

# Advanced Energy Design Guide for Small Office Buildings

This is an ASHRAE Design Guide. Design Guides are developed under ASHRAE's Special Publication procedures and are not consensus documents. This document is an application manual that provides voluntary recommendations for consideration in achieving greater levels of energy savings relative to minimum standards.

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# Advanced Energy Design Guide for Small Office Buildings

Achieving 30% Energy Savings Over ANSI/ASHRAE/IESNA Standard 90.1-1999

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.  
The American Institute of Architects  
Illuminating Engineering Society of North America  
New Buildings Institute  
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# Contents

## **Acknowledgments · VII**

### Chapter 1 **Introduction · 1**

### Chapter 2 **Integrated Process to Achieve Energy Savings · 3**

Pre-Design Phase—Prioritize Goals 4

Design Phase 8

Construction 9

Acceptance 9

Occupancy 10

Operation 10

### Chapter 3 **Recommendations by Climate · 15**

Zone 1 18

Zone 2 22

Zone 3 26

Zone 4 30

Zone 5 34

Zone 6 38

Zone 7 42

Zone 8 46

### Chapter 4 **How to Implement Recommendations · 51**

Quality Assurance 51

Envelope 57

Opaque Envelope Components 57

Vertical Glazing (Envelope) 65

Window Design Guidelines for Thermal Conditions 66

Window Design Guidelines for Daylight 69

Lighting	71
Daylighting	71
Daylighting Controls	73
Electric Lighting Design	75
HVAC	80
Service Water Heating	89
Bonus Savings	91
Plug Loads	91
Exterior Lighting	92

Appendix A    **Envelope Thermal Performance Factors • 95**

# Acknowledgments

The primary contributors to the Advanced Energy Design Guide were the 13 members of the ASHRAE Special Project 102 Committee (SP-102) representing the various participating organizations that worked collaboratively to produce this document. While the document was produced under the organizational mantle of ASHRAE, much of the heavy lifting was done by representatives of the ASHRAE technical and standards project committee members, the American Institute of Architects (AIA), the Illuminating Engineering Society of North America (IESNA), the New Buildings Institute (NBI), and the United States Department of Energy (DOE). Within ASHRAE special thanks go to members of Standing Standards Project Committee 90.1 (SSPC 90.1), the Technical Committee on Building Environmental Impact and Sustainability (TC 2.8), and the Technical Committee on Systems Energy Utilization (TC 7.6) for the participation of their representatives on the SP-102 committee.

No document of this type and scope, with a very limited timeline and with a diverse group of collaborating partners, would have been possible without the firm guidance provided by the members of the Cognizant Committee. Without the vision for this document provided by 2002-2003 ASHRAE President Don Colliver as part of his presidential theme speech, as well as his steady hand as chair of the Cognizant Committee, this document would likely not have been produced. The well-focused scope and purpose for the Advanced Energy Design Guide developed by the Cognizant Committee provided a clear roadmap for the SP-102 committee to follow in producing the document in a timely manner.

During the eight-month development cycle of this document, the SP-102 committee conducted three review periods designed to gain input at the concept stage, the technical refinement stage, and the final stage of the document. Many comments were received from members of the partner organizations, as well as from others in the HVAC&R and energy efficiency communities, all of which helped to make the document better. The committee carefully assembled and considered all of these comments and made their best attempt to incorporate them where appropriate. In addition, ASHRAE convened a focus group made up of designers, consulting engineers, and contractors that provided valuable input into the document format and content. Many of their ideas are represented in the current Guide.

The chairman wishes to specifically thank the ASHRAE representatives on the committee for their willingness to put their shoulders into the job and get it done, the AIA representatives for their constant pushing to make the document more user friendly for those in the design community, the IESNA representatives for their professionalism and for again demonstrating the value of their longstanding partnership with ASHRAE in developing energy efficiency documents, the NBI representatives for their insights drawn from having plowed some of this ground already, the many ASHRAE TC and SSPC members who contributed in so many ways to the document, and to the DOE for its generous support of the project. And finally, special thanks go to Bing Liu of Pacific Northwest National Laboratory for her passion and dedication in producing well-documented simulation runs and timely energy savings results that allowed the committee to make the key decisions necessary to bring this project to a successful conclusion.

