Development of a design guide to improve building IAQ

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SUMMARY
Building owners and developers, and the designers and contractors they employ, are faced with a variety of requirements related to building function, regulations, and environmental impacts. These professionals often address indoor air quality (IAQ) through compliance with minimum codes or regulations. Others attempt to improve IAQ through measures such as increased outdoor air ventilation rates or specification of low emitting materials, but often without a consistent technical basis for these measures. Based on these motivations, several organizations are collaborating on an *Indoor Air Quality Guide* for commercial and institutional buildings. The goals of this effort are to delineate best practices for IAQ while recognizing the constraints of building design, construction, and operation processes, and to simplify adoption of these practices through integrated design processes. The primary users of the guide are expected to be the architects, design engineers, product specifiers and contractors who will apply the guidance to specific projects.

KEYWORDS
Standards, Guidelines, Regulations, Building codes

INTRODUCTION

Indoor air quality (IAQ) is one of many factors that determine the functionality and economics of buildings. IAQ affects building occupants and their ability to conduct their activities; creates positive or negative impressions on customers, clients and other visitors; and can impact the ability to rent building space. When a building has good IAQ, it will be a more desirable place to work, to learn, to conduct business and to rent. When IAQ is poor, the negative outcomes vary from relatively minor unpleasantness to more serious outcomes such as potential occupant health problems, vacancies, periods of building closure, major repair costs and expensive legal actions.

While controlling indoor pollutant levels, providing adequate ventilation, and maintaining thermal comfort have motivated the design and use of buildings for centuries, awareness of and concerns about indoor air quality have increased in recent decades. However, IAQ is still not a primary design or building management issue compared to function, cost, space, aesthetics, and attributes such as location and parking. But given the very real benefits of good IAQ, the potentially serious consequences of poor IAQ, and the ability to design,

construct and operate buildings with good IAQ using existing knowledge and without incurring significant costs, building owners, designers and other professionals need a better appreciation of the importance of providing good IAQ in their buildings.

Based on these motivations, several U.S. organizations in the building industry are collaborating to develop an *Indoor Air Quality Guide* for commercial and institutional buildings. The goal of this effort is to improve IAQ by accelerating the adoption of best practices into the mainstream of building design and construction. Key objectives designed to accomplish this goal include:

- Delineate key IAQ best practices, drawing on the knowledge of a project committee and outside consultants and reviewers with extensive expertise in all facets of IAQ and building design and construction,
- Prioritize best practices for improved IAQ, recognizing the constraints of design and construction costs and processes as well as trends towards increasing energy costs,
- Simplify adoption of best practices by providing reliable information and practical tools (e.g., application guidance, sample detail drawings and specification guidance) that help designers modify their practices without unreasonable effort,
- Identify integrated design processes and techniques that enable design teams to achieve enhanced IAQ with lower first costs, and
- Provide a companion dissemination and educational program.

DOCUMENT OVERVIEW

The organizations developing the forthcoming *Indoor Air Quality Guide* include the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Institute of Architects (AIA), the Building Owners and Managers Association International (BOMA), the U.S. Environmental Protection Agency (EPA), the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) and the U.S. Green Building Council (USGBC). A Steering Committee of representatives from these organizations guides the work of the Project Committee, which is responsible for drafting the document. The Project Committee includes architects, engineers, design-build contractors and IAQ researchers. The project is being funded by the EPA through a cooperative agreement with ASHRAE.

The primary users of the guide are intended to be the architects, design engineers, product specifiers and contractors who will apply the guidance to specific projects. The contents of the guide will be written with these professionals in mind. However building owners, developers and other decision makers are expected to use the guide to direct the work of these professionals. Facility managers and building operators may use the guide to understand the IAQ implications of their existing systems and O&M practices. Additional users include organizations with sustainable building rating programs and those who conduct training for the primary users identified above. Some tenants may also use the guide to create market demand for higher quality indoor environments.

The document will address the design and construction of the commercial and institutional building types that are covered by ASHRAE Standard 62.1 (ASHRAE, 2007). Some space types and IAQ issues will not be covered directly, though their interactions with the rest of the building will be discussed. For example the document will not address the design of

commercial kitchens. However, the impacts of kitchen exhaust systems on other building airflows will be covered.

