Designation: E2623 – 14

Standard Practice for Reporting Thermometer Calibrations[1]

This standard is issued under the fixed designation E2623; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice contains reporting requirements for thermometer calibrations included in ASTM Committee E20 Test Methods.

1.2 This practice covers reports of calibration for radiation thermometers, liquid-in-glass thermometers, resistance thermometers, digital thermometers, and new thermocouples.

NOTE 1—This practice does not apply to used thermocouples.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E77 Test Method for Inspection and Verification of Thermometers

E344 Terminology Relating to Thermometry and Hydrometry

E1137 Specification for Industrial Platinum Resistance Thermometers

2.2 *Other Standards or Guides:*

ANSI/NCSL Z540.3-2006 American National Standard for Calibration—Calibration Laboratories and Measuring and Test Equipment—General Requirements[3]

ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories[3]

JCGM100:2008 Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement

ISO/IEC Guide 98-3 Uncertainty of Measurement—Part 3: Guide to the Expression of Uncertainty in Measurement (GUM:1995)

NIST Technical Note 1297 Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, 1994 Edition

UKAS M3003 The Expression of Uncertainty and Confidence in Measurement, Edition 2

ANSI/NCSL Z540.2-1997 (R2002) U.S. Guide to the Expression of Uncertainty in Measurement

3. Terminology

3.1 *Definitions*—Definitions given in Terminology E344, unless otherwise defined herein, apply to terms as used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *correction, n*—numerical value added to the uncorrected result of a measurement to compensate for errors.

3.2.1.1 *Discussion*—The correction is equal to the negative of the estimated errors. Since the systematic error cannot be known perfectly, the compensation cannot be complete.

3.2.2 *error, n*—the indication of a thermometer or temperature measuring device minus the true value of the corresponding input quantity.

3.2.2.1 *Discussion*—Since the true value cannot be determined, in practice a conventional true value is used. This concept applies mainly when the instrument is compared to a reference standard.

3.2.3 *gradient zone, n*—the section of a thermocouple that is exposed during a measurement to temperatures in the range from $t_{amb} + 0.1(t_m - t_{amb})$ to $t_{amb} + 0.9(t_m - t_{amb})$, where t_{amb} is ambient temperature and t_m is the temperature of the measuring junction (all in °C).

3.2.3.1 *Discussion*—This term is used in thermocouple calibration reports as part of the description of the thermal profile along the length of the thermocouple. Although thermocouple emf is a function of the measuring and reference junction temperatures, the emf is actually generated along the length of the thermocouple, wherever the thermoelements pass through a temperature gradient. The gradient zone definition is intended to describe, in an approximate way, the section of thermocouple that created most of the emf during the calibration.

3.2.4 *half-maximum heated length, n*—the distance between the tip of the temperature sensor and the position along the

[1] This practice is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.07 on Fundamentals in Thermometry.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

length of the sensor leads or sheath where the temperature equals the average of the calibration-point and ambient temperatures.

3.2.4.1 *Discussion*—This term is used in thermocouple calibration reports as part of the description of the thermal profile along the length of the thermocouple.

4. Summary of Practice

4.1 This practice describes the required information necessary for reporting results of temperature calibrations included in ASTM Test Methods.

5. Significance and Use

5.1 This practice is adequate for use with all ASTM Test Methods which require the reporting of temperature measurements.

5.2 The Report of Calibration, however named, is the physical output of the calibration laboratory. It shall be prepared so that both the results of the measurement(s) and the non-technical information necessary to support those results are conveyed in a manner that ensures accurate communication and justification of the results.

5.3 This practice is not meant to supersede requirements of other standards practice such as ISO/IEC 17025 or ANSI/NCSL Z540.3.

6. Procedure

6.1 *Requirements for Written Report*— The requirements in 6.1.1 through 6.1.14 are mandatory for all written reports issued in compliance with this practice. Subsections 6.1.15 through 6.1.19 include general provisions for information that may be omitted if not required by a calibration procedure or client/user.

6.1.1 *Title Examples*—Report of Calibration, Calibration Certificate, Test Report or Test Certificate.

6.1.2 Name and address of the laboratory and location where the calibration was performed, if different from the laboratory address.

6.1.3 Unique identification of the report or certificate, and on each page an identification in order to ensure that the page is recognized as part of the report or certificate, a clear identification of the end of the report or certificate, and the page number and total number of pages.

