ANSI/ASHRAE Addendum *e* to
ANSI/ASHRAE Standard 90.2-2001

ASHRAE® STANDARD

Energy-Efficient Design of Low-Rise Residential Buildings

Approved by the ASHRAE Standards Committee January 25, 2003; by the ASHRAE Board of Directors January 30, 2003; and by the American National Standards Institute April 3, 2003.

This standard is under continuous maintenance 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. The change submittal form, instructions, and deadlines are given at the back of this document and may be obtained in electronic form from ASHRAEís Internet Home Page, *http://www.ashrae.org*, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard and printed copies of a public review draft may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: *orders@ashrae.org*. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (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,
d. permission to reprint portions of the Standard.

(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.)

FOREWORD

This addendum revises the current calculation procedures for domestic hot water heating. The revised calculation procedures were developed for 90.2 by ASHRAE Technical Committee (TC) 6.6, Service Water Heating, and include a method for estimating the average gallons per day of hot water consumption for living units, which is then used in calculating hot water energy consumption. In addition, the addendum adds Section 7.1.3, "Central Water Heating Equipment," which was inadvertently deleted from ASHRAE 90.2-1993 after its first printing.

Although the proposed calculation procedures contain a note that they are not appropriate for nor intended for use for system sizing purposes, it is generally known that consumption on peak days will be considerably higher than the amount given by the equation. Consumption levels occurring over periods of 15 to 35 minutes typically drive required water heating system design. Consumption over a 5-minute interval can equal 25% to 75% of the average daily total, while consumption over a 15-minute interval can equal 35% to 125% of the average daily total. System design and sizing requirements are heavily influenced by the presence or absence of washing machines, bathtubs vs. showers, and spa-tubs vs. regular tubs, whereas average hot water consumption is influenced to a lesser degree by these devices, due to their intermittent use. The following are some example calculations of average gallons per day using the proposed procedures:

Example 1: Single-family detached residence having two bedrooms, a washing machine, and no spa tub.

$$AGPD = [2.0 + 0 + 13.2] (1.0)(2) = 30.4 \text{ gallons/day}$$

Example 2: Single-family detached residence having two bedrooms, a washing machine, no spa tub, but known to have three residents.

$$AGPD = [2.0 + 0 + 13.2] (3) = 45.6 \text{ gallons/day}$$

Example 3: Single-family detached residence having six bedrooms, a washing machine, and a spa tub.

$$AGPD = [2.0 + 1.25 + 13.2] [(1.0)(4) + (0.5)(2)] = 82.25 \text{ gallons/day}$$

Example 4: Efficiency apartment with no washing machine hook-up, no spa tub, and unit has its own water heater.

$$AGPD = [0 + 0 + 13.2] (1.25)(1) = 16.5 \text{ gallons/day}$$

Example 5: Luxury apartment with no washing machine hook-up, but with spa tub and six bedrooms, and unit has its own water heater.

$$AGPD = [0 + 1.25 + 13.2] [(1.25)(4) + (0.5)(2)] = 86.7 \text{ gallons/day}$$

Example 6: Two-bedroom apartment with no washing machine, no spa tub, and central building water heating system with cost of water heating included in rent.

$$AGPD = \text{Equation not applicable}$$

There is some evidence indicating that where water heating cost is included in the rent, hot water consumption is moderately to significantly higher than that indicated by Equation 8-11. However, insufficient data exist to produce predictive average hot water consumption equations for such situations.

References:

1. *Lowenstein, A., and C. Hiller. "Desegregating Residential Hot Water Use—Part II," ASHRAE paper no. SF-98-31-2.*
2. *Hiller, C. "New Hot Water Consumption Analysis and Water-Heating System Sizing Methodology," ASHRAE paper no. SF-98-31-3.*
3. *Goldner, F. "DWH Modeling: System Sizing and Selection Criteria—A Study of Baseloads and Seasonal Efficiency," NYSERDA report no. 99-2, January 1999.*

Unless otherwise noted, underlining indicates addition and strikethrough indicates deletion.

ANSI/ASHRAE ADDENDUM e to 90.2-2001

7. SERVICE WATER HEATING

7.1.3 Central Water Heating Equipment. Service water heating equipment (central systems) that does not fall under the requirements of residential-type service water heating equipment addressed in Section 7 shall meet the applicable requirements for service water heating equipment found in ASHRAE Standard 90.1-1999.

