (at which pure water exists in its three possible phases, liquid, solid and vapor) is the most complicated to realize. In 1082, Cox and Vaughan described a method, which they called the "slush" method, for realizing the triple point of water [3]. Briefly, the method comprises supercooling the water in the cell to -7°C and then shaking the cell to initiate nucleation. This procedure is sufficient to convert about 30% of the liquid water to fine ice crystals and to raise the temperature to the equilibrium temperature, 0.01°C. The liquid-solid equilibrium is then maintained in an apparatus set slightly below the triple-point temperature.

We will describe how we employ this method, using our smaller water triple point cell and the Hyperion block bath. We place the cell in the Hyperion block adjusted to cool the water to -6° or -7°C. When the water is at that temperature, we remove the cell and shake it to create a slush of ice and water (the effect is visually quite dramaticl). After a further 30 minutes at -7°C the Hyperion controller is reset to 0°C. To gauge the accuracy of this method, a 25.5 Ω quartz-sheathed standard platinum resistance thermometer was calibrated in a large standard water triple point cell and then transferred to the smaller cell in the Hyperion bath. A plateau lasting more than 16 hours was obtained, with the thermometer indicating a temperature within 0.3 mK of the calibrated value. This is illustrated on Chart 1.

Such a system can be automated (except for the shake) using RS-232 communications, to provide an economically-priced triple point of water; the most fundamental fixed point of the temperature scale, available all day, every day.

THE MELTING POINT OF GALLIUM (29.7646°C)

By replacing the water triple point cell in the Hyperion bath, or by having a second such bath on hand, the melting point of gallium can also be realized. (Note: The gallium point is always used in the melt mode because gallium expands as it solidifies).

A slim gallium cell was placed in the Hyperion block. The controller temperature was set so that the block was 2° to 3°C above the melting temperature of gallium. A thermometer in the call was used to monitor the rise in temperature and the achievement of the melt plateau arrest. Once the gallium began to melt, 5 cc of warm water was introduced into the thermometer well to melt a thin film of gallium around the well, and the block temperature was reduced to 0.5°C above the melting temperature of the gallium. After 20 minutes the monitoring thermometer read within 1 mK of the expected melt temperature, and remain within 1 mK for over 48 hours. Chart 2 illustrates this.

[Note: Unlike the Model 18233 Gallium Melt Standard, the Hyperion is not self-protective of the cell; its flexibility precludes that. Thus after melting it is necessary to remove the cell from the Hyperion and freeze tha gallium from the bottom of the cell upward, to accomodate the 3% freeze expansion. This is done by placing the cell upright in 30 to 50 mm of cold water or upon a bed of ice cubes].

Thus with one bench-top apparatus and two slim cells, the water triple point and the gallium melting point, two fundamental defining points of ITS-90 can be realized and maintained for a working day or longer, with accuracy of 0.001°C. Also some thermometer calibrations can be extrapolated, with reduced accuracy, over a much wider range of temperature using these two equilibrium points alone [4].

In addition to direct calibration, the methods described above permit useful quality assurance of the user's standard thermometer. A check at the water triple point and/or the gallium point each time the standard is used, and the values found conveyed to a control chart, provides a history of the standard's performance and indicates when outside recalibration is required. Such a check should be performed whenever the standard is returned from an outside calibration, to assure that shifts have not occurred in transportation. (It is our belief that a standard thermometer should *never* be exposed to the risks of transportation to a calibration laboratory unless the need can be demonstrated. The cost of owning the apparatus to establish a standard's validity is not much greater than that of a National Laboratory calibration charge).

GROUP II CELLS

We can go beyond the water triple point and the gallium point with a second group of cells, which we shall call Group II. This group comprises cells for realizing the freezing points of indium (156.5985°C), tin (231.928°C) and zinc (419.527°C), and requires a second piece of apparatus, Isotech's Medusa 1, whose control range is 30° to 550°C.

