CALIBRATION REPORT FOR DIGITAL THERMOMETER

WASHINGTON STATE PATROL
S/N: 091795 ID #SPXM02307
Sensor S/N: 091795
Report Number: A245816

ICL CALIBRATION LABORATORIES, INC.

ISO/IEC 17025 and ANSI/NCSL Z540-1 accredited
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CALIBRATION REPORT FOR DIGITAL THERMOMETER

The instrument or device identified below was examined and calibrated in ICL's metrology laboratory following the calibration procedure referenced below. This calibration fulfills the requirements of ISO/IEC 17025-2005, 'General Requirements for the Competence of Testing and Calibration Laboratories' and ANSI/NCSL Z540-1-1994, 'Calibration Laboratories and Measuring and Test Equipment - 'General Requirements'.

CLIENT
WASHINGTON STATE PATROL
3860 AIRPORT WAY
BELLINGHAM, WA 98226
Purchase order number: NOT AVAILABLE
Submitted by: WASHINGTON STATE PATROL
ICL internal reference (SO): 368330

DATES
Date received: 10-03-2017
Date report issued: 10-19-2017
Recalibration date specified by client: October 19, 2018

UUT (Unit Under Test) INFORMATION

Sensor information:

Manufacturer: GUTH LABS INC.
Model No: 4300
Serial No: 091795
Description: 165mm X 4.05mm STEM
Manufacturer's specified temperature range: 29.5 to 38.5 °C
Calibrated range (limited calibration): 33 to 35 °C
Sensor immersion: AT LEAST 93mm RECOMMENDED

Readout device information:

Manufacturer: GUTH LABS INC.
Model No: 4300
Serial No: 091795 ID #SPXM02307
Engineering units: degrees Celsius (ºC) or degrees Fahrenheit (ºF), user selectable.

NOTE: The accuracy tolerance for this system calibration (sensor and readout) is either the root-sum-square of the accuracy tolerance of the sensor and the accuracy tolerance of the readout device, (if separate, independent devices), or the manufacturer's specification for the sensor and readout combination. Please see the 'Tolerance' column which appears in the 'Results of Calibration' table on the next page.

RESULTS OF PHYSICAL EXAMINATION
The condition of this device was satisfactory with no visually apparent defects, unless noted below. Minor cosmetic defects are generally not noted unless they are judged to impact the usability of the device.

Technician's comments: UUT needs a full battery for calibration. A new 9 volt battery was installed prior to calibration.

CALIBRATION PROCEDURE
ICL Procedure 04, which references relevent elements of ASTM E77, ASTM E220, ASTM E644 and ASTM E2593.

LABORATORY ENVIRONMENTAL CONDITIONS
Temperature: 23 °C +/- 5 °C, Relative humidity: between 30% and 80%

RESULTS OF CALIBRATION

AS FOUND

Nominal Temp	Standard Rdg.	UUT Reading	Correction	Tolerance	Accept Limit*	P/F/Ind	Uncertainty
33.000 °C	33.001 °C	33.01 °C	-0.01 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C
34.000 °C	33.998 °C	34.00 °C	0.00 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C
35.000 °C	35.001 °C	35.01 °C	-0.01 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C

The 'As Found' values were determined to be within tolerance, and no adjustment of this device was required or undertaken.

AS LEFT

Nominal Temp	Standard Rdg.	UUT Reading	Correction	Tolerance	Accept Limit*	P/F/Ind	Uncertainty
33.000 °C	33.001 °C	33.01 °C	-0.01 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C
34.000 °C	33.998 °C	34.00 °C	0.00 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C
35.000 °C	35.001 °C	35.01 °C	-0.01 °C	± 0.020 °C	± 0.013 °C	Pass	± 0.016 °C

GUARD BANDING

ISO/IEC 17025:2005(E) requires, in Section 5.10.4.2., that, "When statements of compliance are made, the uncertainty of measurement shall be taken into account." One valid way of complying with this requirement is applying a 'guard band' to the device's tolerance. The guard band is calculated as a function of the test uncertainty ratio (TUR), the ratio of the tolerance of the UUT to the measurement uncertainty. Basically, the smaller the uncertainty is relative to the tolerance, the smaller the guard band. A TUR of 5:1 typically results in a guard band of zero, or nearly zero. A 4:1 TUR produces in a guard band very close to zero. A 3:1 TUR results in a modest guard band. And so forth. As TUR declines, the guard band becomes larger. The use of the guard band in the decision process is designed to reduce the probability of a false acceptance (PFA), or a false failure, to 2% or less. The method and equations we use for calculation of the guard band comply with the requirements of ANSI/NCSL Z540.3

*The *Accept Limit(s) are calculated by subtracting the guard band from the tolerance. The Accept Limit is essentially a new tolerance, for this calibration only, which we use to make a declaration of Pass, Fail, or Indeterminate, as explained below:*

Pass The measured value falls within the interval described by the test point plus or minus the Accept Limit.
Fail The measured value falls outside the interval described by the test point plus or minus (the tolerance + the guard band).
Ind (Indeterminate) The measured value is indeterminate, falling in that statistical 'grey' area, too close to permit a credible determination. It is statistically and metrologically imprudent to declare that the instrument is definitively either 'in-tolerance' or 'out-of-tolerance'.

LIMITATIONS OF USE

This is a limited, or partial-range calibration, and accordingly, this thermometer may be used with confidence only within the range bracketed by the test points. The calibrated range for this thermometer is effectively from 33 to 35 °C

MEASUREMENT UNCERTAINTY

The measurement uncertainty reported is the expanded uncertainty at 2 sigma (k=2), to provide a confidence level of approximately 95%.

