



ADDENDA

**ANSI/ASHRAE Addendum a to
ANSI/ASHRAE Standard 41.1-2020**

Standard Methods for Temperature Measurements

Approved by ASHRAE and the American National Standards Institute on May 31, 2022 .

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. Instructions for how to submit a change can be found on the ASHRAE® website (<https://www.ashrae.org/continuous-maintenance>).

The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 180 Technology Parkway, Peachtree Corners, GA 30092. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2022 ASHRAE

ISSN 1041-2336



ASHRAE Standing Standard Project Committee 41

Cognizant TC: 1.2, Instruments and Measurements

SPLS Liaison: Gwelen Paliaga

Michael E. Shows*†, *Chair*
Margaret M. Mathison*, *Vice-Chair*
Michael S. Creamer*†, *Secretary*
Erik S. Anderson*†
B. Terry Beck*†
Thomas A. Butcher*
Patrick E. Collins*†
James L. Douglas*†
Alex Fridlyand
Joseph S.F. Goh
Richard L. Hall

Harshad V. Inamdar
Michelle E. Hull
Judd Jackson*†
Mark A. Kedzierski*†
Brandon Kelley*†
Orkan Kurtulus*
Chris Lesnar*†
Alexander D. Leyderman
Hongmei Liang*†
James D. Lutz*
Brian McClintock

Adam Michalson*†
John L. Neel*
Michael Perevozchikov*†
Patrick Riley
Alexander Schmig
John P. Scott*
Paul Sohler
Michael S. Todd
Stephen L.J. Wage
Robert C. Walker
Jeffrey R. Wilms

* Denotes members of voting status when the document was approved for publication

† Denotes members of Subcommittee 41.1

ASHRAE STANDARDS COMMITTEE 2021–2022

Rick M. Heiden, *Chair*
Susanna S. Hanson, *Vice-Chair*
Charles S. Barnaby
Robert B. Burkhead
Thomas E. Cappellin
Douglas D. Fick
Michael W. Gallagher
Patricia Graef
Srinivas Katipamula
Gerald J. Kettler

Essam E. Khalil
Malcolm D. Knight
Jay A. Kohler
Cesar L. Lim
Paul A. Lindahl, Jr.
James D. Lutz
Julie Majurin
Lawrence C. Markel
Margret M. Mathison
Gwelen Paliaga

Justin M. Prosser
David Robin
Lawrence J. Schoen
Steven C. Sill
Christian R. Taber
Russell C. Tharp
William F. Walter
Craig P. Wray
Jaap Hogeling, BOD ExO
Tim J. McGinn, CO

Connor Barbaree, *Senior Manager of Standards*

SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus Standard developed under the auspices of ASHRAE. *Consensus* is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this Standard as an ANS, as “substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution.” Compliance with this Standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Senior Manager of Standards of ASHRAE should be contacted for

- interpretation of the contents of this Standard,
- participation in the next review of the Standard,
- offering constructive criticism for improving the Standard, or
- permission to reprint portions of the Standard.

DISCLAIMER

ASHRAE uses its best efforts to promulgate Standards and Guidelines for the benefit of the public in light of available information and accepted industry practices. However, ASHRAE does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with ASHRAE's Standards or Guidelines or that any tests conducted under its Standards or Guidelines will be nonhazardous or free from risk.

ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for them, and conformance to them is completely voluntary.

In referring to this Standard or Guideline and in marking of equipment and in advertising, no claim shall be made, either stated or implied, that the product has been approved by ASHRAE.

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

Addendum a clearly defines the steady-state criteria; adds pretest uncertainty requirements; updates the test plan, values to be determined, steady-state requirements, and test results; and revises other requirements to make it easier for higher-tier standards to adopt Standard 41.1 by reference.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~striking through~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum a to Standard 41.1-2020

Modify Section 3 as shown.

~~error: the difference between the test result and its corresponding true value. the difference between the observed value of the measurand and its corresponding true value.~~

post-test uncertainty: an analysis to establish the uncertainty of a test result after conducting the test.

pretest uncertainty: an analysis to establish the expected uncertainty of a test result before conducting the test.

steady-state criteria: the criteria that establish negligible change of temperature or temperature difference with time.

~~**uncertainty:** a measure of the potential error in a measurement that reflects the lack of confidence in the result to a specified level. the limits of error within which the true value lies.~~

Revise Section 5.1 as shown.

