

**2005  
ASHRAE HANDBOOK**

**FUNDAMENTALS**

**I-P Edition**

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# **2005 ASHRAE® HANDBOOK**

## **FUNDAMENTALS**

**Inch-Pound Edition**

**American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.**

1791 Tullie Circle, N.E., Atlanta, GA 30329

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# ASHRAE Research: Improving the Quality of Life

The American Society of Heating, Refrigerating and Air-Conditioning Engineers is the world's foremost technical society in the fields of heating, ventilation, air conditioning, and refrigeration. Its members worldwide are individuals who share ideas, identify needs, support research, and write the industry's standards for testing and practice. The result is that engineers are better able to keep indoor environments safe and productive while protecting and preserving the outdoors for generations to come.

One of the ways that ASHRAE supports its members' and industry's need for information is through ASHRAE Research. Thousands of individuals and companies support ASHRAE Research

annually, enabling ASHRAE to report new data about material properties and building physics and to promote the application of innovative technologies.

Chapters in the ASHRAE Handbook are updated through the experience of members of ASHRAE Technical Committees and through results of ASHRAE Research reported at ASHRAE meetings and published in ASHRAE special publications and in *ASHRAE Transactions*.

For information about ASHRAE Research or to become a member, contact ASHRAE, 1791 Tullie Circle, Atlanta, GA 30329; telephone: 404-636-8400; [www.ashrae.org](http://www.ashrae.org).

## Preface

The 2005 *ASHRAE Handbook—Fundamentals* covers basic principles and data used in the HVAC&R industry. Research sponsored by ASHRAE and others continues to generate new information to support the HVAC&R technology that has improved the quality of life worldwide. The ASHRAE Technical Committees that prepare these chapters strive not only to provide new information, but also to clarify existing information, delete obsolete materials, and reorganize chapters to make the Handbook more understandable and easier to use.

This edition includes a new chapter (26), Insulation for Mechanical Systems, and an accompanying CD-ROM containing not only all the chapters in both I-P and SI units, but also the vastly expanded and revised climatic design data described in Chapter 28.

Some of the major revisions and additions are as follows:

- Chapter 2, Fluid Flow, has new examples on calculating pressure loss, flow, and pipe sizes, and new text on port-shape friction factors in laminar flow.
- Chapter 3, Heat Transfer, contains updated convection correlations; more information on enhanced heat transfer, radiation, heat exchangers, conduction shape factors, and transient conduction; a new section on plate heat exchangers; and several new examples.
- Chapter 4, Two-Phase Flow, has new information on boiling and pressure drop in plate heat exchangers, revised equations for boiling heat transfer and forced-convection evaporation in tubes, and a rewritten section on pressure drop correlations.
- Chapter 7, Sound and Vibration, contains expanded and clarified discussions on key concepts and methods throughout, and updates for research and standards.
- Chapter 12, Air Contaminants, contains a rewritten section on bioaerosols, added text on mold, and updated tables.
- Chapter 14, Measurement and Instruments, has a new section on optical pyrometry, added text on infrared radiation thermometers, thermal anemometers, and air infiltration measurement with tracer gases, as well as clarified guidance on measuring flow in ducts.
- Chapter 20, Thermophysical Properties of Refrigerants, has newly reconciled reference states for tables and diagrams, plus diagrams for R-143a, R-245fa, R-410A, and R-507A.
- Chapter 25, Thermal and Water Vapor Transmission Data, contains a new table relating water vapor transmission and relative humidity for selected materials.
- Chapter 26, Insulation for Mechanical Systems, a new chapter, discusses thermal and acoustical insulation for mechanical systems in residential, commercial, and industrial facilities, including design, materials, systems, and installation for pipes, tanks, equipment, and ducts.
- Chapter 27, Ventilation and Infiltration, updated to reflect ASHRAE *Standards* 62.1 and 62.2, has new sections on the

shelter-in-place strategy and safe havens from outdoor air quality hazards.

- Chapter 28, Climatic Design Information, extensively revised, has expanded table data for each of the 4422 stations listed (USA/Canada/world; on the CD-ROM accompanying this book), more than three times as many stations as in the 2001 edition.
- Chapter 29, Residential Cooling and Heating Load Calculations, completely rewritten, presents the Residential Load Factor (RLF) method, a simplified technique suitable for manual calculations, derived from the Heat Balance (HB) method. A detailed example is provided.
- Chapter 30, Nonresidential Cooling and Heating Load Calculations, rewritten, has a new, extensively detailed example demonstrating the Radiant Time Series (RTS) method for a realistic office building, including floor plans and details.
- Chapter 32, Energy Estimating and Modeling Methods, includes new information on boilers, data-driven models, combustion chambers, heat exchangers, and system controls, and a new section on model validation and testing.
- Chapter 33, Space Air Diffusion, has a rewritten, expanded section on displacement ventilation.
- Chapter 34, Indoor Environmental Modeling, rewritten, retitled, and significantly expanded, now covers multizone network airflow and contaminant transport modeling as well as HVAC computational fluid dynamics.
- Chapter 35, Duct Design, includes new guidance on flexible duct losses, balancing dampers, and louvers.
- Chapter 36, Pipe Sizing, has new text and tables on losses for ells, reducers, expansions, and tees, and the interactions between fittings.

This volume is published, both as a bound print volume and in electronic format on a CD-ROM, in two editions: one using inch-pound (I-P) units of measurement, the other using the International System of Units (SI).

Corrections to the 2002, 2003, and 2004 Handbook volumes can be found on the ASHRAE Web site at <http://www.ashrae.org> and in the Additions and Corrections section of this volume. Corrections for this volume will be listed in subsequent volumes and on the ASHRAE Web site.

To make suggestions for improving a chapter or for information on how you can help revise a chapter, please comment using the form on the ASHRAE Web site; or e-mail [mowen@ashrae.org](mailto:mowen@ashrae.org); or write to Handbook Editor, ASHRAE, 1791 Tullie Circle, Atlanta, GA 30329; or fax 404-321-5478.

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