



Standard Practice for Specifying Data for Evaluation of Energy Used in Residential Buildings¹

This standard is issued under the fixed designation E1410; 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 covers the measurement of energy used for space conditioning and domestic water heating in both single and multifamily buildings. It is intended to assist those who design test methods for field monitoring projects. It establishes a uniform set of guidelines for specifying the data needed to evaluate energy used for space conditioning and domestic water heating in residential buildings, and is intended to promote the exchange of data and to improve measurement practices.

1.2 This practice neither specifies the complete experimental design nor defines the data analysis technique to be used.

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

C1060 Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
E631 Terminology of Building Constructions
E741 Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution
E779 Test Method for Determining Air Leakage Rate by Fan Pressurization

2.2 ANSI/ASHRAE Standards:³

ANSI/ASHRAE Standard 101: Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics

¹ This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.25 on Whole Buildings and Facilities.

Current edition approved May 1, 2005. Published May 2005. Originally approved in 1991. Last previous edition approved in 1997 as E1410 – 91 (1997). DOI: 10.1520/E1410-91R05.

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 Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

ANSI/ASHRAE Standard 103: Methods of Testing for Heating Seasonal Efficiency of Central Furnaces and Boilers
ANSI/ASHRAE Standard 116: Methods of Testing for Seasonal Efficiency of Unitary Air Conditioners and Heat Pumps

2.3 Other Standards:

US/DOE 10CFR 430.22(e) Appliance Efficiency Standards⁴

3. Terminology

3.1 Terms in this standard are defined in Terminology E631.

4. Significance and Use

4.1 Variations in the building envelope, indoor temperature, weather, occupant behavior, and equipment performance can cause large variations in energy performance. In order to determine whether a new building performs as designed, or whether a retrofit of an existing building saves energy as predicted, the measured energy performance must be adjusted to standard conditions. This practice describes the kinds of data that must be collected to perform such an adjustment, but does not describe the necessary adjustment.

4.2 At present, insufficient data are available to assess the in-situ effectiveness of most energy-saving techniques. Gathering and storing energy-use data in a standard format would allow the development of a database and facilitate such an assessment. This practice contains a recommended format for the storage of data.

4.3 This practice is to be used in the development of an experimental design to measure the energy used for space conditioning and domestic water heating of a residential building. The set of parameters to be collected depends on the analysis technique that will be used. Details of experimental design may be found in: Guiding Principles Concerning Design

⁴ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. U.S. Department of Energy, Report No. DOE/CE-0220. Title 10—Energy, Chapter 11—Department of Energy, Subchapter D—Energy Conservation. Part 430—Energy Conservation Program for Consumer Products.



TABLE 1 Core Data Set

Measurements	System Evaluated		
	Heating	Cooling	DHW
Continuous Measurements:			
Space Conditioning			
Heating energy consumption	•		
Cooling energy consumption		•	
Non space-conditioning energy use	•	•	
Indoor temperature	•	•	
Utility Bills	•	•	
Domestic Water Heating (DHW)			
DHW energy consumption			•
Hot water consumption			•
Cold water temperature			•
Hot water temperature			•
Weather Conditions			
Outdoor air temperature	•	•	
Wind speed	•	•	
Outdoor humidity		•	
One-time Measurements:			
Building description			
Areas	•	•	
Envelope characteristics	•	•	
Exterior energy use	•	•	
HVAC system description			
Equipment	•	•	
Nameplate information	•	•	
Thermostat and controls	•	•	
Auxiliary equipment	•	•	
Power consumption	•		
DHW system description			
Equipment			•
Nameplate information			•
Thermostat and controls			•
Power consumption			•
Occupant survey			
Number of occupants	•	•	•

TABLE 2 Specific Data Set

Measurements	System Evaluated		
	Heating	Cooling	DHW
Continuous Measurements:			
Space Conditioning and DHW			
Auxiliary conditioning	•	•	
Indoor humidity		•	
Multiple indoor temperatures	•	•	
Fenestration management	•	•	
Exterior energy use	•	•	
Air temperature near boiler	•		•
Weather Conditions			
Solar insolation	•	•	
On-site wind speed and direction	•	•	
One-time Measurements:			
Building description			
Additional building data	•	•	
Pressurization test (Test Method E779)	•	•	
Infiltration test (Test Method E741)	•	•	
Solar shading	•	•	
Wind shielding	•	•	
Thermography	•	•	
HVAC system description			
Heating system efficiency	•		
Cooling system efficiency		•	
DHW system description			
DHW system efficiency			•
DHW appliances			•
Occupant survey			
Extended questionnaire	•	•	•

that is needed for more detailed energy analysis, or for the evaluation of specific energy systems, for example, an active or passive solar system.

5.1.1 Core data is required in all cases. Specific data must be taken whenever this data has significant impact. (See text for guidance.)

5.2 Continuous Measurements:

5.2.1 Because they vary throughout the test period, building operating characteristics, energy consumption, indoor conditions, and weather conditions must be monitored continuously. The length of the test period depends upon the experimental design that has been chosen and determines the level of accuracy that can be expected. For a retrofit, the before and after test periods should be of similar lengths and contain similar weather conditions.

5.2.2 The data collected is known as time-series data. Store data weekly or hourly; hourly values are preferred. Building conditions, such as occupancy or temperature or DHW use, often change every hour, and it may not be possible to extract representative values from weekly data.

5.2.3 Store time-integrated (average or sum) hourly values using real-time data acquisition systems that scan sensors at least once per hour; more frequent reading will be necessary in some cases. Store weekly readings from individual time integrating sensors.

5.2.4 Space Conditioning:

of Experiments, and Measuring Techniques;⁵ Monitoring Methodology Handbook for Residential HVAC Systems;⁶ and Monitoring the Performance of Solar Heated and Cooled Buildings, Vols 1 and 2.⁷

4.4 The user of this practice needs to be familiar with the fundamental techniques of energy monitoring.

5. Data Acquisition

5.1 The parameters that must be collected to evaluate the energy consumption of heating, cooling, and domestic hot water (DHW) systems are shown in the following two tables. Table 1 (Core Data) gives the minimum required data that must be collected, and Table 2 (Specific Data) gives additional data

⁵ Guiding Principles Concerning Design of Experiments, Instrumentation, and Measuring Techniques ISBN 91-540-3955-X. Swedish Council for Building Research, edited by Gian Fracastoro and Mats Lyberg, Stockholm, Sweden (1983). (In English)

⁶ Monitoring Methodology Handbook for Residential HVAC Systems, EPRI/EM-3003, Electric Power Research Institute, Palo Alto, California, May 1983.

⁷ Monitoring and Performance of Solar Heated and Cooled Buildings, Volumes 1 and 2, EPRI/ER-1239/1 and EPRI/ER-1239/2. Electric Power Research Institute, Palo Alto, California, November 1979.