CALIBRATION REPORT FOR THERMOHYDROMETER

SAMPLE CUSTOMER
S/N: XXXXX
Report Number: Y205188

ICL CALIBRATION LABORATORIES, INC.

Cert 526.01 Calibration

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CALIBRATION REPORT FOR THERMOHYDROMETER

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 CODE
Purchase order number: NOT AVAILABLE
Submitted by: SAMPLE COMPANY
ICL internal reference (SO): 444444

DATES
Date report issued: 03-13-2015
Next due (specified by client): March 13, 2016

UUT (Unit Under Test) INFORMATION
Model number: 40054HL-C
THERMOHYDROMETER ASTM 54HL
Manufacturer, brand or mark: LSW
Serial No: XXXXX

HYDROMETER PORTION OF INSTRUMENT
Engineering units: °API Gravity for petroleum products
Range: 29/41 °API Scale divisions: 0.10 °API
Accuracy tolerance (maximum scale error per ASTM E100 or E2995, as appropriate): 0.10 °API

THERMOMETER PORTION OF INSTRUMENT
Engineering units: °F Scale range: 0 to 150 °F
Scale divisions: 2.0 °F Immersion: TOTAL
Accuracy tolerance (maximum scale error per ASTM E100 or E2995, as appropriate): +/- 1.0

RESULTS OF PHYSICAL EXAMINATION
This thermohydrometer was examined under a polariscope, and strains in the glass, if any, were judged to be minimal and of no detriment to the function of the instrument. The instrument was then examined under magnification, looking for cracks, fissures, scratches, irregularities or other defects in the glass which might adversely affect its function. None of concern were observed, unless indicated below. The capillary of the integral thermometer was examined under magnification. No foreign material, moisture, oxidation, or other evidence of contamination could be seen. No discernable capillary irregularities were noted. There was no loose ballast or other material observed within the hydrometer. A scale slippage indicator of a type required by ASTM E100 and ASTM E2995 was present and correctly positioned, unless noted otherwise below. It was determined that this instrument is in apparent good working order and is therefore suitable for calibration.

CALIBRATION PROCEDURES
Hydrometer portion: ICL Procedure 02, which is based on ASTM E126. Thermometer portion: ICL Procedure 01, which is based on ASTM E77

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

RESULTS OF CALIBRATION FOR HYDROMETER

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	*UUT reading*	*Correction*	*Tolerance*	*Accept Limit**	*P/F/Ind*	*Uncertainty*
30.00 °API	29.97 °API	0.03 °API	± 0.10 °API	± 0.093 °API	Pass	± 0.037 °API
35.00 °API	35.00 °API	0.00 °API	± 0.10 °API	± 0.093 °API	Pass	± 0.038 °API
40.00 °API	39.94 °API	0.06 °API	± 0.10 °API	± 0.092 °API	Pass	± 0.039 °API

The test points listed in the above table satisfy the requirements of ASTM E126 (current revision).

The scale reading is determined by the intersection of the horizontal plane, tangent to the bottom of the meniscus, on the stem scale. See ASTM D1298 for drawings, discussion, and instruction on making accurate hydrometer readings.

The readings of this hydrometer were made under magnification, estimated and resolved to one-tenth of one scale division.

The readings (and corrections) presented above represent the average of (a minimum of) three independent observations of the UUT and at least six observations of the reference hydrometer at each test point.

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

This is a full range calibration. 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 precision and repeatability of the comparison process obtained from process statistics, and the standard deviation of repeated measurements made during the performance of the calibration. Type B contributors include the uncertainty of the calibration of the NIST standard, the uncertainty of the calibration of the transfer standard, the resolution of the standard, and the resolution of the UUT, among other contributors. 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.

TRACEABILITY INFORMATION

This calibration is traceable to NIST through an unbroken chain of comparisons. The NIST reference standards are used only for calibration of the transfer standard hydrometers, which in turn are used to calibrate the client's hydrometer(s). Measurement uncertainty has been calculated at each step in the chain and fully documented.

The NIST primary reference hydrometer(s) and transfer standard hydrometers(s) utilized in the performance of this calibration are listed below. Transfer standard hydrometers are calibrated annually against the NIST reference hydrometers.

Test point	NIST reference	Transfer standard	MTE#	Manufacturer	Next Due
30.00 °API	NIST 13506008 & 117269	ASTM 4H 12486737	364	LSW	09/16/15
35.00 °API	NIST 13506008 & 117269	ASTM 4H 12486737	364	LSW	09/16/15
40.00 °API	NIST 13506008 & 117269	ASTM 4H 12486737	364	LSW	09/16/15

(End of hydrometer section. Thermometer information appears on the following page.)

RESULTS OF CALIBRATION FOR THERMOMETER

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	UUT reading	Correction	Tolerance	Accept Limit*	P/F/Ind	Uncertainty
32.00 °F	32.0 °F	0.0 °F	± 1.0 °F	± 0.88 °F	Pass	± 0.46 °F
100.00 °F	100.0 °F	0.0 °F	± 1.0 °F	± 0.88 °F	Pass	± 0.46 °F

The above readings were made under magnification and resolved to one-tenth of one scale division. 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

This is a limited, or partial-range calibration, and accordingly, this instrument may be used with confidence only within the range bracketed by the test points.

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.

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.

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
32.00 °F	9510 Glycol bath	002	PolyScience	5614 PRT 597010	135	Hart Scientific	09/06/15
100.00 °F	7310 Water bath	006	PolyScience	5614 PRT 576776	130	Hart Scientific	09/06/15

(End of thermometer section)

NOTES AND SUPPLEMENTAL INFORMATION

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

For additional information on hydrometers and usage see ASTM E100, ASTM E126, ASTM D1298 and ASTM D6822.

TECHNICIANS

Hydrometer portion: ROB FOX Thermometer portion: DEBORAH M. WEBER

ICL CALIBRATION LABORATORIES, INC.

An ISO/IEC 17025 & ANSI/NCSL Z-540-1 accredited laboratory - American Association for Laboratory Accreditation Certificate #526.01

Approved by: _____ *Reviewed by: _____*

J. Jeff Kelly, Technical Director
Deborah M. Weber, Quality Deputy
Date report issued: 03-13-2015

This report document was prepared by Lori J. Parr
Recalibration date specified by client: March 13, 2016

Caution: Users should be aware that both density and temperature indications of thermohydrometers may change with rough handling, shock, exposure to aggressive liquids, and thermal cycling, among other factors. Consequently, test results and performance obtained at time of calibration may not necessarily apply throughout an extended period of use. Periodic recalibration of this instrument, in accordance with procedures set forth in ASTM E126 (for the hydrometer), and ASTM E77 (for the thermometer), is recommended.

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.