MODEL 962
HOTSPOT

Isotech North America
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GUARANTEE

This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical breakdown or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuses.
In the event of failure covered by this guaranteed, the instrument must be returned, carriage paid, to the supplier for examination, and will be replaced or repaired at our option.

FRAGILE CERAMIC AND/OR GLASS PARTS ARE NOT COVERED BY THIS GUARANTEE

INTERFERENCE WITH, OR FAILURE TO PROPERLY MAINTAIN THIS INSTRUMENT MAY INVALIDATE THIS GUARANTEE

RECOMMENDATION

The life of your **ISOTECH** Instrument will be prolonged if regular maintenance and cleaning to remove general dust and debris is carried out.

We recommend this instrument to be re-calibrated annually.

Serial No:........................

Date:............................

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INTRODUCTION

You or your company has just paid a considerable sum of money to purchase this 962.

Although the materials to make the 962 are very costly, it has also taken up to 1000 hours to prepare the 962 for your use.

It is not a product that can be assembled, tested and sold, it is produced, calibrated, aged and recalibrated, until its characteristics are stable enough to meet the exacting needs of ITS-90.

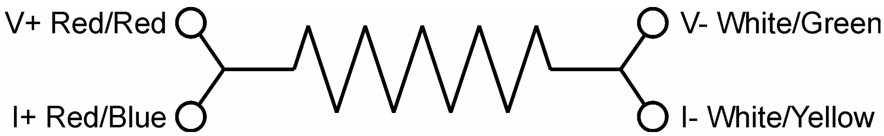
The weeks of work that go into its production make each 962 more than another product. Each 962 already has a character and a history before it leaves us. Please look after it. Regard yourself as its custodian rather than its owner.

1. Always keep the 962 in its case when not in use.
2. When in use, support the handle.
3. Cool and store the 962 in the same place as you normally use it.
4. Each time before you use the 962 clean off all traces of grease by using a suitable alcohol and dry thoroughly.
5. Even go so far as using gloves to handle the 962, and keep the gloves clean.
6. Quartz is glass. It is a supercooled liquid. At 800°C and above, your 962 will bend and bow if you do not support it along its complete length. At high temperatures I recommend that the 962 be housed inside a close fitting recrystallised Alumina closed ended tube, which has been pre-fired to 1000°C.
7. Quartz is transparent in two senses of the word. At temperatures above 700°C metallic vapours can pass through the quartz and attack the pure platinum sensing element. Isotech have developed a product which can be attached to the 962 to prevent this happening. A unit is provided free with each 962.
8. Remember 962's cannot be repaired!
9. Do not drop or knock.
10. Do not put lateral pressure on the stem, it is rigid and will break
11. The handle and top 40mm of the stem should not be heated over 50°C. The cable will withstand 200°C.

To keep the original characteristics:

1. Do not use the standard in conditions where there is vibration or mechanical shock.
2. Avoid thermal shock - allow the standard to warm-up and cool-down slowly.
3. Do not exceed the temperature limits.
4. If used above 450°C, always cool slowly to 450°C, and maintain at 450°C for approximately ½ hour, and then withdraw to ambient.
5. Always cool a hot SPRT in a thermometer rack where the SPRT can cool in an upright position, never cool in a horizontal position.

The cable is connected as follows:



A NEW HIGH TEMPERATURE PLATINUM RESISTANCE THERMOMETERS FOR 1990

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It is not often that one can pin down to the hour of the day when a product is born, however, I was sitting at the back of the ITS-90 workshop session at N.C.S.L. in 1987. Concern was expressed that there were no western suppliers of the new S.P.R.T. required for 1990 to work to the Silver Point.

During the discussion I conceived the notion that I should produce such a product.

Knowing that the problems to be surmounted were larger than my experience could solve, technically and financially, I sought expert advice upon my return to England.

My first call was to N.P.L. where the staff were most helpful and provided me with much background material - in particular the articles written by John Evans proved most useful and informative.

