# EUROMET PROGRESS REPORT 2010

**Project 732**

**Toward more accurate temperature fixed points**

#### Coordinator: E. Renaot

**Projected Impact**

Within the ITS-90 the Standard Long Stem Platinum Resistance Thermometer (LSPRT) is used to realize the scale from the Argon triple point (83.8058 K) to the Silver freezing point (1234.93 K). The defining fixed points used in this range correspond to the triple, freezing and melting points of ideally pure substance. These last years, the results of the Temperature Comparisons make appear unexplained discrepancies in the calibration results and sometimes a relatively large spread of the uncertainties quotations. The European uncertainties data look to be well grouped together but at a quality level below some few other laboratories in the world. There are two possible explanations to this situation either the uncertainties are not correctly estimated (in the Europe or elsewhere) or the European Temperature services correspond to a lower grade quality. In order to clarify this very important point the Temperature EUROMET community decided to work together on a long lasting project, named EUROMET project 732. The aim of this project is:

* to improve the Temperature European standards and to reduce the uncertainty of the primary fixed points by making profitable the technological progress appeared these 10 last years in many fields such as: the chemical analysis, the metallurgy, the monitoring of thermal exchange,…..
* to show the international consistency of the European realization
* to increase the confidence in the uncertainty budget

**Technical Objectives**

The technical achievements were to carry out a new generation of temperature standards, with substances of the highest purity existing and characterized chemically with the best currently available means and to position the temperature materialized by this new generation of cells at the international level.

The project also included the development of temperature generators allowing a control of the heat exchanges which can affect the practical realization of the fixed points. It was expected to reduce the uncertainty of the primary fixed points by a factor of 2-3 by the end of the project.

The synthesis of the studies would allow to redefine the uncertainties associated with the realization of the different temperature fixed point (CMCs) and would provide objective data that will help to clarify the debates relating to the estimate of uncertainties that currently interest the international community of the specialists in thermometry.

It was agreed by the participants to organize the project in workpackages for covering the fields of activities. Every WP was led by a specific laboratory and involved several participating laboratories.

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| --- | --- |
| Workpackage | Leader |
| Management | LNE-INM/CNAM |
| Argon fixed point | LNE-INM/CNAM |
| Mercury fixed point | CEM |
| Water fixed point | NMi-VSL |
| Gallium fixed point | SMU |
| Indium fixed point | PTB |
| Tin fixed point | NPL |
| Zinc fixed point | PTB |
| Aluminium fixed point | LNE-INM/CNAM |
| Silver fixed point | LNE-INM/CNAM |
| Inventory of the Chemical Laboratories | INRiM |
| Collect the knowledge | NPL |
| Modelling of the thermal exchange | FE-LMK |

**Organization of European Worshops as part of this projet**

An European Workshop was organized at LNE-INM on the 23th –24th November 2006 gathering 55 participants from 13 Countries. One afternoon was completely devoted to communications in the field of the impurity effect (Capability associated with Chemical analysis and knowledge about the distribution coefficient between the liquid and the solid phases). This workshop provided the advisability of appreciating the progress of the work in the different laboratories.

A Second fixed-point workshop was organized by NPL (3-4 June 2008). The latest scientific developments on research about the most accurate temperature fixed point were presented.

A 3rd EURAMET 732 workshop was held in CEM during 14th to 15th October 2009, with the participation of 26 attendants from 16 European NMIs. There were 12 presentations on different topics related to the main sources of uncertainties that influence the fixed point realization.

**Outcomes of the project**

The studies completed within the framework of this project were published. The interested persons could consult the articles listed below. The most important outcomes of these studies are:

* Reduction of the uncertainty of the impurity content analysis from (200 – 500) % to less that 30 %.
* An improvement of the understanding of the impurity effect and the isotopic composition impact.
* The demonstration that the realization of fixed point plateaux under strict adiabatic conditions is feasible and that the influence of thermal effects in conventional fixed-point cells can be considerably reduced by quasiadiabatic operation conditions

Nevertheless, further research is required with the potential to improve the quality of the SPRT calibration. Some doubts remains about

* + the mechanism of the contamination process
  + the influence of the mutual interaction of impurities
  + the binding state and dissolution process of impurities
  + the best methods for initiating the freeze
  + the isotopic effect in fixed points other than mercury
  + the interaction between thermal and impurity effects
  + etc,

An inventory of the interrogations which remains are developed in the following paper:

“Uncertainties in the SPRT Sub-ranges of ITS-90: Topics for Further research”

D.R. *Whiteet al,* *International Journal of Thermophysics (2010) 31:1749–1761.* DOI 10.1007/s10765-010-0832-7

**Publications as part of this project**

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**FLEURENCE N. ,** Contribution au développement d’un calorimeter adiabatique dédié à la mise en oeuvre du point fixe de l’indium (156,598 5 °C), *Dissertation Conservatoire National des Arts et Métiers, Instrumentation-Mesure, option Metrologie, 2009*

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