STANDARD

ANSI/ASHRAE Standard 41.11-2014

Standard Methods for Power Measurement

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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 Manager of Standards of ASHRAE should be contacted for:

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

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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.

(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

The scope of ASHRAE Standard 41.11 includes electrical and nonelectrical power measurements for heating, ventilating, air-conditioning, and refrigerating (HVAC&R) laboratory and field applications. This standard is intended to be used with IEEE 120-1989, Master Test Guide for Electrical Measurements in Power *and relies on IEEE 120 to provide fundamental guidance and more detailed information for electrical power measurement. Standard 41.11 also contains descriptions and measurement methods for the predominant forms of nonelectrical power in HVAC&R applications, which include shaft power, the power derived from the first law of thermodynamics, and the fluid power output from a pump.*

Whether electrical power measurements are to be taken in a laboratory or in the field, selecting the appropriate instruments and/or components should be based on the required measurement accuracy. Once an instrument has been selected, the user may need to consult with the instrument manufacturer regarding installation specifics, operating range limits, calibration limits, and other similar performance specifics in order to obtain the expected measurement accuracy.

Working with electricity can be hazardous. Users of this standard are cautioned to obtain appropriate electrical safety training and equipment at the outset. For example, NFPA 70E (2009), Standard for Electrical Safety in the Workplace, *and OSHA 29 CFR 1910, Sub Part S, describe all of the safety equipment required to perform energized equipment measurements, including arc-flash protection, approach boundaries, and other personal protective equipment.*

Informative Annex A contains a bibliography that lists sources of information that were used during the writing of this standard, as well as sources of supplemental information that may be of interest. Informative Annex B, "Power Measurement Basics," should be carefully reviewed before planning or conducting any power measurement tests. Informative Annex D contains an example of uncertainty calculations, and Informative Annex E contains examples of power derived from the first law of thermodynamics. This standard is written in compliance with ASHRAE's mandatory language requirements.

1. PURPOSE

This standard prescribes methods for power measurements.

2. SCOPE

This standard applies to power measurements under laboratory conditions and under field conditions when testing heating, ventilating, air-conditioning, and refrigerating systems and components.

3. DEFINITIONS

active power: see *power, active*.

apparent power: see *power, apparent*.

constant-speed drive (CSD): a device fitted between a rotating power source and the rotating load to achieve constant rotational speed regardless of the power source rotational speed (for example, a steady 400-hertz current). Compare to *variable-speed drives*.

current (electrical): flow rate of electric charge through a medium, measured in amperes (A).

current shunt: a low-resistance device used to measure current in a circuit. The voltage across the current shunt is measured, and the current can be calculated using Ohm's Law ($I = V/R$).

current transformer: an instrument transformer intended to have its primary winding connected in series with a circuit carrying the current to be measured or controlled; the current is measured across the secondary winding. Note: an open circuit across the secondary winding shall be avoided.

current transducer: a current transducer (sensor) is a device that detects electrical current (alternating current [AC] or direct current [DC]) in a conductor and generates a signal proportional to it. The combinations of sensed current and the output signal are as follows:

- AC current input with
  - analog output, which duplicates the wave shape of the sensed current;
  - bipolar output, which duplicates the wave shape of the sensed current; or
  - unipolar output, which is proportional to the average or RMS value of the sensed current.
- DC current input with
  - unipolar output, which duplicates the wave shape of the sensed current; or
  - digital output, which switches when the sensed current exceeds a certain threshold.

energy: capability to do work. Forms include chemical, electrical, mechanical, and thermal. Energy may be either stored or transient and can be transformed from one form into another. Compare to *power*. In electricity, expressed as watt-hour or sometimes joule (joule = watt-second).

error: the difference between the *true* value of the quantity measured and the observed value. All errors in experimental data can be 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.*