



**PERFORMANCE-BASED GUIDELINES
FOR THE DESIGN AND CONSTRUCTION OF
UNDG COMMON PREMISES OFFICE BUILDINGS
UNITED NATIONS DEVELOPMENT GROUP**



**UNITED NATIONS
DEVELOPMENT GROUP**

**PERFORMANCE-BASED Guidelines
for the Design and Construction of UNDG Common Premises Office Buildings
United Nations Development Group**

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PREFACE

These United Nations (UN) guidelines are intended to facilitate the consistent and safe construction of UN office spaces in various countries around the globe. The predominant approach used is that of a performance approach; however, excerpts of the 2009 *International Building Code*® (IBC®) have also been incorporated to provide additional support.*

Sections, tables and figures excerpted from the IBC are not necessarily in the order that they appear in the code and they may not include all subsections, exceptions and notes. Only the most important and relevant information for office buildings is reproduced. Occupancy Classifications most relevant to UN office buildings are Group B, Group A-3 and Group U as described in Section 4.1.2; however, some sections and tables still include reference to other occupancy groups or classifications of the IBC because they are required for the application of office provisions. The user should refer to Section 4.1.2.1.1 for a listing of all of the IBC occupancy groups and apply the requirements for Group B, Group A-3 and Group U occupancies as applicable. For example, Table 4.1.2.7.4 includes all of the occupancies that are not related to office buildings however, all of those occupancies must be present in the table to determine the fire resistant rated separation of office buildings from other occupancies.

The term “Reserved” has been used in certain sections or exceptions where the provision did not apply to the UN office buildings. This was done to keep the sequence of section numbers as closely aligned as possible with the base code, allow consistency for possible future editions of these guidelines and assist those users who might want to refer to the base code for additional information.

Section numbering system assigned is unique to these guidelines to facilitate the navigation and cross referencing to various chapters and sections of the entire document. Where applicable and to assist in referencing the source materials, the appropriate reference to the IBC Section number has been provided in parentheses following the guidelines section number. Brackets in front of an IBC Section indicate the committee responsible for updates to that section. For example, in Section 5.4.2.6.4, [F] is an indication that the updating of that provision is the responsibility of the ICC Fire Code Development Committee. Accordingly, [P] represents the ICC Plumbing Code Development Committee.

The SI system of units (metric units) used in the IBC excerpts of this publication do not exactly follow the soft or hard metric conversions of the IBC. The SI units of measurements used in the IBC were modified and rounded based on suggestions from the UN TTCP and agreement of ICC as follows: millimeters have not been used with the exception of dimensions less than one centimeter, for material thicknesses or for standard test protocols that need detailed accuracy. Centimeters have been rounded to the nearest whole number with no decimal points. Meters have been rounded to whole numbers where possible, otherwise two decimal points have been used to stay as close as possible to the code or standard text such that the true intent of the IBC is preserved. General rounding rules have been used to round up or down depending on the subject matter and the impact to safety. For example, a dimension dealing with guardrail minimum height that protects from falling over has always been rounded up and a dimension dealing with guardrail rail spacing that protects people from falling through has always been rounded down.

These metrication criteria should be followed considering the local market conditions. The designer should take the dimensions provided in these Guidelines as a general reference and follow the local industry standard that are commonly used with the caveat that the dimensions provided in these Guidelines are the minimum requirements and they should be kept as such in order to keep the safety objectives of this document.

* The 2009 edition was the latest edition of the IBC available at the time the development of these guidelines were undertaken.

PREFACE

As described in the “Background” section, these guidelines focus on office buildings of small to moderate size that are not tall enough to be considered high-rise buildings; however, some provisions of the IBC for high-rise buildings have been excerpted and provided for possible application to those existing or future office spaces that might be leased in high-rise buildings.

Finally, this publication is intended for the internal use of the United Nations for evaluation and guidance of UN office buildings design and construction. It is not intended for outside publication or reproduction. The use of the 2009 *International Building Code* and its support publications, such as the *IBC Commentary* and the *IBC Handbook*, are recommended for additional guidance when using these guidelines.

ACKNOWLEDGEMENTS

This Publication was commissioned by the Task Team on Common Premises (TTCP) of United Nations Development Group (UNDG) and the UNDG is very grateful for the financial contribution provided by the United Nations Children's Fund (UNICEF); the United Nations Development Programme (UNDP); the United Nations Population Fund (UNFPA); and the World Food Programme (WFP), who are all members of the TTCP. The UNDG would also like to express its gratitude to the International Code Council (ICC) for developing the Publication which has benefited extensively from ICC's pre-existing codes and other copyrighted materials.

BACKGROUND

The intent of the guidelines is to provide an easy to use and flexible set of documents, which when applied to the design, renovation or construction of United Nations' Common Premises (UNCP) office buildings, will result in office buildings with comparable levels of safety, function and performance, regardless of the country in which they are located.

To achieve the target ease of use and flexibility, the guidelines are performance-oriented, following a structure generally used for performance-based building regulation in many parts of the world. In brief, this approach focuses on describing the expected performance of buildings (e.g., resist earthquake loads, provide safety in case of fire, etc.) rather than on detailing how the performance is to be achieved (e.g., minimum dimensions of a column of a particular material, etc.). To assess the compliance of design solutions with the performance, various means of verification and deemed-to-comply solutions may be used. Each chapter contains sections which include some of the most relevant prescriptive requirements tied to the performance concepts presented in that chapter.[†] This structure, and how it has been adapted to meet TTCP needs, is described in Chapter 1, Philosophical Approach.

The guidelines will be applied primarily to United Nations common premises office buildings with incidental interior spaces designated as dispensaries/ambulatory medical services (for minor interventions) and conference rooms. In general, the buildings in which the office space and incidental spaces are located are no more than 10,000 square meters in area and are typically lower in height than the minimum height for “high-rise” designation, as defined by the IBC (a building with an occupied floor located more than 23 meters above the lowest level of fire department vehicle access).

Finally, a key aspect to the guidelines is that, quite simply, they are guidelines—not regulations—and it is the responsibility of the designers and engineers using the guidelines to meet the requirements of local building regulations as well as the guidelines. As such, the guidelines have been developed to address key building performance issues, but are not to be viewed as equivalent to or as complete as any building code, and no liability is assumed by the International Code Council or the United Nations for any perceived shortcoming relative to comparison with a promulgated building code. Additionally, the IBC excerpts in the Performance/Prescriptive Criteria and Means of Verification section of each chapter shall not be viewed as always being the same as the IBC text, as in many instances table notes, exceptions or portions of sections that were not related to office buildings were deleted and in many cases were renumbered to be applicable to the scope of these guidelines.

[†] These requirements are based on the 2009 *International Building Code*® (IBC®)

TABLE OF CONTENTS

Copyright	ii
Preface	iii
Acknowledgements	v
Background	vii
Chapter 1 – Philosophical Approach.....	1
1.0 Overview and Key Concepts.....	1
Chapter 2 – How to Use these Guidelines	3
2.0 Overview and Key Concepts.....	3
Chapter 3 – Overview of Chapters.....	5
3.0 Overview and Key Concepts.....	5
Chapter 4 – General Building Classification Concepts.....	7
4.0 Overview and Key Concepts.....	7
4.1 Use and Occupancy Considerations.....	9
4.2 Special Use Considerations	19
Chapter 5 – Fire Protection	29
5.0 Overview and Key Concepts.....	29
5.1 Building Construction, Materials, Height and Area Considerations	31
5.2 Passive Fire Protection Systems and Features	39
5.3 Interior Finish Considerations	79
5.4 Active Fire Protection Systems and Features	87
5.5 Exterior Wall and Roof Assembly Considerations	107
Chapter 6 – Occupant Movement and Safety	115
6.0 Overview and Key Concepts.....	115
6.1 Means of Egress.....	117
6.2 Accessibility.....	155
6.3 Elevators and Escalators.....	171
6.4 Safety of Users.....	181
Chapter 7 – Building Systems, Interior Environment and Building Envelope	191
7.0 Overview and Key Concepts.....	191
7.1 Interior Environment and Energy Performance	193
7.2 Electrical, Mechanical and Plumbing Systems.....	203
7.3 Building Envelope	215
Chapter 8 – Structural Design Considerations.....	221
8.0 Overview and Key Concepts.....	221
8.1 Loads and Actions on Structures.....	223
8.2 Soils and Foundations	243
8.3 Materials	251

TABLE OF CONTENTS

Chapter 9 – Safeguards During Construction, Alteration and Demolition	259
9.0 Overview and Key Concepts.....	259
Chapter 10 – Existing Structures	267
10.0 Overview and Key Concepts.....	267
Chapter 11 – Operations and Maintenance	277
11.0 Overview and Key Concepts.....	277
Chapter 12 – Referenced Standards	283
Appendix A – Definitions	291
Appendix B – Acronyms	299

CHAPTER 1 PHILOSOPHICAL APPROACH

1.0 OVERVIEW AND KEY CONCEPTS

The aim of these guidelines is to reflect basic design requirements for office occupancies in terms of expected function and performance of the spaces rather than through detailed specifications of how the performance is to be achieved. Such an approach provides engineers and designers with flexibility in selecting and utilizing a wide range of materials and methods of construction, which are appropriate to the country in which the building is located, while providing guidance in terms of how the finished building is expected to perform. In developing these guidelines, a structure which is widely used in performance-based building regulation^{1, 2, 3} has generally been adopted. This structure of the performance-based building regulatory approach is illustrated in Figure 1.

In brief, goals are qualitative statements that reflect high-level targets, such as “protect building occupants from fire.” Functional requirements, or functional objectives, build upon the goal, providing more detailed statements regarding how the building is expected to function in meeting the top-level goal. For example, for the goal of “protect building occupants from fire,” there may be a set of functional requirements that reflect how the building is expected to function to meet that goal, including “provide protection against the spread of fire,” “provide occupants with a safe means of egress in the event of fire,” “provide means to detect fires and notify occupants,” and so forth.

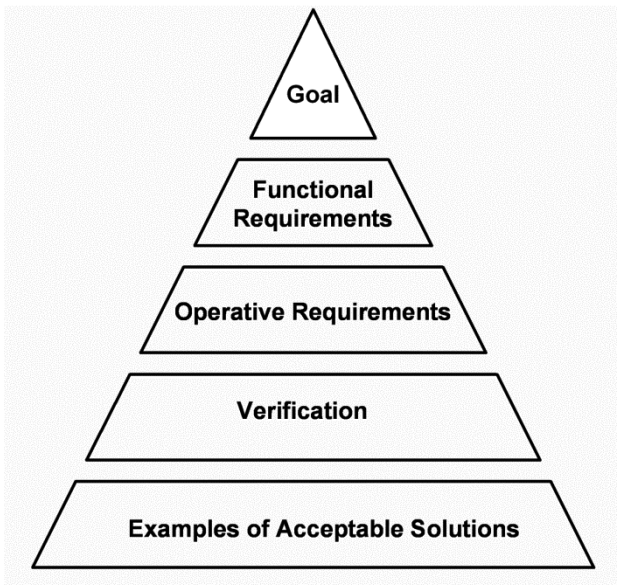


Figure 1. NKB Hierarchy^{1, 3}

In some cases, the functional requirements alone do not provide the desired level of guidance, and operative requirements (sometimes called performance requirements, statements or objectives) are used to provide more detail with respect to how the building and its systems are expected to perform in order to achieve the intended functional requirements. These operative or performance requirements are typically qualitative, but may contain some quantitative statements.

Since the functional and performance requirements are often expressed as qualitative statements, it is helpful to have a means to guide the development, assessment and verification of solutions for compliance with the functional and performance requirement. Such means of verification may include the application of acceptable engineering analysis methods (e.g., finite element analysis for the design of a structural member), or compliance with specific test, installation or design standards (e.g., standards published by the International Organization for Standardization (ISO), the National Fire Protection Association (NFPA), etc.), or compliance with engineering codes of practice (e.g., Eurocodes). Depending upon how these approaches are referenced and used, some level of engi-

¹ Nordic Committee on Building Regulations (NKB), Structure for Building Regulations, Report No. 34, Stockholm, 1978.

² Meacham, B.J., Moore, A., Bowen, R. and Traw, J., “Performance-Based Building Regulation: Current Situation and Future Needs,” *Building Research & Information*, Vol. 33, No. 1, pp.91-106, 2005.

³ Meacham, B.J. “A Risk-Informed Performance-Based Approach to Building Regulation,” *Journal of Risk Research*, Volume 13, Issue 7, 2010.

neering analysis and review may be required (e.g., application of Eurocodes), whereas in other cases, the presence of a label indicating that testing has been undertaken in accordance with a duly recognized standard (e.g., a CE mark or UL label indicating testing to an approved standard is satisfactory).

In those cases where comprehensive codes, regulations or standards exist—which fully address a topic in detail—they can be referenced as an “acceptable solution” for demonstrating compliance with the functional and operative (performance) requirements. These are also sometimes called “deemed-to-comply” solutions, “approved documents,” “compliance documents,” or similar. For example, compliance with *Approved Document B: Fire Safety* (<http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partb/bcapproveddocumentsb/bcapproveddocbvol2/volume2>) is an “acceptable solution” for complying with the fire and life safety requirements of *The Building Regulations England and Wales* (<http://www.legislation.gov.uk/uksi/2010/2214/contents/made>).

In addition to being found as self-contained codes, regulations or standards, “acceptable solutions” might also be available in the form of specific design details, methods of construction, or other self-contained solutions to specific building components, or in the form of acceptable methods of analysis. One example is the Eurocodes, which provide acceptable methods for structural analysis in Europe. Again, using *The Building Regulations England and Wales* as an example, *Approved Document A: Structure* is an acceptable solution for demonstrating compliance with the structural provisions of *The Building Regulations England and Wales*, and within *Approved Document A*, British Standards and Eurocodes are referenced as “acceptable methods” for demonstrating compliance with *Approved Document A* (http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_A_2004.pdf).

These guidelines have been developed following the above general structure, with a few modifications aimed at better fitting the needs of the TTCP. The modifications include the following:

NKB STRUCTURE	TTCP GUIDELINES
Goals	Overview and Key Concepts
Functional Statements	Functional Objectives and Performance Requirements
Operational Requirements	Performance/Prescriptive Criteria [from the <i>International Building Code</i> (IBC)]
Means of Verification	Means of Verification (as referenced in the IBC)
Acceptable Solutions	Alternate Methods of Verification

The section on Overview and Key Concepts is intended to introduce readers to the fundamental and important concepts in each chapter. The Functional Objectives and Performance Requirements section then translates those concepts into a minimum set of requirements for UN buildings, focusing on what is required rather than how the requirement is to be met. These are the only requirements stated in the guidelines that must be achieved—all other material is for additional information and support as deemed appropriate to local conditions.

To demonstrate compliance with the Functional Objectives and Performance Requirements, there are essentially three options: demonstrate that local regulations meet the requirements, adopt and implement in its entirety a deemed-to-comply document, or utilize the Performance/Prescriptive Criteria and associated Means of Verification provided in the guidelines. Because the TTCP specifically requested that Performance/Prescriptive Criteria is to be based on the latest edition of the 2009 *International Building Code*® (IBC®), and because the Means of Verification for demonstrating compliance with the IBC are tightly coupled with the IBC, the Performance/Prescriptive Criteria and Means of Verification are extracted from the 2009 IBC.

Because the provisions of the IBC may not be universally applicable and alternative compliance means may be desired, the Alternative Means of Verification section of the guidelines lists some representative alternate/acceptable methods of verification.

CHAPTER 2 HOW TO USE THESE GUIDELINES

2.0 OVERVIEW AND KEY CONCEPTS

The chapters provided in these Guidelines are arranged by major building function, such as Fire Protection, Occupant Movement and Safety, and Structural Design Considerations. Chapters may then have subsections as appropriate to the function (e.g., Fire Protection has subsections on Passive Systems and Features, Active Systems and Features, etc.). Chapters or subsections, as appropriate, are then divided into four major parts: Overview and Key Concepts; Functional Objectives and Performance Requirements; Performance/Prescriptive Criteria and Means of Verification and Alternate Methods of Verification. The Appendix materials (definitions and acronyms) are located at the end of the Guideline).

The Overview and Key Concepts sections are used to provide a summary of the key concepts addressed in a chapter or subsection and explain why they are important. For example, the Overview and Key Concepts for Chapter 6, Section 6.1.0, explains the concepts of exits, travel to exit, occupant load and other important features related to safe evacuation of occupants. This material is informational only and is not intended to be used for enforcement. Section 6.1.1 is used to describe the basic functions and performance requirements of the building features. These Functional Objectives and Performance Requirements represent the minimum requirements for all UN offices to which these guidelines are applied. Again, using Chapter 6, Section 6.1.1, notes that the intended function is to provide building occupants with reasonable means of safe egress from a building during fire and other emergency events, and that performance can be demonstrated in terms of providing appropriate exit identification, capacity, protection, lighting and so forth. From a fundamental performance perspective, any design shown to meet these functional requirements meets the intent of the guidelines. Recognizing that in some countries additional detail beyond that which is provided in Sections 6.1.0 and 6.1.1 may be helpful to designers and reviews, Section 6.1.2 provides more specific performance and prescriptive criteria which reflects the function and performance identified in Section 6.1.1. For example, whereas Section 6.1.1 indicates that means of egress should have sufficient capacity and protect occupants while they evacuate, Section 6.1.2 provides specific criteria, such as travel distance to an exit, exit width, and fire resistance rating of exit enclosures, which can be helpful in benchmarking minimal performance. As appropriate, reference is made to other parts within a chapter or subsection and to other chapters and subsections (e.g., Section 6.1.0, Means of Egress, makes reference to guidance in Chapter 4, Fire Protection). Since performance/prescriptive criteria are from the 2009 *International Building Code*® (IBC®), and those requirements reflect specific means of verification, such as testing required to demonstrate an exit enclosure assembly has a 1 hour fire rating, means of verification are incorporated into the Performance/Prescriptive Criteria and Means of Verification section. The Alternate Means of Verification section provides a representative listing of documents that may be deemed appropriate as alternate methods of verification (e.g., Section 6.1.3, Means of Egress, references Chapter 10 of the 2009 IBC as an alternate means of verification).

It is intended and required that the project's primary consultant possess an understanding of the functional and performance requirements as well as the minimum prescriptive provisions of these guidelines. The consultant then reviews the requirements of the guidelines and compares the requirements with local regulations. If the local regulations meet all of the requirements, it may be determined that local regulations can be used. To aid in the determination of compliance of local regulations with the guidelines, the consultant will need to develop a code compliance analysis report and include the report along with all other required project submittals. If local regulations do not provide the minimum level of safety required (e.g., "Section 6.1.1.1.2 There must be access from UN occupied space to at least two independent exits from any building, and any floor of any building, where the UN occupies space"), the consultant must then either apply the minimum Performance/Prescriptive Criteria and Means of Verification section, or adopt any international building code in its entirety providing that it complies

HOW TO USE THESE GUIDELINES

with the minimum requirements stated in the guidelines *and* that the local authorities approve adoption of such code. In all cases, it is permitted to undertake an engineering analysis to demonstrate compliance with the minimum safety requirements of these guidelines, subject to approval of the local building code authority.

CHAPTER 3 OVERVIEW OF CHAPTERS

3.0 OVERVIEW AND KEY CONCEPTS

The following is an overview of the chapters contained within these guidelines. These guidelines have been developed using the latest edition of 2009 *International Building Code*® (IBC®) as the primary reference document, and the content of each chapter generally parallels the IBC.

Chapter 1 provides an overview of the philosophical approach to the development and structure of these guidelines.

Section 1.0 provides a general overview of the chapter.

Chapter 2 provides a discussion on how the guidelines are intended to be used.

Section 2.0 provides general overview of the chapter.

Chapter 3 provides a brief overview of the chapters contained within the guidelines.

Section 3.0 provides a general overview of this chapter.

Chapter 4 provides an overview of issues associated with classification of office occupancies and special considerations for UN office buildings.

Section 4.0 provides a general overview of the chapter.

Section 4.1 describes the fundamental approach to building classification and how office buildings are considered.

Section 4.2 identifies some considerations and features of office buildings which fall outside of the general requirements for the use classification, and which warrant additional attention in concert with specific building system requirements which follow in other chapters of these guidelines.

Chapter 5 provides an overview of fire protection features and systems.

Section 5.0 provides a general overview of the chapter.

Section 5.1 focuses on the fire resistance requirements for the structural frame, especially load bearing elements, and issues associated with allowable heights and areas given the materials used for construction.

Section 5.2 is primarily focused on limiting the spread of fire and smoke within a building through building construction and other passive features (e.g., walls, floors and ceilings).

Section 5.3 discusses the contribution of interior finish material (e.g., wall covering, floor covering) to the overall fire load and the need to control the fire load within the exit system.

Section 5.4 addresses the wide range of active fire protection systems, including fire and smoke detection, alarm and communication systems, automatic and manual fire suppression systems and features, and active smoke control (management) systems and features.

Section 5.5 addresses issues associated with the potential for fire spread into or out of a building given various aspects of exterior wall and roof assembly materials, construction and protection.

Chapter 6 provides an overview of issues associated with occupant movement and safety.

Section 6.0 provides a general overview of the chapter.

OVERVIEW OF CHAPTERS

Section 6.1 provides an overview of the components of an exit system, providing functional and performance objectives aimed at providing a safe means of escape during fire or other hazard events.

Section 6.2 presents a discussion of basic accessibility issues and performance targets, from gaining unobstructed access to an office building to the ability to move without obstruction to essential areas of the building.

Section 6.3 discusses the performance of the elevators and escalators in providing means of mechanical conveyance for occupants.

Section 6.4 outlines issues associated with the safety of occupants in buildings during normal building use and under normal operating conditions. Note that safety of user issues associated with fire and natural hazard events is largely addressed in other chapters (e.g., fire protection, Chapter 4; means of egress, Chapter 6; structural, Chapter 8), as is safety during construction and demolition (Chapter 9).

Chapter 7 provides guidance on building systems, interior environment and building envelope issues.

Section 7.0 provides a general overview of the chapter.

Section 7.1 focuses on issues associated with the interior environment and building energy performance, including interior climate, indoor air quality, airborne and impact sound, artificial and natural lighting, and energy efficiency.

Section 7.2 is primarily focused on the performance of building systems, specifically electrical, mechanical, plumbing, and fuel gas systems.

Section 7.3 discusses the performance of the exterior envelope, with an emphasis on protection against moisture penetration.

Chapter 8 provides guidance on structural design issues for office buildings.

Section 8.0 provides a general overview of the chapter.

Section 8.1 provides an overall discussion of structural design issues. While the focus is on addressing loads and actions on structures, it also provides an overall philosophy for prescriptive and performance design.

Section 8.2 provides general guidance on site preparation and foundation issues. This guidance is limited to recommendations for local geotechnical investigation and the need for foundations which have suitable load bearing capacity and moisture penetration prevention.

Section 8.3 provides general guidance on the need to undertake proper designs using the selected materials in accordance with specific design standards in place in the country where the structure will be built.

Chapter 9 provides guidance on safeguards during construction.

Section 9.0 provides a general overview of the chapter.

Chapter 10 provides guidance on addressing issues in existing buildings.

Section 10.0 provides a general overview of the chapter.

Chapter 11 provides guidance on operations and maintenance considerations.

Section 11.0 provides a general overview of the chapter.

Chapter 12 provides a list of all standards referenced in the guidelines.

Appendix A contains definitions excerpted from the 2009 *International Building Code*® (IBC®)

Appendix B provides a list of terms and organizations and the acronyms used to represent them.

CHAPTER 4 GENERAL BUILDING CLASSIFICATION CONCEPTS

4.0 OVERVIEW AND KEY CONCEPTS

For reasons of practicality in regulation, design and enforcement, buildings are often grouped together by use, function or purpose. This affords a mechanism to describe a range of features, functions and performance requirements, generally related to a level of occupant risk, hazard or likewise, which are specific to one classification of buildings (e.g., business uses) but clearly differ from others (e.g., residential or industrial). However, it is not possible to address every variation in building design and construction within broad classifications. As such, there may be special building features or considerations that are appropriate to address outside of the classification itself.

This chapter provides an overview of these two concepts: building classifications and special use considerations. Following *Using the 2009 International Building Code® (IBC®)* as the primary reference document, these concepts are addressed in the following sections, which generally parallel the IBC:

- 4.1 Use and Occupancy Considerations
- 4.2 Security and Special Use Considerations

Section 4.1 describes the fundamental approach to building classification, and how office buildings are considered.

Section 4.2 identifies some considerations and features of office buildings which fall outside the general requirements for the use classification and which warrant additional attention in concert with specific building system requirements which appear in other chapters of this guide.

It should be noted that these guidelines have been developed to address a particular building use—office buildings with incidental interior spaces designated as dispensaries/ambulatory medical services (for minor interventions) and conference rooms, where the office buildings are generally no larger than 10,000 square meters in total building area and are typically lower in height than 23 meters (less than the minimum height for “high-rise” designation by many building regulations). This is the basis for Section 4.1 and the sections that follow. Section 4.2 highlights areas of consideration for buildings which fall outside of the limits identified above. In cases where such buildings or attributes are present, additional guidance may be warranted.

4.1 USE AND OCCUPANCY CONSIDERATIONS

4.1.0 OVERVIEW AND KEY CONCEPTS

Buildings are used for a variety of purposes, including housing, commerce, storage, medical care and more. Depending on the primary use of a building—including the activities undertaken in the building, the expected characteristics of the occupants, and the potential risks faced by the occupants while using the building—there can be a wide range of performance expectations for the building. Since building regulations cannot anticipate every possible combination of the above factors for every individual building design, many building regulations group buildings together in terms of use and occupancy characteristics. These groupings are variously known as Use Groups, Occupancy Types, Purpose Groups or a similar designation. The main purpose of these groupings is to provide a common set of requirements or considerations for any building designed and constructed to facilitate the primary intended use of the building.

While it is helpful to group or to classify buildings by primary use, occupancy or purpose, there are clearly situations in which other uses are also present. In some cases the secondary uses are considered incidental and do not warrant significant additional consideration (e.g., small storage closets in an office building which are not intended to store hazardous materials have no particular requirements beyond the general requirements for a building; however, if significant quantities of hazardous materials are intended to be stored in the storage closets, they may be subject to an increased level of protection). In other cases, there may be two or more principle activities in the building, such as a combination of restaurants, offices, mercantile and residential. If the percentage of the building for each use is sufficiently large, the building is considered a mixed-use occupancy and may have specific requirements for additional protection or separation between uses, or additional fire protection, exiting, or other requirements. Such additional requirements are sometimes required for particular building aspects, such as when atria are present or when the building is considered a high-rise building.

As indicated in the Background section on page iv, these guidelines have been developed to address a particular building use — office buildings with incidental interior spaces designated as dispensaries/ambulatory medical services (for minor interventions) and conference rooms, where the office buildings are generally no larger than 10,000 square meters in total building area and are typically lower in height than 23 meters (less than the minimum height for “high-rise” designation by many building regulations). This section outlines general considerations associated with the classification of office building as a “business” use group, a generally low risk occupancy. For those buildings which fall outside of the above height and area considerations or are mixed use, additional guidance is provided in Section 4.2. For very large or very tall buildings, additional engineering analysis may be required.

Summary

Key building use considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 4.1.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Primary use of the building within which UN offices are located.	Recommendations/requirements for all building performance features as discussed in these guidelines.	Design of all required building systems and features.

4.1.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with the classification of an office building as a “business” use group, a generally low risk occupancy, as defined below. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 4.1.2. A list of alternate means of verification is provided in Section 4.1.3.

- 4.1.1.1 A Business use classification shall apply to any building, structure or portion of a building or structure for office, professional, or service type transactions, including storage of records and accounts. It shall be assumed that:
 - 4.1.1.1.1 Occupants, visitors and employees are awake, alert, predominantly able to exit without the assistance of others, and are familiar with the building or structure layout, exit system and site access, protection and egress conditions.
 - 4.1.1.1.2 Risk of injury and adverse health effects assumed by occupants, visitors and employees during their use of the building or structure are predominantly voluntary in nature.
 - 4.1.1.1.3 Public expectations regarding the protection afforded those occupying, visiting or working in a building classified as a business use are neither unusually high nor unusually low.
- 4.1.1.2 For the purpose of these guidelines, a business use classification applies to office buildings no larger than 10,000 square meters in total building area and are lower in height than 23 meters with incidental interior spaces such as dispensaries/ambulatory medical services (for minor interventions) and conference rooms.
 - 4.1.1.2.1 For those buildings which fall outside of the above height and area considerations, are considered mixed use based on the percentage of building occupied by other uses, or have unique features such as atria, additional guidance as provided in Section 4.2 may be appropriate.

4.1.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 4.1.2.1 (IBC 302) CLASSIFICATION

4.1.2.1.1 (IBC 302.1) General. Structures or portions of structures shall be classified with respect to occupancy in one or more of the groups listed below. A room or space that is intended to be occupied at different times for different purposes shall comply with all of the requirements that are applicable to each of the purposes for which the room or space will be occupied. Structures with multiple occupancies or uses shall comply with Section 4.1.2.7 (IBC Section 508). Where a structure is proposed for a purpose that is not specifically provided for in these guidelines, such structure shall be classified in the group that the occupancy most nearly resembles, according to the fire safety and relative hazard involved. (Note: Occupancy Classifications most relevant to UN office buildings are Group B, Group A-3 and Group U as described in this section; however, some sections and tables in these guidelines still include reference to other occupancy groups or classifications of the IBC because certain requirements for office buildings might be contingent upon other adjoining occupancies.)

1. Assembly see Section 4.1.2.2 (IBC Section 303): Groups A-1, A-2, A-3, A-4 and A-5
2. Business see Section 4.1.2.3 (IBC Section 304): Group B
3. Educational see IBC Section 305: Group E
4. Factory and Industrial see IBC Section 306: Groups F-1 and F-2
5. High Hazard see IBC Section 307: Groups H-1, H-2, H-3, H-4 and H-5
6. Institutional see IBC Section 308: Groups I-1, I-2, I-3 and I-4
7. Mercantile see IBC Section 309: Group M
8. Residential see IBC Section 310: Groups R-1, R-2, R-3 and R-4
9. Storage see IBC Section 311: Groups S-1 and S-2
10. Utility and Miscellaneous see Section 4.1.2.4 (IBC Section 312): Group U

SECTION 4.1.2.2 (IBC 303) ASSEMBLY GROUP A

4.1.2.2.1 (IBC 303.1) Assembly Group A. Assembly Group A occupancy includes, among others, the use of a building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation.

Exceptions:

1. A building or tenant space used for assembly purposes with an *occupant load* of less than 50 persons shall be classified as a Group B occupancy.
2. A room or space used for assembly purposes with an occupant load of less than 50 persons and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.
3. A room or space used for assembly purposes that is less than 70 m² in area and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.

A-3 Assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A including, but not limited to:

- Amusement arcades
- Art galleries
- Bowling alleys
- Community halls
- Courtrooms
- Dance halls (not including food or drink consumption)

USE AND OCCUPANCY CONSIDERATIONS

- Exhibition halls
- Funeral parlors
- Gymnasiums (without spectator seating)
- Indoor swimming pools (without spectator seating)
- Indoor tennis courts (without spectator seating)
- Lecture halls
- Libraries
- Museums
- Places of religious worship
- Pool and billiard parlors
- Waiting areas in transportation terminals

SECTION 4.1.2.3 (IBC 304) BUSINESS GROUP B

4.1.2.3.1 (IBC 304.1) Business Group B. Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:

- Airport traffic control towers
- Ambulatory health care facilities
- Animal hospitals, kennels and pounds
- Banks
- Barber and beauty shops
- Car wash
- Civic administration
- Clinic—outpatient
- Dry cleaning and laundries: pick-up and delivery stations and self-service
- Educational occupancies for students above the 12th grade
- Electronic data processing
- Laboratories: testing and research
- Motor vehicle showrooms
- Post offices
- Print shops
- Professional services (architects, attorneys, dentists, physicians, engineers, etc.)
- Radio and television stations
- Telephone exchanges
- Training and skill development not within a school or academic program

SECTION 4.1.2.4 (IBC 312) UTILITY AND MISCELLANEOUS GROUP U

4.1.2.4.1 (IBC 312.1) General. Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy. Group U shall include, but not be limited to, the following:

- Agricultural buildings
- Aircraft hangars, accessory to a one-or two family residence (see Section 412.5)
- Barns
- Carports
- Fences more than 6 feet (1.80 m) high
- Grain silos, accessory to a residential occupancy

Greenhouses
 Livestock shelters
 Private garages
 Retaining walls
 Sheds
 Stables
 Tanks
 Towers

SECTION 4.1.2.5 (IBC 503) GENERAL BUILDING HEIGHT AND AREA LIMITATIONS

4.1.2.5.1 (IBC 503.1) General. The *building height and area* shall not exceed the limits specified in Table 4.1.2.5. (IBC Table 503) based on the type of construction as determined by Section 5.1.2.1 (IBC Section 602) and the occupancies as determined by Section 4.1.2.1 (IBC Section 302) except as modified hereafter. Each portion of a building separated by one or more *fire walls* complying with Section 5.2.2.3 (IBC Section 706) shall be considered to be a separate building.

4.1.2.5.1.1 (IBC 503.1.2) Buildings on same lot. Two or more buildings on the same lot shall be regulated as separate buildings or shall be considered as portions of one building if the *building height* of each building and the aggregate *building area* of the buildings are within the limitations of Table 4.1.2.5 (IBC Table 503) as modified by IBC Sections 504 and 506. The provisions of these guidelines applicable to the aggregate building shall be applicable to each building.

SECTION 4.1.2.6 (IBC 505) MEZZANINES

4.1.2.6.1 (IBC 505.1) General. A *mezzanine* or *mezzanines* in compliance with Section 4.1.2.6 (IBC Section 505) shall be considered a portion of the *story* in which it is contained. Such *mezzanines* shall not contribute to either the *building area* or number of *stories* as regulated by Section 4.1.2.5.1 (IBC Section 503.1). The area of the *mezzanine* shall be included in determining the *fire area* defined in IBC Section 902. The clear height above and below the *mezzanine* floor construction shall not be less than 2.15 m.

4.1.2.6.2 (IBC 505.2) Area limitation. The aggregate area of a *mezzanine* or *mezzanines* within a room shall not exceed one-third of the floor area of that room or space in which they are located. The enclosed portion of a room shall not be included in a determination of the floor area of the room in which the *mezzanine* is located. In determining the allowable *mezzanine* area, the area of the *mezzanine* shall not be included in the floor area of the room.

Exceptions:

1. The aggregate area of *mezzanines* in buildings and structures of Type I or II construction for special industrial occupancies in accordance with IBC Section 503.1.1 shall not exceed two-thirds of the floor area of the room.
2. The aggregate area of *mezzanines* in buildings and structures of Type I or II construction shall not exceed one-half of the floor area of the room in buildings and structures equipped throughout with an *approved automatic sprinkler system* in accordance with NFPA 13 and an *approved* emergency voice/alarm communication system.

4.1.2.6.3 (IBC 505.3) Egress. Each occupant of a *mezzanine* shall have access to at least two independent *means of egress* where the *common path of egress travel* exceeds the limitations of Section 6.1.2.2.13 (IBC Section 1014.3). Where a *stairway* provides a means of *exit access* from a *mezzanine*, the maximum travel distance includes the distance traveled on the *stairway* measured in the plane of the tread nosing. *Accessible means of egress* shall be provided in accordance with Section 6.1.2.2.2 (IBC Section 1007).

Exception: A single *means of egress* shall be permitted in accordance with Section 6.1.2.8.1 (IBC Section 1015.1).

4.1.2.6.4 (IBC 505.4) Openness. A *mezzanine* shall be open and unobstructed to the room in which such *mezzanine* is located except for walls not more than 1.05 m high, columns and posts.

USE AND OCCUPANCY CONSIDERATIONS

Exceptions:

1. *Mezzanines* or portions thereof are not required to be open to the room in which the *mezzanines* are located, provided that the *occupant load* of the aggregate area of the enclosed space does not exceed 10.
2. A *mezzanine* having two or more *means of egress* is not required to be open to the room in which the *mezzanine* is located if at least one of the *means of egress* provides direct access to an exit from the *mezzanine* level.
3. *Mezzanines* or portions thereof are not required to be open to the room in which the *mezzanines* are located, provided that the aggregate floor area of the enclosed space does not exceed 10% of the *mezzanine* area.
5. In occupancies that are no more than two *stories* above *grade plane* and equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13, a *mezzanine* having two or more *means of egress* shall not be required to be open to the room in which the *mezzanine* is located.

SECTION 4.1.2.7 (IBC 508) MIXED USE AND OCCUPANCY

4.1.2.7.1 (IBC 508.1) General. Each portion of a building shall be individually classified in accordance with Section 4.1.2.1.1 (IBC Section 302.1). Where a building contains more than one occupancy group, the building or portion thereof shall comply with the applicable provisions of Section 4.1.2.7.2, 4.1.2.7.3 or 4.1.2.7.4 (IBC Sections 508.2, 508.3 or 508.4), or a combination of these sections.

Exception:

1. Reserved.
2. Reserved.
3. Uses within live/work units, complying with IBC Section 419, are not considered separate occupancies.

4.1.2.7.2 (IBC 508.2) Accessory occupancies. Accessory occupancies are those occupancies that are ancillary to the main occupancy of the building or portion thereof. Accessory occupancies shall comply with the provisions of Sections 4.1.2.7.2.1 through 4.1.2.7.2.4.3 (IBC Sections 508.2.1 through 508.2.5.3).

4.1.2.7.2.1 (IBC 508.2.1) Area limitations. Aggregate accessory occupancies shall not occupy more than 10% of the *building area* of the *story* in which they are located and shall not exceed the tabular values in Table 4.1.2.5 (IBC Table 503), without *building area* increases in accordance with IBC Section 506 for such accessory occupancies.

TABLE 4.1.2.5 (IBC TABLE 503)
ALLOWABLE BUILDING HEIGHTS AND AREAS^a

Building height limitations shown in meters above grade plane. Story limitations shown as stories above grade plane.
Building area limitations shown in square meters, as determined by the definition of "Area, building," per story

GROUP		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT(m)	UL	49	20	17	20	17	20	15	12
		STORIES(S)								
		AREA (A)								
A-3	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
B	S	UL	11	5	3	5	3	5	3	2
	A	UL	UL	3,500	2,150	2,650	1,750	3,350	1,650	835.0
U ^b	S	UL	5	4	2	3	2	4	2	1
	A	UL	35,500	19,000	8,500	14,000	8,500	18,000	9,000	5,500

A = building area per story, S = stories above grade plane, UL = Unlimited, NP = Not permitted.

a. See the following sections for general exceptions to Table 4.1.2.5 (IBC Table 503):

1. IBC Section 504.2, Allowable building height and story increase due to automatic sprinkler system installation.
2. IBC Section 506.2, Allowable building area increase due to street frontage.
3. IBC Section 506.3, Allowable building area increase due to automatic sprinkler system installation.
4. IBC Section 507, Unlimited area buildings.

b. Private garages and carports shall be limited to 93 square meters and one story, except where no repair work is conducted or fuel is dispensed, such garages are limited to 280 square meters where the exterior wall and opening protection for the Group U portion of the building are as required for the major occupancy of the building.

4.1.2.7.2.2 (IBC 508.2.2) Occupancy classification. Accessory occupancies shall be individually classified in accordance with Section 4.1.2.1.1 (IBC Section 302.1). The requirements of these guidelines shall apply to each portion of the building based on the occupancy classification of that space.

4.1.2.7.2.3 (IBC 508.2.4) Separation of occupancies. No separation is required between accessory occupancies and the main occupancy.

Exception:

1. Reserved.
2. Incidental accessory occupancies required to be separated or protected by Section 4.1.2.7.2.4 (IBC Section 508.2.5).
3. Reserved.

4.1.2.7.2.4 (IBC 508.2.5) Separation of incidental accessory occupancies. The incidental accessory occupancies listed in Table 4.1.2.7.2.4 (Table 508.2.5) shall be separated from the remainder of the building or equipped with an automatic fire-extinguishing system, or both, in accordance with Table 4.1.2.7.2.4 (IBC Table 508.2.5).

4.1.2.7.2.4.1 (IBC 508.2.5.1) Fire-resistance-rated separation. Where Table 4.1.2.7.2.4 (IBC 508.2.5) specifies a fire-resistance-rated separation, the incidental accessory occupancies shall be separated from the remainder of the *building* by a *fire barrier* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or a *horizontal assembly* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. Construction supporting 1-hour fire-resistance-rated *fire barriers* or *horizontal assemblies* used for incidental accessory occupancy separations in buildings of Type IIB, IIIB and VB construction are not required to be fire-resistance rated unless required by other sections of these guidelines.

**TABLE 4.1.2.7.2.4 (IBC TABLE 508.2.5)
INCIDENTAL ACCESSORY OCCUPANCIES**

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 115.0 kW input	1 hour or provide automatic fire-extinguishing system
Rooms with boilers where the largest piece of equipment is over 105 kPa and 7.4 kW	1 hour or provide automatic fire-extinguishing system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen cutoff rooms, not classified as Group H	1 hour in Group B and U occupancies; 2 hours in Group A occupancies.
Incinerator rooms	2 hours and automatic sprinkler system
Paint shops, not classified as Group H, located in occupancies other than Group F	2 hours; or 1 hour and provide automatic fire-extinguishing system
Laundry rooms over 9.30 m ²	1 hour or provide automatic fire-extinguishing system
Waste and linen collection rooms over 9.30 m ²	1 hour or provide automatic fire-extinguishing system
Stationary storage battery systems having a liquid electrolyte capacity of more than 190.0 L, or a lithium-ion capacity of 455.0 kg used for facility standby power, emergency power or uninterrupted power supplies	1 hour in Group B and U occupancies; 2 hours in Group A occupancies.
Rooms containing fire pumps in nonhigh-rise buildings	2 hours; or 1 hour and provide automatic sprinkler system throughout the building
Rooms containing fire pumps in high-rise buildings	2 hours

4.1.2.7.2.4.2 (IBC 508.2.5.2) Nonfire-resistance-rated separation and protection. Where Table 4.1.2.7.2.4 (IBC Table 508.2.5) permits an automatic fire-extinguishing system without a *fire barrier*, the incidental accessory occupancies shall be separated from the remainder of the building by construction capable of resisting the passage of smoke. The walls shall extend from the top of the foundation or floor assembly below to the underside of the ceiling that is a component of a fire-resistance-rated floor assembly or roof assembly above or to the underside of the floor or roof

USE AND OCCUPANCY CONSIDERATIONS

sheathing, deck or slab above. Doors shall be self- or automatic closing upon detection of smoke in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3). Doors shall not have air transfer openings and shall not be undercut in excess of the clearance permitted in accordance with NFPA 80. Walls surrounding the incidental accessory occupancy shall not have air transfer openings unless provided with smoke dampers in accordance with Section 5.2.2.8.7 (IBC Section 711.7).

4.1.2.7.2.4.3 (IBC 508.2.5.3) Protection. Except as specified in Table 4.1.2.7.2.4 (IBC Table 508.2.5) for certain incidental accessory occupancies, where an automatic fire-extinguishing system or an *automatic sprinkler system* is provided in accordance with Table 4.1.2.7.2.4 (IBC Table 508.2.5), only the space occupied by the incidental accessory occupancy need be equipped with such a system.

4.1.2.7.3 (IBC 508.3) Nonseparated occupancies. Buildings or portions of buildings that comply with the provisions of this section shall be considered as nonseparated occupancies.

4.1.2.7.3.1 (IBC 508.3.1) Occupancy classification. Nonseparated occupancies shall be individually classified in accordance with Section 4.1.2.1.1 (IBC Section 302.1). The requirements of these guidelines shall apply to each portion of the building based on the occupancy classification of that space except that the most restrictive applicable provisions of Section 4.2.2.1 (IBC Section 403) and IBC Chapter 9 shall apply to the building or portion thereof in which the nonseparated occupancies are located.

4.1.2.7.3.2 (IBC 508.3.2) Allowable building area and height. The allowable *building area and height* of the building or portion thereof shall be based on the most restrictive allowances for the occupancy groups under consideration for the type of construction of the building in accordance with Section 4.1.2.5.1 (IBC Section 503.1) and Section 4.1.2.5.1.1 (IBC 503.1.2).

4.1.2.7.3.3 (IBC 508.3.3) Separation. No separation is required between nonseparated occupancies.

4.1.2.7.4 (IBC 508.4) Separated occupancies. Buildings or portions of buildings that comply with the provisions of this section shall be considered as separated occupancies.

4.1.2.7.4.1 (IBC 508.4.1) Occupancy classification. Separated occupancies shall be individually classified in accordance with Section 4.1.2.1.1 (IBC Section 302.1). Each separated space shall comply with these guidelines based on the occupancy classification of that portion of the building.

4.1.2.7.4.2 (IBC 508.4.4) Separation. Individual occupancies shall be separated from adjacent occupancies in accordance with Table 4.1.2.7.4 (IBC Table 508.4.)

**TABLE 4.1.2.7.4 (IBC TABLE 508.4)
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)**

OCCUPANCY	A ^d , E		I-1, I-3, I-4		I-2		R		F-2, S-2 ^b , U		B, F-1, M, S-1		H-1		H-2		H-3, H-4, H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A ^d , E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3 ^a
I-1, I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP
R	—	—	—	—	—	—	N	N	1 ^c	2 ^c	1	2	NP	NP	3	NP	2	NP
F-2, S-2 ^b , U	—	—	—	—	—	—	—	—	N	N	1	2	NP	NP	3	4	2	3 ^a
B, F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2 ^a
H-1	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP
H-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP
H-3, H-4, H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 ^{e,f}	NP

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13.

NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13.

N = No separation requirement.

NP = Not permitted.

TABLE 4.1.2.7.4 (IBCTABLE 508.4)—continued
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)

- a. Reserved.
- b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but to not less than 1 hour.
- c. See IBC Section 406.1.4.
- d. Commercial kitchens need not be separated from the restaurant seating areas that they serve.
- e. Separation is not required between occupancies of the same classification.
- f. Reserved.

4.1.2.7.4.2.1 (IBC 508.4.4.1) Construction. Required separations shall be fire barriers constructed in accordance with Section 5.2.2.4 (IBC Section 707) or horizontal assemblies constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both, so as to completely separate adjacent occupancies.

SECTION 4.1.2.8 (IBC 509) SPECIAL PROVISIONS

4.1.2.8.1 (IBC 509.2) Horizontal building separation allowance. A building shall be considered as separate and distinct building for the purpose of determining area limitations, continuity of *fire walls*, limitation of number of *stories* and type of construction where all of the following conditions are met:

1. The buildings are separated with a *horizontal assembly* having a minimum 3-hour *fire-resistance rating*.
2. The building below the *horizontal assembly* is no more than one *story above grade plane*.
3. The building below the *horizontal assembly* is of Type IA construction.
4. Shaft, *stairway*, ramp and escalator enclosures through the *horizontal assembly* shall have not less than a 2-hour *fire-resistance rating* with opening protectives in accordance with Section 5.2.2.12.4 (IBC Section 715.4).

Exception: Where the enclosure walls below the *horizontal assembly* have not less than a 3-hour *fire-resistance rating* with opening protectives in accordance with Section 5.2.2.12.4 (IBC Section 715.4), the enclosure walls extending above the *horizontal assembly* shall be permitted to have a 1-hour *fire-resistance rating*, provided:

1. The building above the horizontal assembly is not required to be of Type I construction;
2. The enclosure connects less than four stories; and
3. The enclosure opening protectives above the horizontal assembly have a minimum 1-hour fire protection rating.
5. The building or buildings above the horizontal assembly shall be permitted to have multiple Group A occupancy uses, each with an occupant load of less than 300, or Group B occupancies.
6. The building below the horizontal assembly shall be protected throughout by an approved automatic sprinkler system in accordance with NFPA 13, and shall be permitted to be any of the following occupancies:
 - 6.2. Multiple Group A, each with an *occupant load* of less than 300;
 - 6.3. Group B;
 - 6.6. Uses incidental to the operation of the building (including entry lobbies, mechanical rooms, storage areas and similar uses).

USE AND OCCUPANCY CONSIDERATIONS

4.1.3 ALTERNATE MEANS OF VERIFICATION

- 4.1.3.1 Chapters 3 and 4 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for Use and Occupancy Considerations can be demonstrated by compliance with Chapters 3 and 4 of the 2009 IBC.

4.2 SPECIAL USE CONSIDERATIONS

4.2.0 OVERVIEW AND KEY CONCEPTS

Office buildings are generally considered low risk occupancies due to their typical building protection features and typical occupant characteristics. They can, however, have special features or attributes which present factors that may warrant additional consideration. These may be building features, such as the presence of an atrium, the fact that the building has a very large area or is very tall, or has significant portions of the building designated by other uses (mixed-use occupancy), or has an underground or attached garage. In some cases, there may be security or extreme event concerns associated with the location of the building or the building tenants.

Given that the scope of the guidelines is limited to areas, low-rise to mid-rise office buildings, the considerations in this chapter are noted primarily for awareness reasons. Security requirements are addressed by the United Nations Department of Safety and Security (UNDSS).

Atria Considerations

In many mid- and high-rise buildings, atria are used to help provide a more open interior environment between floors, often with façade or roof features which allow natural lighting into the building. In general terms, an atrium is a vertical space within a building (other than a shaft used solely for exit stairs, elevators, escalators and building mechanical and electrical services), openly connecting two or more stories¹, which is enclosed at the top by a floor or roof assembly. In some cases, atria may open to connecting stories, but often require some sort of fire or smoke barrier or smoke control system, a complete automatic fire sprinkler system installed throughout the building, or some combination of these features. Requirements vary widely by country, and often fire engineering analysis is used to help determine appropriate fire and smoke control performance based on the specific building design (fire and smoke control are discussed in Chapter 5).

Basement Garages/Underground Structures

For larger office buildings, there may be instances where underground components exist, not only in terms of basement spaces for storage, utilities and similar accessory uses, but in terms of car parks or as part of mixed-use occupancies including retail spaces, transit stations and other occupancies. As with the high-rise challenges discussed above, there may be concerns over and above those for “typical” office buildings, including physical protection and resilience to natural, technological and deliberate events, fire protection and emergency egress.

Much like the high-rise discussion above, the types of additional measures that may be recommended or required for underground garages and facilities will vary by building system and functional objective. The structural system has to be able to support the mass of the structure, withstanding expected natural, technological and deliberate event loads. If extreme fires could be expected, more emphasis may need to be placed on fire containment and automatic suppression, especially given the challenges associated with manual firefighting operations in spaces with limited access. Smoke control measures need to consider wind and weather effects, location relative to air intakes for upper portions of the building and related factors.

¹ In some countries, the opening is defined as connecting three or more stories.

SPECIAL USE CONSIDERATIONS

Extreme Events Considerations

While these guidelines have been developed to address basic performance requirements for office buildings of a particular size, consideration may be warranted for extreme events. By definition, these are events which are not typically considered to impact buildings, but if they occur, could result in extreme loading and other challenges on the building. The types of events typically falling into this category include extreme seismic, wind, water or snow loads, deliberate events (arson, terrorist attack), and combination events (e.g., post-earthquake fire). Consideration of such events is beyond the scope of these guidelines. However, should such events be of concern, appropriate threat, vulnerability and risk assessment, along with appropriate mitigation analysis, should be considered.

Summary

Key building use considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 4.2.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Building height	Structural, mechanical, electrical and plumbing (MEP), fire protection, security, exit and access systems	May require additional fire protection systems; may need engineered analysis.
Atria	Fire and smoke control, suppression system	May require additional fire protection systems; may need engineered analysis.
Underground features	Structural, MEP, fire protection, security, exit and access systems	May require additional fire protection systems; may need engineered analysis.
Extreme events	All safety systems	Should be based on threat, vulnerability and risk assessment (TVRA).

4.2.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

UN-occupied buildings must comply with the following functional objectives and performance requirements as appropriate to the presence of the feature or aspect in the building. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 4.2.2. A list of alternate means of verification is provided in Section 4.2.3.

- 4.2.1.1 The security requirements for the building shall be determined as a result of the UNDSS assessment.
- 4.2.1.2 In buildings more than 22 meters in height above the lowest fire department vehicle access, appropriate consideration shall be given to the loads imposed on and by the structure and the associated impacts on building systems performance, and due consideration shall be given to fire and life safety challenges associated with the nature of emergency evacuation and firefighting operations in tall buildings.
- 4.2.1.3 In buildings in which an atrium is present, the function and performance of the fire and life safety systems shall appropriately account for the challenges presented by the inter-story opening presented by the atrium.
- 4.2.1.4 In buildings with occupied underground spaces, appropriate consideration shall be given to the loads imposed on and by the structure and the associated impacts on building systems performance, and due consideration shall be given to fire and life safety challenges associated with the nature of emergency evacuation and firefighting operations in underground buildings.
- 4.2.1.5 In assessing the hazard-related risks to users of UN-occupied buildings and structures, for special considerations as outlined above, shall, at a minimum, consider:
 - 4.2.1.5.1 The nature of the hazard, whether it is likely to originate internal or external to the structure, and how it may impact the occupants, structure, contents and mission.
 - 4.2.1.5.2 The number of persons normally occupying, visiting, employed in or otherwise using the building, structure or portion of the building or structure of concern.
 - 4.2.1.5.3 The time of day and length of time the building is normally occupied.
 - 4.2.1.5.4 Whether people are normally expected to sleep in any portion of the building or structure.
 - 4.2.1.5.5 Whether the building occupants and other users can be considered to be familiar with the building layout and exit system.
 - 4.2.1.5.6 Whether a significant percentage of building occupants, visitors, employees or other users are, or are expected to be, members of vulnerable population groups such as infants, young children, elderly persons, persons with temporary or permanent physical disabilities, persons with mental disabilities, or persons with other conditions or impairments which could affect their ability to understand and respond to signals of emergency situations, make decisions, egress or otherwise protect themselves without the physical assistance of others.
 - 4.2.1.5.7 Whether a significant percentage of building occupants and other users have familial or dependent relationships.

4.2.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

(Note: Certain provisions of the IBC for high-rise buildings have been excerpted and provided for possible application to those existing or future office spaces that might be leased in high-rise buildings)

SECTION 4.2.2.1 (IBC 403) HIGH-RISE BUILDING

4.2.2.1.1 (IBC 403.2) Construction. The construction of high-rise buildings shall comply with the provisions of Sections 4.2.2.1.1.1 through 4.2.2.1.1.3 (IBC Sections 403.2.1 through 403.2.4).

4.2.2.1.1.1 (IBC 403.2.1) Reduction in fire-resistance rating. The *fire-resistance-rating* reductions listed in Sections 4.2.2.1.1.1.1 and 4.2.2.1.1.1.2 (IBC Sections 403.2.1.1 and 403.2.1.2) shall be allowed in buildings that have sprinkler control valves equipped with supervisory initiating devices and water-flow initiating devices for each floor.

4.2.2.1.1.1.1 (IBC 403.2.1.1) Type of construction. The following reductions in the minimum *fire-resistance rating* of the building elements in Table 5.1.2.1.1(1) (IBC Table 601) shall be permitted as follows:

1. For buildings not greater than 130 m in *building height*, the *fire-resistance rating* of the building elements in Type IA construction shall be permitted to be reduced to the minimum *fire-resistance ratings* for the building elements in Type IB.

Exception: The *fire-resistance rating* of the building elements in Type IB construction shall be permitted to be reduced to the *fire-resistance ratings* in Type IIA.

2. Reserved.
3. The *building height* and *building area* limitations of a building containing building elements with reduced *fire-resistance ratings* shall be permitted to be the same as the building without such reductions.

4.2.2.1.1.1.2 (IBC 403.2.1.2) Shaft enclosures. For buildings not greater than 130 m in *building height*, the required *fire-resistance rating* of the *fire barriers* enclosing vertical shafts, other than *exit enclosures* and elevator hoistway enclosures, is permitted to be reduced to 1 hour where automatic sprinklers are installed within the shafts at the top and at alternate floor levels.

4.2.2.1.1.2 (IBC 403.2.3) Structural integrity of exit enclosures and elevator hoistway enclosures. For high-rise buildings of occupancy category III or IV in accordance with IBC Section 1604.5, and for all buildings that are more than 130 m in *building height*, *exit enclosures* and elevator hoistway enclosures shall comply with IBC Section 403.2.3.1 and Sections 4.2.2.1.1.2.1 through 4.2.2.1.1.2.3 (IBC Sections 403.2.3.2 through 403.2.3.4).

4.2.2.1.1.2.1 (IBC 403.2.3.2) Wall assembly materials. The face of the wall assemblies making up the *exit enclosures* and elevator hoistway enclosures that are not exposed to the interior of the *exit enclosure* or elevator hoistway enclosure shall be constructed in accordance with one of the following methods:

1. The wall assembly shall incorporate not less than two layers of impact-resistant construction board each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.
2. The wall assembly shall incorporate not less than one layer of impact-resistant construction material that meets or exceeds Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C 1629/C 1629M.
3. The wall assembly incorporates multiple layers of any material, tested in tandem, that meet or exceed Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C 1629/C 1629M.

4.2.2.1.1.2.2 (IBC 403.2.3.3) Concrete and masonry walls. Concrete or masonry walls shall be deemed to satisfy the requirements of IBC Section 403.2.3.1 and from this guideline, Section 4.2.2.1.1.2.1 (IBC Section 403.2.3.2).

4.2.2.1.1.2.3 (IBC 403.2.3.4) Other wall assemblies. Any other wall assembly that provides impact resistance equivalent to that required by IBC Section 403.2.3.1 and from this guideline, Section 4.2.2.1.1.2.1 (IBC Section 403.2.3.2) for Hard Body Impact Classification Level 3, as measured by the test method described in ASTM C 1629/C 1629M, shall be permitted.

4.2.2.1.1.3 (IBC 403.2.4) Sprayed fire-resistant materials (SFRM). The bond strength of the SFRM installed throughout the building shall be in accordance with Table 4.2.2.1.1.3 (IBC Table 403.2.4).

**TABLE 4.2.2.1.1.3 (IBC TABLE 403.2.4)
MINIMUM BOND STRENGTH**

HEIGHT OF BUILDING ^a	SFRM MINIMUM BOND STRENGTH
Up to 130 m	20.5 kPa
Greater than 130 m	48.0 kPa

a. Above the lowest level of fire department vehicle access.

4.2.2.1.2 (IBC 403.3) Automatic sprinkler system. Buildings and structures shall be equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13 and a secondary water supply where required by IBC Section 903.3.5.2. (Note: IBC Section 903.3.5.2 not reproduced in this guideline is related to high seismic risk areas)

4.2.2.1.2.1 (IBC 403.3.1) Number of sprinkler risers and system design. Each sprinkler system zone in buildings that are more than 130 m in *building height* shall be supplied by a minimum of two risers. Each riser shall supply sprinklers on alternate floors. If more than two risers are provided for a zone, sprinklers on adjacent floors shall not be supplied from the same riser.

4.2.2.1.2.1.1 (IBC [F] 403.3.1.1) Riser location. Sprinkler risers shall be placed in *exit enclosures* that are remotely located in accordance with Section 6.1.2.8.2.2 (IBC Section 1015.2).

4.2.2.1.2.2 (IBC 403.3.2) Water supply to required fire pumps. Required fire pumps shall be supplied by connections to a minimum of two water mains located in different streets. Separate supply piping shall be provided between each connection to the water main and the pumps. Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

Exception: Two connections to the same main shall be permitted provided the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through at least one of the connections.

4.2.2.1.3 (IBC 403.4) Emergency systems. The detection, alarm and emergency systems of high-rise buildings shall comply with Sections 4.2.2.1.3.1 through 4.2.2.1.3.8 (IBC Sections 403.4.1 through 403.4.8).

4.2.2.1.3.1 (IBC 403.4.1) Smoke detection. Smoke detection shall be provided in accordance with Section 5.4.2.6.3.1 (IBC Section 907.2.13.1).

4.2.2.1.3.2 (IBC 403.4.2) Fire alarm systems. A fire alarm system shall be provided in accordance with Section 5.4.2.6.3 (IBC Section 907.2.13).

4.2.2.1.3.3 (IBC 403.4.3) Emergency voice/alarm communication system. An emergency voice/alarm communication system shall be provided in accordance with Section 5.4.2.6.5.2.2 (IBC Section 907.5.2.2).

4.2.2.1.3.4 (IBC 403.4.4) Emergency responder radio coverage. Emergency responder radio coverage shall be provided in accordance with Section 510 of the *International Fire Code*.

4.2.2.1.3.5 (IBC 403.4.5) Fire command. A fire command center complying with IBC Section 911 shall be provided in a location *approved* by the fire department.

SPECIAL USE CONSIDERATIONS

4.2.2.1.3.6 (IBC 403.4.6) Smoke removal. To facilitate smoke removal in post-fire salvage and overhaul operations, buildings and structures shall be equipped with natural or mechanical ventilation for removal of products of combustion in accordance with one of the following:

1. Easily identifiable, manually operable windows or panels shall be distributed around the perimeter of each floor at not more than 15 m intervals. The area of operable windows or panels shall not be less than 3.70 m² per 15 m of perimeter.

Exception: Windows shall be permitted to be fixed provided that glazing can be cleared by fire fighters.

2. Mechanical air-handling equipment providing one exhaust air change every 15 minutes for the area involved. Return and exhaust air shall be moved directly to the outside without recirculation to other portions of the building.
3. Any other *approved* design that will produce equivalent results.

4.2.2.1.3.7 (IBC 403.4.7) Standby power. A standby power system complying with IBC Chapter 27 shall be provided for standby power loads specified in Section 4.2.2.1.3.7.2 (IBC Section 403.4.7.2).

4.2.2.1.3.7.1 (IBC 403.4.7.1) Special requirements for standby power systems. If the standby system is a generator set inside a building, the system shall be located in a separate room enclosed with 2-hour *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. System supervision with manual start and transfer features shall be provided at the fire command center.

4.2.2.1.3.7.2 (IBC 403.4.7.2) Standby power loads. The following are classified as standby power loads:

1. Power and lighting for the fire command center required by Section 4.2.2.1.3.5 (IBC Section 403.4.5);
2. Ventilation and automatic fire detection equipment for smokeproof enclosures; and
3. Standby power shall be provided for elevators.

4.2.2.1.3.8 (IBC 403.4.8) Emergency power systems. An emergency power system complying with IBC Chapter 27 shall be provided for emergency power loads specified in Section 4.2.2.1.3.8.1 (IBC Section 403.4.8.1).

4.2.2.1.3.8.1 (IBC 403.4.8.1) Emergency power loads. The following are classified as emergency power loads:

1. Exit signs and *means of egress* illumination required by Section 6.1 (IBC Chapter 10);
2. Elevator car lighting;
3. Emergency voice/alarm communications systems;
4. Automatic fire detection systems;
5. Fire alarm systems; and
6. Electrically powered fire pumps.

4.2.2.1.4 (IBC 403.5) Means of egress and evacuation. The *means of egress* in high-rise buildings shall comply with Sections 4.2.2.1.4.1 through 4.2.2.1.4.6 (IBC Sections 403.5.1 through 403.5.6).

4.2.2.1.4.1 (IBC 403.5.1) Remoteness of exit stairway enclosures. The required *exit stairway* enclosures shall be separated by a distance not less than 9.15 m or not less than one-fourth of the length of the maximum overall diagonal dimension of the building or area to be served, whichever is less. The distance shall be measured in a straight line between the nearest points of the *exit stairway* enclosures. In buildings with three or more *exit stairway* enclosures, at least two of the *exit stairway* enclosures shall comply with this section. Interlocking or *scissor stairs* shall be counted as one *exit stairway*.

4.2.2.1.4.2 (IBC 403.5.2) Additional exit stairway. For buildings that are more than 130 m in *building height*, one additional *exit stairway* meeting the requirements of Sections 6.1.2.19 and 6.1.2.10 (IBC Sections 1009 and 1022) shall be provided in addition to the minimum number of *exits* required by Section 6.1.2.9.1 (IBC Section 1021.1). The total width of any combination of remaining *exit stairways* with one *exit stairway* removed shall not be less than the total width required by Section 6.1.2.2.9 (IBC Section 1005.1). *Scissor stairs* shall not be considered the additional *exit stairway* required by this section.

Exception: An additional *exit stairway* shall not be required to be installed in buildings having elevators used for occupant self-evacuation in accordance with IBC Section 3008.

4.2.2.1.4.3 (IBC 403.5.3) Stairway door operation. Stairway doors other than the *exit discharge* doors shall be permitted to be locked from the stairway side. Stairway doors that are locked from the stairway side shall be capable of being unlocked simultaneously without unlatching upon a signal from the fire command center.

4.2.2.1.4.3.1 (IBC 403.5.3.1) Stairway communication system. A telephone or other two-way communications system connected to an *approved* constantly attended station shall be provided at not less than every fifth floor in each *stairway* where the doors to the *stairway* are locked.

4.2.2.1.4.4 (IBC 403.5.4) Smokeproof exit enclosures. Every required level *exit stairway* serving floors more than 23 m above the lowest level of fire department vehicle access shall comply with IBC Sections 909.20 and 1022.9.

4.2.2.1.4.5 (IBC 403.5.5) Luminous egress path markings. Luminous egress path markings shall be provided in accordance with Section 6.1.2.12 (IBC Section 1024).

4.2.2.1.4.6 (IBC 403.5.6) Emergency escape and rescue. Emergency escape and rescue openings required by IBC Section 1029 are not required.

4.2.2.1.5 (IBC 403.6) Elevators. Elevator installation and operation in high-rise buildings shall comply with IBC Chapter 30 and Section 4.2.2.1.5.1 (IBC Section 403.6.1) and IBC Section 403.6.2.

4.2.2.1.5.1 (IBC 403.6.1) Fire service access elevator. In buildings with an occupied floor more than 36.50 m above the lowest level of fire department vehicle access, a minimum of one fire service access elevator shall be provided in accordance with IBC Section 3007.

SECTION 4.2.2.2 (IBC 404) ATRIUMS

4.2.2.2.1 (IBC 404.3) Automatic sprinkler protection. An *approved automatic sprinkler system* shall be installed throughout the entire building.

Exceptions:

1. That area of a building adjacent to or above the atrium need not be sprinklered provided that portion of the building is separated from the atrium portion by not less than 2-hour fire barriers constructed in accordance with Section 5.2.2.4 (IBC Section 707) or horizontal assemblies constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both.
2. Where the ceiling of the atrium is more than 17 m above the floor, sprinkler protection at the ceiling of the atrium is not required.

4.2.2.2.2 (IBC 404.4) Fire alarm system. A fire alarm system shall be provided in accordance with IBC Section 907.2.14.

4.2.2.2.3 (IBC 404.5) Smoke control. A smoke control system shall be installed in accordance with Section 5.4.2.7 (IBC Section 909).

Exception: Smoke control is not required for atriums that connect only two *stories*.