The uncertainty is calculated considering both Type A and Type B contributors. Type A contributors include the standard deviation of the measurement process from check standard control charts, comparator uniformity, the standard deviation of monthly Triple Point of Water calibrations of the standard, and UUT variability observed during the calibration. Type B contributors include the uncertainty of the calibration of the reference standard, stem conduction and other immersion effects, the sensitivity and accuracy of the reference standard thermometer's readout, resolution of the reference standard and resolution of the UUT.

The Type A and B contributors are combined using the root-sum-square method to obtain the standard uncertainty at 1 sigma. The standard uncertainty is then multiplied by 2 to obtain the expanded uncertainty at 2 sigma (k=2). This uncertainty calculation is consistent with the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (the 'GUM') and NIST Technical Note 1297.

The expanded uncertainties (k=2) reported here do not contain estimates for (1) any effects that may be introduced by transportation of the instrument between ICL and the user's facility, (2) drift of the instrument, (3) hysteresis of the instrument, or (4) any measurement uncertainties introduced by the user.

NOTES AND SUPPLEMENTAL INFORMATION

All temperatures given in this report are those defined by the International Temperature Scale of 1990 (ITS-90).

IMPORTANT NOTE: The correct operation of digital electronic thermometers is dependent upon all components functioning properly. Correct temperature indication may be impeded by physical damage to the sensor or cable assembly, contamination of electrical contacts or components by water, oil or other contaminants, or by other, less obvious causes such as low battery level or failure of internal components. Accordingly, ICL Calibration Laboratories, Inc. represents that the calibration data provided in this report were those values observed during the performance of this calibration, however cannot be responsible for inaccurate readings which may be experienced in future uses due to conditions or circumstances which are beyond our control.

TRACEABILITY INFORMATION

This calibration is traceable to the International System of Units (the SI, or Système international d'unités) through NIST, via an unbroken chain of comparisons. Our primary temperature reference is a NIST calibrated SPRT (Standard Platinum Resistance Thermometer), used exclusively for the calibration of our secondary reference PRTs, which in turn are used to calibrate our clients' instruments. Measurement uncertainty, which increases at each comparison in the chain, has been calculated at each step and is fully documented.

ICL maintains three NIST calibrated Rosemount model 162CE 25.5 Ohm SPRTs, for redundancy and to permit sequential rotation to NIST for calibration. As of this date, traceability from -196 to 420 °C (-320 to 788 °F) is conveyed through S/N 5369, MTE-358, calibrated by NIST on May 28, 2015. NIST GMP-11 recommends a 36-month calibration interval for SPRTs. Secondary reference PRTs and other working standard thermometers are calibrated annually against this reference SPRT, per NIST GMP-11 recommendations, and are monitored continually using measurement assurance strategies including check standards, control charts, and documented monthly verifications at the triple point of water.

The comparators and working standards used in the performance of this calibration are indicated below, organized by test point.

Nominal Temp	Calibration method	Comparator	Serial No.	MTE No.	Manufacturer
33.000 °C	Comparison w/PRT	PP15R water bath	1B13C0895	414	PolyScience
34.000 °C	Comparison w/PRT	PP15R water bath	1B13C0895	414	PolyScience
35.000 °C	Comparison w/PRT	PP15R water bath	1B13C0895	414	PolyScience

Nominal Temp	Standard ID / Mfgr. / Model / Serial	Readout ID / Mfgr. / Model / Serial	Next Due	Position
33.000 °C	MTE-374 Fluke 5628-15 PRT 2521	MTE-396 Fluke 1595A B45115	09/29/18	Standard
33.000 °C	MTE-375 Fluke 5628-15 PRT 2603	MTE-396 Fluke 1595A B45115	09/29/18	Check Standard
34.000 °C	MTE-374 Fluke 5628-15 PRT 2521	MTE-396 Fluke 1595A B45115	09/29/18	Standard
34.000 °C	MTE-375 Fluke 5628-15 PRT 2603	MTE-396 Fluke 1595A B45115	09/29/18	Check Standard
35.000 °C	MTE-374 Fluke 5628-15 PRT 2521	MTE-396 Fluke 1595A B45115	09/29/18	Standard
35.000 °C	MTE-375 Fluke 5628-15 PRT 2603	MTE-396 Fluke 1595A B45115	09/29/18	Check Standard

TECHNICIAN: *CHRIS KELLY*

ICL CALIBRATION LABORATORIES, INC.

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Approved by: _____ *Reviewed by:* _____

Deborah M. Weber, Quality Associate
J. Jeff Kelly, Senior Quality Associate
Michael C. Kelly, Technical Manager
Date report issued: 10-19-2017

This report document was prepared by Lori J. Parr
Recalibration date specified by client: October 19, 2018

NIST GMP-11 (September 2014), 'Good Measurement Practice for Assignment and Adjustment of Calibration Intervals for Standards' cautions that, 'Temperature standards are dynamic with use. Shock, contamination and other factors can cause drift from accepted values'. GMP-11 recommends an initial calibration interval of 12 months for digital thermometers, standard thermistors and PRTs.

The user should be aware that any number of factors may cause this instrument to drift out of calibration before the specified calibration interval has expired.

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This report applies only to the item calibrated. This calibration report shall not be used to claim product endorsement by the A2LA.

End of Report No. A245816