6.1.4 Name and address of the client.

6.1.5 Statement and concise description of the test method or calibration procedure used. This statement shall include revisions and the date of the test method or calibration procedure. Test methods can consist of published standards (such as ASTM Test Methods), internally developed methods, or a combination of both.

6.1.5.1 Information describing deviations from previously agreed-upon procedures.

6.1.6 Description of the thermometer or thermocouple, the overall range, and, if different, the calibrated range. This shall also include the manufacturer, model number (as applicable), identification or unique serial number, and the condition of the thermometer or thermocouple upon receipt.

6.1.7 *Date of Calibration:*

6.1.7.1 Where applicable, additional dates, including date received, date of report preparation and next due date may be included.

6.1.8 *Calibration Results*—This can take the form of a table with reading of standard temperature, reading of test instrument, corrections to be applied and consistent units of measure or any form of reporting as requested by the customer.

6.1.8.1 When an instrument has been repaired or adjusted, the calibration results before and after repair or adjustment shall be reported, if available.

6.1.9 Conditions (for example, environmental conditions) under which the calibrations were made that have an influence on the measurement results.

6.1.10 A statement of the estimated uncertainty(ies) of measurement and the corresponding level of confidence.

6.1.10.1 Method for estimating uncertainties. Internationally the BIPM document JCGM100:2008 (“Guide to the Expression of Uncertianty of Measurement”) is cited, ISO/IEC Guide 98-3, NIST Technical Note 1297, UKAS M3003 and Z540.2-1997 (R2002) also meet this requirement.

6.1.10.2 Coverage factor and estimated confidence interval. Typically the coverage factor (k) is 2 for an approximate confidence level of 95%.

6.1.11 Traceability statement to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI) of test equipment used in the test or calibration.

6.1.12 Signature or equivalent identification of the responsible party.

6.1.12.1 Other signatures may be required, at the discretion of the laboratory manager. Each signatory or named person accepts responsibility for the contents of the report.

6.1.13 A statement specifying that the calibration certificate, however named, shall not be reproduced except in full, without written approval of the laboratory.

6.1.14 Statement of Temperature Scale (for example, International Temperature Scale of 1990 (ITS-90)).

6.1.15 Where appropriate and needed, opinions and interpretations, including additional information which may be required by specific methods, clients or groups of clients.

6.1.16 Where relevant, a sampling plan and procedure and a statement to the effect that the results relate only to the items calibrated.

6.1.17 Where relevant, a statement of compliance/non-compliance with requirements or specification, or both.

6.1.17.1 Compliance may refer to all criteria, including both specifications and maximum permissible error, of a referenced standard. When the scope of calibration is limited to only certain portions of the standard, the statement of compliance shall cite and be limited to those sections of the referenced standard with which the thermometer complies. If non-compliance is to be noted, the statement should cite those sections of the referenced standard for which the thermometer fails to comply.

6.1.18 Date of receipt of calibration item where this is critical to the validity and application of the results.

6.1.19 When applicable, customer purchase order or reference number and date.

6.2 *Additional Requirements for All Reported Calibrations for Radiation Thermometers only:*

6.2.1 Statement of source type (blackbody, filament lamp, and so forth).

6.2.2 Statement of source aperture or diameter of flat type sources.

6.2.3 Statement of measuring distances between the objective lens and the source aperture or cavity bottom, or both.

6.2.4 Statement of aperture distance, if an aperture is used.

6.2.5 Statement of field-of-view or size of source (as referenced to the thermometer under test).

6.2.6 Statement of emissivity of the thermometer under test (emissivity setting of the thermometer under test).

6.2.7 Statement of source emissivity.

6.2.8 Statement of the spectral response of the thermometer under test.

6.2.9 Statement of traceability of the source through contact or radiation thermometry.

6.3 *Additional Requirements for All Reported Calibrations of Liquid-in-Glass Thermometers:*

6.3.1 Statement of minimum length of time at test temperature before reading.

NOTE 2—The time allowed for equilibrium of a liquid-in-glass thermometer is dependent on the type of thermometric liquid used. For the purposes of this practice, the timing device for this measurement does not need to be traceable to an National Metrology Institute (NMI).

6.3.2 Statement of emergent stem temperature either in chart or text form (for partial immersion thermometers or total immersion thermometers calibrated with partial immersion only).