4.2.2.2.4 (IBC 404.6) Enclosure of atriums. Atrium spaces shall be separated from adjacent spaces by a 1-hour *fire barrier* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or a *horizontal assembly* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both.

SPECIAL USE CONSIDERATIONS

Exceptions:

1. A glass wall forming a smoke partition where automatic sprinklers are spaced 1.85 m or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and between 10 cm and 30 cm away from the glass and designed so that the entire surface of the glass is wet upon activation of the sprinkler system without obstruction. The glass shall be installed in a gasketed frame so that the framing system deflects without breaking (loading) the glass before the sprinkler system operates.
2. A glass-block wall assembly in accordance with IBC Section 2110 and having a $\frac{3}{4}$ -hour *fire protection rating*.
3. The adjacent spaces of any three *floors* of the atrium shall not be required to be separated from the atrium where such spaces are accounted for in the design of the smoke control system.

4.2.2.2.5 (IBC 404.7) Standby power. Equipment required to provide smoke control shall be connected to a standby power system in accordance with Section 5.4.2.7.1 (IBC Section 909.11).

4.2.2.2.6 (IBC 404.8) Interior finish. The *interior finish* of walls and ceilings of the atrium shall not be less than Class B with no reduction in class for sprinkler protection.

4.2.2.2.7 (IBC 404.9) Travel distance. In other than the lowest level of the atrium, where the required *means of egress* is through the atrium space, the portion of exit access travel distance within the atrium space shall not exceed 61 m. The travel distance requirements for areas of buildings open to the atrium and where access to the *exits* is not through the atrium, shall comply with the requirements of Section 6.1.2.5 (IBC Section 1016).

4.2.3 ALTERNATE MEANS OF VERIFICATION

- 4.2.3.1 Chapter 5 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for Special Use Considerations, with the exception of Security Considerations, as stated in the UNDSS assessment can be demonstrated by compliance with Chapter 5 of the 2009 IBC.

CHAPTER 5 FIRE PROTECTION

5.0 OVERVIEW AND KEY CONCEPTS

Building fire protection design is a complex process which requires a holistic view of building design, construction, operation and maintenance. At the highest levels, it should consider the interrelationships between the building, building occupants and any fire that may occur, taking into account the building construction, materials, fire protection and safety systems installed, and expected response of the local fire service.

This section of the guidelines addresses fire protection systems and features of importance to office buildings. It focuses on concepts aimed at limiting the development and spread of fire, hot gases and smoke. It does not address the prevention of fire ignitions, which other than from electrical building systems, is primarily a function of occupant rules (e.g., implementation of no smoking policies), good housekeeping (e.g., reducing the accumulation of combustible materials, not overloading electrical outlets, maintaining electrical and electronic equipment, etc.) and appropriate security measures (to address the potential for deliberate ignitions).

There are five primary concepts addressed in this chapter: contribution of building materials to the overall fire load, resistance of building elements to thermal loads from fire, restricting the spread of fire, smoke and hot gases, detecting and notifying occupants and the fire service of a fire in the building, and fire suppression. Some of these concepts overlap and some have several sub-components. Using the 2009 *International Building Code*® (IBC®) as the primary reference document, these concepts are addressed in the following sections, which generally parallel the IBC:

- 5.1 Building Construction, Materials, Height and Area Considerations
- 5.2 Passive Fire Protection Systems and Features
- 5.3 Interior Finish Concerns
- 5.4 Active Systems and Features
- 5.5 Exterior Wall and Roof Assembly Considerations

Section 5.1 focuses on the fire resistance requirements for the structural frame, especially load bearing elements, and issues associated with allowable heights and areas given the materials used for construction.

Section 5.2 is primarily focused on limiting the spread of fire and smoke within a building through building construction and other passive features (e.g., walls, floors and ceilings).

Section 5.3 discusses the contribution of interior finish material (e.g., wall covering, floor covering) to the overall fire load and the need to control the fire load within the exit system.

Section 5.4 addresses the wide range of active fire protection systems, including fire and smoke detection, alarm and communication systems, automatic and manual fire suppression systems and features, and active smoke control (management) systems and features.

Section 5.5 addresses issues associated with the potential for fire spread into or out of a building given various aspects of exterior wall and roof assembly materials, construction and protection.

5.1 BUILDING CONSTRUCTION, MATERIALS, HEIGHT AND AREA CONSIDERATIONS

5.1.0 OVERVIEW AND KEY CONCEPTS

Buildings can be constructed using a wide range of materials, can range in floor area from a few thousand square meters to several hundred square meters in area, and vary in height from a few meters to several hundred meters. As one might expect, fire and life safety hazards and risks can vary significantly for different combinations of these factors, especially as buildings increase in size. As such, it is important to consider the relationship between construction materials (primarily structural members), building height, floor area and fire protection systems and features.

The materials used in construction—primarily the structural framing elements—play an important role with respect to response of the building to the hazard of concern and the associated risk to occupants, property and mission. With respect to fire, principal considerations include the combustibility of the framing material and associated resistance to fire, particularly when no suppression systems are installed.¹ Construction materials which are combustible, such as light timber and some heavy timber framing, are sometimes limited (by regulation) in terms of overall height and floor area. Concerns include the contribution of the framing to the fire load, the possibility for spread of fire by the structural system, and the time to reach loss of stability. By contrast, building materials which are noncombustible, such as concrete or masonry, often have no height or area limitation (by regulation), as they do not contribute to the fire load or spread flame, and are typically expected to withstand a fire for a period of time that is suitable for allowing evacuation and firefighting operations.²

It should be noted, however, that the relative importance of structural framing material (construction type³), building height and area features vary widely within building regulations (building codes) from one country to another. In some countries, there are limitations on building heights and compartment areas based on the type of construction (framing) material and use of the building, while in other countries no such limits may exist. For example, in the 2009 *International Building Code*® (IBC®) (IBC Table 601, page 89), a Type I-A building element used as part of the primary structural frame is required to have a fire resistance rating of 3 hours (180 minutes), with other building elements having other fire resistance ratings, and a Type V-B building element used as part of the primary structural frame has no required fire resistance rating (nor do other building structural elements). For an commercial office building in Table 4.1.2.5 (IBC Table 503, page 80, Business use group), there is no height limit or area limit if Type 1-A construction is used, but if Type V-B construction is used, the height is limited to 2 stories above grade and the area of the building is limited to 840 square meters. By contrast, there is no limitation on height and building area, regardless of structural framing material (construction type) in the *Building Regulations for England and Wales* and associated Approved Document B, Fire Safety (DCLG, 2007, Table 12, page 74).

¹ Construction is also important for egress, for natural hazards (e.g., earthquakes and cyclones) and for deliberate events, where damage to the structure and nonstructural systems could result in damage to the structural framing, means of egress and related building safety features. See the relevant chapters for additional discussion.

² In countries which impose height and area limitations based on structural framing material, there are often exceptions to the limits if automatic fire sprinklers are installed in the building.

³ In some countries, the term “building construction type” is used to describe the relationship between required fire resistance rating of structural members based on the combustibility and/or fire performance aspects of the material.

BUILDING CONSTRUCTION, MATERIALS, HEIGHT AND AREA CONSIDERATIONS

One of the reasons for the diversity in regulatory approaches is that, in general, the risk to life from fire in office occupancies is considered low in comparison with other building use types, as people are awake and alert, there are fewer sources of potential accidental ignition (e.g., no cooking appliances, stable utilities and electrical installations, etc.), and office buildings are often located in commercial areas, which may have better fire suppression infrastructure (e.g., water supplies, hydrants, and fire service location and capabilities). There may also be geographical variations in fuel loading and therefore expected fire intensity and duration. Given the diversity of locations in which UN offices are constructed, these factors should be considered when evaluating construction, height, area and fire protection issues and protection strategies.

With respect to the fire suppression infrastructure, in particular the fire service response, it is important to have appropriate access to the building for rescue and firefighting operations. In addition to access to the building site itself, there should be adequate access around the building to facilitate locating fire service equipment close enough for aerial apparatus (ladders, buckets, suppression, etc.) operations. It is also important to understand the limits of the apparatus, i.e., the reach they have with respect to facilitating rescue and firefighting operations. In many countries, buildings more than 5 stories above grade (generally 20-25 meters) are considered high-rise buildings, as the height is at the limit of fire department apparatus. (High-rise buildings generally have additional fire protection requirements for this reason.)

With a growing focus on “green” buildings and sustainable development and site planning, which may utilize strategies such as trees for shading, green roofs, photovoltaic panels, localized wind turbines, and other similar features, attention should be paid to maintaining appropriate means of access to the building for firefighting and rescue operations (equipment access, access of ladders or others to building, etc.). Likewise, in wild-fire prone areas, care should be taken to meet vegetation separation distances as well (i.e., the potentially competing objectives between vegetation for shading and fire risk should be considered).

In summary, key considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 5.1.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED FIRE PROTECTION	CONSEQUENCES OF DESIGN CONSIDERATIONS
Structural framing material	Variation in fire resistance provided by different materials (with or without treatment for additional fire resistance).	Potential regulatory limits on overall building height, compartment or building area, and fire resistance rating of structural elements, or need to add fire resisting treatments or fire suppression systems.
Building height	Structural fire resistance, fire suppression systems, fire service site and building access, fire suppression infrastructure.	Potential regulatory limits on fire resistance rating of structural elements, compartment or building area or need to add fire resisting treatments or fire suppression systems. Tall buildings should have reliable fire suppression water supply and utilities.
Building/compartment size	Structural fire resistance, fire suppression systems, fire service site and building access, fire suppression infrastructure.	Potential regulatory limits on fire resistance rating of structural elements, building height and/or need to add fire resisting treatments or fire suppression systems. Large buildings should have reliable fire suppression water supply and utilities.
Fuel load	Fire resistance, fire suppression systems, fire service access, fire suppression infrastructure.	Large fuel loads may drive need for increased fire resistance, more compartmentation or use of fire sprinklers, or some combination.

5.1.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Building construction, materials, height, and area aspects of all UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 5.1.2. A list of alternate means of verification is provided in Section 5.1.3.

- 5.1.1.1 The structure, and portions thereof, shall be designed and constructed in such a manner as to provide acceptable performance during construction, alteration and throughout its intended life, taking into account the expected fire load, intensity and duration that may be experienced in the building and the associated risk to life, property and operations.
- 5.1.1.2 The fire resistance rating of key structural and building elements shall be appropriate to the building height, building area, maximum compartment area, fire suppression systems installed in the building, site location and conditions, spatial relationship to adjacent buildings, fire service access, fire suppression infrastructure and reliability of utilities.
 - 5.1.1.2.1 Testing for fire resistance, flame spread, smoke generation and other parameters deemed necessary for describing and assessing the performance of installed materials, systems and assemblies shall be in accordance with appropriate internationally recognized fire test standards.
 - 5.1.1.2.2 When required to be installed, materials, systems, components and assemblies shall be designed, installed, tested, operated and maintained in accordance with internationally recognized standards.
- 5.1.1.3 Access for fire service apparatus shall be appropriate to the building height, area, expected fire load, intensity and duration, fire suppression infrastructure and fire suppression systems installed in the building.

5.1.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 International Building Code® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 5.1.2.1 (IBC 602) CONSTRUCTION CLASSIFICATION

5.1.2.1.1 (IBC 602.1) General. Buildings and structures erected or to be erected, altered or extended in height or area shall be classified in one of the five construction types defined in Sections 5.1.2.1.2 through 5.1.2.1.5 (IBC Sections 602.2 through 602.5). The building elements shall have a *fire-resistance rating* not less than that specified in Table 5.1.2.1.1(1) (IBC Table 601) and exterior walls shall have a *fire-resistance rating* not less than that specified in Table 5.1.2.1.1(2) (IBC Table 602). Where required to have a *fire-resistance rating* by Table 5.1.2.1.1(2) (IBC Table 601), building elements shall comply with the applicable provisions of IBC Section 703.2. The protection of openings, ducts and air transfer openings in building elements shall not be required unless required by other provisions of these guidelines.

5.1.2.1.1.1 (IBC 602.1.1) Minimum requirements. A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.

5.1.2.1.2 (IBC 602.2) Types I and II. Types I and II construction are those types of construction in which the building elements listed in Table 5.1.2.1.1(1) (IBC Table 601) are of noncombustible materials, except as permitted in IBC Section 603 and elsewhere in these guidelines.

(Note: IBC Section 603 not reproduced in this guideline lists combustible materials such as Millwork (doors, door frames, window sashes, and window frames), blocking such as for handrails, millwork and cabinets, and thermal and acoustical insulation, other than foam plastics, having a flame spread index of not more than 25, that are allowed to be used in Type I and II buildings.)

5.1.2.1.3 (IBC 602.3) Type III. Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by these guidelines. *Fire-retardant-treated wood* framing shall be permitted within *exterior wall* assemblies of a 2-hour rating or less.

5.1.2.1.4 (IBC 602.4) Type IV. Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section. *Fire-retardant-treated wood* framing shall be permitted within exterior wall assemblies with a 2-hour rating or less. Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued-laminated members the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 5.1.2.1.4 (IBC Table 602.4).

5.1.2.1.4.1 (IBC 602.4.1) Columns. Wood columns shall be sawn or glued laminated and shall not be less than 21 cm, nominal, in any dimension where supporting floor loads and not less than 15 cm nominal in width and not less than 21 cm nominal in depth where supporting roof and ceiling loads only. Columns shall be continuous or superimposed and connected in an *approved* manner.

5.1.2.1.4.2 (IBC 602.4.2) Floor framing. Wood beams and girders shall be of sawn or glued-laminated timber and shall be not less than 15 cm nominal in width and not less than 26 cm nominal in depth. Framed sawn or glued-laminated timber arches, which spring from the floor line and support floor loads, shall be not less than 21 cm nominal in any dimension. Framed timber trusses supporting floor loads shall have members of not less than 15 cm nominal in any dimension.

5.1.2.1.4.3 (IBC 602.4.3) Roof framing. Wood-frame or glued-laminated arches for roof construction, which spring from the floor line or from grade and do not support floor loads, shall have members not less than 15 cm nominal in width and have not less than 21 cm nominal in depth for the lower half of the

height and not less than 15 cm nominal in depth for the upper half. Framed or glued-laminated arches for roof construction that spring from the top of walls or wall abutments, framed timber trusses and other roof framing, which do not support floor loads, shall have members not less than 10 cm nominal in width and not less than 15 cm nominal in depth. Spaced members shall be permitted to be composed of two or more pieces not less than 8 cm nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 5 cm nominal in thickness secured to the underside of the members. Splice plates shall be not less than 8 cm nominal in thickness. Where protected by *approved* automatic sprinklers under the roof deck, framing members shall be not less than 8 cm nominal in width.

5.1.2.1.4.4 (IBC 602.4.4) Floors. Floors shall be without concealed spaces. Wood floors shall be of sawn or glued-laminated planks, splined or tongue-and-groove, of not less than 8 cm nominal in thickness covered with 3 cm nominal dimension tongue-and-groove flooring, laid crosswise or diagonally, or 1 cm particleboard or planks not less than 10 cm nominal in width set on edge close together and well spiked and covered with 3 cm nominal dimension flooring or 1 cm wood structural panel or 1 cm particleboard. The lumber shall be laid so that no continuous line of joints will occur except at points of support. Floors shall not extend closer than 1 cm to walls. Such 1 cm space shall be covered by a molding fastened to the wall and so arranged that it will not obstruct the swelling or shrinkage movements of the floor. Corbeling of masonry walls under the floor shall be permitted to be used in place of molding.

5.1.2.1.4.5 (IBC 602.4.5) Roofs. Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank, not less than 5 cm nominal in thickness, 3 cm-thick wood structural panel (exterior glue), or of planks not less than 8 cm nominal in width, set on edge close together and laid as required for floors. Other types of decking shall be permitted to be used if providing equivalent *fire resistance* and structural properties.

5.1.2.1.4.6 (IBC 602.4.6) Partitions. Partitions shall be of solid wood construction formed by not less than two layers of 3 cm matched boards or laminated construction 10 cm thick, or of 1-hour fire-resistance-rated construction.

5.1.2.1.4.7 (IBC 602.4.7) Exterior structural members. Where a horizontal separation of 6.10 m or more is provided, wood columns and arches conforming to heavy timber sizes shall be permitted to be used externally.

5.1.2.1.5 (IBC 602.5) Type V. Type V construction is that type of construction in which the structural elements, *exterior walls* and interior walls are of any materials permitted by these guidelines.

TABLE 5.1.2.1.1(1) (IBC TABLE 601)
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	Type I		Type II		Type III		Type IV	Type V	
	A	B	A ^d	B	A ^d	B	HT	A ^d	B
Primary structural frame ^g (see IBC Section 202)	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^{f, g}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 5.1.2.1.1(2) (IBC Table 602)								
Exterior									
Nonbearing walls and partitions									
Interior ^e	0	0	0	0	0	0	See Section 5.1.2.1.4.6 (IBC 602.4.6)	0	0
Floor construction and secondary Members (see IBC Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and secondary Members (see IBC Section 202)	1½ ^b	1 ^{b, c}	1 ^{b, c}	0 ^c	1 ^{b, c}	0	HT	1 ^{b, c}	0

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

(continued)

BUILDING CONSTRUCTION, MATERIALS, HEIGHT AND AREA CONSIDERATIONS

TABLE 5.1.2.1.1(1) (IBC TABLE 601)—continued
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

- b. Fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 6.10 m or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
- c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.
- d. An approved automatic sprinkler system in accordance with NFPA 13 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of these guidelines or used for an allowable area increase in accordance with IBC Section 506.3 or an allowable height increase in accordance with IBC Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.
- e. Not less than the fire-resistance rating required by other sections of these guidelines.
- f. Not less than the fire-resistance rating based on fire separation distance [see Table 5.1.2.1.1(2) (IBC Table 602)].
- g. Not less than the fire-resistance rating as referenced in Section 5.2.2.1.9 (IBC Section 704.10).

TABLE 5.1.2.1.1(2) (IBC TABLE 602)
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE^{a,e}

FIRE SEPARATION DISTANCE = X meters)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP A, B, U ^b
$X < 1.50^c$	All	1
$1.50 \leq X < 3.05$	IA Others	1 1
$3.50 \leq X < 9.15$	IA, IB IIB, VD Others	1 ^d 0 1 ^d
$X \geq 9.15$	All	0

- a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 5.1.2.1.1(1) (IBC Table 601).
- b. For special requirements for Group U occupancies, see IBC Section 406.1.2.
- c. See Section 5.2.2.3.1.1 (IBC Section 706.1.1) for party walls.
- d. Open parking garages complying with IBC Section 406 shall not be required to have a fire-resistance rating.
- e. The fire-resistance rating of an exterior wall is determined based upon the fire separation distance of the exterior wall and the story in which the wall is located.

TABLE 5.1.2.1.4 (IBC TABLE 602.4)
WOOD MEMBER SIZE

MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NET SIZE	
Width, (cm)	Depth, (cm)	Width, (cm)	Depth, (cm)
2	21	17	21
15	26	13	27
15	21	13	21
15	15	13	15
10	15	8	18

5.1.3 ALTERNATE MEANS OF VERIFICATION

- 5.1.3.1 Requirements related to construction type, building height and building area for business occupancies, as addressed in Chapters 5 and 6 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for construction type, materials, building heights and areas can be demonstrated by compliance with applicable sections of Chapters 5 and 6 of the 2009 IBC.

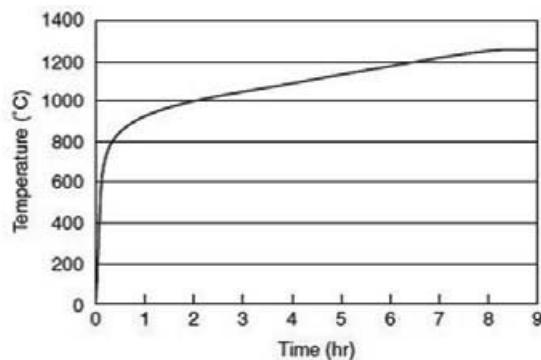
5.2 PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.2.0 OVERVIEW AND KEY CONCEPTS

Passive fire protection generally refers to those features and systems which resist the influences of, or inhibit the spread of, fire (and sometimes smoke), without the need for activation of an electrically or mechanically powered system. This includes the resistance of a material to ignition, combustion and failure due to heat or thermal radiation from a fire, and to the resistance of or the protection of an opening in wall, ceiling or floor against the spread of fire, hot gases and smoke through the opening. While there is a large range and diversity in the terms used to identify and describe passive fire protection components, they are generally focused on minimizing the potential for a fire external to a building from getting in, for a fire within a building to spread from one space to another in the building, and for a fire to spread from a building to an adjacent property.

Fire Resistance

Many building materials are required by regulation to be tested and rated on their ability to resist the increased temperatures associated with a fire for a defined period of time without failing to perform their intended function. To facilitate a common mode of reference for establishing resistance to fire, standard test methods exist which essentially result in the application of a specific time-temperature relationship to a building element, product, system or assembly, in a specially designed test furnace, and a fire resistance rating is determined based on the time at which the material “fails” under the criteria established within the test method. This is illustrated below.



Time-Temperature Curve



Column in Fire Test Furnace¹

Two widely applied test standards for fire resistance are the American Society of Testing and Materials (ASTM) Standard E 119 and the International Organization for Standardization (ISO) Standard 834. Ratings are typically provided in terms of minutes or hours, depending on the standard used (e.g., 15 minute, 30 minute, 60 minute, 90 minute, ..., or 1 hour, 2 hour, 3 hour...). The determination of what fire resistance rating is required for different building elements, products, systems or assemblies is typically defined in building regulations (codes) or associated compliance documents.²

¹ Source: Professor Venkatesh Kudor, Michigan State University

² In countries which have performance-based building regulations (codes), details such as fire resistance ratings are often not defined within the regulation. However, as a companion to the regulation, there is typically a compliance document (approved document, deemed-to-satisfy solution, etc.) of some sort which provides one or more means of complying with the regulation, and such compliance documents often provide guidance on fire resistance requirements for various building elements.

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

In general, the fire resistance rating that is required by a building regulation for a building element, product, system or assembly increases based on the relative importance of that building feature to the overall fire performance of a building [e.g., columns supporting a high-rise building (load-bearing element) will have higher fire resistance requirements than partitions which separate offices within a single space in a building (interior partition)]. This concept generally holds true as well where fire protection requirements are established based on engineering analysis rather than regulatory provisions (i.e., more important elements are required to resist temperatures longer than less important elements).

Within building regulations, fire resistance ratings are generally required for load bearing elements, such as columns, beams, trusses and joists, floor and ceiling assemblies, fire walls used to separate buildings or major building uses, and certain types/classes of interior partitions which are intended to restrict the spread of fire within or between floors (variously defined as fire compartments, fire cells and similar) and into the exit system.

Fire Spread

Fire spread is a complex phenomenon. For the purpose of these guidelines, the dominant mechanisms for the spread of fire (and increased localized and compartment temperatures) can be considered ignition of materials due to direct flame impingement and to thermal radiation. Flame impingement can be important in such situations as spread vertically up a stack of combustible items (e.g., flame from burning items on a low shelf of a bookshelf or storage rack impinges upon and ignites combustible materials above), or flame extension outside of a compartment ignites materials in an adjacent space (e.g., from one space to another within a building through an open doorway, from one floor to another via an open/broken window in an exterior wall).



Flame Impingement on Ceiling (NIST Test)³



Flame Extension of Compartment (TUD Building)⁴

Thermal radiation can result in the ignition of nearby materials in the following ways:

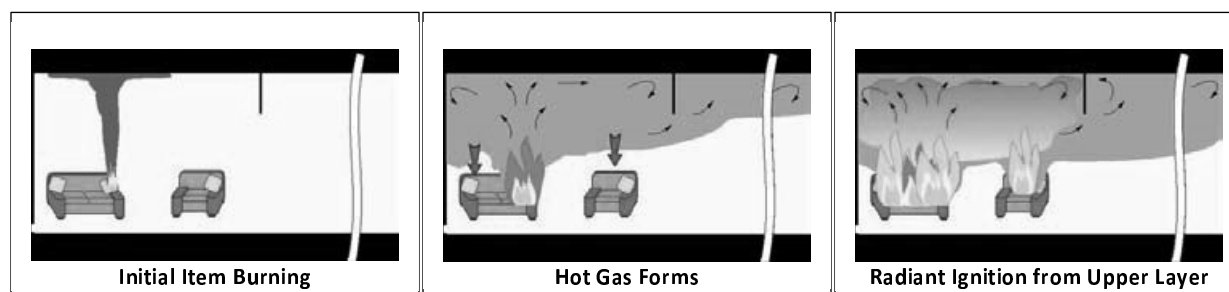
- the initiation fire (first materials burning) in a compartment creates a sufficiently high radiant heat flux to ignite a nearby item (or items),

³ Source: National Institute of Standards and Technology (NIST)
http://www.nist.gov/public_affairs/techbeat/tb2003_1219.htm

⁴ Source <http://www.flickr.com/photos/26498881@N06/3028280750/>

- the initiation fire in a compartment is sufficiently large, and the compartment is sufficiently small, such that the fire creates a sufficiently hot upper gas layer that radiates thermal energy downward to other materials in the compartment, causing them to ignite (when all secondary items in the compartment ignite at about the same time, the phenomenon is known as flashover, and the resulting condition is referred to as full room involvement),
- hot gases escaping the compartment extend into an adjacent space, ignite and result in flame extension or an extended hot upper gas layer, which ignites additional materials as per the above mechanisms.

The sequence of fire growing from the initiation fire to flashover through the creation of a hot upper gas layer and subsequent ignition of other materials in a compartment is illustrated below.



One can also use the above illustrations to imagine item-to-item radiant ignition. In this case, assume there is no ceiling, or that the ceiling is very high. In this case, the initiation fire would still likely grow to engulf the entire sofa (last illustration), at which point the energy output would likely be high enough to ignite the nearby chair. This concept also applies to radiant ignition via windows or other exterior openings (inside-to-outside and vice versa).

Given that fire spread results primarily from flame impingement or thermal radiation (from a burning item or a hot gas layer), the control of fire spread through passive features is aimed at keeping the fire and resulting hot gases contained to the compartment (room, space) of fire origin. This is accomplished by having compartment barriers that resist ignition and failure under high temperatures, and by protecting openings in compartment barriers, vertical shafts, ventilation ductwork, plenums and similar spaces so as to prohibit or limit flame extension or spread of hot gases (using measures such as heat-activated dampers, door closers, and shutters).

Smoke Spread

Much like controlling the spread of fire by containment to the compartment of origin, the aim of passive means of smoke control is to limit the ability of smoke to pass from one compartment to another by protecting openings in compartment barriers, vertical shafts, ventilation ductwork, plenums and similar spaces. While passive smoke control measures are similar to controls for the spread of hot gases, the difference is that smoke can be toxic at low temperatures, so passive smoke control measures should consider low energy fires (smoldering, sprinkler controlled) as well as larger fires. Of particular concern is the spread of smoke into the exit system and vertically throughout the building. While the use of some opening protective devices may be temperature actuated (e.g., fire doors, dampers and shutters), others may be actuated by smoke detectors (e.g., smoke dampers and door closers). As such, for a complete perspective on smoke control options, see Section 5.4, Active Fire Protection Systems and Features, for more discussion on smoke detection and mechanical smoke control components and systems.

Compartment Barriers

While the concept of using compartment barriers (compartmentation) for the control of fire and smoke spread is easy to understand, the descriptions and definitions of the various levels of compartmentation are numerous, and

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

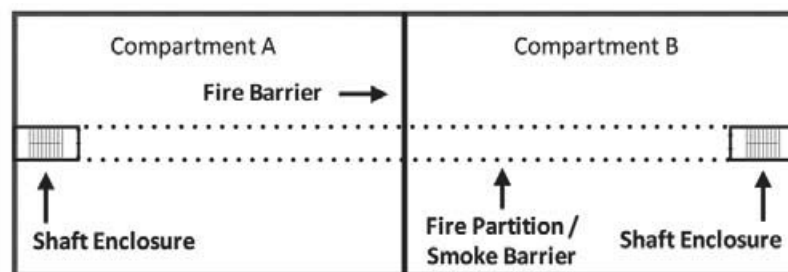
it can sometimes be difficult to understand why the differences exist. This is further complicated by the use of different terms for the same function in different countries [e.g., a fire area in the United States of America (USA) is essentially the same as a fire cell in New Zealand or a compartment in England, but the fire resistance ratings of compartment barriers, the allowable floor areas, and protection of openings all differ by country].

The following represents the range of barrier terminology as used in the 2009 *International Building Code*® (IBC®) and as reflected in Section 5.2.2. The definitions and discussion is not meant to be comprehensive, but to provide an overview of the concepts. Please refer to Section 5.2.2 and/or the IBC for more details and requirements.

Fire walls are building elements used to divide a single building into two or more buildings. Starting at the foundation and continuing vertically to or through the roof, a fire wall is intended to fully restrict the spread of fire from one side of the wall to the other (as illustrated in the plan view below). Fire walls are higher level fire-resistance-rated building elements than both fire barriers and fire partitions. Because the concept of fire walls is to create smaller buildings within one larger structure, it is critical that a fire wall be capable of maintaining structural stability under fire conditions. If construction on either side of a fire wall should collapse, such a failure should not cause the fire wall to collapse for the prescribed fire resistant time period of the wall. The use of one or more fire walls within a building is optional, based upon a decision by the designer.



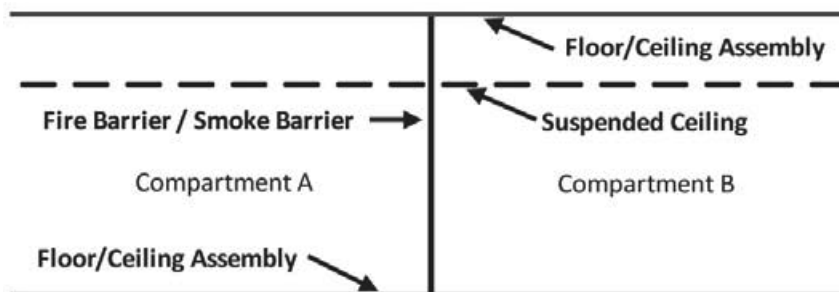
Fire barriers are fire-resistance-rated building elements which create a barrier that restricts fire spread to and from one portion of a building to another. All openings within a fire barrier should be protected with a fire-protective assembly. Fire barriers are often used to create smaller fire areas containing the same use of the building or to provide egress through a protected exit system. A common use of fire barriers is to totally isolate one portion of a floor level from another (fire compartment or fire area). This is illustrated in the floor plan below, where the fire barrier is used to separate a floor. This arrangement also serves to provide a horizontal exit, such that each compartment has two exits: stair and horizontal exit (see Section 6.1 for more details).



Shaft enclosures are intended to restrict the spread of fire, hot gases and smoke vertically within a building. Shaft enclosures are typically required to have a fire-resistance rating equivalent to the floors/ceilings through which the shaft penetrates. Exit stairways, elevator shafts, pipe chases and rubbish chutes are examples where shaft enclosure requirements would apply. The above shows a shaft enclosure around the exit stairways.

A **fire partition** is a wall or similar vertical building element that is utilized to provide fire-resistive protection under specific conditions, such as corridor walls (see above). A fire partition is considered a lower type of fire-resistance-rated assembly than a fire barrier; thus it is not permitted as an enclosure element for defining a fire area.

Smoke barriers are intended to prevent the spread of smoke from one floor or area of a floor to another. Smoke barriers should form an effective membrane continuous from outside wall to outside wall, and from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, deck or slab above, including continuity through concealed spaces, such as those found above suspended ceilings, and interstitial structural and mechanical spaces. This is illustrated in the elevation view below, where the smoke barrier (blue) is continuous from floor deck to underside of ceiling deck, even through the interstitial space above the suspended ceiling (dashed line). (Note: fire barriers need to be continuous from deck-to-deck in the same manner.) Smoke barriers typically have a 1 hour fire-resistance rating. [In the above diagram, the corridor wall (fire partition) could also serve as a smoke barrier, if properly installed and protected.]



A **smoke partition** is intended to restrict the spread of smoke from one area to another, but is not required to restrict the spread of flame and heat, and therefore has no fire-resistance rating requirement.

Penetrations and openings in the above barriers, shafts and partitions, including doors, ducts and plenums, are typically required to be sealed or protected, respectively, by materials, systems or components which match the barrier performance (in terms of fire-resistance rating, restriction of smoke passage, etc.). Concealed spaces, if breached by fire, can provide a route for the spread of fire, hot gases and smoke. Care should therefore be taken to provide barriers against the spread of fire, hot gases and smoke, and to restrict the use of combustibles (other than allowable combustible building elements), in concealed spaces.

Summary

Some key considerations are summarized in the table below. More detailed discussion on design requirements can be found in Section 5.2.2, Performance/Prescriptive Criteria and Means of Verification.

KEY CONCEPT	IMPACTED PASSIVE PROTECTION COMPONENT	CONSEQUENCES OF DESIGN CONSIDERATIONS
Fire resistance of materials	Structural frame, interior and exterior walls, doors, ceilings, floors and roofs	Overall height and area of building, size of compartments, other FP systems
Fire spread	Interior walls, exterior walls, doors, windows, opening protection	Barrier construction, opening protection, area of exterior windows, building spacing (to building or property line)
Smoke spread	Interior walls, doors, ducts, plenums	Requires contiguous barriers, may also need active systems (see Section 5.4)
Compartment barriers	Interior walls, shafts, ceilings, floors	Serve to divide buildings or spaces within a building: requirements function of fire resistance, fire and smoke spread control

5.2.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Passive fire protection systems and features in all UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 5.2.2. A list of alternate methods of verification is provided in Section 5.2.3.

5.2.1.1 Building elements shall be designed, constructed, maintained and operated in such a manner that the spread of fire and smoke into, throughout and out of a building is restricted, that appropriate structural stability is maintained, that occupants are afforded sufficient time for safe evacuation, that the fire service can undertake firefighting operations and that fire does not spread to adjacent properties.

5.2.1.1.1 The fire resistance and protection requirements for structural members shall be appropriate to the structural stability required to prevent partial or total collapse for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.2.1.1.2 The fire resistance and protection requirements for exterior walls shall be appropriate for minimizing the potential for fire spread into, along the exterior or out of a building to an adjacent property.

5.2.1.1.3 The fire resistance and protection requirements for fire walls shall be appropriate to prevent the spread of fire from one building to another or from one major building use to another building use, located at the other side of the wall within the same structure (multi-use building).

5.2.1.1.4 The fire resistance and protection requirements for fire barriers shall be appropriate to prevent the spread of fire from one fire compartment to another within a building or major building use (in multi-use building) for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.2.1.1.5 The fire resistance and protection requirements for shaft enclosures shall be appropriate to prevent the vertical spread of fire and smoke.

5.2.1.1.6 The fire resistance and protection requirements for fire partitions shall be appropriate to limit the spread of fire within a compartment for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.2.1.1.7 The smoke resistance and protection requirements for smoke barriers shall be appropriate to prevent the spread of smoke between one fire or smoke compartment and another for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.2.1.1.8 The fire resistance and protection requirements for smoke partitions shall be appropriate to prevent the spread of smoke between spaces within a smoke or fire compartment for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

- 5.2.1.1.9 The fire resistance and protection requirements for horizontal assemblies, which serve as barriers between spaces in a fire compartment, shall be appropriate to the fire hazard risk to life and time required to limit the spread of fire for a suitable amount of time to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.
 - 5.2.1.1.10 The fire resistance and protection requirements for penetrations, which are openings in rated wall or ceiling assemblies which, if unsealed, could permit the spread of smoke and fire, shall be appropriate to the fire hazard, risk to life, and time required to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.
 - 5.2.1.1.11 The fire resistance and protection requirements for fire resistant joint systems, which serve to allow movement of the building without passage of smoke or fire from structurally-isolated compartment to another, shall be appropriate to the fire hazard, risk to life, and time required to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.
 - 5.2.1.1.12 The fire resistance and protection requirements for opening protectives, which serve to limit the spread of smoke or fire through necessary openings in wall partitions, barriers or enclosures or ceilings, shall be appropriate to the fire hazard, risk to life, and time required to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.
 - 5.2.1.1.13 Testing for fire resistance, flame spread, smoke generation, and other parameters deemed necessary for describing and assessing the performance of installed materials, systems and assemblies shall be in accordance with appropriate internationally recognized fire test standards.
 - 5.2.1.1.14 When required to be installed, materials, systems, components and assemblies shall be designed, installed, tested, operated and maintained in accordance with internationally recognized standards.
- 5.2.1.2 Heating, ventilation and air-conditioning ducts and air transfer openings shall be designed and protected to limit the spread of fire, hot gases and smoke to non-fire areas of the building appropriate to the fire hazard, risk to life, and time required to allow occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.
 - 5.2.1.3 Construction in concealed spaces shall be designed and protected to inhibit the unseen, undetected, and uncontrolled spread of fire, hot gases and smoke appropriate to the fire hazard, risk to life, time required to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.2.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 5.2.2.1 (IBC 704) FIRE-RESISTANCE RATING OF STRUCTURAL MEMBERS

5.2.2.1.1 (IBC 704.2) Column protection. Where columns are required to be fire-resistance rated, the entire column shall be provided individual encasement protection by protecting it on all sides for the full column length, including connections to other structural members, with materials having the required *fire-resistance rating*. Where the column extends through a ceiling, the encasement protection shall be continuous from the top of the foundation or floor/ceiling assembly below through the ceiling space to the top of the column.

5.2.2.1.2 (IBC 704.3) Protection of the primary structural frame other than columns. Members of the primary structural frame other than columns that are required to have a *fire-resistance rating* and support more than two floors or one floor and roof, or support a *load-bearing wall* or a nonload-bearing wall more than two *stories* high, shall be provided individual encasement protection by protecting them on all sides for their full length, including connections to other structural members, with materials having the required *fire-resistance rating*.

5.2.2.1.3 (IBC 704.4) Protection of secondary members. Secondary members that are required to have a *fire-resistance rating* shall be protected by individual encasement protection, by the membrane or ceiling of a *horizontal assembly* in accordance with Section 5.2.2.9 (IBC Section 712), or by a combination of both.

5.2.2.1.3.1 (IBC 704.4.1) Light-frame construction. King studs and boundary elements that are integral elements in *load-bearing walls* of light-frame construction shall be permitted to have required *fire-resistance ratings* provided by the membrane protection provided for the *load-bearing wall*.

5.2.2.1.4 (IBC 704.5) Truss protection. The required thickness and construction of fire-resistance-rated assemblies enclosing trusses shall be based on the results of full-scale tests or combinations of tests on truss components or on *approved* calculations based on such tests that satisfactorily demonstrate that the assembly has the required *fire resistance*.

5.2.2.1.5 (IBC 704.6) Attachments to structural members. The edges of lugs, brackets, rivets and bolt heads attached to structural members shall be permitted to extend to within 2 cm of the surface of the fire protection.

5.2.2.1.6 (IBC 704.7) Reinforcing. Thickness of protection for concrete or masonry reinforcement shall be measured to the outside of the reinforcement except that stirrups and spiral reinforcement ties are permitted to project not more than 1 cm into the protection.

5.2.2.1.7 (IBC 704.8) Embedments and enclosures. Pipes, wires, conduits, ducts or other service facilities shall not be embedded in the required fire protective covering of a structural member that is required to be individually encased.

5.2.2.1.8 (IBC 704.9) Impact protection. Where the fire protective covering of a structural member is subject to impact damage from moving vehicles, the handling of merchandise or other activity, the fire protective covering shall be protected by corner guards or by a substantial jacket of metal or other noncombustible material to a height adequate to provide full protection, but not less than 2 cm from the finished floor.

Exception: Corner protection is not required on concrete columns in open or enclosed parking garages.

5.2.2.1.9 (IBC 704.10) Exterior structural members. Load-bearing structural members located within the *exterior walls* or on the outside of a building or structure shall be provided with the highest *fire-resistance rating* as determined in accordance with the following:

1. As required by Table 5.1.2.1.1(1) (IBC Table 601) for the type of building element based on the type of construction of the building;

2. As required by Table 5.1.2.1.1(1) (IBC Table 601) for exterior bearing walls based on the type of construction; and
3. As required by Table 5.1.2.1.1(1) (IBC Table 602) for *exterior walls* based on the *fire separation distance*.

5.2.2.1.10 (IBC 704.11) Bottom flange protection. Fire protection is not required at the bottom flange of lintels, shelf angles and plates, spanning not more than 1.85 m whether part of the primary structural frame or not, and from the bottom flange of lintels, shelf angles and plates not part of the primary structural frame, regardless of span.

5.2.2.1.11 (IBC 704.13) Sprayed fire-resistant materials (SFRM). Sprayed fire-resistant materials (SFRM) shall comply with Sections 5.2.2.1.11.1 through 5.2.2.1.11.5 (IBC Sections 704.13.1 through 704.13.5).

5.2.2.1.11.1 (IBC 704.13.1) Fire-resistance rating. The application of SFRM shall be consistent with the *fire-resistance rating* and the listing, including, but not limited to, minimum thickness and dry density of the applied SFRM, method of application, substrate surface conditions and the use of bonding adhesives, sealants, reinforcing or other materials.

5.2.2.1.11.2 (IBC 704.13.2) Manufacturer's installation instructions. The application of SFRM shall be in accordance with the manufacturer's installation instructions. The instructions shall include, but are not limited to, substrate temperatures and surface conditions and SFRM handling, storage, mixing, conveyance, method of application, curing and ventilation.

5.2.2.1.11.3 (IBC 704.13.3) Substrate condition. The SFRM shall be applied to a substrate in compliance with Sections 5.2.2.1.11.3.1 through 5.2.2.1.11.3.2 (IBC Sections 704.13.3.1 through 704.13.3.2).

5.2.2.1.11.3.1 (IBC 704.13.3.1) Surface conditions. Substrates to receive SFRM shall be free of dirt, oil, grease, release agents, loose scale and any other condition that prevents adhesion. The substrates shall also be free of primers, paints and encapsulants other than those fire tested and *listed* by a nationally recognized testing agency. Primed, painted or encapsulated steel shall be allowed, provided that testing has demonstrated that required adhesion is maintained.

5.2.2.1.11.3.2 (IBC 704.13.3.2) Primers, paints and encapsulants. Where the SFRM is to be applied over primers, paints or encapsulants other than those specified in the listing, the material shall be field tested in accordance with ASTM E 736. Where testing of the SFRM with primers, paints or encapsulants demonstrates that required adhesion is maintained, SFRM shall be permitted to be applied to primed, painted or encapsulated wide flange steel shapes in accordance with the following conditions:

1. The beam flange width does not exceed 30 cm; or
2. The column flange width does not exceed 40 cm; or
3. The beam or column web depth does not exceed 40 cm.
4. The average and minimum bond strength values shall be determined based on a minimum of five bond tests conducted in accordance with ASTM E 736. Bond tests conducted in accordance with ASTM E 736 shall indicate a minimum average bond strength of 80% and a minimum individual bond strength of 50%, when compared to the bond strength of the SFRM as applied to clean uncoated 3.20 mm steel plate.

5.2.2.1.11.4 (IBC 704.13.4) Temperature. A minimum ambient and substrate temperature of 4.45°C shall be maintained during and for a minimum of 24 hours after the application of the SFRM, unless the manufacturer's installation instructions allow otherwise.

5.2.2.1.11.5 (IBC 704.13.5) Finished condition. The finished condition of SFRM applied to structural members or assemblies shall not, upon complete drying or curing, exhibit cracks, voids, spalls, delamination or any exposure of the substrate. Surface irregularities of SFRM shall be deemed acceptable.

SECTION 5.2.2.2 (IBC 705) EXTERIOR WALLS

5.2.2.2.1 (IBC 705.3) Buildings on the same lot. For the purposes of determining the required wall and opening protection and roof-covering requirements, buildings on the same lot shall be assumed to have an imaginary line between them. Where a new building is to be erected on the same lot as an existing building, the location of the assumed imaginary line with relation to the existing building shall be such that the *exterior wall* and opening protection of the existing building meet the criteria as set forth in Sections 5.2.2.2.3 and 5.2.2.2.5 (IBC Sections 705.5 and 705.8).

Exception: Two or more buildings on the same lot shall either be regulated as separate buildings or shall be considered as portions of one building if the aggregate area of such buildings is within the limits specified in IBC Chapter 5 for a single building. Where the buildings contain different occupancy groups or are of different types of construction, the area shall be that allowed for the most restrictive occupancy or construction.

5.2.2.2.2 (IBC 705.4) Materials. *Exterior walls* shall be of materials permitted by the building type of construction.

5.2.2.2.3 (IBC 705.5) Fire-resistance ratings. *Exterior walls* shall be fire-resistance rated in accordance with Tables 5.1.2.1.1(1) and 5.1.2.1.1(2) (IBC Tables 601 and 602) and this section. The required *fire-resistance rating* of *exterior walls* with a *fire separation distance* of greater than 3.05 m shall be rated for exposure to fire from the inside. The required *fire-resistance rating* of *exterior walls* with a *fire separation distance* of less than or equal to 3.05 m shall be rated for exposure to fire from both sides.

5.2.2.2.4 (IBC 705.6) Structural stability. The wall shall extend to the height required by Section 5.2.2.2.8 (IBC Section 705.11) and shall have sufficient structural stability such that it will remain in place for the duration of time indicated by the required *fire-resistance rating*.

5.2.2.2.5 (IBC 705.8) Openings. Openings in *exterior walls* shall comply with Sections 5.2.2.2.5.1 through 5.2.2.2.5.6 (IBC Sections 705.8.1 through 705.8.6).

5.2.2.2.5.1 (IBC 705.8.1) Allowable area of openings. The maximum area of unprotected and protected openings permitted in an *exterior wall* in any *story* of a building shall not exceed the percentages specified in Table 5.2.2.2.5 (IBC Table 705.8).

Exceptions:

1. Unlimited unprotected openings are permitted in the first *story* above grade either:
 - 1.1. Where the wall faces a street and has a fire separation distance of more than 4.55 m;
or
 - 1.2. Where the wall faces an unoccupied space. The unoccupied space shall be on the same lot or dedicated for public use, shall not be less than 9.15 m in width and shall have access from a street by a posted fire lane accordance with the *International Fire Code*.
2. Buildings whose exterior bearing walls, exterior nonbearing walls and exterior primary structural frame are not required to be fire-resistance rated shall be permitted to have unlimited unprotected openings.

5.2.2.2.5.2 (IBC 705.8.2) Protected openings. Where openings are required to be protected, *fire doors* and fire shutters shall comply with Section 5.2.2.12.4 (IBC Section 715.4) and *fire window assemblies* shall comply with Section 5.2.2.12.5 (IBC Section 715.5).

Exception: Opening protectives are not required where the building is equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13 and the exterior openings are protected by a water curtain using automatic sprinklers *approved* for that use.

5.2.2.2.5.3 (IBC 705.8.3) Unprotected openings. Where unprotected openings are permitted, windows and doors shall be constructed of any *approved* materials. Glazing shall conform to the requirements of IBC Chapters 24 and 26.

5.2.2.2.5.4 (IBC 705.8.4) Mixed openings. Where both unprotected and protected openings are located in the *exterior wall* in any *story* of a building, the total area of openings shall be determined in accordance with the following:

$$(A_p/a_p) + (A_u/a_u) \leq 1 \quad \text{(Equation 7-2)}$$

where:

A_p = Actual area of protected openings, or the equivalent area of protected openings, A_e [see IBC Section 705.7].

a_p = Allowable area of protected openings.

A_u = Actual area of unprotected openings.

a_u = Allowable area of unprotected openings.

**TABLE 5.2.2.2.5 (IBC TABLE 705.8)
MAXIMUM AREA OF EXTERIOR WALL OPENINGS BASED ON FIRE SEPARATION DISTANCE
AND DEGREE OF OPENING PROTECTION**

FIRE SEPARATION DISTANCE (meters)	DEGREE OF OPENING PROTECTION	ALLOWABLE AREA ^a
0 to less than 0.92 ^{b, c}	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S)	Not Permitted
	Protected (P)	Not Permitted
0.92 to less than 1.50 ^{d, e}	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S)	15%
	Protected (P)	15%
1.50 to less than 3.05 ^e	Unprotected, Nonsprinklered (UP, NS)	10% ^h
	Unprotected, Sprinklered (UP, S)	25%
	Protected (P)	25%
3.05 to less than 4.55 ^e	Unprotected, Nonsprinklered (UP, NS)	15% ^h
	Unprotected, Sprinklered (UP, S)	45%
	Protected (P)	45%
4.55 to less than 6.10	Unprotected, Nonsprinklered (UP, NS)	25%
	Unprotected, Sprinklered (UP, S)	75%
	Protected (P)	75%
6.10 to less than 7.60	Unprotected, Nonsprinklered (UP, NS)	45%
	Unprotected, Sprinklered (UP, S)	No Limit
	Protected (P)	No Limit
7.60 to less than 9.2	Unprotected, Nonsprinklered (UP, NS)	70%
	Unprotected, Sprinklered (UP, S)	No Limit
	Protected (P)	No Limit
9.2 or greater	Unprotected, Nonsprinklered (UP, NS)	No Limit
	Unprotected, Sprinklered (UP, S)	Not Required
	Protected (P)	Not Required

UP, NS = Unprotected openings in buildings not equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

UP, S = Unprotected openings in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

P = Openings protected with an opening protective assembly in accordance with Section 5.2.2.2.5.2 (IBC Section 705.8.2).

a. Values indicated are the percentage of the area of the exterior wall, per story.

b. For the requirements for fire walls of buildings with differing heights, see Section 5.2.2.3.6.1 (IBC Section 706.6.1).

c. For openings in a fire wall for buildings on the same lot, see Section 5.2.2.3.7 (IBC Section 706.8).

d. Reserved.

e. Reserved.

g. The area of openings in an open parking structure with a fire separation distance of 10 feet or greater shall not be limited.

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.2.2.2.5.5 (IBC 705.8.5) Vertical separation of openings. Openings in *exterior walls* in adjacent *stories* shall be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 1.50 m of each other horizontally and the opening in the lower *story* is not a protected opening with a *fire protection rating* of not less than $\frac{3}{4}$ hour. Such openings shall be separated vertically at least 0.91 m by spandrel girders, *exterior walls* or other similar assemblies that have a *fire-resistance rating* of at least 1 hour or by flame barriers that extend horizontally at least 76 cm beyond the *exterior wall*. Flame barriers shall also have a *fire-resistance rating* of at least 1 hour. The unexposed surface temperature limitations specified in ASTM E 119 or UL 263 shall not apply to the flame barriers or vertical separation unless otherwise required by the provisions of these guidelines.

Exceptions:

1. This section shall not apply to buildings that are three *stories* or less above *grade plane*.
2. This section shall not apply to buildings equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13.
3. Open parking garages.

5.2.2.2.5.6 (IBC 705.8.6) Vertical exposure. For buildings on the same lot, opening protectives having a *fire protection rating* of not less than $\frac{3}{4}$ hour shall be provided in every opening that is less than 4.55 m vertically above the roof of an adjacent building or structure based on assuming an imaginary line between them. The opening protectives are required where the *fire separation distance* between the imaginary line and the adjacent building or structure is less than 4.55 m.

Exceptions:

1. Opening protectives are not required where the roof assembly of the adjacent building or structure has a *fire-resistance rating* of not less than 1 hour for a minimum distance of 3.05 m from the *exterior wall* facing the imaginary line and the entire length and span of the supporting elements for the fire-resistance-rated roof assembly has a *fire-resistance rating* of not less than 1 hour.
2. Buildings on the same lot and considered as portions of one building in accordance with Section 5.2.2.2.1 (IBC Section 705.3) are not required to comply with Section 5.2.2.2.5.6 (IBC Section 705.8.6).

5.2.2.2.6 (IBC 705.9) Joints. Joints made in or between *exterior walls* required by this section to have a *fire-resistance rating* shall comply with Section 5.2.2.11 (IBC Section 714).

Exception: Joints in *exterior walls* that are permitted to have unprotected openings.

5.2.2.2.6.1 (IBC 705.9.1) Voids. The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be protected in accordance with Section 5.2.2.11.4 (IBC Section 714.4).

5.2.2.2.7 (IBC 705.10) Ducts and air transfer openings. Penetrations by air ducts and air transfer openings in fire-resistance-rated *exterior walls* required to have protected openings shall comply with Section 5.2.2.13 (IBC Section 716).

Exception: Foundation vents installed in accordance with these guidelines are permitted.

5.2.2.2.8 (IBC 705.11) Parapets. Parapets shall be provided on *exterior walls* of buildings.

Exceptions: A parapet need not be provided on an *exterior wall* where any of the following conditions exist:

1. The wall is not required to be fire-resistance rated in accordance with Table 5.1.2.1.1(2) (Table 602) because of *fire separation distance*.
2. The building has an area of not more than 93 m² on any floor.

3. Walls that terminate at roofs of not less than 2-hour fire-resistance-rated construction or where the roof, including the deck or slab and supporting construction, is constructed entirely of non-combustible materials.
4. One-hour fire-resistance-rated *exterior walls* that terminate at the underside of the roof sheathing, deck or slab, provided:
 - 4.1. Where the roof/ceiling framing elements are parallel to the walls, such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction for a width of 1.20 m for Group U and 3.05 m for other occupancies, measured from the interior side of the wall.
 - 4.2. Where roof/ceiling framing elements are not parallel to the wall, the entire span of such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction.
 - 4.3. Openings in the roof shall not be located within 1.50 m of the 1-hour fire-resistance-rated *exterior wall* for Group U and 3.05 m for other occupancies, measured from the interior side of the wall.
 - 4.4. The entire building shall be provided with not less than a Class B roof covering.
5. Reserved.
6. Where the wall is permitted to have at least 25% of the *exterior wall* areas containing unprotected openings based on *fire separation distance* as determined in accordance with Section 5.2.2.2.5 (IBC Section 705.8).

5.2.2.2.8.1 (IBC 705.11.1) Parapet construction. Parapets shall have the same *fire-resistance rating* as that required for the supporting wall, and on any side adjacent to a roof surface, shall have noncombustible faces for the uppermost 46 cm, including counterflashing and coping materials. The height of the parapet shall not be less than 76 cm above the point where the roof surface and the wall intersect. Where the roof slopes toward a parapet at a slope greater than two units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a *fire separation distance* where protection of wall openings is required, but in no case shall the height be less than 76 cm.

SECTION 5.2.2.3 (IBC 706) FIRE WALLS

5.2.2.3.1 (IBC 706.1) General. Each portion of a building separated by one or more *fire walls* that comply with the provisions of this section shall be considered a separate building. The extent and location of such *fire walls* shall provide a complete separation. Where a *fire wall* also separates occupancies that are required to be separated by a *fire barrier wall*, the most restrictive requirements of each separation shall apply.

5.2.2.3.1.1 (IBC 706.1.1) Party walls. Any wall located on a *lot line* between adjacent buildings, which is used or adapted for joint service between the two buildings, shall be constructed as a *fire wall* in accordance with Section 5.2.2.3 (IBC Section 706). Party walls shall be constructed without openings and shall create separate buildings.

Exception: Openings in a party wall separating an *anchor building* and a mall shall be in accordance with IBC Section 402.7.3.1.

5.2.2.3.2 (IBC 706.2) Structural stability. *Fire walls* shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall for the duration of time indicated by the required *fire-resistance rating*.

5.2.2.3.3 (IBC 706.3) Materials. *Fire walls* shall be of any *approved* noncombustible materials.

Exception: Buildings of Type V construction.

5.2.2.3.4 (IBC 706.4) Fire-resistance rating. *Fire walls* shall have a *fire-resistance rating* of not less than that required by Table 5.2.2.3.4 (IBC Table 706.4).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

**TABLE 5.2.2.3.4 (IBC TABLE 706.4)
FIRE WALL FIRE-RESISTANCE RATINGS**

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, U	3 ^a

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.

5.2.2.3.5 (IBC 706.5) Horizontal continuity. *Fire walls* shall be continuous from *exterior wall* to *exterior wall* and shall extend at least 46 cm beyond the exterior surface of *exterior walls*.

Exceptions:

1. *Fire walls* shall be permitted to terminate at the interior surface of combustible exterior sheathing or siding provided the *exterior wall* has a *fire-resistance rating* of at least 1 hour for a horizontal distance of at least 1.20 m on both sides of the *fire wall*. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than $\frac{3}{4}$ hour.
2. *Fire walls* shall be permitted to terminate at the interior surface of noncombustible exterior sheathing, exterior siding or other noncombustible exterior finishes provided the sheathing, siding, or other exterior noncombustible finish extends a horizontal distance of at least 1.20 m on both sides of the *fire wall*.
3. *Fire walls* shall be permitted to terminate at the interior surface of noncombustible exterior sheathing where the building on each side of the *fire wall* is protected by an *automatic sprinkler system* installed in accordance with NFPA 13.

5.2.2.3.5.1 (IBC 706.5.1) Exterior walls. Where the *fire wall* intersects *exterior walls*, the *fire-resistance rating* and opening protection of the *exterior walls* shall comply with one of the following:

1. The *exterior walls* on both sides of the *fire wall* shall have a 1-hour *fire-resistance rating* with $\frac{3}{4}$ hour protection where opening protection is required by Section 5.2.2.2.5 (IBC Section 705.8). The *fire-resistance rating* of the *exterior wall* shall extend a minimum of 1.20 m on each side of the intersection of the *fire wall* to *exterior wall*. *Exterior wall* intersections at *fire walls* that form an angle equal to or greater than 180 degrees do not need *exterior wall* protection.
2. Buildings or spaces on both sides of the intersecting *fire wall* shall assume to have an imaginary *lot line* at the *fire wall* and extending beyond the exterior of the *fire wall*. The location of the assumed line in relation to the *exterior walls* and the *fire wall* shall be such that the *exterior wall* and opening protection meet the requirements set forth in Sections 5.2.2.2.3 and 5.2.2.2.5 (IBC Sections 705.5 and 705.8). Such protection is not required for *exterior walls* terminating at *fire walls* that form an angle equal to or greater than 180 degrees.

5.2.2.3.6 (IBC 706.6) Vertical continuity. *Fire walls* shall extend from the foundation to a termination point at least 76 cm above both adjacent roofs.

Exceptions:

1. Stepped buildings in accordance with Section 5.2.2.3.6.1 (IBC Section 706.6.1).
2. Two-hour fire-resistance-rated walls shall be permitted to terminate at the underside of the roof sheathing, deck or slab, provided:
 - 2.1. The lower roof assembly within 1.20 m of the wall has not less than a 1-hour *fire-resistance rating* and the entire length and span of supporting elements for the rated roof assembly has a *fire-resistance rating* of not less than 1 hour.
 - 2.2. Openings in the roof shall not be located within 1.20 m of the *fire wall*.
 - 2.3. Each building shall be provided with not less than a Class B roof covering.
3. Walls shall be permitted to terminate at the underside of noncombustible roof sheathing, deck or slabs where both buildings are provided with not less than a Class B roof covering. Openings in the roof shall not be located within 1.20 m of the *fire wall*.

4. In buildings of Type III, IV and V construction, walls shall be permitted to terminate at the underside of combustible roof sheathing or decks, provided:
 - 4.1. There are no openings in the roof within 1.20 m of the *fire wall*,
 - 4.2. The roof is covered with a minimum Class B roof covering, and
 - 4.3. The roof sheathing or deck is constructed of *fire-retardant-treated wood* for a distance of 1.20 m on both sides of the wall or the roof is protected with 16 mm Type X gypsum board directly beneath the underside of the roof sheathing or deck, supported by a minimum of 51 mm nominal ledgers attached to the sides of the roof framing members for a minimum distance of 1.20 m on both sides of the *fire wall*.
5. In buildings designed in accordance with Section 4.1.2.8.1 (IBC Section 509.2), *fire walls* located above the 3-hour *horizontal assembly* required by Section 4.1.2.8.1 (IBC Section 509.2), Item 1 shall be permitted to extend from the top of this *horizontal assembly*.

5.2.2.3.6.1 (IBC 706.6.1) Stepped buildings. Where a *fire wall* serves as an *exterior wall* for a building and separates buildings having different roof levels, such wall shall terminate at a point not less than 76 cm above the lower roof level, provided the *exterior wall* for a height of 4.55 m above the lower roof is not less than 1-hour fire-resistance-rated construction from both sides with openings protected by fire assemblies having a *fire protection rating* of not less than $\frac{3}{4}$ hour.

Exception: Where the *fire wall* terminates at the underside of the roof sheathing, deck or slab of the lower roof, provided:

1. The lower roof assembly within 3.05 m of the wall has not less than a 1-hour *fire-resistance rating* and the entire length and span of supporting elements for the rated roof assembly has a fire-resistance rating of not less than 1 hour.
2. Openings in the lower roof shall not be located within 3.05 m of the *fire wall*.

5.2.2.3.7 (IBC 706.8) Openings. Each opening through a *fire wall* shall be protected in accordance with Section 5.2.2.12.4 (IBC Section 715.4) and shall not exceed 14.50 m². The aggregate width of openings at any floor level shall not exceed 25% of the length of the wall.

Exceptions:

1. Openings are not permitted in party walls constructed in accordance with Section 5.2.2.3.1 (IBC Section 706.1.1).
2. Openings shall not be limited to 14.50 m² where both buildings are equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13.

SECTION 5.2.2.4 (IBC 707) FIRE BARRIERS

5.2.2.4.1 (IBC 707.1) General. *Fire barriers* installed as required elsewhere in these guidelines or the *International Fire Code* shall comply with this section.

5.2.2.4.2 (IBC 707.2) Materials. *Fire barriers* shall be of materials permitted by the building type of construction.

5.2.2.4.3 (IBC 707.3) Fire-resistance rating. The *fire-resistance rating* of *fire barriers* shall comply with this section.

5.2.2.4.3.1 (IBC 707.3.1) Shaft enclosures. The *fire-resistance rating* of the *fire barrier* separating building areas from a shaft shall comply with Section 5.2.2.5.4 (IBC Section 708.4).

5.2.2.4.3.2 (IBC 707.3.2) Exit enclosures. The *fire-resistance rating* of the *fire barrier* separating building areas from an *exit* shall comply with Section 6.1.2.10.1 (IBC Section 1022.1).

5.2.2.4.3.3 (IBC 707.3.3) Exit passageway. The *fire-resistance rating* of the *fire barrier* separating building areas from an *exit* passageway shall comply with Section 6.1.2.11.3 (IBC Section 1023.3).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.2.2.4.3.4 (IBC 707.3.4) Horizontal exit. The *fire-resistance rating* of the separation between building areas connected by a horizontal *exit* shall comply with Section 6.1.2.13.1 (IBC Section 1025.1).

5.2.2.4.3.5 (IBC 707.3.5) Atriums. The *fire-resistance rating* of the *fire barrier* separating atriums shall comply with Section 4.2.2.2.4 (IBC Section 404.6).

5.2.2.4.3.6 (IBC 707.3.6) Incidental accessory occupancies. The *fire barrier* separating incidental accessory occupancies from other spaces in the building shall have a *fire-resistance rating* of not less than that indicated in Table 4.1.2.7.2.4 (IBC Table 508.2.5).

5.2.2.4.3.7 (IBC 707.3.8) Separated occupancies. Where the provisions of Section 4.1.2.7.4 (IBC Section 508.4) are applicable, the *fire barrier* separating mixed occupancies shall have a *fire-resistance rating* of not less than that indicated in Table 4.1.2.7.4 (IBC Table 508.4) based on the occupancies being separated.

5.2.2.4.3.8 (IBC 707.3.9) Fire areas. The *fire barriers* or *horizontal assemblies*, or both, separating a single occupancy into different *fire areas* shall have a *fire-resistance rating* of not less than that indicated in Table 5.2.2.4.3.8 (IBC Table 707.3.9). The *fire barriers* or *horizontal assemblies*, or both, separating *fire areas* of mixed occupancies shall have a *fire-resistance rating* of not less than the highest value indicated in Table 5.2.2.4.3.8 (IBC Table 707.3.9) for the occupancies under consideration.

**TABLE 5.2.2.4.3.8 (IBC TABLE 707.3.9)
FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE BARRIER
ASSEMBLIES OR HORIZONTAL ASSEMBLIES BETWEEN FIRE AREAS**

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
A, B	2
U	1

5.2.2.4.4 (IBC 707.4) Exterior walls. Where *exterior walls* serve as a part of a required fire-resistance-rated shaft or *exit* enclosure, or separation, such walls shall comply with the requirements of Section 5.2.2.4.5 (IBC Section 705) for *exterior walls* and the fire-resistance-rated enclosure or separation requirements shall not apply.

Exception: *Exterior walls* required to be fire-resistance rated in accordance with Section 6.1.2.4 (IBC Section 1019) for exterior egress balconies, Section 6.1.2.10.6 (IBC Section 1022.6) for *exit* enclosures and Section 6.1.2.15.6 (IBC Section 1026.6) for exterior *exit* ramps and *stairways*.

5.2.2.4.5 (IBC 707.5) Continuity. Fire barriers shall extend from the top of the floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above and shall be securely attached thereto. Such *fire barriers* shall be continuous through concealed spaces, such as the space above a suspended ceiling.

5.2.2.4.5.1 (IBC 707.5.1) Supporting construction. The supporting construction for a *fire barrier* shall be protected to afford the required *fire-resistance rating* of the *fire barrier* supported. Hollow vertical spaces within a *fire barrier* shall be fireblocked at every floor level.

Exceptions:

1. The maximum required *fire-resistance rating* for assemblies supporting *fire barriers* separating tank storage as provided for in IBC Section 415.6.2.1 shall be 2 hours, but not less than required by Table 5.1.2.1.1(1) (IBC Table 601) for the building construction type.
2. Shaft enclosures shall be permitted to terminate at a top enclosure complying with Section 5.2.2.5.12 (IBC Section 708.12).
3. Supporting construction for 1-hour *fire barriers* required by Table 4.1.2.7.2.4 (IBC Table 508.2.5) in buildings of Type IIB, IIIB and VB construction is not required to be fire-resistance rated unless required by other sections of these guidelines.

5.2.2.4.6 (IBC 707.6) Openings. Openings in a *fire barrier* shall be protected in accordance with Section 5.2.2.12 (IBC Section 715). Openings shall be limited to a maximum aggregate width of 25% of the length of the wall, and the maximum area of any single opening shall not exceed 14.50 m². Openings in exit enclosures

and exit passageways shall also comply with Section 6.1.2.10.3 and 6.1.2.11.5 (IBC Sections 1022.3 and 1023.5), respectively.