Operation in the melt mode is extremely simple. The Medusa controller is set 1° to 2°C above the melt temperature of the fixed point cell. The metal will melt over a period of 6 to 8 hours after the first liquid metal appears, and calibrations can be performed at any time during these hours. (Only one cell can be melted in one Medusa, and therefore only one equilibrium temperature can be realized in the day. With two or three Medusa block baths available, the laboratory can use a timer to initiate the cycle before the laboratory day begins, and have all three fixed points available for use, all day, every day).

We have done a number of experiments to evaluate the performance of slim cells in the melting mode. We will describe our experience with one of these, choosing a zinc cell for illustration since it has the most sensitivity to stem conductance and thermal gradients and therefore shows the largest errors. Two Isotech Model 909 25.5 Ω SPRTs were used for this study. Model 909 has a long sensing length, which would increase stem conductance errors from this source, if indeed they exist. The readout instrument was an Isotech TTI2 (True Temperature Indicator Type 2, an autmatic indicating bridge). In order to observe the melt plateau on a chart recorder (which we consider essential) the TTI2 was set to give an output of 0 to 5 volts d-c for the range 420° to 421°C. This allowed close monitoring of the melt plateau and of its stability.

To establish a base line, the thermometer was checked in a standard-size cell in the Model 17701 standard freezing-point furnace, and a temperature value determined as reported by the thermometer. The quartz surface of a slim zinc cell was cleaned (of fingerprints, etc) with a swab wetted with alcohol, and placed in its inconel basket. The cell in the basket was then lowered into the throat of the 17701 standard furnace. A freeze duration and temperature was measured, and then a melt temperature, duration and plateau slope was determined. The slim cell was then transferred to a Medusa 1 furnace. It was not possible to find an actual freeze plateau, probably because of the large air gap between the cell and the furnace throat. However it was easy to find a melt plateau of good duration and slope. The results of these three experiments are shown in Table 1 and Chart 3.

Encouraged by these results, we performed a similar experiment with a slim tin cell. The results are shown on Chart 4.

TYPE III CELLS

Group III cells comprise the aluminium (660.323°C) and silver (961.78°C) cells which represent an extension, new in the ITS-90, of the former limit of 631°C of the platinum resistance thermometer range of previous International Temperature Scales. To obtain usefully long plateau from these requires Isotech's Oberon furnace, whose throat is a sodium heat pipe. The combination of Oberon and a slim aluminium cell provides a plateau of more than 2 hours with a flatness of 3 to 5 mK, as Chart 5 shows.

FURTHER WORK AT THE MELTING POINTS

To establish the accuracy of melting point measurements versus the conventional comparison method, we calibrated a number of semi-standard thermometers in Isotech's N.A.M.A.S. Laboratory both by comparison with standard thermometers and in slim cells used in the melting mode. The results are shown on Chart 6. Not only were the uncertainties of the melting point calibrations smaller than those achieved by comparison calibration, as one would expect, but the time required to calibrate was considerably shorter due to the stability and plateau duration of the slim cells, and the availability of having aluminium, zinc and tin cells melting in separate block furnaces concurrently

FINAL WORD

We have described, above, the cells, apparatus, techniques, advantages and limitations of melting points when used to recertify standard thermometers such as SPRTs. These are also useful to evaluate such systems when they are used with industrial platinum resistance thermometers (and, by extension, thermocouples).

TABLE 1

TYPE OF CELL	APPARATUS	DURATION	FREEZE SLOPE	VALUE	DURATION	MELT SLOPE	VALUE
(a) STAND	11701	10 HR	0,2 mK OVER 5 HR	419.527	1 HR 40	0.2 mk FOR 90%	419.528
(b) SLIM	17701	12 HR	0.1 mK OVER 6 HR	419.5265	6 HR	1 mK FOR 80%	419.527
(c) SLIM	MEDUSA 1	NO REAL FREEZE PLATEAU........			8 HR	2 mK FOR 80%	419.5235

THREE MEASURMENTS OF A ZINC CELL: (a) standard cell in standard frecz-point furnace, for comparison (b) zinc slim cell in standard furnace, to establish its value relative to a standard (c) zinc slim cell in Medusa 1 furnace. No real freeze plateau was found. In the melt mode, the cell was stable within 2 mK for 80% of the freeze, at a temperature mean value of 419.5235°C, 4.5 mK below the standard cell.

