

Quartz encased higher temperature fixed point cells

to the highest standards ever defined

Optimal Realizations

CCT/96-8 a document issued by the CCT in 1996 describes a set of constraints and procedures which would produce the most accurate realizations of the ITS-90 in the world.

During two years when Isotech was upgrading its Primary Laboratory in preparation for a new accreditation from UKAS. We created a laboratory in which we realized the ITS-90 temperature scale in terms described in "Optimal Realizations".

So when the term optimal realization is used in this databook it is to be understood that the cell or apparatus conforms to the highest possible standards.

Those interested in optimally realizing ITS-90 should consult the document CCT/96-8 and Isotech's Journal of Thermometry 10.1.

The Water Triple Point Cell and Apparatus, the Gallium Melt Point Cell and Apparatus and the Mercury Triple Point Cell already described meet the requirements of Optimal Realizations.

Above gallium, ITS-90 requires:-

Indium	156.5985°C	-0.5mK	typical 6N purity
Tin	231.9280°C	-0.3mK	typical 6N purity
Zinc	419.5270°C	-0.5mK	typical 6N purity
Aluminium	660.3230°C	-0.7mK	typical 6N purity
Silver	961.7800°C	-1.1mK	typical 6N purity

The document titled "Optimal Realizations" tells us that these Fixed Points must be contained in quartz in such a way that the internal pressure of argon can be measured and adjusted to 1 bar at the freeze point.

It also specifies that Cells having 6N (99.9999%) purity will realize ITS-90 with typical depressions as tabled above. Further that the useable depth below the metal surface of the cell should be at least 20cm.

Having studied these and other requirements of the document, Isotech developed and can offer you fixed points conforming to the ideals of optimal realizations.

Furthermore the metal purity is guaranteed to be 99.99995% (6N5) or above, halving the offsets listed. We are therefore offering embodiments of higher accuracy than ever before available commercially.

In fact if you have a special need we can offer purities of 6N8, 7N, or even for gallium 8N purity.

Optimal Realizations are transportable and are assembled on site into one of two designs (see figures 1 and 2).

Additionally they can be supplied with UKAS certification for proven traceability.

A vacuum and pure gas supply is required to protect the Cells from contamination. Isotech can supply a complete system, please request details.

Fig 1

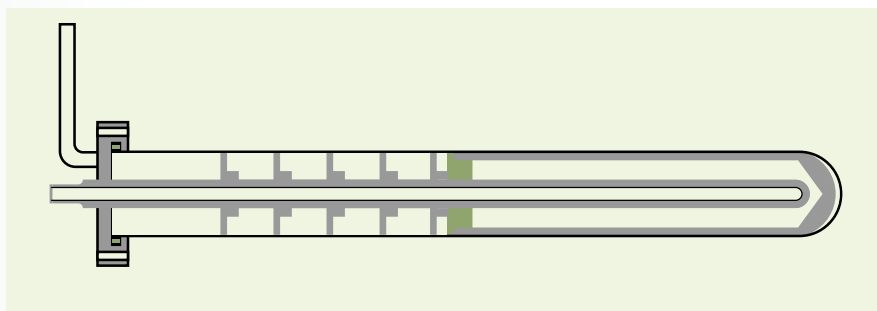
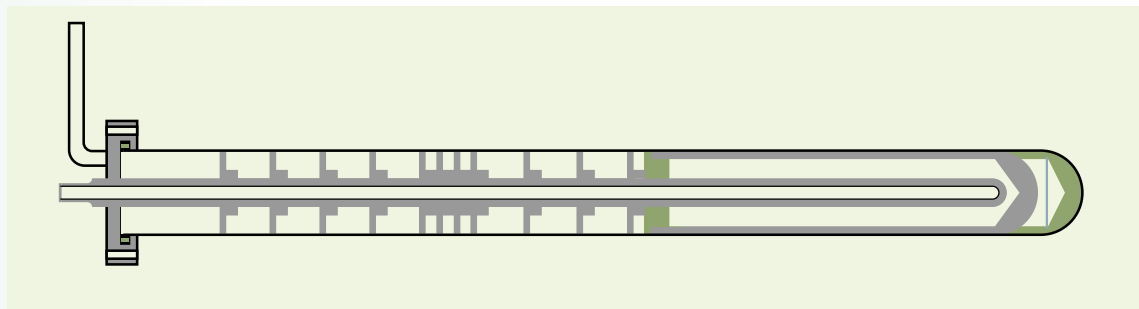
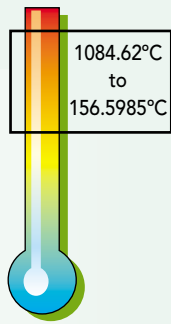


Fig 2



Sealed & Open

Fixed Point Cells



Sealed Cells

First developed during the 1970's by Henry Sostmann these cells meet all the requirements of science and industry for Fixed Point Realizations of ITS-90.