Exceptions:

1. Openings shall not be limited to 14.50 m² where adjoining floor areas are equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13.
2. Openings shall not be limited to 14.50 m² or an aggregate width of 25% of the length of the wall where the opening protective is a *fire door* serving an *exit* enclosure.
3. Openings shall not be limited to 14.50 m² or an aggregate width of 25% of the length of the wall where the opening protective has been tested in accordance with ASTM E 119 or UL 263 and has a minimum *fire-resistance rating* not less than the *fire-resistance rating* of the wall.
4. Fire window assemblies permitted in atrium separation walls shall not be limited to a maximum aggregate width of 25% of the length of the wall.
5. Openings shall not be limited to 14.50 m² or an aggregate width of 25% of the length of the wall where the opening protective is a *fire door* assembly in a *fire barrier* separating an *exit* enclosure from an *exit* passageway in accordance with Section 6.1.2.10.2.1 (IBC Section 1022.2.1).

5.2.2.4.7 (IBC 707.7) Penetrations. Penetrations of *fire barriers* shall comply with Section 5.2.2.10 (IBC Section 713).

5.2.2.4.7.1 (IBC 707.7.1) Prohibited penetrations. Penetrations into an *exit* enclosure or an *exit* passageway shall be allowed only when permitted by Section 6.1.2.10.4 or 6.1.2.11.6 (IBC Section 1022.4 or 1023.6), respectively.

5.2.2.4.8 (IBC 707.8) Joints. Joints made in or between *fire barriers*, and joints made at the intersection of *fire barriers* with underside of the floor or roof sheathing, slab or deck above, shall comply with Section 5.2.2.11 (IBC Section 714).

SECTION 5.2.2.5 (IBC 708) SHAFT ENCLOSURES

5.2.2.5.1 (IBC 708.1) General. The provisions of this section shall apply to shafts required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies. Shaft enclosures shall be constructed as *fire barriers* in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* in accordance with Section 5.2.2.9 (IBC Section 712), or both.

5.2.2.5.2 (IBC 708.2) Shaft enclosure required. Openings through a floor/ceiling assembly shall be protected by a shaft enclosure complying with this section.

Exceptions:

1. Reserved.
2. A shaft enclosure is not required in a building equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13 for an escalator opening or *stairway* that is not a portion of the *means of egress* protected according to Item 2.1 or 2.2.
 - 2.1. Where the area of the floor opening between *stories* does not exceed twice the horizontal projected area of the escalator or *stairway* and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B this application is limited to openings that do not connect more than four *stories*.
 - 2.2. Where the opening is protected by *approved* power-operated automatic shutters at every penetrated floor. The shutters shall be of noncombustible construction and have a *fire-resistance rating* of not less than 1.5 hours. The shutter shall be so constructed as to close immediately upon the actuation of a smoke detector installed in accordance with Section 5.4.2.6.4 (IBC Section 907.3) and shall completely shut off the well opening. Escalators shall cease operation when the shutter begins to close. The shutter shall operate at a speed of not more than 15 cm/s and shall be equipped with a sensitive

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

leading edge to arrest its progress where in contact with any obstacle, and to continue its progress on release therefrom.

3. A shaft enclosure is not required for penetrations by pipe, tube, conduit, wire, cable and vents protected in accordance with Section 5.2.2.10.2 (IBC Section 713.4).
4. A shaft enclosure is not required for penetrations by ducts protected in accordance with Section 5.2.2.13.6 (IBC Section 716.6). Grease ducts shall be protected in accordance with the *International Mechanical Code*.
5. A shaft enclosure is not required for floor openings complying with the provisions for atriums in Section 4.2.2.2 (IBC Section 404).
6. Reserved.
7. A shaft enclosure is not required for a floor opening or an air transfer opening that complies with the following:
 - 7.1. Does not connect more than two *stories*.
 - 7.2. Is not part of the required *means of egress* system.
 - 7.3. Is not concealed within the construction of a wall or a floor/ceiling assembly.
 - 7.4. Reserved.
 - 7.5. Is not open to a *corridor* on nonsprinklered floors in any occupancy.
 - 7.6. Is separated from floor openings and air transfer openings serving other floors by construction conforming to required shaft enclosures.
 - 7.7. Is limited to the same smoke compartment.
8. A shaft enclosure is not required for floor openings between a *mezzanine* and the floor below.
9. A shaft enclosure is not required for joints protected by a *fire-resistant joint system* in accordance with Section 5.2.2.11 (IBC Section 714).
10. Where permitted by other sections of these guidelines.
11. Reserved.
12. Reserved.
13. Reserved.
14. Reserved.
15. Reserved.
16. Reserved.

5.2.2.5.3 (IBC 708.3) Materials. The shaft enclosure shall be of materials permitted by the building type of construction.

5.2.2.5.4 (IBC 708.4) Fire-resistance rating. Shaft enclosures shall have a *fire-resistance rating* of not less than 2 hours where connecting four *stories* or more, and not less than 1 hour where connecting less than four *stories*. The number of *stories* connected by the shaft enclosure shall include any basements but not any *mezzanines*. Shaft enclosures shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours. Shaft enclosures shall meet the requirements of IBC Section 703.2.1.

5.2.2.5.5 (IBC 708.5) Continuity. Shaft enclosures shall be constructed as *fire barriers* in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both, and shall have continuity in accordance with Section 5.2.2.4.5 (IBC Section 707.5) for *fire barriers* or Section 5.2.2.9.4 (IBC Section 712.4) for *horizontal assemblies* as applicable.

5.2.2.5.6 (IBC 708.6) Exterior walls. Where *exterior walls* serve as a part of a required shaft enclosure, such walls shall comply with the requirements of Section 5.2.2.2 (IBC Section 705) for *exterior walls* and the fire-resistance-rated enclosure requirements shall not apply.

Exception: *Exterior walls* required to be fire-resistance rated in accordance with Section 6.1.2.4.2 (IBC Section 1019.2) for exterior egress balconies, Section 6.1.2.10.6 (IBC Section 1022.6) for *exit* enclosures and Section 6.1.2.15.6 (IBC Section 1026.6) for exterior *exit* ramps and *stairways*.

5.2.2.5.7 (IBC 708.7) Openings. Openings in a shaft enclosure shall be protected in accordance with Section 5.2.2.12 (IBC Section 715) as required for *fire barriers*. Doors shall be self- or automatic-closing by smoke detection in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3).

5.2.2.5.7.1 (IBC 708.7.1) Prohibited openings. Openings other than those necessary for the purpose of the shaft shall not be permitted in shaft enclosures.

5.2.2.5.8 (IBC 708.8) Penetrations. Penetrations in a shaft enclosure shall be protected in accordance with Section 5.2.2.10 (IBC Section 713) as required for *fire barriers*.

5.2.2.5.8.1 (IBC 708.8.1) Prohibited penetrations. Penetrations other than those necessary for the purpose of the shaft shall not be permitted in shaft enclosures.

5.2.2.5.9 (IBC 708.9) Joints. Joints in a shaft enclosure shall comply with Section 5.2.2.11 (IBC Section 714).

5.2.2.5.10 (IBC 708.10) Ducts and air transfer openings. Penetrations of a shaft enclosure by ducts and air transfer openings shall comply with Section 5.2.2.13 (IBC Section 716).

5.2.2.5.11 (IBC 708.11) Enclosure at the bottom. Shafts that do not extend to the bottom of the building or structure shall comply with one of the following:

1. They shall be enclosed at the lowest level with construction of the same *fire-resistance rating* as the lowest floor through which the shaft passes, but not less than the rating required for the shaft enclosure.
2. They shall terminate in a room having a use related to the purpose of the shaft. The room shall be separated from the remainder of the building by *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. The *fire-resistance rating* and opening protectives shall be at least equal to the protection required for the shaft enclosure.
3. They shall be protected by *approved fire dampers* installed in accordance with their listing at the lowest floor level within the shaft enclosure.

Exceptions:

1. The fire-resistance-rated room separation is not required, provided there are no openings in or penetrations of the shaft enclosure to the interior of the building except at the bottom. The bottom of the shaft shall be closed off around the penetrating items with materials permitted by IBC Section 717.3.1 for draftstopping, or the room shall be provided with an *approved* automatic fire suppression system.
2. A shaft enclosure containing a refuse chute or laundry chute shall not be used for any other purpose and shall terminate in a room protected in accordance with IBC Section 708.13.4.
3. The fire-resistance-rated room separation and the protection at the bottom of the shaft are not required provided there are no combustibles in the shaft and there are no openings or other penetrations through the shaft enclosure to the interior of the building.

5.2.2.5.12 (IBC 708.12) Enclosure at the top. A shaft enclosure that does not extend to the underside of the roof sheathing, deck or slab of the building shall be enclosed at the top with construction of the same *fire-resistance rating* as the topmost floor penetrated by the shaft, but not less than the *fire-resistance rating* required for the shaft enclosure.

5.2.2.5.13 (IBC 708.14) Elevator, dumbwaiter and other hoistways. Elevator, dumbwaiter and other hoistway enclosures shall be constructed in accordance with Section 5.2.2.5 (IBC Section 708) and IBC Chapter 30.

5.2.2.5.13.1 (IBC 708.14.1) Elevator lobby. An enclosed elevator lobby shall be provided at each floor where an elevator shaft enclosure connects more than three *stories*. The lobby enclosure shall separate

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

the elevator shaft enclosure doors from each floor by *fire partitions*. In addition to the requirements in Section 5.2.2.6 (IBC Section 709) for *fire partitions*, doors protecting openings in the elevator lobby enclosure walls shall also comply with Section 5.2.2.12.4.3 (IBC Section 715.4.3) as required for *corridor* walls and penetrations of the elevator lobby enclosure by ducts and air transfer openings shall be protected as required for *corridors* in accordance with Section 5.2.2.13.5.4.1 (IBC Section 716.5.4.1). Elevator lobbies shall have at least one *means of egress* complying with IBC Chapter 10 and other provisions within these guidelines.

Exceptions:

1. Enclosed elevator lobbies are not required at the street floor, provided the entire street floor is equipped with an *automatic sprinkler system* in accordance with NFPA 13.
2. Elevators not required to be located in a shaft in accordance with Section 5.2.2.5.2 (IBC Section 708.2) are not required to have enclosed elevator lobbies.
3. Enclosed elevator lobbies are not required where additional doors are provided at the hoistway opening in accordance with Section 6.3.2.1.6 (IBC Section 3002.6). Such doors shall be tested in accordance with UL 1784 without an artificial bottom seal.
4. Enclosed elevator lobbies are not required where the building is protected by an *automatic sprinkler system* installed in accordance with NFPA 13. This exception shall not apply to the following:
 - 4.1. Reserved.
 - 4.2. Reserved.
 - 4.3. High-rise buildings.
5. Reserved.
6. Enclosed elevator lobbies are not required where the elevator hoistway is pressurized in accordance with IBC Section 708.14.2.

SECTION 5.2.2.6 (IBC 709) FIRE PARTITIONS

5.2.2.6.1 (IBC 709.1) General. The following wall assemblies shall comply with this section.

1. Reserved.
2. Reserved.
3. Reserved.
4. Corridor walls as required by Section 6.1.2.3.1 (IBC Section 1018.1).
5. Elevator lobby separation as required by Section 5.2.2.5.13.1 (IBC Section 708.14.1).

5.2.2.6.2 (IBC 709.2) Materials. The walls shall be of materials permitted by the building type of construction.

5.2.2.6.3 (IBC 709.3) Fire-resistance rating. Fire partitions shall have a *fire-resistance rating* of not less than 1 hour.

Exception:

1. Corridor walls permitted to have a $\frac{1}{2}$ hour *fire-resistance rating* by Table 6.1.2.3.1 (IBC Table 1018.1).
2. Reserved.

5.2.2.6.4 (IBC 709.4) Continuity. Fire partitions shall extend from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above or to the fire-resistance-rated floor/ceiling or roof/ceiling assembly above, and shall be securely attached thereto. If the partitions are not continuous to the sheathing, deck or slab, and where constructed of combustible construction, the space between the ceiling and the sheathing, deck or slab above shall be fireblocked or draftstopped in accordance with IBC Sections 717.2 and 717.3 at the partition line. The supporting construction shall be protected to afford the required *fire-resistance rating* of the wall supported, except for walls separating tenant spaces in *covered mall buildings*, and *corridor* walls in buildings of Type IIB, IIIB and VB construction.

Exceptions:

1. The wall need not be extended into the crawl space below where the floor above the crawl space has a minimum 1-hour *fire-resistance rating*.
2. Where the room-side fire-resistance-rated membrane of the *corridor* is carried through to the underside of the floor or roof sheathing, deck or slab of a fire-resistance-rated floor or roof above, the ceiling of the *corridor* shall be permitted to be protected by the use of ceiling materials as required for a 1-hour fire-resistance-rated floor or roof system.
3. Where the *corridor* ceiling is constructed as required for the *corridor* walls, the walls shall be permitted to terminate at the upper membrane of such ceiling assembly.
4. Fireblocking or draftstopping is not required at the partition line in buildings equipped with an *automatic sprinkler system* installed throughout in accordance with NFPA 13, provided that automatic sprinklers are installed in combustible floor/ceiling and roof/ceiling spaces.

5.2.2.6.5 (IBC 709.5) Exterior walls. Where *exterior walls* serve as a part of a required fire-resistance-rated separation, such walls shall comply with the requirements of Section 5.2.2.2 (IBC Section 705) for *exterior walls*, and the fire-resistance-rated separation requirements shall not apply.

Exception: *Exterior walls* required to be fire-resistance rated in accordance with Section 6.1.2.4.2 (IBC Section 1019.2) for exterior egress balconies, Section 6.1.10.2.6 (IBC Section 1022.6) for *exit* enclosures and Section 6.1.2.15.6 (IBC Section 1026.6) for exterior *exit* ramps and *stairways*.

5.2.2.6.6 (IBC 709.6) Openings. Openings in a *fire partition* shall be protected in accordance with Section 5.2.2.12 (IBC Section 715).

5.2.2.6.7 (IBC 709.7) Penetrations. Penetrations of *fire partitions* shall comply with Section 5.2.2.10 (IBC Section 713).

5.2.2.6.8 (IBC 709.8) Joints. Joints made in or between *fire partitions* shall comply with Section 5.2.2.11.(IBC Section 714).

SECTION 5.2.2.7 (IBC 710) SMOKE BARRIERS

5.2.2.7.1 (IBC 710.1) General. *Smoke barriers* shall comply with this section.

5.2.2.7.2 (IBC 710.2) Materials. *Smoke barriers* shall be of materials permitted by the building type of construction.

5.2.2.7.3 (IBC 710.3) Fire-resistance rating. A 1-hour *fire-resistance rating* is required for *smoke barriers*.

5.2.2.7.4 (IBC 710.4) Continuity. *Smoke barriers* shall form an effective membrane continuous from outside wall to outside wall and from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, deck or slab above, including continuity through concealed spaces, such as those found above suspended ceilings, and interstitial structural and mechanical spaces. The supporting construction shall be protected to afford the required *fire-resistance rating* of the wall or floor supported in buildings of other than Type IIB, IIIB or VB construction.

Exception: Smoke-barrier walls are not required in interstitial spaces where such spaces are designed and constructed with ceilings that provide resistance to the passage of fire.

5.2.2.7.5 (IBC 710.5) Openings. Openings in a *smoke barrier* shall be protected in accordance with Section 5.2.2.12 (IBC Section 715).

5.2.2.7.6 (IBC 710.6) Penetrations. Penetrations of *smoke barriers* shall comply with Section 5.2.2.10 (IBC Section 713).

5.2.2.7.7 (IBC 710.7) Joints. Joints made in or between *smoke barriers* shall comply with Section 5.2.2.11 (IBC Section 714).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

SECTION 5.2.2.8 (IBC 711) SMOKE PARTITIONS

5.2.2.8.1 (IBC 711.1) General. Smoke partitions installed as required elsewhere in these guidelines shall comply with this section.

5.2.2.8.2 (IBC 711.2) Materials. The walls shall be of materials permitted by the building type of construction.

5.2.2.8.3 (IBC 711.3) Fire-resistance rating. Unless required elsewhere in these guidelines, smoke partitions are not required to have a *fire-resistance rating*.

5.2.2.8.4 (IBC 711.4) Continuity. Smoke partitions shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.

5.2.2.8.5 (IBC 711.5) Openings. Windows shall be sealed to resist the free passage of smoke or be automatic-closing upon detection of smoke. Doors in smoke partitions shall comply with this section.

5.2.2.8.5.1 (IBC 711.5.1) Louvers. Doors in smoke partitions shall not include louvers.

5.2.2.8.5.2 (IBC 711.5.2) Smoke and draft control doors. Where required elsewhere in these guidelines, doors in smoke partitions shall meet the requirements for a smoke and draft control door assembly tested in accordance with UL 1784. The air leakage rate of the door assembly shall not exceed $0.0155 \text{ m}^3/(\text{s}\cdot\text{m}^2)$ of door opening at 3 mm of water (25 Pa) for both the ambient temperature test and the elevated temperature exposure test. Installation of smoke doors shall be in accordance with NFPA 105.

5.2.2.8.5.3 (IBC 711.5.3) Self- or automatic-closing doors. Where required elsewhere in these guidelines, doors in smoke partitions shall be self- or automatic-closing by smoke detection in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3).

5.2.2.8.6 (IBC 711.6) Penetrations and joints. The space around penetrating items and in joints shall be filled with an *approved* material to limit the free passage of smoke.

5.2.2.8.7 (IBC 711.7) Ducts and air transfer openings. The space around a duct penetrating a smoke partition shall be filled with an *approved* material to limit the free passage of smoke. Air transfer openings in smoke partitions shall be provided with a *smoke damper* complying with Section 5.2.2.13.3.2.2 (IBC Section 716.3.2.2).

Exception: Where the installation of a *smoke damper* will interfere with the operation of a required smoke control system in accordance with Section 5.4.2.7 (IBC Section 909), *approved* alternative protection shall be utilized.

SECTION 5.2.2.9 (IBC 712) HORIZONTAL ASSEMBLIES

5.2.2.9.1 (IBC 712.1) General. Floor and roof assemblies required to have a *fire-resistance rating* shall comply with this section. Nonfire-resistance-rated floor and roof assemblies shall comply with Section 5.2.2.10.2.2 (IBC Section 713.4.2).

5.2.2.9.2 (IBC 712.2) Materials. The floor and roof assemblies shall be of materials permitted by the building type of construction.

5.2.2.9.3 (IBC 712.3) Fire-resistance rating. The *fire-resistance rating* of floor and roof assemblies shall not be less than that required by the building type of construction. Where the floor assembly separates mixed occupancies, the assembly shall have a *fire-resistance rating* of not less than that required by Section 4.1.2.7.4 (IBC Section 508.4) based on the occupancies being separated. Where the floor assembly separates a single occupancy into different *fire areas*, the assembly shall have a *fire-resistance rating* of not less than that required by Section 5.2.2.4.3.8 (IBC Section 707.3.9).

5.2.2.9.3.1 (IBC 712.3.1) Ceiling panels. Where the weight of lay-in ceiling panels, used as part of fire-resistance-rated floor/ceiling or roof/ceiling assemblies, is not adequate to resist an upward force of 48.00 Pa, wire or other *approved* devices shall be installed above the panels to prevent vertical displacement under such upward force.

5.2.2.9.3.2 (IBC 712.3.2) Access doors. Access doors shall be permitted in ceilings of fire-resistance-rated floor/ceiling and roof/ceiling assemblies provided such doors are tested in accordance with ASTM E 119 or UL 263 as horizontal assemblies and labeled by an *approved agency* for such purpose.

5.2.2.9.3.3 (IBC 712.3.3) Unusable space. In 1-hour fire-resistance-rated floor assemblies, the ceiling membrane is not required to be installed over unusable crawl spaces. In 1-hour fire-resistance-rated roof assemblies, the floor membrane is not required to be installed where unusable *attic* space occurs above.

5.2.2.9.4 (IBC 712.4) Continuity. Assemblies shall be continuous without openings, penetrations or joints except as permitted by this section and Sections 5.2.2.5.2, 5.2.2.10.2, 5.2.2.11 and 6.1.2.10.1 (IBC Sections 708.2, 713.4, 714 and 1022.1). Skylights and other penetrations through a fire-resistance-rated roof deck or slab are permitted to be unprotected, provided that the structural integrity of the fire-resistance-rated roof assembly is maintained. Unprotected skylights shall not be permitted in roof assemblies required to be fire-resistance rated in accordance with Section 5.2.2.1.9 (IBC Section 704.10). The supporting construction shall be protected to afford the required *fire-resistance rating* of the *horizontal assembly* supported.

Exception: In buildings of Type IIB, IIIB or VB construction, the construction supporting the *horizontal assembly* is not required to be fire-resistance-rated at the following:

1. Reserved.
2. Reserved.
3. Horizontal assemblies at *smoke barriers* constructed in accordance with Section 5.2.2.7 (IBC Section 710).

5.2.2.9.5 (IBC 712.5) Penetrations. Penetrations of *horizontal assemblies* shall comply with Section 5.2.2.10 (IBC Section 713).

5.2.2.9.6 (IBC 712.6) Joints. Joints made in or between *horizontal assemblies* shall comply with Section 5.2.2.11 (IBC Section 714). The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be protected in accordance with Section 5.2.2.11.4 (IBC Section 714.4).

5.2.2.9.7 (IBC 712.7) Ducts and air transfer openings. Penetrations in *horizontal assemblies* by ducts and air transfer openings shall comply with Section 5.2.2.13 (IBC Section 716).

5.2.2.9.8 (IBC 712.8) Floor fire door assemblies. Floor *fire door* assemblies used to protect openings in fire-resistance-rated floors shall be tested in accordance with NFPA 288, and shall achieve a *fire-resistance rating* not less than the assembly being penetrated. Floor *fire door* assemblies shall be labeled by an *approved agency*. The *label* shall be permanently affixed and shall specify the manufacturer, the test standard and the *fire-resistance rating*.

5.2.2.9.9 (IBC 712.9) Smoke barrier. Where *horizontal assemblies* are required to resist the movement of smoke by other sections of these guidelines in accordance with the definition of *smoke barrier*, penetrations and joints in such *horizontal assemblies* shall be protected as required for *smoke barriers* in accordance with IBC Section 713.5 and 5.2.2.11.6 (IBC Section 714.6) of this guideline. Regardless of the number of *stories* connected by elevator shaft enclosures, doors located in elevator shaft enclosures that penetrate the *horizontal assembly* shall be protected by enclosed elevator lobbies complying with Section 5.2.2.5.13.1 (IBC Section 708.14.1). Openings through *horizontal assemblies* shall be protected by shaft enclosures complying with Section 5.2.2.5 (IBC Section 708). *Horizontal assemblies* shall not be allowed to have unprotected vertical openings.

SECTION 5.2.2.10 (IBC 713) PENETRATIONS

5.2.2.10.1 (IBC 713.3) Fire-resistance-rated walls. Penetrations into or through *fire walls*, *fire barriers*, *smoke barrier walls* and *fire partitions* shall comply with Sections 5.2.2.10.1.1 through 5.2.2.10.1.3 (IBC Sections 713.3.1 through 713.3.3). Penetrations in *smoke barrier walls* shall also comply with IBC Section 713.5.

5.2.2.10.1.1 (IBC 713.3.1) Through penetrations. Through penetrations of fire-resistance-rated walls shall comply with Section 5.2.2.10.1.1.1 or 5.2.2.10.1.1.2 (IBC Section 713.3.1.1 or 713.3.1.2).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

Exception: Where the penetrating items are steel, ferrous or copper pipes, tubes or conduits, the *annular space* between the penetrating item and the fire-resistance-rated wall is permitted to be protected as follows:

1. In concrete or masonry walls where the penetrating item is a maximum 15 cm nominal diameter and the area of the opening through the wall does not exceed 0.09 m², concrete, grout or mortar is permitted where it is installed the full thickness of the wall or the thickness required to maintain the *fire-resistance rating*; or
2. The material used to fill the *annular space* shall prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 or UL 263 time-temperature fire conditions under a minimum positive pressure differential of 0.25 mm of water (3 Pa) at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated.

5.2.2.10.1.1.1 (IBC 713.3.1.1) Fire-resistance-rated assemblies. Penetrations shall be installed as tested in an *approved* fire-resistance-rated assembly.

5.2.2.10.1.1.2 (IBC 713.3.1.2) Through-penetration firestop system. *Through penetrations* shall be protected by an *approved* penetration firestop system installed as tested in accordance with ASTM E 814 or UL 1479, with a minimum positive pressure differential of 0.25 mm of water (3 Pa) and shall have an F rating of not less than the required *fire-resistance rating* of the wall penetrated.

5.2.2.10.1.2 (IBC 713.3.2) Membrane penetrations. Membrane penetrations shall comply with Section 5.2.2.10.1.1 (IBC Section 713.3.1). Where walls or partitions are required to have a *fire-resistance rating*, recessed fixtures shall be installed such that the required fire-resistance will not be reduced.

5.2.2.10.1.3 (IBC 713.3.3) Dissimilar materials. Noncombustible penetrating items shall not connect to combustible items beyond the point of firestopping unless it can be demonstrated that the fire-resistance integrity of the wall is maintained.

5.2.2.10.2 (IBC 713.4) Horizontal assemblies. Penetrations of a floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly not required to be enclosed in a shaft by Section 5.2.2.5.2 (IBC Section 708.2) shall be protected in accordance with Sections 5.2.2.10.2.1 through 5.2.2.10.2.2.2 (IBC Sections 713.4.1 through 713.4.2.2).

5.2.2.10.2.1 (IBC 713.4.1) Fire-resistance-rated assemblies. Penetrations of the fire-resistance-rated floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly shall comply with Sections 5.2.2.10.2.1.1 through 5.2.2.10.2.1.3 (IBC Sections 713.4.1.1 through 713.4.1.4). Penetrations in horizontal *smoke barriers* shall also comply with IBC Section 713.5.

5.2.2.10.2.1.1 (IBC 713.4.1.1) Through penetrations. Through penetrations of fire-resistance-rated *horizontal assemblies* shall comply with Section 5.2.2.10.2.1.1.1 or 5.2.2.10.2.1.1.2 (IBC Section 713.4.1.1.1 or 713.4.1.1.2).

Exceptions:

1. Penetrations by steel, ferrous or copper conduits, pipes, tubes or vents or concrete or masonry items through a single fire-resistance rated floor assembly where the *annular space* is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 or UL 263 time-temperature fire conditions under a minimum positive pressure differential of 0.3 mm of water (3 Pa) at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated. Penetrating items with a maximum 15 cm nominal diameter shall not be limited to the penetration of a single fire-resistance-rated floor assembly, provided the aggregate area of the openings through the assembly does not exceed 0.09 m² in any 9.30 m² of floor area.
2. Penetrations in a single concrete floor by steel, ferrous or copper conduits, pipes, tubes or vents with a maximum 15 cm nominal diameter, provided the concrete, grout or

mortar is installed the full thickness of the floor or the thickness required to maintain the *fire-resistance rating*. The penetrating items shall not be limited to the penetration of a single concrete floor, provided the area of the opening through each floor does not exceed 0.09 m².

3. Penetrations by *listed* electrical boxes of any material, provided such boxes have been tested for use in fire-resistance-rated assemblies and installed in accordance with the instructions included in the listing.

5.2.2.10.2.1.1 (IBC 713.4.1.1.1) Installation. *Through penetrations* shall be installed as tested in the *approved* fire-resistance-rated assembly.

5.2.2.10.2.1.1.2 (IBC 713.4.1.1.2) Through-penetration firestop system. *Through penetrations* shall be protected by an *approved through-penetration firestop system* installed and tested in accordance with ASTM E 814 or UL 1479, with a minimum positive pressure differential of 0.3 mm of water (3 Pa). The system shall have an F rating/T rating of not less than 1 hour but not less than the required rating of the floor penetrated.

Exception: Floor penetrations contained and located within the cavity of a wall above the floor or below the floor do not require a T rating.

5.2.2.10.2.1.2 (IBC 713.4.1.2) Membrane penetrations. Penetrations of membranes that are part of a *horizontal assembly* shall comply with Section 5.2.2.10.2.1.1.1 or 5.2.2.10.2.1.1.2 (IBC Section 713.4.1.1.1 or 713.4.1.1.2). Where floor/ceiling assemblies are required to have a *fire-resistance rating*, recessed fixtures shall be installed such that the required *fire resistance* will not be reduced.

5.2.2.10.2.1.3 (IBC 713.4.1.4) Dissimilar materials. Noncombustible penetrating items shall not connect to combustible materials beyond the point of firestopping unless it can be demonstrated that the fire-resistance integrity of the *horizontal assembly* is maintained.

5.2.2.10.2.2 (IBC 713.4.2) Nonfire-resistance-rated assemblies. Penetrations of nonfire-resistance-rated floor or floor/ceiling assemblies or the ceiling membrane of a nonfire-resistance-rated roof/ceiling assembly shall meet the requirements of Section 5.2.2.5 (IBC Section 708) or shall comply with Section 5.2.2.10.2.2.1 or 5.2.2.10.2.2.2 (IBC Section 713.4.2.1 or 713.4.2.2).

5.2.2.10.2.2.1 (IBC 713.4.2.1) Noncombustible penetrating items. Noncombustible penetrating items that connect not more than three *stories* are permitted, provided that the *annular space* is filled to resist the free passage of flame and the products of combustion with an *approved* noncombustible material or with a fill, void or cavity material that is tested and classified for use in through-penetration firestop systems.

5.2.2.10.2.2.2 (IBC 713.4.2.2) Penetrating items. Penetrating items that connect not more than two *stories* are permitted, provided that the *annular space* is filled with an *approved* material to resist the free passage of flame and the products of combustion.

SECTION 5.2.2.11 (IBC 714) FIRE-RESISTANT JOINT SYSTEMS

5.2.2.11.1 (IBC 714.1) General. Joints installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies shall be protected by an *approved fire-resistant joint system* designed to resist the passage of fire for a time period not less than the required *fire-resistance rating* of the wall, floor or roof in or between which it is installed. *Fire-resistant joint systems* shall be tested in accordance with Section 5.2.2.11.3 (IBC Section 714.3). The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be protected in accordance with Section 5.2.2.11.4 (IBC Section 714.4).

Exception: *Fire-resistant joint systems* shall not be required for joints in all of the following locations:

- 1 Reserved.
2. Floors where the joint is protected by a shaft enclosure in accordance with Section 5.2.2.5 (IBC Section 708).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

3. Floors within atriums where the space adjacent to the atrium is included in the volume of the atrium for smoke control purposes.
4. Reserved.
5. Reserved.
6. *Mezzanine* floors.
7. Walls that are permitted to have unprotected openings.
8. Roofs where openings are permitted.
9. Control joints not exceeding a maximum width of 16 mm and tested in accordance with ASTM E 119 or UL 263.

5.2.2.11.2 (IBC 714.2) Installation. *Fire-resistant joint systems* shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to accommodate expected building movements and to resist the passage of fire and hot gases.

5.2.2.11.3 (IBC 714.3) Fire test criteria. *Fire-resistant joint systems* shall be tested in accordance with the requirements of either ASTM E 1966 or UL 2079. Nonsymmetrical wall joint systems shall be tested with both faces exposed to the furnace, and the assigned *fire-resistance rating* shall be the shortest duration obtained from the two tests. When evidence is furnished to show that the wall was tested with the least fire-resistant side exposed to the furnace, subject to acceptance of the *building official*, the wall need not be subjected to tests from the opposite side.

Exception: For *exterior walls* with a horizontal *fire separation distance* greater than 1.50 m, the joint system shall be required to be tested for interior fire exposure only.

5.2.2.11.4 (IBC 714.4) Exterior curtain wall/floor intersection. Where fire resistance-rated floor or floor/ceiling assemblies are required, voids created at the intersection of the exterior curtain wall assemblies and such floor assemblies shall be sealed with an *approved* system to prevent the interior spread of fire. Such systems shall be securely installed and tested in accordance with ASTM E 2307 to prevent the passage of flame for the time period at least equal to the *fire-resistance rating* of the floor assembly and prevent the passage of heat and hot gases sufficient to ignite cotton waste. Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 5.2.2.2.5.5 (IBC Section 705.8.5).

5.2.2.11.4.1 (IBC 714.4.1) Exterior curtain wall/nonfire-resistance-rated floor assembly intersections. Voids created at the intersection of exterior curtain wall assemblies and nonfire-resistance-rated floor or floor/ceiling assemblies shall be sealed with an *approved* material or system to retard the interior spread of fire and hot gases between *stories*.

5.2.2.11.5 (IBC 714.5) Spandrel wall. Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 5.2.2.2.5.5 (IBC Section 705.8.5). Where Section 5.2.2.2.5.5 (IBC Section 705.8.5) does not require a fire-resistance-rated spandrel wall, the requirements of Section 5.2.2.11.4 (IBC Section 714.4) shall still apply to the intersection between the spandrel wall and the floor.

5.2.2.11.6 (IBC 714.6) Fire-resistant joint systems in smoke barriers. Fire-resistant joint systems in smoke barriers, and joints at the Intersection of a horizontal *smoke barrier* and an exterior curtain wall, shall be tested in accordance with the requirements of UL 2079 for air leakage. The air leakage rate of the joint shall not exceed $0.008\text{m}^3/(\text{s}\cdot\text{m})$ of joint at 8 mm of water (75 Pa) for both the ambient temperature and elevated temperature tests.

SECTION 5.2.2.12 (IBC 715) OPENING PROTECTIVES

5.2.2.12.1 (IBC 715.1) General. Opening protectives required by other sections of these guidelines shall comply with the provisions of this section.

5.2.2.12.2 (IBC 715.2) Fire-resistance-rated glazing. Fire-resistance-rated glazing tested as part of a fire-resistance-rated wall assembly in accordance with ASTM E 119 or UL 263 and labeled in accordance with IBC Section 703.5 shall be permitted in *fire doors* and *fire window assemblies* in accordance with their listings and shall not otherwise be required to comply with this section.

5.2.2.12.3 (IBC 715.3) Alternative methods for determining fire protection ratings. The application of any of the alternative methods *listed* in this section shall be based on the fire exposure and acceptance criteria specified in NFPA 252, NFPA 257 or UL 9. The required *fire resistance* of an opening protective shall be permitted to be established by any of the following methods or procedures:

1. Designs documented in *approved* sources.
2. Calculations performed in an *approved* manner.
3. Engineering analysis based on a comparison of opening protective designs having *fire protection ratings* as determined by the test procedures set forth in NFPA 252, NFPA 257 or UL 9.
4. Alternative protection methods as allowed by IBC Section 104.11.

5.2.2.12.4 (IBC 715.4) Fire door and shutter assemblies. Approved *fire door* and fire shutter assemblies shall be constructed of any material or assembly of component materials that conforms to the test requirements of Section 5.2.2.12.4.1, 5.2.2.12.4.2 or 5.2.2.12.4.3 (IBC Section 715.4.1, 715.4.2 or 715.4.3) and the *fire protection rating* indicated in Table 5.2.2.12.4 (IBC Table 715.4). *Fire door* frames with transom lights, sidelights or both shall be permitted in accordance with Section 5.2.2.12.4.3.4 (IBC Section 715.4.5). *Fire door* assemblies and shutters shall be installed in accordance with the provisions of this section and NFPA 80.

Exceptions:

1. Labeled protective assemblies that conform to the requirements of this section or UL 10A, UL 14B and UL 14C for tin-clad *fire door* assemblies.
2. Floor *fire door* assemblies in accordance with Section 5.2.2.9.8 (IBC Section 712.8).

**TABLE 5.2.2.12.4 (IBC TABLE 715.4)
FIRE DOOR AND FIRE SHUTTER FIRE PROTECTION RATINGS**

TYPE OF ASSEMBLY	REQUIRED ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)
Fire walls and fire barriers having a required fire-resistance rating greater than 1 hour	4	3
	3	3 ^a
	2	1 ¹ / ₂
	1 ¹ / ₂	1 ¹ / ₂
Fire barriers having a required fire-resistance rating of 1 hour: Shaft, exit enclosure and exit passageway walls Other fire barriers	1	1
	1	3 ³ / ₄
Fire Partitions: Corridor walls Other fire partitions	1	1 ¹ / ₂ ^b
	0.5	1 ¹ / ₃ ^b
	1	3 ³ / ₄
	0.5	1 ¹ / ₃
Exterior walls	3	1 ¹ / ₂
	2	1 ¹ / ₂
	1	3 ³ / ₄
Smoke Barriers	1	1 ¹ / ₃ ^b

- a. Two doors, each with a fire protection rating of 1¹/₂ hours, installed on opposite sides of the same opening in a fire wall, shall be deemed equivalent in fire protection rating to one 3-hour fire door.
- b. For testing requirements, see Section 5.2.2.12.4.3 (IBC Section 715.4.3).

5.2.2.12.4.1 (IBC 715.4.1) Side-hinged or pivoted swinging doors. *Fire door* assemblies with side-hinged and pivoted swinging doors shall be tested in accordance with NFPA 252 or UL 10C. After 5 minutes into the NFPA 252 test, the neutral pressure level in the furnace shall be established at 1 m or less above the sill.

5.2.2.12.4.2 (IBC 715.4.2) Other types of assemblies. *Fire door* assemblies with other types of doors, including swinging elevator doors and fire shutter assemblies, shall be tested in accordance with NFPA 252 or UL 10B. The pressure in the furnace shall be maintained as nearly equal to the atmospheric pressure as possible. Once established, the pressure shall be maintained during the entire test period.

5.2.2.12.4.3 (IBC 715.4.3) Door assemblies in corridors and smoke barriers. *Fire door* assemblies required to have a minimum *fire protection rating* of 20 minutes where located in *corridor* walls or *smoke barrier* walls having a *fire-resistance rating* in accordance with Table 5.2.2.12.4 (IBC Table 715.4) shall be tested in accordance with NFPA 252 or UL 10C without the hose stream test.

Exceptions:

1. Viewports that require a hole not larger than 2.55 cm in diameter through the door, have at least a 6 mm-thick glass disc and the holder is of metal that will not melt out where subject to temperatures of 925°C.
2. Reserved.
3. Unprotected openings shall be permitted for *corridors* in multitheater complexes where each motion picture auditorium has at least one-half of its required *exit* or *exit access doorways* opening directly to the exterior or into an *exit* passageway.

5.2.2.12.4.3.1 (IBC 715.4.3.1) Smoke and draft control. *Fire door* assemblies shall also meet the requirements for a smoke and draft control door assembly tested in accordance with UL 1784. The air leakage rate of the door assembly shall not exceed $0.015 \text{ m}^3/(\text{s}\cdot\text{m}^2)$ of door opening at 3 mm of water (25 Pa) for both the ambient temperature and elevated temperature tests. Louvers shall be prohibited. Installation of smoke doors shall be in accordance with NFPA 105.

5.2.2.12.4.3.2 (IBC 715.4.3.2) Glazing in door assemblies. In a 20-minute *fire door* assembly, the glazing material in the door itself shall have a minimum fire-protection-rated glazing of 20 minutes and shall be exempt from the hose stream test. Glazing material in any other part of the door assembly, including transom lights and sidelights, shall be tested in accordance with NFPA 257 or UL 9, including the hose stream test, in accordance with Section 5.2.2.12.5 (IBC Section 715.5).

5.2.2.12.4.3.3 (IBC 715.4.4) Doors in exit enclosures and exit passageways. *Fire door* assemblies in *exit* enclosures and *exit* passageways shall have a maximum transmitted temperature end point of not more than 230°C above ambient at the end of 30 minutes of standard fire test exposure.

Exception: The maximum transmitted temperature rise is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13.

5.2.2.12.4.3.3.1 (IBC 715.4.4.1) Glazing in doors. Fire-protection-rated glazing in excess of 0.06 m^2 shall be permitted in *fire door* assemblies when tested as components of the door assemblies and not as glass lights, and shall have a maximum transmitted temperature rise of 230 °C in accordance with Section 5.2.2.12.4.3.3 (IBC Section 715.4.4).

Exception: The maximum transmitted temperature rise is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13.

5.2.2.12.4.3.4 (IBC 715.4.5) Fire door frames with transom lights and sidelights. Door frames with transom lights, sidelights, or both, shall be permitted where a $\frac{3}{4}$ -hour *fire protection rating* or less is required in accordance with Table 5.2.2.12.4 (IBC Table 715.4). Where a *fire protection rating* exceeding $\frac{3}{4}$ hour is required in accordance with Table 5.2.2.12.4 (IBC Table 715.4), *fire door* frames with transom lights, sidelights, or both, shall be permitted where installed with fire-resistance-rated glazing tested as an assembly in accordance with ASTM E 119 or UL 263.

5.2.2.12.4.3.5 (IBC 715.4.6) Labeled protective assemblies. *Fire door* assemblies shall be labeled by an *approved agency*. The *labels* shall comply with NFPA 80, and shall be permanently affixed to the door or frame.

5.2.2.12.4.3.5.1 (IBC 715.4.6.1) Fire door labeling requirements. *Fire doors* shall be labeled showing the name of the manufacturer or other identification readily traceable back to the manufacturer, the name or trademark of the third-party inspection agency, the *fire protection rating* and, where required for *fire doors* in *exit* enclosures and *exit* passageways by Section 5.2.2.12.4 (IBC Section 715.4.4), the maximum transmitted temperature end point. Smoke and draft control doors complying with UL 1784 shall be labeled as such and shall also comply with Section 5.2.2.12.4.3.5.3 (IBC Section 715.4.6.3). Labels shall be *approved* and permanently affixed. The *label* shall be applied at the factory or location where fabrication and assembly are performed.

5.2.2.12.4.3.5.2 (IBC 715.4.6.2) Oversized doors. Oversized *fire doors* shall bear an oversized *fire door label* by an *approved agency* or shall be provided with a certificate of inspection furnished by an *approved* testing agency. When a certificate of inspection is furnished by an *approved* testing agency, the certificate shall state that the door conforms to the requirements of design, materials and construction, but has not been subjected to the fire test.

5.2.2.12.4.3.5.3 (IBC 715.4.6.3) Smoke and draft control door labeling requirements. Smoke and draft control doors complying with UL 1784 shall be labeled in accordance with Section 5.2.2.12.4.3.5.1 (IBC Section 715.4.6.1) and shall show the letter “S” on the fire rating *label* of the door. This marking shall indicate that the door and frame assembly are in compliance when *listed* or labeled gasketing is also installed.

5.2.2.12.4.3.5.4 (IBC 715.4.6.4) Fire door frame labeling requirements. *Fire door* frames shall be labeled showing the names of the manufacturer and the third-party inspection agency.

5.2.2.12.4.3.6 (IBC 715.4.7) Glazing material. Fire-protection-rated glazing conforming to the opening protection requirements in Section 5.2.2.12.4 (IBC Section 715.4) shall be permitted in *fire door* assemblies.

5.2.2.12.4.3.6.1 (IBC 715.4.7.1) Size limitations. Fire-protection-rated glazing used in *fire doors* shall comply with the size limitations of NFPA 80.

Exceptions:

1. Fire-protection-rated glazing in *fire doors* located in *fire walls* shall be prohibited except where serving in a *fire door* in a horizontal *exit*, a self-closing swinging door shall be permitted to have a vision panel of not more than 0.06 m² without a dimension exceeding 25 cm.
2. Fire-protection-rated glazing shall not be installed in *fire doors* having a 1½-hour *fire protection rating* intended for installation in *fire barriers*, unless the glazing is not more than 0.06 m² in area.

5.2.2.12.4.3.6.2 (IBC 715.4.7.2) Exit and elevator protectives. *Approved* fire-protection-rated glazing used in *fire door* assemblies in elevator and *exit* enclosures shall be so located as to furnish clear vision of the passageway or approach to the elevator, ramp or *stairway*.

5.2.2.12.4.3.6.3 (IBC 715.4.7.3) Labeling. Fire-protection-rated glazing shall bear a *label* or other identification showing the name of the manufacturer, the test standard and information required in Section 5.2.2.12.5.9.1 (IBC Section 715.5.9.1) that shall be issued by an *approved agency* and shall be permanently affixed to the glazing.

5.2.2.12.4.3.6.3.1 (IBC 715.4.7.3.1) Identification. For fire protection-rated glazing, the *label* shall bear the following four-part identification: “D – H or NH – T or NT – XXX.” “D” indicates that the glazing shall be used in *fire door* assemblies and that the glazing meets the fire protection requirements of NFPA 252. “H” shall indicate that the glazing meets the hose stream requirements of NFPA 252. “NH” shall indicate that the glazing does not meet the hose stream requirements of the test. “T” shall indicate that the glazing meets the temperature requirements of Section 5.2.2.12.4.3.3.1 (IBC Section 715.4.4.1). “NT” shall indicate that the

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

glazing does not meet the temperature requirements of Section 5.2.2.12.4.3.3.1 (IBC Section 715.4.4.1). The placeholder “XXX” shall specify the fire-protection-rating period, in minutes.

5.2.2.12.4.3.6.4 (IBC 715.4.7.4) Safety glazing. Fire-protection-rated glazing installed in *fire doors* in areas subject to human impact in hazardous locations shall comply with IBC Chapter 24.

5.2.2.12.4.3.7 (IBC 715.4.8) Door closing. *Fire doors* shall be self- or automatic-closing in accordance with this section.

Exceptions:

1. Reserved.
2. The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 6.3.2.2.2 (IBC Section 3003.2) shall be permitted to remain open during Phase I emergency recall operation.

5.2.2.12.4.3.7.1 (IBC 715.4.8.1) Latch required. Unless otherwise specifically permitted, single *fire doors* and both leaves of pairs of side-hinged swinging *fire doors* shall be provided with an active latch bolt that will secure the door when it is closed.

5.2.2.12.4.3.7.2 (IBC 715.4.8.2) Automatic-closing fire door assemblies. Automatic-closing *fire door* assemblies shall be self-closing in accordance with NFPA 80.

5.2.2.12.4.3.7.3 (IBC 715.4.8.3) Smoke-activated doors. Automatic-closing doors installed in the following locations shall be automatic-closing by the actuation of smoke detectors installed in accordance with Section 5.4.2.6.4 (IBC Section 907.3) or by loss of power to the smoke detector or hold-open device. Doors that are automatic-closing by smoke detection shall not have more than a 10-second delay before the door starts to close after the smoke detector is actuated:

1. Doors installed across a *corridor*.
2. Doors that protect openings in *exits* or *corridors* required to be of fire-resistance-rated construction.
3. Doors that protect openings in walls that are capable of resisting the passage of smoke in accordance with Section 4.1.2.7.2.4.2 (IBC Section 508.2.5.2).
4. Doors installed in *smoke barriers* in accordance with Section 5.2.2.7.5 (IBC Section 710.5).
5. Doors installed in *fire partitions* in accordance with Section 5.2.2.6.6 (IBC Section 709.6).
6. Doors installed in a *fire wall* in accordance with Section 5.2.2.3.7 (IBC Section 706.8).
7. Doors installed in shaft enclosures in accordance with Section 5.2.2.5.7 (IBC Section 708.7).
8. Reserved.
9. Reserved.
10. Reserved.
11. Doors installed in smoke partitions in accordance with Section 5.2.2.8.5.3 (IBC Section 711.5.3).

5.2.2.12.4.3.7.4 (IBC 715.4.8.4) Doors in pedestrian ways. Vertical sliding or vertical rolling steel *fire doors* in openings through which pedestrians travel shall be heat activated or activated by smoke detectors with alarm verification.

5.2.2.12.4.3.8 (IBC 715.4.9) Swinging fire shutters. Where fire shutters of the swinging type are installed in exterior openings, not less than one row in every three vertical rows shall be arranged to be readily opened from the outside, and shall be identified by distinguishing marks or letters not less than 15 cm high.

5.2.2.12.4.3.9 (IBC 715.4.10) Rolling fire shutters. Where fire shutters of the rolling type are installed, such shutters shall include *approved* automatic-closing devices.

5.2.2.12.5 (IBC 715.5) Fire-protection-rated glazing. Glazing in *fire window assemblies* shall be fire-protection rated in accordance with this section and Table 5.2.2.12.5 (IBC Table 715.5). Glazing in *fire door* assemblies shall comply with Section 5.2.2.14.3.6 (IBC Section 715.4.7). Fire-protection-rated glazing shall be tested in accordance with and shall meet the acceptance criteria of NFPA 257 or UL 9. Fire-protection-rated glazing shall also comply with NFPA 80. Openings in nonfire-resistance-rated *exterior wall* assemblies that require protection in accordance with Sections 5.2.2.2.1, 5.2.2.2.5.3, 5.2.2.2.5.5, or 5.2.2.2.5.6 (IBC Section 705.3, 705.8, 705.8.5 or 705.8.6) shall have a fire-protection rating of not less than $\frac{3}{4}$ hour.

Exceptions:

1. Wired glass in accordance with Section 5.2.2.12.5.4 (IBC Section 715.5.4).
2. Fire protection-rated glazing in 0.5-hour fire-resistance-rated partitions is permitted to have an 0.33-hour fire-protection rating.

**TABLE 5.2.2.12.5 (IBC TABLE 715.5)
FIRE WINDOW ASSEMBLY FIRE PROTECTION RATINGS**

TYPE OF ASSEMBLY		REQUIRED ASSEMBLY RATING (hours)	MINIMUM FIRE WINDOW ASSEMBLY RATING (hours)
Interior walls	Fire walls	All	NP ^a
	Fire barriers	>1 1	NP ^a $\frac{3}{4}$
	Smoke barriers	1	$\frac{3}{4}$
	Fire partitions	1 $\frac{1}{2}$	$\frac{3}{4}$ $\frac{1}{3}$
Exterior walls		>1 1	>1 1
Party wall		All	All

NP= Not Permitted.

a = Not permitted except as specified in Section 5.2.2.12.2 (IBC Section 715.2).

5.2.2.12.5.1 (IBC 715.5.1) Testing under positive pressure. NFPA 257 or UL 9 shall evaluate fire-protection-rated glazing under positive pressure. Within the first 10 minutes of a test, the pressure in the furnace shall be adjusted so at least two-thirds of the test specimen is above the neutral pressure plane, and the neutral pressure plane shall be maintained at that height for the balance of the test.

5.2.2.12.5.2 (IBC 715.5.2) Nonsymmetrical glazing systems. Nonsymmetrical fire-protection-rated glazing systems in *fire partitions*, *fire barriers* or in *exterior walls* with a *fire separation distance* of 1.50 m or less pursuant to Section 5.2.2.2 (IBC Section 705) shall be tested with both faces exposed to the furnace, and the assigned *fire protection rating* shall be the shortest duration obtained from the two tests conducted in compliance with NFPA 257 or UL 9.

5.2.2.12.5.3 (IBC 715.5.3) Safety glazing. Fire-protection-rated glazing installed in *fire window assemblies* in areas subject to human impact in hazardous locations shall comply with IBC Chapter 24.

5.2.2.12.5.4 (IBC 715.5.4) Wired glass. Steel window frame assemblies of 3 mm minimum solid section or of not less than nominal 1 mm-thick formed sheet steel members fabricated by pressing, mitering, riveting, interlocking or welding and having provision for glazing with 6 mm wired glass where securely installed in the building construction and glazed with 6 mm labeled wired glass shall be deemed to meet the requirements for a $\frac{3}{4}$ -hour *fire window assembly*. Wired glass panels shall conform to the size limitations set forth in Table 5.2.2.12.5.4 (IBC Table 715.5.4).

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

**TABLE 5.2.2.12.5.4 (IBC TABLE 715.5.4)
LIMITING SIZES OF WIRED GLASS PANELS**

OPENING FIRE PROTECTION RATING	MAXIMUM AREA (square meters)	MAXIMUM HEIGHT (centimeters)	MAXIMUM WIDTH (centimeters)
3 hours	0	0	0
1½ hour doors in exterior walls	0	0	0
1 and 1½ hours	0.06	84	25
¾ hour	0.83	135	135
20 minutes	Not Limited	Not Limited	Not Limited
Fire window assemblies	0.83	135	135

5.2.2.12.5.5 (IBC 715.5.5) Nonwired glass. Glazing other than wired glass in *fire window assemblies* shall be fire-protection-rated glazing installed in accordance with and complying with the size limitations set forth in NFPA 80.

5.2.2.12.5.6 (IBC 715.5.6) Installation. Fire-protection-rated glazing shall be in the fixed position or be automatic-closing and shall be installed in *approved* frames.

5.2.2.12.5.7 (IBC 715.5.7) Window mullions. Metal mullions that exceed a nominal height of 3.65 m shall be protected with materials to afford the same *fire-resistance rating* as required for the wall construction in which the protective is located.

5.2.2.12.5.8 (IBC 715.5.8) Interior fire window assemblies. Fire-protection-rated glazing used in *fire window assemblies* located in *fire partitions* and *fire barriers* shall be limited to use in assemblies with a maximum *fire-resistance rating* of 1 hour in accordance with this section.

5.2.2.12.5.8.1 (IBC 715.5.8.1) Where ¾-hour fire protection window assemblies permitted. Fire-protection-rated glazing requiring 45-minute opening protection in accordance with Table 5.2.2.12.5 (IBC Table 715.5) shall be limited to *fire partitions* designed in accordance with Section 5.2.2.6 (IBC Section 709) and *fire barriers* utilized in the applications set forth in Section 5.2.2.4.3.6 and 5.2.2.4.3.7 (IBC Sections 707.3.6 and 707.3.8) where the *fire-resistance rating* does not exceed 1 hour.

5.2.2.12.5.8.2 (IBC 715.5.8.2) Area limitations. The total area of windows shall not exceed 25% of the area of a common wall with any room.

5.2.2.12.5.9 (IBC 715.5.9) Labeling requirements. Fire-protection-rated glazing shall bear a *label* or other identification showing the name of the manufacturer, the test standard and information required in Section 5.2.2.12.5.9.1 (IBC Section 715.5.9.1) that shall be issued by an *approved agency* and shall be permanently affixed to the glazing.

5.2.2.12.5.9.1 (IBC 715.5.9.1) Identification. For fire-protection-rated glazing, the *label* shall bear the following two-part identification: "OH – XXX." "OH" indicates that the glazing meets both the fire protection and the hose-stream requirements of NFPA 257 or UL 9 and is permitted to be used in openings. "XXX" represents the fire-protection rating period, in minutes, that was tested.

SECTION 5.2.2.13 (IBC 716) DUCTS AND AIR TRANSFER OPENINGS

5.2.2.13.1 (IBC 716.1) General. The provisions of this section shall govern the protection of duct penetrations and air transfer openings in assemblies required to be protected.

5.2.2.13.1.1 (IBC 716.1.1) Ducts that penetrate fire-resistance-rated assemblies without dampers. Ducts that penetrate fire-resistance-rated assemblies and are not required by this section to have *dampers* shall comply with the requirements of IBC Section 713.2 and Sections 5.2.2.10 through 5.2.2.10.1.3 (IBC Sections 713.3 through 713.3.3) of the guideline. Ducts that penetrate *horizontal assemblies* not required to be contained within a shaft and not required by this section to have *dampers* shall comply with the requirements of Sections 5.2.2.10.2 through 5.2.2.10.2.2.2 (IBC Sections 713.4 through 713.4.2.2).

5.2.2.13.1.1.1 (IBC 716.1.1.1) Ducts that penetrate nonfire-resistance-rated assemblies. The space around a duct penetrating a nonfire-resistance-rated floor assembly shall comply with Section 5.2.2.13.6.3 (IBC Section 716.6.3).

5.2.2.13.2 (IBC 716.2) Installation. *Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling radiation dampers* located within air distribution and smoke control systems shall be installed in accordance with the requirements of this section, the manufacturer's installation instructions and the *dampers'* listing.

5.2.2.13.2.1 (IBC 716.2.1) Smoke control system. Where the installation of a fire *damper* will interfere with the operation of a required smoke control system in accordance with Section 5.4.2.7 (IBC Section 909), *approved* alternative protection shall be utilized. Where mechanical systems including ducts and *dampers* utilized for normal building ventilation serve as part of the smoke control system, the expected performance of these systems in smoke control mode shall be addressed in the rational analysis required by IBC Section 909.4.

5.2.2.13.2.2 (IBC 716.2.2) Hazardous exhaust ducts. *Fire dampers* for hazardous exhaust duct systems shall comply with the *International Mechanical Code*.

5.2.2.13.3 (IBC 716.3) Damper testing, ratings and actuation. *Damper* testing, ratings and actuation shall be in accordance with Sections 5.2.2.13.3.1 through 5.2.2.13.3.3 (IBC Sections 716.3.1 through 716.3.3).

5.2.2.13.3.1 (IBC 716.3.1) Damper testing. *Dampers* shall be *listed* and bear the *label* of an *approved* testing agency indicating compliance with the standards in this section. *Fire dampers* shall comply with the requirements of UL 555. Only *fire dampers* labeled for use in dynamic systems shall be installed in heating, ventilation and air-conditioning systems designed to operate with fans on during a fire. *Smoke dampers* shall comply with the requirements of UL 555S. *Combination fire/smoke dampers* shall comply with the requirements of both UL 555 and UL 555S. *Ceiling radiation dampers* shall comply with the requirements of UL 555C.

5.2.2.13.3.2 (IBC 716.3.2) Damper rating. *Damper* ratings shall be in accordance with Sections 5.2.2.13.3.2.1 through 5.2.2.13.3.2.3 (IBC Sections 716.3.2.1 through 716.3.2.3).

5.2.2.13.3.2.1 (IBC 716.3.2.1) Fire damper ratings. *Fire dampers* shall have the minimum *fire protection rating* specified in Table 5.2.2.13.3.2.1 (IBC Table 716.3.2.1) for the type of penetration.

5.2.2.13.3.2.2 (IBC 716.3.2.2) Smoke damper ratings. *Smoke damper* leakage ratings shall not be less than Class II. Elevated temperature ratings shall not be less than 120°C.

5.2.2.13.3.2.3 (IBC 716.3.2.3) Combination fire/smoke damper ratings. *Combination fire/smoke dampers* shall have the minimum *fire protection rating* specified for *fire dampers* in Table 5.2.2.13.3.2.1 (IBC Table 716.3.2.1) for the type of penetration and shall also have a minimum Class II leakage rating and a minimum elevated temperature rating of 120°C.

5.2.2.13.3.3 (IBC 716.3.3) Damper actuation. *Damper* actuation shall be in accordance with Sections 5.2.2.13.3.3.1 through 5.2.2.13.3.3.4 (IBC Sections 716.3.3.1 through 716.3.3.4) as applicable.

5.2.2.13.3.3.1 (IBC 716.3.3.1) Fire damper actuation device. The *fire damper* actuation device shall meet one of the following requirements:

1. The operating temperature shall be approximately 10°C above the normal temperature within the duct system, but not less than 71°C.
2. The operating temperature shall be not more than 175°C where located in a smoke control system complying with Section 5.4.2.7 (IBC Section 909).

5.2.2.13.3.3.2 (IBC 716.3.3.2) Smoke damper actuation. The *smoke damper* shall close upon actuation of a *listed* smoke detector or detectors installed in accordance with Section 5.4.2.6.4 (IBC Section 907.3) and one of the following methods, as applicable:

1. Where a *smoke damper* is installed within a duct, a smoke detector shall be installed in the duct within 1.50 m of the *damper* with no air outlets or inlets between the detector and the

PASSIVE FIRE PROTECTION SYSTEMS AND FEATURES

damper. The detector shall be *listed* for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, *dampers* shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.

2. Where a *smoke damper* is installed above *smoke barrier* doors in a *smoke barrier*, a spot-type detector *listed* for releasing service shall be installed on either side of the *smoke barrier* door opening.
3. Where a *smoke damper* is installed within an air transfer opening in a wall, a spot-type detector *listed* for releasing service shall be installed within 1.50 m horizontally of the *damper*.
4. Where a *smoke damper* is installed in a *corridor* wall or ceiling, the *damper* shall be permitted to be controlled by a smoke detection system installed in the *corridor*.
5. Where a total-coverage smoke detector system is provided within areas served by a heating, ventilation and air-conditioning (HVAC) system, *smoke dampers* shall be permitted to be controlled by the smoke detection system.

TABLE 5.2.2.13.3.2.1 (IBC TABLE 716.3.2.1)
FIRE DAMPER RATING

TYPE OF PENETRATION	MINIMUM DAMPER RATING (hours)
Less than 3-hour fire-resistance-rated assemblies	1.5
3-hour or greater fire-resistance-rated Assemblies	3

5.2.2.13.3.3.3 (IBC 716.3.3.3) Combination fire/smoke damper actuation. *Combination fire/smoke damper* actuation shall be in accordance with Section 5.2.2.13.3.3.1 and 5.2.2.13.3.3.2 (IBC Sections 716.3.3.1 and 716.3.3.2). *Combination fire/smoke dampers* installed in smoke control system shaft penetrations shall not be activated by local area smoke detection unless it is secondary to the smoke management system controls.

5.2.2.13.3.3.4 (IBC 716.3.3.4) Ceiling radiation damper actuation. The operating temperature of a *ceiling radiation damper* actuation device shall be 10°C above the normal temperature within the duct system, but not less than 71°C.

5.2.2.13.4 (IBC 716.4) Access and identification. Fire and smoke *dampers* shall be provided with an *approved* means of access, which is large enough to *permit* inspection and maintenance of the *damper* and its operating parts. The access shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the *fire-resistance rating* of the assembly. Access points shall be permanently identified on the exterior by a *label* having letters not less than 1 cm in height reading: FIRE/SMOKE DAMPER, SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

5.2.2.13.5 (IBC 716.5) Where required. *Fire dampers*, *smoke dampers* and *combination fire/smoke dampers* shall be provided at the locations prescribed in Sections 5.2.2.13.5.1 through 5.2.2.13.5.7 and Section 5.2.2.13.6 (IBC Sections 716.5.1 through 716.5.7 and 716.6). Where an assembly is required to have both *fire dampers* and *smoke dampers*, *combination fire/smoke dampers* or a *fire damper* and a *smoke damper* shall be required.

5.2.2.13.5.1 (IBC 716.5.1) Fire walls. Ducts and air transfer openings permitted in *fire walls* in accordance with IBC Section 706.11 shall be protected with *listed fire dampers* installed in accordance with their listing.

5.2.2.13.5.1.1 (IBC 716.5.1.1) Horizontal exits. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire wall* that serves as a horizontal *exit*.

5.2.2.13.5.2 (IBC 716.5.2) Fire barriers. Ducts and air transfer openings of *fire barriers* shall be protected with *approved fire dampers* installed in accordance with their listing. Ducts and air transfer openings shall

not penetrate *exit* enclosures and *exit* passageways except as permitted by Section 6.1.2.10.4 and 6.1.2.11.6 (IBC Sections 1022.4 and 1023.6), respectively.

Exception: *Fire dampers* are not required at penetrations of *fire barriers* where any of the following apply:

1. Penetrations are tested in accordance with ASTM E 119 or UL 263 as part of the fire-resistance-rated assembly.
2. Ducts are used as part of an *approved* smoke control system in accordance with Section 5.4.2.7 (IBC Section 909) and where the use of a *fire damper* would interfere with the operation of a smoke control system.
3. Such walls are penetrated by ducted HVAC systems, have a required *fire-resistance rating* of 1 hour or less and are in buildings equipped throughout with an *automatic sprinkler system* in accordance with IBC Section 903.3.1.1 or 903.3.1.2. For the purposes of this exception, a ducted HVAC system shall be a duct system for conveying supply, return or exhaust air as part of the structure's HVAC system. Such a duct system shall be constructed of sheet steel not less than No. 26 gage thickness and shall be continuous from the air-handling appliance or equipment to the air outlet and inlet terminals.

5.2.2.13.5.2.1 (IBC 716.5.2.1) Horizontal exits. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire barrier* that serves as a horizontal *exit*.

5.2.2.13.5.3 (IBC 716.5.3) Shaft enclosures. Shaft enclosures that are permitted to be penetrated by ducts and air transfer openings shall be protected with *approved* fire and smoke *dampers* installed in accordance with their listing.

Exceptions:

1. *Fire dampers* are not required at penetrations of shafts where:
 - 1.1. Steel exhaust subducts are extended at least 56 cm vertically in exhaust shafts, provided there is a continuous airflow upward to the outside; or
 - 1.2. Penetrations are tested in accordance with ASTM E 119 or UL 263 as part of the fire-resistance-rated assembly; or
 - 1.3. Ducts are used as part of an approved smoke control system designed and installed in accordance with Section 5.4.2.7 (IBC Section 909) and where the fire damper will interfere with the operation of the smoke control system; or
2. In Group B occupancies equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13, *smoke dampers* are not required at penetrations of shafts where:
 - 2.1. Kitchen, clothes dryer, bathroom and toilet room exhaust openings are installed with steel exhaust subducts, having a minimum wall thickness of 0.50 mm (No. 26 gage);
 - 2.2. The subducts extend at least 56 cm vertically; and
 - 2.3. An exhaust fan is installed at the upper terminus of the shaft that is powered continuously in accordance with the provisions of Section 5.4.2.7.1 (IBC Section 909.11), so as to maintain a continuous upward airflow to the outside.
3. Reserved.
4. *Smoke dampers* are not required at penetrations of shafts where ducts are used as part of an *approved* mechanical smoke control system designed in accordance with Section 5.4.2.7 (IBC Section 909) and where the *smoke damper* will interfere with the operation of the smoke control system.
5. *Fire dampers* and *combination fire/smoke dampers* are not required in kitchen and clothes dryer exhaust systems when installed in accordance with the *International Mechanical Code*.

5.2.2.13.5.4 (IBC 716.5.4) Fire partitions. Ducts and air transfer openings that penetrate fire partitions shall be protected with listed fire dampers installed in accordance with their listing.

Exceptions: Fire dampers are not required where any of the following apply:

1. Corridor walls in buildings equipped throughout with an automatic sprinkler system in accordance with IBC Section 903.3.1.1 or 903.3.1.2 and the duct is protected as a through penetration in accordance with Section 5.2.2.10 (IBC Section 713).
2. Tenant partitions in covered mall buildings where the walls are not required by provisions elsewhere in these guidelines to extend to the underside of the floor or roof sheathing, slab or deck above.
3. The duct system is constructed of approved materials in accordance with the *International Mechanical Code* and the duct penetrating the wall complies with all of the following requirements:
 - 3.1. The duct shall not exceed 0.06 m².
 - 3.2. The duct shall be constructed of steel a minimum of 0.50 mm in thickness.
 - 3.3. The duct shall not have openings that communicate the *corridor* with adjacent spaces or rooms.
 - 3.4. The duct shall be installed above a ceiling.
 - 3.5. The duct shall not terminate at a wall register in the fire-resistance-rated wall.
 - 3.6. A minimum 31 cm-long by 1.50 mm-thick steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 4 cm by 4 cm by 1.50 mm steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 (M5) screws. The annular space between the steel sleeve and the wall opening shall be filled with mineral wool batting on all sides.

5.2.2.13.5.4.1 (IBC 716.5.4.1) Corridors. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *corridor* enclosure required to have smoke and draft control doors in accordance with Section 5.2.2.12.4.3 (IBC Section 715.4.3).