6.4 *Additional Requirements for Reported Calibrations of Resistance Thermometers*—The requirements in 6.4.1 – 6.4.4 are mandatory for all written reports for resistance thermometers issued in compliance with this practice. Subsections 6.4.5 – 6.4.9 include general provisions for information that may be omitted if not required by a calibration procedure or client/user.

6.4.1 As found values R(0.01 °C), R(0 °C) or other agreed-upon value.

6.4.2 Change in R(0.01 °C) or R(0 °C) observed during calibration.

6.4.3 Nominal excitation current.

6.4.4 Uncertainty of fitted results, if different from the uncertainty of measurement data.

6.4.5 Tabulated resisteance, $R(t)$ when specified by the client/user.

6.4.6 Hysteresis results, if applicable.

6.4.7 Fitting equation or reference to fitting equation, if applicable.

6.4.8 Fitting residuals, if applicable.

6.4.9 Repeatability results, if applicable.

6.5 *Additional Requirements for Reported Calibrations of Thermocouples*—The requirements in 6.5.1 and 6.5.2 are mandatory for all written reports for thermocouples issued in compliance with this practice. Subsections 6.5.3 – 6.5.6 include general provisions for information that may be omitted if not required by a calibration procedure or the client/user.

6.5.1 Mathematical description of any fitting equation used in reporting the results of the calibration. The equation may consist of a deviation function modeling the difference in emf from a reference function of a stated thermocouple type, or the equation may consist of a function giving emf-versus-measuring junction temperature.

6.5.2 Statement whether any allowance is included in the uncertainty for thermocouple drift and inhomogeneity.

6.5.3 Immersion depth used during the test.

6.5.4 Gradient zone of the thermocouple during the test.

6.5.5 Statement of calibration set up, if applicable.

6.5.6 Reference junction temperature.

6.6 *Additional Requirements for Reported Calibrations of Digital Thermometers*—The requirements in 6.6.1 – 6.6.3 are mandatory for all written reports for digital thermometers issued in compliance with this practice. Subsections 6.6.4 – 6.6.6 include general provisions for information that may be omitted if not required by a calibration procedure or the client/user.

6.6.1 For digital thermometers with multiple probes or multiple channels, or both, the report shall identify each thermometer probe calibrated and each corresponding channel used for the calibration.

6.6.2 For digital thermometers that include one or more algorithms for temperature conversion, the report shall include a method of conversion statement, identifying the method(s), all relevant standards, and identify coefficients (if applicable) used for each thermometer channel and probe calibrated.

6.6.3 Where a digital thermometer is checked without a thermometer probe using either resistance or voltage simulation, each sensor type or curve, or both, shall be reported.

6.6.3.1 *Discussion Example*—A common digital thermometer, having two inputs with the capability to read both Type J and K thermocouples, is first calibrated using mV simulation. Secondly, two thermocouple probes, one each Type J and Type K, are calibrated with this unit as a system after verification and adjustment of individual probe ice point offsets on the digital thermometer front panel.

6.6.4 Repeatability results, if applicable.

6.6.5 Reference junction temperature, if applicable (thermocouple probes only).

6.6.6 Statement regarding the recommended upper temperature limit for the probes(s) calibrated (if known).

7. Recordkeeping Requirements

7.1 A record system of all calibrations shall be kept. This system shall contain sufficient information to permit regeneration of the Certificate, however named, and shall include the identity of personnel involved in preparation and calibration.

7.2 Calibration records shall be retained for the period of time defined by the laboratory's quality system.

APPENDIXES

(Nonmandatory Information)

X1. SAMPLE REPORT FOR LIQUID-IN-GLASS THERMOMETERS

ABS Calibration Laboratory
1234 Main Street
City, State 12345-6789
Telephone: (555) 555-5555 Fax: (555) 555-5556

REPORT OF CALIBRATION
FOR
_____ Thermometer
Test Number: S-01-098

Type: _____ Range: _____ Serial #: 12345

Maker: _____ Lab Test #: _____ Calibration Date: _____

Submitted by:

CUSTOMER NAME
Customer Address
City, State 23456-7890

Calibration Temperature (°C)	Reading of Test Thermometer (°C)	Correction (°C)	Emergent Stem Temperature (°C)	Expanded Uncertainty (°C)
0.00	0.00	0.00	19	0.04
50.00	49.99	+0.01	20	0.04
100.00	100.02	–0.02	21	0.04
200.00	200.00	0.00	28	0.04

The data in the above table apply only to the item specifically listed on this report.
The temperatures in this Report are those defined by the International Temperature Scale of 1990 (ITS- 90).
The minimum amount of time at test temperature before reading is three minutes.