Preparation of this Design Guide was a high priority for each of the partner organizations. Perhaps one of the most important criteria was the issue of timeliness of the document. An aggressive development schedule was developed and adhered to, which frequently took its toll on the members of the committee as well as the external reviewers. However, the committee members responded to the challenge with an unprecedented spirit of cooperation that allowed the project to be completed successfully. From the initial organizational meeting of the project committee to a final approved document in eight months, all done with volunteer labor, ASHRAE and its partners helped prove that ASHRAE can operate at the speed of business!

As chairman of the committee I would like to say that I am extremely proud of the effort and the results put forth by the committee and commend each and every one of them for the Herculean effort in producing this Guide.

Ron Jarnagin  
SP-102 Chair  
October 2004



# Introduction

# 1

The *Advanced Energy Design Guide for Small Office Buildings* (Guide) is intended to provide a simple approach for contractors and designers who create office buildings up to 20,000 ft<sup>2</sup>. Application of the recommendations in the Guide should result in small office buildings with 30% energy savings when compared to those same office buildings designed to the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-1999. This document contains recommendations and *is not* a minimum code or standard. It is intended to be used *in addition to* existing codes and standards and is not intended to circumvent them. This Guide represents *a way*, but *not the only way*, to build energy-efficient small offices buildings that use significantly less energy than those built to minimum code requirements. The recommendations in this Guide provide benefits for the owner while maintaining quality and functionality of the space.

This Guide has been developed by a committee representing a diverse group of energy professionals drawn from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Institute of Architects (AIA), the New Buildings Institute (NBI), and the Illuminating Engineering Society of North America (IESNA). To quantify the expected energy savings, these professionals selected potential envelope, lighting, HVAC, and service water heating energy-saving measures for analysis. These included products that were deemed to be both practical and commercially available. Although some of the products may be considered premium, products of similar performance are available from multiple manufacturers. Each set of measures was simulated using an hour-by-hour building energy analysis computer program for two small office prototypes in representative cities in various climates. Simulations were run for reference buildings (buildings designed to Standard 90.1-1999 criteria) compared to buildings built using recommendations contained in this Guide to determine that the expected 30% savings target was achieved.

The scope of this Guide covers small office buildings up to 20,000 ft<sup>2</sup> in size that use unitary heating and air-conditioning equipment. Buildings of this size with these HVAC system configurations represent a large fraction of commercial office space in the United States. This Guide provides straightforward recommendations and “how-to” guidance to facilitate its use by anyone in the construction process who wants to produce more energy-efficient buildings.

As an added value for designers and contractors, this Guide features examples of energy efficient buildings appropriate for each climate zone. The examples demonstrate that effectively addressing environmental challenges can also result in the creation of good, often excellent, architecture. The examples were selected from the American Institute of Architects' annual Top Ten Green Projects competition winners, the Department of Energy's High Performance Buildings Database, and individual project architects. The examples illustrate how energy considerations have been incorporated in various design strategies and techniques. However, the example buildings may incorporate additional features that go beyond the scope of the recommendations of the Guide. The result of the Guide, it is hoped, will be a better built environment for society.

## HOW TO USE THIS GUIDE

Chapter 2 of this Guide contains a chart that walks the user through the design process of applying the recommendations in this Guide, while chapter 3 provides the actual recommendations for a way to meet the 30% energy savings goal. Chapter 3 consists of eight recommendation tables, which are broken down by building component and organized by climate according to the eight climate zones identified by the U.S. Department of Energy. The user should note that the recommendation tables do not include all of the components listed in Standard 90.1 since the Guide focuses only on the primary energy systems within a building. Chapter 3 is illustrated with the examples provided by AIA. Chapter 4 provides essential guidance in the form of concise “how-to” tips to help the user to understand and apply the recommendations from this Guide. In addition, this Guide provides recommendations that would assist the user in achieving energy efficiency credits for LEED™ or other building energy rating systems.

This Guide includes specific recommendations for energy-efficient improvements in the following technical areas to meet the 30% goal:

- Building Envelope
  - Roofs
  - Walls
  - Floors
  - Slabs
  - Doors
  - Vertical Glazing
  - Skylights
- Lighting
  - Daylighting
  - Interior Electric Lighting
  - Controls
- HVAC Equipment and Systems
  - Cooling Equipment Efficiencies
  - Heating Equipment Efficiencies
  - Supply Fans
  - Ventilation Control
  - Ducts
- Service Water Heating
  - Equipment efficiencies
  - Pipe insulation

In addition, “Bonus Savings” strategies to improve energy efficiency beyond the 30% are included for:

- Exterior Façade Lighting
- Parking Lot Lighting
- Plug Loads

Quality assurance and commissioning are also covered in chapter 4.