Exceptions:

1. *Smoke dampers* are not required where the building is equipped throughout with an *approved smoke control system* in accordance with Section 5.4.2.7 (IBC Section 909), and *smoke dampers* are not necessary for the operation and control of the system.
2. *Smoke dampers* are not required in *corridor* penetrations where the duct is constructed of steel not less than 0.50 mm in thickness and there are no openings serving the *corridor*.

5.2.2.13.5.5 (IBC 716.5.5) Smoke barriers. A listed smoke damper designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a smoke barrier. Smoke dampers and smoke damper actuation methods shall comply with Section 5.2.2.13.3.2 (IBC Section 716.3.3.2).

Exception: Smoke dampers are not required where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.

5.2.2.13.5.6 (IBC 716.5.6) Exterior walls. Ducts and air transfer openings in fire-resistance-rated *exterior walls* required to have protected openings in accordance with Section 5.2.2.2.7 (IBC Section 705.10) shall be protected with *listed fire dampers* installed in accordance with their listing.

5.2.2.13.5.7 (IBC 716.5.7) Smoke partitions. A listed smoke damper designed to resist the passage of smoke shall be provided at each point that an air transfer opening penetrates a smoke partition. Smoke dampers and smoke damper actuation methods shall comply with Section 5.2.2.13.3.2 (IBC Section 716.3.3.2).

Exception: Where the installation of a smoke damper will interfere with the operation of a required smoke control system in accordance with Section 5.4.2.7 (IBC Section 909), approved alternative protection shall be utilized.

5.2.2.13.6 (IBC 716.6) Horizontal assemblies. Penetrations by ducts and air transfer openings of a floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly shall be protected by a shaft enclosure that complies with Section 5.2.2.5 (IBC Section 708) or shall comply with Sections 5.2.2.13.6.1 through 5.2.2.13.6.3 (IBC Sections 716.6.1 through 716.6.3).

5.2.2.13.6.1 (IBC 716.6.1) Through penetrations. A duct constructed of approved materials in accordance with the *International Mechanical Code* that penetrates a fire-resistance-rated floor/ceiling assembly that connects not more than two stories is permitted without shaft enclosure protection, provided a listed fire damper is installed at the floor line or the duct is protected in accordance with Section 5.2.2.10.2 (IBC Section 713.4). For air transfer openings, see Exception 7 to Section 5.2.2.5.2 (IBC Section 708.2).

Exception: A duct is permitted to penetrate three floors or less without a *fire damper* at each floor, provided such duct meets all of the following requirements:

1. The duct shall be contained and located within the cavity of a wall and shall be constructed of steel having a minimum wall thickness of 0.50 mm (No. 26 gage).
2. Reserved.
3. The duct shall not exceed 10 cm nominal diameter and the total area of such ducts shall not exceed 0.06 m² in any 9.30 m² of floor area.
4. The annular space around the duct is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E 119 or UL 263 time-temperature conditions under a minimum positive pressure differential of 0.3 mm of water (3 Pa) at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated.
5. Grille openings located in a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with a *listed ceiling radiation damper* installed in accordance with Section 5.2.2.13.6.2.1 (IBC Section 716.6.2.1).

5.2.2.13.6.2 (IBC 716.6.2) Membrane penetrations. Ducts and air transfer openings constructed of approved materials in accordance with the *International Mechanical Code* that penetrate the ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with one of the following:

1. A shaft enclosure in accordance with Section 5.2.2.5 (IBC Section 708).
2. A listed ceiling radiation damper installed at the ceiling line where a duct penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.
3. A listed ceiling radiation damper installed at the ceiling line where a diffuser with no duct attached penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.

5.2.2.13.6.2.1 (IBC 716.6.2.1) Ceiling radiation dampers. Ceiling radiation dampers shall be tested as part of a fire-resistance-rated floor/ceiling or roof/ceiling assembly in accordance with ASTM E 119 or UL 263. Ceiling radiation dampers shall be installed in accordance with the details listed in the fire-resistance-rated assembly and the manufacturer's installation instructions and the listing. Ceiling radiation dampers are not required where either of the following applies:

1. Tests in accordance with ASTM E 119 or UL 263 have shown that ceiling radiation dampers are not necessary in order to maintain the fire-resistance rating of the assembly.
2. Where exhaust duct penetrations are protected in accordance with Section 5.2.2.10.2.1.2 (IBC Section 713.4.1.2), are located within the cavity of a wall and do not pass through another dwelling unit or tenant space.

5.2.2.13.6.3 (IBC 716.6.3) Nonfire-resistance-rated floor assemblies. Duct systems constructed of approved materials in accordance with the *International Mechanical Code* that penetrate nonfire-resistance-rated floor assemblies shall be protected by any of the following methods:

1. A shaft enclosure in accordance with Section 5.2.2.5 (IBC Section 708).
2. The duct connects not more than two stories, and the annular space around the penetrating duct is protected with an approved noncombustible material that resists the free passage of flame and the products of combustion.
3. The duct connects not more than three stories, and the annular space around the penetrating duct is protected with an approved noncombustible material that resists the free passage of flame and the products of combustion and a fire damper is installed at each floor line.

Exception: Reserved.

5.2.2.13.7 (IBC 716.7) Flexible ducts and air connectors. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly. Flexible air connectors shall not pass through any wall, floor or ceiling.

5.2.3 ALTERNATE MEANS OF VERIFICATION

- 5.2.3.1 Requirements related to passive fire protection systems for business occupancies, as addressed in Chapter 7 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for passive fire protection systems can be demonstrated by compliance with applicable sections of Chapter 7 of the 2009 IBC.

5.3 INTERIOR FINISH CONSIDERATIONS

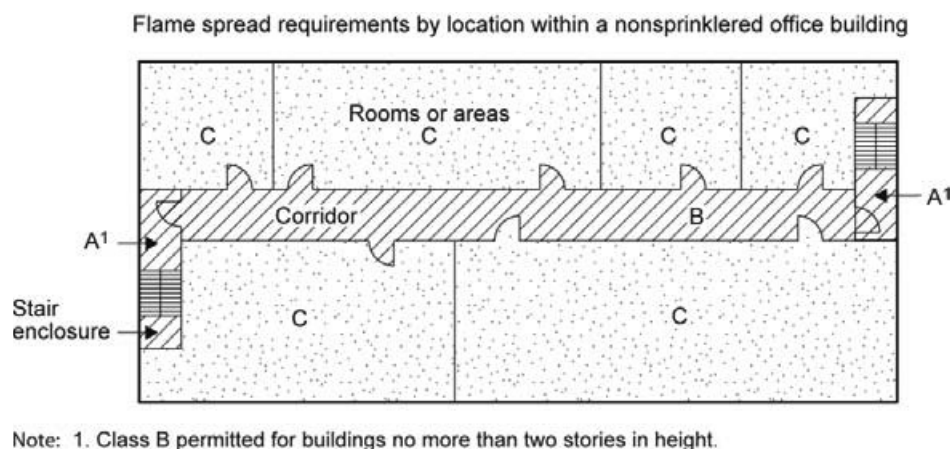
5.3.0 OVERVIEW AND KEY CONCEPTS

As one might expect, the amount of fuel available to burn will have a significant impact on the ultimate size of a fire. The location and orientation of the fuel plays a role as well. While building regulations generally do not control the fuel load as embodied within normal contents (e.g., desks, chairs, book shelves and such in offices), the use of combustible interior finish materials may be controlled in terms of ignitability, propensity to spread flame, amount and orientation. Of particular concern is the use of combustible materials in paths of egress, particularly on upper walls and ceilings, which if ignited, could impact occupant evacuation as well as contribute to flame, smoke and fire spread.

To address these concerns, care should be exercised in the selection and use of materials used as interior finishes, including interior wall and ceiling linings/finishes, floor coverings/finishes, decorative materials, trim on walls and ceilings, wall, ceiling and floor insulation, and acoustical or other suspended ceiling systems. In many building regulations, interior finish materials are addressed in two ways: materials are subjected to standard fire tests in order to classify (rate) them in terms of ignition, flame spread and smoke generation at different temperatures and radiant heat fluxes, and the regulations specify which class (category) of material can be used in which locations.

Given the variation between test standards and building regulations, there is no globally common classification/rating scheme or set of regulatory requirements. However, as a general rule, ratings relate to flame spread distance and smoke production with time, and utilize a letter scheme, such as A for “best” performers and C for “least”. Likewise, within regulations, vertical exit enclosures and exit passageways are regulated at the highest level of performance because of their importance as exit components in the means of egress. Corridors are also highly regulated, but not to the extent that vertical exit enclosures and exit passageways are. Requirements for other rooms and areas are not as restrictive; however, the wall and ceiling finishes are still regulated to some degree.

The concept is illustrated in the figure below, which reflects the maximum flame spread classification of finish materials in the 2009 *International Building Code*® (IBC®) based on location for a nonsprinklered office building.



Flame-spread requirements by location within a nonsprinklered office building within the IBC (source IBC handbook, 2009, Figure 803-1)

INTERIOR FINISH CONSIDERATIONS

Key considerations for interior finish materials are summarized in the table below. More detailed discussion on design requirements can be found in Section 5.3.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED FIRE PROTECTION	CONSEQUENCES OF DESIGN CONSIDERATIONS
Contribution to fuel load	The total fuel load influences the size of a potential fire, how long it may burn, and the propensity for fire spread.	Increased use of combustible interior finish materials adds to the overall fuel load in a building.
Contribution to flame spread	The ability of a material to support flame spread increases the possibility for spreading fire along the surface of the material.	Use of combustible interior finish materials, particularly along upper walls and ceilings, can significantly contribute to fire spread. Where this occurs within the exit system, means of egress could be rendered untenable. Materials with higher resistance to spread of flame help to reduce the risk of flame spread.
Contribution to smoke production	The amount of smoke and toxic products of combustion released by a burning material can play a significant role in the tenability of building spaces, in particular components of the exit system.	Use of combustible interior finish materials, particularly along upper walls and ceilings, can significantly contribute to development and spread of smoke and toxic products of combustion. Where this occurs within the exit system, means of egress could be rendered untenable. Materials with higher resistance to development of smoke and toxic products of combustion, particularly within the exit system, helps to reduce the risk of rendering the exit system untenable.

5.3.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Interior finishes in all UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 5.3.2. A list of alternate means of verification is provided in Section 5.3.3.

5.3.1.1 Materials used as interior finishes for walls, ceilings and floors shall be appropriate to the fire hazard, risk to occupants, ability to provide for a safe means of egress, and other building fire protection systems and features.

5.3.1.1.1 Materials used for interior finishes on walls, ceilings and floors must be tested and listed for use in accordance with a recognized standard for flame spread and smoke production, and shall be classified according to the requirements of the standard.

5.3.1.1.2 Temporary wall or ceiling decorations, artwork, poster boards and similar may be approved by the local authority having jurisdiction (AHJ) with any restrictions on location, type of material, test requirements, amount and distribution imposed by the AHJ.

5.3.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

Section 5.3.2.1 (IBC 803) Wall and Ceiling Finishes

5.3.2.1.1 (IBC 803.1) General. *Interior wall and ceiling finish materials* shall be classified for fire performance and smoke development in accordance with Section 5.3.2.1.1.1 or 5.3.2.1.1.2 (IBC Section 803.1.1 or 803.1.2), except as shown in IBC Sections 803.2 through 803.13. Materials tested in accordance with Section 5.3.2.1.1.2 (IBC Section 803.1.2) shall not be required to be tested in accordance with Section 5.3.2.1.1.1 (IBC Section 803.1.1).

5.3.2.1.1.1 (IBC 803.1.1) Interior wall and ceiling finish materials. Interior wall and ceiling finish materials shall be classified in accordance with ASTM E 84 or UL 723. Such *interior finish materials* shall be grouped in the following classes in accordance with their flame spread and *smoke-developed indexes*.

Class A: Flame spread index 0-25; smoke-developed index 0-450.

Class B: Flame spread index 26-75; smoke-developed index 0-450.

Class C: Flame spread index 76-200; smoke-developed index 0-450.

Exception: Materials tested in accordance with Section 5.3.2.1.1.2 (IBC Section 803.1.2).

5.3.2.1.1.2 (IBC 803.1.2) Room corner test for interior wall or ceiling finish materials. *Interior wall or ceiling finish materials* shall be permitted to be tested in accordance with NFPA 286. Interior wall or ceiling finish materials tested in accordance with NFPA 286 shall comply with IBC Section 803.1.2.1.

5.3.2.1.2 (IBC 803.9) Interior finish requirements based on group. *Interior wall and ceiling finish* shall have a flame spread index not greater than that specified in Table 5.3.2.1.2 (IBC Table 803.9) for the group and location designated. *Interior wall and ceiling finish materials* tested in accordance with NFPA 286 and meeting the acceptance criteria of IBC Section 803.1.2.1, shall be permitted to be used where a Class A classification in accordance with ASTM E 84 or UL 723 is required.

TABLE 5.3.2.1.2 (IBC TABLE 803.9)
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY^k

GROUP	SPRINKLERED ^l			NONSPRINKLERED		
	Exit enclosures and exit passageways ^{a, b}	Corridors	Rooms and enclosed spaces ^c	Exit enclosures and exit passageways ^{a, b}	Corridors	Rooms and enclosed spaces ^c
A-3 ^f	B	B	C	A	A ^d	C
B	B	C	C	A	B	C
U	No restrictions			No restrictions		

- Class C interior finish materials shall be permitted for wainscotting or paneling of not more than 93 m² of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 5.3.2.1.4.1 (IBC Section 803.11.1).
- In exit enclosures of buildings less than three stories above grade plane of Class B interior finish for nonsprinklered buildings and Class C interior finish for sprinklered buildings shall be permitted.
- Requirements for rooms and enclosed spaces shall be based upon spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered enclosing spaces and the rooms or spaces on both sides shall be considered one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.
- Lobby areas in Group A-3 occupancies shall not be less than Class B materials.
- Class C interior finish materials shall be permitted in places of assembly with an occupant load of 300 persons or less.
- For places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be permitted.
- Class B material is required where the building exceeds two stories.
- Class C interior finish materials shall be permitted in administrative spaces.
- Class C interior finish materials shall be permitted in rooms with a capacity of four persons or less.
- Class B materials shall be permitted as wainscotting extending not more than 1.20 m above the finished floor in corridors.
- Finish materials as provided for in other sections of these guidelines.
- Applies when the exit enclosures, exit passageways, corridors or rooms and enclosed spaces are protected by an automatic sprinkler system installed in accordance with NFPA 13.

5.3.2.1.3 (IBC 803.10) Stability. *Interior finish* materials regulated by this chapter shall be applied or otherwise fastened in such a manner that such materials will not readily become detached where subjected to room temperatures of 93.50°C for not less than 30 minutes.

5.3.2.1.4 (IBC 803.11) Application of interior finish materials to fire-resistance-rated structural elements. Where *interior finish* materials are applied on walls, ceilings or structural elements required to have a *fire-resistance rating* or to be of noncombustible construction, they shall comply with the provisions of this section.

5.3.2.1.4.1 (IBC 803.11.1) Direct attachment and furred construction. Where walls and ceilings are required by any provision in these guidelines to be of fire-resistance-rated or noncombustible construction, the *interior finish* material shall be applied directly against such construction or to furring strips not exceeding 4 cm applied directly against such surfaces. The intervening spaces between such furring strips shall comply with one of the following:

1. Be filled with material that is inorganic or noncombustible
2. Be filled with material that meets the requirements of a Class A material in accordance with Section 5.3.2.1.1.1 or 5.3.2.1.1.2 (IBC Section 803.1.1 or 803.1.2); or
3. Be fireblocked at a maximum of 2.45 m in any direction in accordance with IBC Section 717.

5.3.2.1.4.2 (IBC 803.11.2) Set-out construction. Where walls and ceilings are required to be of fire-resistance-rated or noncombustible construction and walls are set out or ceilings are dropped distances greater than specified in Section 5.3.2.1.4.1 (IBC Section 803.11.1), Class A finish materials, in accordance with Section 5.3.2.1.1.1 or 5.3.2.1.1.2 (IBC Section 803.1.1 or 803.1.2), shall be used except where *interior finish* materials are protected on both sides by an *automatic sprinkler system* in accordance with NFPA 13, or attached to noncombustible backing or furring strips installed as specified in Section 5.3.2.1.4.1 (IBC Section 803.11.1). The hangers and assembly members of such dropped ceilings that are below the main ceiling line shall be of noncombustible materials, except that in Types III and V construction, *fire-retardant-treated wood* shall be permitted. The construction of each set-out wall shall be of fire-resistance-rated construction as required elsewhere in these guidelines.

5.3.2.1.4.3 (IBC 803.11.3) Heavy timber construction. Wall and ceiling finishes of all classes as permitted in this chapter that are installed directly against the wood decking or planking of Type IV construction or to wood furring strips applied directly to the wood decking or planking shall be fireblocked as specified in Section 5.3.2.1.4.1 (IBC Section 803.11.1).

5.3.2.1.4.4 (IBC 803.11.4) Materials. An interior wall or ceiling finish that is not more than 6.35 mm thick shall be applied directly against a noncombustible backing.

Exceptions:

1. Noncombustible materials.
2. Materials where the qualifying tests were made with the material suspended or furred out from the noncombustible backing.

SECTION 5.3.2.2 (IBC 804) INTERIOR FLOOR FINISH

5.3.2.2.1 (IBC 804.1) General. *Interior floor finish* and floor covering materials shall comply with Sections 5.3.2.2.2 through 5.3.2.2.4.1 (IBC Sections 804.2 through 804.4.1).

Exception: Floor finishes and coverings of a traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials that are not comprised of fibers.

5.3.2.2.2 (IBC 804.2) Classification. *Interior floor finish* and floor covering materials required by Section 5.3.2.2.4.1 (IBC Section 804.4.1) to be of Class I or II materials shall be classified in accordance with NFPA 253. The classification referred to herein corresponds to the classifications determined by NFPA 253 as follows: Class I, 0.45 W/cm² or greater; Class II, 0.22 W/cm² or greater.

5.3.2.2.3 (IBC 804.3) Testing and identification. *Interior floor finish* and floor covering materials shall be tested by an agency in accordance with NFPA 253 and identified by a hang tag or other suitable method so as to identify the manufacturer or supplier and style, and shall indicate the *interior floor finish* or floor covering classification according to Section 5.3.2.2.2 (IBC Section 804.2). Carpet-type floor coverings shall be tested as proposed for use, including

INTERIOR FINISH CONSIDERATIONS

underlayment. Test reports confirming the information provided in the manufacturer's product identification shall be furnished to the building official upon request.

5.3.2.2.4 (IBC 804.4) Interior floor finish requirements. In all occupancies, *interior floor finish* and floor covering materials in *exit* enclosures, *exit* passageways, corridors and rooms or spaces not separated from corridors by full-height partitions extending from the floor to the underside of the ceiling shall withstand a minimum critical radiant flux as specified in Section 5.3.2.2.4.1 (IBC Section 804.4.1).

5.3.2.2.4.1 (IBC 804.4.1) Minimum critical radiant flux. *Interior floor finish* and floor covering materials in exit enclosures, *exit* passageways and corridors shall not be less than Class II in Groups A and B. In all areas, floor covering materials shall comply with the DOC FF-1 "pill test" (CPSC 16 CFR, Part 1630).

Exception: Where a building is equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13, Class II materials are permitted in any area where Class I materials are required, and materials complying with the DOC FF-1 "pill test" (CPSC 16 CFR, Part 1630) are permitted in any area where Class II materials are required.

5.3.3 ALTERNATE MEANS OF VERIFICATION

- 5.3.3.1 Requirements related to interior finishes for business occupancies, as addressed in Chapter 8 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for interior finishes can be demonstrated by compliance with applicable sections of Chapter 8 of the 2009 IBC.

5.4 ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.4.0 OVERVIEW AND KEY CONCEPTS

The term “active fire protection system” broadly refers to fire protection systems which require electrical or mechanical power to activate, operate or perform their intended function. This includes systems for fire suppression, detection, communication and smoke control (management).

Automatic Fire Suppression Systems

Automatic fire suppression systems encompass any system intended to suppress or extinguish a fire without the need for manual intervention. The most common automatic fire suppression system is the automatic fire sprinkler system. There are other water-based systems as well, including fine water mist, deluge and foam systems, which are variations on the theme (water, pipes and nozzles). There are also gaseous and chemical fire extinguishing systems, which are typically used for special applications, such as in electrical equipment rooms, kitchen range hoods and similar uses. For the purpose of the guidelines, the focus will be on automatic sprinkler systems, with a brief discussion on alternative systems.

In concept, automatic sprinkler systems are simple, comprised of a water supply, distribution network (risers and branch lines), control valves, and sprinkler heads (water discharge), as illustrated on the right. The intent is to deliver water to the general location of where a fire is burning to control the spread of fire in order to facilitate evacuation and limit damage to property while the fire service responds. If detected early enough, and if sufficient water is delivered to the fire, only a small amount of water is needed to control a fire. In cases where the initial fire is small, and the fuel load limited, the sprinkler system may suppress (extinguish) the fire. Each sprinkler head operates individually (i.e., they do not all activate at the same time). Sprinkler systems can be “wet” or “dry,” i.e., water is always in the system, or water is introduced only when a sprinkler head or other detection device actuates. Wet systems are most common. Dry systems may be used in such cases as when sub-freezing temperatures are a concern (e.g., unconditioned storage building, loading dock, attic spaces, etc.). Water flow and pressure requirements will be established in relevant design and installation standards.

A sprinkler head is activated when the heat from a fire melts a fusible link, which in turn releases a cap (cover) whose function is to contain the water in the system, allowing the water to discharge onto the fire. The shape of



the deflector drives the resulting pattern of water spray. Typical sprinkler activation temperatures are in the range of 57°C – 80°C, although much higher activation temperature heads are also available for use where the ambient room temperatures are high. Temperature ratings, response time indices, flow and pressure specifications are generally based on the hazard classification for a space, which is typically “light” for office occupancies. Different sprinkler head designs are available for mounting in an upright, downward (pendant), or sideways (side wall) orientation.

As noted above, there are some situations for which automatic suppression system options other than sprinklers may be viable, appropriate or even necessary. For the purpose of these guidelines, such systems are referred to as alternative automatic fire-extinguishing systems. Water-based systems include fine water mist systems, deluge systems and foam systems. Fire water mist systems are typically high-pressure systems which use less water than sprinklers. Such systems may be viable in small volume spaces with limited water supply. Deluge systems apply a large amount of wa-

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

ter to all heads simultaneously. Although a variation on a sprinkler system, the heads do not have fusible links, so water flows from all heads when the system is actuated. Such systems are used for water curtains and similar applications. Foam systems employ additives to either provide a layer of material on the surface of the resulting water pool to help smother a fire (used for fuel storage tanks, for example) or to result in large volumes of lightweight foam (like a thick layer of soap bubbles) to engulf and surround the materials to be protected.

Gaseous systems deliver either inert gas or gaseous compounds to reduce the oxygen to support combustion, interrupt the chemical reaction supporting combustion, or transfer heat away from the reacting materials. These systems can be total flooding (completely fill the space of concern, such as the former halons, current halon replacements, and CO₂) or applied locally (e.g., CO₂ fire extinguisher). Typical applications are computer, data or electrical equipment rooms. Chemical fire extinguishing systems deliver chemical compounds, typically in dry powder form, to smother a fire or to interrupt the chemical reaction supporting combustion. Typical applications include hand-held fire extinguishers and kitchen exhaust hood extinguishing systems.

Manual Fire Suppression Systems

Manual fire suppression systems include all systems which require human intervention and action, whether trained fire service, trained fire brigade or trained building occupant. These systems include internal standpipe (hydrant) systems, interior hose systems and portable fire extinguishers.

Standpipe (hydrant) systems are comprised of interior risers and branch lines aimed at distributing the fire suppression water supply to various points in a building, primarily for the use of the responding fire service, for connection of hoses to facilitate manual fire suppression operations. Such systems are generally seen in high-rise or large floor-plate buildings, where it is more challenging to effect fire suppression operations from outside of the building. As illustrated in the image on the right, outlets will typically be a combination of on/off valve and fire service connection, which should be matched to the threads on hoses used by the local fire service. In tall buildings, such systems will include pressure reducing valves to regulate pressure to appropriate levels at each floor.



Although generally discouraged in many countries, some countries allow for interior hose systems for use by either responding fire fighters or trained building occupants. Such systems are often characterized by small diameter, rigid hose (like garden hose) on hose reels (often called hose reel systems). These systems allow the user to turn on the water immediately and move toward the fire with a charged line. In some cases, interior hose systems have folded or rolled flat flexible hose, which needs to be first extended before the water supply is turned on.

Portable fire extinguishers discharge small amounts of water, gaseous or chemical fire extinguishing agents when activated. Portable fire extinguishers are rated based on the suitability of the extinguishing agent for the expected hazard. The rating scheme varies by country and region, but for office occupancies, a multi-use rating suitable for paper, liquid fuel and electrical sources is common.

Fire Suppression Water Supplies

The efficacy of any fixed water-based automatic or manual suppression system in a building is strongly related to the appropriateness and reliability of the water supply. There are three primary sources: piped supply (mains), on-site storage (tanks or perhaps ponds), and fire service connections (to standpipe or sprinkler system). When assessing

building fire suppression system needs, the type of system, source of water, and reliability of the system should be considered, especially where water supply infrastructure may be unreliable or water resources are limited. Fire suppression water flow rates, pressures and minimum supply (quantity or time) requirements will be established by relevant design and installation standards for suppression systems and water supplies.

Piped (mains) systems typically rely on a local or regional water authority (government or privately owned and/or operated) to provide a connection from the nearest water main(s) into the building. To minimize the potential for loss of water supply due to a problem with the water authority system, it is generally recommended to have two separate lines into a building, particularly for high-rise or large area buildings. Inside of the building, a series of check valve, backflow prevention valves and other controls are used to isolate the fire suppression water from potable supplies. Where increased pressure is needed to support the hydraulic demands of sprinkler or standpipe systems, fire pumps may be used (see below).

In locations where there is no water authority piped mains system, the water supply infrastructure is unreliable, a supplemental water supply may be needed within the building, or water shortages can be expected due to climatic conditions (e.g., drought), on-site storage is an option. In high-rise buildings, this may involve tanks within the building (basement, upper floors or roof). For water mist systems, there may be numerous tanks distributed in areas protected by the system. In some cases, the use of a dedicated fire suppression water pond or other outside source may be considered, but only if suitable controls are placed on screening of debris and the water supply (source) can be considered suitably reliable (e.g., it would be inappropriate to rely on a source which cannot be expected to meet demands at any time).



Fire Pump⁵

In locations where the water authority main supply lacks the pressure or flow rate to meet the design requirements for sprinklers and/or standpipe systems, a fire pump may be needed. Fire pumps come in a variety of sizes based on system design parameters, but are often located near the incoming mains (or on-site storage, if at a low level) and supply directly into the sprinkler and/or standpipe systems. Fire pumps are typically powered by diesel or electric motors, with a suitable emergency backup power source. Fire pumps should be sized to meet fire suppression needs for a period of time commensurate with the automatic and manual fire suppression systems design parameters (i.e., most installation standards require flow and pressure criteria to be met for some minimum period of time).

In some buildings, particularly high-rise buildings, there will typically be fire service (fire department) connections outside of the building which allow connection from the responding fire apparatus into the building's sprinkler and/or standpipe systems. These connections may be built into the exterior wall, come up through the ground (sidewalk or other surface), or have some other suitable arrangement. Threads of these external fire service connections should match local fire service hose connections.



⁵ Source: Milosh Puchovsky

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

Fire Detection, Alarm and Communication Systems

Fire detection, alarm and communications systems provide for the opportunity to detect fire through a wide range of automatic fire detection devices, provide a means for manual fire alarm initiation, provide for a range of alarm signaling capabilities [audible (voice or non-voice) and visual], and provide interfaces with other fire protection systems (such as smoke control/management systems) and other building systems, as appropriate. The types of fire detection, alarm and communication equipment required in office buildings varies widely by country and local regulation, as well as by other fire safety systems installed.



Automatic fire detection devices include smoke, heat, gas (e.g., CO), and flame detectors, as well as water flow switches within sprinkler systems, and occasionally other safety related initiation devices. In office buildings, automatic fire detection is typically limited to smoke detection (spot type, beam type, in-duct or other, as appropriate) and sprinkler water flow switches. The extent to which smoke detectors are required varies based on building height, presence of sprinklers and other fire protection systems, and country within which the building is located [e.g., if sprinklers are installed, area smoke detection typically is not required; in high-rise buildings, smoke detectors are usually found in elevator (lift) lobbies to initiate elevator recall; etc.].

Manual fire alarm stations (boxes, points, buttons) are used to manually activate the fire alarm system. Manual fire alarm stations are typically located near exit doors which discharge directly to the outside, as well as at the entry point to an exit enclosure (e.g., exit stairway) in multistory buildings, and within predetermined travel distances within buildings with long travel distances to an exit.



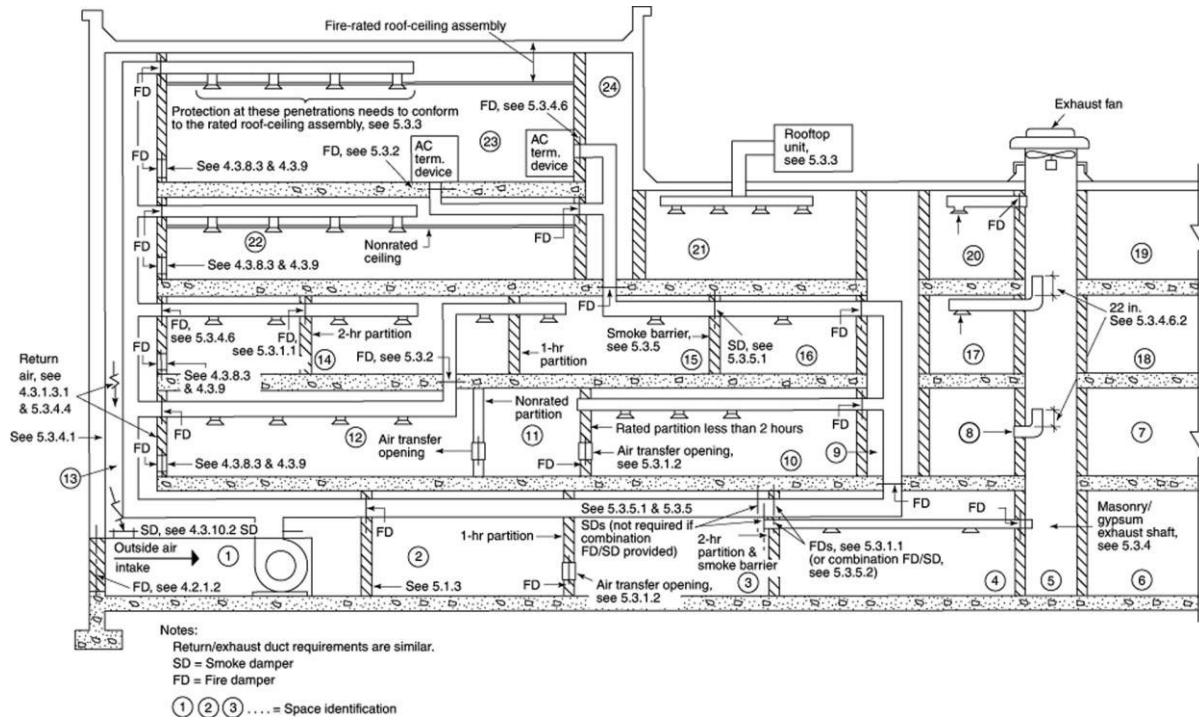
Fire detection and alarm systems are typically controlled by a fire alarm control unit (panel, system). The fire alarm control unit (FACU) receives input from automatic fire detection and manual alarm devices, initiates alarm signals to occupants within the building, and in some cases, notifies the local fire service, and when needed, activates other fire protection systems, such as door releases, smoke exhaust fans and dampers, and so forth. FACUs and alarm signaling systems (see below) require reliable primary and back-up power.

The fire alarm, or occupant notification, component typically consists of audible and visual signals. Audible signals may be provided by bells, horns, buzzers or similar non-voice devices, or by audio speakers. In some situations, such as high-rise buildings, pre-recorded and live voice systems are required. Visual signals are typically provided by strobe lights or other approved visual alarm indicators. High-rise buildings may also require two-way communication systems for use by firefighters, typically located within or near stairways and elevator lobbies.

Smoke control (management) systems

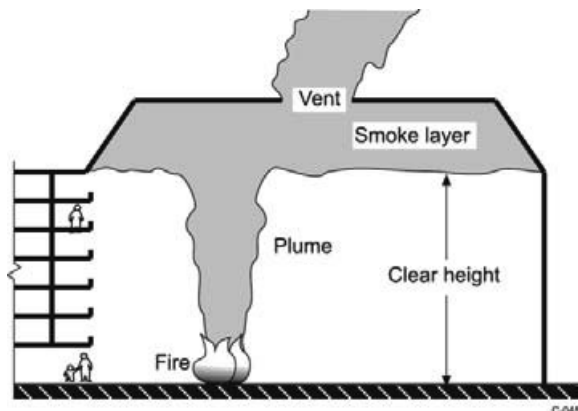
Smoke control systems, or smoke management systems as they are also known, serve two primary functions: restricting the passage of smoke from one area to another, and venting or exhausting smoke from a building or portion of a building to the outside. Systems designed to restrict the passage of smoke from one area to another may use dampers in ductwork and return air plenums and may use fans to provide pressure differentials (to keep smoke contained to a specific area). They are often coupled with either independent smoke detection devices (such as in-duct smoke detectors) to close dampers, or may receive input from a fire alarm control unit or building management system. Such systems may require the use of self-closing doors or employ automatic door release/closure devices, where doors are electromechanically held open during normal use, but release (close) upon activation of a local smoke detector or the fire alarm system. Smoke control systems need to be closely coordinated with passive fire protection systems.

Smoke control systems can be complex, with requirements varying by country or region, as well as by standard. An illustration of the types and locations of smoke control and passive fire protection features and components aimed at restricting the passage of smoke from one area to another is provided below.⁶



The concept of using positive and negative pressure to contain or restrict the passage of smoke can be targeted at whatever level is desired [e.g., floor of a building, compartment within a floor, exit stair enclosures, stair or elevator vestibule (lobby), etc.] and may be required in some instances, such as within high-rise buildings.

Smoke control or management systems used specifically to exhaust smoke from a particular space, such as an atrium, may employ natural ventilation (i.e., smoke or heat actuated vents) or mechanical exhaust. In either case, the aim is to provide sufficient venting or exhaust capacity to remove the required amount of smoke for the target time. Such systems are often used to maintain the smoke layer above a certain point from the highest occupied floor level during occupant evacuation, as illustrated to the right.



Key aspects for the design of a smoke exhaust system include the design fire size (which dictates how much smoke will be produced), the level at which the smoke layer needs to be maintained and for how long, the availability of make-up air and the location and size of vents or exhaust ducts and fans. Reliable primary and back-up power is required.

⁶ Reprinted with permission from NFPA 90A, *Installation of Warm Air Heating and Air-conditioning Systems*, Copyright© 2009, National Fire Protection Association. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the Standard in its entirety.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

Fire Command Center

In high-rise buildings, it is common to have a fire command center, which is a secure and protected space within a building, near a main entrance on the level of building access, for use by fire service command when responding to a fire or other emergency event. The fire command center typically houses either the fire alarm control unit or a remote control station for such, any fan control for smoke management systems, microphone and controls for voice alarm signaling, elevator controls, and other building management or security systems, displays or controls as deemed necessary to understand the situation and communicate with occupants and fire fighters as appropriate. Fire command centers often contain building layouts and other critical information to help facilitate fire-fighting and emergency response activities.

Summary

Key considerations for active fire protection systems are summarized in the table below. More detailed discussion on design requirements can be found in Section 5.4.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED FIRE PROTECTION	CONSEQUENCES OF DESIGN CONSIDERATIONS
Automatic fire suppression required or desired	Life and property protection. Choice of automatic sprinkler systems and/or alternate automatic fire extinguishing systems.	All automatic fire suppression systems and components need to be maintained, inspected and tested to assure proper operation. Water based systems require a reliable water supply. Alternate fire extinguishing systems need to be matched to the hazard.
Manual fire suppression required or desired	Life and property protection. Choice of standpipe systems and/or portable fire extinguishers.	All manual fire suppression systems and components need to be maintained, inspected and tested to assure proper operation. Water based systems require a reliable water supply. Portable fire extinguishers need to be matched to the hazard.
Water supply	Life and property protection. May come from water authority mains or local water storage.	Fire suppression water supplies need to reliably be able to provide the necessary amount, flow rate and pressure needed for the required amount of time (based on standards or design). The water supply system and components (e.g., tanks, valves and pumps) need to be maintained, inspected and tested to assure proper operation. Reliable primary and backup power is needed for pumps.
Fire detection, alarm and communication systems	Occupant notification and evacuation, fire service notification, smoke control system activation.	All detection, alarm and communication systems and components need to be maintained, inspected and tested to assure proper operation. Reliable primary and backup power is needed.
Smoke control system	Life safety via restriction of smoke spread, maintaining tenable conditions in egress paths, and smoke exhaust.	All smoke control systems and components need to be maintained, inspected and tested to assure proper operation. Reliable primary and backup power is needed.
Fire command center	Occupant and emergency responder life safety.	Provides base for fire/emergency command operations on site. Needs to be accessible and protected.

5.4.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Active fire protection systems and features in all UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 5.4.2. A list of alternative means of verification is provided in Section 5.4.3.

- 5.4.1.1 Fire protection systems shall be designed, installed, tested, operated and maintained so as to provide their intended function throughout the installed life of the systems.
 - 5.4.1.1.1 Any fire protection system installed in the building shall be listed for the purpose by a recognized testing and approval laboratory.
 - 5.4.1.1.2 Inspection, testing and reporting on the condition and operability of installed fire protection systems shall be in accordance with the design standards used for each system, but in no case any less frequent than once per annum.
 - 5.4.1.1.3 Design, installation, testing, operation and maintenance of any fire protection system shall be by suitably qualified, registered and/or licensed individuals or firms.
 - 5.4.1.1.4 Disconnecting, disabling, removing or modifying of any fire protection system installed or maintained under the provisions of these guidelines shall only be permitted with the written approval of the local authority having jurisdiction (e.g., fire department, building department, or other designated authority).
- 5.4.1.2 The primary function of an automatic sprinkler system is to deliver fire suppression water to the location of a fire without the need for human intervention.
 - 5.4.1.2.1 Automatic sprinkler systems shall be designed, installed, tested, operated and maintained so that when actuated, the appropriate flow and pressure of water will automatically be released from the actuated sprinkler head(s) without the need for human intervention.
 - 5.4.1.2.2 Automatic sprinkler systems shall be designed, installed, tested, operated and maintained in accordance with Section 5.4.2 of this chapter.
- 5.4.1.3 The primary function of a standpipe (internal hydrant) system is to deliver fire suppression water to points inside of a building to facilitate manual fire suppression by the fire service or qualified internal fire brigade.
 - 5.4.1.3.1 Standpipe systems shall be designed, installed, tested, operated and maintained so that when actuated, the appropriate flow and pressure of water will be released at the required point of discharge. For wet standpipe systems, the fire suppression system water shall be available upon demand. For dry standpipe systems, for which fire suppression water is supplied via connection to responding firefighting apparatus, the fire suppression system water shall be available within a reasonably short period after the arrival of the apparatus, but in no case within less time than mandated by the relevant design, installation and operation standard.
 - 5.4.1.3.2 Standpipe systems shall be designed, installed, tested, operated and maintained in accordance with an internationally recognized standard for internal standpipe systems.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

- 5.4.1.4 The primary function of a fire suppression water supply infrastructure is to provide a reliable source of fire suppression water, for automatic sprinkler and manual fire suppression systems installed within the building, that is available when needed as appropriate to the installed automatic sprinkler and manual fire suppression systems, and which supplies water for the amount of time deemed necessary by the automatic and manual fire suppression systems designs.
 - 5.4.1.4.1 Whenever an automatic sprinkler system or wet standpipe system is installed in the building, the building shall be supplied by a municipal (governmental) water supply network, or be provided with on-site storage of fire suppression water, that meets or exceeds minimum requirements for fire suppression water supply requirements for automatic and manual fire suppression systems installed in the building.
 - 5.4.1.4.2 Water supply and storage systems shall be designed, installed, tested, operated and maintained in accordance with an internationally recognized standard for fire suppression water supply or storage systems, as appropriate.
- 5.4.1.5 The primary function of a fire pump is to assure that required fire suppression water flow rates and pressures are available to all automatic sprinkler systems and manual fire suppression systems installed throughout a building.
 - 5.4.1.5.1 When installed, fire pumps shall be designed (sized), installed, tested, operated and maintained so that when actuated, the appropriate flow and pressure of water will automatically be provided to connected automatic sprinkler systems and standpipe systems without the need for human intervention.
 - 5.4.1.5.2 Automatic sprinkler systems shall be designed, installed, tested, operated and maintained in accordance with an internationally recognized standard for fire pumps.
- 5.4.1.6 There are two primary functions for fire department connections: (a) provide the ability for the local fire service to connect apparatus to the building dry standpipe system, and (b) provide the ability for the local fire service to connect their fire hoses to the internal standpipe system for manual fire suppression.
 - 5.4.1.6.1 Threads provided for fire department connections to sprinkler systems, standpipes, yard hydrants or any other fire hose connection shall be compatible with the connections used by the local fire department.
- 5.4.1.7 The primary function of an alternative automatic fire-extinguishing system is to provide for automatic means of fire suppression other than via the use of an automatic sprinkler system. Alternative automatic fire extinguishing systems may include, among other suppression agents, fine water mist, gaseous agents (including inert gases), and powdered chemicals.
 - 5.4.1.7.1 When installed, alternative automatic fire extinguishing systems shall be designed, installed, tested, operated and maintained appropriate to the hazard and risk and such that when actuated, the appropriate flow and pressure of extinguishing agent will automatically be released without the need for human intervention.
 - 5.4.1.7.2 When installed, alternative automatic fire extinguishing systems shall be designed, installed, tested, operated and maintained in accordance with Section 5.4.2 of this chapter.

- 5.4.1.8 The primary function of portable fire extinguishers is to provide building occupants with a means of extinguishing very small fires.
- 5.4.1.8.1 When installed, portable fire extinguishers shall be located, installed, tested, operated and maintained in accordance with Section 5.4.2.
- 5.4.1.9 The primary function of a fire detection and alarm system is to provide early detection and notification of a fire within a building, and may include activation or control functions for closing of smoke doors, recall of elevators, activation of smoke control systems and related fire protection functions.
- 5.4.1.9.1 Where required, automatic fire detection shall be provided via individual or combination smoke, heat, gas and flame detection devices, and/or sprinkler system water flow devices, connected to a fire alarm control panel, which when actuated, will cause the indication of a fire condition at the fire alarm control unit, will automatically notify occupants without the need for human intervention, and may notify the local fire service of the fire, as appropriate.
- 5.4.1.9.2 Where automatic sprinkler systems are installed, all valves controlling the water supply for automatic sprinkler systems serving more than 20 sprinklers, as well as pumps, tanks, water levels and temperatures, critical air pressures and water flow switches on all sprinkler systems shall be electrically supervised by a *listed* fire alarm control unit (with the exception of Jockey pump control valves, valves controlling the fuel supply to fire pump engines, and trim valves to pressure switches in dry, pre-action and deluge sprinkler systems that are sealed or locked in the open position).
- 5.4.1.9.3 Manual alarm points (buttons, stations, boxes), when actuated, shall cause the indication of a fire condition at the fire alarm control unit, automatically notify occupants of a fire, and as appropriate, notify the local fire service of the fire.
- 5.4.1.9.4 When installed, fire detection and alarm systems shall be designed, installed, tested, operated and maintained in accordance with an internationally recognized standard for fire detection and alarm systems.
- 5.4.1.10 The primary function of emergency voice alarm communication systems is to provide pre-recorded and/or live voice messages to building occupants in case of fire or other emergency event.
- 5.4.1.10.1 When installed, emergency voice alarm communication systems shall be designed, installed, tested, operated and maintained in accordance with Section 5.4.2.
- 5.4.1.11 The primary functions of a smoke control (smoke management) system are to: restrict the spread of smoke through heating, ventilation and air-conditioning systems and ductwork, and through doorways, by closing dampers, doors or other opening protection devices when smoke is detected, and to mechanically exhaust smoke from a space inside of a building to the outside, usually for the purpose of providing additional time for occupant evacuation or to facilitate firefighting operations.
- 5.4.1.11.1 When installed, smoke control (management) systems shall be designed, installed, tested, operated and maintained in accordance with an internationally recognized standard for smoke control (management) systems.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.4.1.12 The primary function of a fire command center is to provide a common, easily accessible and protected location for all fire and emergency building systems control equipment for use by responding fire service personnel in the event of fire or other emergency in the building.

5.4.1.12.1 When installed, a fire command center shall be designed, operated and maintained in accordance with local regulations and fire service requirements.

5.4.1.12.2 Fire command centers should be designed to withstand the fire, natural and deliberate events of concern for the building.

5.4.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

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SECTION 5.4.2.1 (IBC 901) GENERAL – FIRE PROTECTION SYSTEMS

5.4.2.1.1 (IBC 901.1) Scope. The provisions of this chapter shall specify where *fire protection systems* are required and shall apply to the design, installation and operation of *fire protection systems*.

5.4.2.1.2 (IBC 901.2) Fire protection systems. *Fire protection systems* shall be installed, repaired, operated and maintained in accordance with these guidelines and the *International Fire Code*.

Any *fire protection system* for which an exception or reduction to the provisions of these guidelines has been granted shall be considered to be a required system.

Exception: Any *fire protection system* or portion thereof not required by these guidelines shall be permitted to be installed for partial or complete protection provided that such system meets the requirements of these guidelines.

5.4.2.1.3 (IBC 901.6) Supervisory service. Where required, *fire protection systems* shall be monitored by an supervising station in accordance with NFPA 72.

5.4.2.1.3.1 (IBC 901.6.1) Automatic sprinkler systems. Automatic sprinkler systems shall be monitored by an *approved* supervising station.

Exceptions:

1. Reserved.
2. Limited area systems serving fewer than 20 sprinklers.

5.4.2.1.3.2 (IBC 901.6.2) Fire alarm systems. Fire alarm systems required by the provisions of IBC Section 907.2 and Sections 907.2 and 907.3 of the *International Fire Code* shall be monitored by an *approved* supervising station in accordance with Section 907.6.5.

Exceptions:

1. Single- and multiple-station smoke alarms required by IBC Section 907.2.11.
2. Reserved.
3. Reserved.

5.4.2.1.4 (IBC 901.7) Fire areas. Where buildings, or portions thereof, are divided into *fire areas* so as not to exceed the limits established for requiring a *fire protection system* in accordance with this chapter, such *fire areas* shall be separated by *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both, having a *fire-resistance rating* of not less than that determined in accordance with Section 5.2.2.4.3.8 (IBC Section 707.3.9).

SECTION 5.4.2.2 (IBC 903) AUTOMATIC SPRINKLER SYSTEMS

5.4.2.2.1 (IBC [F] 903.2.1.3) Group A-3. An *automatic sprinkler system* shall be provided for Group A-3 occupancies where one of the following conditions exists:

1. The *fire area* exceeds 1100 m²;
2. The *fire area* has an *occupant load* of 300 or more;
or
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.4.2.2.2 (IBC [F] 903.2.11) Specific building areas and hazards. In all occupancies an *automatic sprinkler system* shall be installed for building design or hazards in the locations set forth in Sections 5.4.2.2.2.1 through 5.4.2.2.2.3 of this guideline and IBC Sections 903.2.11.1 through 903.2.11.6.

5.4.2.2.2.1 (IBC [F] 903.2.11.1) Stories without openings. An *automatic sprinkler system* shall be installed throughout all *stories*, including basements, of all buildings where the floor area exceeds 140 m² and where there is not provided at least one of the following types of *exterior wall* openings:

1. Openings below grade that lead directly to ground level by an exterior *stairway* complying with Section 6.1.2.19 (IBC Section 1009) or an outside ramp complying with Section 6.1.2.14 (IBC Section 1010). Openings shall be located in each 15 m, or fraction thereof, of *exterior wall* in the *story* on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 15 m.
2. Openings entirely above the adjoining ground level totaling at least 1.85 m² in each 15 m, or fraction thereof, of *exterior wall* in the *story* on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 15 m.

5.4.2.2.2.1.1 (IBC [F] 903.2.11.1.1) Opening dimensions and access. Openings shall have a minimum dimension of not less than 76 cm. Such openings shall be accessible to the fire department from the exterior and shall not be obstructed in a manner that fire fighting or rescue cannot be accomplished from the exterior.

5.4.2.2.2.1.2 (IBC [F] 903.2.11.1.2) Openings on one side only. Where openings in a *story* are provided on only one side and the opposite wall of such *story* is more than 23 m from such openings, the *story* shall be equipped throughout with an *approved automatic sprinkler system*, or openings as specified above shall be provided on at least two sides of the *story*.

5.4.2.2.2.1.3 (IBC [F] 903.2.11.1.3) Basements. Where any portion of a basement is located more than 23 m from openings required by Section 5.4.2.2.2.1 (IBC Section 903.2.11.1), the basement shall be equipped throughout with an *approved automatic sprinkler system*.

5.4.2.2.2.2 (IBC [F] 903.2.11.2) Rubbish and linen chutes. An *automatic sprinkler system* shall be installed at the top of rubbish and linen chutes and in their terminal rooms. Chutes extending through three or more floors shall have additional sprinkler heads installed within such chutes at alternate floors. Chute sprinklers shall be accessible for servicing.

5.4.2.2.2.3 (IBC [F] 903.2.11.3) Buildings 17 m or more in height. An *automatic sprinkler system* shall be installed throughout buildings with a floor level having an *occupant load* of 30 or more that is located 17 m or more above the lowest level of fire department vehicle access.

SECTION 5.4.2.3 (IBC 904) ALTERNATIVE AUTOMATIC FIRE-EXTINGUISHING SYSTEMS

5.4.2.3.1 (IBC [F] 904.1) General. Automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall be designed, installed, inspected, tested and maintained in accordance with the provisions of this section and the applicable referenced standards.

5.4.2.3.2 (IBC [F] 904.2) Where required. Automatic fire-extinguishing systems installed as an alternative to the required *automatic sprinkler systems* of Section 5.4.2.2 (IBC Section 903) shall be *approved* by the fire code official. Automatic fire-extinguishing systems shall not be considered alternatives for the purposes of exceptions or reductions allowed by other requirements of these guidelines.

5.4.2.3.3 (IBC [F] 904.3) Installation. Automatic fire-extinguishing systems shall be installed in accordance with this section.

5.4.2.3.3.1 (IBC [F] 904.3.1) Electrical wiring. Electrical wiring shall be in accordance with NFPA 70.

5.4.2.3.3.2 (IBC [F] 904.3.2) Actuation. Automatic fire-extinguishing systems shall be automatically actuated and provided with a manual means of actuation in accordance with IBC Section 904.11.1.

5.4.2.3.3.3 (IBC [F] 904.3.3) System interlocking. Automatic equipment interlocks with fuel shutoffs, ventilation controls, door closers, window shutters, conveyor openings, smoke and heat vents and other features necessary for proper operation of the fire-extinguishing system shall be provided as required by the design and installation standard utilized for the hazard.

5.4.2.3.3.4 (IBC [F] 904.3.4) Alarms and warning signs. Where alarms are required to indicate the operation of automatic fire-extinguishing systems, distinctive audible and visible alarms and warning signs shall be provided to warn of pending agent discharge. Where exposure to automatic-extinguishing agents poses a hazard to persons and a delay is required to ensure the evacuation of occupants before agent discharge, a separate warning signal shall be provided to alert occupants once agent discharge has begun. Audible signals shall be in accordance with IBC Section 907.6.2.

5.4.2.3.3.5 (IBC [F] 904.3.5) Monitoring. Where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the building fire alarm system in accordance with NFPA 72.

SECTION 5.4.2.4 (IBC 905) STANDPIPE SYSTEMS

5.4.2.4.1 (IBC [F] 905.3.1) Height. Class III standpipe systems shall be installed throughout buildings where the floor level of the highest *story* is located more than 9.15 m above the lowest level of fire department vehicle access, or where the floor level of the lowest *story* is located more than 9.15 m below the highest level of fire department vehicle access.

Exceptions:

1. Class I standpipes are allowed in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.
2. Class I manual standpipes are allowed in open parking garages where the highest floor is located not more than 45.50 m above the lowest level of fire department vehicle access.
3. Class I manual dry standpipes are allowed in open parking garages that are subject to freezing temperatures, provided that the hose connections are located as required for Class II standpipes in accordance with Section 5.4.2.4.4 (IBC Section 905.5).
4. Class I standpipes are allowed in basements equipped throughout with an automatic sprinkler system.
5. In determining the lowest level of fire department vehicle access, it shall not be required to consider:
 - 5.1. Recessed loading docks for four vehicles or less; and
 - 5.2. Conditions where topography makes access from the fire department vehicle to the building impractical or impossible.

5.4.2.4.2 (IBC [F] 905.3.5) Underground buildings. Underground buildings shall be equipped throughout with a Class I automatic wet or manual wet standpipe system.

5.4.2.4.3 (IBC [F] 905.4) Location of Class I standpipe hose connections. Class I standpipe hose connections shall be provided in all of the following locations:

1. In every required *stairway*, a hose connection shall be provided for each floor level above or below grade. Hose connections shall be located at an intermediate floor level landing between floors, unless otherwise *approved* by the fire code official.
2. On each side of the wall adjacent to the *exit* opening of a *horizontal exit*.

Exception: Where floor areas adjacent to a *horizontal exit* are reachable from *exit stairway* hose connections by a 9.15 m hose stream from a nozzle attached to 30.50 m of hose, a hose connection shall not be required at the *horizontal exit*.
3. In every *exit* passageway, at the entrance from the *exit* passageway to other areas of a building.

Exception: Where floor areas adjacent to an *exit* passageway are reachable from *exit stairway* hose connections by a 9.15 m hose stream from a nozzle attached to 30.50 m of hose, a hose

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

connection shall not be required at the entrance from the *exit* passageway to other areas of the building.

4. Reserved.
5. Where the roof has a slope less than four units vertical in 12 units horizontal (33.3-percent slope), each standpipe shall be provided with a hose connection located either on the roof or at the highest landing of a *stairway* with *stair* access to the roof. An additional hose connection shall be provided at the top of the most hydraulically remote standpipe for testing purposes.
6. Reserved.

5.4.2.4.3.1 (IBC [F] 905.4.1) Protection. Risers and laterals of Class I standpipe systems not located within an enclosed *stairway* or pressurized enclosure shall be protected by a degree of *fire resistance* equal to that required for vertical enclosures in the building in which they are located.

Exception: In buildings equipped throughout with an *approved automatic sprinkler system*, laterals that are not located within an enclosed *stairway* or pressurized enclosure are not required to be enclosed within fire-resistance-rated construction.

5.4.2.4.4 (IBC [F] 905.5) Location of Class II standpipe hose connections. Class II standpipe hose connections shall be accessible and located so that all portions of the building are within 9.15 m of a nozzle attached to 30.50 m of hose.

5.4.2.4.4.1 (IBC [F] 905.5.2) Protection. Fire-resistance-rated protection of risers and laterals of Class II standpipe systems is not required.

5.4.2.4.5 (IBC [F] 905.6) Location of Class III standpipe hose connections. Class III standpipe systems shall have hose connections located as required for Class I standpipes in Section 5.4.2.4.3 (IBC Section 905.4) and shall have Class II hose connections as required in Section 5.4.2.4.4 (IBC Section 905.5).

5.4.2.4.5.1 (IBC [F] 905.6.1) Protection. Risers and laterals of Class III standpipe systems shall be protected as required for Class I systems in accordance with Section 5.4.2.4.3.1 (IBC Section 905.4.1).

SECTION 5.4.2.5 (IBC 906) PORTABLE FIRE EXTINGUISHERS

5.4.2.5.1 (IBC [F] 906.1) Where required. Portable fire extinguishers shall be installed in the following locations.

1. In new and existing Group B occupancies.

Exception: In new and existing Group B occupancies equipped throughout with quick response sprinklers, portable fire extinguishers shall be required only in locations specified in Items 2 through 6.

SECTION 5.4.2.6 (IBC 907) FIRE ALARM AND DETECTION SYSTEMS

5.4.2.6.1 (IBC [F] 907.2.1) Group A. A manual fire alarm system that activates the occupant notification system in accordance with Section 5.4.2.6.5 (IBC Section 907.5) shall be installed in Group A occupancies having an *occupant load* of 300 or more.

Exception: Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 and the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

5.4.2.6.2 (IBC [F] 907.2.2) Group B. A manual fire alarm system shall be installed in Group B occupancies where one of the following conditions exists:

1. The combined Group B *occupant load* of all floors is 500 or more.
2. The Group B *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.
3. The Group B *fire area* contains a Group B ambulatory health care facility.

Exception: Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 and the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

5.4.2.6.3 (IBC [F] 907.2.13) High-rise buildings. Buildings with a floor used for human occupancy located more than 23 m above the lowest level of fire department vehicle access shall be provided with an automatic smoke detection system in accordance with Section 5.4.2.6.3.1 (IBC Section 907.2.13.1), a fire department communication system in accordance with Section 5.4.2.6.3.2 (IBC Section 907.2.13.2) and an emergency voice/alarm communication system in accordance with Section 5.4.2.6.5.2.2 (IBC Section 907.5.2.2).

5.4.2.6.3.1 (IBC [F] 907.2.13.1) Automatic smoke detection. Automatic smoke detection in high-rise buildings shall be in accordance with NFPA 13.

5.4.2.6.3.1.1 (IBC [F] 907.2.13.1.1) Area smoke detection. Area smoke detectors shall be provided in accordance with this section. Smoke detectors shall be connected to an automatic fire alarm system. The activation of any detector required by this section shall operate the emergency voice/alarm communication system in accordance with Section 5.4.2.6.5.2.2 (IBC Section 907.5.2.2). Smoke detectors shall be located as follows:

1. In each mechanical equipment, electrical, transformer, telephone equipment or similar room which is not provided with sprinkler protection.
2. In each elevator machine room and in elevator lobbies.

5.4.2.6.3.1.2 (IBC [F] 907.2.13.1.2) Duct smoke detection. Duct smoke detectors complying with Section 5.4.2.6.4.1 (IBC Section 907.3.1) shall be located as follows:

1. In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 0.95 m³/s. Such detectors shall be located in a serviceable area downstream of the last duct inlet.
2. At each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air-conditioning system.

5.4.2.6.3.2 (IBC [F] 907.2.13.2) Fire department communication system. Where a wired communication system is *approved* in lieu of a radio coverage system in accordance with IBC Section 510 of the *International Fire Code*, the wired fire department communication system shall be designed and installed in accordance with NFPA 72 and shall operate between a fire command center complying with IBC Section 911, elevators, elevator lobbies, emergency and standby power rooms, fire pump rooms, *areas of refuge* and inside enclosed *exit stairways*. The fire department communication device shall be provided at each floor level within the enclosed *exit stairway*.

5.4.2.6.4 (IBC [F] 907.3) Fire safety functions. Automatic fire detectors utilized for the purpose of performing fire safety functions shall be connected to the building's fire alarm control unit where a fire alarm system is required by IBC Section 907.2. Detectors shall, upon actuation, perform the intended function and activate the alarm notification appliances or activate a visible and audible supervisory signal at a *constantly attended location*. In buildings not equipped with a fire alarm system, the automatic fire detector shall be powered by normal electrical service and, upon actuation, perform the intended function. The detectors shall be located in accordance with NFPA 72.

5.4.2.6.4.1 (IBC [F] 907.3.1) Duct smoke detectors. Smoke detectors installed in ducts shall be *listed* for the air velocity, temperature and humidity present in the duct. Duct smoke detectors shall be connected to the building's fire alarm control unit when a fire alarm system is required by IBC Section 907.2. Activation of a duct smoke detector shall initiate a visible and audible supervisory signal at a *constantly attended location* and shall perform the intended fire safety function in accordance with these guidelines and the *International Mechanical Code*. Duct smoke detectors shall not be used as a substitute for required open area detection.

Exceptions:

1. The supervisory signal at a *constantly attended location* is not required where duct smoke detectors activate the building's alarm notification appliances.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an *approved* location. Smoke detector trouble conditions shall activate a visible or audible signal in an *approved* location and shall be identified as air duct detector trouble.

5.4.2.6.5 (IBC [F] 907.5) Occupant notification systems. A fire alarm system shall annunciate at the panel and shall initiate occupant notification upon activation, in accordance with Section 5.4.2.6.5.1 through 5.4.2.6.5.2.2.6 and IBC Sections 907.5.2.3 through 907.5.2.3.4. Where a fire alarm system is required by another section of these guidelines, it shall be activated by:

1. Automatic fire detectors.
2. Sprinkler waterflow devices.
3. Manual fire alarm boxes.
4. Automatic fire-extinguishing systems.

Exception: Where notification systems are allowed elsewhere in Section 5.4.2.6 (IBC Section 907) to annunciate at a *constantly attended location*.

5.4.2.6.5.1 (IBC [F] 907.5.1) Presignal feature. A presignal feature shall not be installed unless *approved* by the fire code official and the fire department. Where a presignal feature is provided, a signal shall be annunciated at a *constantly attended location approved* by the fire department, in order that occupant notification can be activated in the event of fire or other emergency.

5.4.2.6.5.2 (IBC [F] 907.5.2) Alarm notification appliances. Alarm notification appliances shall be provided and shall be *listed* for their purpose.

5.4.2.6.5.2.1 (IBC [F] 907.5.2.1) Audible alarms. Audible alarm notification appliances shall be provided and emit a distinctive sound that is not to be used for any purpose other than that of a fire alarm.

5.4.2.6.5.2.1.1 (IBC 907.5.2.1.1) Average sound pressure. The audible alarm notification appliances shall provide a sound pressure level of 15 decibels [dB(A)] above the average ambient sound level or 5 dB(A) above the maximum sound level having a duration of at least 60 seconds, whichever is greater, in every occupiable space within the building, 90 dB(A) in mechanical equipment rooms and 60 dB(A) in occupancies.

5.4.2.6.5.2.1.2 (IBC 907.5.2.1.2) Maximum sound pressure. The maximum sound pressure level for audible alarm notification appliances shall be 110 dB(A) at the minimum hearing distance from the audible appliance. Where the average ambient noise is greater than 95 dB(A), visible alarm notification appliances shall be provided in accordance with NFPA 72 and audible alarm notification appliances shall not be required.

5.4.2.6.5.2.2 (IBC 907.5.2.2) Emergency voice/alarm communication systems. Emergency voice/alarm communication systems required by these guidelines shall be designed and installed in accordance with NFPA 72. The operation of any automatic fire detector, sprinkler waterflow device or manual fire alarm box shall automatically sound an alert tone followed by voice instructions giving *approved* information and directions for a general or staged evacuation in accordance with the building's fire safety and evacuation plans required by Section 4.2.2.2 (IBC Section 404). In high-rise buildings, the system shall operate on a minimum of the alarming floor, the floor above and the floor below. Speakers shall be provided throughout the building by paging zones. At a minimum, paging zones shall be provided as follows:

1. Elevator groups.
2. Exit stairways.
3. Each floor.
4. *Areas of refuge* as defined in IBC Section 1002.1.

5.4.2.6.5.2.2.1 (IBC [F] 907.5.2.2.1) Manual override. A manual override for emergency voice communication shall be provided on a selective and all-call basis for all paging zones.

5.4.2.6.5.2.2.2 (IBC [F] 907.5.2.2.2) Live voice messages. The emergency voice/alarm communication system shall also have the capability to broadcast live voice messages by paging zones on a selective and all-call basis.

5.4.2.6.5.2.2.3 (IBC [F] 907.5.2.2.3) Alternate uses. The emergency voice/alarm communication system shall be allowed to be used for other announcements, provided the manual fire alarm use takes precedence over any other use.

5.4.2.6.5.2.2.4 (IBC [F] 907.5.2.2.4) Emergency power. Emergency voice/alarm communications systems shall be provided with an *approved* emergency power source.

5.4.2.6.5.2.2.5 (IBC [F] 907.5.2.3.1) Public and common areas. Visible alarm notification appliances shall be provided in public areas and common areas.

5.4.2.6.5.2.2.6 (IBC [F] 907.5.2.3.2) Employee work areas. Where employee work areas have audible alarm coverage, the notification appliance circuits serving the employee work areas shall be initially designed with a minimum of 20-percent spare capacity to account for the potential of adding visible notification appliances in the future to accommodate hearing impaired employee(s).

SECTION 5.4.2.7 (IBC 909) SMOKE CONTROL SYSTEMS

5.4.2.7.1 (IBC [F] 909.11) Power systems. The smoke control system shall be supplied with two sources of power. Primary power shall be from the normal building power systems. Secondary power shall be from an *approved* standby source complying with Chapter 27 of the IBC. The standby power source and its transfer switches shall be in a room separate from the normal power transformers and switch gears and ventilated directly to and from the exterior. The room shall be enclosed with not less than 1-hour *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or horizontal assemblies constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both.

SECTION 5.4.2.8 (IBC 912) FIRE DEPARTMENT CONNECTIONS

5.4.2.8.1 (IBC [F] 912.1) Installation. Fire department connections shall be installed in accordance with the NFPA standard applicable to the system design and shall comply with Sections 5.4.2.8.2 through 5.4.2.8.5 (IBC Sections 912.2 through 912.5).

5.4.2.8.2 (IBC [F] 912.2) Location. With respect to hydrants, driveways, buildings and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the buildings for other fire apparatus. The location of fire department connections shall be *approved* by the fire chief.

5.4.2.8.2.1 (IBC [F] 912.2.1) Visible location. Fire department connections shall be located on the street side of buildings, fully visible and recognizable from the street or nearest point of fire department vehicle access or as otherwise *approved* by the fire chief.

5.4.2.8.2.2 (IBC [F] 912.2.2) Existing buildings. On existing buildings, wherever the fire department connection is not visible to approaching fire apparatus, the fire department connection shall be indicated by an *approved* sign mounted on the street front or on the side of the building. Such sign shall have the letters "FDC" at least 15 cm high and words in letters at least 5 cm high or an arrow to indicate the location. All such signs shall be subject to the approval of the fire code official.

5.4.2.8.3 (IBC [F] 912.3) Access. Immediate access to fire department connections shall be maintained at all times and without obstruction by fences, bushes, trees, walls or any other fixed or moveable object. Access to fire department connections shall be *approved* by the fire chief.

Exception: Fences, where provided with an access gate equipped with a sign complying with the legend requirements of Section 5.4.2.8.4 (IBC Section 912.4) and a means of emergency operation. The gate and the means of emergency operation shall be *approved* by the fire chief and maintained operational at all times.

