Properties of Standard Platinum Resistance Thermometers

Over the range −189 °C to 962 °C, Standard Platinum Resistance Thermometers (SPRTs) are the defining, primary thermometers on the International Temperature Scale of 1990 (ITS-90). SPRTs are widely used to transfer the ITS-90 to other types of thermometers in broad industrial usage, such as industrial grades of platinum resistance thermometers. In practice, the measurement uncertainty of an SPRT is often limited by SPRT instability caused by improper use or by imperfections in the ITS-90 interpolation equations, and not by the inherent uncertainty of the NIST temperature standards used to calibrate the SPRTs. An understanding of the stability and interpolation properties of SPRTs is essential to determine uncertainties of SPRT measurements in industry and government. We have addressed this need by constructing a database of 15 years of SPRT calibrations at NIST, and then analyzing variations in SPRT calibrations associated with either the choice of calibration points or by drift of the SPRT with extended use.

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As a consequence of the sensitivity of SPRTs to mechanical shock, SPRTs often need to be stabilized by thermal treatment prior to calibration to obtain optimum calibration uncertainties. Based on the SPRT calibration database, a compilation of results on SPRT stabilization was published and presented at the 2005 NCSLI Workshop & Symposium, where it received the ***Best Paper Award in the Applied Metrology*** category. This paper describes the stabilization techniques used at NIST and the remarkable stability of an SPRT (better than 0.001 °C) that may be achieved with careful subsequent usage. The NIST techniques are straightforward and are readily adopted by other laboratories that calibrate SPRTs. We have recently completed two additional papers on the variance in SPRT temperature due to the choice of calibration points, termed the sub-range inconsistency, and on correlation effects of the uncertainty components. For certain SPRTs at temperatures below 84 K, the sub-range inconsistency is larger than all other uncertainty components combined, and its inclusion is critical to avoid underestimating the measurement uncertainty.

The NIST SPRT stabilization methods are now used by several US industry calibration facilities. The integration of these methods into US industry quality assurance programs and calibration procedures is one facet of NIST training that has supported these facilities in achieving uncertainties that are comparable to uncertainties of other NMIs.

The NIST work on sub-range inconsistency has been requested by an international committee that is preparing recommended procedures for evaluation of SPRT uncertainty; thus, we anticipate the values obtained will have broad usage.

Future Plans: Presently we are using our SPRT calibration database to obtain a correlation between SPRT drift at the triple point of water with drift at all other temperatures of use. Such a correlation will be invaluable to all users of SPRTs in industry and government because it will provide a simple, user-implemented method to determine when an SPRT requires recalibration, thereby avoiding either unneeded, expensive calibrations or use of an SPRT that has drifted beyond allowable tolerances.

Dennis Minor at the NCSLI Symposium, presenting the paper that won the Best Paper Award in the Applied Metrology category.

References:
D.B. Minor and G.F. Strouse, ***"Stabilization of SPRTs for ITS-90 Calibration"***, NCSLI Workshop & Symposium proceedings.