



STANDARD

ANSI/ASHRAE Standard 41.1-2013
(Supersedes ANSI/ASHRAE Standard 41.1-1986 [RA 2006])

Standard Method for Temperature Measurement

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NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE Web site at www.ashrae.org/technology.

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FOREWORD

This version represents a significant update compared to the previous version that was published in 1986 and reaffirmed in 2006. A change to this standard results from the completion of ASHRAE research project 1460-RP, "Design Specifications for Wet-Bulb Aspirator Apparatus." The aspirated wet-bulb psychrometer descriptions are no longer included in this standard but will be included in the next published version of Standard 41.6.

The following changes were made for the 2013 revision:

- *Methods for noncontact temperature measurement, additional information for thermistor-type devices, descriptions for thermopiles, and sample tree devices were updated.*
- *Uncertainty analysis for temperature measurements was included.*
- *The standard has been arranged to be consistent with recently published 41-series standards, which include a Classifications section and updated definitions and references.*
- *This standard has been revised to comply with ASHRAE's mandatory language and SI (I-P) format requirements.*

1. PURPOSE

The purpose of this standard is to prescribe methods for measuring temperature.

2. SCOPE

The temperature measurement methods described herein are intended for use in testing heating, refrigerating, and air-conditioning equipment and components.

3. DEFINITIONS

accuracy: the ability of an instrument to indicate or record the true value of a measured quantity. The error of indication, which is the difference between the indicated value and the true value of the measured quantity, expresses the accuracy of an instrument.

error: the difference between the true value of the quantity measured and the observed value. All errors in experimental data are classified as one of two types: systematic (fixed) errors or random (precision) errors. The terms accuracy and precision are often used to distinguish between systematic and random errors. A measurement with small systematic errors is said to be unbiased. A measurement with small random errors

is said to have high precision. A measurement that is unbiased and precise is said to be accurate.

fixed error: same as *systematic error*.

precision: closeness of agreement among repeated measurements of the same physical quantity by the same method under the same conditions and with the same instrument.

precision error: same as *random error*.

random error: an error which causes readings to take random values on either side of a mean value. A random error is quantified based on how well an instrument reproduces subsequent readings for an unchanging input. Random errors cannot be corrected through calibration.

sensitivity: the relationship between an observed change in the position of an instrument pen, pointer, or indicator and the magnitude of change in the measured quantity required to produce that reaction of the indicator. It is expressed as a numerical ratio if the units of measurement of the two quantities are stated. An increase in sensitivity means a corresponding increase in the ability of an instrument to react to extremely small changes in the measured quantity.

steady-state conditions: an operating state of a system, including its surroundings, in which the extent of change over time of all the significant parameters is so small as to have no effect on the performance being observed or measured. (Compare to *transient condition*.)

systematic error: an error that persists and is not due entirely to chance. Systematic error is corrected through calibration.

temperature, adiabatic saturation: the temperature at which liquid or solid water, by evaporating into air, brings the air to saturation adiabatically (i.e., without heat transfer).

temperature, dry-bulb: the temperature of a gas or mixture of gases indicated by an accurate thermometer after correction for radiation.

temperature, wet-bulb: the temperature indicated by a wet-bulb psychrometer constructed and used according to specifications.

transducer: a device that changes one form of physical quantity into another. In the measurement field, transducers are used to sense a variety of measurands, such as line voltage, current, power, pressure, and temperature, and to convert these to a common output signal for use with a controlling or recording instrument.

transient condition: the state in which the system undergoes a change in operation, such as thermostat cycling or actuation of a defrost control. (Compare to *steady-state condition*.)

uncertainty: an estimated value for the bound on the error in a measurement resulting from both systematic and random error. Because only random errors are treated by statistical methods, and only systematic errors are corrected through calibration, uncertainty computed using this standard result from random errors.