8. ANNUAL ENERGY COST METHOD

8.9 Calculation Procedures for Domestic Hot Water Heating

8.9.1 General. Domestic hot water shall be assumed to be supplied to all living units. Both the proposed design and the prescriptive design shall use the domestic ~~hot~~ water heating system designed for the proposed ~~design~~ application, ~~which may include~~ including high-efficiency equipment, ~~use of~~ waste heat use, off-peak storage, and renewable energy sources.

8.9.2 Domestic Hot Water Load. The total domestic hot water load used to calculate the annual energy consumption (AEC) shall be the same for the prescriptive design and the proposed design. It shall be determined using Equation 8-10.

$$DHWL = \text{~~((30 × Units) + (10 × Bedrooms))~~ } AGPD \times 8.28 \times (135 - T_{inlet}) \quad (8\text{-}10)$$

where

DHWL = domestic hot water load of the ~~building~~ living unit (Btu/day),

~~*Units* = number of living units in the proposed design,~~

~~*Bedrooms* = total number of bedrooms in all the living units in the proposed design,~~

AGPD = average gallons per day of hot water consumption, determined using the procedure described in Section 8.9.3, and

T_{inlet} = inlet mean water temperature (°F), which ~~may~~ shall be assumed to be equal to the average annual outdoor dry-bulb air temperature for the location or 40°F, whichever is higher (see Section 9 for climatic data).

8.9.3 Determine Average Gallons Per Day. The average gallons per day of hot water consumption for living units to be used in calculating hot water energy consumption shall be estimated with Equation 8-11.

$$AGPD = [CW + SPA + B]\,(NP) \qquad (8\text{-}11)$$

where

AGPD = average gallons per day of hot water consumption

CW = 2.0 gal/day per person if a clothes washer is present in living unit, otherwise zero

SPA = 1.25 gal/day per person additional hot water use if a "spa-tub" is present in living unit, otherwise zero

B = 13.2 gal/day per person

NP = number of people in living unit; if exact information is unknown, estimate as follows:

(1.0)(NSR) for single-family detached and manufactured (mobile) homes with one to four sleeping rooms, plus (0.5)(NSR) for each sleeping room beyond four, or

(1.25)(NSR) for multifamily buildings with one to four sleeping rooms per dwelling unit, plus (0.5)(NSR) for each sleeping room beyond four.

NSR = number of sleeping rooms

Notes:

1. Equation 8-11 is based on the assumption that each living unit has its own individual water heater and cooking and bathing facilities and that water heating costs are paid for directly by the living unit's occupants, i.e., not included in rent.
2. For the purposes of Equation 8-11, the value for the number of sleeping rooms (NSR) has to be a number greater than zero per living unit.
3. Equation 8-11 is intended for use in estimating average energy consumption (AEC) only. It is not appropriate for, nor intended for use for, system sizing purposes.

8.9.~~3~~4 Energy Consumption. The daily average electric energy consumption of electric water heaters shall be determined by Equation 8-~~11~~12 if the equipment is listed in Table 7-1; otherwise Equation 8-~~13~~14 shall be used. The daily average gas consumption of gas water heaters shall be determined by Equation 8-~~12~~13 if the equipment is listed in Table 7.1; otherwise Equation 8-~~14~~15 shall be used. The daily average energy use of domestic water heaters using other fuels shall be determined using appropriate conversion factors.

$$DHW_E = (DHWL/0.98 + Heaters \times (41{,}000/EF - 41{,}837))/3413 \qquad (8\text{-}11\text{12})$$

$$DHW_G = (DHWL/E_r + Heaters \times (41{,}000/EF - 41{,}000/Er))/100{,}000 \qquad (8\text{-}12\text{13})$$

$$DHW_E = (DHWL + 24 \times Standby)/3413 \qquad (8\text{-}13\text{14})$$

$$DHW_G = (DHWL + 24 \times Standby)/((1.0 - Flue) \times 100{,}000 \qquad (8\text{-}14\text{15})$$

where

DHW_E = domestic hot water electricity use (kwh/day),

DHW_G = domestic hot water gas use (therms/day),

Heaters = number of water heaters in the proposed design,

EF = energy factor,

E_r = recovery efficiency (if E_r is unknown, use 0.76),

Standby = total hourly standby loss from all water heaters (Btu/h), and

Flue = flue losses (fraction).

8.9.~~4~~5 Hourly Domestic Hot Water Fraction. Where hourly hot water load is required, it shall be distributed over the day according to the profile in Table 8-4. The hourly hot water load is DHWL multiplied by the factor for the hour.

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.