The cells now offered by Isotech have been increased in purity and length to conform to the idealized requirements of optimal realizations except that we have sealed in 1 atmosphere of 6N pure argon at the freeze temperature for you. Sealed optimal realizations of ITS-90 are made from metal exceeding 6N5 purity and have a useable depth below the metal surface of more than 200mm. They come complete with Inconel basket, a carry case and the necessary heat shunts and reflectors to enable them to fit into our apparatus.

Sealed cells must be hand carried. UKAS certification is also available for sealed cells (see Databook 5).

Lastly we can still offer our standard sealed cell with guaranteed 6N purity while stocks last.

Features of Isotech Optimal Realisations (sealed or open cells)

	Purity (1)	Typical Depression (2) from ITS-90 (mK)	Well depth below (3) metal surface (mm)	Variation with	
				Depth (mK/metre)	Pressure (mK/bar)
Mercury	7N	0.02	200	7.1	5.4
TP. H ₂ O	n/a	0.04	290	-0.73	-7.5
Ga	8N	0.01	260	-1.2	-2.0
In	6N5	0.25	200	3.3	4.9
Sn	6N5	0.15	200	2.2	3.3
Zn	6N5	0.25	200	2.7	4.3
Al	6N5	0.35	200	1.6	7.0
Ag	6N5	0.55	200	5.4	6.0
Cu	6N5	1.0	200	2.6	3.3

(1) Analysis by emission spectrophotograph. Results in ppm wt (6N5=0.5ppm)

(2) Assuming the law of Dilute Solutions (ref CCT/96-8. P6)

(3) Minimum values

*Cells of International Acceptance
99.99995% purity, ITS-90 Fixed Points*

Fact:
*Isotech is the only UKAS
Laboratory accredited to certify
Fixed Point Cells*



All Cells are intended for use in, and are dimensionally compatible, with the appropriate Isotech furnaces.

Diameter	typically 50mm
Length (sealed cell)	typically 275mm excluding sealing tip
Length (open cell)	
Indium, Tin, Lead, Zinc	520mm to underneath of flange
Antimony, Aluminium, Silver, Copper	610mm to underneath of flange
*Thermometer immersion	Below metal surface 200mm

*N.B. clients often confuse the immersion in the cell with the total immersion.

over which length the temperature gradient should be less than 1°C if the apparatus is operated properly.

Weight	2.5kg or less, depending on metal
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How to order

ITL-M-17668	Indium	156.5985°C
ITL-M-17669	Tin	231.928°C
ITL-M-17670	Lead (secondary)	327.462°C
ITL-M-17671	Zinc	419.527°C
ITL-M-18204	Antimony (secondary)	630.63°C
ITL-M-17672	Aluminium	660.323°C
ITL-M-17673	Silver	961.78°C
ITL-M-17674	Copper	1084.62°C

Quote model no and then add S for Sealed Cell or O for Open Cell. Sealed Cells will be supplied if no additional instructions are given. Other metals to special order.

Sealed & Open

Fixed Point Cells

Isotech Ultra Pure-Metal Freezing Point Cells are designed specifically to realize the liquid-solid equilibrium temperatures of certain high-purity metal elements, for calibration of thermometers at the ITS-90 Fixed Points.

Defining points of the ITS-90 include the freezing points of pure metals as shown in the table in the Specifications.

1. Cells are available as Sealed or Open Cells. All Cells contain the thermometric metals in graphite crucibles, surrounded by an envelope of pure fused quartz. Sealed Cells are completely enclosed in quartz and filled with an inert gas, which assumes a pressure of one standard atmosphere at the freeze point. Sealed Cells are consequently protected against contamination and the influence of ambient pressure. Open Cells include a gas port. A proper atmosphere must be supplied with suitable gas-handling and purification equipment. Unless circumstances are unusual, Isotech recommends Sealed Cells for all calibration laboratories.

2. All Cells are equipped with a re-entrant well for the insertion of a Standard Platinum Resistance Thermometer. The well's inside diameter is 8mm. The depth is sufficient to avoid stem losses in the thermometer being calibrated when used in conjunction with Isotech apparatus.

3. Sealed Cells are supplied with an Inconel Cell Holder, which is used to (a) contain the Cell (b) accommodate insulation above the Cell (c) allow lifting the Cell from the furnace (which must be done with tin, in realizing the equilibrium)

4. The mass of metal contained in the cell varies from 0.5kg (aluminium) to 1.5kg (silver). The volume of metal is the same in all cells.

5. Sealed Cells must be regarded as fragile and cannot endure the risks of commercial transportation. Isotech recommends that they be hand-carried from the factory, or from Leico Industries Inc in New York, where they are usually in stock. Pick-up in England will provide an opportunity for a visit to the Isotech Laboratory and some training in the use of Cells.

6. Open Cells may be shipped by common carrier, as a kit of components to be assembled by the user. Assembly instructions are provided.

7. Confidence is the main requirement from a Cell purchased commercially. Isothermal's cells have been in production for more than 20 years and are successfully in use in National and Primary Laboratories world-wide.