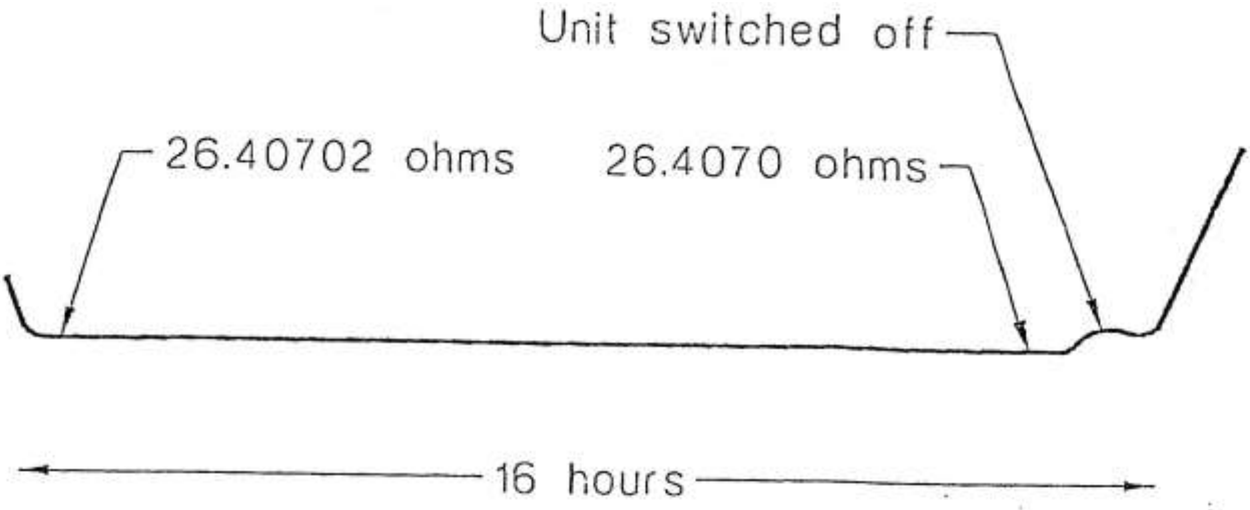


CHART 1: SLIM T.P.W. CELL IN HYPERION 92

MONITOR T5
Rga (Large Cell) 29.52604 ohms

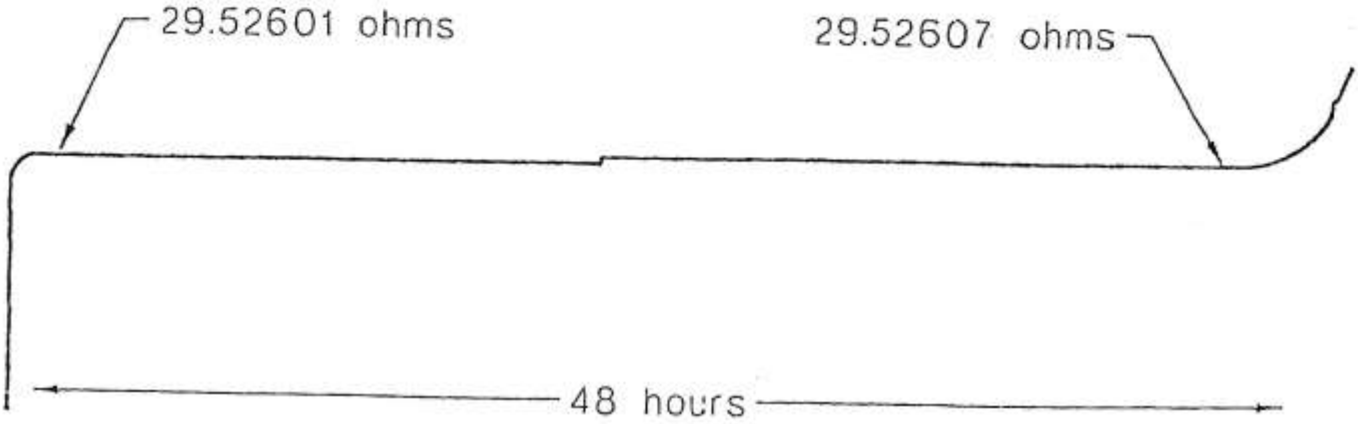