Uncertainty statement: The combined standard uncertainty includes the standard uncertainty reported for the standard, the standard uncertainty for the measurement process, and the standard uncertainty for any uncorrected bath gradients. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines an interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the JCGM100:2008 Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Traceability statement: The standards of ABS Calibration Laboratory are traceable to the International System of Units (SI) through the National Metrology Institute, and are part of a comprehensive measurement assurance program for ensuring continued accuracy and measurement traceability within the level of uncertainty reported by this laboratory. The laboratory test number identified above is the unique report number to be used in referencing measurement traceability for the thermometer identified in this report only.

Supplemental Information:

Description of thermometer submitted for calibration: Thermometer has an immersion length of 76 mm. Thermometer received with residue along stem.

Results of physical examination and treatment of thermometer before calibration: The thermometer was examined under a polariscope and strains in the glass, if any, were judged to be minimal and of no detriment to the functioning of the thermometer. The capillary of the thermometer was examined under magnification and no foreign matter, moisture or other evidence of contamination was discovered. No discernible capillary irregularities were noted. This thermometer was in good working order and suitable for calibration. The thermometer was cleaned of residue using isopropyl alcohol and a soft rag.

As found: In Tolerance **As left:** In Tolerance **Tolerance:** 0.1 °C

Environmental conditions at time of calibration:
Temperature: 21 °C **Relative humidity:** 44 %

Equipment and standards:

Temperature	Calibration Bath	Standard Used	Calibration Due
0 °C	Ice Melting Bath	N/A	N/A
50 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004
100 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004
200 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004

Procedure used: WI-001-5 Rev B dated May 16, 2002 which is based, in part on ASTM E77

Date test thermometer received: November 1, 2003

Date of report preparation: November 7, 2003

Date of calibration: November 6, 2003

Due date per customer's request: November 6, 2004

Signature: _____

Calibration performed by: John A. Smith, Assistant Technical Manager

X2. SAMPLE REPORT FOR RESISTANCE THERMOMETERS

ABS Calibration Laboratory
1234 Main Street
City, State 12345-6789
Telephone: (555) 555-5555 Fax: (555) 555-5556

REPORT OF CALIBRATION
FOR
Platinum Resistance Thermometer
Test Number: S-01-098

Model: _____ Range: _____ Serial #: 12345

Mfg: _____ Lab Test #: _____ Calibration Date: _____

Submitted by:

CUSTOMER NAME
Customer Address
City, State 23456-7890

Actual Temperature (°C)	Reading of UUT Thermometer (Ω)	Method of Realization	Fitting Residuals (°C)	Expanded Uncertainty (°C)
0.000	100.0740	Ice Melting Piont	0.0000	0.002
156.595	161.1019	comparison	–0.0053	0.025
231.952	189.4059	comparison	0.0121	0.025
300.022	214.4248	comparison	–0.0029	0.025

The data in the above table of this report apply only to the item specifically listed on this report.
The temperatures in this Report are those defined by the International Temperature Scale of 1990 (ITS- 90).
The UUT was measured with an excitation current of 1 mA at all temperatures.

Uncertainty statement: The combined standard uncertainty includes the standard uncertainty reported for the standard, the standard uncertainty for the measurement process, and the standard uncertainty for any uncorrected bath gradients. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines an interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the JCGM100:2008 Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Traceability statement: The standards of ABS Calibration Laboratory are traceable to the International System of Units (SI) through the National Metrology Institute, and are part of a comprehensive measurement assurance program for ensuring continued accuracy and measurement traceability within the level of uncertainty reported by this laboratory. The laboratory test number identified above is the unique report number to be used in referencing measurement traceability for the thermometer identified in this report only.