5.1 Test Plan. ~~A test plan shall specify the temperature measurement system accuracy and the test points to be performed.~~ The test plan shall be one of the following documents:

- a. A document provided by the person or the organization that authorized the tests and calculations to be performed
- b. A method of test standard
- c. A rating standard
- d. A regulation or code
- e. Any combination of items (a) through (d)

The test plan shall specify the following:

- a. The maximum allowable value for either the accuracy or the measurement uncertainty of the temperature or temperature difference measurement system
- b. The values to be determined and recorded selected from this list: temperature, temperature difference, pretest temperature measurement uncertainty, post-test temperature measurement uncertainty, pretest temperature difference measurement uncertainty, and post-test temperature difference measurement uncertainty
- c. Any combination of test points and targeted set points to be performed together with operating tolerances

Revise Section 5.2 as shown.

5.2 Values to be Determined and Reported. The test values to be determined and reported shall be as shown in Table 5-1 if specified in the test plan in Section 5.1. Use the units of measure in Table 5-1 unless otherwise specified in the test plan in Section 5.1.

Add new Section 5.4 and revise and renumber previous Section 5.4 as shown.

5.4 Pretest Temperature or Temperature Difference Uncertainty Analysis. If required by the test plan in Section 5.1, perform an analysis to establish the expected uncertainty for each temperature

or temperature difference test point prior to the conduct of that test in accordance with the pretest uncertainty analysis procedures in ASME PTC 19.1¹.

5.45 Post-Test Temperature or Temperature Difference Uncertainty Analysis. If required by the test plan in Section 5.1, perform an analysis to establish the temperature or temperature difference measurement uncertainty for ~~The uncertainty in~~ each temperature or temperature difference test point in accordance with the post-test uncertainty analysis procedures in ASME PTC 19.1¹. ~~mea-~~surement shall be estimated as described in Section 10 for each test point if specified in the test plan. Alternatively, if specified in the test plan, the worst-case uncertainty for all test points shall be estimated and reported for each test point.

Revise Section 5.5 as shown.

5.56 Steady-State Test Criteria. Temperature and temperature difference test data shall be recorded at steady-state conditions unless otherwise specified in the test plan in Section 5.1. ~~If the test plan requires temperature or temperature difference test data points to be recorded at steady-state test conditions and provides the operating condition tolerance but does not specify the steady-state criteria, then determine that steady-state test conditions have been achieved using one of the following methods:~~

- a. ~~Apply the steady-state criteria in Section 5.5.1 if the test plan provides test points for temperature measurement.~~
- b. ~~Apply the steady-state criteria in Section 5.5.2 if the test plan provides test points for temperature difference measurement.~~
- c. ~~Apply the steady-state criteria in Section 5.5.3 if the test plan provides targeted set points for temperature measurement.~~
- d. ~~Apply the steady-state criteria in Section 5.5.4 if the test plan provides targeted set points for temperature difference measurement.~~

5.6.1 Steady-State Test Criteria Under Laboratory Test Conditions. ~~If the test plan requires temperature or temperature difference test data points to be recorded at steady-state test conditions and provides the operating condition tolerance but does not specify the steady-state criteria, then determine that steady-state test conditions have been achieved using one of the following methods:~~

- a. ~~Apply the steady-state criteria in Section 5.6.1.1 if the test plan provides test points for temperature measurement.~~
- b. ~~Apply the steady-state criteria in Section 5.6.1.2 if the test plan provides test points for temperature difference measurement.~~
- c. ~~Apply the steady-state criteria in Section 5.6.1.3 if the test plan provides targeted set points for temperature measurement.~~
- d. ~~Apply the steady-state criteria in Section 5.6.1.4 if the test plan provides targeted set points for temperature difference measurement.~~

5.6.2 Steady-State Test Criteria Under Field Test Conditions. ~~If the test plan requires temperature or temperature difference test data points to be recorded at steady-state test conditions and provides the operating condition tolerance but does not specify the steady-state criteria, the methods in Section 5.6.1 are optional.~~

Informative Note: ~~The steady-state methods in Section 5.6.1 are likely to be impractical under field test conditions. Under these circumstances, the user may want to select another method to determine the conditions for field test data to be recorded.~~

Revise subsection title numbers and Equations 5-23 and 5-32 as shown.

