

WORKING GROUP 3 REPORT TO CCT: May 2012

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Terms of reference:

1. To establish and recommend methods for quoting uncertainties in realizing ITS-90 using contact thermometry.
2. To ensure notational consistency in methods for quoting uncertainty for other areas of interest to the CCT (including optical thermometry and humidity).

Working Group 3 is tasked with continuing the production of documents on uncertainty budgets for contact thermometry, and to act in an oversight role for similar documents produced by other working groups.

1. Introduction

During this term, the WG3 paper presented to the TEMPMEKO 2010 conference, “*Uncertainties in the SPRT Subranges of ITS-90: Topics for Further Research*”, was published. Otherwise, the Working Group’s activities have been light with little more than discussion on relevant issues. We have received no requests from other working groups for assistance with uncertainty analyses.

The current activities on WG3 task list include

- Uncertainty in the extrapolation of long-stem SPRT calibration to liquid nitrogen temperatures
- The possible management of Type 1 non-uniqueness (sub-range inconsistency) in the SPRT sub-ranges of ITS-90.
- The continuing revival of Bayesian statistics.
- The need for uncertainty guides for secondary contact thermometers, especially rare metal thermocouples.

These issues are discussed in more detail below.

2. Membership

During the term:

Sun Jianping (NIM), replaced Wang Tiejun

Daniel Cárdenas-García (CENAM) replaced Edgar Mendez

Vito Fericola replaces Franco Pavese as INRIM representative, who stays on as independent expert

Murat Kalemci (UME) replaces Aliye Kartal Dogan

Ronan Maurice resigned, and

Jonathan Pearce (NPL) joined the group.

3. Issues

3.1 Extrapolation of long-stem SPRTs to liquid nitrogen temperatures

Prior to the last meeting, Dr R. Rusby (NPL) raised concerns about the uncertainties associated with the extrapolation of calibrated long-stem SPRTs below the triple point of argon. A number of laboratories use this procedure but there was, at the time, no authoritative document justifying the

procedure. The situation has improved with the publication of EURAMET Technical Guide tg-1, which specifically addresses the issue. Although the issue is no longer urgent, WG3 is still of the view that an archival paper presenting an uncertainty analysis that provides supporting mathematics to the empirical evidence given in the EURAMET document and is consistent with the WG3 SPRT uncertainty guide, would be of value to the community.

3.2 Sub-range inconsistency in the SPRT sub-ranges of ITS-90

Sub-range inconsistency (SRI or Type 1 non-uniqueness) has three main causes (i) variations in the $R(T)$ of different SPRTs, (ii) inconsistency amongst the W_r values assigned to the fixed points by ITS-90, and (iii) variations in the fixed point realisations. SRI is a major contributor to uncertainty in the realisation of the SPRT sub-ranges of ITS-90, and, at present, the uncertainty guide prepared by the Working Group has simply adopted a single uncertainty to characterise all SPRTs. Although no progress has been made, we have a group of members interested in studying SRI, with a view to assigning an SRI uncertainty to specific SPRTs. The same study would also provide information on the inconsistency of the W_r values assigned by ITS-90. Such a study has gathered increased importance with the exposure of the discontinuity in ITS-90 at the triple point of water, which is an artefact of SRI.

3.3 Frequentist vs Bayesian Statistics

The issue of frequentist versus Bayesian statistics continues to gain importance, especially with the JCGM announcement of their intention to revise the GUM. Working Group 3 has only briefly discussed the issue and is currently not willing to express a firm view for or against, other than to express concern. The group notes the submission of CCT working document CCT/12-07, which describes the differences between the Bayesian and frequentist approaches, and opposes a Bayesian revision of the GUM.

3.4 Uncertainty guides for secondary thermometer

Dr Mark Ballico (NMIA) has raised concerns about uncertainties associated with the use of calibrated Type R and Type S thermocouples, in particular the fact that the effects of oxidation and consequential hysteresis effects are eliminated from calibration uncertainties by defining the anneal state. This then means that users of the thermocouples may be oblivious to the additional uncertainty arising from the oxidation state. This situation is made worse by the fact that different NMIs commonly use different anneal states for the calibration conditions.

This concern raises the bigger issue of uncertainty guides for other secondary thermometers. We have commenced discussions with WG2 on how best to ensure that uncertainty analyses are available for secondary thermometers. WG2 has suggested that WG3 is best placed to prepare an uncertainty guide for rare-metal thermocouples, and this will be a WG3 task for the future.

References

D. R. White, M. Ballico, D. del Campo, S. Duris, E. Filipe, A. Ivanova, A. Kartal Dogan, E. Mendez-Lango, C. Meyer, F. Pavese, A. Peruzzi, E. Renaot, S. Rudtsch, T. Wang, K. Yamazawa, Uncertainties in the SPRT Subranges of ITS-90: Topics for Further Research, *Int J Thermophys*, **31**, 1749–1761, 2010

EURAMET, *Extrapolation of SPRT calibrations below the triple point of argon, 83.8058 K, and traceability in baths of liquid nitrogen at ~77.3 K*, EURAMET tg-1 Vers. 1 (3/2011), available at http://www.euramet.org/index.php?id=technical_guides.