CHART 2: SLIM GALLIUM CELL IN HYERION 92

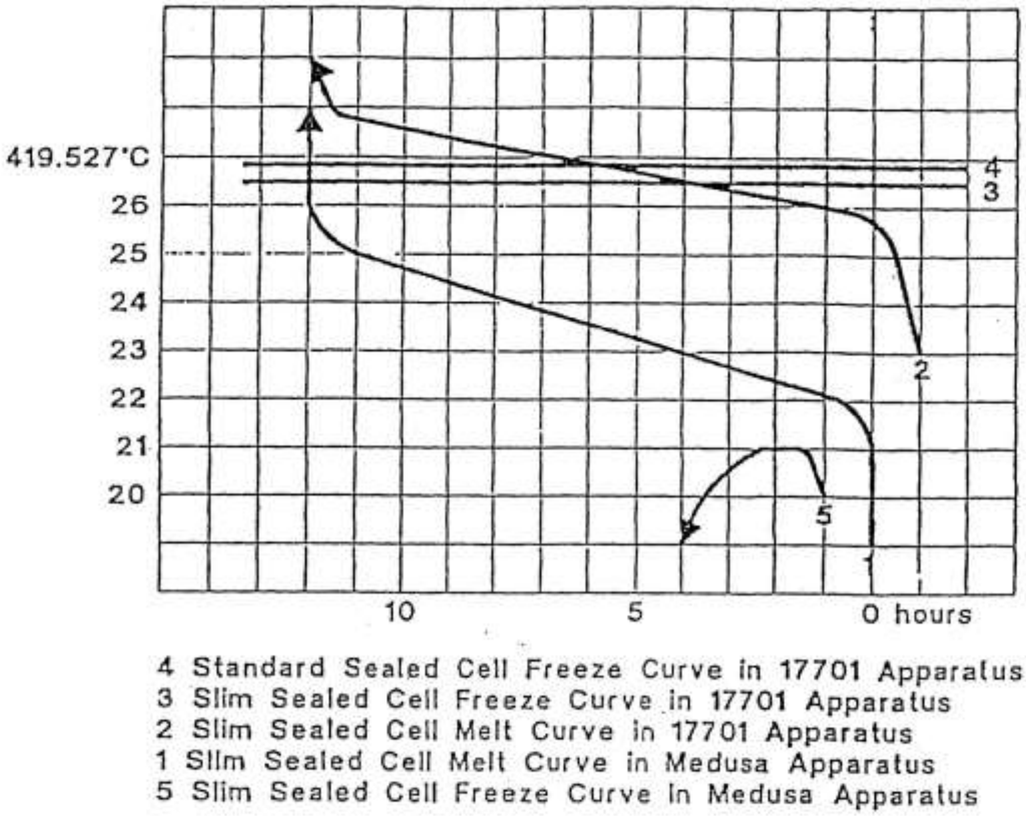


CHART 3: ZINC MELT CURVES IN SLIM AND STANDARD CELLS