The document will focus on enhanced design, construction and commissioning practices and processes that can improve IAQ, rather than on quantitative measures of air quality such as contaminant concentrations. In pursuing the goal of accelerating the adoption of best practices for IAQ, the guide will target the mid-range of current practice in an attempt to move the bulk of current practitioners and projects into the realm of better practice. In addition, the guidance is expected to be useful to those professionals who are already trying to use best practices by providing them more information on specific issues. While Standard 62.1 contains minimum requirements for acceptable IAQ, this document will provide information on options to achieve better IAQ as well as to more reliably achieve the requirements in the standard.

In order to ensure the relevance and practicality of the design guidance, the effort includes numerous opportunities for input from industry professionals. A 60% draft was made available for peer review in February 2008 and a 90% review is planned for completion in June 2008. Focus group meetings were held in October 2007 and March 2008. Publication of the document is planned for early 2009, to be followed by dissemination and educational programs to foster implementation of the guidance. Information on the guide can be viewed at www.ashrae.org/technology/page/678.

OUTLINE AND FORMAT

The printed document is currently organized according to the outline in Figure 1. This distinction of the printed document is important because, as discussed later, the book will be accompanied by a CD containing additional information that will not be in the printed document. Chapter 1 presents a high-level view of IAQ, intended primarily for building owners, developers and other key decision makers. It begins with a persuasive statement of the value of IAQ to building owners (Why IAQ Matters). The document then makes the case for the critical importance of project management processes in establishing and achieving IAQ design objectives (Project Management for IAQ). Key goals and objectives related to IAQ (Design & Construction for IAQ), such as controlling moisture and controlling entry of outdoor contaminants, are next addressed in Chapter 1. The chapter ends with a section on How to Use this Guide.

Chapter 2 describes important project management strategies that can make the difference between good and bad IAQ in building projects. The eight steps listed in the outline are identified as critical to achieving good IAQ, as well as many other project objectives. These same issues are covered in more detail in Chapter 3.

Chapter 3 is the heart of the printed document and is intended to identify and provide a brief description of each of the many issues relevant to IAQ. This chapter is designed to help users quickly grasp the significance of each of the six issues listed in Figure 1, including how to assess their applicability for a given project and what the design solutions might be, without distracting them with a large volume of detailed information. The chapter is organized into a number of topics under each of the six areas listed in the table of contents, with each topic presented through summary text, an overview graphic, brief case studies and a "roadmap table." The graphic and roadmap table both provide entry (via hyperlinks) to the detailed information in Chapter 4, which is available only on the companion CD. The case studies are intended to highlight key points and to capture the interest of readers browsing the guide. Figure 2 is an example of a topic area overview for one of the six main issue areas, Control

Entry of Outdoor Contaminants. It includes a text description of the topic and a diagram that highlights those building features that relate to this topic. As noted above, the graphic contains a number of links to more detailed information on each issue. The topic summaries, an example of which is presented in Figure 3, contain more detailed descriptions of individual issues within the broader topic area, in this case, Control Entry of Radon. The accompanying graphic illustrates the relevant issues and provides clickable links to send the user to the more detailed information in Chapter 4. Figure 4 presents a listing of the individual topics under each of the five topics areas as of the 60% draft, though this list will likely be modified before the final draft is complete.

Table 1. Table of contents of printed portions of IAQ Guide.

Chapter 1: Executive Summary

- Why Indoor Air Quality Matters
- Project Management for IAQ
- Design & Construction for IAQ
- How to Use this Guide

Chapter 2: Project Management for IAQ

- Establish Explicit Project IAQ Requirements
- Integrate Design Across Disciplines
- Consider IAQ from Conceptual Design
- Consider IAQ in Selection of HVAC Systems
- Commission to Assure IAQ Requirements Are Met
- Establish a Project Schedule that Facilitates Key Actions to Achieve Improved IAQ
- Control Moisture and Contaminants in Occupied Buildings Under Construction
- Provide High Quality O&M Documentation and Training Focused on IAQ

Chapter 3: Design, Construction, and Commissioning for IAQ

- Project Management for IAQ
- Control Moisture
- Control Entry of Outdoor Contaminants
- Control Contaminants from Indoor Sources
- Capture and Exhaust Emissions from Building Equipment and Activities
- Provide Ventilation to Dilute Contaminants