ACTIVE FIRE PROTECTION SYSTEMS AND FEATURES

5.4.2.8.3.1 (IBC [F] 912.3.1) Locking fire department connection caps. The fire code official is authorized to require locking caps on fire department connections for water-based *fire protection systems* where the responding fire department carries appropriate key wrenches for removal.

5.4.2.8.3.2 (IBC [F] 912.3.2) Clear space around connections. A working space of not less than 92 cm in width, 92 cm in depth and 2 m in height shall be provided and maintained in front of and to the sides of wall-mounted fire department connections and around the circumference of free-standing fire department connections, except as otherwise required or *approved* by the fire chief.

5.4.2.8.3.3 (IBC [F] 912.3.3) Physical protection. Where fire department connections are subject to impact by a motor vehicle, vehicle impact protection shall be provided in accordance with Section 312 of the *International Fire Code*.

5.4.2.8.4 (IBC [F] 912.4) Signs. A metal sign with raised letters at least 3 cm in size shall be mounted on all fire department connections serving automatic sprinklers, standpipes or fire pump connections. Such signs shall read: AUTOMATIC SPRINKLERS or STANDPIPES or TEST CONNECTION or a combination thereof as applicable. Where the fire department connection does not serve the entire building, a sign shall be provided indicating the portions of the building served.

5.4.2.8.5 (IBC [P] 912.5) Backflow protection. The potable water supply to automatic sprinkler and standpipe systems shall be protected against backflow as required by the *International Plumbing Code*.

SECTION 5.4.2.9 (IBC 913) FIRE PUMPS

5.4.2.9.1 (IBC [F] 913.1) General. Where provided, fire pumps shall be installed in accordance with this section and NFPA 20.

5.4.2.9.2 (IBC [F] 913.2) Protection against interruption of service. The fire pump, driver and controller shall be protected in accordance with NFPA20 against possible interruption of service through damage caused by explosion, fire, flood, earthquake, rodents, insects, windstorm, freezing, vandalism and other adverse conditions.

SECTION 5.4.2.10 (IBC 914) EMERGENCY RESPONDER SAFETY FEATURES

5.4.2.10.1 (IBC [F] 914.1) Shaftway markings. Vertical shafts shall be identified as required by Sections 5.4.2.10.1.1 and 5.4.2.10.1.2 (IBC Sections 914.1.1 and 914.1.2).

5.4.2.10.1.1 (IBC [F] 914.1.1) Exterior access to shaftways. Outside openings accessible to the fire department and that open directly on a hoistway or shaftway communicating between two or more floors in a building shall be plainly marked with the word "SHAFTWAY" in red letters at least 15 cm high on a white background. Such warning signs shall be placed so as to be readily discernible from the outside of the building.

5.4.2.10.1.2 (IBC [F] 914.1.2) Interior access to shaftways. Door or window openings to a hoistway or shaftway from the interior of the building shall be plainly marked with the word "SHAFTWAY" in red letters at least 15 cm high on a white background. Such warning signs shall be placed so as to be readily discernible.

Exception: Markings shall not be required on shaftway openings that are readily discernible as openings onto a shaftway by the construction or arrangement.

5.4.3 ALTERNATE MEANS OF VERIFICATION

- 5.4.3.1 Requirements related to active fire protection systems for business occupancies, as addressed in Chapter 9 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for active fire protection systems can be demonstrated by compliance with applicable sections of Chapter 9 of the 2009 IBC.

5.5 EXTERIOR WALL AND ROOF ASSEMBLY CONSIDERATIONS

5.5.0 OVERVIEW AND KEY CONCEPTS

While the fire protection of exterior walls and roof assemblies can be considered under the umbrella of passive fire protection, there are aspects of planning and exterior flame spread which warrant special consideration.

In brief, there are three basic fire protection considerations with respect to exterior wall and roof assemblies: resistance to ignition, resistance to fire, and resistance to flame spread. As used here, resistance to ignition refers both to the material itself (e.g., a roof covering, such as wood shingles or asphalt covering) and to the ability to protect against ignition on either side of the assembly (e.g., a fire inside of a building causing the radiant ignition of property adjacent to but outside of the building). Resistance to fire relates to the response of the wall and roof assemblies to applied fire loads, such as performance against a time temperature relationship as described in Section 5.2. Flame spread relates to the propensity of materials in wall and roof assemblies to spread flame along their surface, such as discussed for interior finishes in Section 5.3.

As discussed in earlier chapters, for the purpose of these guidelines, dominant mechanisms for the spread of fire can be considered ignition of materials due to direct flame impingement and to thermal radiation, and the combustibility and flame spread characteristics of the materials involved.



Flame Extension out of Compartment¹

With respect to exterior walls and roof assemblies, flame impingement can be important in such situations as flame extension into or out of an opening, such as through a window opening. Depending on building geometry, flames extending out an opening could come in contact with a surface which could, if combustible, result in ignition, or could otherwise cause damage depending on the material (e.g., flame impingement could cause breakage of glass in window opening or façade). Similar responses can result from thermal radiation emanating from the flame as well (i.e., ignition of materials, breakage of glass). The potential results of flame extension through an opening in an external wall assembly,

and the results (should upper levels of the wall assembly be exposed to direct flame impingement or thermal radiation from the flame), are illustrated in the photo on the left from the 2003 fire in the Windsor Building in Madrid, Spain. The reverse situation is also of concern; that is, where direct flame impingement or thermal radiation from exterior fire threats, such as from adjacent buildings, exterior combustibles (e.g., trash, stored combustible materials), or wildland fires, could result in ignition on the exterior or interior of the building of concern. In addition, in areas prone to wildland fires, additional threats exist in terms of burning brands which may come to rest on combustible surfaces, in some cases being driven by winds through screening and other protective measures.

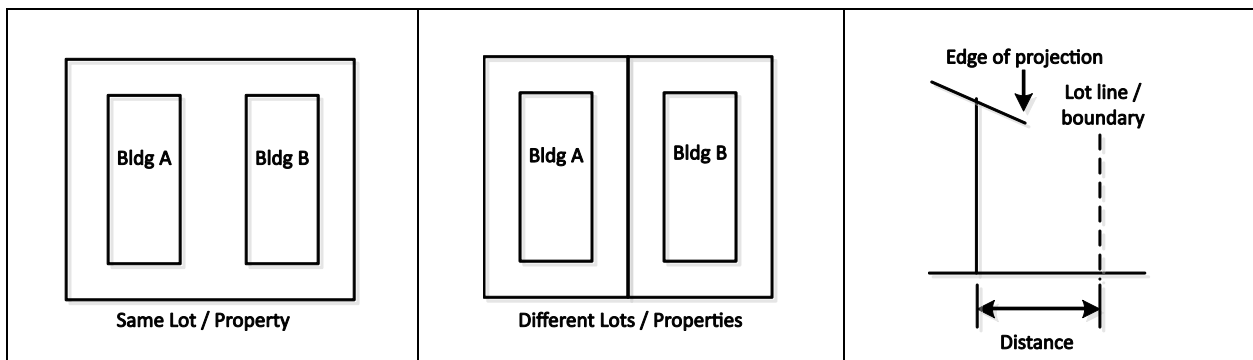
To address these concerns there are two primary strategies: provide adequate separation distance between the building of concern and other buildings, property and vegetation, or protect the exterior wall and roof assemblies

¹ Source: Rob Jastrzebski

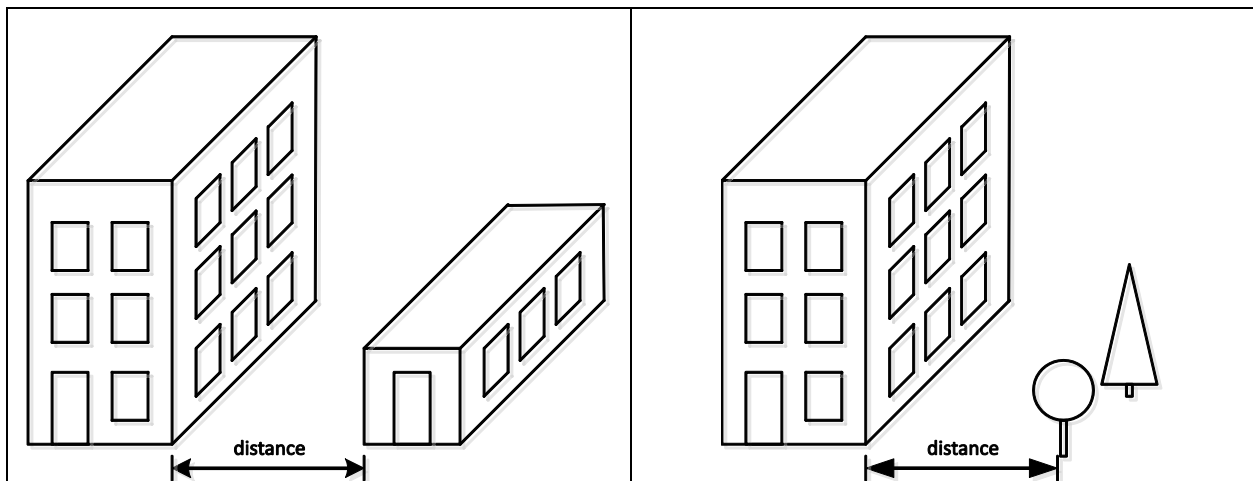
EXTERIOR WALL AND ROOF ASSEMBLY CONSIDERATIONS

through choice of materials, limitation in openings, and/or protection of openings. There are a variety of factors influencing separation distance and protection, outlined in Section 5.5.2, other sections (e.g., Sections 5.2 and 5.3), various methods of analysis and verification, and local regulations. A few key concepts are illustrated below.

The first two diagrams illustrate that typically, some level of separation distance is required between buildings on the same lot (property) or adjacent lots, particularly when the exterior walls and roof assemblies are combustible or have unprotected openings. This not only helps to reduce the likelihood of building-to-building ignition, but allows access for fire service apparatus. In some cases, the distance will be impacted by building shapes or features, such as projection (as in a roof overhang). In such cases, distances may need to be increased, since the overhang could trap hot gases and result in a more intense (hotter) fire. The required distances, if any, may be set by regulation or calculated by verification methods.



The following diagrams illustrate issues associated with unprotected openings (windows, in this case), which play a role in distances from other properties and from vegetation (in areas prone to wildland fires). There may also be concerns with the height of adjacent buildings, especially with respect to roof construction, but also from general fire exposure. With respect to roof construction, the lower building in the diagram below would be exposed to radiant energy from a fire in the taller building, which would impact the fire resistance requirements for the roof of the lower building and/or the protection of openings in the exposed sides of each building.



Given the wide range of construction materials, exterior wall (cladding) materials and roof materials, there are numerous ways to address the above concerns, ranging from well-defined regulatory requirements for separation and protection based on combinations of materials, construction and distance, to engineering analysis of thermal

EXTERIOR WALL AND ROOF ASSEMBLY CONSIDERATIONS

radiation exposure. While one approach to addressing these issues is detailed in Section 5.5.2, close coordination with local planning and regulations and the fire service is required.

Summary

Key considerations related to fire protection of exterior walls and roof assemblies are summarized in the table below. More detailed discussion on design requirements can be found in Section 5.5.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED FIRE PROTECTION	CONSEQUENCES OF DESIGN CONSIDERATIONS
Fire resistance of materials	Structural frame, exterior walls, doors, windows and roof assemblies. Separation distance. Fire department access.	Selection of structural frame material, exterior wall (cladding, façade) material and construction; materials, design and construction of roof assembly; area, location and protection of openings (such as windows); planning and resource restrictions; area and height of building; exterior vegetation.
Fire spread	Exterior walls, doors, windows and roof assemblies. Separation distance [location of adjacent property and lot (property) lines, vegetation, etc.]. Fire department access.	Selection of exterior wall (cladding, façade) material and construction; materials, design and construction of roof assembly; area, location and protection of openings (such as windows); planning and resource restrictions; area and height of building; exterior vegetation.

5.5.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Fire protection requirements for exterior wall and roof assemblies in all UN-occupied buildings must comply with the following functional objectives and performance requirements, as well as appropriate functional objectives and performance criteria listed in Section 5.2, Passive Fire Protection Systems and Features. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 5.5.2. A list of alternate means of verification is provided in Section 5.5.3.

- 5.5.1.1 Exterior wall assemblies and roof assemblies shall be designed, tested, constructed, maintained and operated in such a manner that the spread of fire into or out of a building, or along the surface of the exterior wall assembly or roof assembly, is minimized and/or restricted.
 - 5.5.1.1.1 The fire resistance and protection requirements for exterior wall assemblies and roof assemblies shall be appropriate for minimizing the potential for fire spread into, along the exterior, or out of a building to an adjacent property.
 - 5.5.1.1.2 The fire resistance and protection requirements for penetrations in exterior wall assemblies and roof assemblies, which are openings in rated wall or ceiling assemblies which, if unsealed, could permit the spread of fire, shall be appropriate to the fire hazard.
 - 5.5.1.1.3 The fire resistance and protection requirements for opening protectives, which serve to limit the spread of fire through necessary openings in exterior wall assemblies and ceiling assemblies, shall be appropriate to the fire hazard.
 - 5.5.1.1.4 Testing for fire resistance, flame spread, smoke generation, and other parameters deemed necessary for describing and assessing the performance of installed materials, systems and assemblies shall be in accordance with appropriate internationally recognized fire test standards.
 - 5.5.1.1.5 When required to be installed, materials, systems, components and assemblies shall be designed, installed, tested, operated and maintained in accordance with internationally recognized standards.
- 5.5.1.2 Construction in concealed spaces associated with exterior wall assemblies and roof assemblies shall be designed and protected to inhibit the unseen, undetected, and uncontrolled spread of fire, hot gases and smoke appropriate to the fire hazard, risk to life, time required to allow for occupants to safely evacuate and for fire fighters to undertake rescue and firefighting operations.

5.5.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 5.5.2.1 (IBC 1403) PERFORMANCE REQUIREMENTS

5.5.2.1.1 (IBC 1403.4) Fire resistance. Exterior walls shall be fire-resistance rated as required by other sections of these guidelines with opening protection as required by IBC Chapter 7.

SECTION 5.5.2.2 (IBC 1406) COMBUSTIBLE MATERIALS ON THE EXTERIOR SIDE OF EXTERIOR WALLS

5.5.2.2.1 (IBC 1406.1) General. Section 5.5.2.2 (IBC Section 1406) shall apply to *exterior wall coverings*; balconies and similar projections; and bay and oriel windows constructed of combustible materials.

5.5.2.2.2 (IBC 1406.2) Combustible exterior wall coverings. Combustible *exterior wall coverings* shall comply with this section.

Exception: Plastics complying with IBC Chapter 26.

5.5.2.2.2.1 (IBC 1406.2.1) Ignition resistance. Combustible exterior wall coverings shall be tested in accordance with NFPA 268.

Exceptions:

1. Wood or wood-based products.
2. Other combustible materials covered with an exterior covering other than vinyl sidings listed in IBC Table 1405.2.
3. Aluminum having a minimum thickness of 0.48 mm.
4. Exterior wall coverings on exterior walls of Type V construction.

5.5.2.2.2.1.1 (IBC 1406.2.1.1) Fire separation 1.50 m or less. Where installed on exterior walls having a fire separation distance of 1.50 m or less, combustible exterior wall coverings shall not exhibit sustained flaming as defined in NFPA 268.

5.5.2.2.2.1.2 (IBC 1406.2.1.2) Fire separation greater than 1.50 m. For fire separation distances greater than 1.50 m, an assembly shall be permitted that has been exposed to a reduced level of incident radiant heat flux in accordance with the NFPA 268 test method without exhibiting sustained flaming. The minimum *fire separation distance* required for the assembly shall be determined from Table 5.5.2.2.2.1.2 (IBC Table 1406.2.1.2) based on the maximum tolerable level of incident radiant heat flux that does not cause sustained flaming of the assembly.

5.5.2.2.2.2 (IBC 1406.2.2) Type I, II, III and IV construction. On buildings of Type I, II, III and IV construction, *exterior wall coverings* shall be permitted to be constructed of wood in accordance with IBC Section 1405.5, or other equivalent combustible material, complying with the following limitations:

1. Combustible *exterior wall coverings* shall not exceed 10% of an *exterior wall* surface area where the *fire separation distance* is 1.50 m or less.
2. Combustible architectural *trim* shall be limited to 12 m in height above grade.
3. Combustible *exterior wall coverings* constructed of *fire-retardant-treated wood* complying with IBC Section 2303.2 for exterior installation shall not be limited in wall surface area where the *fire separation distance* is 1.50 m or less and shall be permitted up to 18.50 m in height above grade regardless of the *fire separation distance*.

5.5.2.2.2.3 (IBC 1406.2.3) Location. Where combustible *exterior wall covering* is located along the top of *exterior walls*, such *trim* shall be completely backed up by the *exterior wall* and shall not extend over or above the top of *exterior walls*.

EXTERIOR WALL AND ROOF ASSEMBLY CONSIDERATIONS

5.5.2.2.2.4 (IBC 1406.2.4) Fireblocking. Where the combustible *exterior wall covering* is furred from the wall and forms a solid surface, the distance between the back of the covering and the wall shall not exceed 41.50 mm. Where required by IBC Section 717, the space thereby created shall be fireblocked.

5.5.2.2.3 (IBC 1406.3) Balconies and similar projections. Balconies and similar projections of combustible construction other than *fire-retardant-treated wood* shall be fire-resistance rated in accordance with Table 5.1.2.1.1(1) (IBC Table 601) for floor construction or shall be of Type IV construction in accordance with Section 5.1.2.1.4 (IBC Section 602.4). The aggregate length shall not exceed 50% of the buildings perimeter on each floor.

Exceptions:

1. On buildings of Type I and II construction, three stories or less above *grade plane*, *fire-retardant-treated wood* shall be permitted for balconies, porches, decks and exterior stairways not used as required exits.
2. Untreated wood is permitted for pickets and rails or similar guardrail devices that are limited to 1.05 m in height.
3. Balconies and similar projections on buildings of Type III, IV and V construction shall be permitted to be of Type V construction, and shall not be required to have a *fire-resistance rating* where sprinkler protection is extended to these areas.
4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

TABLE 5.5.2.2.1.2 (IBC Table 1406.2.1.2)
MINIMUM FIRE SEPARATION FOR COMBUSTIBLE VENEERS

FIRE SEPARATION DISTANCE (meters)	TOLERABLE LEVEL INCIDENT RADIANT HEAR ENERGY (kW/m ²)	FIRE SEPARATION DISTANCE (meters)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY (kW/m ²)
1.50	12.5	4.90	5.9
1.85	12.0	5.20	5.5
2.15	11.0	5.50	5.2
2.45	10.5	5.80	4.9
2.75	9.6	6.10	4.6
3.05	8.9	6.40	4.4
3.35	8.3	6.70	4.1
3.65	7.7	7.00	3.9
3.95	7.2	7.30	3.7
4.25	6.7	7.60	3.5
4.55	6.3		

5.5.2.2.4 (IBC 1406.4) Bay windows and oriel windows. Bay and oriel windows shall conform to the type of construction required for the building to which they are attached.

Exception: *Fire-retardant-treated wood* shall be permitted on buildings three stories or less of Type I, II, III and IV construction.

SECTION 5.5.2.3 (IBC 1505) FIRE CLASSIFICATION

5.5.2.3.1 (IBC 1505.1) General. Roof assemblies shall be divided into the classes defined below. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108 or UL 790. In addition, *fire-retardant-treated wood* roof coverings shall be tested in accordance with ASTM D 2898. The minimum roof coverings installed on buildings shall comply with Table 5.5.2.3.1 (IBC Table 1505.1) based on the type of construction of the building.

TABLE 5.5.2.3.1 (TABLE 1505.1)^a
MINIMUM ROOF COVERING CLASSIFICATION
FOR TYPES OF CONSTRUCTION

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C ^b	B	C ^b	B	B	C ^b

- a. Unless otherwise required in accordance with the *International Wildland-Urban Interface Code* or due to the location of the building within a fire district in accordance with IBC Appendix D.
- b. Buildings that are not more than two stories above grade plane and having not more than 555 m² of projected roof area and where there is a minimum 3.05 m fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood shakes and No. 1 shingles.

5.5.2.3.2 (IBC 1505.2) Class A roof assemblies. Class A roof assemblies are those that are effective against severe fire test exposure. Class A roof assemblies and roof coverings shall be *listed* and identified as Class A by an *approved* testing agency. Class A roof assemblies shall be permitted for use in buildings or structures of all types of construction.

Exceptions:

1. Class A roof assemblies include those with coverings of brick, masonry or an exposed concrete roof deck.
2. Class A roof assemblies also include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile or slate installed on noncombustible decks or ferrous, copper or metal sheets installed without a roof deck on noncombustible framing.

5.5.2.3.3 (IBC 1505.3) Class B roof assemblies. Class B roof assemblies are those that are effective against moderate fire-test exposure. Class B roof assemblies and roof coverings shall be *listed* and identified as Class B by an *approved* testing agency.

5.5.2.3.4 (IBC 1505.4) Class C roof assemblies. Class C roof assemblies are those that are effective against light fire-test exposure. Class C roof assemblies and roof coverings shall be listed and identified as Class C by an *approved* testing agency.

5.5.2.3.5 (IBC 1505.5) Nonclassified roofing. Nonclassified roofing is *approved* material that is not *listed* as a Class A, B or C roof covering.

5.5.2.3.6 (IBC 1505.6) Fire-retardant-treated wood shingles and shakes. *Fire-retardant-treated wood* shakes and shingles shall be treated by impregnation with chemicals by the full-cell vacuum-pressure process, in accordance with AWPAC1. Each bundle shall be marked to identify the manufactured unit and the manufacturer, and shall also be labeled to identify the classification of the material in accordance with the testing required in Section 5.5.2.3.1 (IBC Section 1505.1), the treating company and the quality control agency.

5.5.2.3.7 (IBC 1505.7) Special purpose roofs. Special purpose wood shingle or wood shake roofing shall conform with the grading and application requirements of IBC Section 1507.8 or 1507.9. In addition, an underlayment of 16 mm Type X water-resistant gypsum backing board or gypsum sheathing shall be placed under minimum nominal 12 mm thick wood structural panel solid sheathing or 3 cm nominal spaced sheathing.

5.5.3 ALTERNATE MEANS OF VERIFICATION

- 5.5.3.1 Requirements related to fire protection of exterior walls, roof systems and rooftop structures for business occupancies, as addressed in Chapters 14 and 15 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for fire protection of exterior walls, roof systems and rooftop structures can be demonstrated by compliance with applicable sections of Chapters 14 and 15 of the 2009 IBC.

CHAPTER 6 OCCUPANT MOVEMENT AND SAFETY

6.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with occupant movement and safety in buildings. Specifically, this chapter provides guidance on means of egress, accessibility, elevators and escalators, and safety of users with respect to in-use hazards one might find in office buildings.

Using the 2009 *International Building Code*® (IBC®) as the primary reference document, these concepts are addressed in the following sections, which generally parallel the IBC:

- 6.1 Means of Egress
- 6.2 Accessibility
- 6.3 Elevators and Escalators
- 6.4 Safety of Users

Section 6.1 provides an overview of the components of an exit system, providing functional and performance objectives aimed at providing a safe means of escape during fire or other hazard events.

Section 6.2 presents a discussion of basic accessibility issues and performance targets, from gaining unobstructed access to an office building, to the ability to move without obstruction to essential areas of the building.

Section 6.3 discusses the performance of the elevators and escalators in providing a means of mechanical conveyance for occupants.

Section 6.4 outlines issues associated with the safety of occupants in buildings during normal building use and under normal operating conditions. Note that safety of user issues associated with fire and natural hazard events are largely addressed in other chapters (e.g., fire protection, Chapter 4; means of egress, Chapter 6; structural, Chapter 8), as is safety during construction and demolition (Chapter 9).

6.1 MEANS OF EGRESS

6.1.0 OVERVIEW AND KEY CONCEPTS

Means of egress describes the path of travel that a building occupant encounters, starting with any occupiable point in a building, and ending when they reach a public way (e.g., public walkway, street, alley, etc.).

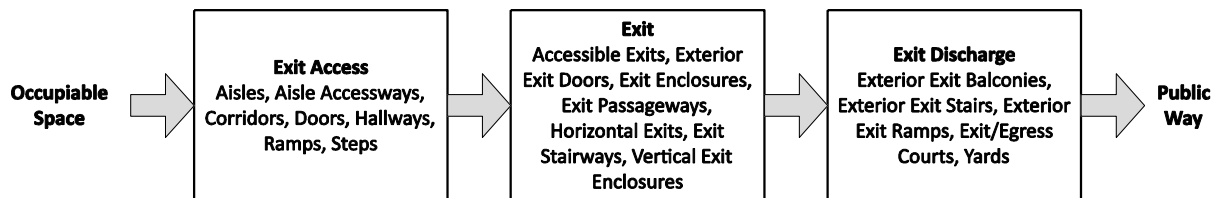


Figure 1. Means of Egress Components

As illustrated in Figure 1, means of egress is often described in terms of three fundamental components: the **exit access**, is unprotected or has limited protection and includes the portion of the building between any occupied point and an exit; the **exit**, which provides a protected path of egress between the exit access and **exit discharge**; and the **exit discharge** which is outside the building and is the portion between the point where occupants leave an exit and the point where they reach a public way.

The means of egress components can be visualized with the help of Figure 2, which is a generalized representation of a three-story office building. The top illustration reflects a typical floor, highlighting the corridor (grey), part of the exit access system (path to get to an exit) and two exits, which on upper floors of a building are protected stairways (hash lines). The middle illustration is an elevation, or side view, showing the corridors (exit access) on floors 1 and 2 (grey); the exits, shown in this view as vertical stairway enclosures (hash lines); and an exit passageway (horizontal lines) on the ground floor, which is a protected path to the outside. The bottom illustration shows how an exit stairway may discharge directly to the outside (top right) or connect to an exit passageway (horizontal lines, lower left), which in turn discharges to the outside. In these diagrams, the hash lines and the horizontal lines reflect the protected components that make up the exit, whereas white and grey are unprotected spaces occupants must walk through to reach a protected exit.

Typically, the “exit access” component makes up most of the means of egress in a building, as it essentially covers all of the occupied portions of the building aside from the exit (white and pink spaces). In office buildings, many parts of the exit access have no particular requirements

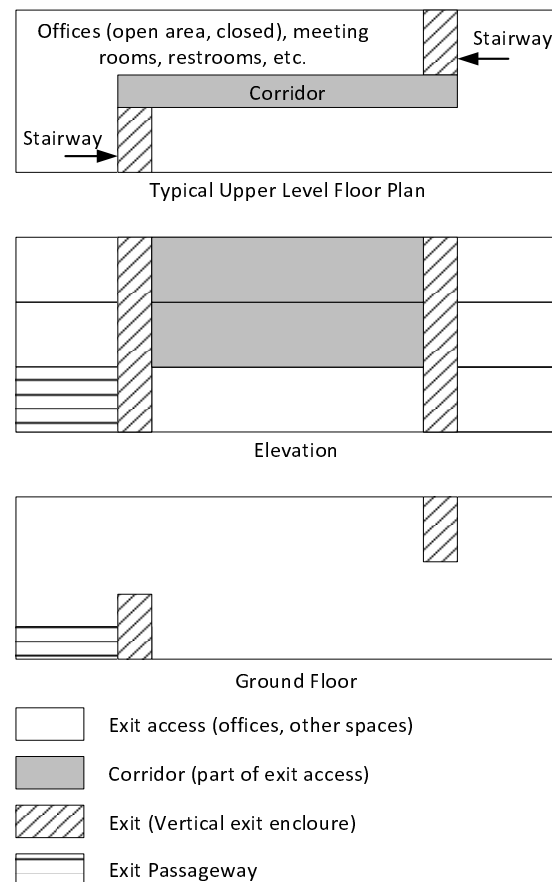


Figure 2. Generalized Means of Egress

MEANS OF EGRESS

for protection (e.g., from smoke or flame), except where separation is required due to limits on compartment size or for separation from other uses in the buildings that may be more hazardous (e.g., kitchen). Some exit access components, such as corridors (grey), may have smoke- or fire-protective features to help maintain safe environments while occupants exit the space. Components that make up the exits are typically protected by fire-resistance-rated construction and other safety features, as the intent is to provide a protected environment from the time occupants enter the exit until they are discharged outside of the building.

A means of *egress* often includes both vertical and horizontal components. In Figure 2 there are two vertical exit enclosures (protecting the stairways). One vertical exit enclosure (on the left) connects to an *exit passageway* on the ground level (protecting occupants until they reach the exit discharge to the outside). The second vertical exit enclosure (on the right) discharges directly to the outside.

To aid safe egress in an emergency, *means of egress* should be designed, constructed and maintained to be obvious, continuous, direct, unobstructed and undiminished throughout. Features such as unobstructed and illuminated exit signage, emergency lighting and photoluminescent markings help make the means of egress obvious.

Direct and continuous means of egress is often achieved through such features as corridors connecting to vertical exit enclosures housing stairways, the use of horizontal exit enclosures if occupants need to change from one stairwell to another on a transfer floor (as it may be the case in high-rise buildings), and use of exit passageways to reach the exterior of the building on the ground level.

An unobstructed means of egress is a function of design (e.g., providing minimum functional corridor widths and heights, door openings, stairway widths and headroom, minimizing wall-mounted fixtures within the path of travel, etc.) and operational procedures (e.g., keeping furniture and storage out of corridors, stairways landings, exit passageways, etc.). Undiminished means of egress are those which maintain their required capacities throughout (e.g., widths and capacities for the occupant load anticipated).

The number, arrangement and capacity of exits required for portions of a building (e.g., leased spaces, such as offices, meeting rooms and dispensary, etc.) and for the entire building (all spaces) are largely a function of the use(s) of the building, travel distance to an exit, the occupant load and the expected characteristics of the occupants (e.g., age, ability, etc.). Protection of the exits is dependent upon the above factors, as well as on the size of the building (height and area) and fire safety systems installed.

A building's occupancy or use classification is important as it is typically used to convey to the designers, users and emergency responders a sense of key attributes, such as activities (e.g., retail, medical, office space, etc.), as well as time of day and day of week the building is occupied, associated occupant characteristics (e.g., awake or asleep, restrained, medicated or otherwise incapable of self evacuation, familiar with the building layout, etc.), and hazards that may be present (e.g., combustible or flammable liquid storage, natural gas, propane or other flammable gases for heating or cooking, hazardous operations, etc.). For example, considering the aforementioned factors, if a building primarily houses offices, the egress requirements would be different than if a building had some office space, but also had retail space, large assembly spaces (e.g., movie theater), or significant medical facilities, with shared means of egress.

In egress system design, travel distance is important because of the time required for occupants to reach an exit and the potential hazards occupants may face along the way. Occupant load is important due to factors such as occupant density and related reduction in movement, speed, and flow through corridors, down or up stairs, and through doorways and the number of persons at risk during an event (e.g., fire, earthquake, deliberate event, etc.).

Occupant characteristics reflect those attributes of the expected occupants which may be important to response, decision-making and susceptibility to hazard events. For office spaces alone, occupants may be considered to be awake, alert, unrestrained, familiar with the building and in residence a limited number of hours per day. However, this may not be the case if a large number of visitors are expected, or if the office is just one part of a mixed-use building, in these instances characteristics of other occupants also need to be considered. In all cases, design of means of egress and associated safety systems should take into account such factors as occupant familiarity with the building and exits, occupant roles and responsibilities, particularly where delays may be associated with waiting for a responsible person to indicate the need to evacuate the building and the presence and number of sensitive or vulnerable populations, including those with diminished sight, hearing, mental or physical capacities.

Building height is important with respect to availability of exits, travel distance, travel time and the ability for emergency personnel to undertake operations. In high-rise buildings, there are typically only a few exits (two to four vertical exit enclosures housing stairways), significant queue times could be expected, and walking speeds are slower on stairs than on horizontal surfaces. In addition, firefighting and rescue apparatus cannot reach above the fifth floor above street level of most buildings, meaning there may be counterflow on stairs as fire fighters are going up as occupants go down, which can further slow egress, and at least one stairway may be taken out of use by fire fighters who are staging an attack, thereby reducing the overall number of available exits and exit capacity.

Building construction is important with respect to response of the building to the hazard of concern. With respect to egress design, building construction often focuses on combustibility of the framing material and associated resistance to fire, particularly when no suppression systems are installed. More combustible materials, such as light frame timber, are typically limited in height and area since less fire protection may be afforded to occupants. Concrete structures, in some cases, have no height or area limitation, as they are typically expected to withstand a fire for a period of time to allow evacuation and firefighting operations. However, construction is also important for egress for hazards such as earthquake and deliberate events, where damage to the structure and nonstructural systems could result in damage to means of egress.

To help facilitate safe egress during emergencies, fire safety and communications systems play significant roles in detecting fires, notifying and communicating with occupants, notifying emergency responders, providing smoke control or management, suppressing or controlling fires, preventing the passage of smoke or fire from one compartment to another and providing for emergency responder communications.

Key considerations are summarized in the table below. More detailed discussion on design requirements can be found in Section 6.1.2, Performance/Prescriptive Criteria and Means of Verification.

MEANS OF EGRESS

DRIVING FEATURE	IMPACTED MEANS OF EGRESS COMPONENTS	CONSEQUENCES OF DESIGN CONSIDERATIONS
Occupant load – speed of movement, flow through openings, protection needs	Number of exits, exit capacity, protection of exit enclosures, exit discharge	More occupants mean more exits or more protection during evacuation process.
Travel distance – time to reach exit	Exit access components, number and location of exits	Potential trade-offs may be considered when reducing the occupant load, adding exits or adding protection.
Exit separation – providing alternate exits in case of blockage or damage	Number and location of exits	Exits cannot be grouped together – adequate separation is needed to allow access in case one exit is compromised.
Geometry of components – should be sized to maintain unobstructed and unrestricted flow	Corridors, hallways, doors, doorways, stairways, exit passages	Components should be sized to facilitate flow based on number and density of occupants, with no flow obstructions or restrictions and no hazards to occupants.
Protection of exits – type and duration of hazard, occupant load, building size and layout, building type/construction, other safety systems installed	Exit enclosures, exit passageways, horizontal exits, exit stairways, vertical exit enclosures	The longer it takes occupants to reach an exit the more protection is needed – particularly in high-rise buildings (limited number of exits) – hazard mitigation or higher level of protection is needed.
Ease of identification and use – time to identify exit, safe travel in exit	Aisles, aisle accessways, corridors, doors, hallways, illumination, marking, ramps, signs, steps, surfaces	Occupants need to be able to easily identify and locate exits, have unrestricted flow to and through exits, have easily opening and unlocked doors, expect regular walking surfaces and stair configurations and have adequate lighting.
Accessible exits – ability to provide protection and egress capability for persons with disabilities	All egress components	To account for a range of disabilities, it may be necessary to provide areas of refuge, lifts, evacuation chairs or other devices and suitable audible, visual and tactile signage.

6.1.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

The means of egress in all UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 6.1.2. A list of regulations deemed-to-comply with the functional objectives and performance requirements is provided in Section 6.1.3.

- 6.1.1.1 The *means of egress* system should be designed, constructed and maintained so as to provide building occupants with reasonable means of safe egress from a building during fire and other emergency events.
 - 6.1.1.1.1 The arrangement, number and construction of means of egress should be appropriate to the occupant load, occupant characteristics, travel distance, building construction, building height, safety systems and features, hazards that might be expected over the life of the building, and local conditions which may have an impact on safe evacuation of occupants during hazard events.
 - 6.1.1.1.2 There must be access from UN-occupied space to at least two independent exits from any building, and any floor of any building, where the UN occupies space.
- 6.1.1.2 To facilitate ready identification and use, the *means of egress* should be clearly identified, easily located, illuminated, safe and easy to use.
 - 6.1.1.2.1 Exits should be conspicuously located such that they are easy to identify and reach in emergencies.
 - 6.1.1.2.2 Signage should be provided and made clearly visible under normal and emergency conditions.
 - 6.1.1.2.3 *Means of egress* should be illuminated under normal and emergency conditions.
 - 6.1.1.2.4 The path along a *means of egress* should not be interrupted by any building element other than a means of egress component (e.g., door).
 - 6.1.1.2.5 Doors that form part of the means of egress:
 - a. must not be locked as accessed from the direction of egress travel, or if locked for security reasons, must be automatically unlocked upon detection of fire in the building or activation of an *automatic sprinkler system*, if provided;
 - b. should, whenever possible, open in the primary direction of exit travel and should not restrict the flow of occupant evacuation; and
 - c. should be outfitted with panic hardware at the level of exit discharge.
 - 6.1.1.2.6 Building-related obstructions or protrusions must not reduce the required width of a *means of egress* (except required means of egress elements, such as handrails).
 - 6.1.1.2.7 Walking surfaces of the *means of egress* should be slip-resistant and securely attached.
 - 6.1.1.2.8 Where small changes in elevation exist in the *means of egress*, sloped surfaces may be used.

6.1.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 6.1.2.1 (IBC 1004) OCCUPANT LOAD

6.1.2.1.1 (IBC 1004.1) Design occupant load. In determining means of egress requirements, the number of occupants for whom means of egress facilities shall be provided shall be determined in accordance with this section. Where occupants from accessory areas egress through a primary space, the calculated occupant load for the primary space shall include the total occupant load of the primary space plus the number of occupants egressing through it from the accessory area.

6.1.2.1.1.1 (IBC 1004.1.1) Areas without fixed seating. The number of occupants shall be computed at the rate of one occupant per unit of area as prescribed in Table 6.1.2.1.1.1 (IBC Table 1004.1.1). For areas without fixed seating, the *occupant load* shall not be less than that number determined by dividing the floor area under consideration by the occupant per unit of area factor assigned to the occupancy as set forth in Table 6.1.2.1.1.1 (IBC Table 1004.1.1). Where an intended use is not listed in Table 6.1.2.1.1.1 (IBC Table 1004.1.1), the *building official* shall establish a use based on a listed use that most nearly resembles the intended use.

Table 6.1.2.1.1.1 (IBC TABLE 1004.1.1)
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	FLOOR AREA (square meters per person)
Accessory storage areas, mechanical equipment room	28.00 gross
Assembly with fixed seats	See Section 6.1.2.1.7 (IBC Section 1004.7)
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	0.65 net
Standing space	0.46 net
Unconcentrated (tables and chairs)	1.40 net
Business areas	9.30 gross
Day care	3.25 net
Exercise rooms	4.65 gross
Kitchens, commercial	18.50 gross
Library	
Reading rooms	4.65 net
Stack area	9.30 gross
Locker rooms	4.65 gross
Parking garages	18.50 gross

6.1.2.1.2 (IBC 1004.2) Increased occupant load. The *occupant load* permitted in any building, or portion thereof, is permitted to be increased from that number established for the occupancies in Table 6.1.2.1.1.1 (IBC Table 1004.1.1), provided that all other requirements of these guidelines are also met based on such modified number and the *occupant load* does not exceed one occupant per 0.65 m² of occupiable floor space. Where required by the *building official*, an *approved aisle*, seating or fixed equipment diagram substantiating any increase in *occupant load* shall be submitted. Where required by the *building official*, such diagram shall be posted.

6.1.2.1.3 (IBC 1004.3) Posting of occupant load. Every room or space that is an assembly occupancy shall have the *occupant load* of the room or space posted in a conspicuous place, near the main *exit* or *exit access doorway* from the room or space. Posted signs shall be of an *approved* legible permanent design and shall be maintained by the owner or authorized agent.

6.1.2.1.4 (IBC 1004.4) Exiting from multiple levels. Where *exits* serve more than one floor, only the *occupant load* of each floor considered individually shall be used in computing the required capacity of the *exits* at that floor, provided that the *exit* capacity shall not decrease in the direction of egress travel.

6.1.2.1.5 (IBC 1004.5) Egress convergence. Where *means of egress* from floors above and below converge at an intermediate level, the capacity of the *means of egress* from the point of convergence shall not be less than the sum of the two floors.

6.1.2.1.6 (IBC 1004.6) Mezzanine levels. The *occupant load* of a *mezzanine* level with egress onto a room or area below shall be added to that room or area's *occupant load*, and the capacity of the exits shall be designed for the total *occupant load* thus established.

6.1.2.1.7 (IBC 1004.7) Fixed seating. For areas having fixed seats and *aisles*, the *occupant load* shall be determined by the number of fixed seats installed therein. The *occupant load* for areas in which fixed seating is not installed, such as waiting spaces and *wheelchair spaces*, shall be determined in accordance with Section 6.1.2.1.1.1 (IBC Section 1004.1.1) and added to the number of fixed seats.

For areas having fixed seating without dividing arms, the *occupant load* shall not be less than the number of seats based on one person for each 45 cm of seating length. The *occupant load* of seating booths shall be based on one person for each 61 cm of booth seat length measured at the backrest of the seating booth.

6.1.2.1.8 (IBC 1004.8) Outdoor areas. Yards, patios, courts and similar outdoor areas accessible to and usable by the building occupants shall be provided with *means of egress* as required by this chapter. The *occupant load* of such outdoor areas shall be assigned by the *building official* in accordance with the anticipated use. Where outdoor areas are to be used by persons in addition to the occupants of the building, and the path of egress travel from the outdoor areas passes through the building, *means of egress* requirements for the building shall be based on the sum of the *occupant loads* of the building plus the outdoor areas.

6.1.2.1.9 (IBC 1004.9) Multiple occupancies. Where a building contains two or more occupancies, the *means of egress* requirements shall apply to each portion of the building based on the occupancy of that space. Where two or more occupancies utilize portions of the same *means of egress* system, those egress components shall meet the more stringent requirements of all occupancies that are served.

SECTION 6.1.2.2 (IBC 1003) EXIT ACCESS COMPONENTS AND CHARACTERISTICS

6.1.2.2.1 (IBC 1003.2) Ceiling height. The *means of egress* shall have a ceiling height of not less than 2.30 m.

Exceptions:

1. Sloped ceilings in accordance with IBC Section 1208.2.
2. Allowable projections in accordance with Section 6.1.2.2.2 (IBC Section 1003.3).
3. Stair headroom in accordance with Section 6.1.2.19.2 (IBC Section 1009.2).
4. Door height in accordance with Section 6.1.2.18.1.1 (IBC Section 1008.1.1).
5. Ramp headroom in accordance with Section 6.1.2.14.5.2 (IBC Section 1010.5.2).
6. The clear height of floor levels in vehicular and pedestrian traffic areas in parking garages in accordance with IBC Section 406.2.2.
7. Areas above and below *mezzanine* floors in accordance with Section 4.1.2.6.1 (IBC Section 505.1).

6.1.2.2.2 (IBC 1003.3) Protruding objects. Protruding objects shall comply with the requirements of Sections 6.1.2.2.2.1 through 6.1.2.2.2.3 (IBC Sections 1003.3.1 through 1003.3.4).

6.1.2.2.2.1 (IBC 1003.3.1) Headroom. Protruding objects are permitted to extend below the minimum ceiling height required by Section 6.1.2.2.1 (IBC Section 1003.2) provided a minimum headroom of 2.05 m

MEANS OF EGRESS

shall be provided for any walking surface, including walks, *corridors*, *aisles* and passageways. Not more than 50% of the ceiling area of a *means of egress* shall be reduced in height by protruding objects.

Exception: Door closers and stops shall not reduce headroom to less than 2 m.

A barrier shall be provided where the vertical clearance is less than 2.05 m high. The leading edge of such a barrier shall be located 69 cm maximum above the floor.

6.1.2.2.2.2 (IBC 1003.3.3) Horizontal projections. Structural elements, fixtures or furnishings shall not project horizontally from either side more than 10 cm over any walking surface between the heights of 0.70 m and 2.05 m above the walking surface.

6.1.2.2.2.3 (IBC 1003.3.4) Clear width. Protruding objects shall not reduce the minimum clear width of *accessible routes*.

6.1.2.2.3 (IBC 1003.4) Floor surface. Walking surfaces of the *means of egress* shall have a slip-resistant surface and be securely attached.

6.1.2.2.4 (IBC 1003.5) Elevation change. Where changes in elevation of less than 31 cm exist in the *means of egress*, sloped surfaces shall be used. Where the slope is greater than one unit vertical in 20 units horizontal (5-percent slope), *ramps* complying with Section 6.1.2.14 (IBC Section 1010) shall be used. Where the difference in elevation is 15 cm or less, the *ramp* shall be equipped with either handrails or floor finish materials that contrast with adjacent floor finish materials.

Exceptions:

1. A *stair* with a single riser or with two risers and a tread is permitted at locations not required to be *accessible* by IBC Chapter 11, provided that the risers and treads comply with IBC Section 1009.4, the minimum depth of the tread is 33 cm and at least one *handrail* complying with Section 6.1.2.20 (IBC Section 1012) is provided within 76 cm of the centerline of the normal path of egress travel on the *stair*.
2. A step is permitted in *aisles* serving seating that has a difference in elevation less than 31 cm at locations not required to be *accessible* by IBC Chapter 11, provided that the risers and treads comply with Section 6.1.2.16.10 (IBC Section 1028.11) and the *aisle* is provided with a *handrail* complying with IBC Section 1028.13.

6.1.2.2.5 (IBC 1003.6) Means of egress continuity. The path of egress travel along a *means of egress* shall not be interrupted by any building element other than a *means of egress* component as specified in this chapter. Obstructions shall not be placed in the required width of a *means of egress* except projections permitted by this chapter. The required capacity of a *means of egress* system shall not be diminished along the path of egress travel.

6.1.2.2.6 (IBC 1014.2) Egress through intervening spaces. Egress through intervening spaces shall comply with this section.

1. Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, and provide a discernible path of egress travel to an *exit*.
2. An *exit access* shall not pass through a room that can be locked to prevent egress.
3. Reserved.
4. Egress shall not pass through kitchens, storage rooms, closets or spaces used for similar purposes.

6.1.2.2.7 (IBC 1014.2.1) Multiple tenants. Where more than one tenant occupies any one floor of a building or structure, each tenant space shall be provided with access to the required *exits* without passing through adjacent tenant spaces, dwelling units and sleeping units.

6.1.2.2.8 (IBC 1003.7) Elevators, escalators and moving walks. Elevators, escalators and moving walks shall not be used as a component of a required *means of egress* from any other part of the building.

Exception: Elevators used as an *accessible means of egress* in accordance with Section 6.1.2.22.4 (IBC Section 1007.4).

6.1.2.2.9 (IBC 1005.1) Minimum required egress width. The *means of egress* width shall not be less than required by this section. The total width of *means of egress* in millimeters shall not be less than the total *occupant load* served by the *means of egress* multiplied by 8 mm per occupant for stairways and by 5 mm per occupant for other egress components. The width shall not be less than specified elsewhere in these guidelines. Multiple *means of egress* shall be sized such that the loss of any one *means of egress* shall not reduce the available capacity to less than 50% of the required capacity. The maximum capacity required from any *story* of a building shall be maintained to the termination of the *means of egress*.

6.1.2.2.10 (IBC 1005.2) Door encroachment. Doors, when fully opened, and handrails shall not reduce the required *means of egress* width by more than 18 cm. Doors in any position shall not reduce the required width by more than one-half. Other nonstructural projections such as trim and similar decorative features shall be permitted to project into the required width a maximum of 4 cm on each side.

6.1.2.2.11 (IBC 1006.3) Illumination emergency power. The power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply.

In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Aisles* and unenclosed egress *stairways* in rooms and spaces that require two or more *means of egress*.
2. *Corridors*, *exit enclosures* and *exit passageways* in buildings required to have two or more *exits*.
3. Exterior egress components at other than their *levels of exit discharge* until *exit discharge* is accomplished for buildings required to have two or more *exits*.
4. Interior *exit discharge* elements, as permitted in Section 6.1.2.17.1 (IBC Section 1027.1), in buildings required to have two or more *exits*.
5. Exterior landings as required by Section 6.1.2.18.1.6 (IBC Section 1008.1.6) for *exit discharge* doorways in buildings required to have two or more *exits*.

The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with IBC Chapter 27.

6.1.2.2.12 (IBC 1006.4) Performance of system. Emergency lighting facilities shall be arranged to provide initial illumination that is at least an average of 11 lx and a minimum at any point of 1.10 lx measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.65 lx average and a minimum at any point of 0.65 lx at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded.

6.1.2.2.13 (IBC 1014.3) Common path of egress travel. The *common path of egress travel* shall not exceed 23 m. For *common path of egress travel* in Group A occupancies having fixed seating, see Section 6.1.2.16.7 (IBC Section 1028.8).

Exceptions:

1. The length of a *common path of egress travel* in Group B occupancies shall not be more than 30.50 m, provided that the building is equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13.
2. Where a tenant space in Group B and U occupancies has an *occupant load* of not more than 30, the length of a *common path of egress travel* shall not be more than 30.50 m.

6.1.2.2.14 (IBC 1017.1) General. *Aisles* serving as a portion of the *exit access* in the *means of egress* system shall comply with the requirements of this section. *Aisles* shall be provided from all occupied portions of the *exit access* which contain seats, tables, furnishings, displays and similar fixtures or equipment. *Aisles* serving

MEANS OF EGRESS

assembly areas shall comply with Section 6.1.2.16 (IBC Section 1028). Aisles serving reviewing stands, *grandstands* and *bleachers* shall also comply with Section 6.1.2.16 (IBC Section 1028). The required width of *aisles* shall be unobstructed.

6.1.2.2.15 (IBC 1017.2) Aisles in Group B. In Group B occupancies, the minimum clear *aisle* width shall be determined by Section 6.1.2.2.9 (IBC Section 1005.1) for the *occupant load* served, but shall not be less than 92 cm.

Exception: Nonpublic *aisles* serving less than 50 people and not required to be *accessible* by IBC Chapter 11 need not exceed 71 cm in width.

SECTION 6.1.2.3 (IBC 1018) CORRIDORS

6.1.2.3.1 (IBC 1018.1) Construction. *Corridors* shall be fire-resistance rated in accordance with Table 6.1.2.3.1 (IBC Table 1018.1). The *corridor* walls required to be fire-resistance rated shall comply with Section 5.2.2.6 (IBC Section 709) for *fire partitions*.

Exceptions:

1. Reserved.
2. Reserved.
3. A fire-resistance rating is not required for corridors in open parking garages.
4. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group B which is a space requiring only a single *means of egress* complying with Section 6.1.2.8.1 (IBC Section 1015.1).

**TABLE 6.1.2.3.1 (IBC TABLE 1018.1)
CORRIDOR FIRE-RESISTANCE RATING**

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system
A, B, U	Greater than 30	1	0

6.1.2.3.2 (IBC 1018.2) Corridor width. The minimum *corridor* width shall be as determined in Section 6.1.2.2.9 (IBC Section 1005.1), but not less than 1.10 m.

Exceptions:

1. For access to and utilization of electrical, mechanical or plumbing systems or equipment: 61 cm.
2. With a required occupant capacity of less than 50: 92 cm.

6.1.2.3.3 (IBC 1018.3) Corridor obstruction. The required width of *corridors* shall be unobstructed.

6.1.2.3.4 (IBC 1018.4) Dead ends. Where more than one *exit* or *exit access doorway* is required, the *exit access* shall be arranged such that there are no dead ends in *corridors* more than 6.10 m in length.

Exceptions:

1. In occupancies in Groups B and U, where the building is equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13, the length of the dead-end *corridors* shall not exceed 15 m.
2. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.

6.1.2.3.5 (IBC 1018.5) Air movement in corridors. *Corridors* shall not serve as supply, return, exhaust, relief or ventilation air ducts.

Exceptions:

1. Use of a *corridor* as a source of makeup air for exhaust systems in rooms that open directly onto such *corridors*, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor

closets, shall be permitted, provided that each such *corridor* is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the *corridor*.

2. Where located within tenant spaces of 93 m² or less in area, utilization of *corridors* for conveying return air is permitted.
3. Incidental air movement from pressurized rooms within health care facilities, provided that the *corridor* is not the primary source of supply or return to the room.

6.1.2.3.5.1 (IBC 1018.5.1) Corridor ceiling. Use of the space between the *corridor* ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The *corridor* is not required to be of fire-resistance-rated construction;
2. The *corridor* is separated from the plenum by fire-resistance-rated construction;
3. The air-handling system serving the *corridor* is shut down upon activation of the air-handling unit *smoke detectors* required by the *International Mechanical Code*;
4. The air-handling system serving the *corridor* is shut down upon detection of sprinkler water flow where the building is equipped throughout with an *automatic sprinkler system*; or
5. The space between the *corridor* ceiling and the floor or roof structure above the *corridor* is used as a component of an *approved* engineered smoke control system.

6.1.2.3.6 (IBC 1018.6) Corridor continuity. Fire-resistance-rated corridors shall be continuous from the point of entry to an *exit*, and shall not be interrupted by intervening rooms.

Exception: Foyers, lobbies or reception rooms constructed as required for *corridors* shall not be construed as intervening rooms.

SECTION 6.1.2.4 (IBC 1019) EGRESS BALCONIES

6.1.2.4.1 (IBC 1019.1) General. Balconies used for egress purposes shall conform to the same requirements as *corridors* for width, headroom, dead ends and projections.

6.1.2.4.2 (IBC 1019.2) Wall separation. Exterior egress balconies shall be separated from the interior of the building by walls and opening protectives as required for *corridors*.

Exception: Separation is not required where the exterior egress balcony is served by at least two *stairs* and a dead-end travel condition does not require travel past an unprotected opening to reach a *stair*.

6.1.2.4.3 (IBC 1019.3) Openness. The long side of an egress balcony shall be at least 50% open, and the open area above the guards shall be so distributed as to minimize the accumulation of smoke or toxic gases.

SECTION 6.1.2.5 (IBC 1016) EXIT ACCESS TRAVEL DISTANCE

6.1.2.5.1 (IBC 1016.1) Travel distance limitations. *Exits* shall be so located on each *story* such that the maximum length of *exit access* travel, measured from the most remote point within a *story* along the natural and unobstructed path of egress travel to an *exterior exit door* at the *level of exit discharge*, an entrance to a vertical *exit enclosure*, an *exit passageway*, a *horizontal exit*, an *exterior exit stairway* or an *exterior exit ramp*, shall not exceed the distances given in Table 6.1.2.5 (IBC Table 1016.1).

Exceptions:

1. Travel distance in *open parking garages* is permitted to be measured to the closest riser of open *exit stairways*.
2. In outdoor facilities with open *exit access* components and open *exterior exit stairways* or *exit ramps*, travel distance is permitted to be measured to the closest riser of an *exit stairway* or the closest slope of the *exit ramp*.
3. The *exit access* travel distance to a maximum of 50% of the *exits* is permitted to be measured from the most remote point within a building to an *exit* using unenclosed *exit access stairways* or

MEANS OF EGRESS

ramps when connecting a maximum of two stories. The two connected stories shall be provided with at least two *means of egress*. Such interconnected stories shall not be open to other stories.

4. *Exit access* travel distance is permitted to be measured from the most remote point within a building to an *exit* using unenclosed *exit access stairways* or *ramps* in the first and second stories above *grade plane* in buildings equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13. The first and second stories above *grade plane* shall be provided with at least two *means of egress*. Such interconnected stories shall not be open to other stories.

Where applicable, travel distance on unenclosed *exit access stairways* or *ramps* and on connecting stories shall also be included in the travel distance measurement. The measurement along *stairways* shall be made on a plane parallel and tangent to the *stair tread nosings* in the center of the *stairway*.

**TABLE 6.1.2.5 (IBC TABLE 1016.1)
EXIT ACCESS TRAVEL DISTANCE**

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (meters)	WITH SPRINKLER SYSTEM (meters)
A	61	76
B	61	91.50
U	91.50	120.0

6.1.2.5.2 (IBC 1016.2) Exterior egress balcony increase. Travel distances specified in Section 6.1.2.5.1 (IBC Section 1016.1) shall be increased up to an additional 30.50 m provided the last portion of the *exit access* leading to the *exit* occurs on an exterior egress balcony constructed in accordance with Section 6.1.2.4 (IBC Section 1019). The length of such balcony shall not be less than the amount of the increase taken.

SECTION 6.1.2.6 (IBC 1013) GUARDS

6.1.2.6.1 (IBC 1013.1) Where required. *Guards* shall be located along open-sided walking surfaces, including *mezzanines*, *equipment platforms*, *stairs*, *ramps* and landings that are located more than 76 cm measured vertically to the floor or grade below at any point within 92 cm horizontally to the edge of the open side. *Guards* shall be adequate in strength and attachment in accordance with IBC Section 1607.7.

6.1.2.6.1.1 (IBC 1013.1.1) Glazing. Where glass is used to provide a *guard* or as a portion of the *guard system*, the *guard* shall also comply with Section 6.4.2.2 (IBC Section 2407). Where the glazing provided does not meet the strength and attachment requirements of IBC Section 1607.7, complying *guards* shall also be located along glazed sides of open-sided walking surfaces.

6.1.2.6.2 (IBC 1013.2) Height. Required *guards* shall be not less than 1.05 m high, measured vertically above the adjacent walking surfaces, adjacent fixed seating or the line connecting the leading edges of the treads.

Exceptions:

1. The height in assembly seating areas shall be in accordance with IBC Section 1028.14.
2. Along *alternating tread devices* and ship ladders, *guards* whose top rail also serves as a *handrail*, shall have height not less than 76 cm and not more than 87 cm, measured vertically from the leading edge of the device tread *nosings*.

6.1.2.6.3 (IBC 1013.3) Opening limitations. Required *guards* shall not have openings which allow passage of a sphere 10 cm in diameter from the walking surface to the required *guard* height.

Exceptions:

1. From a height of 92 cm to 1.05 m, *guards* shall not have openings which allow passage of a sphere 11 cm in diameter.
2. The triangular openings at the open sides of a *stair*, formed by the riser, tread and bottom rail shall not allow passage of a sphere 15 cm in diameter.

3. At elevated walking surfaces for access to and use of electrical, mechanical or plumbing systems or equipment, *guards* shall not have openings which allow passage of a sphere 53 cm in diameter.
4. Reserved.
5. In assembly seating areas, *guards* at the end of *aisles* where they terminate at a fascia of boxes, balconies and galleries shall not have openings which allow passage of a sphere 10 cm in diameter up to a height of 66 cm. From a height of 66 cm to 1.05 m above the adjacent walking surfaces, *guards* shall not have openings which allow passage of a sphere 20 cm in diameter.
6. Reserved.

6.1.2.6.4 (IBC 1013.5) Mechanical equipment. *Guards* shall be provided where appliances, equipment, fans, roof hatch openings or other components that require service are located within 3.05 m of a roof edge or open side of a walking surface and such edge or open side is located more than 76 cm above the floor, roof or grade below. The *guard* shall be constructed so as to prevent the passage of a sphere 53 cm in diameter. The *guard* shall extend not less than 76 cm beyond each end of such appliance, equipment, fan or component.

6.1.2.6.5 (IBC 1013.6) Roof access. *Guards* shall be provided where the roof hatch opening is located within 3.05 m of a roof edge or open side of a walking surface and such edge or open side is located more than 76 cm above the floor, roof or grade below. The *guard* shall be constructed so as to prevent the passage of a sphere 53 cm in diameter.

SECTION 6.1.2.7 (IBC 1020) NUMBER OF EXITS

6.1.2.7.1 (IBC 1020.1) General. *Exits* shall comply with Sections 6.1.2.7, 6.1.2.9, 6.1.2.10, 6.1.2.11, 6.1.2.12, 6.1.2.13, and 6.1.2.15 (IBC Sections 1020 through 1026) and the applicable requirements of Section 6.1.2.1, 6.1.2.2, 6.1.2.6, 6.1.2.14, 6.1.2.18, 6.1.2.19, 6.1.2.20, 6.1.2.21 and 6.1.2.22 (IBC Sections 1003 through 1013). An *exit* shall not be used for any purpose that interferes with its function as a *means of egress*. Once a given level of exit protection is achieved, such level of protection shall not be reduced until arrival at the *exit discharge*.

6.1.2.7.2 (IBC 1020.2) Exterior exit doors. Buildings or structures used for human occupancy shall have at least one exterior door that meets the requirements of Section 6.1.2.18.1.1 (IBC Section 1008.1.1).

6.1.2.7.2.1 (IBC 1020.2.1) Detailed requirements. Exterior *exit* doors shall comply with the applicable requirements of Section 6.1.2.18.1 (IBC Section 1008.1).

6.1.2.7.2.2 (IBC 1020.2.2) Arrangement. Exterior *exit* doors shall lead directly to the *exit discharge* or the *public way*.

SECTION 6.1.2.8 (IBC 1015) EXIT AND EXIT ACCESS DOORWAYS

6.1.2.8.1 (IBC 1015.1) Exits or exit access doorways from spaces. Two *exits* or *exit access doorways* from any space shall be provided where one of the following conditions exists:

1. The *occupant load* of the space exceeds one of the values in Table 6.1.2.8.1 (IBC Table 1015.1).
2. The *common path of egress travel* exceeds one of the limitations of Section 6.1.2.2.13 (IBC Section 1014.3).
3. Where required by Section 6.1.2.8.3, 6.1.2.8.4, 6.1.2.8.5 or IBC Sections 1015.3, 1015.4, 1015.5, 1015.6 or 1015.6.1.

Where a building contains mixed occupancies, each individual occupancy shall comply with the applicable requirements for that occupancy. Where applicable, cumulative *occupant loads* from adjacent occupancies shall be considered in accordance with the provisions of Section 6.1.2.1.1.1 (IBC Section 1004.1).

**TABLE 6.1.2.8.1 (IBC TABLE 1015.1)
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY**

OCCUPANCY	MAXIMUM OCCUPANT LOAD
A, B, U	49

6.1.2.8.1.1 (IBC 1015.1.1) Three or more exits or exit access doorways. Three *exits* or *exit access doorways* shall be provided from any space with an *occupant load* of 501 to 1000. Four *exits* or *exit access doorways* shall be provided from any space with an *occupant load* greater than 1,000.

6.1.2.8.2 (IBC 1015.2) Exit or exit access doorway arrangement. Required *exits* shall be located in a manner that makes their availability obvious. *Exits* shall be unobstructed at all times. *Exit* and *exit access doorways* shall be arranged in accordance with Sections 6.1.2.8.2 and 6.1.2.8.2.2 (IBC Sections 1015.2.1 and 1015.2.2).

6.1.2.8.2.1 (IBC 1015.2.1) Two exits or exit access doorways. Where two *exits* or *exit access doorways* are required from any portion of the *exit access*, the *exit* doors or *exit access doorways* shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between *exit* doors or *exit access doorways*. Interlocking or *scissor stairs* shall be counted as one *exit stairway*.

Exceptions:

1. Where *exit enclosures* are provided as a portion of the required *exit* and are interconnected by a 1-hour fire-resistance-rated *corridor* conforming to the requirements of Section 6.1.2.3 (IBC Section 1018), the required *exit* separation shall be measured along the shortest direct line of travel within the *corridor*.
2. Where a building is equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13 or NFPA 13R, the separation distance of the *exit* doors or *exit access doorways* shall not be less than one-third of the length of the maximum overall diagonal dimension of the area served.

6.1.2.8.2.2 (IBC 1015.2.2) Three or more exits or exit access doorways. Where access to three or more *exits* is required, at least two *exit* doors or *exit access doorways* shall be arranged in accordance with the provisions of Section 6.1.2.8.2 (IBC Section 1015.2.1).

6.1.2.8.3 (IBC 1015.3) Boiler, incinerator and furnace rooms. Two *exit access doorways* are required in boiler, incinerator and furnace rooms where the area is over 46.50 m² and any fuel-fired equipment exceeds 422 000 KJ input capacity. Where two *exit access doorways* are required, one is permitted to be a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the length of the maximum overall diagonal dimension of the room.

6.1.2.8.4 (IBC 1015.4) Refrigeration machinery rooms. Machinery rooms larger than 93 m² shall have not less than two *exits* or *exit access* doors. Where two *exit access doorways* are required, one such doorway is permitted to be served by a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the maximum horizontal dimension of room. All portions of machinery rooms shall be within 45.50 m of an *exit* or *exit access doorway*. An increase in travel distance is permitted in accordance with Section 6.1.2.5.1 (IBC Section 1016.1). Doors shall swing in the direction of egress travel, regardless of the *occupant load* served. Doors shall be tight fitting and self-closing.

6.1.2.8.5 (IBC 1015.5) Refrigerated rooms or spaces. Rooms or spaces having a floor area larger than 93 m², containing a refrigerant evaporator and maintained at a temperature below 20°C, shall have access to not less than two *exits* or *exit access* doors. Travel distance shall be determined as specified in Section 1016.1, but all portions of a refrigerated room or space shall be within 45.50 m of an *exit* or *exit access* door where such rooms are not protected by an *approved automatic sprinkler* system. Egress is allowed through adjoining refrigerated rooms or spaces.

Exception: Where using refrigerants in quantities limited to the amounts based on the volume set forth in the *International Mechanical Code*.

SECTION 6.1.2.9 (IBC 1021) NUMBER OF EXITS AND CONTINUITY

6.1.2.9.1 (IBC 1021.1) Exits from stories. All spaces within each *story* shall have access to the minimum number of *approved* independent *exits* as specified in Table 6.1.2.9.1 (IBC Table 1021.1) based on the *occupant load* of the *story*. For the purposes of this chapter, occupied roofs shall be provided with *exits* as required for stories.

TABLE 6.1.2.9.1 (IBC TABLE 1021.1)
MINIMUM NUMBER OF EXITS FOR OCCUPANT LOAD

OCCUPANT LOAD (persons per story)	MINIMUM NUMBER OF EXITS (per story)
1 to 500	2
501 to 1000	3
More than 1000	4

6.1.2.9.1.1 (IBC 1021.1.1) Exits maintained. The required number of *exits* from any *story* shall be maintained until arrival at grade or the *public way*.

6.1.2.9.2 (IBC 1021.2) Single exits. Only one *exit* shall be required from stories of buildings as indicated in Table 6.1.2.9.2 (IBC Table 1021.2). Occupancies shall be permitted to have a single *exit* in buildings otherwise required to have more than one *exit* if the areas served by the single *exit* do not exceed the limitations of Table 6.1.2.9.2 (IBC Table 1021.2). Mixed occupancies shall be permitted to be served by single *exits* provided each individual occupancy complies with the applicable requirements of Table 6.1.2.9.2 (IBC Table 1021.2) for that occupancy. Where applicable, cumulative *occupant loads* from adjacent occupancies shall be considered in accordance with the provisions of Section 6.1.2.1.1 (IBC Section 1004.1). Basements with a single *exit* shall not be located more than one *story* below *grade plane*.

TABLE 6.1.2.9.2 (IBC TABLE 1021.2)
STORIES WITH ONE EXIT

STORY	OCCUPANCY	MAXIMUM OCCUPANTS PER FLOOR AND TRAVEL DISTANCE
First story or basement	A, B, U	49 occupants and 23 m travel distance
Second story	B,	29 occupants and 23 m travel distance

Note: First story in the context of these guidelines is generally the story at grade level where occupants enter the building and the story above that is designated as the second story. In some parts of the world, this first floor is referred to as the ground floor and the floor above that as first floor.