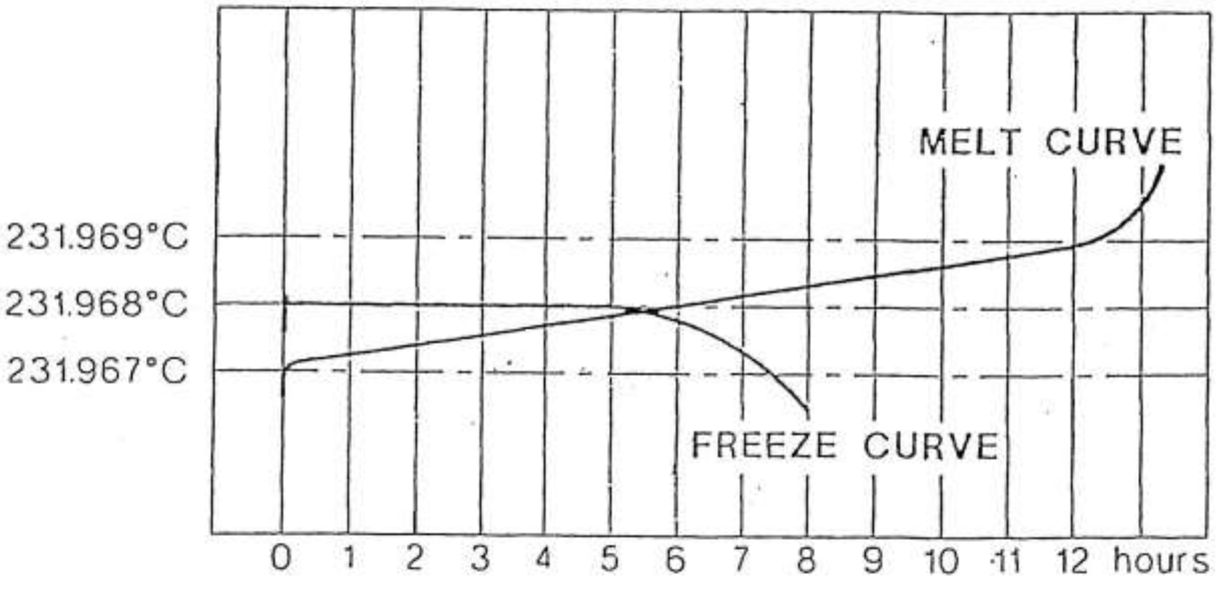


CHART 4: TIN MELT AND FREEZE CURVES IN SLIM CELLS

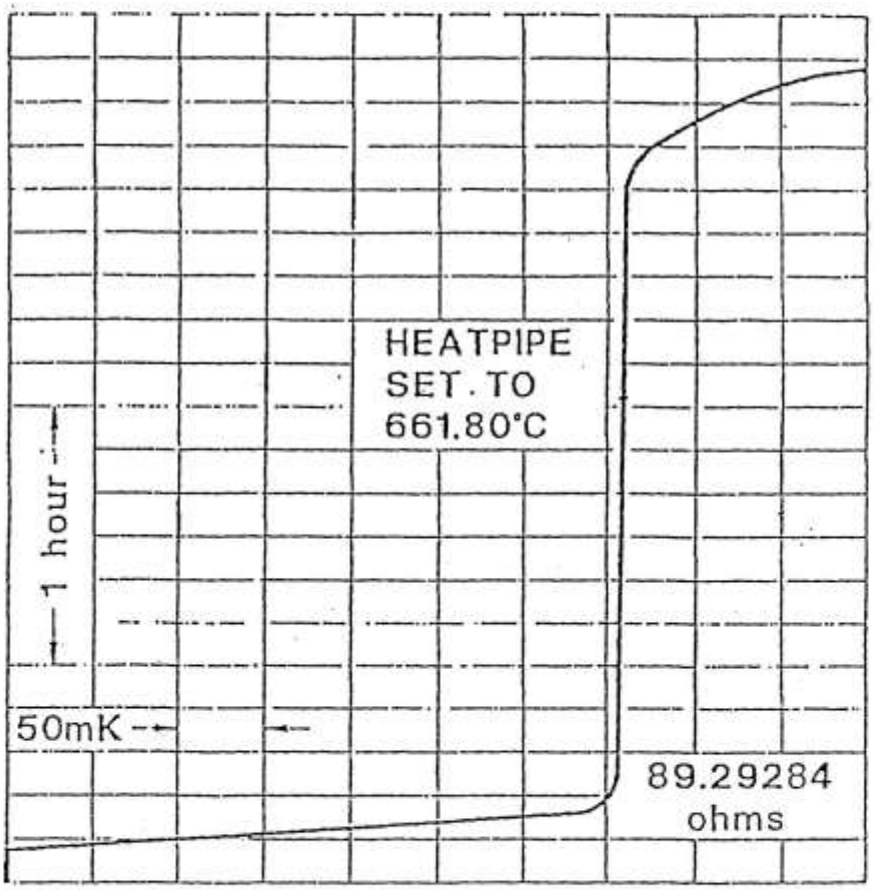
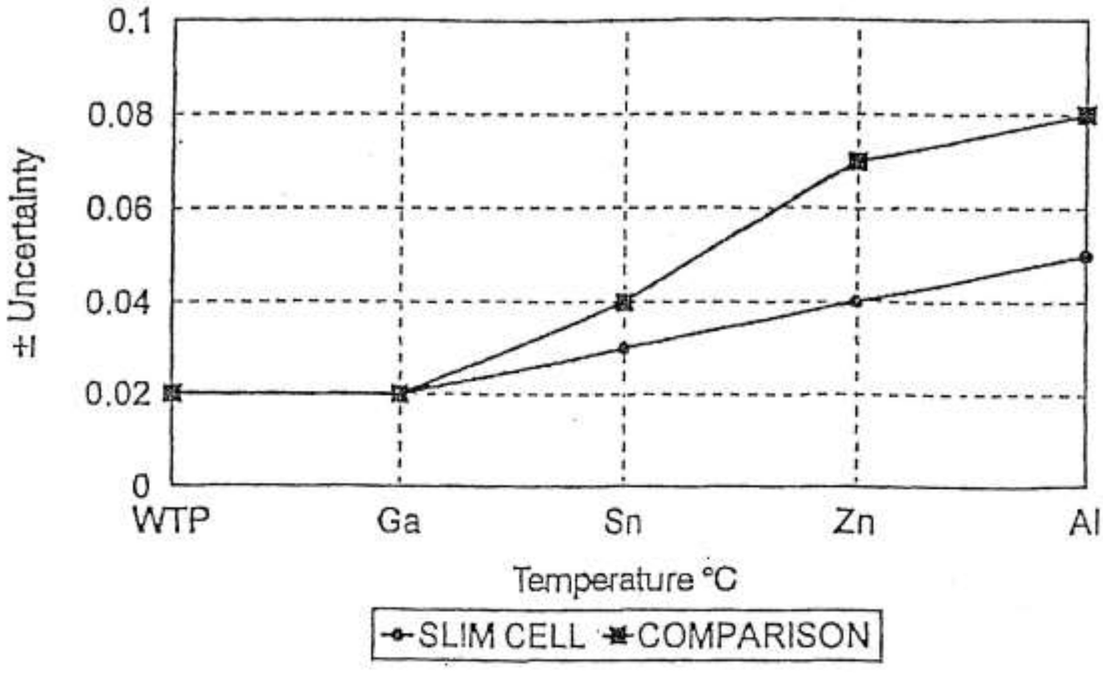


