



Designation: ~~E2623-08~~ Designation: E 2623 – 08^{ε1}

Standard Practice for Reporting Thermometer Calibrations¹

This standard is issued under the fixed designation E 2623; 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.

^{ε1} NOTE—The title was corrected editorially in May 2009.

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, 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

E 77 Test Method for Inspection and Verification of Thermometers

E 344 Terminology Relating to Thermometry and Hydrometry

2.2 Other Standards:

ANSI/NCSL Z540-1-1994 American National Standard for Calibration—Calibration Laboratories and Measuring and Test Equipment—General Requirements³

ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories³

3. Terminology

3.1 *Definitions*—Definitions given in Terminology E 344, 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 ~~systematic error~~ 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 a 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 where 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.

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 a 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.

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>.

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

5.3 This practice is not meant to supersede requirements of other standards practice such as ISO/IEC 17025 or ANSI/NCSL Z540-1.

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. Sections 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 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 thermometer or thermocouple, including overall range, and if different, range calibrated. This shall also include 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 calculated measurement uncertainty and corresponding level of confidence.

6.1.10.1 Method for calculating uncertainties.

6.1.10.2 Coverage factor and estimated confidence interval.

6.1.11 Traceability statement to NIST or other National Metrological Institute (NMI) of test equipment used in the test or calibration.

6.1.12 Signature or equivalent identification of 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 (e.g. 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 and/or specification.

6.1.17.1 Compliance refers to all criteria, both specifications and maximum permissible error, of a referenced standard and not just portions, such as, compliance with maximum permissible error only.

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 (black body, filament lamp, etc.).

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

6.2.3 Statement of calibration distance.

6.2.4 Statement of target size (as referenced to the thermometer under test).

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

6.2.6 Statement of source emissivity.

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

6.2.8 Statement of optical resolution.

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 NMI.

6.3.2 Statement of emergent stem temperature either in chart form 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 through 6.4.4 are mandatory for all written reports for resistance thermometers issued in compliance with this practice. Sections 6.4.5 through 6.4.8 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 uncertainty of measurement data.

6.4.5 Tabulated 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 through 6.5.4 are mandatory for all written reports for thermocouples issued in compliance with this practice. Sections 6.5.5 and 6.5.6 include general provisions for information that may be omitted if not required by a calibration procedure or 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 Immersion depth used during the test.

6.5.3 Gradient zone of the thermocouple during the test.

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

6.5.5 Statement of calibration set up, if applicable.

6.5.6 Reference junction temperature.

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:	

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

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°C	0.04
50.00	49.99	+0.01	20°C	0.04
100.00	100.02	-0.02	21°C	0.04
200.00	200.00	0.00	28°C	0.04

The data in the above table of this report applies 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).
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 1993 ISO 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 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 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 is in good working order and suitable for calibration. The thermometer was cleaned of the 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 E 77

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

ASTM E2623-08e1

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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

iTech Standards
 (https://standards.iteh.ai)

Actual Temperature (°C)	Reading of UUT Thermometer (Ω)	Method of Realization	Fitting Residuals (°C)	Expanded Uncertainty (°C)
0.012	100.0752	comparison	0.0000	0.025
156.595	161.1019	comparison	-0.0213	0.025
231.952	189.4059	comparison	0.0311	0.025
300.022	214.4248	comparison	-0.0129	0.025

The data in the above table of this report applies 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 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 1993 ISO 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 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: UUT data was fitted to the Callendar equation (below) per customer request. Results are as follows: $R_0 = 100.0740$, $\alpha = 0.00392787$, $\delta = 1.51686$. The fitting residuals are shown in the table above.

$$R(t) = R_0 \left\{ 1 + \alpha \left[t - \delta \left(\frac{t}{100} \right) \left(\frac{t}{100} - 1 \right) \right] \right\}$$

Description of thermometer submitted for calibration: 100 Ω working standard quality PRT. Instrument received with slight oxidation and minor dimpling of sheath.