Supplemental information: The unit under test (UUT) data were fitted to the Callendar equation (below) per customer request. Results are as follows: R_0 = 100.0740, α = 0.00392787, δ = 1.51686. The fitting residuals are shown in the table above. The fitting function contributes negligible uncertainty compared to the calibration uncertainties as stated in the table.

$$R(t) = Ro\left\{1 + \alpha\left[t - \delta\left(\frac{t}{100}\right)\left(\frac{t}{100} - 1\right)\right]\right\}$$

Description of thermometer submitted for calibration: 100 Ω working standard quality platinum resistance thermometer (PRT). The instrument was received with slight oxidation and minor dimpling of sheath.

Results of physical examination and treatment of thermometer before calibration: Prior to calibration the insulation resistance was measured and found to be acceptable. The As Found R(0 °C) was measured as 100.0830 Ω. The change in the R(0 °C) value during the course of the calibration was –0.009 Ω. The results of these measurements indicated that the thermometer was in good working order and suitable for calibration. The thermometer was then annealed.

Environmental conditions at time of calibration:
Temperature: 21 °C **Relative humidity:** 44 %

Equipment and standards:

Manufacturer	Model	Description	Serial Number	Calibration Due
ABC Scientific	F17	Thermometer Bridge	1750/002	2/10/2006
ABC Scientific	162CE	SPRT	4431	8/10/2006
ABC Scientific	9171	Dry-Well Calibrator	23456	10/8/2005
ABC Scientific	9172	Dry-Well Calibrator	12345	10/8/2005

Procedure used: HSC-122 Revision 3 dated January 10, 2005

Date test thermometer received: July 1, 2005

Date of report preparation: July 17, 2005

Date of Calibration: July 15, 2005

Due date per customer's request: July 16, 2006

Signature: _____

Calibration performed by: John A. Smith, Assistant Technical Manager

X3. SAMPLE REPORT FOR THERMOCOUPLE THERMOMETERS

ABS Calibration Laboratory
1234 Main Street
City, State 12345-6789
Telephone: (555) 555-5555 Fax: (555) 555-5556

REPORT OF CALIBRATION
FOR
Noble Metal Thermocouple Thermometer
Test Number: S-01-098

Model: _____ Range: _____ Serial #: 12345

Mfg: _____ Lab Test #: _____ Calibration Date: _____

Submitted by:

CUSTOMER NAME
Customer Address
City, State 23456-7890

Nominal Temperature (°C)	Actual Temperature (°C)	Reading of UUT Thermometer (mV)	Method of Realization	Fitting Residuals (°C)	Expanded Uncertainty (°C)
0.00	0.000	0.000	fixed point	0.000	0.05
300.00	300.320	2.3215	comparison	–0.078	0.05
500.00	500.736	4.2306	comparison	0.040	0.05
700.00	700.040	6.2606	comparison	0.027	0.05
900.00	900.448	8.4336	comparison	–0.018	0.05

The data in the above table of this report apply only to the item specifically listed on this report.
The temperatures written in this Report are those defined by the International Temperature Scale of 1990 (ITS- 90).

The thermocouple calibration listed above, physically ice-point referenced to 0 °C, was performed by imposing a temperature step, between laboratory temperature 21 °C and the calibration temperatures, beginning 35 cm from the measuring junction and extending for a distance of 20 cm. This thermal profile has a gradient zone between X cm and Y cm, and a half-maximum heated length of Z cm, all as measured from the measuring junction. This certified calibration, uncertainty, and traceability apply specifically to this particular test segment only.

Uncertainty statement: The combined standard uncertainty includes the standard uncertainty reported for the standard, the standard uncertainty for the measurement process, and the standard uncertainty for any uncorrected furnace gradients. No allowance is included in the uncertainty for thermocouple drift and inhomogeneity. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines and interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the JCGM100:2008 Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Traceability statement: The standards of ABS Calibration Laboratory are traceable to the International System of Units (SI) through the National Metrology Institute, and are part of a comprehensive measurement assurance program for ensuring continued accuracy and measurement traceability within the level of uncertainty reported by this laboratory. The laboratory test number identified above is the unique report number to be used in referencing measurement traceability for the thermometer identified in this report only.

Supplemental information: The unit under test (UUT) data were fitted to a 2nd order deviation function per customer request: $\Delta E = \Delta C1\ t + \Delta C2\ t^2$, where ΔE is the emf deviation from the reference function, and t is the temperature in degrees Celsius. Results are as follows: ΔC1= -1.40095349 E-02, ΔC2= -1.01941216E-05. The fitting residuals are shown in the table above.