CHART 5: ALUMINIUM MELT IN SLIM CELLS



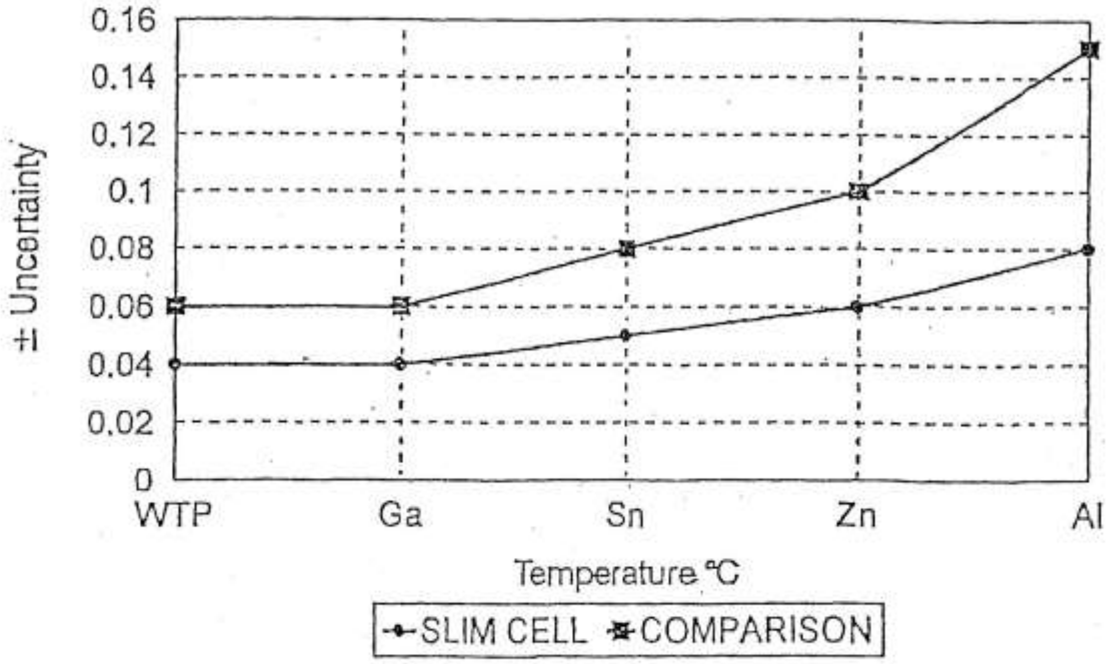


CHART 6: UPPER: CALIBRATION OF THERMOMETER 935-14-95 WITH SLIM CELLS AND BY COMPARISON

LOWER: CALIBRATION OF THERMOMETER 935-14-73 WITH SLIM CELLS AND BY COMPARISON

EQUIPMENT REFERENCES

Class I fixed points: water triple point cell. slim gallium cell, Hyperion block furnace

Class II fixed points: indium, tin, zinc slim cells, Medusa 1 block furnace

Class III fixed point cells: aluminium and silver slim cells, Oberon block furnace (500° to 1100°C)