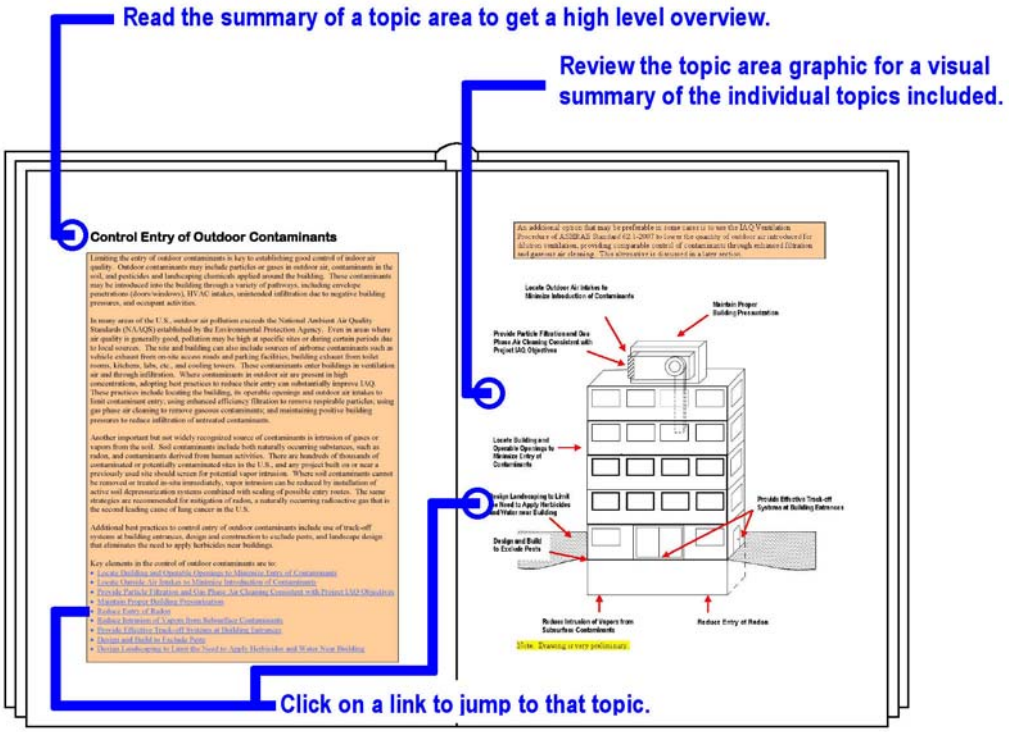

Figure 1. Example topic overview.