Description of thermometer submitted for calibration: Alumina sheathed reference standard quality thermocouple probe with attached stainless steel sheathed reference junction probe. Instrument received in new condition.

Results of physical examination and treatment of thermometer before calibration: Prior to calibration the main and reference junction sheaths were inspected for cracks and the interconnecting cable was inspected for damage. Additionally, a qualitative evaluation was performed to verify satisfactory homogeneity. The results of these inspections indicated that the thermometer was in good working order and suitable for calibration.

Environmental conditions at time of calibration:
Temperature: 21 °C **Relative humidity:** 44 %

Equipment and standards:

Manufacturer	Model	Description	Serial Number	Calibration Due
ABC Scientific	8508	Long Scale DMM	811257	2/10/2006
ABC Scientific	163B23A	Au/Pt Thermocouple	4632	8/10/2006
ABC Scientific	9107	Dry-Well Calibrator	23456	10/8/2005
ABC Scientific	9112	Calibration Furnace	12345	10/10/2005

Procedure used: HSC-126 Revision 3 dated January 10, 2005

Date test thermometer received: July 1, 2005

Date of report preparation: July 17, 2005

Date of calibration: July 15, 2005

Due date per customer's request: July 16, 2006

Signature: _____

Calibration performed by: John A. Smith, Assistant Technical Manager

X4. SAMPLE REPORT FOR RADIATION THERMOMETER

ABS Calibration Laboratory
1234 Main Street
City, State 12345-6789
Telephone: (555) 555-5555 Fax: (555) 555-5556

REPORT OF CALIBRATION
FOR
Radiation Thermometer
Test Number: S-01-098

Model: _____ Range: _____ Serial #: _____12345_____

Mfg: _____ Lab Test #: _____ Calibration Date: _____

Submitted by:

CUSTOMER NAME
Customer Address
City, State 23456-7890

Target Temperature (°C)	Blackbody Temperature (°C)	Reading of Test Thermometer (°C)	Correction (°C)	Expanded Uncertainty (°C)
300	300	302	–2	2
400	400	400	0	2
500	500	499	–1	2
700	700	702	–2	3
800	800	803	–3	3

The data in the above table of this report apply only to the item specifically listed on this report.
The temperatures written in this Report are those defined by the International Temperature Scale of 1990 (ITS- 90).

Uncertainty statement: The combined standard uncertainty includes the Type A and Type B standard uncertainties reported for the source, transfer standard and measurement process. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines an interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the JCGM100:2008 Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Traceability statement: The standards of ABS Calibration Laboratory are traceable to the International System of Units (SI) through the National Metrology Institute, and are part of a comprehensive measurement assurance program for ensuring continued accuracy and measurement traceability within the level of uncertainty reported by this laboratory. The laboratory test number identified above is the unique report number to be used in referencing measurement traceability for the thermometer identified in this report only.

Description of test: The variable-temperature blackbody has an estimated emissivity of 0.999. Its temperature is controlled by a calibrated thermocouple providing feedback to the control system. The thermocouple is used to set the target temperature. The furnace is allowed to come to a stable target temperature ±1 °C or less, as indicated by the controller's thermocouple reading. The reference radiance temperature is determined by radiation thermometry using a certified high precision reference radiation thermometer operating in the same waveband as the test thermometer with its emissivity control set at 1.00. Both the test and the reference thermometer were aligned so their optical axes, when viewing the variable-temperature blackbody, coincided with the geometrical center of the blackbody. The thermometers were used sequentially to measure the apparent temperature of the blackbody source with multiple readings taken at each temperature. The reported values are the averages of each set, rounded to the nearest whole degree.

Temperatures measured: 300 to 800 °C

Measuring Distance: 1 m from the thermometer datum mark to the blackbody cavity entrance aperture.

Source Aperture: 20 mm diameter aperture at a distance of 300 mm from the cavity bottom.

Operating mode: continuous mode

Calculated target size: 15 mm diameter focused on the center of the plane of the blackbody cavity aperture.

Description of thermometer submitted for calibration: Brand X 241 portable radiation thermometer Spectral response of 1.1 to 1.7 μm and having adjustable focus and a nominal temperature range of 250 to 800 °C .