TTI 2 (Total Temperature Indicator 2)

Also: Daedalus software: an MS-DOS program for interpolation of platinum resistance thermometer calibrations on ITS-90

Also: Model 909/25.5Ω Standard Platinum Resistance Thermometer.

ASK for Isotech's Product Manual - Much more than a catalog! Fax (+ 44-1704-544 799, att Michael Trim.

FOOTNOTES AND REFERENCES

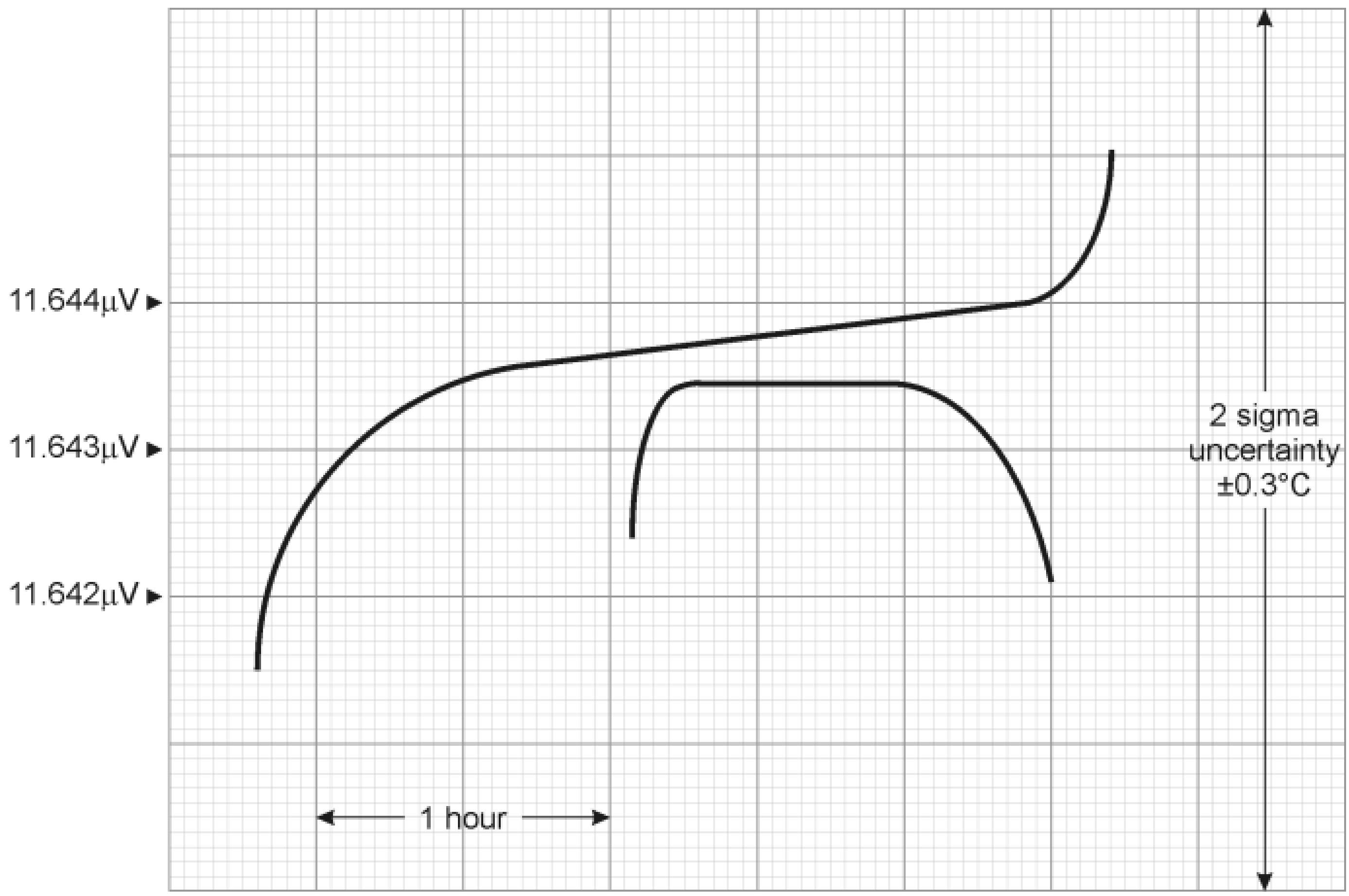
NOTE: DESCRIPTIONS OF THE ACTUAL USE OF CELLS AND APPARATUS ARE PROVIDED MORE FULLY AND EXPLICITLY IN THE APPROPRIATE CELL AND APPARATUS MANUALS.

