ICL CALIBRATION LABORATORIES, INC.

ISO/IEC 17025 and ANSI/NCSL Z540-1 accredited
The specialists in ASTM and laboratory thermometers & hydrometers
Members: **A2LA ASTM API NCSLI ASQ NCWM**
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Cert 526.01 Calibration

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CALIBRATION REPORT FOR LIQUID-IN-GLASS THERMOMETER

The instrument or device identified below was examined and calibrated in ICL's metrology laboratory, using NIST traceable standards, 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
SAMPLE CUSTOMER
STREET ADDRESS
CITY, STATE ZIP
Purchase order number: NOT AVAILABLE
Submitted by: SAMPLE COMPANY
ICL internal reference (SO): 123456

DATES
Date report issued: 06-21-2015
Next due (specified by client): June 21, 2016

UUT (Unit Under Test) INFORMATION
Model number: 10063C-C
Thermometer, ASTM 63C-86
Manufacturer, brand or marking: M & W Serial No: XXXX
Engineering units: degrees Celsius
Range: -8/32 °C Scale divisions: 0.1 °C Immersion: TOTAL
Accuracy tolerance (maximum scale error per ASTM E1 or E2251, as appropriate): +/- 0.1 °C

RESULTS OF PHYSICAL EXAMINATION
This instrument was examined under a polarized lens and strains in the glass, if any, were judged to be minimal and of no detriment to the function of the instrument. The capillary of this thermometer was examined under 20X magnification. No foreign material, moisture, or other evidence of contamination were discovered, unless noted below. No discernible capillary irregularities were noted. It was determined that this instrument is in good working order and is therefore suitable for calibration.

CALIBRATION PROCEDURE
ICL Procedure 01, which is based on ASTM E77 and relevant portions of NIST Special Publication 250-23.

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

RESULTS OF CALIBRATION
NOTE: The indications of this instrument cannot be adjusted or modified by ordinary means; accordingly, the readings given in the table below should be considered, in effect, to be both 'As Found' and 'As Left' readings.

Nominal	Standard	UUT Reading	Correction	Tolerance	Accept Limit*	P/F/Ind	Uncertainty
-7.0 °C	-7.00 °C	-7.01 °C	+0.01 °C	± 0.10 °C	± 0.098 °C	Pass	± 0.027 °C
0.0 °C	0.00 °C	0.00 °C	0.00 °C	± 0.10 °C	± 0.099 °C	Pass	± 0.024 °C
10.0 °C	10.00 °C	10.00 °C	0.00 °C	± 0.10 °C	± 0.097 °C	Pass	± 0.028 °C
20.0 °C	20.00 °C	20.00 °C	0.00 °C	± 0.10 °C	± 0.097 °C	Pass	± 0.028 °C
30.0 °C	30.00 °C	30.01 °C	-0.01 °C	± 0.10 °C	± 0.097 °C	Pass	± 0.028 °C

The test points listed in the above table comprise the full set of test points specified in ASTM E1 or E2251, as appropriate.

Unless otherwise stated, the thermometer was permitted to stabilize for a minimum of 5 minutes at each test temperature prior to reading.

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 or even 4:1 results in a guard band of zero, or very close to zero. A 3:1 TUR results in a modest guard band. 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 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
The calibration performed is a full range calibration and no limitations of use are imposed on this instrument.

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, the standard deviation of monthly Triple Point of Water calibrations of the standard, and UUT variability observed during the calibration. Type B contributors include comparator uniformity, 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.

NOTES AND SUPPLEMENTAL INFORMATION
All temperatures given in this report are those defined by the International Temperature Scale of 1990 (ITS-90). For discussion of accuracies attainable with thermometers such as this device, see NIST SP 250-23, ASTM E1, ASTM E2251, and ASTM E77.

TRACEABILITY INFORMATION
This calibration is traceable to NIST through an unbroken chain of comparisons. Our primary reference standard, a NIST calibrated SPRT, is used only to calibrate our transfer standards, which in turn are used to calibrate our clients' instruments. Measurement uncertainty has been calculated at each step in the chain and is fully documented.

ICL maintains three Rosemount model 162CE 25.5 Ohm SPRTs, for redundancy and to permit sequential rotation to NIST for calibration. As of this date, traceability is conveyed through S/N 5058, our MTE-262, calibrated by NIST on August 17, 2012. NIST GMP-11 recommends a 36 month calibration cycle for SPRTs. PRT transfer standards are calibrated annually against this SPRT, per NIST GMP-11 recommendations, and are monitored continually using measurement assurance strategies including check standards, control charts and monthly triple point of water checks.

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

Test point	Comparator	MTE#	Manufacturer	Transfer standard	MTE#	Manufacturer	Next Due
-7.00 °C	7341 Alc bath	292	Hart Scientific	5628-15 PRT 1111	286	Hart Scientific	09/24/15
0.00 °C	Ice bath	000	Lab Glass	Ice bath	222	Lab Glass	09/04/15
10.00 °C	7341 Water bath	342	Hart Scientific	5614 PRT 528663	128	Hart Scientific	05/27/16
20.00 °C	7341 Water bath	342	Hart Scientific	5614 PRT 528663	128	Hart Scientific	05/27/16
30.00 °C	7341 Water bath	342	Hart Scientific	5614 PRT 528663	128	Hart Scientific	05/27/16

TECHNICIAN: *DEBORAH M. WEBER*

ICL CALIBRATION LABORATORIES, INC.

Approved by: _____ *Reviewed by: _____*

J. Jeff Kelly, Technical Director
Deborah M. Weber, Quality Deputy
Date report issued: 06-21-2015

This report document was prepared by Lori J. Parr
Recalibration date specified by client: June 21, 2016

The user should be cognizant that the indications of liquid-in-glass thermometers are dynamic with use and may change with rough handling, physical shock, thermal shock, fluid deterioration (from unclean capillary, impure filling, or other internal issues beyond the control of the user), and thermal cycling, among other factors. Calibration results and performance data obtained at time of calibration may not necessarily apply throughout an extended period of use. The magnitude and direction of these changes in indication, if any, can be determined by periodic recalibration. 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.

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