6.1.2.9.3 (IBC 1021.3) Exit continuity. *Exits* shall be continuous from the point of entry into the *exit* to the *exit discharge*.

6.1.2.9.4 (IBC 1021.4) Exit door arrangement. *Exit* door arrangement shall meet the requirements of Sections 6.1.2.8.2 through 6.1.2.8.2.2 (IBC Sections 1015.2 through 1015.2.2).

6.1.2.10 (IBC 1022) EXIT COMPONENT CHARACTERISTICS

6.1.2.10.1 (IBC 1022.1) Enclosures required. *Interior exit stairways* and *interior exit ramps* shall be enclosed with *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. *Exit enclosures* shall have a *fire-resistance rating* of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the *exit enclosure* shall include any basements but not any *mezzanines*. *Exit enclosures* shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours. *Exit enclosures* shall lead directly to the exterior of the building or shall be extended to the exterior of the building with an *exit passageway* conforming to the requirements of Section 6.1.2.11 (IBC Section 1023), except as permitted in Section 6.1.2.17.1 (IBC Section 1027.1). An *exit enclosure* shall not be used for any purpose other than *means of egress*.

MEANS OF EGRESS

Exceptions:

1. A *stairway* is not required to be enclosed when the *stairway* serves an *occupant load* of less than 10 and the *stairway* complies with either Item 1.1 or 1.2. In all cases, the maximum number of connecting open stories shall not exceed two.
 - 1.1. The *stairway* is open to not more than one *story* above its *level of exit discharge*; or
 - 1.2. The *stairway* is open to not more than one *story* below its *level of exit discharge*.
- 1.2. Reserved.
2. *Stairways* in open parking structures that serve only the parking structure are not required to be enclosed.
3. Reserved.
4. *Means of egress stairways* as required by IBC Sections 410.5.3 and 1015.6.1 are not required to be enclosed.
5. *Means of egress stairways* from balconies, galleries or press boxes as provided for in Section Section 6.1.2.16.4.1 (IBC 1028.5.1) are not required to be enclosed.

6.1.2.10.2 (IBC 1022.2) Termination. *Exit enclosures* shall terminate at an *exit discharge* or a *public way*.

Exception: An *exit enclosure* shall be permitted to terminate at an *exit passageway* complying with Section 6.1.2.11 (IBC Section 1023), provided the *exit passageway*

6.1.2.10.2.1 (IBC 1022.2.1) Extension. Where an *exit enclosure* is extended to an *exit discharge* or a *public way* by an *exit passageway*, the *exit enclosure* shall be separated from the *exit passageway* by a *fire barrier* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or a *horizontal assembly* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. The *fire-resistance rating* shall be at least equal to that required for the *exit enclosure*. A *fire door* assembly complying with Section 5.2.2.12.4 (IBC Section 715.4) shall be installed in the *fire barrier* to provide a *means of egress* from the *exit enclosure* to the *exit passageway*. Openings in the *fire barrier* other than the *fire door assembly* are prohibited. Penetrations of the *fire barrier* are prohibited.

Exception: Penetrations of the *fire barrier* in accordance with Section 6.1.2.10.4 (IBC Section 1022.4) shall be permitted.

6.1.2.10.3 (IBC 1022.3) Openings and penetrations. *Exit enclosure* opening protectives shall be in accordance with the requirements of Section 5.2.2.12 (IBC Section 715).

Openings in *exit enclosures* other than unprotected exterior openings shall be limited to those necessary for *exit access* to the enclosure from normally occupied spaces and for egress from the enclosure. Elevators shall not open into an *exit enclosure*.

6.1.2.10.4 (IBC 1022.4) Penetrations. Penetrations into and openings through an *exit enclosure* are prohibited except for required *exit doors*, equipment and ductwork necessary for independent ventilation or pressurization, sprinkler piping, standpipes, electrical raceway for fire department communication systems and electrical raceway serving the *exit enclosure* and terminating at a steel box not exceeding 105 cm². Such penetrations shall be protected in accordance with Section 5.2.2.10 (IBC Section 713). There shall be no penetrations or communication openings, whether protected or not, between adjacent *exit enclosures*.

6.1.2.10.5 (IBC 1022.5) Ventilation. Equipment and ductwork for *exit enclosure* ventilation as permitted by Section 6.1.2.10.4 (IBC Section 1022.4) shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the *exit enclosure* by ductwork enclosed in construction as required for shafts.
2. Where such equipment and ductwork is located within the *exit enclosure*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required for shafts.

3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.

In each case, openings into the fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 5.2.2.12 (IBC Section 715) for shaft enclosures. *Exit enclosure* ventilation systems shall be independent of other building ventilation systems.

6.1.2.10.6 (IBC 1022.6) Exit enclosure exterior walls. *Exterior walls* of an *exit enclosure* shall comply with the requirements of Section 5.2.2.2 (IBC Section 705) for *exterior walls*. Where nonrated walls or unprotected openings enclose the exterior of the *stairway* and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building *exterior walls* within 3.05 m horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than $\frac{3}{4}$ hour. This construction shall extend vertically from the ground to a point 3.05 m above the topmost landing of the *stairway* or to the roof line, whichever is lower.

6.1.2.10.7 (IBC 1022.7) Discharge identification. A *stairway* in an *exit enclosure* shall not continue below its *level of exit discharge* unless an approved barrier is provided at the *level of exit discharge* to prevent persons from unintentionally continuing into levels below. Directional *exit* signs shall be provided as specified in Section 5.1.2.21 (IBC Section 1011).

6.1.2.10.8 (IBC 1022.8) Floor identification signs. A sign shall be provided at each floor landing in *exit enclosures* connecting more than three stories designating the floor level, the terminus of the top and bottom of the *exit enclosure* and the identification of the *stair* or *ramp*. The signage shall also state the *story* of, and the direction to, the *exit discharge* and the availability of roof access from the enclosure for the fire department. The sign shall be located 1.50 m above the floor landing in a position that is readily visible when the doors are in the open and closed positions. Floor level identification signs in tactile characters complying with ICC A117.1 shall be located at each floor level landing adjacent to the door leading from the enclosure into the corridor to identify the floor level.

6.1.2.10.8.1 (IBC 1022.8.1) Signage requirements. *Stairway* identification signs shall comply with all of the following requirements:

1. The signs shall be a minimum size of 46 cm by 31 cm.
2. The letters designating the identification of the stair enclosure shall be a minimum of 4 cm in height.
3. The number designating the floor level shall be a minimum of 13 cm in height and located in the center of the sign.
4. All other lettering and numbers shall be a minimum of 3 cm in height.
5. Characters and their background shall have a nonglare finish. Characters shall contrast with their background, with either light characters on a dark background or dark characters on a light background.
6. When signs required by Section 6.1.2.10.8 (IBC Section 1022.8) are installed in interior *exit enclosures* of buildings subject to Section 6.1.2.12 (IBC Section 1024), the signs shall be made of the same materials as required by IBC Section 1024.4.

SECTION 6.1.2.11 (IBC 1023) EXIT PASSAGEWAYS

6.1.2.11.1 (IBC 1023.1) Exit passageway. *Exit passageways* serving as an *exit* component in a *means of egress* system shall comply with the requirements of this section. An *exit passageway* shall not be used for any purpose other than as a *means of egress*.

6.1.2.11.2 (IBC 1023.2) Width. The width of *exit passageways* shall be determined as specified in Section 6.1.2.2.9 (IBC Section 1005.1) but such width shall not be less than 1.10 m, except that *exit passageways* serv-

MEANS OF EGRESS

ing an *occupant load* of less than 50 shall not be less than 92 cm in width. The required width of *exit passageways* shall be unobstructed.

Exception: Doors complying with Section 6.1.2.2.10 (IBC Section 1005.2).

6.1.2.11.3 (IBC 1023.3) Construction. *Exit passageway* enclosures shall have walls, floors and ceilings of not less than 1-hour *fire-resistance rating*, and not less than that required for any connecting *exit enclosure*. *Exit passageways* shall be constructed as *fire barriers* in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both.

6.1.2.11.4 (IBC 1023.4) Termination. *Exit passageways* shall terminate at an *exit discharge* or a *public way*.

6.1.2.11.5 (IBC 1023.5) Openings and penetrations. *Exit passageway* opening protectives shall be in accordance with the requirements of Section 5.2.2.12 (IBC Section 715).

Except as permitted in IBC Section 402.4.6, openings in *exit passageways* other than exterior openings shall be limited to those necessary for *exit access* to the *exit passageway* from normally occupied spaces and for egress from the *exit passageway*.

Where an *exit enclosure* is extended to an *exit discharge* or a *public way* by an *exit passageway*, the *exit passageway* shall also comply with Section 6.1.2.10.2.1 (IBC Section 1022.2.1).

Elevators shall not open into an *exit passageway*.

6.1.2.11.6 (IBC 1023.6) Penetrations. Penetrations into and openings through an *exit passageway* are prohibited except for required *exit* doors, equipment and ductwork necessary for independent pressurization, sprinkler piping, standpipes, electrical raceway for fire department communication and electrical raceway serving the *exit passageway* and terminating at a steel box not exceeding 105 cm². Such penetrations shall be protected in accordance with Section 5.2.2.10 (IBC Section 713). There shall be no penetrations or communicating openings, whether protected or not, between adjacent *exit passageways*.

SECTION 6.1.2.12 (IBC 1024) LUMINOUS EGRESS PATH MARKINGS

6.1.2.12.1 (IBC 1024.2) Markings within exit enclosures. Egress path markings shall be provided in *exit enclosures*, including vertical *exit enclosures* and *exit passageways*, in accordance with IBC Sections 1024.2.1 through 1024.2.6.

6.1.2.12.1.1 (IBC 1024.2.5) Obstacles. Obstacles at or below 2 m in height and projecting more than 10 cm into the egress path shall be outlined with markings no less than 3 cm in width comprised of a pattern of alternating equal bands, of luminescent luminous material and black, with the alternating bands no more than 5 cm thick and angled at 45 degrees. Obstacles shall include, but are not limited to, standpipes, hose cabinets, wall projections and restricted height areas. However, such markings shall not conceal any required information or indicators including, but not limited to, instructions to occupants for the use of standpipes.

SECTION 6.1.2.13 (IBC 1025) HORIZONTAL EXITS

6.1.2.13.1 (IBC 1025.1) Horizontal exits. *Horizontal exits* serving as an *exit* in a *means of egress* system shall comply with the requirements of this section. A *horizontal exit* shall not serve as the only *exit* from a portion of a building, and where two or more *exits* are required, not more than one-half of the total number of *exits* or total *exit* width shall be *horizontal exits*.

6.1.2.13.2 (IBC 1025.2) Separation. The separation between buildings or refuge areas connected by a *horizontal exit* shall be provided by a *fire wall* complying with Section 5.2.2.3 (IBC Section 706); or it shall be provided by a *fire barrier* complying with Section 5.2.2.4 (IBC Section 707) or a *horizontal assembly* complying with Section 5.2.2.9 (IBC Section 712), or both. The minimum *fire-resistance rating* of the separation shall be 2 hours. Opening protectives in *horizontal exits* shall also comply with Section 5.2.2.12 (IBC Section 715). Duct and air transfer openings in a *fire wall* or *fire barrier* that serves as a *horizontal exit* shall also comply with Section 5.2.2.13 (IBC Section 716). The *horizontal exit* separation shall extend vertically through all levels of the building unless floor assemblies have a *fire-resistance rating* of not less than 2 hours with no unprotected openings.

Exception: A *fire-resistance rating* is not required at *horizontal exits* between a building area and an above-grade *pedestrian walkway* constructed in accordance with IBC Section 3104, provided that the distance between connected buildings is more than 6.10 m. *Horizontal exits* constructed as *fire barriers* shall be continuous from *exterior wall* to *exterior wall* so as to divide completely the floor served by the *horizontal exit*.

6.1.2.13.3 (IBC 1025.3) Opening protectives. *Fire doors* in *horizontal exits* shall be self-closing or automatic-closing when activated by a *smoke detector* in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3). Doors, where located in a cross-corridor condition, shall be automatic-closing by activation of a *smoke detector* installed in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3).

6.1.2.13.4 (IBC 1025.4) Capacity of refuge area. The refuge area of a *horizontal exit* shall be a space occupied by the same tenant or a public area and each such refuge area shall be adequate to accommodate the original *occupant load* of the refuge area plus the *occupant load* anticipated from the adjoining compartment. The anticipated *occupant load* from the adjoining compartment shall be based on the capacity of the *horizontal exit* doors entering the refuge area. The capacity of the refuge area shall be computed based on a net floor area allowance of 0.28 m² for each occupant to be accommodated therein.

SECTION 6.1.2.14 (IBC 1010) RAMPS

6.1.2.14.1 (IBC 1010.1) Scope. The provisions of this section shall apply to *ramps* used as a component of a *means of egress*.

6.1.2.14.2 (IBC 1010.2) Slope. *Ramps* used as part of a *means of egress* shall have a running slope not steeper than one unit vertical in 12 units horizontal (8-percent slope). The slope of other pedestrian *ramps* shall not be steeper than one unit vertical in eight units horizontal (12.5-percent slope).

6.1.2.14.3 (IBC 1010.3) Cross slope. The slope measured perpendicular to the direction of travel of a *ramp* shall not be steeper than one unit vertical in 48 units horizontal (2-percent slope).

6.1.2.14.4 (IBC 1010.4) Vertical rise. The rise for any *ramp* run shall be 76 cm maximum.

6.1.2.14.5 (IBC 1010.5) Minimum dimensions. The minimum dimensions of *means of egress ramps* shall comply with Sections 6.1.2.14.5.1 through 6.1.2.14.5.3 (IBC Sections 1010.5.1 through 1010.5.3).

6.1.2.14.5.1 (IBC 1010.5.1) Width. The minimum width of a *means of egress ramp* shall not be less than that required for *corridors* by Section 6.1.3.2 (IBC Section 1018.2). The clear width of a *ramp* between *handrails*, if provided, or other permissible projections shall be 92 cm minimum.

6.1.2.14.5.2 (IBC 1010.5.2) Headroom. The minimum headroom in all parts of the *means of egress ramp* shall not be less than 2.05 m.

6.1.2.14.5.3 (IBC 1010.5.3) Restrictions. *Means of egress ramps* shall not reduce in width in the direction of egress travel. Projections into the required *ramp* and landing width are prohibited. Doors opening onto a landing shall not reduce the clear width to less than 1.05 m.

6.1.2.14.6 (IBC 1010.6) Landings. *Ramps* shall have landings at the bottom and top of each *ramp*, points of turning, entrance, exits and at doors. Landings shall comply with Sections 6.1.2.14.6.1 through 6.1.2.14.6.5 (IBC Sections 1010.6.1 through 1010.6.5).

6.1.2.14.6.1 (IBC 1010.6.1) Slope. Landings shall have a slope not steeper than one unit vertical in 48 units horizontal (2-percent slope) in any direction. Changes in level are not permitted.

6.1.2.14.6.2 (IBC 1010.6.2) Width. The landing shall be at least as wide as the widest *ramp* run adjoining the landing.

6.1.2.14.6.3 (IBC 1010.6.3) Length. The landing length shall be 1.50 m minimum.

Exceptions:

1. Reserved.
2. Where the *ramp* is not a part of an *accessible route*, the length of the landing shall not be required to be more than 1.20 m in the direction of travel.

MEANS OF EGRESS

6.1.2.14.6.4 (IBC 1010.6.4) Change in direction. Where changes in direction of travel occur at landings provided between *ramp* runs, the landing shall be 1.50 m by 1.50 m minimum.

6.1.2.14.6.5 (IBC 1010.6.5) Doorways. Where doorways are located adjacent to a *ramp* landing, maneuvering clearances required by ICC A117.1 are permitted to overlap the required landing area.

6.1.2.14.7 (IBC 1010.7) Ramp construction. All *ramps* shall be built of materials consistent with the types permitted for the type of construction of the building, except that wood *handrails* shall be permitted for all types of construction. *Ramps* used as an *exit* shall conform to the applicable requirements of Sections 6.1.2.10.1 through 6.1.2.10.6 (IBC Sections 1022.1 through 1022.6) for *exit enclosures*.

6.1.2.14.7.1 (IBC 1010.7.1) Ramp surface. The surface of *ramps* shall be of slip-resistant materials that are securely attached.

6.1.2.14.7.2 (IBC 1010.7.2) Outdoor conditions. Outdoor *ramps* and outdoor approaches to *ramps* shall be designed so that water will not accumulate on walking surfaces.

6.1.2.14.8 (IBC 1010.8) Handrails. *Ramps* with a rise greater than 15 cm shall have handrails on both sides. *Handrails* shall comply with Section 6.1.2.20 (IBC Section 1012).

6.1.2.14.9 (IBC 1010.9) Edge protection. Edge protection complying with IBC Section 1010.9.1 or 1010.9.2 shall be provided on each side of *ramp* runs and at each side of *ramp* landings.

Exceptions:

1. Edge protection is not required on *ramps* that are not required to have *handrails*, provided they have flared sides that comply with the ICC A117.1 curb ramp provisions.
2. Edge protection is not required on the sides of ramp landings serving an adjoining *ramp* run or *stairway*.
3. Edge protection is not required on the sides of *ramp* landings having a vertical drop off of not more than 1 cm within 26 cm horizontally of the required landing area.
4. In assembly spaces with fixed seating, edge protection is not required on the sides of *ramps* where the *ramps* provide access to the adjacent seating and *aisle accessways*.

SECTION 6.1.2.15 (IBC 1026) EXTERIOR EXIT RAMPS AND STAIRWAYS

6.1.2.15.1 (IBC 1026.1) Exterior exit ramps and stairways. *Exterior exit ramps* and *stairways* serving as an element of a required *means of egress* shall comply with this section.

6.1.2.15.2 (IBC 1026.2) Use in a means of egress. *Exterior exit ramps* and *stairways* shall be permitted as an element of a required *means of egress* for buildings not exceeding six stories above *grade plane* or having occupied floors more than 23 m above the lowest level of fire department vehicle access.

6.1.2.15.3 (IBC 1026.3) Open side. *Exterior exit ramps* and *stairways* serving as an element of a required *means of egress* shall be open on at least one side. An open side shall have a minimum of 3.25 m² of aggregate open area adjacent to each floor level and the level of each intermediate landing. The required open area shall be located not less than 1.05 m above the adjacent floor or landing level.

6.1.2.15.4 (IBC 1026.4) Side yards. The open areas adjoining *exterior exit ramps* or *stairways* shall be either *yards*, *courts* or *public ways*; the remaining sides are permitted to be enclosed by the *exterior walls* of the building.

6.1.2.15.5 (IBC 1026.5) Location. *Exterior exit ramps* and *stairways* shall be located in accordance with Section 6.1.2.17.3 (IBC Section 1027.3).

6.1.2.15.6 (IBC 1026.6) Exterior ramps and stairway protection. *Exterior exit ramps* and *stairways* shall be separated from the interior of the building as required in Section 6.1.2.10.1 (IBC Section 1022.1). Openings shall be limited to those necessary for egress from normally occupied spaces.

Exceptions:

1. Separation from the interior of the building is not required in buildings that are no more than two stories above *grade plane* where a *level of exit discharge* serving such occupancies is the first *story above grade plane*.
2. Separation from the interior of the building is not required where the *exterior ramp* or *stairway* is served by an exterior *ramp* or balcony that connects two remote *exterior stairways* or other *approved exits*, with a perimeter that is not less than 50% open. To be considered open, the opening shall be a minimum of 50% of the height of the enclosing wall, with the top of the openings no less than 2.15 m above the top of the balcony.
3. Separation from the interior of the building is not required for an *exterior ramp* or *stairway* located in a building or structure that is permitted to have unenclosed *interior stairways* in accordance with Section 6.1.2.10.1 (IBC Section 1022.1).
4. Separation from the interior of the building is not required for *exterior ramps* or *stairways* connected to open-ended *corridors*, provided that Items 4.1 through 4.4 are met:
 - 4.1. The building, including *corridors*, *ramps* and *stairs*, shall be equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13 or NFPA 13R.
 - 4.2. The open-ended *corridors* comply with Section 6.1.2.3 (IBC Section 1018).
 - 4.3. The open-ended *corridors* are connected on each end to an *exterior exit ramp* or *stairway* complying with Section 6.1.2.15 (IBC Section 1026).
 - 4.4. At any location in an open-ended *corridor* where a change of direction exceeding 45 degrees occurs, a clear opening of not less than 3.25 m² or an *exterior ramp* or *stairway* shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.

SECTION 6.1.2.16 (IBC 1028) ASSEMBLY

6.1.2.16.1 (IBC 1028.1) General. Occupancies in Group A which contain seats, tables, displays, equipment or other material shall comply with this section.

6.1.2.16.1.1 (IBC 1028.1.1) Bleachers. *Bleachers, grandstands and folding and telescopic seating*, that are not building elements, shall comply with ICC 300.

6.1.2.16.2 (IBC 1028.2) Assembly main exit. Group A occupancies and assembly occupancies accessory to Group E occupancies that have an *occupant load* of greater than 300 shall be provided with a main *exit*. The main *exit* shall be of sufficient width to accommodate not less than one-half of the *occupant load*, but such width shall not be less than the total required width of all *means of egress* leading to the *exit*. Where the building is classified as a Group A occupancy, the main *exit* shall front on at least one street or an unoccupied space of not less than 3.05 m in width that adjoins a street or *public way*.

Exception: In assembly occupancies where there is no well-defined main *exit* or where multiple main *exits* are provided, *exits* shall be permitted to be distributed around the perimeter of the building provided that the total width of egress is not less than 100% of the required width.

6.1.2.16.3 (IBC 1028.3) Assembly other exits. In addition to having access to a main *exit*, each level in Group A occupancies having an *occupant load* greater than 300, shall be provided with additional *means of egress* that shall provide an egress capacity for at least one-half of the total *occupant load* served by that level and comply with Section 6.1.2.8.2 (IBC Section 1015.2).

Exception: In assembly occupancies where there is no well-defined main *exit* or where multiple main *exits* are provided, *exits* shall be permitted to be distributed around the perimeter of the building, provided that the total width of egress is not less than 100% of the required width.

MEANS OF EGRESS

6.1.2.16.4 (IBC 1028.5) Interior balcony and gallery means of egress. For balconies, galleries or press boxes having a seating capacity of 50 or more located in Group A occupancies, at least two *means of egress* shall be provided, with one from each side of every balcony, gallery or press box and at least one leading directly to an *exit*.

6.1.2.16.4.1 (IBC 1028.5.1) Enclosure of openings. *Interior stairways* and other vertical openings shall be enclosed in an *exit enclosure* as provided in Section 6.1.2.10.1 (IBC Section 1022.1), except that *stairways* are permitted to be open between the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, *places of religious worship*, auditoriums and sports facilities. At least one *accessible means of egress* is required from a balcony, gallery or press box level containing accessible seating locations in accordance with Section 6.1.2.22.3 or 6.1.2.22.4 (IBC Section 1007.3 or 1007.4).

6.1.2.16.5 (IBC 1028.6) Width of means of egress for assembly. The clear width of *aisles* and other *means of egress* shall comply with Section 6.1.2.16.5.1 (IBC Section 1028.6.1) where *smoke-protected seating* is not provided and with Section 6.1.2.16.5.2 or 6.1.2.16.5.3 (IBC Section 1028.6.2 or 1028.6.3) where *smoke-protected seating* is provided. The clear width shall be measured to walls, edges of seating and tread edges except for permitted projections.

6.1.2.16.5.1 (IBC 1028.6.1) Without smoke protection. The clear width of the *means of egress* shall provide sufficient capacity in accordance with all of the following, as applicable:

1. At least 8 mm of width for each occupant served shall be provided on *stairs* having riser heights 18 cm or less and tread depths 28 cm or greater, measured horizontally between tread *nosings*.
2. At least 0.12 mm of additional *stair* width for each occupant shall be provided for each 3 mm of riser height above 18 cm.
3. Where egress requires *stair* descent, at least 1.90 mm of additional width for each occupant shall be provided on those portions of *stair* width having no *handrail* within a horizontal distance of 76 cm.
4. Ramped *means of egress*, where slopes are steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have at least 6 mm of clear width for each occupant served. Level or ramped *means of egress*, where slopes are not steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have at least 5 mm of clear width for each occupant served.

6.1.2.16.5.2 (IBC 1028.6.2) Smoke-protected seating. The clear width of the *means of egress* for *smoke-protected assembly seating* shall not be less than the *occupant load* served by the egress element multiplied by the appropriate factor in Table 6.1.2.16.5.2 (IBC Table 1028.6.2). The total number of seats specified shall be those within the space exposed to the same smoke-protected environment. Interpolation is permitted between the specific values shown. A life safety evaluation, complying with NFPA 101, shall be done for a facility utilizing the reduced width requirements of Table 6.1.2.16.6.2 (IBC Table 1028.5.2) for *smoke-protected assembly seating*.

6.1.2.16.5.2.1 (IBC 1028.6.2.1) Smoke control. *Means of egress* serving a *smoke-protected assembly seating* area shall be provided with a smoke control system complying with Section 5.4.2.7 (IBC Section 909) or natural ventilation designed to maintain the smoke level at least 1.85 m above the floor of the *means of egress*.

6.1.2.16.5.2.2 (IBC 1028.6.2.2) Roof height. A *smoke-protected assembly seating* area with a roof shall have the lowest portion of the roof deck not less than 4.55 m above the highest *aisle* or *aisle accessway*.

6.1.2.16.5.2.3 (IBC 1028.6.2.3) Automatic sprinklers. Enclosed areas with walls and ceilings in buildings or structures containing *smoke-protected assembly seating* shall be protected with an *approved automatic sprinkler system* in accordance with NFPA 13.

TABLE 6.1.2.16.5.2 (IBC TABLE 1028.6.2)
WIDTH OF AISLES FOR SMOKE-PROTECTED ASSEMBLY

TOTAL NUMBER OF SEATS IN THE SMOKE-PROTECTED ASSEMBLY OCCUPANCY	MILLIMETERS OF CLEAR WIDTH PER SEAT SERVED			
	Stairs and aisle steps with handrails within 76 cm	Stairs and aisle steps without handrails within 76 cm	Passageways, doorways and ramps not steeper than 1 in 10 in slope	Ramps steeper than 1 in 10 in slope
Equal to or less than 5000	5.10	6.35	3.80	4.20

6.1.2.16.5.3 (IBC 1028.6.3) Width of means of egress for outdoor smoke-protected assembly. The clear width in millimeters of *aisles* and other *means of egress* shall be not less than the total *occupant load* served by the egress element multiplied by 2.05 mm where egress is by *aisles* and *stairs* and multiplied by 1.50 mm where egress is by *ramps*, *corridors*, *tunnels* or *vomitories*.

6.1.2.16.6 (IBC 1028.7) Travel distance. *Exits* and *aisles* shall be so located that the travel distance to an *exit* door shall not be greater than 61 m measured along the line of travel in nonsprinklered buildings. Travel distance shall not be more than 76 m in sprinklered buildings. Where *aisles* are provided for seating, the distance shall be measured along the *aisles* and *aisle accessway* without travel over or on the seats.

Exceptions:

1. *Smoke-protected assembly seating:* The travel distance from each seat to the nearest entrance to a vomitory or concourse shall not exceed 61 m. The travel distance from the entrance to the vomitory or concourse to a *stair*, *ramp* or walk on the exterior of the building shall not exceed 61 m.

6.1.2.16.7 (IBC 1028.8) Common path of egress travel. The *common path of egress travel* shall not exceed 9.50 m from any seat to a point where an occupant has a choice of two paths of egress travel to two *exits*.

Exceptions:

1. For areas serving less than 50 occupants, the *common path of egress travel* shall not exceed 23 m.
2. For smoke-protected assembly seating, the common path of egress travel shall not exceed 15 m.

6.1.2.16.7.1 (IBC 1028.8.1) Path through adjacent row. Where one of the two paths of travel is across the *aisle* through a row of seats to another *aisle*, there shall be not more than 24 seats between the two *aisles*, and the minimum clear width between rows for the row between the two *aisles* shall be 35 cm plus 2 cm for each additional seat above seven in the row between *aisles*.

Exception: For *smoke-protected assembly seating* there shall not be more than 40 seats between the two *aisles* and the minimum clear width shall be 31 cm plus 7.60 mm for each additional seat.

6.1.2.16.8 (IBC 1028.9) Assembly aisles are required. Every occupied portion of any occupancy in Group A that contains seats, tables, displays, similar fixtures or equipment shall be provided with *aisles* leading to *exits* or *exit access doorways* in accordance with this section. *Aisle accessways* for tables and seating shall comply with IBC Section 1017.4.

6.1.2.16.8.1 (IBC 1028.9.1) Minimum aisle width. The minimum clear width for *aisles* shall be as shown:

1. For *aisle stairs* having seating on each side: 1.20 m.

Exception: Where the aisle serves less than 50 seats: 92 cm.

2. For *aisle stairs* having seating on only one side: 92 cm.
3. Between an *aisle stair handrail* or *guard* and seating where the *aisle* is subdivided by a *handrail*: 56 cm.
4. For level or ramped *aisles* having seating on both sides 1.05 m.

Exceptions:

1. Where the *aisle* serves less than 50 seats: 92 cm.

MEANS OF EGRESS

2. Where the *aisle* does not serve more than 14 seats: 76 cm.
5. For level or ramped *aisles* having seating on only one side: 92 cm.

Exceptions:

1. Where the aisle does not serve more than 14 seats: 76 cm.
2. Between an *aisle stair* handrail and seating where an *aisle* does not serve more than five rows on one side: 59 cm.

6.1.2.16.8.2 (IBC 1028.9.2) Aisle width. The *aisle* width shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the *aisle*. The catchment area served by an *aisle* is that portion of the total space that is served by that section of the *aisle*. In establishing catchment areas, the assumption shall be made that there is a balanced use of all *means of egress*, with the number of persons in proportion to egress capacity.

6.1.2.16.8.3 (IBC 1028.9.3) Converging aisles. Where *aisles* converge to form a single path of egress travel, the required egress capacity of that path shall not be less than the combined required capacity of the converging *aisles*.

6.1.2.16.8.4 (IBC 1028.9.4) Uniform width. Those portions of *aisles*, where egress is possible in either of two directions, shall be uniform in required width.

6.1.2.16.8.5 (IBC 1028.9.5) Assembly aisle termination. Each end of an *aisle* shall terminate at cross *aisle*, foyer, doorway, vomitory or concourse having access to an *exit*.

Exceptions:

1. Dead-end *aisles* shall not be greater than 6.10 m in length.
2. Dead-end *aisles* longer than 6.10 m are permitted where seats beyond the 6.10 m dead-end *aisle* are no more than 24 seats from another *aisle*, measured along a row of seats having a minimum clear width of 31 cm plus 2 cm for each additional seat above seven in the row.
3. For *smoke-protected assembly seating*, the dead-end *aisle* length of vertical *aisles* shall not exceed a distance of 21 rows.
4. For *smoke-protected assembly seating*, a longer dead-end *aisle* is permitted where seats beyond the 21-row dead-end aisle are not more than 40 seats from another *aisle*, measured along a row of seats having an *aisle accessway* with a minimum clear width of 31 cm plus 8 mm for each additional seat above seven in the row.

6.1.2.16.8.6 (IBC 1028.9.6) Assembly aisle obstructions. There shall be no obstructions in the required width of *aisles* except for *handrails* as provided in IBC Section 1028.13.

6.1.2.16.9 (IBC 1028.10) Clear width of aisle accessways serving seating. Where seating rows have 14 or fewer seats, the minimum clear *aisle accessway* width shall not be less than 31 cm measured as the clear horizontal distance from the back of the row ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurements shall be made with the seat in the down position. For seats with folding tablet arms, row spacing shall be determined with the tablet arm in the used position.

Exception: For seats with folding tablet arms, row spacing is permitted to be determined with the tablet arm in the stored position where the tablet arm when raised manually to vertical position in one motion automatically returns to the stored position by force of gravity

6.1.2.16.9.1 (IBC 1028.10.1) Dual access. For rows of seating served by *aisles* or doorways at both ends, there shall not be more than 100 seats per row. The minimum clear width of 31 cm between rows shall be increased by 7.60 mm for every additional seat beyond 14 seats, but the minimum clear width is not required to exceed 56 cm.

Exception: For *smoke-protected assembly seating*, the row length limits for a 31 cm-wide *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 6.1.2.16.9.1 (IBC Table 1028.10.1).

TABLE 6.1.2.16.9.1 (IBC TABLE 1028.10.1)
SMOKE-PROTECTED ASSEMBLY AISLE ACCESSWAYS

TOTAL NUMBER OF SEATS IN THE SMOKEPROTECTED ASSEMBLY OCCUPAN- CY	MAXIMUM NUMBER OF SEATS PER ROW PERMITTED TO HAVE A MINIMUM 31 cm CLEAR WIDTH AISLE ACCESSWAY	
	Aisle or doorway at both ends of row	Aisle or doorway at one end of row only
Less than 4000	14	7

6.1.2.16.9.2 (IBC 1028.10.2) Single access. For rows of seating served by an *aisle* or doorway at only one end of the row, the minimum clear width of 31 cm between rows shall be increased by 2 cm for every additional seat beyond seven seats, but the minimum clear width is not required to exceed 56 cm.

Exception: For *smoke-protected assembly seating*, the row length limits for a 31 cm-wide *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 6.1.2.16.9.1 (IBC Table 1028.10.1).

6.1.2.16.10 (IBC 1028.11) Assembly aisle walking surfaces. *Aisles* with a slope not exceeding one unit vertical in eight units horizontal (12.5-percent slope) shall consist of a *ramp* having a slip-resistant walking surface. *Aisles* with a slope exceeding one unit vertical in eight units horizontal (12.5-percent slope) shall consist of a series of risers and treads that extends across the full width of *aisles* and complies with IBC Sections 1028.11.1 through 1028.11.3.

SECTION 6.1.2.17 (IBC 1027) EXIT DISCHARGE

6.1.2.17.1 (IBC 1027.1) General. *Exits* shall discharge directly to the exterior of the building. The *exit discharge* shall be at grade or shall provide direct access to grade. The *exit discharge* shall not reenter a building. The combined use of Exceptions 1 and 2 below shall not exceed 50% of the number and capacity of the required *exits*.

Exceptions:

1. A maximum of 50% of the number and capacity of the *exit enclosures* is permitted to egress through areas on the level of discharge provided all of the following are met:
 - 1.1. Such *exit enclosures* egress to a free and unobstructed path of travel to an exterior *exit* door and such *exit* is readily visible and identifiable from the point of termination of the *exit* enclosure.
 - 1.2. The entire area of the *level of exit discharge* is separated from areas below by construction conforming to the *fire-resistance rating* for the *exit enclosure*.
 - 1.3. The egress path from the *exit enclosure* on the *level of exit discharge* is protected throughout by an *approved automatic sprinkler system*. All portions of the *level of exit discharge* with access to the egress path shall either be protected throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R, or separated from the egress path in accordance with the requirements for the enclosure of *exits*.
2. A maximum of 50% of the number and capacity of the *exit enclosures* is permitted to egress through a vestibule provided all of the following are met:
 - 2.1. The entire area of the vestibule is separated from areas below by construction conforming to the *fire-resistance rating* for the *exit enclosure*.
 - 2.2. The depth from the exterior of the building is not greater than 3.05 m and the length is not greater than 9.15 m.

MEANS OF EGRESS

- 2.3. The area is separated from the remainder of the *level of exit discharge* by construction providing protection at least the equivalent of *approved* wired glass in steel frames.
- 2.4. The area is used only for *means of egress* and *exits* directly to the outside.
3. *Stairways* in *open parking garages* complying with Section 6.1.2.10.1 (IBC Section 1022.1), Exception 4, are permitted to egress through the *open parking garage* at their *levels of exit discharge*.
4. *Horizontal exits* complying with Section 6.1.2.13 (IBC Section 1025) shall not be required to discharge directly to the exterior of the building.

6.1.2.17.2 (IBC 1027.2) Exit discharge capacity. The capacity of the *exit discharge* shall be not less than the required discharge capacity of the *exits* being served.

6.1.2.17.3 (IBC 1027.3) Exit discharge location. Exterior balconies, *stairways* and *ramps* shall be located at least 3.05 m from adjacent *lot lines* and from other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 5.2.2.2 (IBC Section 705) based on *fire separation distance*.

6.1.2.17.4 (IBC 1027.4) Exit discharge components. *Exit discharge* components shall be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases.

SECTION 6.1.2.18 (IBC 1008) DOORS

6.1.2.18.1 (IBC 1008.1) Doors. *Means of egress* doors shall meet the requirements of this section. Doors serving a *means of egress* system shall meet the requirements of this section and Section 6.1.2.7.2 (IBC Section 1020.2). Doors provided for egress purposes in numbers greater than required by these guidelines shall meet the requirements of this section. *Means of egress* doors shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Mirrors or similar reflecting materials shall not be used on *means of egress* doors. *Means of egress* doors shall not be concealed by curtains, drapes, decorations or similar materials.

6.1.2.18.1.1 (IBC 1008.1.1) Size of doors. The minimum width of each door opening shall be sufficient for the *occupant load* thereof and shall provide a clear width of 82 cm. Clear openings of doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees. Where this section requires a minimum clear width of 82 cm and a door opening includes two door leaves without a mullion, one leaf shall provide a clear opening width of 82 cm. The maximum width of a swinging door leaf shall be 120 cm nominal.

6.1.2.18.1.1.1 (IBC 1008.1.1.1) Projections into clear width. There shall not be projections into the required clear width lower than 87 cm above the floor or ground. Projections into the clear opening width between 87 cm and 2.05 m above the floor or ground shall not exceed 1 cm.

Exception: Door closers and door stops shall be permitted to be 2 m minimum above the floor.

6.1.2.18.1.2 (IBC 1008.1.2) Door swing. Egress doors shall be of the pivoted or side-hinged swinging type.

Exceptions:

1. Private garages, office areas, factory and storage areas with an *occupant load* of 10 or less.
2. Reserved.
3. Critical or intensive care patient rooms within suites of health care facilities.
4. Revolving doors complying with Section 6.1.2.18.1.4.1 (IBC Section 1008.1.4.1).
5. Horizontal sliding doors complying with Section 6.1.2.18.1.4.3 (IBC Section 1008.1.4.3) are permitted in a *means of egress*.
6. Power-operated doors in accordance with Section 6.1.2.18.1.4.2 (IBC Section 1008.1.4.2).
7. Manually operated horizontal sliding doors are permitted in a *means of egress* from spaces with an *occupant load* of 10 or less.

Doors shall swing in the direction of egress travel where serving an *occupant load* of 50 or more persons.

6.1.2.18.1.3 (IBC 1008.1.3) Door opening force. The force for pushing or pulling open interior swinging egress doors, other than *fire doors*, shall not exceed 22.00 N. For other swinging doors, as well as sliding and folding doors, the door latch shall release when subjected to a 66.50 N force. The door shall be set in motion when subjected to a 135.0 N force. The door shall swing to a full-open position when subjected to a 66.50 N force.

6.1.2.18.1.3.1 (IBC 1008.1.3.1) Location of applied forces. Forces shall be applied to the latch side of the door.

6.1.2.18.1.4 (IBC 1008.1.4) Special doors. Special doors and security grilles shall comply with the requirements of Sections 6.1.2.18.1.4.1 through 6.1.2.18.1.4.5 (IBC Sections 1008.1.4.1 through 1008.1.4.5).

6.1.2.18.1.4.1 (IBC 1008.1.4.1) Revolving doors. Revolving doors shall comply with the following:

1. Each revolving door shall be capable of collapsing into a bookfold position with parallel egress paths providing an aggregate width of 92 cm.
2. A revolving door shall not be located within 3.05 m of the foot of or top of *stairs* or escalators. A dispersal area shall be provided between the *stairs* or escalators and the revolving doors.
3. The revolutions per minute (rpm) for a revolving door shall not exceed those shown in Table 6.1.2.18.1.4.1 (IBC Table 1008.1.4.1).
4. Each revolving door shall have a side-hinged swinging door which complies with Section 6.1.2.18.1 (IBC Section 1008.1) in the same wall and within 3.05 m of the revolving door.
5. Revolving doors shall not be part of an *accessible route* required by Section 6.1.2.22 (IBC Section 1007) and Chapter 11.

**TABLE 6.1.2.18.1.4.1 (IBC TABLE 1008.1.4.1)
REVOLVING DOOR SPEEDS**

INSIDE DIAMETER (meters)	POWER-DRIVEN-TYPE SPEED CONTROL (rpm)	MANUAL-TYPE SPEED CONTROL (rpm)
2.00	11	12
2.15	10	11
2.30	9	11
2.45	9	10
2.60	8	9
2.75	8	9
2.90	7	8
3.05	7	8

6.1.2.18.1.4.1.1 (IBC 1008.1.4.1.1) Egress component. A revolving door used as a component of a *means of egress* shall comply with Section 6.1.2.18.1.4.1 (IBC Section 1008.1.4.1) and the following three conditions:

1. Revolving doors shall not be given credit for more than 50% of the required egress capacity.
2. Each revolving door shall be credited with no more than a 50-person capacity.
3. Each revolving door shall be capable of being collapsed when a force of not more than 580.0 N is applied within 8 cm of the outer edge of a wing.

6.1.2.18.1.4.2 (IBC 1008.1.4.2) Power-operated doors. Where *means of egress* doors are operated by power, such as doors with a photoelectric-actuated mechanism to open the door upon the approach of a person, or doors with power-assisted manual operation, the design shall be such that in the event of power failure, the door is capable of being opened manually to permit *means of egress* travel.

MEANS OF EGRESS

el or closed where necessary to safeguard *means of egress*. The forces required to open these doors manually shall not exceed those specified in Section 6.1.2.18.1.3 (IBC Section 1008.1.3), except that the force to set the door in motion shall not exceed 220.0 N. The door shall be capable of swinging from any position to the full width of the opening in which such door is installed when a force is applied to the door on the side from which egress is made. Full-power-operated doors shall comply with BHMA A156.10. Power-assisted and low-energy doors shall comply with BHMA A156.19.

Exceptions:

1. Horizontal sliding doors complying with Section 6.1.2.18.1.4.3 (IBC Section 1008.1.4.3).
2. For a biparting door in the emergency breakout mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 82 cm single-leaf requirement of Section 6.1.2.18.1.1 (IBC Section 1008.1.1), provided a minimum 82 cm clear opening is provided when the two biparting leaves meeting in the center are broken out.

6.1.2.18.1.4.3 (IBC 1008.1.4.3) Horizontal sliding doors. Horizontal sliding doors permitted to be a component of a *means of egress* in accordance with Exception 6 to Section 6.1.2.18.1.2 (IBC Section 1008.1.2) shall comply with all of the following criteria:

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure.
2. The doors shall be openable by a simple method from both sides without special knowledge or effort.
3. The force required to operate the door shall not exceed 135 N to set the door in motion and 66.50 N to close the door or open it to the minimum required width.
4. The door shall be openable with a force not to exceed 66.50 N when a force of 1100 N is applied perpendicular to the door adjacent to the operating device.
5. The door assembly shall comply with the applicable *fire protection rating* and, where rated, shall be self-closing or automatic closing by smoke detection in accordance with Section 5.2.2.12.4.3.7.3 (IBC Section 715.4.8.3), shall be installed in accordance with NFPA 80 and shall comply with Section 5.2.2.12 (IBC Section 715).
6. The door assembly shall have an integrated standby power supply.
7. The door assembly power supply shall be electrically supervised.
8. The door shall open to the minimum required width within 10 seconds after activation of the operating device.

6.1.2.18.1.4.4 (IBC 1008.1.4.4) Access-controlled egress doors. The entrance doors in a *means of egress* in buildings with an occupancy in Group A, B, and entrance doors to tenant spaces in occupancies in Groups A, B, are permitted to be equipped with an *approved* entrance and egress access control system which shall be installed in accordance with all of the following criteria:

1. A sensor shall be provided on the egress side arranged to detect an occupant approaching the doors. The doors shall be arranged to unlock by a signal from or loss of power to the sensor.
2. Loss of power to that part of the access control system which locks the doors shall automatically unlock the doors.
3. The doors shall be arranged to unlock from a manual unlocking device located 1 m to 1.20 m vertically above the floor and within 1.50 m of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign that reads "PUSH TO EXIT." When operated, the manual unlocking device shall result in direct interruption of power to the lock—independent of the access control system electronics—and the doors shall remain unlocked for a minimum of 30 seconds.

4. Activation of the building fire alarm system, if provided, shall automatically unlock the doors, and the doors shall remain unlocked until the fire alarm system has been reset.
5. Activation of the building automatic sprinkler or fire detection system, if provided, shall automatically unlock the doors. The doors shall remain unlocked until the fire alarm system has been reset.
6. Entrance doors in buildings with an occupancy in Group A, B shall not be secured from the egress side during periods that the building is open to the general public.

6.1.2.18.1.4.5 (IBC 1008.1.4.5) Security grilles. In Group B, horizontal sliding or vertical security grilles are permitted at the main exit and shall be openable from the inside without the use of a key or special knowledge or effort during periods that the space is occupied. The grilles shall remain secured in the full-open position during the period of occupancy by the general public. Where two or more *means of egress* are required, not more than one-half of the *exits* or *exit access doorways* shall be equipped with horizontal sliding or vertical security grilles.

6.1.2.18.1.5 (IBC 1008.1.5) Floor elevation. There shall be a floor or landing on each side of a door. Such floor or landing shall be at the same elevation on each side of the door. Landings shall be level except for exterior landings, which are permitted to have a slope not to exceed 0.25 unit vertical in 12 units horizontal (2-percent slope).

Exceptions:

1. Exterior doors as provided for in Section 6.1.2.2.4 (IBC Section 1003.5), Exception 1, and Section 6.1.2.7.2 (IBC Section 1020.2), which are not on an *accessible route*.
2. Variations in elevation due to differences in finish materials, but not more than 1 cm.
3. Reserved.

6.1.2.18.1.6 (IBC 1008.1.6) Landings at doors. Landings shall have a width not less than the width of the *stairway* or the door, whichever is greater. Doors in the fully open position shall not reduce a required dimension by more than 18 cm. When a landing serves an *occupant load* of 50 or more, doors in any position shall not reduce the landing to less than one-half its required width. Landings shall have a length measured in the direction of travel of not less than 1.10 m.

6.1.2.18.1.7 (IBC 1008.1.7) Thresholds. Thresholds at doorways shall not exceed 1 cm for doors. Raised thresholds and floor level changes greater than 6 mm at doorways shall be beveled with a slope not greater than one unit vertical in two units horizontal (50-percent slope).

6.1.2.18.1.8 (IBC 1008.1.8) Door arrangement. Space between two doors in a series shall be 1.20 m minimum plus the width of a door swinging into the space. Doors in a series shall swing either in the same direction or away from the space between the doors.

Exceptions:

1. The minimum distance between horizontal sliding power-operated doors in a series shall be 1.20 m.
2. Reserved.
3. Reserved.

6.1.2.18.1.9 (IBC 1008.1.9) Door operations. Except as specifically permitted by this section egress doors shall be readily openable from the egress side without the use of a key or special knowledge or effort.

6.1.2.18.1.9.1 (IBC 1008.1.9.1) Hardware. Door handles, pulls, latches, locks and other operating devices on doors required to be *accessible* by IBC Chapter 11 shall not require tight grasping, tight pinching or twisting of the wrist to operate.

MEANS OF EGRESS

6.1.2.18.1.9.2 (IBC 1008.1.9.3) Locks and latches. Locks and latches shall be permitted to prevent operation of doors where any of the following exists:

1. Reserved.
2. In buildings in occupancy Group A having an *occupant load* of 300 or less, Groups B, the main exterior door or doors are permitted to be equipped with key-operated locking devices from the egress side provided:
 - 2.1. The locking device is readily distinguishable as locked;
 - 2.2. A readily visible durable sign is posted on the egress side on or adjacent to the door stating: THIS DOOR TO REMAIN UNLOCKED WHEN BUILDING IS OCCUPIED. The sign shall be in letters 30 mm high on a contrasting background; and
 - 2.3. The use of the key-operated locking device is revokable by the *building official* for due cause.
3. Where egress doors are used in pairs, approved automatic flush bolts shall be permitted to be used, provided that the door leaf having the automatic flush bolts has no doorknob or surface-mounted hardware.
4. Reserved.
5. *Fire doors* after the minimum elevated temperature has disabled the unlatching mechanism in accordance with listed fire door test procedures.

6.1.2.18.1.9.3 (IBC 1008.1.9.4) Bolt locks. Manually operated flush bolts or surface bolts are not permitted.

Exceptions:

1. Where a pair of doors serves a storage or equipment room, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf.
2. Where a pair of doors serves an *occupant load* of less than 50 persons in a Group B occupancy, manually operated edge- or surface- mounted bolts are permitted on the inactive leaf. The inactive leaf shall contain no doorknobs, panic bars or similar operating hardware.
3. Where a pair of doors serves a Group B occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf provided such inactive leaf is not needed to meet egress width requirements and the building is equipped throughout with an *automatic sprinkler system* in accordance with NFPA 13. The inactive leaf shall contain no doorknobs, panic bars or similar operating hardware.

6.1.2.18.1.9.4 (IBC 1008.1.9.8) Electromagnetically locked egress doors. Doors in the *means of egress* that are not otherwise required to have panic hardware in buildings with an occupancy in Group A, B, and doors to tenant spaces in Group A, B, shall be permitted to be electromagnetically locked if equipped with *listed* hardware that incorporates a built-in switch and meet the requirements below:

1. The *listed* hardware that is affixed to the door leaf has an obvious method of operation that is readily operated under all lighting conditions.
2. The *listed* hardware is capable of being operated with one hand.
3. Operation of the *listed* hardware releases to the electromagnetic lock and unlocks the door immediately.
4. Loss of power to the *listed* hardware automatically unlocks the door.

6.1.2.18.1.9.5 (IBC 1008.1.9.10) Stairway doors. *Interior stairway means of egress* doors shall be openable from both sides without the use of a key or special knowledge or effort.

Exceptions:

1. *Stairway* discharge doors shall be openable from the egress side and shall only be locked from the opposite side.
2. In *stairways* serving not more than four stories, doors are permitted to be locked from the side opposite the egress side, provided they are openable from the egress side and capable of being unlocked simultaneously without unlatching upon a signal from the fire command center, if present, or a signal by emergency personnel from a single location inside the main entrance to the building.

6.1.2.18.1.10 (IBC 1008.1.10) Panic and fire exit hardware. doors serving rooms or spaces with an *occupant load* of 50 or more in a Group A occupancy shall not be provided with a latch or lock unless it is panic hardware or *fire exit hardware*.

Electrical rooms with equipment rated 1200 A or more and over 1.85 m wide that contain overcurrent devices, switching devices or control devices with *exit* or *exit access* doors shall be equipped with panic hardware or *fire exit hardware*. The doors shall swing in the direction of egress travel.

6.1.2.18.1.10.1 (IBC 1008.1.10.1) Installation. Where panic or *fire exit hardware* is installed, it shall comply with the following:

1. Panic hardware shall be *listed* in accordance with UL 305;
2. *Fire exit hardware* shall be *listed* in accordance with UL 10C and UL 305;
3. The actuating portion of the releasing device shall extend at least one-half of the door leaf width; and
4. The maximum unlatching force shall not exceed 66.50 N.

6.1.2.18.2 (IBC 1008.2) Gates. Gates serving the means of egress system shall comply with the requirements of this section. Gates used as a component in a *means of egress* shall conform to the applicable requirements for doors.

Exception: Horizontal sliding or swinging gates exceeding the 1.20 m maximum leaf width limitation are permitted in fences and walls surrounding a stadium.

6.1.2.18.3 (IBC 1008.3) Turnstiles. Turnstiles or similar devices that restrict travel to one direction shall not be placed so as to obstruct any required *means of egress*.

Exception: Each turnstile or similar device shall be credited with no more than a 50-person capacity where all of the following provisions are met:

1. Each device shall turn free in the direction of egress travel when primary power is lost, and upon the manual release by an employee in the area.
2. Such devices are not given credit for more than 50% of the required egress capacity.
3. Each device is not more than 99 cm high.
4. Each device has at least 42 cm clear width at and below a height of 99 cm and at least 56 cm clear width at heights above 99 cm.

Where located as part of an *accessible route*, turnstiles shall have at least 92 cm clear at and below a height of 87 cm, at least 82 cm clear width between 87 cm and 2.05 m and shall consist of a mechanism other than a revolving device.

6.1.2.18.3.1 (IBC 1008.3.1) High turnstile. Turnstiles more than 99 cm high shall meet the requirements for revolving doors.

6.1.2.18.3.2 (IBC 1008.3.2) Additional door. Where serving an *occupant load* greater than 300, each turnstile that is not portable shall have a side-hinged swinging door which conforms to Section 6.1.2.18.1 (IBC Section 1008.1) within 15 m.

SECTION 6.1.2.19 (IBC 1009) STAIRWAYS

6.1.2.19.1 (IBC 1009.1) Stairway width. The width of *stairways* shall be determined as specified in Section 6.1.2.2.9 (IBC Section 1005.1), but such width shall not be less than 1.10 m. See Section 6.1.2.22.3 (IBC Section 1007.3) for *accessible means of egress stairways*.

6.1.2.19.2 (IBC 1009.2) Headroom. *Stairways* shall have a minimum headroom clearance of 2.05 m measured vertically from a line connecting the edge of the *nosings*. Such headroom shall be continuous above the *stairway* to the point where the line intersects the landing below, one tread depth beyond the bottom riser. The minimum clearance shall be maintained the full width of the *stairway* and landing.

6.1.2.19.3 (IBC 1009.5) Stairway landings. There shall be a floor or landing at the top and bottom of each *stairway*. The width of landings shall not be less than the width of *stairways* they serve. Every landing shall have a minimum dimension measured in the direction of travel equal to the width of the *stairway*. Such dimension need not exceed 1.20 m where the *stairway* has a straight run. Doors opening onto a landing shall not reduce the landing to less than one-half the required width. When fully open, the door shall not project more than 18 cm into a landing. When *wheelchair spaces* are required on the *stairway* landing in accordance with Section 6.1.2.22.6.1 (IBC Section 1007.6.1), the *wheelchair space* shall not be located in the required width of the landing and doors shall not swing over the *wheelchair spaces*.

Exception: *Aisle stairs* complying with Section 6.1.2.16 (IBC Section 1028).

6.1.2.19.4 (IBC 1009.6) Stairway construction. All *stairways* shall be built of materials consistent with the types permitted for the type of construction of the building, except that wood handrails shall be permitted for all types of construction.

6.1.2.19.4.1 (IBC 1009.6.1) Stairway walking surface. The walking surface of treads and landings of a *stairway* shall not be sloped steeper than one unit vertical in 48 units horizontal (2-percent slope) in any direction. *Stairway* treads and landings shall have a solid surface. Finish floor surfaces shall be securely attached.

Exceptions:

1. Openings in stair walking surfaces shall be a size that does not permit the passage of 1 cm diameter sphere. Elongated openings shall be placed so that the long dimension is perpendicular to the direction of travel.
2. Reserved.

6.1.2.19.4.2 (IBC 1009.6.2) Outdoor conditions. Outdoor *stairways* and outdoor approaches to *stairways* shall be designed so that water will not accumulate on walking surfaces.

6.1.2.19.4.3 (IBC 1009.6.3) Enclosures under stairways. The walls and soffits within enclosed usable spaces under enclosed and unenclosed *stairways* shall be protected by 1-hour fire-resistance-rated construction or the *fire-resistance rating* of the stairway enclosure, whichever is greater. Access to the enclosed space shall not be directly from within the stair enclosure.

There shall be no enclosed usable space under *exterior exit stairways* unless the space is completely enclosed in 1-hour fire-resistance-rated construction. The open space under *exterior stairways* shall not be used for any purpose.

6.1.2.19.5 (IBC 1009.7) Vertical rise. A *flight* of *stairs* shall not have a vertical rise greater than 4 m between floor levels or landings.

Exceptions:

1. *Aisle stairs* complying with Section 6.1.2.16 (IBC Section 1028).
2. *Alternating tread devices* used as a *means of egress* shall not have a rise greater than 6.10 m between floor levels or landings.

6.1.2.19.6 (IBC 1009.13) Stairway to roof. In buildings four or more stories above *grade plane*, one *stairway* shall extend to the roof surface, unless the roof has a slope steeper than four units vertical in 12 units horizontal (33-percent slope). In buildings without an occupied roof, access to the roof from the top story shall be permitted to be by an *alternating tread device*.

6.1.2.19.6.1 (IBC 1009.13.1) Roof access. Where a *stairway* is provided to a roof, access to the roof shall be provided through a *penthouse* complying with IBC Section 1509.2.

Exception: In buildings without an occupied roof, access to the roof shall be permitted to be a roof hatch or trap door not less than 1.50 m² in area and having a minimum dimension of 61 cm.

6.1.2.19.6.2 (IBC 1009.13.2) Protection at roof hatch openings. Where the roof hatch opening providing the required access is located within 3.05 m of the roof edge, such roof access or roof edge shall be protected by *guards* installed in accordance with the provisions of Section 6.1.2.6 (IBC Section 1013).

6.1.2.19.7 (IBC 1009.14) Stairway to elevator equipment. Roofs and *penthouses* containing elevator equipment that must be accessed for maintenance are required to be accessed by a *stairway*.

6.1.2.19.8 (IBC 1009.12) Handrails. *Stairways* shall have *handrails* on each side and shall comply with Section 6.1.2.20 (IBC Section 1012). Where glass is used to provide the *handrail*, the *handrail* shall also comply with Section 6.4.2.2 (IBC Section 2407).

SECTION 6.1.2.20 (IBC 1012) HANDRAILS

6.1.2.20.1 (IBC 1012.2) Height. *Handrail* height, measured above *stair* tread *nosings*, or finish surface of *ramp* slope, shall be uniform, not less than 87 cm and not more than 97 cm. *Handrail* height of *alternating tread devices* and ship ladders, measured above tread *nosings*, shall be uniform, not less than 76 cm and not more than 87 cm.

6.1.2.20.2 (IBC 1012.4) Continuity. *Handrail* gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

Exceptions:

1. *Handrail* brackets or balusters attached to the bottom surface of the *handrail* that do not project horizontally beyond the sides of the *handrail* within 4 cm of the bottom of the *handrail* shall not be considered obstructions. For each 10 cm of additional *handrail* perimeter dimension above 1 cm, the vertical clearance dimension of 4 cm shall be permitted to be reduced by 3 mm.
2. Where *handrails* are provided along walking surfaces with slopes not steeper than 1:20, the bottoms of the *handrail* gripping surfaces shall be permitted to be obstructed along their entire length where they are integral to crash rails or bumper guards.

6.1.2.20.3 (IBC 1012.6) Handrail extensions. *Handrails* shall return to a wall, *guard* or the walking surface or shall be continuous to the *handrail* of an adjacent *stair flight* or ramp run. Where *handrails* are not continuous between *flights*, the *handrails* shall extend horizontally at least 31 cm beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At *ramps* where *handrails* are not continuous between runs, the *handrails* shall extend horizontally above the landing 31 cm minimum beyond the top and bottom of *ramp* runs. The extensions of *handrails* shall be in the same direction of the *stair flights* at *stairways* and the *ramp* runs at *ramps*.

Exceptions:

1. Reserved.
2. *Aisle handrails* in Group A occupancies in accordance with IBC Section 1028.13.
3. *Handrails* for *alternating tread devices* and ship ladders are permitted to terminate at a location vertically above the top and bottom risers. *Handrails* for *alternating tread devices* and ship ladders are not required to be continuous between *flights* or to extend beyond the top or bottom risers.

MEANS OF EGRESS

6.1.2.20.4 (IBC 1012.8) Projections. On ramps, the clear width between *handrails* shall be 91.50 cm minimum. Projections into the required width of *stairways* and *ramps* at each *handrail* shall not exceed 12 cm at or below the *handrail* height. Projections into the required width shall not be limited above the minimum headroom height required in Section 6.1.2.19.2 (IBC Section 1009.2).

6.1.2.20.5 (IBC 1012.9) Intermediate handrails. *Stairways* shall have intermediate *handrails* located in such a manner that all portions of the *stairway* width required for egress capacity are within 76 cm of a *handrail*. On monumental *stairs*, *handrails* shall be located along the most direct path of egress travel.

SECTION 6.1.2.21 (IBC 1011) SIGNAGE

6.1.2.21.1 (IBC 1011.1) Where required. *Exits* and *exit access* doors shall be marked by an *approved exit* sign readily visible from any direction of egress travel. The path of egress travel to *exits* and within *exits* shall be marked by readily visible *exit* signs to clearly indicate the direction of egress travel in cases where the *exit* or the path of egress travel is not immediately visible to the occupants. Intervening *means of egress* doors within *exits* shall be marked by *exit* signs. *Exit* sign placement shall be such that no point in an *exit access corridor* or *exit passageway* is more than 30.50 m or the *listed* viewing distance for the sign, whichever is less, from the nearest visible *exit* sign.

Exceptions:

1. *Exit* signs are not required in rooms or areas that require only one *exit* or *exit access*.
2. Main exterior *exit* doors or gates that are obviously and clearly identifiable as *exits* need not have *exit* signs where *approved* by the *building official*.

6.1.2.21.2 (IBC 1011.2) Illumination. *Exit* signs shall be internally or externally illuminated.

Exception: Tactile signs required by IBC Section 1011.3 need not be provided with illumination.

6.1.2.21.2.1 (IBC 1011.5.1) Graphics. Every *exit* sign and directional *exit* sign shall have plainly legible letters not less than 15 cm high with the principal strokes of the letters not less than 2 cm wide. The word "EXIT" shall have letters having a width not less than 5 cm wide, except the letter "I," and the minimum spacing between letters shall not be less than 1 cm. Signs larger than the minimum established in this section shall have letter widths, strokes and spacing in proportion to their height.

The word "EXIT" shall be in high contrast with the background and shall be clearly discernible when the means of *exit* sign illumination is or is not energized. If a chevron directional indicator is provided as part of the *exit* sign, the construction shall be such that the direction of the chevron directional indicator cannot be readily changed.

6.1.2.21.2.2 (IBC 1011.5.2) Exit sign illumination. The face of an *exit* sign illuminated from an external source shall have an intensity of not less than 54.00 lx.

6.1.2.21.2.3 (IBC 1011.5.3) Power source. *Exit* signs shall be illuminated at all times. To ensure continued illumination for a duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with IBC Chapter 27.

Exception: *Approved exit* sign illumination means that provide continuous illumination independent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.

SECTION 6.1.2.22 (IBC 1007) ACCESSIBLE EXITS

6.1.2.22.1 (IBC 1007.1) Accessible means of egress required. *Accessible means of egress* shall comply with this section. *Accessible* spaces shall be provided with not less than one *accessible means of egress*. Where more than one *means of egress* are required by Section 6.1.2.8.1 or 6.1.2.9.1 (IBC Section 1015.1 or 1021.1) from any *accessible* space, each *accessible* portion of the space shall be served by not less than two *accessible means of egress*.

6.1.2.22.2 (IBC 1007.2) Continuity and components. Each required *accessible means of egress* shall be continuous to a *public way* and shall consist of one or more of the following components:

1. *Accessible routes* complying with Section 6.2.2.3 (IBC Section 1104).
2. *Interior exit stairways* complying with Sections 6.1.2.22.3 and 6.1.2.10 (IBC Sections 1007.3 and 1022).
3. *Exterior exit stairways* complying with Sections 6.1.2.22.3 and 6.1.2.15 (IBC Sections 1007.3 and 1026).
4. Elevators complying with Section 6.1.2.22.4 (IBC Section 1007.4).
5. Platform lifts complying with Section 6.1.2.22.5 (IBC Section 1007.5).
6. *Horizontal exits* complying with Section 6.1.2.13 (IBC Section 1025).
7. *Ramps* complying with Section 6.1.2.14 (IBC Section 1010).
8. *Areas of refuge* complying with Section 6.1.2.22.6 (IBC Section 1007.6).

Exceptions:

1. Where the *exit discharge* is not *accessible*, an exterior area for assisted rescue must be provided in accordance with IBC Section 1007.7.
2. Where the *exit stairway* is open to the exterior, the *accessible means of egress* shall include either an *area of refuge* in accordance with Section 6.1.2.22.6 (IBC Section 1007.6) or an exterior area for assisted rescue in accordance with IBC Section 1007.7.

6.1.2.22.2.1 (IBC 1007.2.1) Elevators required. In buildings where a required *accessible floor* is four or more stories above or below a *level of exit discharge*, at least one required *accessible means of egress* shall be an elevator complying with Section 6.1.2.22.4 (IBC Section 1007.4).

Exceptions:

1. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R, the elevator shall not be required on floors provided with a *horizontal exit* and located at or above the *levels of exit discharge*.
2. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R, the elevator shall not be required on floors provided with a ramp conforming to the provisions of Section 6.1.2.14 (IBC Section 1010).

6.1.2.22.3 (IBC 1007.3) Stairways. In order to be considered part of an *accessible means of egress*, an *exit access stairway* as permitted by Section 6.1.2.5.1 (IBC Section 1016.1) or *exit stairway* shall have a clear width of 1.20 m minimum between handrails and shall either incorporate an *area of refuge* within an enlarged floor-level landing or shall be accessed from either an *area of refuge* complying with Section 6.1.2.2.2.6 (IBC Section 1007.6) or a *horizontal exit*.

Exceptions:

1. The *area of refuge* is not required at open *exit access* or *exit stairways* as permitted by Sections 6.1.2.5.1 and 6.1.2.10.1 (IBC Sections 1016.1 and 1022.1) in buildings that are equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R.
2. The clear width of 1.20 m between *handrails* is not required at *exit access stairway* as permitted by Section 6.1.2.5.1 (IBC Section 1016.1) or *exit stairways* in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R.
3. *Areas of refuge* are not required at *exit stairways* in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R.
4. The clear width of 1.20 m between *handrails* is not required for *exit stairways* accessed from a *horizontal exit*.
5. Areas of refuge are not required at exit stairways serving open parking garages.

MEANS OF EGRESS

6. *Areas of refuge* are not required for smoke protected seating areas complying with IBC Section 1028.6.2.7.

6.1.2.22.4 (IBC 1007.4) Elevators. In order to be considered part of an *accessible means of egress*, an elevator shall comply with the emergency operation and signaling device requirements of Section 2.27 of A17.1-2007/CSA B44-07. Standby power shall be provided in accordance with IBC Chapter 27 and Section 6.3.2.2 (IBC Section 3003). The elevator shall be accessed from either an *area of refuge* complying with Section 6.1.2.22.6 (IBC Section 1007.6) or a *horizontal exit*.