~~5.5.1~~**5.6.3 Steady-State Temperature Criteria for Test Points**

~~5.5.1~~**5.6.4 Steady-State Temperature Difference Criteria for Test Points**

~~5.5.1~~**5.6.5 Steady-State Temperature Criteria for Targeted Set Points**

~~5.5.1~~**5.6.6 Steady-State Temperature Difference Criteria for Targeted Set Points**

[...]

$$b\Delta t \leq 0.50T_L \text{ } ^\circ\text{C (} ^\circ\text{F)} \quad (5-23)$$

$$|b\Delta t| \leq 0.50T_L \text{ } ^\circ\text{C (} ^\circ\text{F)} \quad (5-23)$$

[. . .]

$$\cancel{b\Delta t} \leq 0.500_L \cancel{K (^{\circ}\text{R})} \quad (5-32)$$

$$|b\Delta t| \leq 0.500_L K (^{\circ}\text{R}) \quad (5-32)$$

Revise Section 8.1 as shown.

8.1 Post-Test Uncertainty Estimate Analysis. ~~An estimate~~ A post-test analysis of the measurement system uncertainty, performed in accordance with ASME PTC 19.1⁴, shall accompany each temperature measurement and temperature difference measurement if specified in the test plan in Section 5.1. Where two temperature measuring instruments are used to measure a temperature difference, the individual instrument accuracies shall be included in the temperature difference measurement uncertainty estimate.

Informative Note: An example of temperature measurement uncertainty calculations is provided in Informative Appendix B.

Revise Section 9.5 as shown.

9.5 Test Results. If specified in the test plan in Section 5.1, report the following test results:

- a. Temperature, °C (°F)
- b. ~~Uncertainty of temperature measurement~~ Pretest uncertainty estimate for the temperature measurement, °C (°F)
- c. Post-test uncertainty estimate for the temperature measurement, °C (°F)
- d. Temperature difference, K (°R)
- e. Pretest uncertainty estimate for the temperature difference measurement, K (°R)
- f. Post-test uncertainty estimate for the temperature difference measurement, K (°R)

Modify Section 10 as shown.

10. REFERENCES

1. ASME. 2018. ASME PTC 19.1, *Test Uncertainty*. New York: American Society of Mechanical Engineers.
- ~~2.~~ ASME. 2017. ASME PTC 19.3 TW, *Thermowells*. New York: American Society of Mechanical Engineers.
- ~~3.~~ ASHRAE. 2014. ANSI/ASHRAE Standard 41.6, *Standard Method for Humidity Measurement*. Atlanta: ASHRAE.
- ~~4.~~ ASTM. 1993. ASTM STP MANL 12-4TH, *The Use of Thermocouples in Temperature Measurement*, 4th Edition. West Conshohocken, PA: ASTM International.
- ~~5.~~ Doebelin, E.O. 2003. *Measurement Systems: Application and Design*, 5th Edition. Boston, MA: McGraw-Hill.
- ~~5. ASME. 2018. ASME PTC 19.1, *Test Uncertainty*. New York: American Society of Mechanical Engineers.~~

[Informative Notes:

1. Reference ~~4~~ 2 is only required if thermowells are used for ~~included in the thermocouple~~ temperature measurement.
2. Reference ~~2~~ 3 is only required if thermocouples are used for the temperature measurement.
3. Reference ~~3~~ 4 is only required if solid state devices are used for the temperature measurement.]

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

ASHRAE · 180 Technology Parkway · Peachtree Corners, GA 30092 · www.ashrae.org

About ASHRAE

Founded in 1894, ASHRAE is a global professional society committed to serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration, and their allied fields.

As an industry leader in research, standards writing, publishing, certification, and continuing education, ASHRAE and its members are dedicated to promoting a healthy and sustainable built environment for all, through strategic partnerships with organizations in the HVAC&R community and across related industries.

To stay current with this and other ASHRAE Standards and Guidelines, visit www.ashrae.org/standards, and connect on LinkedIn, Facebook, Twitter, and YouTube.

Visit the ASHRAE Bookstore

ASHRAE offers its Standards and Guidelines in print, as immediately downloadable PDFs, and via ASHRAE Digital Collections, which provides online access with automatic updates as well as historical versions of publications. Selected Standards and Guidelines are also offered in redline versions that indicate the changes made between the active Standard or Guideline and its previous version. For more information, visit the Standards and Guidelines section of the ASHRAE Bookstore at www.ashrae.org/bookstore.

IMPORTANT NOTICES ABOUT THIS STANDARD

To ensure that you have all of the approved addenda, errata, and interpretations for this Standard, visit www.ashrae.org/standards to download them free of charge.

Addenda, errata, and interpretations for ASHRAE Standards and Guidelines are no longer distributed with copies of the Standards and Guidelines. ASHRAE provides these addenda, errata, and interpretations only in electronic form to promote more sustainable use of resources.