

# Introduction

## Primary & Secondary Laboratory Equipment

...our knowledge, product quality and integrity are the reasons for buying from Isotech

In our catalogues, datasheets and website you will not find unsubstantiated claims by our own scientists (although they are as good as the best), you will find the results of independent international intercomparisons done by such organisations as BIPM and NIST.

Where we have to summarise we provide references to the appropriate document for you to download and read in full.

Our uncertainties of calibration and procedures have all been scrutinised and agreed with UKAS, who are party to the ILAC-MRA.

Each year we are audited by UKAS who check our electrical and thermal standards, examine and witness our procedures and question our uncertainty spread sheets.

This ensures a continuous improvement in our services to you, our customer.

Our electrical standards are certified by NPL, the UK's National Laboratory.

Our fixed points from argon through to silver have been intercompared at NIST in the US to their references.

Our UKAS certificates are presented in a form which makes them instantly useful. Our staff of experts are available to help with your enquiries and problems.

### Selecting the best equipment for a Primary Temperature Laboratory

#### The Purpose

The purpose of a primary laboratory realising part of ITS-90 is to calibrate SPRTs at fixed temperatures, by comparing their resistance to a fixed and known resistance.

#### Uncertainty Limits

For fixed resistors the limit is about  $\pm 0.05\text{ppm}$ .

For 6N purity metallic cells the limits are (ref CCT/2000-13 p.5)

Hg	$\pm 0.2\text{mK}$
Ga	$\pm 0.1\text{mK}$
In	$\pm 0.5\text{mK}$
Sn	$\pm 0.3\text{mK}$
Zn	$\pm 0.5\text{mK}$
Al	$\pm 0.7\text{mK}$
Ag	$\pm 1.1\text{mK}$

For SPRTs  $\pm 0.5\text{mK}$  (non-uniqueness of ITS-90 between fixed point of water and gallium),  $\pm 0.5\text{mK}$  (2 oxide state).

When selecting equipment the uncertainties should match the above. This is because uncertainties are combined using root sum of squares. So if an uncertainty is much larger than the above it will dominate the rest, if it is very small it becomes insignificant.

### Equipment Required

Can be grouped under four headings:

1. An accurate electrical measuring system.
2. A number of ITS-90 fixed point cells.
3. Apparatus to melt, freeze and maintain the cells.
4. Stable thermometers to monitor the cells.

When selecting the equipment for the laboratory look at performance, uncertainties and price.

### The Electrical Measuring System

#### The Bridges

A ratio bridge that compares a temperature controlled stable fixed resistor to the SPRT under test is ideal.

Bridge linearity, noise and stability are the main things to consider. The uncertainty should be of the order of 0.1ppm.

The Isotech microK 70 is the ideal solution, it contributes just 0.07ppm to the measurement uncertainties with noise and linearity and uniquely it is drift-free. It has input 3 channels extendable to over 90 with

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microKanners and with no mechanical switches, relays, potentiometers or moving parts is the most reliable product available.

## Fixed Resistors

The best resistors are made for us by Tinsley and we can UKAS certify them to 0.1ppm or better.

Even fixed resistors have a tempco and so we offer a maintenance bath.

The maintenance bath needs to be monitored using an SPRT. It can be connected to the one channel of the microK to save cost.

You now have a world-class measuring system. To maintain it the resistors will need regular recalibration (every year or two years).

The SPRT can be recalibrated in your own fixed point cells at water and gallium.

The microK can be rechecked by you using compliment checks with your fixed resistors.

## Fixed Point Cells

ITS-90 gives 7 optional ranges, check the graph on the inside front cover and select the range for your laboratory.

Every primary laboratory needs water triple point and the gallium melt point, because to qualify as an ITS-90 SPRT a

thermometer must have a W Gallium equal to or greater than 1.11807.

Mercury triple point is the next most useful temperature.

Isotech is unique in offering the other commonly used fixed points of Indium, Tin, Zinc and Aluminium in choice of 4 housings;

- Open quartz    ■ Open metal clad
- Sealed quartz    ■ Sealed metal clad

You will find full details on the following pages.

See Isotech's technical library on the website for a comparison of our UKAS results of quartz clad and metal clad cells compared to CCT/2000-13.

Silver, gold and copper require special handling and with many years of experience we can help you with the temperature points.

Isotech can UKAS certify any of these cells to the smallest uncertainties outside NIST.

## Selecting Furnaces

For indium through copper we have a choice of furnaces. The Isotech Dual Furnaces use heat pipes for best performance, and include a second independent furnace for annealing. For those with existing annealing furnaces we offer Heat Pipe only models. Three Zone furnaces can be used over very wide ranges. Our Furnace Selection Guide will help you select the appropriate models for your needs.

## Monitoring Thermometers

Ideally each fixed point cell should have its own designated SPRT. If this is unaffordable one SPRT can be used with a number of fixed point cells.

These SPRTs need to be very stable. We recommend model 670SQ/25.5/480 for use with Hg, H<sub>2</sub>O, Ga, In and Sn.

670SQ/25.5/650 for any cell from Hg to and including Al. and 96178/0.25 for Zn, Al and Ag.

The above monitor thermometers can be supplied with UKAS certificates or you can certify them in your own fixed point cells.

In the primary lab, only the resistors and the cells require external traceability.

## Procedures and Uncertainties

One of the great things about thermal metrology is that there is no approved way to calibrate. One of our staff was asked by a UKAS Auditor how long it took to calibrate an SPRT... "Oh!" she said without hesitation "until its right!". The auditor was so impressed he asked if he could use the saying elsewhere.

Your calibration procedures need to be unique to you to suit your equipment, your staff and your customers.

Likewise uncertainties, you will have a unique combination of equipment and procedures. These will dictate your uncertainty.

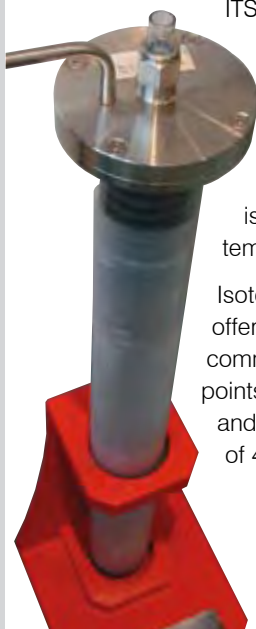
Although we cannot write your procedures and calculate your uncertainties, we want to help, and so if you go to our website you will find some examples that may help you develop your own budgets.

## More Information

A list of our recommended books is available on the Isotech website and the Isotech journal of thermometry.

We have an e-learning course and we run occasional 2 or 3 day courses here in Southport.

World-wide, we have a network of 90 agencies to help you locally. Contact us for your nearest.



<http://www.isotech.co.uk>