[1] John V. McAllan, Practical reference temperatures using melting point techniques, *Journal of Physics - E* (1982). reproduced in this issue of the *Isotech Journal of Thermometry* with permission of the Institute of Physics (England)

[2] Bari, A-Etti, Chandra; Calibration of high-temperature standard platinum resistance thermometers in Saudi Arabia, *Isotech Journal of Thermometry*, pp .90-91, Vol. 6 No. 2 (1995)

[3] J. D. Cox, M. F. Vaughan, Temperature fixed points: evaluation of four types of triple point cell, in *Temperature, Its Measurement and Control in Science and Industry*, pp. 267-280, Vol. 5, Ed. Schooley, Am Inst Phys. (1972).

[4] P. Klasmeier, The water triple point and gallium point in secondary laboratories in Germany, *Isotech Journal of Thermometry*, Vol. 3 No. 1 (1992)


11.644μV ▸
11.643μV ▸
11.642μV ▸
2 sigma
uncertainty
±0.3°C
1 hour

THE COPPER SLIM CELL

The Copper Point 1084.62°C is a secondary point of the ITS-90.

It requires the use of thermocouple technology to measure the melt and freeze performance.

The hand-drawn graph was made from a series of readings taken with a calibrated type R thermocouple. On the edge of the graph is shown the uncertainty of calibration of the thermocouple which as can be seen swamps the measurement itself.

DEVITRIFICATION AND CARE OF THE COPPER CELL

All glass is a supercooled liquid and once it begins to devitrify (crystalize) the process cannot be reversed. Devitrified glass looks like frosted, or sand blasted glass.

Quartz glass which is the glass used to cover the Silver and Copper Slim Cells has an annealing (softening) temperature of 1050°C. Some 35°C below the Copper Melt Point.

A user should not therefore be surprised if his Copper Cell begins to devitrify at these elevated temperatures.

Silver and especially Copper Cells should be regularly checked by immersing them in clean hot water to make sure there are no leaks.

If a leak is detected the cell should be returned to Isotech for a new Quartz cover.