Exceptions:

1. Elevators are not required to be accessed from an *area of refuge* or *horizontal exit* in *open parking garages*.
2. Elevators are not required to be accessed from an *area of refuge* or *horizontal exit* in buildings and facilities equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13 or NFPA 13R.
3. Elevators not required to be located in a shaft in accordance with Section 5.2.2.5.2 (IBC Section 708.2) are not required to be accessed from an *area of refuge* or *horizontal exit*.
4. Elevators are not required to be accessed from an *area of refuge* or *horizontal exit* for smoke protected seating areas complying with Section 6.1.2.16.5.2 (IBC Section 1028.6.2).

6.1.2.22.5 (IBC 1007.5) Platform lifts. Platform (wheelchair) lifts shall not serve as part of an *accessible means of egress*, except where allowed as part of a required *accessible route* in IBC Section 1109.7, Items 1 through 9. Standby power shall be provided in accordance with IBC Chapter 27 for platform lifts permitted to serve as part of a *means of egress*.

6.1.2.22.5.1 (IBC 1007.5.1) Openness. Platform lifts on an *accessible means of egress* shall not be installed in a fully enclosed hoistway.

6.1.2.22.6 (IBC 1007.6) Areas of refuge. Every required *area of refuge* shall be *accessible* from the space it serves by an *accessible means of egress*. The maximum travel distance from any *accessible* space to an *area of refuge* shall not exceed the travel distance permitted for the occupancy in accordance with Section 6.1.2.5.1 (IBC Section 1016.1). Every required *area of refuge* shall have direct access to a *stairway* within an *exit enclosure* complying with Sections 6.1.2.22.3 and 6.1.2.10 (IBC Sections 1007.3 and 1022) or an elevator complying with Section 6.1.2.22.4 (IBC Section 1007.4). Where an elevator lobby is used as an *area of refuge*, the shaft and lobby shall comply with IBC Section 1022.9 for *smokeproof enclosures* except where the elevators are in an *area of refuge* formed by a *horizontal exit* or *smoke barrier*.

6.1.2.22.6.1 (IBC 1007.6.1) Size. Each *area of refuge* shall be sized to accommodate one *wheelchair space* of 76 cm by 120 cm for each 200 occupants or portion thereof, based on the *occupant load* of the *area of refuge* and areas served by the *area of refuge*. Such *wheelchair spaces* shall not reduce the required *means of egress* width. Access to any of the required *wheelchair spaces* in an *area of refuge* shall not be obstructed by more than one adjoining *wheelchair space*.

6.1.2.22.6.2 (IBC 1007.6.2) Separation. Each *area of refuge* shall be separated from the remainder of the story by a *smoke barrier* complying with Section 5.2.2.7 (IBC Section 710) or a *horizontal exit* complying with Section 6.1.2.13 (IBC Section 1025). Each *area of refuge* shall be designed to minimize the intrusion of smoke.

6.1.2.22.6.3 (IBC 1007.6.3) Two-way communication. *Areas of refuge* shall be provided with a two-way communication system complying with IBC Sections 1007.8.1 and 1007.8.2.

6.1.2.22.7 (IBC 1007.9) Signage. Signage indicating special accessibility provisions shall be provided as shown:

1. Each door providing access to an *area of refuge* from an adjacent floor area shall be identified by a sign stating: AREA OF REFUGE.
2. Each door providing access to an exterior area for assisted rescue shall be identified by a sign stating: EXTERIOR AREA FOR ASSISTED RESCUE.

6.1.2.22.8 (IBC 1007.10) Directional signage. Direction signage indicating the location of the other *means of egress* and which are *accessible means of egress* shall be provided at the following:

1. At *exits* serving a required *accessible* space but not providing an *approved accessible means of egress*.
2. At elevator landings.
3. Within areas of refuge.

MEANS OF EGRESS

6.1.3 ALTERNATE MEANS OF VERIFICATION

- 6.1.3.1 Chapter 10 of the 2009 IBC, including all reference standards, is deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for Means of Egress can be demonstrated by compliance with Chapter 10 of the 2009 IBC

6.2 ACCESSIBILITY

6.2.0 OVERVIEW AND KEY CONCEPTS

In recent years, many countries have passed civil rights legislation aimed at protecting persons with disabilities from discrimination. Examples include the Americans with Disabilities Act (ADA) in the USA (<http://www.ada.gov/>), the Equality Act in the UK (<http://www.legislation.gov.uk/ukpga/2010/15/contents>) and the Disability Discrimination Act (DDA) in Australia (http://www.austlii.edu.au/au/legis/cth/consol_act/dda1992264/).

The World Health Organization (WHO) characterizes disability as a contextual variable, dynamic over time and in relation to circumstances, being a function of impairments, activity limitation, participation restrictions and environment (WHO, 2011) http://whqlibdoc.who.int/publications/2011/9789240685215_eng.pdf). One is more or less disabled based on the interaction between the person and the individual, institutional and social environments. Disability discrimination, then, is broadly characterized as any distinction, exclusion, or restriction on the basis of disability that has the purpose or effect of impairing or nullifying the recognition, enjoyment, or exercise on an equal basis with others, of all human rights and fundamental freedoms [this includes denial of reasonable accommodation (WHO, 2011)]. While definitions and implementation vary, discrimination may include limiting or classifying a job applicant or employee in an adverse way, denying employment opportunities to people who truly qualify, not making reasonable accommodations to the known physical or mental limitations of disabled employees, not advancing employees with disabilities in the business, and/or not providing needed accommodations in training (ADA, 2010).

When, where and how disabilities legislation is applied to buildings varies by country, and in all cases local regulations should be consulted. Generally speaking, however, the main concerns relate to the issue of potential discrimination by failure to provide reasonable accommodations to the known physical or mental limitations of disabled employees, occupants and visitors. Within this broad category, providing accessibility into and throughout the building is a primary focus, with several countries having developed standards or technical guidelines for accessible design (note: issues such as signage for sight impaired persons and alarm signaling for hearing impaired persons are often included in addition to accessibility issues). Examples from the USA include ICC/ANSI Standard A117.1, *Accessible and Useable Buildings and Facilities* (ICC/ANSI, 2009) and the *ADA Design Standards for Accessible Design* (http://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards_prt.pdf).¹ In the USA, as well as in other countries, close connection is provided to building regulation, often in the form of the building code identifying when and where buildings need to provide accessibility features [e.g., the *International Building Code*® (IBC®)], with the design details in the referenced standard (e.g., ICC/ANSI A117.1).

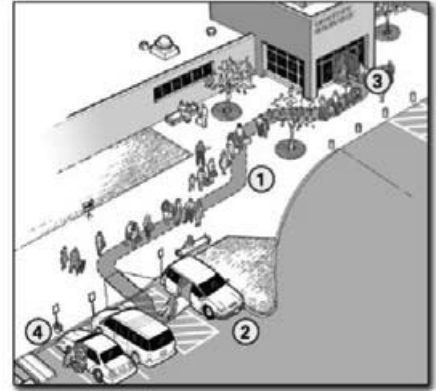
Although accessibility standards vary by country, key concepts include: accessible route(s) to the building, accessible entrance(s), parking and passenger loading facilities, accessible route(s) within the building, accessible building elements (e.g., door handles, handrails) and sanitary facilities (washrooms, lavatories), communication elements (e.g., signage, audible and visual devices) and built-in building elements. Many building regulations now also address design for emergency situations, which may involve use of refuge areas, lifts for evacuation, or other acceptable systems and strategies.

¹ While two standards exist in the USA, they cover essentially the same issues, with ICC/ANSI A117.1 updated as needed to reflect changes to the *ADA Design Standards for Accessible Design*, and ICC/ANSI A117.1 being the compliance standard referenced within the IBC.

ACCESSIBILITY

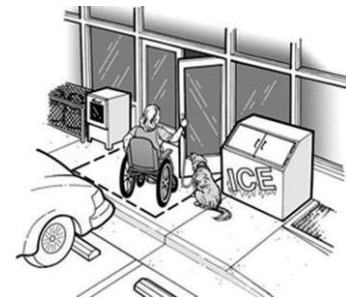
Accessible Route(s) to the Building

In brief, an accessible route is a continuous, unobstructed path that does not present a barrier to travel for the target population.² This objective is aimed at assuring that for persons who may be expected to work within or visit a building can gain access to the building (3) from site parking (2, 4), public transportation or other public ways. If the building is part of a multi-structure complex, there should be an accessible route to the site, and within the site to the building(s) of concern. An accessible route to a building may require a smooth transportation surface along the route (1), a maximum slope of grade along the route, involve use of a ramp, lift or other assisting apparatus.



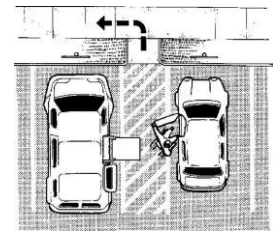
Accessible Entrance(s)

An accessible entrance is one which is sized and located to permit unobstructed entry by the target population. The sizing involves factors such as width, force required to open the door, and hardware used for opening the doors. The location is primarily a function of the relationship to grade. If the entrance is not level with grade, this may require installation of a ramp or elevating device.³



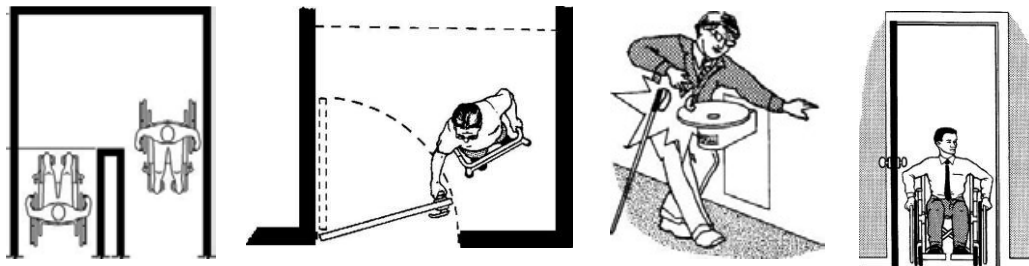
Parking and Passenger Loading Facilities

Suitably sized parking spaces and/or passenger loading areas facilitate ready entry/exit from vehicles to an accessible route or entrance [see figure to the right as well as (2) in the figure above]. Parking for the disabled should be properly marked [see (4) in the figure above].⁴



Accessible Route(s) Within the Building

As noted above, an accessible route is a continuous, unobstructed path that does not present a barrier to travel for the target population. Within buildings, this generally pertains to such items as providing suitable turning radius for wheelchairs, providing suitable clearances from obstructions which may impact sight or mobility impaired persons, providing suitable widths of corridors and door openings, providing suitable space for accessing door hardware, and so forth.⁵



² For the purpose of these guidelines, the target population is predominantly a function of the accessibility legislation in the country wherein the building is constructed. Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

³ Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

⁴ Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

⁵ Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

Accessible Building Elements and Facilities

Once inside a building, persons with disabilities need to be able to access various areas and facilities (such as lavatories), and there are many building elements and building arrangement issues that should be considered. To facilitate changes in elevation, regular spacing of stair rise and run is helpful for stairways, and proper location and dimensioning of handrails is important for stairways and ramps. Where occupants need to access spaces via doorways, turnstiles or security gates, not only is the dimensioning important (accessible route), but also the action and force required for opening (e.g., activating the door handle and for moving the door). For essential facilities, such as lavatories, space (e.g., turning radius) and support mechanisms (e.g., handrails) should be appropriate for providing the necessary access. As illustrated in the diagrams, proper consideration should be given to such factors as whether doors swing into or out of the target space, and the associated clearances which may be required.

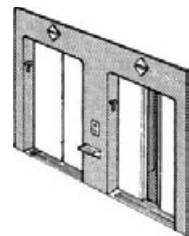
Communication Elements

In addition to providing appropriate facilities for moving about within a building, it is important to consider appropriate signage indicating disabled facilities, appropriate marking of access and exit routes using braille, large letters and audible signals where needed, and appropriate use of emergency signaling devices for persons with audible and visual impairments (e.g., flashing lights/strobes of appropriate intensity, audible signals of appropriate sound power level, frequency and intelligibility).⁶



Egress Considerations

While it is important to provide access for building use under normal operating conditions, it is also important to consider issues associated with evacuation of persons with disabilities during emergency situations. The key egress system design considerations are addressed in Section 6.1 (e.g., number and capacity of exits, travel distances, etc.). When designing for persons with disabilities, consideration has to be given to alarm audibility, visibility and signage (see also above), and for buildings with levels accessible by elevators (lifts), the need for places of refuge (while awaiting rescue) and/or emergency evacuation via elevators (see also Section 6.3).



In buildings with stories above grade, it is also prudent to have apparatus to help evacuate mobility impaired occupants down stairs, and to incorporate the “buddy system” or other appropriate strategy for assisting mobility and otherwise impaired occupants into emergency evacuation plans (see also Tubbs and Meacham, 2006).⁷

Existing Buildings

While access for all is a basic human right and common legislative theme, it is also recognized that not all buildings, or all portions of buildings, can be accessible by all people. This is especially true for existing buildings, where it may be physically or financially impractical to modify all aspects of a building to the same level as new construction. Where modification to existing buildings is desired or required, in the first instance it is recommended that a needs assessment be conducted to determine which aspects of the building may need to be modified to provide reasonable accommodation. These needs may be more than existing, but less than the standard for new construction. Selection of required features can then be made by assessing needs, performance objectives and costs of modification to determine potential changes.

⁶ Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

⁷ Source: Accredited to the U.S. Department of Justice and the U.S. Access Board.

ACCESSIBILITY

Summary

Key accessibility considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 6.2.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Accessible route(s) to the building	Site conditions	May need to provide level (smooth) transportation surfaces, remove obstructions along path of travel, have ramps (or lift) instead of/in addition to steps, connect to accessible parking/loading areas and/or public transportation loading areas.
Accessible entrance(s)	Entrance doorways	At least one entrance may need to be of appropriate width, and with appropriate landing, to allow wheelchair and other access.
Parking and passenger loading facilities	Parking and passenger loading facilities	May need to modify parking, curbs or other to provide suitable parking and loading facilities.
Accessible route(s) within the building	Doorways, doors, turnstiles, security gates, door hardware, steps, stairways, elevators	May need to provide access to those areas of the building needed to be accessed by employee or visitor, including design for or modification to, doorways, doors, door hardware, lifts, ramps, handrails, railings, etc.
Accessible building elements and facilities	Doorways, doors, sanitary facilities	Design should accommodate access to sanitary facilities and not result in obstruction of movement to key areas.
Communication elements	Signs, audible and visual alarms	May need to provide signage, audible and visual alarms that meet requirements for persons with disabilities.
Egress considerations	Place(s) of refuge, elevator for evacuation, evacuation planning	Consideration should be given to place(s) of refuge or lifts for evacuation of persons with disabilities; alarm signaling needs to meet requirements for persons with disabilities; evacuation plans should include features and products to support evacuation of persons with disabilities.

6.2.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with occupant accessibility issues. UN-occupied office buildings shall be designed and constructed barrier free and buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 6.2.2. A list of alternate means of verification is provided in Section 6.2.3.

- 6.2.1.1 The building site shall be designed or modified such that any persons with the right or need to use the building for its intended purpose can approach and gain access to the building in a dignified, safe and unobstructed manner.
 - 6.2.1.1.1 Access to the building from a proximate public transportation facility, on-site parking area, or passenger unloading area shall be provided via a continuous, unobstructed path that does not present a barrier to travel for the target population.
 - 6.2.1.1.2 Where provided, parking areas designated for persons with disabilities shall be so marked and sized as to allow dignified and safe entrance and exit from the vehicle.
 - 6.2.1.1.3 Where provided, passenger unloading areas designated for persons with disabilities shall be so marked and sized as to allow dignified and safe entrance and exit from the vehicle.
 - 6.2.1.1.4 Facilities shall be provided to allow for the safe, unobstructed and dignified entrance to a building for persons of all abilities.
- 6.2.1.2 The building shall be designed or modified to provide persons with disabilities reasonable access to those parts of the building necessary to undertake their job or obtain the service offered by the facility in a manner consistent with that provided to persons without disabilities in nonemergency conditions.
 - 6.2.1.2.1 To facilitate safe, unobstructed and dignified travel within the building;
 - a. walking surfaces must have safe gradients;
 - b. doorways and doors shall not impede access or egress, or cause occupants to be trapped within a building;
 - c. stairways and ramps shall have slip-resistant walking surfaces, suitable handrails, suitable landings, suitable access to and from landings; and
 - d. elevators (lifts) shall accommodate persons with disabilities and their transportation support system.
 - 6.2.1.2.2 Sanitary and other necessary facilities within a building shall be designed to accommodate safe, unobstructed and dignified access for persons of all abilities, and shall be designed to avoid inadvertently trapping occupants.
- 6.2.1.3 Signage shall be appropriate to persons with visual impairments.
- 6.2.1.4 Audible and visual alarm and communication systems shall be appropriate to persons with hearing impairments.
- 6.2.1.5 For those parts of the building accessible by persons with disabilities, the exit system shall be designed to provide safe, unobstructed and dignified means of egress or protection in place.

6.2.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 6.2.2.1 (IBC 1101) GENERAL (ASSECCIBILITY)

6.2.2.1.1 (IBC 1101.2) Design. Buildings and facilities shall be designed and constructed to be *accessible* in accordance with these guidelines and ICC A117.1.

SECTION 6.2.2.2 (IBC 1103) SCOPING REQUIREMENTS

6.2.2.2.1 (IBC 1103.1) Where required. *Sites*, buildings, *structures*, *facilities*, elements and spaces, temporary or permanent, shall be accessible to persons with physical disabilities.

6.2.2.2.2 (IBC 1103.2) General exceptions. *Sites*, buildings, *structures*, *facilities*, elements and spaces shall be exempt from this chapter to the extent specified in this section.

6.2.2.2.2.1 (IBC 1103.2.1) Specific requirements. *Accessibility* is not required in buildings and *facilities*, or portions thereof, to the extent permitted by Sections 6.2.2.3 through 6.2.2.8 (IBC Sections 1104 through 1110).

6.2.2.2.2.2 (IBC 1103.2.2) Existing buildings. Existing buildings shall comply with Section 6.2.2.9 (IBC Section 3411).

6.2.2.2.2.3 (IBC 1103.2.3) Employee work areas. Spaces and elements within *employee work areas* shall only be required to comply with Sections 5.4.2.6.5.2.6, 6.1.2.22 and 6.2.2.3.3.1 (IBC Sections 907.5.2.3.2, 1007 and 1104.3.1) and shall be designed and constructed so that individuals with disabilities can approach, enter and *exit* the work area. Work areas, or portions of work areas, other than raised courtroom stations, that are less than 28 m² in area and elevated 18 cm or more above the ground or finish floor where the elevation is essential to the function of the space shall be exempt from all requirements.

6.2.2.2.2.4 (IBC 1103.2.5) Utility buildings. Occupancies in Group U are exempt from the requirements of this chapter other than the following:

1. Reserved.
2. Private garages or carports that contain required *accessible* parking.

6.2.2.2.2.5 (IBC 1103.2.6) Construction sites. Structures, *sites* and equipment directly associated with the actual processes of construction including, but not limited to, scaffolding, bridging, materials hoists, materials storage or construction trailers are not required to be *accessible*.

6.2.2.2.2.6 (IBC 1103.2.7) Raised areas. Raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to, observation galleries, prison guard towers, fire towers or lifeguard stands, are not required to be *accessible* or to be served by an *accessible route*.

6.2.2.2.2.7 (IBC 1103.2.8) Limited access spaces. Nonoccupiable spaces accessed only by ladders, catwalks, crawl spaces, freight elevators or very narrow passageways are not required to be *accessible*.

6.2.2.2.2.8 (IBC 1103.2.9) Equipment spaces. Spaces frequented only by personnel for maintenance, repair or monitoring of equipment are not required to be *accessible*. Such spaces include, but are not limited to, elevator pits, elevator *penthouses*, mechanical, electrical or communications equipment rooms, piping or equipment catwalks, water or sewage treatment pump rooms and stations, electric substations and transformer vaults, and highway and tunnel utility facilities.

6.2.2.2.2.9 (IBC 1103.2.10) Single-occupant structures. Single-occupant structures accessed only by passageways below grade or elevated above grade including, but not limited to, toll booths that are accessed only by underground tunnels, are not required to be *accessible*.

SECTION 6.2.2.3 (IBC 1104) ACCESSIBLE ROUTE

6.2.2.3.1 (IBC 1104.1) Site arrival points. *Accessible routes* within the *site* shall be provided from public transportation stops; *accessible* parking; *accessible* passenger loading zones; and public streets or sidewalks to the *accessible* building entrance served.

Exception: An *accessible route* shall not be required between *site* arrival points and the building or facility entrance if the only means of access between them is a vehicular way not providing for pedestrian access.

6.2.2.3.2 (IBC 1104.2) Within a site. At least one *accessible route* shall connect *accessible* buildings, *accessible* facilities, *accessible* elements and *accessible* spaces that are on the same *site*.

Exception: An *accessible route* is not required between *accessible* buildings, *accessible* facilities, *accessible* elements and *accessible* spaces that have, as the only means of access between them, a vehicular way not providing for pedestrian access.

6.2.2.3.3 (IBC 1104.3) Connected spaces. When a building or portion of a building is required to be *accessible*, an *accessible route* shall be provided to each portion of the building, to *accessible* building entrances connecting *accessible pedestrian walkways* and the public way.

Exceptions:

1. In assembly areas with fixed seating, an accessible route shall not be required to serve levels where wheelchair spaces are not provided.
2. Reserved.

6.2.2.3.3.1 (IBC 1104.3.1) Employee work areas. Common use circulation paths within employee work areas shall be accessible routes.

Exceptions:

1. *Common use circulation paths*, located within *employee work areas* that are less than 28 m² in size and defined by permanently installed partitions, counters, casework or furnishings, shall not be required to be *accessible routes*.
2. *Common use circulation paths*, located within *employee work areas*, that are an integral component of equipment, shall not be required to be *accessible routes*.
3. *Common use circulation paths*, located within exterior *employee work areas* that are fully exposed to the weather, shall not be required to be *accessible routes*.

6.2.2.3.4 (IBC 1104.4) Multilevel buildings and facilities. At least one *accessible route* shall connect each *accessible* level, including *mezzanines*, in multilevel buildings and facilities.

Exceptions:

1. An *accessible route* is not required to stories and *mezzanines* that have an aggregate area of not more than 280 m² and are located above and below *accessible* levels.
2. Levels that do not contain *accessible* elements or other spaces as determined by IBC Section 1107 or Section 6.2.2.6 (IBC Section 1108) are not required to be served by an *accessible route* from an *accessible* level.
3. Reserved.
4. Where a two-story building or facility has one *story* with an *occupant load* of five or fewer persons that does not contain *public use* space, that *story* shall not be required to be connected by an *accessible route* to the *story* above or below.

6.2.2.3.5 (IBC 1104.5) Location. *Accessible routes* shall coincide with or be located in the same area as a general *circulation path*. Where the *circulation path* is interior, the *accessible route* shall also be interior. Where only one *accessible route* is provided, the *accessible route* shall not pass through kitchens, storage rooms, restrooms, closets or similar spaces.

6.2.2.3.6 (IBC 1104.6) Security barriers. Security barriers including, but not limited to, security bollards and security check points shall not obstruct a required *accessible route* or *accessible means of egress*.

ACCESSIBILITY

Exception: Where security barriers incorporate elements that cannot comply with these requirements, such as certain metal detectors, fluoroscopes or other similar devices, the *accessible route* shall be permitted to be provided adjacent to security screening devices. The *accessible route* shall permit persons with disabilities passing around security barriers to maintain visual contact with their personal items to the same extent provided others passing through the security barrier.

SECTION 6.2.2.4 (IBC 1105) ACCESSIBLE ENTRANCES

6.2.2.4.1 (IBC 1105.1) Public entrances. In addition to *accessible* entrances required by Sections 6.2.2.4.1.1 through 6.2.2.4.1.4 (IBC Sections 1105.1.1 through 1105.1.6) and IBC Section 1105.1.6, at least 60% of all *public entrances* shall be *accessible*.

Exceptions:

1. An *accessible* entrance is not required to areas not required to be *accessible*.
2. Loading and *service entrances* that are not the only entrance to a tenant space.

6.2.2.4.1.1 (IBC 1105.1.1) Parking garage entrances. Where provided, direct access for pedestrians from parking structures to buildings or facility entrances shall be *accessible*.

6.2.2.4.1.2 (IBC 1105.1.2) Entrances from tunnels or elevated walkways. Where direct access is provided for pedestrians from a pedestrian tunnel or elevated walkway to a building or facility, at least one entrance to the building or facility from each tunnel or walkway shall be *accessible*.

6.2.2.4.1.3 (IBC 1105.1.3) Restricted entrances. Where *restricted entrances* are provided to a building or facility, at least one *restricted entrance* to the building or facility shall be *accessible*.

6.2.2.4.1.4 (IBC 1105.1.5) Service entrances. If a *service entrance* is the only entrance to a building or a tenant space in a facility, that entrance shall be *accessible*.

SECTION 6.2.2.5 (IBC 1106) PARKING AND PASSENGER LOADING FACILITIES

6.2.2.5.1 (IBC 1106.1) Required. Where more than one parking facility is provided on a *site*, the number of parking spaces required to be *accessible* shall be calculated separately for each parking facility.

Exception: This section does not apply to parking spaces used exclusively for buses, trucks, other delivery vehicles, law enforcement vehicles or vehicular impound and motor pools where lots accessed by the public are provided with an *accessible* passenger loading zone.

**TABLE 6.2.2.5.1 (IBC TABLE 1106.1)
ACCESSIBLE PARKING SPACES**

TOTAL PARKING SPACES PROVIDED	REQUIRED MINIMUM NUMBER OF ACCESSIBLE SPACES
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2% of total
1001 and over	20, plus one for each 100, Or fraction thereof, over 1000

6.2.2.5.2 (IBC 1106.5) Van spaces. For every six or fraction of six *accessible* parking spaces, at least one shall be a van-accessible parking space.

6.2.2.5.3 (IBC 1106.6) Location. *Accessible* parking spaces shall be located on the shortest *accessible route* of travel from adjacent parking to an *accessible* building entrance. In parking facilities that do not serve a particular building, *accessible* parking spaces shall be located on the shortest route to an *accessible* pedestrian entrance to the parking facility. Where buildings have multiple *accessible* entrances with adjacent parking, *accessible* parking spaces shall be dispersed and located near the *accessible* entrances.

SECTION 6.2.2.6 (IBC 1108) SPECIAL OCCUPANCIES

6.2.2.6.1 (IBC 1108.2) Assembly area seating. Assembly areas with fixed seating shall comply with Sections 6.2.2.6.1.1 through 6.2.2.6.1.5 (IBC Sections 1108.2.2.1 through 1108.2.2.5) and IBC Sections 1108.2.6 through 1108.2.8. Dining areas shall comply with IBC Section 1108.2.9. In addition, lawn seating shall comply with IBC Section 1108.2.6.

6.2.2.6.1.1 (IBC 1108.2.1) Services. If a service or facility is provided in an area that is not *accessible*, the same service or facility shall be provided on an *accessible* level and shall be *accessible*.

6.2.2.6.1.2 (IBC 1108.2.2) Wheelchair spaces. In theaters, *bleachers*, *grandstands*, stadiums, arenas and other fixed seating assembly areas, *accessible wheelchair spaces* complying with ICC A117.1 shall be provided in accordance with Section 6.2.2.6.1.2.1 (IBC Section 1108.2.2.1) and IBC Sections 1108.2.2.2 through 1108.2.2.4.

6.2.2.6.1.2.1 (IBC 1108.2.2.1) General seating. *Wheelchair spaces* shall be provided in accordance with Table 6.2.2.6.1.2.1 (IBC Table 1108.2.2.1).

TABLE 6.2.2.6.1.2.1 (IBC TABLE 1108.2.2.1)
ACCESSIBLE WHEELCHAIR SPACES

CAPACITY OF SEATING IN ASSEMBLY AREAS	MINIMUM REQUIRED NUMBER OF WHEELCHAIR SPACES
4 to 25	1
26 to 50 2	2
51 to 100 4	4
101 to 300 5	5
301 to 500 6	6, plus 1 for each 150, or fraction thereof, between 501 through 5 000
501 to 5 000	5 001 and over 36 plus 1 for each 200, or fraction thereof, over 5 000

6.2.2.6.1.3 (IBC 1108.2.3) Companion seats. At least one companion seat complying with ICC A117.1 shall be provided for each *wheelchair space* required by Section 6.2.2.6.1.2.1 (IBC Section 1108.2.2.1).

6.2.2.6.1.4 (IBC 1108.2.4) Dispersion of wheelchair spaces in multilevel assembly seating areas. In *multilevel assembly seating* areas, *wheelchair spaces* shall be provided on the main floor level and on one of each two additional floor or *mezzanine* levels. *Wheelchair spaces* shall be provided in each luxury box, club box and suite within assembly facilities.

Exceptions:

1. Reserved.
2. In *multilevel assembly seating* where the second floor or *mezzanine* level provides 25% or less of the total seating capacity and 300 or fewer seats, all *wheelchair spaces* shall be permitted to be located on the main level.
3. Reserved.

6.2.2.6.1.5 (IBC 1108.2.5) Designated aisle seats. At least 5%, but not less than one, of the total number of aisle seats provided shall be designated aisle seats and shall be the aisle seats located closest to *accessible routes*.

Exception: Designated aisle seats are not required in team or player seating serving areas of sport activity.

SECTION 6.2.2.7 (IBC 1109) OTHER FEATURES AND FACILITIES

6.2.2.7.1 (IBC 1109.1) General. *Accessible* building features and facilities shall be provided in accordance with Sections 6.2.2.7.2 through 6.2.2.7.8 and IBC Sections 1109.2 through 1109.14.

6.2.2.7.2 (IBC 1109.2) Toilet and bathing facilities. Each toilet room and bathing room shall be *accessible*. Where a floor level is not required to be connected by an *accessible route*, the only toilet rooms or bathing rooms provided within the facility shall not be located on the inaccessible floor. At least one of each type of fixture, element, control or dispenser in each *accessible* toilet room and bathing room shall be *accessible*.

1. In toilet rooms or bathing rooms accessed only through a private office, not for *common* or *public use* and intended for use by a single occupant, any of the following alternatives are allowed:
 - 1.1. Doors are permitted to swing into the clear floor space, provided the door swing can be reversed to meet the requirements in ICC A117.1;
 - 1.2. The height requirements for the water closet in ICC A117.1 are not applicable;
 - 1.3. Grab bars are not required to be installed in a toilet room, provided that reinforcement has been installed in the walls and located so as to permit the installation of such grab bars; and
 - 1.4. The requirement for height, knee and toe clearance shall not apply to a lavatory.
3. Where multiple single-user toilet rooms or bathing rooms are clustered at a single location, at least 50% but not less than one room for each use at each cluster shall be *accessible*.
4. Where no more than one urinal is provided in a toilet room or bathing room, the urinal is not required to be *accessible*.

6.2.2.7.2.1 (IBC 1109.2.2) Water closet compartment. Where water closet compartments are provided in a toilet room or bathing room, at least one wheelchair-*accessible* compartment shall be provided. Where the combined total water closet compartments and urinals provided in a toilet room or bathing room is six or more, at least one ambulatory-*accessible* water closet compartment shall be provided in addition to the wheelchair-*accessible* compartment. Wheelchair-*accessible* and ambulatory-*accessible* compartments shall comply with ICC A117.1.

6.2.2.7.2.2 (IBC 1109.2.3) Lavatories. Where lavatories are provided, at least 5%, but not less than one, shall be *accessible*. Where the total lavatories provided in a toilet room or bathing facility is six or more, at least one lavatory with enhanced reach ranges in accordance with ICC A117.1, shall be provided.

6.2.2.7.3 (IBC 1109.3) Sinks. Where sinks are provided, at least 5% but not less than one provided in *accessible* spaces shall comply with ICC A117.1.

Exception: Mop or service sinks are not required to be *accessible*.

6.2.2.7.4 (IBC 1109.4) Kitchens and kitchenettes. Where kitchens and kitchenettes are provided in *accessible* spaces or rooms, they shall be *accessible* in accordance with ICC A117.1.

6.2.2.7.5 (IBC 1109.5) Drinking fountains. Where drinking fountains are provided on an exterior site, on a floor or within a secured area, the drinking fountains shall be provided in accordance with Section 6.2.2.7.5.1 and 6.2.2.7.5.2 (IBC Sections 1109.5.1 and 1109.5.2).

6.2.2.7.5.1 (IBC 1109.5.1) Minimum number. No fewer than two drinking fountains shall be provided. One drinking fountain shall comply with the requirements for people who use a wheelchair and one drinking fountain shall comply with the requirements for standing persons.

Exception: A single drinking fountain that complies with the requirements for people who use a wheelchair and standing persons shall be permitted to be substituted for two separate drinking fountains.

6.2.2.7.5.2 (IBC 1109.5.2) More than the minimum number. Where more than the minimum number of drinking fountains specified in Section 6.2.2.7.5.1 (IBC Section 1109.5.1) are provided, 50% of the total number of drinking fountains provided shall comply with the requirements for persons who use a wheelchair and 50% of the total number of drinking fountains provided shall comply with the requirements for standing persons.

Exception: Where 50% of the drinking fountains yields a fraction, 50% shall be permitted to be rounded up or down, provided that the total number of drinking fountains complying with this section equals 100% of the drinking fountains.

6.2.2.7.6 (IBC 1109.6) Elevators. Passenger elevators on an *accessible route* shall be *accessible* and comply with IBC Section 3001.3.

6.2.2.7.7 (IBC 1109.8) Storage. Where fixed or built-in storage elements such as cabinets, shelves, medicine cabinets, closets and drawers are provided in required *accessible* spaces, at least one of each type shall contain storage space complying with ICC A117.1.

6.2.2.7.7.1 (IBC 1109.8.2) Shelving and display units. Self-service shelves and display units shall be located on an *accessible route*. Such shelving and display units shall not be required to comply with reach-range provisions.

6.2.2.7.7.2 (IBC 1109.8.3) Coat hooks and shelves. Where coat hooks and shelves are provided in toilet rooms or toilet compartments or in dressing, fitting or locker rooms, at least one of each type shall be *accessible* and shall be provided in *accessible* toilet rooms without toilet compartments, *accessible* toilet compartments and *accessible* dressing, fitting and locker rooms.

6.2.2.7.8 (IBC 1109.12) Controls, operating mechanisms and hardware. Controls, operating mechanisms and hardware intended for operation by the occupant, including switches that control lighting and ventilation and electrical convenience outlets, in *accessible* spaces, along *accessible routes* or as parts of *accessible* elements shall be *accessible*.

Exceptions:

1. Operable parts that are intended for use only by service or maintenance personnel shall not be required to be *accessible*.
2. Electrical or communication receptacles serving a dedicated use shall not be required to be *accessible*.
3. Where two or more outlets are provided in a kitchen above a length of counter top that is uninterrupted by a sink or appliance, one outlet shall not be required to be *accessible*.
4. Floor electrical receptacles shall not be required to be *accessible*.
5. HVAC diffusers shall not be required to be *accessible*.
6. Except for light switches, where redundant controls are provided for a single element, one control in each space shall not be required to be *accessible*.

SECTION 6.2.2.8 (IBC 1110) SIGNAGE

6.2.2.8.1 (IBC 1110.1) Signs. Required *accessible* elements shall be identified by the International Symbol of Accessibility at the following locations:

1. *Accessible* parking spaces required by Section 6.2.2.5.1 (IBC Section 1106.1) except where the total number of parking spaces provided is four or less.
2. *Accessible* passenger loading zones.
3. *Accessible* rooms where multiple single-user toilet or bathing rooms are clustered at a single location.
4. *Accessible* entrances where not all entrances are accessible.
8. *Accessible areas of refuge* in accordance with Section 6.1.2.22.7 (IBC Section 1007.9).
9. Exterior areas for assisted rescue in accordance with Section 6.1.2.22.7 (IBC Section 1007.9).

6.2.2.8.2 (IBC 1110.2) Directional signage. Directional signage indicating the route to the nearest like *accessible* element shall be provided at the following locations. These directional signs shall include the International Symbol of Accessibility:

1. Inaccessible building entrances.
2. Inaccessible public toilets and bathing facilities.
3. Elevators not serving an *accessible route*.

ACCESSIBILITY

4. At each separate-sex toilet and bathing room indicating the location of the nearest family or assisted-use toilet or bathing room where provided in accordance with IBC Section 1109.2.1.
5. At *exits* and *exit stairways* serving a required *accessible* space, but not providing an *approved accessible means of egress*, signage shall be provided in accordance with Section 6.1.2.22.8 (IBC Section 1007.10).

6.2.2.8.3 (IBC 1110.3) Other signs. Signage indicating special accessibility provisions shall be provided as shown:

1. Each assembly area required to comply with IBC Section 1108.2.7 shall provide a sign notifying patrons of the availability of assistive listening systems.

Exception: Where ticket offices or windows are provided, signs are not required at each assembly area provided that signs are displayed at each ticket office or window informing patrons of the availability of assistive listening systems.

2. At each door to an *area of refuge*, an exterior area for assisted rescue, an egress *stairway*, *exit passageway* and *exit discharge*, signage shall be provided in accordance with IBC Section 1011.3.
3. At *areas of refuge*, signage shall be provided in accordance with IBC Section 1007.11.
4. At exterior areas for assisted rescue, signage shall be provided in accordance with IBC Section 1007.11.
5. At two-way communication systems, signage shall be provided in accordance with IBC Section 1007.8.2.
6. Within *exit enclosures*, signage shall be provided in accordance with Section 6.1.2.10.8 (IBC Section 1022.8).

SECTION 6.2.2.9 (IBC 3411) ACCESSIBILITY FOR EXISTING BUILDINGS

6.2.2.9.1 (IBC 3411.1) Scope. The provisions of Sections 6.2.2.9.1 through 6.2.2.9.8.11 (IBC Sections 3411.1 through 3411.8.13) and IBC Section 3411.9 apply to maintenance, change of occupancy, additions and alterations to existing buildings, including those identified as *historic buildings*.

6.2.2.9.2 (IBC 3411.2) Maintenance of facilities. A building, facility or element that is constructed or altered to be *accessible* shall be maintained *accessible* during occupancy.

6.2.2.9.3 (IBC 3411.3) Extent of application. An *alteration* of an existing element, space or area of a building or facility shall not impose a requirement for greater accessibility than that which would be required for new construction. Alterations shall not reduce or have the effect of reducing accessibility of a building, portion of a building or facility.

6.2.2.9.4 (IBC 3411.4) Change of occupancy. Existing buildings that undergo a change of group or occupancy shall comply with this section.

6.2.2.9.4.1 (IBC 3411.4.1) Partial change in occupancy. Where a portion of the building is changed to a new occupancy classification, any alterations shall comply with Sections 6.2.2.9.6, 6.2.2.9.7 and 6.2.2.9.8 (IBC Sections 3411.6, 3411.7 and 3411.8).

6.2.2.9.4.2 (IBC 3411.4.2) Complete change of occupancy. Where an entire building undergoes a change of occupancy, it shall comply with Section 6.2.2.9.4.1 (IBC Section 3411.4.1) and shall have all of the following *accessible* features:

1. At least one *accessible* building entrance.
2. At least one *accessible* route from an *accessible* building entrance to *primary function* areas.
3. Signage complying with Section 6.2.2.8 (IBC Section 1110).
4. Accessible parking, where parking is being provided.
5. At least one *accessible* passenger loading zone, when loading zones are provided.
6. At least one *accessible* route connecting *accessible* parking and *accessible* passenger loading zones to an *accessible* entrance.

Where it is *technically infeasible* to comply with the new construction standards for any of these requirements for a change of group or occupancy, the above items shall conform to the requirements to the maximum extent technically feasible.

6.2.2.9.5 (IBC 3411.5) Additions. Provisions for new construction shall apply to additions. An *addition* that affects the accessibility to, or contains an area of, a primary function shall comply with the requirements in Section 6.2.2.9.7 (IBC Section 3411.7).

6.2.2.9.6 (IBC 3411.6) Alterations. A building, facility or element that is altered shall comply with the applicable provisions in Chapter 11 of the IBC and ICC A117.1, unless *technically infeasible*. Where compliance with this section is *technically infeasible*, the *alteration* shall provide access to the maximum extent technically feasible.

Exceptions:

1. The altered element or space is not required to be on an *accessible* route, unless required by Section 6.2.2.9.7 (IBC Section 3411.7).
2. *Accessible means of egress* required by IBC Chapter 10 are not required to be provided in existing buildings and facilities.

6.2.2.9.7 (IBC 3411.7) Alterations affecting an area containing a primary function. Where an *alteration* affects the accessibility to, or contains an area of *primary function*, the route to the *primary function* area shall be *accessible*. The *accessible* route to the *primary function* area shall include toilet facilities or drinking fountains serving the area of *primary function*.

Exceptions:

1. The costs of providing the *accessible* route are not required to exceed 20% of the costs of the *alterations* affecting the area of *primary function*.
2. This provision does not apply to *alterations* limited solely to windows, hardware, operating controls, electrical outlets and signs.
3. This provision does not apply to *alterations* limited solely to mechanical systems, electrical systems, installation or *alteration* of fire protection systems and abatement of hazardous materials.
4. This provision does not apply to *alterations* undertaken for the primary purpose of increasing the accessibility of an existing building, facility or element.

6.2.2.9.8 (IBC 3411.8) Scoping for alterations. The provisions of Sections 6.2.2.9.8.1 through 6.2.2.9.8.11 (IBC Sections 3411.8.1 through 3411.8.11) and IBC Sections 3411.8.12 through 3411.8.14 shall apply to *alterations* to existing buildings and facilities.

6.2.2.9.8.1 (3411.8.1) Entrances. *Accessible* entrances shall be provided in accordance with Section 6224 (IBC Section 1105).

Exception: Where an *alteration* includes alterations to an entrance, and the building or facility has an *accessible* entrance, the altered entrance is not required to be *accessible*, unless required by Section 6.2.2.9.7 (IBC Section 3411.7). Signs complying with Section 6.2.2.10 (IBC Section 1110) shall be provided.

6.2.2.9.8.2 (IBC 3411.8.2) Elevators. Altered elements of existing elevators shall comply with A17.1-2007/CSA B44-07 and ICC A117.1. Such elements shall also be altered in elevators programmed to respond to the same hall call control as the altered elevator.

6.2.2.9.8.3 (IBC 3411.8.3) Platform lifts. Platform (wheelchair) lifts complying with ICC A117.1 and installed in accordance with ASME A18.1 shall be permitted as a component of an *accessible* route.

6.2.2.9.8.4 (IBC 3411.8.4) Stairs and escalators in existing buildings. In *alterations*, change of occupancy or *additions* where an escalator or *stair* is added where none existed previously and major structural modifications are necessary for installation, an *accessible* route shall be provided between the levels served by the escalator or *stairs* in accordance with Sections 6.2.2.3.4 and 6.2.2.3.5 (IBC Sections 1104.4 and 1104.5).

ACCESSIBILITY

6.2.2.9.8.5 (IBC 3411.8.5) Ramps. Where slopes steeper than allowed by Section 6.1.2.14.2 (IBC Section 1010.2) are necessitated by space limitations, the slope of ramps in or providing access to existing buildings or facilities shall comply with Table 6.2.2.9.8.5 (IBC Table 3411.8.5).

**TABLE 6.2.2.9.8.5 (IBC TABLE 3411.8.5)
RAMPS**

SLOPE	MAXIMUM RISE
Steeper than 1:10 but not steeper than 1:8	7 cm
Steeper than 1:12 but not steeper than 1:10	15 cm

6.2.2.9.8.6 (IBC 3411.8.6) Performance areas. Where it is *technically infeasible* to alter performance areas to be on an *accessible* route, at least one of each type of performance area shall be made *accessible*.

6.2.2.9.8.7 Reserved.

6.2.2.9.8.8 Reserved.

6.2.2.9.8.9 Reserved.

6.2.2.9.8.10 Reserved.

6.2.2.9.8.11 (IBC 3411.8.13) Fuel dispensers. Operable parts of replacement fuel dispensers shall be permitted to be 1.35 m maximum measured from the surface of the vehicular way where fuel dispensers are installed on existing curbs.

6.2.3 ALTERNATE MEANS OF VERIFICATION

- 6.2.3.1 Chapter 11 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for accessibility can be demonstrated by compliance with Chapter 11 of the 2009 IBC.
- 6.2.3.2 ICC/ANSI Standard A117.1, *Accessible and Useable Buildings and Facilities* (ICC/ANSI, 2009) is deemed-to-comply with the provisions of this chapter.
- 6.2.3.3 The Americans with Disabilities Act (ADA) *Design Standards for Accessible Design* (ADAAG) (http://www.ada.gov/regs2010/2010ADASTandards/2010ADASTandards_prt.pdf) is deemed-to-comply with the provisions of this chapter.

6.3 ELEVATORS AND ESCALATORS

6.3.0 OVERVIEW AND KEY CONCEPTS

Elevators (Lifts)

In general, elevator systems consist of elevator hoistways (shafts), elevator cars, movement systems, control systems and machine rooms. Elevator hoistways serve to enclose the required openings between floors, which allows the elevator to move vertically, and to provide structural support for vertical conveyance equipment (pistons, rails, hoist ropes, etc.). Elevator hoistways need to be protected from fire and smoke migration as discussed in Chapter 4. An elevator hoistway may contain a single elevator system or a bank of elevators. Elevator cars may be single level or double level, depending on the size of the building, and will vary greatly in floor area. As appropriate, elevator doors and dimensions need to comply with accessibility requirements. Elevator motion is provided via hydraulic or electric traction systems. Hydraulic systems rely on one or more hydraulic pistons to move the elevator car up and down the elevator shaft. Speeds are generally slow (approximately 45 meters per minute) and limited in height (about 15 meters, depending on the type of system). Electric traction systems are either geared or gearless. In geared systems, the car is supported in the shaft by steel ropes, a sheave and a counterweight, with the car and counterweight riding along vertical guide rails and the drive sheave connected to the motor shaft through gears in a gearbox. This arrangement is typically used for mid-rise applications (five or more floors) requiring typical speeds up to 120 meters per minute. Gearless systems also use steel hoist ropes, sheaves and a counterweight, but in this case the gearless machine has a motor that connects directly to the shaft of the drive sheave. Such systems are typically used for high-rise applications of 10 or more floors requiring typical speeds of 250 meters per minute or greater. Both hydraulic and electric traction elevators utilize controllers to coordinate systems and passenger calls. The controllers are either microprocessor or relay logic controlled. Machine rooms provide space for motors, controllers and other equipment necessary to facilitate elevator operation. Hydraulic systems often require hydraulic pits. Fire protection is typically provided in hoistways, lobbies and mechanical rooms.

Elevators, Access and Evacuation

Elevators (lifts) provide a safe and effective means of moving occupants vertically within buildings, particularly in tall buildings. In addition, they may be used in emergencies for moving fire fighters and emergency responders, for evacuation of persons with disabilities, and in some cases, for occupant self-evacuation. Elevators come in all shapes and sizes to accommodate building needs and design constraints. When an elevator is part of an accessible route (see Section 6.2) it needs to be sized accordingly (door width, internal area and internal dimensions). Likewise, when used for evacuation or emergency response, certain features may be required to ensure that the elevators are available during an emergency and that they provide a safe means of transportation for fire fighters and/or occupants. Some general elevator configurations and their suitability for emergency use are outlined below (Tubbs and Meacham, 2006). Some countries require dedicated fire service elevators with enhanced protection.

Standard Elevators

Standard passenger elevators do not typically have the types of features that support their use for emergency evacuation. They generally open into unprotected vestibules and their hoistways may not be protected. Standard elevators may not be available to occupants during an emergency event because the event could compromise the elevator's operation (e.g., the event could damage the power supply or send smoke or heat into the elevator shaft). In order to be included in an evacuation strategy, elevators should be enhanced or protected, as discussed below.

ELEVATORS AND ESCALATORS

Enhanced Elevators

In some cases, relatively simple enhancements can be implemented, increasing the suitability of elevators to play a role in evacuation. Such enhancements include smoke and heat protected elevator lobbies or vestibules (including doors that seal against smoke and heat) to protect waiting occupants and help prevent the spread of smoke and heat via the elevator shafts, sensors installed in the elevator hoistway to initiate recall if smoke or heat is detected, and controls for firefighter capture and operation.

Protected Elevators

To provide maximum flexibility, the use of protected elevators would be needed. Protected elevators include a series of features that protect the elevator and its occupants through a wide range of emergency events, including fires, earthquakes, terrorist attacks, etc. In order to allow for use during a wide range of emergencies that could damage an unprotected elevator, protected elevators must include features that surpass those of enhanced elevators. Specifically, the design must include features to harden the elevator car, shaft, and the associated mechanical systems against such forces as impacts, blasts, earthquakes, or the like. The following table outlines various protective features for consideration in a protected elevator installation (Tubbs and Meacham, 2007).

PROTECTION FEATURE	DISCUSSION
Smoke and heat protection	Elevator hoistways, and associated machine and control rooms open to the hoistways, should be protected from smoke and fire. Protection can be provided through a combination of fire-rated smoke barriers and positive pressure systems. Elevators are typically open to ground floor lobbies. Ground floors can be a particularly vulnerable point in the system; these areas may need protected lobbies. Additionally, FEMA (2003) suggests that elevators be placed within a protected core of the building to mitigate blast and impact issues. Smoke/heat detection is typically required. In some cases sprinklers may also be necessary.
Emergency power	Because building power often is disabled during emergency events, provisions for emergency power supply should be included for all protected elevators. This will help ensure availability of elevators during emergencies. Conduits for emergency power systems should be routed within the protected elevator shafts.
Water protection	It is likely that elevators will be exposed to water during a fire or explosion emergency. The water can come from the automatic suppression systems of fire department operations. Either the elevators should be designed to operate in wet conditions, or appropriate containment and drainage should be included to prevent the infiltration of water into the elevator shafts.
Overheat protection	Elevator system components may need to be protected against high temperatures to ensure that they operate successfully even under extreme conditions. This is especially true if large fires are possible.
Earthquake protection	Expected earthquake loads should be reviewed, and provisions should be built into the design of protected elevators to ensure their operation subsequent to an earthquake.
Emergency communication	Two-way communication devices should be installed in all vestibules serving protected elevators, as well as within the cabs of the protected elevators, to ensure that occupants are informed of evacuation directions and status.
Controls	Specialized controls are necessary to define the sequence in which floors are evacuated and to ensure that occupants needing to use the elevator for evacuation have the opportunity to do so. Smoke detectors and controls for elevator recall are required.

Enhancements can be considered depending on the building and likely emergency scenarios.

Escalators, Moving Walkways and Other Conveyance Devices

In essence, an escalator is a “moving staircase” designed to move people between floors of a building. Escalators are composed of a motor-driven chain of individual linked steps that move up or down on tracks (which allow the step treads to remain horizontal), support frame (truss) and tracks (for steps), constant-speed motor, moving handrails and landings. While numerous configurations exist, the typical angle of inclination (to the horizontal) is 30 degrees, and the orientation is typically straight (although curved escalators do exist). The total rise (vertical distance) depends on height between floor landings. Escalators are available in a wide range of widths and lengths to accommodate a wide range of facility needs.

Safety Issues

Requirements vary by country; however, in many countries there are mechanisms such as handrails, extended balustrades, clothing guards, anti-slip surfaces, automatic and manual stop sensors or buttons, and related items installed to help people maintain stability, prevent catching on moving parts, and to shut down equipment when needed. Other important aspects to consider are providing sufficient queuing distance around entry and exit points—particularly exit points—to avoid buildup/bottleneck of passengers at the point of disembarkation. This is especially important if any type of security or metering measure is in place (e.g., turnstile). Consideration should be given to providing sufficient flow through such controls during emergency situations.

Fire Safety Issues

Whereas escalators are vertical connections between spaces, escalator openings provide a mechanism for smoke spread from lower to higher levels during a fire. Requirements vary by country on the number of floors that can be connected by unenclosed openings (see Chapter 4). In some cases, smoke curtains, water curtains or other mechanisms may need to be engineered into the design to allow flexibility to meet other building performance objectives (e.g., open areas). Escalators are not typically considered part of a facility’s exit system.

Summary

Key considerations for elevators and escalators are outlined below. More detailed discussion on associated design requirements can be found in Section 6.3.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Vertical shaft protection	Shaft structural, fire and smoke performance of enclosures.	Since elevators and escalators require vertical openings, proper protection from structural, fire and smoke perspectives must be maintained. Elevator shafts (hoistways) have minimum fire requirements. Escalator openings may have limits on contiguously connected floors and/or requirements for additional fire protection.
Occupant evacuation	Shaft, fire detection and suppression systems, controls, water and structural resilience, communication systems, emergency power.	Elevators used for occupant self-evacuation typically require enhanced protection to maintain operability in emergency situations. Two-way communications capabilities are also needed.
Occupant safety	Elevator, escalator and architectural design.	Specific systems and features required. Space (area) requirements (landings and such).

6.3.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with elevators and escalators. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 6.3.2. A list of alternate means of verification is provided in Section 6.3.3.

- 6.3.1.1 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall be designed, installed, operated and maintained in a manner that results in safe and reliable operation under normal operating conditions, and where appropriate, under emergency operating conditions, appropriate to the hazards or events of concern.
 - 6.3.1.1.1 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall move people safely along when starting, stopping, accelerating, decelerating or changing direction of travel, and hold the rated loads (2009 *International Code Council Performance Code® for Buildings and Facilities*).
 - 6.3.1.1.2 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall be constructed to avoid the likelihood of people falling, tripping, becoming caught and coming in contact with sharp edges or projections under normal and reasonably foreseeable conditions of use (2009 ICCPC).
 - 6.3.1.1.3 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall be guided and have sufficient running clearances (2009 ICCPC).
 - 6.3.1.1.4 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall have controls to stop and prevent restarting in the event of activation of a safety device (2009 ICCPC).
 - 6.3.1.1.5 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall be capable of being isolated for inspection, testing and maintenance (2009 ICCPC).
 - 6.3.1.1.6 Elevators, escalators and other means of mechanically-assisted occupant conveying systems shall have adequate lighting and ventilation during normal conditions or upon loss of normal power (2009 ICCPC).
- 6.3.1.2 Elevator and escalator systems shall be designed, installed, operated and maintained to limit the spread of fire and smoke throughout a building, and as appropriate, aid the response of fire service personnel and evacuating occupants.
 - 6.3.1.2.1 Vertical openings required for use of elevators and escalators shall be appropriately protected to minimize the vertical spread of fire, smoke and hot gases in the event of fire in a building.
 - 6.3.1.2.1.1 Protection of vertical openings shall be in accordance with Chapter 4, as appropriate to the height of the building.
 - 6.3.1.2.1.2 Smoke/heat vents shall be provided in elevator shafts to vent smoke and heat in the event of a fire in the building.

- 6.3.1.2.2 Elevator systems shall be provided with fire detection and suppression systems appropriate to the system component (e.g., hoistway, machine room, passenger lobby) and elevator function required in normal and emergency operations.
- 6.3.1.2.3 Elevator machine rooms shall be designed and protected to facilitate the required operation of the elevators during normal and emergency operation.
- 6.3.1.2.4 Where required, dedicated fire service elevators shall be designed, installed and maintained to provide reliable means of conveyance of emergency personnel during emergency conditions.
- 6.3.1.2.5 Where required, dedicated elevators for occupant self-evacuation shall be designed, installed and maintained to provide reliable means of conveyance of occupants during emergency conditions.
- 6.3.1.2.6 Where required, emergency/standby power supplies shall be designed to accommodate required elevator loads for normal and emergency operations.
- 6.3.1.3 Passenger elevators that form part of accessible routes must meet the requirements of Section 6.2 and associated reference documents.
- 6.3.1.4 Elevators shall be provided with two-way communication to a staffed location (2009 ICCPC).
- 6.3.1.5 Provide a means of communication for trapped passengers in stalled elevators (2009 ICCPC).
- 6.3.1.6 Emergency recall operation that discharges passengers at the required designated or alternate landing in the event of a fire emergency (2009 ICCPC).
- 6.3.1.7 Emergency in-car operation for fire-fighting and rescue operations (2009 ICCPC).
- 6.3.1.8 An environment that ensures the safe operation for the anticipated use or application of the equipment (2009 ICCPC).

6.3.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 6.3.2.1 (IBC 3002) HOISTWAY ENCLOSURES

6.3.2.1.1 (IBC 3002.1) Hoistway enclosure protection. Elevator, dumbwaiter and other hoistway enclosures shall be shaft enclosures complying with Section 5.2.2.5 (IBC Section 708).

6.3.2.1.1.1 (IBC 3002.1.1) Opening protectives. Openings in hoistway enclosures shall be protected as required in IBC Chapter 7.

Exception: The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 6.3.2.2.2 (IBC Section 3003.2) shall be permitted to remain open during Phase I Emergency Recall Operation.

6.3.2.1.1.2 (IBC 3002.1.2) Hardware. Hardware on opening protectives shall be of an *approved* type installed as tested, except that *approved* interlocks, mechanical locks and electric contacts, door and gate electric contacts and door-operating mechanisms shall be exempt from the fire test requirements.

6.3.2.1.2 (IBC 3002.2) Number of elevator cars in a hoistway. Where four or more elevator cars serve all or the same portion of a building, the elevators shall be located in at least two separate hoistways. Not more than four elevator cars shall be located in any single hoistway enclosure.

6.3.2.1.3 (IBC 3002.3) Emergency signs. An *approved* pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the *exit stairways* and not to use the elevators in case of fire. The sign shall read: IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS.

Exceptions:

1. The emergency sign shall not be required for elevators that are part of an *accessible means of egress* complying with Section 6.1.2.22.4 (IBC Section 1007.4).
2. The emergency sign shall not be required for elevators that are used for occupant self-evacuation in accordance with IBC Section 3008.

6.3.2.1.4 (IBC 3002.4) Elevator car to accommodate ambulance stretcher. Where elevators are provided in buildings four or more *stories* above, or four or more *stories* below, *grade plane*, at least one elevator shall be provided for fire department emergency access to all floors. The elevator car shall be of such a size and arrangement to accommodate an ambulance stretcher 61 cm by 215 cm with not less than 13 cm radius corners, in the horizontal, open position and shall be identified by the international symbol for emergency medical services (star of life). The symbol shall not be less than 8 cm high and shall be placed inside on both sides of the hoistway door frame.

6.3.2.1.5 (IBC 3002.5) Emergency doors. Where an elevator is installed in a single blind hoistway or on the outside of a building, there shall be installed in the blind portion of the hoistway or blank face of the building, an emergency door in accordance with A17.1-2007/CSA B44-07.

6.3.2.1.6 (IBC 3002.6) Prohibited doors. Doors, other than hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

6.3.2.1.7 (IBC 3002.7) Common enclosure with stairway. Elevators shall not be in a common shaft enclosure with a *stairway*.

Exception: Open parking garages.

6.3.2.1.8 (IBC 3002.8) Glass in elevator enclosures. Glass in elevator enclosures shall comply with Section 6.4.2.3.1 (IBC Section 2409.1).

SECTION 6.3.2.2 (IBC 3003) EMERGENCY OPERATIONS

6.3.2.2.1 (IBC [F] 3003.1) Standby power. In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 6.3.2.2.1.1 through 6.3.2.2.1.4 (IBC Sections 3003.1.1 through 3003.1.4).

6.3.2.2.1.1 (IBC [F] 3003.1.1) Manual transfer. Standby power shall be manually transferable to all elevators in each bank.

6.3.2.2.1.2 (IBC [F] 3003.1.2) One elevator. Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

6.3.2.2.1.3 (IBC [F] 3003.1.3) Two or more elevators. Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, at least one elevator shall remain operable from the standby power source.

6.3.2.2.1.4 (IBC [F] 3003.1.4) Venting. Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

6.3.2.2.2 (IBC [F] 3003.2) Fire-fighters' emergency operation. Elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with A17.1-2007/CSA B44-07.

SECTION 6.3.2.3 (IBC 3004) HOISTWAY VENTING

6.3.2.3.1 (IBC 3004.1) Vents required. Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means for venting smoke and hot gases to the outer air in case of fire.

Exceptions:

1. Venting of hoistways is not required where the building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with NFPA 13.
2. Sidewalk elevator hoistways are not required to be vented.

6.3.2.3.2 (IBC 3004.2) Location of vents. Vents shall be located at the top the hoistway and shall open either directly to the outer air or through noncombustible ducts to the outer air. Noncombustible ducts shall be permitted to pass through the elevator machine room, provided that portions of the ducts located outside the hoistway or machine room are enclosed by construction having not less than the *fire-resistance rating* required for the hoistway. Holes in the machine room floors for the passage of ropes, cables or other moving elevator equipment shall be limited as not to provide greater than 5 cm of clearance on all sides.

6.3.2.3.3 (IBC 3004.3) Area of vents. Except as provided for in Section 6.3.2.3.3.1 (IBC Section 3004.3.1), the area of the vents shall not be less than $3\frac{1}{2}\%$ of the area of the hoistway nor less than 0.28 m^2 for each elevator car, and not less than $3\frac{1}{2}\%$ nor less than 465 cm^2 for each dumbwaiter car in the hoistway, whichever is greater. Of the total required vent area, not less than one-third shall be permanently open. Closed portions of the required vent area shall consist of openings glazed with annealed glass not greater than 3 mm in thickness.

Exception: The total required vent area shall not be required to be permanently open where all the vent openings automatically open upon detection of smoke in the elevator lobbies or hoistway, upon power failure and upon activation of a manual override control. The manual override control shall be capable of opening and closing the vents and shall be located in an *approved* location.

6.3.2.3.3.1 (IBC 3004.3.1) Reduced vent area. Where mechanical ventilation conforming to the *International Mechanical Code* is provided, a reduction in the required vent area is allowed provided that all of the following conditions are met:

1. Reserved.

ELEVATORS AND ESCALATORS

2. The vents required by Section 6.3.2.3.2 (IBC Section 3004.2) do not have outside exposure.
3. The hoistway does not extend to the top of the building.
4. The hoistway and machine room exhaust fan is automatically reactivated by thermostatic means.
5. Equivalent venting of the hoistway is accomplished.

6.3.2.3.4 (IBC 3004.4) Plumbing and mechanical systems. Plumbing and mechanical systems shall not be located in an elevator shaft.

Exception: Floor drains, sumps and sump pumps shall be permitted at the base of the shaft provided they are indirectly connected to the plumbing system.

SECTION 6.3.2.4 (IBC 3005) CONVEYING SYSTEMS

6.3.2.4.1 (IBC 3005.2) Escalators and moving walks. Escalators and moving walks shall be constructed of *approved noncombustible* and fire-retardant materials. This requirement shall not apply to electrical equipment, wiring, wheels, handrails and the use of 1 mm wood veneers on balustrades backed up with noncombustible materials.

6.3.2.4.1.1 (IBC 3005.2.1) Enclosure. Escalator floor openings shall be enclosed with shaft enclosures complying with Section 5.2.2.5 (IBC Section 708).

SECTION 6.3.2.5 (IBC 3006) MACHINE ROOMS

6.3.2.5.1 (IBC 3006.1) Access. An *approved* means of access shall be provided to elevator machine rooms and overhead machinery spaces.

6.3.2.5.2 (IBC 3006.2) Venting. Elevator machine rooms that contain solid-state equipment for elevator operation shall be provided with an independent ventilation or air-conditioning system to protect against the overheating of the electrical equipment. The system shall be capable of maintaining temperatures within the range established for the elevator equipment.

6.3.2.5.3 (IBC 3006.3) Pressurization. The elevator machine room serving a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room.

6.3.2.5.4 (IBC 3006.4) Machine rooms and machinery spaces. Elevator machine rooms and machinery spaces shall be enclosed with *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both. The *fire-resistance rating* shall not be less than the required rating of the hoistway enclosure served by the machinery. Openings in the *fire barriers* shall be protected with assemblies having a *fire protection rating* not less than that required for the hoistway enclosure doors.

Exceptions:

1. Where machine rooms and machinery spaces do not abut and have no openings to the hoistway enclosure they serve the *fire barriers* constructed in accordance with Section 5.2.2.4 (IBC Section 707) or *horizontal assemblies* constructed in accordance with Section 5.2.2.9 (IBC Section 712), or both, shall be permitted to be reduced to a 1-hour *fire-resistance rating*.
2. In buildings four *stories* or less above *grade plane* when machine room and machinery spaces do not abut and have no openings to the hoistway enclosure they serve, the machine room and machinery spaces are not required to be fire-resistance rated.

6.3.2.5.5 (IBC 3006.5) Shunt trip. Where elevator hoistways or elevator machine rooms containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with NFPA72, Section 6.16.4, Elevator Shutdown, shall be provided to disconnect automatically the main line power supply to the affected elevator prior to the application of water. This means shall not be self-resetting. The activation of sprinklers outside the hoistway or machine room shall not disconnect the main line power supply.

6.3.2.5.6 (IBC 3006.6) Plumbing systems. Plumbing systems shall not be located in elevator equipment rooms.

6.3.3 ALTERNATE MEANS OF VERIFICATION

- 6.3.3.1 Chapter 30 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for Elevators and Escalators can be demonstrated by compliance with Chapter 30 of the 2009 IBC. Note that unless otherwise modified by Chapter 30 of the IBC, elevators, escalators and conveyance systems must comply with ASME (American Society of Mechanical Engineers) A17.1-2007/CSA B44-07, ASME A90.1, ASME B20.1, ALI (Automotive Lift Institute) ALCTV (Automotive Lifts—Safety Requirements for Construction, Testing and Validation), and ASCE (American Society of Civil Engineers) 24.

6.4 SAFETY OF USERS

6.4.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with the safety of occupants in buildings during normal building use and under normal operating conditions. Safety of user issues associated with fire and natural hazard events are largely addressed in other chapters (e.g., fire protection, Chapter 4; means of egress, Chapter 6; structural, Chapter 8), and safety during construction and demolition is addressed in Chapter 9.

Hazardous Materials

It is not uncommon to have some quantity of hazardous materials in buildings; these might be materials which pose a physical hazard, such as explosive, combustible, flammable materials, or which pose a health hazard, such as toxic or corrosive materials. Chemicals used for cleaning are a common example of a potential physical and health hazard that can be expected in office buildings. Fuel for heating systems is another common example. While it is accepted that some amounts of hazardous materials may need to be present, the aim of building and fire regulation and building design constraints is to limit the amounts of hazardous material, and to provide associated protection for the hazardous materials, to levels appropriate for the use of the building. For office occupancies, this generally means limiting quantities of hazardous materials to levels which represent a tolerable hazard given the protection measures employed. If larger quantities are needed, this may result in the classification of the building as a hazardous use. Fire prevention codes in many countries provide detailed guidance on types, classification, and amounts of hazardous material permitted within buildings based on use or occupancy classification. Guidance is also provided for the proper storage of, and protection of, allowable quantities of hazardous materials.