Results of physical examination and treatment of thermometer before calibration: Prior to calibration the thermometer was tested for function and all optics were externally checked and cleaned per manufacturer recommendations. Fresh batteries were installed. The results of these inspections indicated that the thermometer was in good working order and suitable for calibration.

Environmental conditions at time of calibration:
Temperature: 21 °C **Relative humidity:** 44 %

Equipment and standards:

Manufacturer	Model	Description	Serial Number	Calibration Due
XYZ Infrared	ABC1	Blackbody Furnace	535	4/11/2006
XYZ Infrared	DEF2	Radiation Thermometer Transfer Standard	2001002	10/8/2005

Procedure used: In-House Practice No. 1 Rev A, dated January 10, 2005

Date test thermometer received: July 1, 2005

Date of report preparation: July 17, 2005

Date of calibration: July 15, 2005

Due date per customer's request: July 16, 2006

Signature: _____

Calibration performed by: John A. Smith, Assistant Technical Manager

X5. SAMPLE REPORT FOR DIGITAL THERMOMETERS

ABS Calibration Laboratory
1234 Main Street
City, State 12345-6789
Telephone: (555) 555-5555 Fax: (555) 555-5556

REPORT OF CALIBRATION
FOR
Digital Thermometer
Test Number: S-01-098

Model: ABC | Range: _____ | Serial #: 12345

Number of Channels: 2 | Channel(s) Calibrated: 1 | Probe Serial #(s): ABC123

Mfg: _____ | Lab Test #: _____ | Calibration Date: _____

Submitted by:

CUSTOMER NAME
Customer Address
City, State 23456-7890

Calibration Temperature (°C)	As-Found Data (°C)	Correction (°C)	Expanded Uncertainty (°C)
0.00	0.10	–0.10	0.002
100.00	100.15	+0.15	0.01
200.00	200.19	–0.19	0.015
300.00	300.24	–0.24	0.02

Uncertainty statement: The combined standard uncertainty includes the standard uncertainty reported for the standard, the standard uncertainty for the measurement process, and the standard uncertainty for any uncorrected bath gradients. The combined standard uncertainty is multiplied by a coverage factor of 2 to give an expanded uncertainty, which defines an interval having a level of confidence of approximately 95 percent. The expanded uncertainty presented in this report is consistent with the JCGM100:2008 Guide to the Expression of Uncertainty in Measurement. The expanded uncertainty is not to be confused with a tolerance limit for the user during application.

Traceability statement: The standards of ABS Calibration Laboratory are traceable to the International System of Units (SI) through the National Metrology Institute, and are part of a comprehensive measurement assurance program for ensuring continued accuracy and measurement traceability within the level of uncertainty reported by this laboratory. The laboratory test number identified above is the unique report number to be used in referencing measurement traceability for the thermometer identified in this report only.

Supplemental Information:

Description of thermometer submitted for calibration: A single thermometer probe, serial number ABC123, was received and calibrated with the instrument. The probe immersion was 20 cm. The probe was used in Channel 1.

Results of physical examination and treatment of thermometer before calibration: The digital readout and thermometer probe were free from any visible defects.

Method of temperature conversion This digital thermometer uses calibration coefficients as specified in Specification E1137 to convert resistance to temperature.

Results of adjustments to stored calibration parameters for channel 1, probe serial number ABC123:

Calibration Coefficients	As found: Coefficients	As Left: Coefficients	Adjustment
A	3.9083E-3	3.9083E-3	None
B	–5.775E-7	–5.775E-7	None
C	–4.183E-12	–4.183E-12	None
R 0	100.00 Ohms	100.04 Ohms	+0.04 Ohms

Environmental conditions at time of calibration:
Temperature: 21 °C **Relative humidity:** 44 %

Equipment and standards:

Temperature	Calibration Bath	Standard Used	Calibration Due
0 °C	Ice Melting Bath	N/A	N/A
50 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004
100 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004
200 °C	Atoz Science Oil Bath	SPRT # 103456-9	1/1/2004

Procedure used: ASTM E*XYZ-13*; ABS Calibration Laboratory document “Calibration Procedures,” dated May 16, 2012

Date test thermometer received: November 1, 2013

Date of report preparation: November 7, 2013

Date of calibration: November 6, 2013

Due date per customer’s request: November 6, 2013

Signature: _____

Calibration performed by: John A. Smith, Assistant Technical Manager

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