

2019 ASHRAE® HANDBOOK

Heating, Ventilating, and Air-Conditioning APPLICATIONS

Inch-Pound Edition

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**DEDICATED TO THE ADVANCEMENT OF
THE PROFESSION AND ITS ALLIED INDUSTRIES**

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Volunteer members of ASHRAE Technical Committees and others compiled the information in this handbook, and it is generally reviewed and updated every four years. Comments, criticisms, and suggestions regarding the subject matter are invited. Any errors or omissions in the data should be brought to the attention of the Editor. Additions and corrections to Handbook volumes in print will be published in the Handbook published the year following their verification and, as soon as verified, on the ASHRAE Internet web site.

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ASHRAE Research: Improving the Quality of Life

ASHRAE 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 conferences and published in ASHRAE special publications, *ASHRAE Transactions*, and ASHRAE's journal of archival research, *Science and Technology for the Built Environment*.

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.

Preface

The 2015 *ASHRAE Handbook—HVAC Applications* comprises more than 60 chapters covering a broad range of facilities and topics, written to help engineers design and use equipment and systems described in other Handbook volumes. Main sections cover comfort, industrial, energy-related, general applications, and building operations and management. ASHRAE Technical Committees in each subject area have reviewed all chapters and revised them as needed for current technology and design practice.

An accompanying CD-ROM contains all the volume's chapters in both I-P and SI units.

This edition includes three new chapters:

- Chapter 6, Indoor Swimming Pools
- Chapter 59, Indoor Airflow Modeling.
- Chapter 65, Occupant-Centric Sensing and Controls

Other selected highlights include the following:

- Chapter 1, Residences, has updated guidance on duct system design and communicating control systems.
- Chapter 4, Tall Buildings, has new content on supertall and megatall buildings; improved stack effect discussion and calculations; and new information on chilled beams, code references, split central plants, and elevator shaft pressurization.
- Chapter 7, Educational Facilities, provides new design criteria updated for current standards, a new section on energy measurement and verification, and a newly compiled list of case studies from *ASHRAE Journal*.
- Chapter 8, Health Care Facilities, has been extensively revised to ANSI/ASHRAE/ASHE *Standard* 170-2013, with new content on regulatory resources, hospital-acquired infections, sustainability, and operations, and expanded text on control measures, outpatient care, isolation and bronchoscopy rooms, plus research results from RP-1343 on heat gain from imaging systems.
- Chapter 16, Laboratories, includes updates on applying usage factors, pressurization control, and energy efficiency measures.
- Chapter 18, Clean Spaces, has extensive new content on demand control, computational fluid dynamics analysis, pharmaceutical manufacturing facilities, safety, environmental systems, installation and testing, and sustainability and energy conservation.
- Chapter 19, Data Centers and Telecommunication Facilities, has been completely rewritten for current best practices as in the ASHRAE Datacom Series.
- Chapter 33, Kitchen Ventilation, was updated for the latest revisions to relevant standards, with new sections added on commissioning and the design process (for the first-time designer), and

the chapter content restructured to reflect the sequence of the design process.

- Chapter 34, Geothermal Energy, has significant new content and examples on ground-coupled heat pump systems design, hybrid ground-source heat pumps, piping, pressure considerations, purging, deep boreholes, central plants, open-loop/surface-water direct cooling, and simulation.
- Chapter 35, Solar Energy Use, has revised examples and figures, plus new content on solar-combi systems; design, control, and operation of solar cooling; and grid-connected photovoltaic systems.
- Chapter 49, Water Treatment, has major revisions on corrosion, deposition, microbiological growth and control, filtration and closed-loop systems, alternative water sources, Legionnaires' disease, thermal storage, and steam boiler systems.
- Chapter 50, Service Water Heating, describes new technologies for hot-water generation and distribution and reducing consumption at end-use fixtures.
- Chapter 53, Fire and Smoke Control, has been revised to align with ASHRAE's *Handbook of Smoke Control Engineering*, with many new figures and examples.

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

Corrections to the 2016, 2017, and 2018 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.

Reader comments are enthusiastically invited. To suggest improvements for a chapter, **please comment using the form on the ASHRAE web site** or write to Handbook Editor, ASHRAE, 1791 Tullie Circle, Atlanta, GA 30329, or fax 678-539-2187, or e-mail hkennedy@ashrae.org.

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