My second call was to a manufacturer of quartz parts where the design which was emerging was altered to suit practical manufacturing techniques, again the staff proved most helpful and cooperative. My last call was to the supplier of platinum who was charged with the task of producing the highest alpha wire.

Defining the Problem

In defining the assembly of the High Temperature Standard Platinum Resistance Thermometer, the history of the device was considered.

Resistance Value

Thermometers have been produced with Ro of between 0.25Ω and 2.5Ω. Clearly the lower the resistance the smaller the effects of parallel resistance and because thicker wire can be used, the more likelihood of a mechanically stable thermometer so I initially chose 0.25Ω. Higher resistances could be introduced at a later date assuming the design proved successful.

Diameter

The thermometer has to be calibrated inside Freeze and Triple Point Cells which smallest sizes suggested a diameter of less than 8mm - 7.5mm was chosen.

Length

Again, the main consideration for the length is to accommodate existing Freeze Point Apparatus. 600 to 700mm seems typical. 650mm was chosen.

SHEATH MATERIAL

The only material ever considered was quartz and I did not feel qualified to challenge this assumption.

INTERNAL CONSTRUCTION

The Sensing Element

Many constructions have been used. The main options seemed to be crucifix or spade. Since the spade option has half the points of contact as that of the crucifix, it was chosen. Laser cutting of the quartz ensured a smooth, polished surface for the coil.

The Leads

Again, two options presented themselves.

Little bits of quartz covering the platinum leads fed, at 50mm intervals through 4 holed quartz discs or single lengths of quartz capillary tubing running from the sensing winding to the handle.

This decision is one of the key points in the construction, since all failures in experimental thermometers have occurred with leads open or short circuiting.

I will reserve my decision, conclusion and reasoning for my lecture.

The Handle

In the handle, the platinum wire interfaces with the cable which connects the thermometer to the reading instrument.

It is also the area where the assembly is vacuumed. It needs to be small so as not to add a large weight to a long, thin fragile stem. This is the second key area, and the one in which I take most pleasure in the solutions.

Atmospherics

It is necessary to ensure that the total assembly and all constituents start clean and remain clean and that over the useful temperature range they do not produce any substances or have properties which might affect the thermometer's performance. Such as parallel resistances. Or absorb substances from outside the assembly, which might damage the performance of the sensor. This can be done by copious applications of acids, alkalis, rinsing, oxidising and many other precautionary techniques, these have been described adequately elsewhere.

MECHANICAL CONSIDERATIONS

Temperature Coefficients

Quartz has the unique property that it does not expand (or contract), in consequence it does not crack - like other glass or ceramics. It is pure and will not contaminate its contents, unlike metals such as nickel or steels. It can be used with good properties at temperatures around 1,000°C.

Platinum, the other constituent in the product has a temperature expansion of 0.9% per 1,000°C expanding up to 5mm. Since the quartz does not expand, the platinum is forced to move with respect to the quartz. Provided the mechanism is understood and the magnitude defined, the shape, size and constraints of the assembly can be designed to accommodate these movements without work hardening stress or strain.

In the lecture I will show the exact solution.

The Unexpected

During his researches, John Evans discovered contaminants which were eventually traced to sources outside the thermometer. These, he concluded were caused by vapours passing through the quartz sheath at high temperatures.

This problem has a number of solutions, the easiest is being tested and will be patented by the time this lecture is presented.

The Guard Ring

This, almost mythical aspect of high temperature thermometers has its proponents and opponents. The most cogent voice I have consulted suggests the dubious advantage of this approach, because of the temperature gradient along the sheath.

My own solution has been a commercial one of offering either a guarded or non-guarded version.

Does It Work

The products at this level of Metrology are only 40% design, 60% consists of evaluation, history and confidence. Even before I began this project I established our National Physical Laboratory's willingness to evaluate such a product.

Firstly however, I needed to establish some initial figures, so as not to waste N.P.L.'s valuable time.

By bending rules at all the suppliers we produced the first two units in 4 weeks. Whilst these were being evaluated, a further 4 were built to a slightly modified design based on improvements from the first two.