A Cell's performance is uniquely described only in conjunction with the apparatus used to create and maintain the freeze plateau. Isothermal's Cells and apparatus have been evaluated successfully by a number of National Laboratories.

All results have been within the National Laboratories uncertainty at the respective fixed points.

The long and successful history of our Cells and apparatus and the confidence this fact brings, is the main advantage in selecting Isothermal's product.

8. A certificate of verification, traceable to NPL and by

reciprocal agreement accepted at most National Laboratories, is furnished with each cell, alternatively Isotech is uniquely UKAS accredited to verify the cells. A comprehensive Manual and Tutorial is also supplied.

During the 1970's Mr. Sostmann and a dedicated team of technologists developed a unique range of Fixed Point Cells that were sealed from atmospheric contamination. He undertook international inter-comparisons and his first results were published in 1972.

As part of the OIML committee Mr. Sostmann was instrumental in introducing these new designs and a new point Gallium onto the scale which was eventually to become ITS-90.

As part of the Yellow Springs company Mr. Sostmann's Cells, together with specially developed apparatus designed only to provide the best possible environment for the cells and thermometers that accompanied the Cells were distributed, tested and accepted world-wide and when in 1988 Yellow Springs decided to sell this division of the company to Isotech, Henry followed and became a consultant in the transfer of the methods of manufacture, ensuring that none of the science or skills were lost.

Following H. Sostmann's traditions, Isotech have continued to develop and improve the range by being able to issue an Internationally traceable UKAS certificate with each cell.

In 1994 Mr. Sostmann was presented with Americas highest metrology award for his outstanding contribution and devotion to temperature metrology.

When you purchase an Isotech Sealed Freeze Cell you are not just purchasing a kilo of metal inside a graphite crucible sealed within a quartz shell, you are getting the fruits of 20 to 30 years of experience and learning of not only how to make such an artifact without introducing contamination but an Internationally accepted embodiment of an ITS-90 fixed point, which has been fully evaluated in the premier UKAS laboratory.

As pedigree you can rest assured that over 600 other laboratories throughout the world are also relying on the same make of Sealed Fixed Point cell.

One disadvantage of any sealed item is that unless you can fit a pressure gauge to it, you do not know whether the seal is still good.

An innovation, suggested by Phil Metz is that we can now energise the gas inside the cell and check that there is no leak.

This development has removed the last concern about Isotech's Sealed Cells.

Free accessories:

Isotech Sealed Cells include an Inconel Cell Holder and carry case supplied free of charge, together with 2 or 3 ceramic 'bricks' and interleaving Platinum foil - recommended for the Aluminium and Silver point measurements

Traceability

"Traceability" is the ability to show an unbroken chain of relationships between a measurement and a calibration by an ultimate authority, usually one's own National Laboratory, or a recognized fundamental constant of nature. The Fixed Points of the ITS-90, which are realized by means of the equipment discussed in this section, are fundamental constants of nature and satisfy any requirement for traceability to accepted values of natural constants.

It is often convenient (and, where auditors are unfamiliar with the Scale, necessary) to establish, as well, traceability to calibration by a legal authority. Isotech is an accredited Laboratory of the British UKAS system, and can, uniquely, UKAS certify its Fixed Point Cells.

Through a system of international documents of metrological equivalence, Isotech's measurements and certificates are legally traceable to a number of other National Laboratories. A document entitled "The Recognition of Equivalence of the National Standards of the U.K. and the U.S.A. for the Measurement of Temperature" (copy on request) became effective on October 14, 1986, and establishes traceability from Isotech's UKAS certificates to NIST. In addition, NPL has negotiated agreements with National Calibration Services in a number of other countries, with the same end result of traceability. These countries, the National Organizations, and the effective year are shown in the table below.

Realization. traceability and mutual recognitions.

CCT/96-8 says:

Purpose of an International Temperature Scale.

The purpose of an International Temperature Scale is to specify Internationally agreed procedures and practical thermometers that enable laboratories to independently realize the scale and/or to independently determine highly reproducible values of temperature, closely approximating the thermodynamic temperature but more easily and accurately measured, such that the disagreement among measured temperature values obtained from independent realizations or determinations is small compared to the uncertainty of the thermodynamic values.

This is realization.

To work Nationally or Internationally the realization needs traceability, this is ideally achieved by accompanying the Cell with a UKAS certificate. The UKAS procedure follows the ideals laid out in CCT/96-8.

A series of International agreements means that a certificate issued in one country is, by mutual recognition accepted in another. A partial list is presented below.

Traceability of Measurements on a National and International Basis

COUNTRY	ACCREDITING BODY	DATE OF EQUIVALENCE AGREEMENT
Australia	NATA	1985
Germany	DKD	1981
France	BNM, RNE	1988
Hong Kong	HOKLAS	1989
Italy	SIT	1982
The Netherlands	NKO	1988
New Zealand	Telarc	1985
Sweden	SMO	1988
Switzerland	SCS	1989
United States	NIST	1986

UKAS calibration certificates issued by Isotech are legally traceable to National Standards in the Nations listed.