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Comparing some of the fixed points of ITS-90 as realized for routine calibration of PRTs in Canada,Argentina,Brazil and Costa Rica

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A comparison of some of the temperature scale defining fixed points of ITS-90 was carried out between Canada (NRC), Argentina (INTI), Brazil (INMETRO) and Costa Rica (ONNUM) using a portable calibration outfit and a home-made ¼ Ω PRT.(Both developed at NRC.)
The comparison was performed under practical conditions as normally exist during routine calibrations of PRTs. I.e. no special precautions were taken with the fixed points the furnaces or with the PRT.

Experimental procedure.

There are different ways of coercing PRTs into reproducible, well annealed states ,after high temperature use.An extensive study is described in [1] .Some other ways are described in[2] .Similarly, there are different ways of realizing the thermometric fixed points of ITS-90 .One way is described in [2],some other ways are described in [3].There is no single “right way” of manipulating quenched and oxidized PRTs into well behaved states just as there is no single “right way” of realizing the thermometric fixed point of ITS-90.However after extensive experimentation with fixed point realizations and trying different ways to “anneal” PRTs after high temperature use one acquires sufficient experience to confidently select and use appropriate ways to reliably determine the difference between the realized fixed points at hand.

A) Comparison by cells

Fixed points were realized using the cells of the laboratory by outside nucleation ,immediately followed by inside nucleation and appropriately lowering the furnace temperature .This routine was used for all fixed points above the Ga point.The PRT was then inserted into the realized fixed point and its resistance was measured after it stabilized (20min-30min)The PRT was then transferred into the portable cell which was heated to near its melting point while the resistance of the PRT was being determined in the realized fixed point of the laboratory.Melting of the portable cell then promptly begun (melting duration 20min-40min) and the resistance of the PRT was determined at the run-off point.(It turned out that the run-off point reproduces within a fraction of 1mK .This behavior remained consistent over several years) These measurements were repeated several times over a period of several days. Table 1 summarizes the average of the measured values .The uncertainties (standard deviations) of the difference of fixed points were calculated from the scatter of measured data.

B) Comparison by calibrating the PRT at the fixed points of the laboratories.

The PRT was calibrated at the realized fixed points of the indicated laboratories .The differences in the calibrated values are shown in table2.

(Further experimental details are described in [4] and [5])

Table 1.Results obtained with the set of portable cells.The indicated uncertainties are standard deviations

	(INTI-NRC)/ mK	(INMETRO-NRC)/ mK	(ONNUM-NRC)/ mK
Ar		0.8 ± 0.5	
Hg	-0.5 ± 0.3	-0.4 ± 0.3	0.9 ± 0.3
Ga	-0.2± 0.3	-0.1 ± 0.3	0.3± 0.3
In	0.2 ± 0.2	-0.3 ± 0.3	0.0± 0.3
Sn	-0.5 ± 0.1	-1.9 ± 0.3	-0.4 ± 0.3
Sn		0.5*	
Zn	1.8 ± 0.4	-1.3 ± 0.6	1.1 ± 0.4
Al	2.8 ± 0.7	3.3 ± 1.0	2.7**,-1.3***

*INMETRO had two Sn cells compared .The upper value is Sn1 and the lower value is Sn2 of table 1 of [5]

**NRC built open cell, ***NRC built sealed cell

Table 2 Results using the homemade ,calibrated PRT

	(INTI-NRC)/ mK	(INMETRO-NRC)/ mK
Hg	-1.0 ± 0.2	-0.5 ± 0.2
Ga	-0.7 ± 0.3	-0.7 ± 0.3
In		-0.5 ± 0.6
Sn	-0.3 ± 0.2	-1.9 ± 0.2
Zn	2.3 ± 0.3	-2.2 ± 0.4
Al	4.1± 0.5	1.6 ± 0.6
Ag	3.6 ±1.0	0.7 ± 1.0

About the tables

Fixed points, using the above-described procedure (for calibrating PRTs), can be realized rapidly (few minutes) and are all reproducible within about ± ¼ mK scatter band. This is known from experience gathered over many years at NRC, and more recently at INTI, at INMETRO and at ONNUM. Eventhough the results of tables 1 and 2 agree within combined uncertainties, the values in table 1 should

be considered more realistic than those of table 2.The PRT was in a more stable metallurgic state (internal stresses, strains etc.) while collecting the data for table 1 than it was while collecting data for table 2.Then, it was repeatedly subjected to large temperature differences.

The differences seen in the tables are due to the combined sum of Type B errors. I.e. differences are mainly due to

a) impurity concentrations(some of which increase others decrease the fixed point temperatures)
b) pressures within the sealed cells

About the uncertainties

Type A uncertainties are shown in the tables.

There may be a negligibly small type B uncertainty due to differences in linearity of the resistance bridges .

References

[1] Ancsin J.,Zhang Y.,Metrologia,1994,**31**,85-91

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[3] Ancsin J., Mendez-Lango E.,Metrologia, 1999,**36** , 117-139

[4] The Costa Rican work, in SIM magazine published in July 2001

[5] The Argentine and the Brazilian work were submitted for publication to Metrologia.

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