One unit from the first two and one from the second batch were sent to N.P.L. for evaluation, after we had aged and tested the thermometers for up to 1,000 hours.

Initial impressions from N.P.L. suggest that after cycling to Tin, Zinc, Aluminium and Silver Points.

1.Ro changed by less than 2mK
2.Alpha by less than ½mK
3.R, Ag by less than 2mK

It is anticipated that full details will be available before N.C.S.L.

AC/DC

Arguments range as to the best means of measurement of such a supreme device. Although it is beyond the scope of a sensor manufacturer to discuss this aspect, since I am a practical person I will allow reference to Berry who suggested that since polarisation effects have time constants of 3 minutes or more, only very slow A.C. is suitable. I hope to be able to offer comparative results by the time of lecture.

The Final Solution

The final solution is nothing new. Just a new combination of good ideas.

Its derivation is the total history of efforts provided by all the worthy researchers into high temperature sensors, Evans, Chattle .... added to it has been the expertise of one of Europe's foremost quartz manufacturers and the world's top producer of pure platinum.

The final alpha values, as measured at N.P.L. confirmed my own findings that the alpha values were very high; typically 0.003928. The importance of this figure is not the high value, but that the high value shows that no contamination has been introduced during manufacture, or in use subsequent to the manufacture.

Limits of Expectation

ITS-90 committee does not expect that the standard P.R.T. will last as long, or with such stability as that standard adopted in IPTS 1968.

The main aspect of the new thermometer is that it should be an improvement on the type R or S thermocouple.

In conclusion, with such a short, if respectable history of the Isotech 962 thermometers, I submit that there is now (at least) a western source of thermometers for ITS-1990.

RETURNING YOUR THERMOMETER TO ISOTECH

REPACKING INSTRUCTIONS:

Place a small foam spacer under the end of the Quartz sheath and one under the handle.

Then place two larger pieces over the end of the sheath.

PREPARING THE BOXES

Place the two foam blocks over the closed case and lower into inner box. Pad out ends with polystyrene chips to stop the unit from moving - seal the box, lower it into the outer box and fill with chips, then lift the inner box slightly so the polystyrene chips completely surround it. Place the protective sheath if supplied on top of the chips and seal the box.

Always remember to label the box thoroughly with “fragile” and “this way up” labels and arrange adequate insurance cover.

Your unit should now be ready to send safely.

PERFORMANCE REPORT
STANDARD THERMOMETER

Various producers of standard platinum resistance thermometers quote the performance of their product in various ways:

Tinsley say of their 5187SA 25.5Ω thermometer	Reproducibility ±0.001℃ Accuracy ±0.01℃ over 0 to 100℃
Y.S.I.	**DO NOT SAY ANYTHING**
Chino quote various drift rates	from 0.001K/year for the 25.5Ω up to 630 to 0.01℃/100 hours when a thermometer is used above 850℃. Their reproducibility is 0.001K.
CLAL drift	10 cycles - 500 hours at 660℃ = 0.01Ω

The following definitions from the International Vocabulary of Metrological terms show that "Accuracy", "Reproducibility" and "Drift" do not define the performance of an SPRT.

The real criteria is how accurately can an SPRT measure temperature and with what uncertainty.

Using a "Measurements International" bridge it is possible to resolve the signal from an S.P.R.T. to ±0.00005K.

In a fixed point cell it is possible to realise the ITS-90 values from about .15mK for the Triple Point of Water and Melting Point of Gallium to between 2 & 4mK at the Silver Point.

With a fixed resistor and the best calibration 0.05 ppm uncertainty is possible.

In addition is the reproducibility of the SPRT and various other small uncertainties; from all this the overall uncertainty can be estimated.

Uncertainties also vary depending on the temperature range of calibration

Isotech's 909 and 962 thermometers are sufficiently stable to conform to uncertainties translated overleaf Models 670 and 96178 can be calibrated as tabulated overleaf or at extra cost to the uncertainties of our latest schedule.

The annual drift, although of interest is of little importance to the calibration process. Certainly 1mK per year drift is an impossibility if the thermometer is used regularly from 90K to 661℃ and Chino have refused to replace a thermometer with higher drift rates than their literature states.