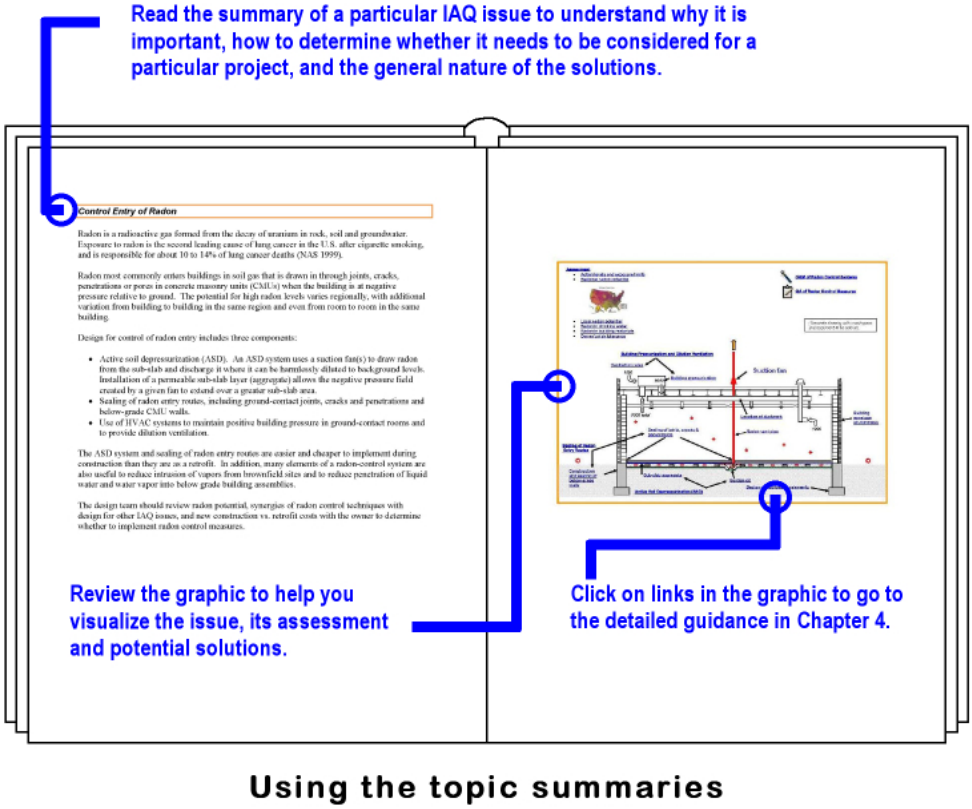

Figure 2. Example topic summary.

Table 2. List of topic areas to be covered by the guide.

Control Moisture

- Limit Penetration of Liquid Water into the Building Envelope
- Limit Condensation within the Building Envelope and on Interior Surfaces
- Maintain Proper Building Pressurization
- Control Indoor Humidity
- Control Moisture in Air Handling Systems
- Control Moisture associated with Piping and Plumbing Fixtures
- Control *Legionella* in Water Systems
- Limit Indoor Moisture Sources
- Select Suitable Materials, Equipment and Assemblies for Areas that Are Unavoidably Wet

Control Entry of Outdoor Contaminants

- Locate Building and Operable Openings to Minimize Entry of Contaminants
- Locate Outside Air Intakes to Minimize Introduction of Contaminants
- Provide Particle Filtration and Gas Phase Air Cleaning Consistent with Project IAQ Objectives
- Maintain Proper Building Pressurization
- Reduce Intrusion of Vapors from Subsurface Contaminants
- Provide Effective Track-off Systems at Building Entrances
- Design and Build to Exclude Pests
- Design Landscaping to Limit the Need to Apply Herbicides and Water Near Buildings

Control Contaminants from Indoor Sources

- Facilitate Access to HVAC Equipment for Inspection, Cleaning and Maintenance
- Select Airstream Surfaces that are Resistant to Erosion and Deposition
- Select Interior Finishes that are Easy to Keep Clean
- Select Finishes that Will Reduce the IAQ Impacts of Cleaning and Maintenance
- Control Indoor Contaminant Sources through Appropriate Selection of Building Materials, Finishes and Furnishings
- Employ Strategies to Limit the Impact of Material Emissions
- Consider the Use of Ultraviolet Germicidal Radiation

Capture and Exhaust Emissions from Building Equipment and Activities

- Properly Vent Combustion Equipment
- Provide Local Capture and Exhaust for Point Sources of Contaminants
- Enclose and Exhaust Areas Where Diffuse Contaminants Are Generated
- Design Exhaust Systems to Prevent Leakage of Exhaust Air into Occupied Spaces or Air Distribution Systems
- Maintain Proper Pressure Relationships between Spaces

Provide Ventilation to Dilute Contaminants

- Provide Appropriate Outdoor Air Quantities for Each Room or Zone
- Distribute Ventilation Air Effectively
- Continuously Monitor and Control Outdoor Air Delivery
- Use Demand-Controlled Ventilation Where Appropriate
- Use the ASHRAE Standard 62.1 IAQ Procedure Where Appropriate
- Use Natural or Mixed Mode Ventilation Where Appropriate
- Use Energy Recovery Ventilation Where Appropriate
- Provide Comfort Conditions that Enhance Occupant Satisfaction

Chapter 4 of the document, which will be contained on a CD distributed with the printed version, contains detailed information on each of the topic areas included in the guide. It will also contain a pdf version of the printed book, with hyperlinks to the detailed information relevant to each such link.

CONCLUSIONS

When published, the contributing organizations hope that this guide will provide practitioners with the information needed to address IAQ in a practical and comprehensive fashion. The guide should assist industry efforts to provide better indoor environments without excessive levels of cost and energy consumption.

ACKNOWLEDGEMENT

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REFERENCES

ASHRAE. 2007. *ANSI/ASHRAE Standard 62.1-2007 Ventilation for Acceptable Indoor Air Quality*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.