United Kingdom Accreditation Service

CALIBRATION LABORATORY
No. 0175

SCHEDULE

National Accreditation of Measurement And Sampling

Address of permanent laboratory	Category 0 — Permanent Laboratory
Isothermal Technology Ltd Pine Grove Southport Merseyside PR9 9AG	Calibration performed on permanent laboratory premises APPROVED SIGNATORIES Head of Laboratory: Mr J P Tavener Deputy: Mr D J Ayres Mrs A S Blundell, Mr D Southworth, Mr N Davies, Mr A Orme
Telephone : Southport (01704) 543830/544611 Fax : 01704 544799	Issue No: 13 — Date: 24 February 1997

Measured Quantities for which UKAS has granted NAMAS Accreditation

Item	Measured Quantity Instrument or Gauge	Range	Best Measurement Capability Expressed as an Expanded Uncertainty (±)*
	TEMPERATURE		
1	Platinum thermocouples	0 to 1100 °C	1 K
		Above 1100 to 1300 °C	2 K
2	Other thermocouples	-196 °C	0.5 K
		-80 to 250 °C	0.3 K
		Above 250 to 660 °C	1 K
		Above 660 to 900 °C	2 K
		Above 900 to 1100 °C	3 K
		Above 1100 to 1300 °C	4 K
3	Compensating and extension cables	-25 to 200 °C	1 K
4	4-wire platinum resistance thermometer		

Uncertainty (±)

Temperature	(°C)	Range 1	Range 2	Range 3	Range 4	Range 5
BP Nitrogen	-196		10 mK	10 mK	10 mK	
TP Mercury	-38.8344	2 mK	2 mK	2 mK	5 mK	
TP Water	0.01	1mK	1 mK	2 mK	5 mK	10 mK
MP Gallium	29.7646	2 mK				
FP Indium	156.5985		3 mK			
FP Tin	231.928		3.5 mK	3.5 mK	5 mK	10 mK
FP Zinc	419.527			3.5 mK	5 mK	10 mK
FP Aluminium	660.323				10 mK	25 mK
FP Silver	961.78					40 mK

Note: TP = Triple Point, MP = Melting Point,
FP = Freezing Point, BP = Boiling Point

*The Expanded Uncertainty is given for k=2, providing a level of confidence of approximately 95%

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The enclosed uncertainties apply on condition that the measurements of resistance at the triple point of water are reproducible within the uncertainty given at that temperature. Uncertainties for thermometers which do not meet this requirement will be increased by a factor of 3 or 10, as appropriate. For the time being, metal-sheathed thermometers will be calibrated by comparison with standard thermometers at the requested points. Calibrations at the triple point of argon are obtained from comparisons with standard thermometers in a bath of liquid nitrogen.

Calibration below 0℃ is optional. Ranges of calibration using combinations of fixed points other than those given above, may be accommodated on request.

3.05 Accuracy of Measurement

The closeness of the agreement between the result of a measurement and the (conventional) true value of the measurand.

3.07 Reproducibility of Measurements

The closeness of the agreement between the results of measurements of the same measurand, where the individual measurements are carried out changing conditions such as:

-method of measurement

-observer

-measuring instrument

-location

-conditions of use

-time

Notes

1. A valid statement of reproducibility requires specification of the conditions changed.

2. Reproducibility may be expressed quantitatively in terms of the dispersion of the results.

3.09 Uncertainty of measurement

An estimate characterising the range of values within which the true value of a measurand lies.

Note Uncertainty of measurement comprises, in general, many components. Some of these components may be estimated on the basis of the statistical distribution of the results of series of measurements and can be characterised by experimental standard deviations. Estimates of other components can only be based on experience or other information.

5.16 Stability

The ability of a measuring instrument to maintain constant its metrological characteristics.

5.18 Drift

The slow variation with time of metrological characteristic of a measuring instrument.

RE- PACKING INSTRUCTIONS FOR THE RETURN OF THERMOMETER 909/962