Hazards from Building Systems, Materials and Components

Buildings provide shelter and safe haven from adverse weather conditions, natural hazard events and other types of hazards. They are outfitted with systems that facilitate the expected use of the building, be it living, working, entertainment or other. However, in some cases, building systems and components can present unintended hazards to building occupants. Care should be taken to use, install, inspect and maintain building systems, materials and components to prevent or minimize unintended hazards to occupants during their expected installed lifetime.

Glazing (e.g., glass) allows for a visible connection between two spaces, be it within a building or from a building interior to the exterior. Glazing at a barrier to the outdoors which allows light and in some cases fresh air into a building, can present a hazard if broken by high winds, windborne debris or other forces. Interior glazing, such as within a door or interior partition, can present a hazard if broken due to impact (e.g., by a person directly, or by an item which impacts the glazing in proximity to a person). Care should be taken to consider the appropriate strength of glazing to withstand the impacts expected within the building based on seismic and wind conditions (see Chapter 8) as well as local safety requirements.

Building materials and interior finishes, such as wall and floor linings, may contain materials that will volatilize, emit or otherwise be released under certain conditions (e.g., temperatures, moisture levels) or with time (material degradation). Such emissions can result in adverse health effects, if the constituents being emitted have been identified as toxics, irritants, carcinogens or other. Many materials will have material safety data sheets (MSDS) indicating the presence of hazardous materials. Testing requirements in some countries include provisions for hazardous emissions as well as other attributes, such as combustibility.

SAFETY OF USERS

Electrical installations that provide for lighting and power may present burn, shock or electrocution hazards if not properly installed, grounded and maintained. While electrical installations are typically addressed by codes and standards outside of the building code, it is important to require that electrical systems be designed, installed and maintained to provide the necessary power for the building in a manner which does not pose unacceptable electrical shock or burn risks to occupants, or unacceptable risk of ignition resulting from overheating, short circuits, sparking or other such electrical hazards. The requirements for electrical installation will vary greatly, in large part due to the range of voltages and currents in use around the world, as well as in associated safety features, such as circuit breakers and associated activation loads. In general, circuits should be designed to accommodate expected electrical loads. Care should be taken to provide a sufficient number of isolated circuits to separately power key building systems and components of concern, such as lighting (normal and emergency), elevators, alarm systems, data equipment, etc. to help minimize the potential for overload-related hazards from occurring. Grounding of circuits, outlets and other electrical system components should be according to the installation standards within the country where the building is constructed. Consideration should be given to the reliability of the power supply to which the building is connected (e.g., municipal system) with respect to such issues as consistency in voltage and current delivered and minimization of power surges, which could result in a electrical hazard within the building. Unless otherwise permitted by local regulation, exposed electrical busses and other circuit paths should be avoided.

Slips, Trips and Falls

While some building systems and features can present unintended hazards, such as outlined above, other building features inherently pose some level of risk. Features to facilitate change in elevation, such as steps and stairs, are typically found in any building of more than a single level at grade. However, by their nature, a change in elevation can contribute to a person tripping, especially if they are not paying attention. As such, features such as signage, lighting, tread design, rise (height) and run (depth) dimensioning, and handrails can be helpful. (Note: for exit stairways, guidance for these issues is provided in Section 10.0.1; however, not all steps and stairs are part of a means of egress, but the features discussed in Section 10.0.1 may be considered for non-exit stairways to help address occupant safety under normal building operating conditions.) Likewise, if changes in elevation are present for elevated walkways, as part of floor openings to atria, and so forth, providing barriers to reduce the likelihood of occupants falling from an upper to lower level is prudent. Such barriers should also be sized to prevent passage of occupants through the barrier. Attention should also be given to surfaces of floors, ramps and stairs to minimize the potential for slipping (e.g., if wet) or tripping (e.g., due to uneven or inconsistent surface).

Summary

Key considerations for safety of building users under normal building operating conditions are outlined below. More detailed discussion on associated design requirements can be found in Section 6.4.2, Performance/Prescriptive Criteria and Means of Verification. Note that additional detail can be found in other chapters, with safety of user issues associated with fire and natural hazard events being largely addressed in other chapters (e.g., fire protection, Chapter 4; means of egress, Chapter 6; structural, Chapter 8), and safety during construction and demolition being addressed in Chapter 9.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Hazardous materials	Potential for stored materials (contents) to present fire, explosion, toxic, corrosive, or related hazards that could present acute or chronic health or safety impacts to building occupants.	Building use classification, special storage arrangements for materials, limitation on quantity of materials permitted in building, limitation on type of material allowed in building, ventilation requirements, posting of warnings.
Hazards from building systems	Potential for building materials (construction products, interior finishes, glazing, etc.) or systems (e.g., electrical) to present fire, explosion, toxic, corrosive, impact, puncture, electrocution, or related hazards that could present acute or chronic health or safety impacts to building occupants.	Selection of construction and interior finish materials, posting of warnings and signage, inspection, test and maintenance of building systems. Posting of warnings and/or marking materials or systems appropriately.
Slips, trips and falls	Potential for slips or trips on horizontal and inclined surfaces, and potential for falls due to change in elevation.	Surface properties of horizontal, inclined and stepped walking surfaces, use of guardrails and handrails, posting of warnings.

6.4.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with safety of building users under normal building operating conditions. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 6.4.2. A list of alternate means of verification is provided in Section 6.4.3.

- 6.4.1.1 Buildings shall be provided with adequate safeguards to minimize the risk of unwanted releases, fires or explosions involving hazardous materials used or stored within the building.
- 6.4.1.2 Buildings shall be provided with adequate safeguards to minimize the consequences of an unsafe condition involving hazardous materials during normal operations and in the event of an abnormal condition.
- 6.4.1.3 Building materials that may present a hazard to building occupants shall be used in ways to avoid undue risk to people.
 - 6.4.1.3.1 The quantities of gas, liquid, radiation or solid particles emitted by materials used in the construction of buildings and as interior lining materials shall not give risk to harmful concentration at the surface of the material where the material is exposed or in the atmosphere of any space within the building.
 - 6.4.1.3.2 Glass or other brittle materials with which people are likely to come in contact shall comply with one or more of the following [2009 ICC *Performance Code® for Buildings and Facilities* (ICCPC)]:
 - 6.4.1.3.2.1 If broken upon impact, break in a way that is unlikely to cause serious injury.
 - 6.4.1.3.2.2 Resist a reasonably foreseeable impact without breaking.
 - 6.4.1.3.2.3 Be reasonably protected from impact.
- 6.4.1.4 Buildings and their facilities shall be constructed to reduce the likelihood of slips, trips and falls associated with walking surfaces.
 - 6.4.1.4.1 Walking surfaces shall have safe gradients.
 - 6.4.1.4.2 Horizontal and inclined pedestrian circulation routes and stair treads shall have slip-resistant walking surfaces.
 - 6.4.1.4.3 Where necessary, suitable handrails shall be provided to ensure stability to persons using stairways and ramps.
- 6.4.1.5 Buildings and their facilities shall be constructed to reduce the likelihood of falls from floors at different elevations.
 - 6.4.1.5.1 A barrier shall be provided where people could fall 76 cm or more from an opening in the external envelope or floor of a building or its facilities.
 - 6.4.1.5.2 Roofs with permanent access shall have barriers provided.

- 6.4.1.5.3 Barriers shall be constructed and installed appropriate to the hazard.
- 6.4.1.5.4 When barriers have openings, the openings shall be of an appropriate size and configuration to keep people from falling through, based upon the anticipated age of the occupants.
- 6.4.1.6 Signs shall be installed to provide occupants with information about hazards and routes to safety in case of hazard conditions within the building.
 - 6.4.1.6.1 Signs shall be clearly visible and readily recognizable under the conditions expected for their purpose (2009 ICCPC).
 - 6.4.1.6.2 Signs shall identify exits and safe places and be located sufficiently to mark escape/rescue routes and guide people to exits and safe places (2009 ICCPC).
 - 6.4.1.6.3 Signs that identify exits, safe places and escape/rescue routes shall remain visible in the event of a power failure (2009 ICCPC).
 - 6.4.1.6.4 Signs indicating hazards shall be provided in sufficient locations to notify people before they encounter the hazard (2009 ICCPC).
 - 6.4.1.6.5 Signs shall identify accessible facilities and be located sufficiently to mark an accessible route (2009 ICCPC).

6.4.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

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- For sloped surfaces and ramps see Section 6.1.2 of these guidelines.
- For stair safety and handrails see Section 6.1.2 of these guidelines.
- For protection from fall at floors of **different** elevation see Section 6.1.2 of these guidelines.
- For occupant safe evacuation and exit signs see Section 6.1.2 of these guidelines.

SECTION 6.4.2.1 (IBC 2406) SAFETY GLAZING

6.4.2.1.1 (IBC 2406.1) Human impact loads. Individual glazed areas, including glass mirrors, in hazardous locations as defined in Section 6.4.2.1.4 (IBC Section 2406.4) shall comply with Sections 6.4.2.1.1 through 6.4.2.1.1.4 (IBC Sections 2406.1.1 through 2406.1.4).

6.4.2.1.1.1 (IBC 2406.1.1) Impact test. Except as provided in Sections 6.4.2.1.1.2 through 6.4.2.1.1.4 (IBC Sections 2406.1.2 through 2406.1.4), all glazing shall pass the impact test requirements of Section 6.4.2.1.2 (IBC Section 2406.2).

6.4.2.1.1.2 (IBC 2406.1.2) Plastic glazing. Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

6.4.2.1.1.3 (IBC 2406.1.3) Glass block. Glass-block walls shall comply with IBC Section 2101.2.5.

6.4.2.1.1.4 (IBC 2406.1.4) Louvered windows and jalousies. Louvered windows and jalousies shall comply with IBC Section 2403.5.

6.4.2.1.2 (IBC 2406.2) Impact test. Where required by other sections of these guidelines, glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category I or II as indicated in Table 6.4.2.1.2(1) [IBC Table 2406.2(1)].

Exception: Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A or B as indicated in Table 6.4.2.1.2.(2) [IBC Table 2406.2(2)].

TABLE 6.4.2.1.2(1) [IBC TABLE 2406.2(1)]
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR 1201

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category class)	GLAZING IN DOORS (Category class)	GLAZED PANELS REGULATED BY ITEM 7 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) (Category class)	GLAZED PANELS REGULATED BY ITEM 6 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) (Category class)	DOORS AND ENCLOSURES REGULATED BY ITEM 5 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) (Category class)	SLIDING GLASS DOORS PATIO TYPE (Category class)
0.83 square meter or less	I	I	No requirement	I	II	II
More than 0.83 square meter	II	II	II	II	II	II

TABLE 6.4.2.1.2(2) [IBC TABLE 2406.2(2)]
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZED PANELS REGULATED BY ITEM 7 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) (Category class)	GLAZED PANELS REGULATED BY ITEM 6 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) (Category class)	DOORS AND ENCLOSURES REGULATED BY ITEM 5 OF SECTION 6.4.2.1.4 (IBC SECTION 2406.4) ^a (Category class)
0.83 square meter or less	No requirement	B	A
More than 0.83 square meter	A	A	A

a. Use is only permitted by the exception to Section 2406.

6.4.2.1.3 (IBC 2406.3) Identification of safety glazing. Except as indicated in Section 6.4.2.1.3.1 (IBC Section 2406.3.1), each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified in IBC Section 2403.1. The designation shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed. A label as defined in IBC Section 202.1 and meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

Exceptions:

1. For other than tempered glass, manufacturer's designations are not required, provided the *building official* approves the use of a certificate, affidavit or other evidence confirming compliance with these guidelines.
2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation

6.4.2.1.3.1 (IBC 2406.3.1) Multi-pane assemblies. Multi-pane glazed assemblies having individual panes not exceeding 930 cm² in exposed areas shall have at least one pane in the assembly marked as indicated in Section 6.4.2.1.3 (IBC Section 2406.3). Other panes in the assembly shall be marked "CPSC 16 CFR 1201" or "ANSI Z97.1," as appropriate.

6.4.2.1.4 (IBC 2406.4) Hazardous locations. The following shall be considered specific hazardous locations requiring safety glazing materials:

1. Glazing in swinging doors except jalousies [see Section 6.4.2.1.4.1 (IBC Section 2406.4.1)].
2. Glazing in fixed and sliding panels of sliding door assemblies and panels in sliding and bifold closet door assemblies.
3. Glazing in storm doors.
4. Glazing in unframed swinging doors.
5. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any portion of a building wall enclosing these compartments where the bottom exposed edge of the glazing is less than 1.50 m above a standing surface.
6. Reserved.
7. Glazing in an individual fixed or operable panel, other than in those locations described in preceding Items 5 and 6, which meets all of the following conditions:
 - 7.1. Exposed area of an individual pane greater than 0.83 m²;
 - 7.2. Exposed bottom edge less than 46 cm above the floor;
 - 7.3. Exposed top edge greater than 92 cm above the floor; and
 - 7.4. One or more walking surface(s) within 92 cm horizontally of the plane of the glazing.

Exception: Safety glazing for Item 7 is not required for the following installations:

1. A protective bar 4 cm or more in height, capable of withstanding a horizontal load of 730 N/m without contacting the glass, is installed on the accessible sides of the glazing 87 cm to 97 cm above the floor.
2. The outboard pane in insulating glass units or multiple glazing where the bottom exposed edge of the glass is 7.60 m or more above any grade, roof, walking surface or other horizontal or sloped (within 45 degrees of horizontal) surface adjacent to the glass exterior.
8. Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface.
9. Reserved.

SAFETY OF USERS

10. Glazing adjacent to *stairways*, landings and ramps within 92 cm horizontally of a walking surface; when the exposed surface of the glass is less than 1.50 m above the plane of the adjacent walking surface.
11. Glazing adjacent to *stairways* within 1.50 m horizontally of the bottom tread of a *stairway* in any direction when the exposed surface of the glass is less than 1.50 m above the nose of the tread.

Exception: Safety glazing for Item 10 or 11 is not required for the following installations where:

1. The side of a *stairway*, landing or ramp which has a *guard* or handrail, including balusters or in-fill panels, complying with the provisions of Section 6.1.2.6.1 (IBC Section 1013) and IBC Section 1607.7;
2. The plane of the glass is greater than 46 cm from the railing.

6.4.2.1.4.1 (IBC 2406.4.1) Exceptions. The following products, materials and uses shall not be considered specific hazardous locations:

1. Openings in doors through which a 8 cm sphere is unable to pass.
2. Decorative glass in Section 6.4.2.1.4 (IBC Section 2406.4), Item 1, 6 or 7.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
5. Glass-block panels complying with IBC Section 2101.2.5.
6. Louvered windows and jalousies complying with the requirements of IBC Section 2403.5.
7. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

SECTION 6.4.2.2 (IBC 2407) GLASS IN HANDRAILS AND GUARDS

6.4.2.2.1 (IBC 2407.1) Materials. Glass used as a handrail assembly or a *guard* section shall be constructed of either single fully tempered glass, laminated fully tempered glass or laminated heat strengthened glass. Glazing in railing in-fill panels shall be of an *approved* safety glazing material that conforms to the provisions of Section 6.4.2.1.1.1 (IBC Section 2406.1.1). For all glazing types, the minimum nominal thickness shall be 6.35 mm. Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR 1201 or Class A of ANSI Z97.1, listed in Chapter 35.

6.4.2.2.1.1 (IBC 2407.1.1 Loads). The panels and their support system shall be designed to withstand the loads specified in IBC Section 1607.7. A safety factor of four shall be used.

6.4.2.2.1.2 (IBC 2407.1.2) Support. Each handrail or *guard* section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster panel fail. Glass balusters shall not be installed without an attached handrail or *guard*.

Exception: A top rail shall not be required where the glass balusters are laminated glass with two or more glass plies of equal thickness and the same glass type when *approved* by the *building official*. The panels shall be designed to withstand the loads specified in IBC Section 1607.7.

SECTION 6.4.2.3 (IBC 2409) GLASS IN ELEVATOR HOISTWAYS AND ELEVATOR CARS

6.4.2.3.1 (IBC 2409.1) Glass in elevator hoistway enclosures. Glass in elevator hoistway enclosures and hoistway doors shall be laminated glass conforming to ANSI Z97.1 or CPSC 16 CFR Part 1201.

6.4.2.3.1.1 (IBC 2409.1.1) Fire-resistance-rated hoistways. Glass installed in hoistways and hoistway doors where the hoistway is required to have a fire-resistance rating shall also comply with Section 5.2.2.12 (IBC Section 715).

6.4.2.3.1.2 (IBC 2409.1.2) Glass hoistway doors. The glass in glass hoistway doors shall be not less than 60% of the total visible door panel surface area as seen from the landing side.

6.4.2.3.2 (IBC 2409.2) Glass vision panels. Glass in vision panels in elevator hoistway doors shall be permitted to be any transparent glazing material not less than 6.35 mm in thickness conforming to Class A in accordance

with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201. The area of any single vision panel shall not be less than 150 cm² and the total area of one or more vision panels in any hoistway door shall be not more than 550 cm².

6.4.2.3.3 (IBC 2409.3) Glass in elevator cars.

6.4.2.3.3.1 (IBC 2409.3.1) Glass types. Glass in elevator car enclosures, glass elevator car doors and glass used for lining walls and ceilings of elevator cars shall be laminated glass conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

Exception: Tempered glass shall be permitted to be used for lining walls and ceilings of elevator cars provided:

1. The glass is bonded to a nonpolymeric coating, sheeting or film backing having a physical integrity to hold the fragments when the glass breaks.
2. The glass is not subjected to further treatment such as sandblasting; etching; heat treatment or painting that could alter the original properties of the glass.
3. The glass is tested to the acceptance criteria for laminated glass as specified for Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

6.4.2.3.3.2 (IBC 2409.3.2) Surface area. The glass in glass elevator car doors shall be not less than 60% of the total visible door panel surface area as seen from the car side of the doors.

6.4.3 ALTERNATE MEANS OF VERIFICATION

- 6.4.3.1 Limitations on the type and quantity of hazardous materials in business occupancies, as defined by the 2009 *International Fire Code*® (IFC®), including all references to provisions in other chapters in the 2009 IFC and to all standards incorporated by reference, are deemed-to-comply with the hazardous materials provisions of this chapter. As such, compliance with the requirements for hazardous materials can be demonstrated by compliance with the 2009 IFC.
- 6.4.3.2 Requirements related to safety to users from building materials, as defined in Chapters 8 and 19 through 27 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters in the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the hazardous materials provisions of this chapter. As such, compliance with the requirements for hazards from building materials can be demonstrated by compliance with relevant sections of Chapters 8 and 19 through 27 of the 2009 IBC.
- 6.4.3.3 Requirements associated with prevention of slips, trips and falls, as defined within Chapters 10 and 11 of the 2009 IBC, including all reference standards, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for minimizing slip, trip and fall hazards can be demonstrated by compliance with appropriate sections of Chapters 10 and 11 of the 2009 IBC.

CHAPTER 7 BUILDING SYSTEMS, INTERIOR ENVIRONMENT AND BUILDING ENVELOPE

7.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues primarily associated with the performance of the interior environment within a building from the perspectives of health, safety and amenity. Specifically, this chapter provides guidance on building electrical, mechanical, and plumbing systems, interior air quality and comfort issues, building energy performance and the external building envelope, particularly with respect to preventing moisture permeation and the negative impacts of such.

Using the 2009 *International Building Code*® (IBC®) as the primary reference document, these concepts are addressed in the following sections, which generally parallel the IBC:

- 7.1 Interior Environment and Energy Performance
- 7.2 Electrical, Mechanical and Plumbing Systems
- 7.3 Exterior Envelope

Section 7.1 focuses on issues associated with the interior environment and building energy performance, including interior climate, indoor air quality, airborne and impact sound, artificial and natural lighting, and energy efficiency.

Section 7.2 is primarily focused on the performance of building systems, specifically electrical, mechanical, plumbing and fuel gas systems.

Section 7.3 discusses the performance of the exterior envelope, with an emphasis on protection against moisture penetration.

7.1 INTERIOR ENVIRONMENT AND ENERGY PERFORMANCE

7.1.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with the interior environment and building energy performance. While largely a function of the building systems (Section 7.2) and the building envelope (Section 7.3), it is important to have a clear set of performance objectives for the comfort, health and safety of the building occupants, and to understand how these aspects might impact upon organizational and legislated energy performance objectives.

Activity and Habitable Space

Adequate space, which is properly designed to support the intended activities, is essential to effectively and efficiently facilitate the intended activities in a building. In office buildings, activity spaces primarily relate to office areas (open plan or enclosed offices), meeting rooms, and storage spaces. In some cases, additional uses, such as cafeteria space, ambulatory care space, or other activity space may be present. Spaces for sanitary facilities will be present as well. Since some activity spaces are not normally occupied (e.g., storage closet), a differentiation is made in terms of habitable activity spaces, or habitable spaces, which are those spaces within a building where occupants can be expected to spend a significant amount of time in conducting their activities. Habitable spaces generally have higher performance targets for important health, safety and comfort issues, such as air temperature, indoor air quality and lighting.

Interior Climate

To facilitate effective, efficient and healthy operational environment, habitable activity spaces should neither be too hot nor too cold. In some locations, this may require the use of heating and/or cooling equipment and perhaps ventilation equipment, to be installed and used in the building (see Section 7.2). In other locations, the annual variation in temperature and climatic conditions may be such that no such systems are required, and temperatures can be maintained via window openings or other passive measures. Where heating and/or cooling systems are required, care should be taken to manage temperature gains and losses via the exterior envelope to help manage operational costs and energy efficiency. Care should also be taken to properly ventilate any combustion gases associated with the systems (see Section 7.2).

Indoor Air Quality

In addition to managing interior air temperature, it is important to provide for an adequate quality of air supply: one which provides sufficient oxygen and removes unhealthy levels of carbon dioxide and other toxins, irritants, noxious odors and related substances that could result in unhealthy, unsafe or unpleasant environments. In some cases, this may require installation of ventilation systems (see Section 7.2), even if such systems are not required to help manage the interior temperatures. Ventilation systems may also be needed to maintain relative humidity at an acceptable level. This is important to help control the growth and spread of molds and mildew, which can result in negative health effects, as well as in damage to building components (e.g. rotting of wood components, corrosion of metal components, etc.).

INTERIOR ENVIRONMENT AND ENERGY PERFORMANCE

Airborne and Impact Sound Transmission

An important aspect of a productive activity space is the management of sound transmission (noise) between spaces within a building, and from the outside of a building to the interior. The primary means of sound transmission are airborne, impact and vibration. Airborne sound can be managed by use of barriers, from window glass to walls. The acoustical properties of the material will influence the effectiveness of sound attenuation. Impact sounds typically result from an object striking a building component, such as shoes striking (impacting) the floor as someone walks or someone knocking on a door. As with airborne sound transmission, the acoustical properties of building and finish materials will influence the effectiveness of sound attenuation (e.g., carpeted floor versus wooden floor). Vibration sounds can be transmitted through building components much like impact sounds. An example might be a motor and fan assembly that is part of a ventilation system, connected to some building element (e.g., floor assembly), that vibrates when it operates and transmits the vibration via the floor assembly. Use of motion or vibration dampers on equipment may help mitigate some types of vibration transmission.

Artificial and Natural Lighting

Adequate and sufficient lighting must be provided via natural and/or artificial means to undertake required activities in the habitable spaces of an office building. For normal operations, the balance of natural and artificial lighting may be a function of minimum illumination requirements at working surfaces, targets for use of natural lighting as an energy conservation objective, or legislated requirements for visual access to the outside from various points within a building. In addition to a general requirement for sufficient illumination to move about safely within the building, illumination requirements for emergency situations are discussed in Chapter 6.

Energy Conservation and Efficiency – Sustainability and Green

In recent years, there has been a strong global movement towards reducing energy demands and usage in buildings to help conserve resources and to reduce greenhouse gas emissions. As one might expect, energy conservation and efficiency are complex issues that cut across many aspects of building design and operation. A wide range of legislation exists for inside and outside of traditional building regulations and control, in addition to the presence of market-based rating schemes, such as Leadership in Energy and Environmental Design (LEED), Energy Star, Building Research Establishment Environmental Assessment Method (BREEAM), Green Mark and myriad others.

Given the diversity that exists from country to country, for the purpose of these guidelines, performance objectives and requirements for energy conservation and efficiency are by necessity limited to broad concepts such as appropriately addressing thermal resistance, solar radiation effects, and air tightness of the building envelope, appropriately addressing power requirements for heating, cooling and ventilation systems, management of heat gain or loss from building services in an appropriate manner, and management of interior environment. Hot water heating requirements need also be addressed. Aspects such as site planning and layout, use of renewable or alternative energy supplies, and overall energy consumption targets (e.g., zero net energy), as well as specific performance criteria for thermal resistance, air tightness and other, can only be effectively managed through selection and application of a comprehensive system that addresses these issues in the context of the local building practices, materials, weather and climatic conditions.

Site selection, building location and orientation on the site, construction materials selection and resources, use of existing and used materials, landscaping plants, water and wastewater efficiency and other related issues must be considered to result in the least impact to the environment and comply with a certain minimum level of green construction as determined by the local authority or law. [Note: Section 7.1.2 of this chapter does not contain prescriptive provisions related to green construction as there were no green model codes published in conjunction

with the 2009 *International Building Code*® (IBC®). The 2012 *International Green Construction Code*™ (IgCC™) was published in April 2012 and is referenced in Section 7.1.3].

Summary

Key considerations for interior environment and energy performance are outlined below. More detailed discussion on associated design requirements can be found in Section 7.1.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Activity and habitable space	Sufficient space needs to be provided to undertake activities in a comfortable, efficient and effective manner. Sanitary facilities need to be provided.	Size of building and habitable spaces. Number and capacity of sanitary facilities.
Interior climate	A healthy and safe range of interior temperatures needs to be provided.	Heating and/or cooling and/or ventilation systems may be required. Operable windows or other means of ventilation may be required.
Indoor air quality	Air quality within habitable spaces needs to be safe, healthy and provide adequate level of comfort.	Mechanical ventilation systems, operable windows or other means of ventilation may be required. Use of certain building materials may not be allowed. Moisture needs to be controlled.
Airborne and impact sound transmission	The transmission of unacceptable levels of airborne, impact and vibration sound should be avoided.	Material specification for interior and exterior walls, ceiling and floor materials and finishes. Potential for vibration dampers on equipment.
Artificial and natural lighting	Adequate and sufficient lighting for normal and emergency use of the building needs to be provided via natural and/or artificial means.	Amount of window area versus floor area. Distance to window from farthest point in habitable space. Illumination requirements for artificial lighting. Normal and emergency power requirements.
Energy conservation and efficiency—sustainability and green	Thermal resistance, solar radiation effects, air tightness of the building envelope, power requirements for heating, cooling and ventilation systems, management of heat gain or loss from building services, management of interior environment.	Size of building and habitable spaces. Heating and/or cooling and/or ventilation systems. operable windows or other means of ventilation. Material specification for interior and exterior walls, ceiling and floor materials and finishes. Amount of window area versus floor area. Distance to window from farthest point in habitable space. Illumination requirements for artificial lighting. Normal and emergency power requirements. Hot water heating requirements. Aspects such as site planning and layout, use of renewable or alternative energy supplies, and overall energy consumption targets as per local requirements.

7.1.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with interior environment and energy performance. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail are necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 7.1.2. A list of alternate means of verification is provided in Section 7.1.3.

- 7.1.1.1 To protect occupants from injury or loss of amenity caused by inadequate activity space, buildings shall be designed and constructed to have adequate activity space for the intended use, including sanitary needs of the occupants (see Section 6.1 on occupant load).
- 7.1.1.2 To minimize the potential for illness caused by interior air temperature, buildings shall be designed and constructed to provide adequately controlled interior temperatures.
- 7.1.1.3 To maintain the habitable spaces of buildings with an environment that is conducive to the comfort, health and safety of the occupants, such spaces shall be provided with air that contains sufficient oxygen and limits the levels of moisture and contaminants to levels that are consistent with good health, safety and comfort.
 - 7.1.1.3.1 Habitable spaces shall be provided means of ventilation that maintains air quality at all times that the spaces are occupied and for the maximum number of occupants anticipated. Buildings shall have a means of collecting or otherwise removing the following products from the spaces in which they are generated.
 - 7.1.1.3.1.1 Cooking fumes and odors.
 - 7.1.1.3.1.2 Excessive water vapor from laundering, utensil washing, bathing and showering.
 - 7.1.1.3.1.3 Odors from sanitary and waste storage spaces.
 - 7.1.1.3.1.4 Gaseous byproducts and excessive moisture from commercial or industrial processes.
 - 7.1.1.3.1.5 Poisonous fumes and gases.
 - 7.1.1.3.1.6 Air-borne particles.
 - 7.1.1.3.1.7 Products of combustion.
 - 7.1.1.3.1.8 Off-gases from building materials, fixtures and contents.
 - 7.1.1.3.2 Contaminated air shall be disposed of in a way that avoids creating a nuisance or hazard to people and other property.
 - 7.1.1.3.3 Building materials that release quantities of contaminants that cannot be maintained at safe levels shall not be used.
- 7.1.1.4 Building elements that are common between tenants or occupancies shall be constructed to prevent excessive noise transmission from other tenants or occupancies or common spaces to habitable spaces (see Section 7.1.3 for a reference to ICC G2-2010 *Guideline for Acoustics*).
 - 7.1.1.4.1 The air-borne transmission of sound through tenant separation walls and floors shall be reduced to a level that minimizes its effect on adjacent occupants.

- 7.1.1.4.2 The structure-borne transmission of sound through floors shall be reduced to a level that minimizes its effect on adjacent occupants.
- 7.1.1.5 Habitable spaces and means of egress within buildings shall be provided with adequate natural and artificial lighting to enable effective use of the space for the intended use and to enable safe movement.
 - 7.1.1.5.1 Adequate illumination shall be provided appropriate to the use and occupancy of the habitable spaces and means of egress.
 - 7.1.1.5.2 Natural light shall provide a luminance appropriate to the use and occupancy of the habitable spaces served.
- 7.1.1.6 Buildings shall have provisions ensuring efficient use of nonrenewable energy.
 - 7.1.1.6.1 For buildings requiring a controlled temperature, the building design and construction shall take into account factors such as thermal resistance, solar radiation, air tightness and heat gain or loss from building services in an appropriate manner (see also Section 7.3).
 - 7.1.1.6.2 To provide for the efficient use of depletable energy sources, the building envelope shall be designed and constructed within energy performance indices appropriate to the location wherein the building will be constructed (see also Section 7.3). The indices should be appropriate to the method of verification required to demonstrate suitable performance.
- 7.1.1.7 To provide for a healthy environment and the least impact to environmental resources, the efficient design for use of best resources and consideration of water and wastewater efficiencies shall be within green and sustainable construction criteria appropriate to the location wherein the building will be constructed. [Note: Section 7.1.2 of this chapter does not contain prescriptive provisions related to green construction as there were no green model codes published in conjunction with the 2009 IBC. The 2012 IgCC was published in April 2012 and is referenced in Section 7.1.3].

7.1.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 7.1.2.1 (IBC 1203) VENTILATION

7.1.2.1.1 (IBC 1203.1) General. Buildings shall be provided with natural ventilation in accordance with Section 7.1.2.1.2 (IBC Section 1203.4), or mechanical ventilation in accordance with the *International Mechanical Code*.

7.1.2.1.2 (IBC 1203.4) Natural ventilation. Natural ventilation of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

7.1.2.1.2.1 (IBC 1203.4.1) Ventilation area required. The minimum openable area to the outdoors shall be 4% of the floor area being ventilated.

7.1.2.1.2.1.1 (IBC 1203.4.1.1) Adjoining spaces. Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the opening to the adjoining room shall be unobstructed and shall have an area of not less than 8% of the floor area of the interior room or space, but not less than 2.30 m². The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

Exception: Exterior openings required for ventilation shall be permitted to open into a *thermally isolated* sunroom addition or patio cover provided that the openable area between the sunroom addition or patio cover and the interior room shall have an area of not less than 8% of the floor area of the interior room or space, but not less than 1.85 m². The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

7.1.2.1.2.1.2 (IBC 1203.4.1.2) Openings below grade. Where openings below grade provide required natural ventilation, the outside horizontal clear space measured perpendicular to the opening shall be one and one-half times the depth of the opening. The depth of the opening shall be measured from the average adjoining ground level to the bottom of the opening.

7.1.2.1.2.2 (IBC 1203.4.2) Contaminants exhausted. Contaminant sources in naturally ventilated spaces shall be removed in accordance with the *International Mechanical Code* and the *International Fire Code*.

7.1.2.1.2.2.1 (IBC 1203.4.2.1) Bathrooms. Rooms containing bathtubs, showers, spas and similar bathing fixtures shall be mechanically ventilated in accordance with the *International Mechanical Code*.

7.1.2.1.2.3 (IBC 1203.4.3) Openings on yards or courts. Where natural ventilation is to be provided by openings onto *yards* or *courts*, such *yards* or *courts* shall comply with Section 7.1.2.4 (Section 1206).

SECTION 7.1.2.2 (IBC 1204) TEMPERATURE CONTROL

7.1.2.2.1 (IBC 1204.1) Equipment and systems. Interior spaces intended for human occupancy shall be provided with active or passive space-heating systems capable of maintaining a minimum indoor temperature of 20°C at a point 0.91 m above the floor on the design heating day.

Exception: Interior spaces where the primary purpose is not associated with human comfort.

SECTION 7.1.2.3 (IBC 1205) LIGHTING

7.1.2.3.1 (IBC 1205.1) General. Every space intended for human occupancy shall be provided with natural light by means of exterior glazed openings in accordance with Section 7.1.2.3.2 (IBC Section 1205.2) or shall be provided with artificial light in accordance with Section 7.1.2.3.3 (IBC Section 1205.3). Exterior glazed openings shall open directly onto a *public way* or *onto a yard or court* in accordance with Section 7.1.2.4 (IBC Section 1206).

7.1.2.3.2 (IBC 1205.2) Natural light. The minimum net glazed area shall not be less than 8% of the floor area of the room served.

7.1.2.3.2.1 (IBC 1205.2.1) Adjoining spaces. For the purpose of natural lighting, any room is permitted to be considered as a portion of an adjoining room where one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room or 2.30 m², whichever is greater.

Exception: Openings required for natural light shall be permitted to open into a *thermally isolated* sunroom addition or patio cover where the common wall provides a glazed area of not less than one-tenth of the floor area of the interior room or 1.85 m², whichever is greater.

7.1.2.3.2.2 (IBC 1205.2.2) Exterior openings. Exterior openings required by Section 7.1.2.3.2 (IBC Section 1205.2) for natural light shall open directly onto a *public way, yard or court*, as set forth in Section 7.1.2.4 (IBC Section 1206).

Exceptions:

1. Required exterior openings are permitted to open into a roofed porch where the porch:
 - 1.1. Abuts a public way, yard or court;
 - 1.2. Has a ceiling height of not less than 2.15 m; and
 - 1.3. Has a longer side at least 65% open and unobstructed.
2. Skylights are not required to open directly onto a *public way, yard or court*.

7.1.2.3.3 (IBC 1205.3) Artificial light. Artificial light shall be provided that is adequate to provide an average illumination of 110.0 lux over the area of the room at a height of 76 cm above the floor level.

SECTION 7.1.2.4 (IBC 1206) YARDS AND COURTS

7.1.2.4.1 (IBC 1206.1) General. This section shall apply to *yards* and *courts* adjacent to exterior openings that provide natural light or ventilation. Such *yards* and *courts* shall be on the same property as the building.

7.1.2.4.2 (IBC 1206.2) Yards. *Yards* shall not be less than 0.92 m in width for buildings two *stories* or less above *grade plane*. For buildings more than two *stories above grade plane*, the minimum width of the *yard* shall be increased at the rate of 0.30 m for each additional *story*. For buildings exceeding 14 *stories above grade plane*, the required width of the *yard* shall be computed on the basis of 14 *stories above grade plane*.

7.1.2.4.3 (IBC 1206.3) Courts. *Courts* shall not be less than 0.92 m in width. *Courts* having windows opening on opposite sides shall not be less than 1.85 m in width. *Courts* shall not be less than 3.05 m in length unless bounded on one end by a *public way* or *yard*. For buildings more than two *stories above grade plane*, the *court* shall be increased 0.30 m in width and 0.61 m in length for each additional *story*. For buildings exceeding 14 *stories above grade plane*, the required dimensions shall be computed on the basis of 14 *stories above grade plane*.

7.1.2.4.3.1 (IBC 1206.3.1) Court access. Access shall be provided to the bottom of *courts* for cleaning purposes.

7.1.2.4.3.2 (IBC 1206.3.2) Air intake. *Courts* more than two *stories* in height shall be provided with a horizontal air intake at the bottom not less than 0.93 m² in area and leading to the exterior of the building unless abutting a *yard* or *public way*.

7.1.2.4.3.3 (IBC 1206.3.3) Court drainage. The bottom of every *court* shall be properly graded and drained to a public sewer or other approved disposal system complying with the *International Plumbing Code*.

SECTION 7.1.2.5 (IBC 1207) SOUND TRANSMISSION

7.1.2.5.1 (IBC 1207.2.1) Masonry. The sound transmission class of concrete masonry and clay masonry assemblies shall be calculated in accordance with TMS 0302 or determined through testing in accordance with ASTM E 90.

INTERIOR ENVIRONMENT AND ENERGY PERFORMANCE

7.1.2.5.2 (IBC 1207.3) Structure-borne sound. Floor/ceiling assemblies between a *dwelling unit* and a public or service area within the structure shall have an impact insulation class (IIC) rating of not less than 50 (45 if field tested) when tested in accordance with ASTM E 492.

SECTION 7.1.2.6 (IBC 1208) INTERIOR SPACE DIMENSIONS

7.1.2.6.1 (IBC 1208.1) Minimum room widths. *Habitable spaces*, other than a kitchen, shall not be less than 2.15 m in any plan dimension. Kitchens shall have a clear passageway of not less than 0.92 m between counter fronts and appliances or counter fronts and walls.

7.1.2.6.2 (IBC 1208.2) Minimum ceiling heights. Occupiable spaces, *habitable spaces* and *corridors* shall have a ceiling height of not less than 2.30 m. Bathrooms, toilet rooms, kitchens, storage rooms and laundry rooms shall be permitted to have a ceiling height of not less than 2.15 m.

Exceptions:

1. Reserved.
2. If any room in a building has a sloped ceiling, the prescribed ceiling height for the room is required in one-half the area thereof. Any portion of the room measuring less than 1.50 m from the finished floor to the ceiling shall not be included in any computation of the minimum area thereof.
3. *Mezzanines* constructed in accordance with Section 4.1.2.6 (IBC Section 505.1).

7.1.2.6.2.1 (IBC 1208.2.1) Furred ceiling. Any room with a furred ceiling shall be required to have the minimum ceiling height in two-thirds of the area thereof, but in no case shall the height of the furred ceiling be less than 2.15 m.

SECTION 7.1.2.7 (IBC 1210) SURROUNDING MATERIALS

7.1.2.7.1 (IBC 1210.3) Showers. Shower compartments and walls above bathtubs with installed shower heads shall be finished with a smooth, nonabsorbent surface to a height not less than 1.80 m above the drain inlet.

7.1.2.7.2 (IBC 1210.4) Waterproof joints. Built-in tubs with showers shall have waterproof joints between the tub and adjacent wall.

SECTION 7.1.2.8 (IBC 1301) GENERAL (ENERGY EFFICIENCY)

7.1.2.8.1 (IBC 1301.1.1) Criteria. Buildings shall be designed and constructed in accordance with the 2009 *International Energy Conservation Code*® (IECC®)

7.1.3 ALTERNATE MEANS OF VERIFICATION

- 7.1.3.1 Requirements related to interior environment, as addressed in Chapter 12 of the 2009 IBC, including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the interior environment provisions of this chapter. As such, compliance with the requirements for interior environment can be demonstrated by compliance with relevant sections of Chapter 12 of the 2009 IBC. In addition to sound transmissions requirements of Section 1207 of the 2009 IBC, compliance with ICC G2-2010, *Guideline for Acoustics*, is also deemed-to-comply with the sound transmission provisions of this chapter.
- 7.1.3.2 Requirements related to energy efficiency as addressed in Chapter 13 of the 2009 IBC, including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the energy efficiency provisions of this chapter. As such, compliance with the requirements for energy efficiency can be demonstrated by compliance with relevant sections of Chapter 13 of the 2009 IBC.
- 7.1.3.3 Requirements related to green and sustainability, as addressed in the 2012 IgCC, at various compliance levels as established by the governing jurisdiction, are deemed-to-comply with the green and sustainability provisions of this chapter. Care should be exercised in evaluating various products whose manufacturers claim a certain level of green or sustainability characteristics. Credible methodology and credible testing and evaluating entities must be used to verify all such claims. Compliance with Evaluation Reports as published by the ICC Evaluation Service (ICC-ES) under the Sustainable Attributes Verification and Evaluation (SAVE) program is an acceptable and deemed-to-comply procedure for this requirement.
- 7.1.3.4 Where demonstrated to the UN to an acceptable degree, the application of provisions associated with the Energy Performance of Buildings Regulations (EPBR), in their totality, may be considered as an alternate means of compliance with the functional and performance objectives identified in this chapter. However, it should be noted that use of requirements of the EPBR does not guarantee that specific levels of performance, as identified by criteria in Section 7.1.2, will be met (due to differences in establishment of energy performance relationships, analytical methods, and material specifications, there can be no claim that the EPBR and the IBC Chapter 13 and associated reference standards are equivalent on all levels of performance as provided in the IBC).
- 7.1.3.5 Requirements for acoustics, as outlined in this chapter, may be considered satisfied when designed and constructed in accordance with ICC G2-2010 *Guideline for Acoustics*.

7.2 ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

7.2.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with electrical, mechanical, plumbing and fuel gas system performance. It should be noted that the specifics of these systems will be highly dependent upon local factors, ranging from weather and climatic conditions, to characteristics of the local power grid (e.g., voltage, current, surge protection, etc.), to the availability for connection to potable, non-potable and waste water connections and treatment. As such, while functional and performance objectives may apply, extreme caution is urged if applying specific performance criteria that has not been validated for, or is inappropriate for, the country in which the building will be constructed [e.g., one cannot apply electrical standards which are based on a 110-120 VAC, 60 Hz power supply (grid) in a country that utilizes a 220-250 VAC, 50 Hz power supply].

Electrical Systems

Building electrical systems provide for the safe and efficient distribution of power within a building. They are typically characterized by sets of components which provide connection and transformation from the local power distribution network (grid) to the building (e.g., step-down transformers, power meters, etc.), protection from fluctuations in the grid (e.g., circuit breakers, surge protection, etc.), distribution within the building (e.g., power busses, distribution panels, branch circuits, etc.), points of connection (e.g., power outlets, direct connection to building electrical equipment, etc.), and built-in lighting (interior and exterior).

Building electrical systems should be sized, designed, installed and maintained to satisfy the required electrical power loads for lighting, electrical equipment and occupant use. Wiring and cable should be installed in conduit, where required, and should have proper insulation, appropriately rated and labeled for the application. All building electrical system components should be tested, approved and labeled by a recognized safety testing laboratory [e.g., Underwriters Laboratories (UL)].

There are different power grid characteristics in use in different countries. It is extremely important to identify critical components, such as voltage, current and frequency characteristics of the power supply, before selecting appropriate design and installation standards, as one cannot “mix and match” between dissimilar systems [e.g., one cannot apply electrical standards which are based on a 110-120 VAC, 60 Hz power supply (grid) in a country that utilizes a 220-250 VAC, 50 Hz power supply]. Specification of any electrical equipment in the building needs to comply with local power requirements. Loads should be determined following applicable local standards and regulations.

Electrical installations installed outside of the building (e.g., parking areas, walkways, etc.), in spaces that could become wet [e.g., lavatories (toilet rooms, bathrooms, restrooms), kitchens, medical examination rooms, etc.], in spaces that could have explosive environments, and in other such hazardous areas should have appropriate protection against those hazards being tested, approved and labeled for said applications.

Steps should be taken to result in a robust power system as appropriate to the operation of the building, or of UN space within the building, for normal and emergency situations. This may be achieved through various means, including dual power feeds from separate sources (or points on the grid, such that loss of a single transmission or distribution line will not result in loss of power to both feeds to the building) or on-site emergency power (e.g., back-up diesel generator, batteries, etc.). The power supply reliability should be appropriate to the mission of UN operations in the building.

Mechanical Systems

The term “building mechanical systems” generally refers to “permanently” installed equipment¹ used to heat, cool, ventilate, and otherwise condition the air for the health, safety and comfort of the occupants. Such systems are also commonly referred to as heating, ventilation and air-conditioning (HVAC) systems. These systems may include: chillers or other refrigeration units for central cooling; boilers, furnaces or other apparatus for central heating;² fan units, ductwork, filters, dampers and associated equipment for warm and cool air distribution and ventilation;³ permanent fan coil units or other such apparatus for compartment heating and cooling (connected to hot and cold water pipes); and controls for such systems. Mechanical systems for conveyance of people [i.e., elevators (lifts) and escalators] are addressed in Chapter 6. Plumbing systems are addressed below.

As reflected in the above discussion, there are many different configurations that may be used for heating and cooling a building.⁴ For heating, there may be a source of steam or hot water outside of the building, with steam or hot water piped into and distributed throughout the building. There may also be a boiler inside of the building, creating steam or hot water for distribution via pipes, or a furnace generating hot air for distribution via ducts. In forced hot water or steam systems, the hot water or steam pipes may be connected to radiators located within building spaces or run through pipe networks underneath floors, with temperature regulated by controlling the flow through the pipes. Electric resistance heaters are also sometimes used in smaller buildings.

Cooling systems generally involve either the centralized or localized conditioning of air via application of the refrigeration cycle. The refrigeration cycle essentially involves removal of heat by passing warm air over cooled (refrigerated) coils and replacing (exchanging) the warm air in a space by the chilled air. Such cooling/air-conditioning systems may involve large central cooling plants/towers/chillers, localized air-handling units (which may heat, cool and dehumidify), or localized fan coil units (for heating and cooling). Chemical refrigerants are often used; however, heat pumps and other mechanisms can be used as well.

Combined forced hot air and cooling systems, which use air handling units (AHUs) to heat and cool the air, supply the hot and cold air to spaces in the building through a system of ducts. An AHU may service a floor, a portion of a floor, or a group of floors, with air supplied by a network of ducts and controlled by dampers. Return air for the system can either be ducted or returned via open plenum space above suspended ceilings or below raised floors.

Various types of controls and control systems exist for managing the flow of hot or cold water or air as appropriate to the type of heating and cooling system and the needs of the building. Large buildings often have a centralized and automated building management system (BMS) which controls heating and cooling. The building is often zoned into different heating and cooling areas based on factors such as floor area, glazing area, building orientation, and other factors that impact thermal loading of the building.

As discussed in Section 7.1, building mechanical systems can play a significant role in helping a building to achieve target performance criteria for comfort and indoor air quality. They can also play a significant role in mitigating the spread of smoke during a fire (see Chapter 5). As these systems require electrical power, they also can have a significant impact on building energy performance (Section 7.1). When selecting building mechanical systems, one should therefore balance the health, safety, comfort and energy performance objectives for the building.

¹ This does not include portable items, such as space heaters, window air-conditioning units, and the like.

² See also commentary on fuel gas systems.

³ See also Chapter 5 for fire protection requirements for ducts and dampers, as well as provisions for smoke control.

⁴ For the purpose of these guidelines, only basic concepts are presented. Details on specific design configurations should be sought in applicable design, installation and operating standards and guidelines.

All building mechanical system components should be tested, approved and labeled by a recognized safety testing laboratory [e.g., Underwriters Laboratories (UL)].

Plumbing Systems

As used in these guidelines, plumbing systems refer to piping, valves, fixtures, and other such components used to:

- a. supply potable and non-potable, hot and cold water to required spaces in the building to facilitate personal hygiene, medical support areas, laundering facilities, food preparation areas, or other such areas that require hot and cold water for occupant use, and
- b. remove and dispose of wastewater from the building.

Understanding that implementation may vary by country, guidance is provided relative to the needs of having appropriate plumbing systems and facilities, and what is expected from these installations, and not on minimum numbers of specific items, such as toilets, washbasins and the like.

Where appropriate, plumbing system components, especially those that may present some type of safety hazard (e.g., hot water distribution) should be tested, approved and labeled by a recognized testing laboratory [e.g., Underwriters Laboratories (UL)].

Fuel Gas Systems

For some types of heating systems or cooking equipments in buildings, a fuel gas such as natural gas or propane may be used. To ensure that fuel gas is distributed and utilized in a safe manner, guidance is provided relative to safe installation, control of leaks and ventilation of spaces where gas accumulation may result.

Given the safety concerns associated with improperly designed and tested fuel gas system components, all fuel gas system components should be tested, approved and labeled by a recognized safety testing laboratory [e.g., Underwriters Laboratories (UL)].

ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

Summary

Key considerations for electrical, mechanical, plumbing and fuel gas systems are outlined below. More detailed discussion on associated design requirements can be found in Section 7.2.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Electrical systems	Safety and performance of electrical power for building systems, lighting and occupant power needs.	Unsafe sizing and installation of building electrical systems could result in safety hazards to occupants (e.g., electrical shock) or ignition hazards (e.g., short circuits, overheating cable, overheating equipment connected to building electrical system, etc.). Inappropriate sizing of design loads may result in insufficient space for transformers, safety devices, etc.
Mechanical systems	Safety and performance of centralized (not self-contained, single room units) heating, ventilation and air-conditioning (cooling) of the building.	Inadequately designed heating, ventilation and air-conditioning systems could result in health, safety and comfort issues for occupants (e.g., temperature related, development of mold, mildew, bacteria, etc.), and could have an impact on building component performance (e.g., rot, corrosion, etc., associated with build-up of moisture).
Plumbing systems	Safety and performance of piping, fixtures and other components for potable and non-potable water supply for building systems and occupant use, and for draining and removal of wastewater.	Inadequately designed plumbing systems could result in health, safety and comfort issues for occupants (e.g., lack of hot water, too hot water, improper waste water removal, development of mold, mildew, bacteria, etc., inadequate number and capacity of sanitary facilities and fixtures), and could have an impact on building component performance (e.g., rot, corrosion, etc., associated with build-up of moisture).
Fuel gas systems	Safety and performance of piping, fixtures and other components for fuel gas distribution and use in buildings.	Inadequately designed fuel gas piping systems could result in safety concerns associated with potential leakage of gases and build-up of flammable or explosive environments.

7.2.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with electrical, mechanical, plumbing and fuel gas system performance. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 7.2.2. A list of alternate means of verification is provided in Section 7.2.3.

- 7.2.1.1 Electrical installations shall be designed, installed, protected and maintained to safely distribute required electrical power within the building, and shall have safeguards against personal injury and the outbreak of fire.
 - 7.2.1.1.1 People and building elements shall be protected against contact with live parts.
 - 7.2.1.1.2 The electrical installation shall allow safe isolation of devices, equipment and appliances.
 - 7.2.1.1.3 People shall be protected from the effects of current exceeding the rating of the installation.
 - 7.2.1.1.4 The installation shall protect all components and equipment from electromechanical stress caused by current exceeding the rating of the installation.
 - 7.2.1.1.5 Building elements shall be protected from thermal damage due to heat transfer or electric installations.
 - 7.2.1.1.6 The installation shall operate safely in the intended environment.
 - 7.2.1.1.7 The installation shall prevent ignition of the atmosphere containing flammable or explosive elements.
 - 7.2.1.1.8 Essential services and equipment shall have a power supply protected in a manner to ensure continued operation for an appropriate time after a power failure.
 - 7.2.1.1.9 The building electrical installation shall protect the safety features of the power supply.
- 7.2.1.2 Mechanical equipment for heating, ventilation and air-conditioning (HVAC) shall deliver air at the appropriate temperature and quality for health, safety and comfort of building occupants, and shall be installed to safeguard maintenance personnel and building occupants from injury related to their presence in the building.
 - 7.2.1.2.1 People and building elements shall be protected from contact with hot and live electrical parts.
 - 7.2.1.2.2 The HVAC system shall allow safe isolation and access for service and replacement of equipment.
 - 7.2.1.2.3 The HVAC system shall include devices to monitor and control the temperature.
 - 7.2.1.2.4 HVAC equipment and appliances shall be secured in place.

ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

- 7.2.1.2.5 Refrigeration equipment shall allow safe isolation and access for service and replacement of equipment.
- 7.2.1.2.6 Refrigeration equipment shall include devices to monitor and control temperature.
- 7.2.1.2.7 Refrigeration equipment shall have appropriate safeguards when utilizing toxic or flammable refrigeration agents.
- 7.2.1.3 In buildings with potentially hazardous services containing hot, cold, flammable, corrosive or toxic liquids or gases, the installations shall be constructed to provide adequate safety for people.
 - 7.2.1.3.1 Piping systems shall be constructed to avoid the likelihood of:
 - 7.2.1.3.1.1 Significant leakage or damage during normal or reasonably foreseeable abnormal conditions.
 - 7.2.1.3.1.2 Detrimental contamination of the contents by other substances.
 - 7.2.1.3.1.3 Adverse interaction between piping and electrical systems.
 - 7.2.1.3.1.4 People having contact with pipes that could cause them harm.
 - 7.2.1.3.1.5 Pipes shall be protected against corrosion in the environment of their use.
 - 7.2.1.3.1.6 If the contents are not readily apparent from the location or associated equipment, piping systems shall be identified with identification markings.
 - 7.2.1.3.1.7 Enclosed spaces shall be constructed to avoid the likelihood of accumulating vented or leaking flammable gas.
 - 7.2.1.3.1.8 A piped system shall have devices that permit the complete system or components of the system to be isolated from the supply system for maintenance, testing, fault detection and repair.
- 7.2.1.4 Plumbing components installed to provide potable and non-potable water and to drain or remove wastewater, including piping, valves, fixtures and other components, shall be installed such that building occupants are reasonably protected from illness and injury associated with the plumbing systems, water supply and removal, and that designed, installed and maintained to provide reasonable access to such fixtures in a manner that is conducive to health, safety and comfort of the occupants.
 - 7.2.1.4.4 Plumbing fixtures shall be provided in sufficient numbers appropriate for the intended use.
 - 7.2.1.4.2 Plumbing fixtures shall be located to protect appropriate privacy.
 - 7.2.1.4.3 Plumbing fixtures shall be designed, installed and maintained to avoid food contamination and accumulation of unhealthy bacteria, and to permit effective cleaning.
 - 7.2.1.4.4 Plumbing fixtures shall be designed, installed and maintained to discharge to drainage systems without contaminating food.

ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

- 7.2.1.4.5 Facilities for personal hygiene shall be provided in convenient locations and spaces of appropriate size to permit the unobstructed access to and use of the fixtures.
- 7.2.1.4.6 Sanitary water shall be delivered to fixtures, appliances and equipment at temperatures appropriate for the intended use.
- 7.2.1.4.7 Water supplies intended for human consumption, oral hygiene, food preparation and the washing of cooking equipment shall be potable.
- 7.2.1.4.8 Water supplies and outlets providing non-potable water shall be clearly identified.
- 7.2.1.4.9 Plumbing fixtures and appliances used for personal hygiene, laundering and the washing of cooking equipment shall be provided with hot water.
 - 7.2.1.4.9.1 Where hot water is provided for personal hygiene, it shall be delivered at a temperature to avoid scalding.
- 7.2.1.4.10 Water supplies shall be installed to avoid potable water contamination.
- 7.2.1.4.11 Water supplies shall be provided to plumbing fixtures, appliances and equipment at a flow rate and pressure adequate for their operation.
- 7.2.1.4.12 Water piping shall be installed in a leak-free manner.
- 7.2.1.4.13 Water systems shall be installed to allow adequate access for maintenance.
- 7.2.1.4.14 Water piping shall be installed with provisions for adequate isolation of the system and branches and to provide protection from contamination.
- 7.2.1.4.15 Vessels used for producing hot water shall be provided with safety devices to relieve excessive pressure and limit temperatures.
- 7.2.1.4.16 The drainage system shall conduct wastewater to an appropriate disposal point, protect people from contamination and unpleasant odor and avoid blockages.
- 7.2.1.4.17 The drainage system shall conduct wastewater from all plumbing fixtures, appliances and equipment, avoiding the likelihood of blockage and leakage.
- 7.2.1.4.18 The drainage system shall be designed and installed to prevent sewer gases from entering the building.
- 7.2.1.4.19 The drainage system shall be accessible for maintenance and clearing of blockages.
- 7.2.1.4.20 The drainage system shall be connected to the sewer in a manner acceptable to the operator of the sewer system.
- 7.2.1.4.21 On-site sewage disposal systems shall be designed and installed in an approved manner.
- 7.2.1.5 To safeguard people against illness or injury that could result from the accumulation of internal moisture, and to protect an occupancy from damage caused by free water from another occupancy in the same building, buildings shall be constructed to avoid the likelihood of fungal growths or the accumula-

ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

tion of contaminants on linings and other building elements, free water overflow penetrating to an adjoining occupancy, and damage to building elements being caused by the use of water.

- 7.2.1.5.1 An adequate means shall be provided to remove excess moisture and condensation from all habitable spaces, bathrooms, laundries and other locations where moisture may be generated.
- 7.2.1.5.2 Accidental overflow from sanitary fixtures shall be constrained from penetrating occupancy in the same building.
- 7.2.1.5.3 Floor surfaces of any space containing sanitary fixtures shall be impervious to water and easily cleaned.
- 7.2.1.5.4 Wall surfaces adjacent to sanitary fixtures shall be impervious to water and easily cleaned.
- 7.2.1.5.5 Surfaces of building elements likely to be splashed or to become contaminated in the course of the intended use of the building shall be impervious to water and easily cleaned.
- 7.2.1.5.6 Water splash shall be prevented from penetrating behind linings or into concealed spaces.
- 7.2.1.6 In buildings where fuel gas is used as an energy source, the gas piping vented in unvented systems shall be safe and adequate for their intended use.
 - 7.2.1.6.1 Gas piping systems shall be free of leaks and operated at a safe pressure appropriate to the appliances served by the system.
 - 7.2.1.6.2 Gas piping systems shall have isolation devices that permit isolation of appliances, or isolation of the gas piping systems from the supply, for maintenance, testing, leak detection or repair.
 - 7.2.1.6.3 Vented gas appliances shall convey products of combustion directly to the exterior without affecting the operation of other gas vents.
 - 7.2.1.6.4 Vented gas appliances shall be provided with safety controls that prevent their operation in the event of failure of forced ventilation systems or natural draft systems.

7.2.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 7.2.2.1 (IBC 2701) ELECTRICAL

7.2.2.1.1 (IBC 2701.1) Scope. This chapter governs the electrical components, equipment and systems used in buildings and structures covered by these guidelines. Electrical components, equipment and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

SECTION 7.2.2.2 (IBC 2801) MECHANICAL SYSTEMS

7.2.2.2.1 (IBC 2801.1) Scope. Mechanical appliances, equipment and systems shall be constructed, installed and maintained in accordance with the *International Mechanical Code* and the *International Fuel Gas Code*.

SECTION 7.2.2.3 (IBC 2902) PLUMBING SYSTEMS

7.2.2.3.1 (IBC [P] 2902.1.1) Fixture calculations. To determine the *occupant load* of each sex, the total *occupant load* shall be divided in half. To determine the required number of fixtures, the fixture ratio or ratios for each fixture type shall be applied to the *occupant load* of each sex in accordance with Table 7.2.2.3.1 (IBC Table 2902.1). Fractional numbers resulting from applying the fixture ratios of Table 7.2.2.3.1 (IBC Table 2902.1) shall be rounded up to the next whole number. For calculations involving multiple occupancies, such fractional numbers for each occupancy shall first be summed and then rounded up to the next whole number.

Exception: The total *occupant load* shall not be required to be divided in half where *approved* statistical data indicate a distribution of the sexes of other than 50% of each sex.

**TABLE 7.2.2.3.1 (IBC [P] TABLE 2902.1)
MINIMUM NUMBER OF REQUIRED PLUMBING FIXTURES^a**

No.	CLASSIFICATION	OCCUPANCY	DESCRIPTION	WATER CLOSETS (URINALS SEE SECTION 419.2 OF THE INTERNATIONAL PLUMBING CODE)		LAVATORIES		BATHTUBS/ SHOWERS	DRINKING FOUNTAINS ^f (SEE SECTION 410.1 OF THE INTERNATIONAL PLUMBING CODE)	OTHER
				MALE	FEMALE	MALE	FEMALE			
1	Assembly	A-3	Auditoriums without permanent seating, art galleries, exhibition halls, museums, lecture halls, libraries, arcades and gymnasiums	1 per 125		1 per 65		1 per 200	—	1 per 500
2	Business	B	Buildings for the transaction of business, professional services, other services involving merchandise, office buildings, banks, light industrial and	1 per 25 for the first 50 and 1 per 50 for the remainder exceeding 50		1 per 40 for the first 80 and 1 per 80 for the remainder exceeding 80		—	1 per 100	1 service sink

a. The fixtures shown are based on one fixture being the minimum required for the number of persons indicated or any fraction of the number of persons indicated. The number of occupants shall be determined by these guidelines.

f. Drinking fountains are not required for an occupant load of 15 or fewer

7.2.2.3.2 (IBC [P] 2902.2) Separate facilities. Where plumbing fixtures are required, separate facilities shall be provided for each sex.

ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS

Exceptions:

1. Reserved.
2. Separate facilities shall not be required in structures or tenant spaces with a total occupant load, including both employees and customers, of 15 or less.
3. Reserved.

7.2.2.3.3 (IBC [P] 2902.3) Required public toilet facilities. Customers, patrons and visitors shall be provided with public toilet facilities in structures and tenant spaces intended for public utilization. The number of plumbing fixtures located within the required toilet facilities shall be provided in accordance with IBC Section 2902.1 for all users. Employees shall be provided with toilet facilities in all occupancies. Employee toilet facilities shall either be separate or combined employee and public toilet facilities.

7.2.2.3.3.1 (IBC [P] 2902.3.1) Access. The route to the public toilet facilities required by Section 7.2.2.3.3 (IBC Section 2902.3) shall not pass through kitchens, storage rooms or closets. Access to the required facilities shall be from within the building or from the exterior of the building. All routes shall comply with the accessibility requirements of these guidelines. The public shall have access to the required toilet facilities at all times that the building is occupied.

7.2.2.3.3.2 (IBC [P] 2902.3.2) Location of toilet facilities in occupancies other than covered mall buildings. In occupancies other than *covered mall buildings*, the required public and employee toilet facilities shall be located not more than one *story* above or below the space required to be provided with toilet facilities and the path of travel to such facilities shall not exceed a distance of 150 m.

7.2.2.2.4 (IBC 2902.4) Signage. A legible sign designating the sex shall be provided in a readily visible location near the entrance to each toilet facility. Signs for *accessible* toilet facilities shall comply with ICC A117.1.

SECTION 7.2.2.4 (IBC 2903) TOILET ROOM REQUIREMENTS

7.2.2.4.1 (IBC [P] 2903.1) Water closet compartment. Each water closet utilized by the public or employees shall occupy a separate compartment with walls or partitions and a door enclosing the fixtures to ensure privacy.

Exceptions:

1. Water closet compartments shall not be required in a single-occupant toilet room with a lockable door.
2. Reserved.
3. Reserved.

7.2.2.4.2 (IBC [P] 2903.2) Urinal partitions. Each urinal utilized by the public or employees shall occupy a separate area with walls or partitions to provide privacy. The walls or partitions shall begin at a height not more than 31 cm from and extend not less than 1.50 m above the finished floor surface. The walls or partitions shall extend from the wall surface at each side of the urinal a minimum of 46 cm or to a point not less than 15 cm beyond the outermost front lip of the urinal measured from the finished back wall surface, whichever is greater.

Exceptions:

1. Urinal partitions shall not be required in a single occupant or family or assisted use toilet room with a lockable door.
2. Reserved.

7.2.2.4.3 (IBC [P] 2903.3) Interior Finish. Interior finish surfaces of toilet rooms shall comply with Section 7.2.2.5 (IBC Section 1210).

SECTION 7.2.2.5 (IBC 1210) SURROUNDING MATERIALS

7.2.2.5.1 (IBC 1210.1) Floors and wall base finish materials. Toilet, bathing and shower room floor finish materials shall have a smooth, hard, nonabsorbent surface. The intersections of such floors with walls shall have a smooth, hard, nonabsorbent vertical base that extends upward onto the walls at least 10 cm.

7.2.2.5.2 (IBC 1210.2) Walls and partitions. Walls and partitions within 61 cm of urinals and water closets shall have a smooth, hard, nonabsorbent surface, to a height of 1.20 m above the floor, and except for structural elements, the materials used in such walls shall be of a type that is not adversely affected by moisture.

Exceptions:

1. Reserved.
2. Toilet rooms that are not accessible to the public and which have not more than one water closet. Accessories such as grab bars, towel bars, paper dispensers and soap dishes, provided on or within walls, shall be installed and sealed to protect structural elements from moisture. For walls and partitions also see Section 7.2.2.4 (IBC Section 2903).

7.2.2.5.3 (IBC 1210.5) Toilet rooms. Toilet rooms shall not open directly into a room used for the preparation of food for service to the public.

7.2.3 ALTERNATE MEANS OF VERIFICATION

- 7.2.3.1 Requirements related to electrical systems (installations), as addressed in Chapter 27 of the 2009 *International Building Code*® (IBC®), including all references to relevant provisions in other chapters of the 2009 IBC, to the *National Electrical Code* (2009 NFPA) and to all standards incorporated by reference, are deemed-to-comply with the electrical systems (installations) provisions of this chapter. As such, compliance with the requirements for electrical systems (installations) can be demonstrated by compliance with relevant sections of Chapter 27 of the 2009 IBC.
- 7.2.3.2 Requirements related to mechanical systems (heating, ventilation and air-conditioning systems and refrigeration systems), as addressed in Chapter 28 of the 2009 IBC, including all references to relevant provisions in other chapters of the 2009 IBC, the 2009 *International Mechanical Code*® (IMC®) and to all standards incorporated by reference, are deemed-to-comply with the mechanical systems provisions of this chapter. As such, compliance with the requirements for mechanical systems can be demonstrated by compliance with relevant sections of Chapter 28 of the 2009 IBC.
- 7.2.3.3 Requirements related to plumbing systems (potable water, sanitary, waste water systems), as addressed in Chapter 29 of the 2009 IBC, including all references to relevant provisions in other chapters of the 2009 IBC, the 2009 *International Plumbing Code*® (IPC®), and to all standards incorporated by reference, are deemed-to-comply with the plumbing systems provisions of this chapter. As such, compliance with the requirements for plumbing systems can be demonstrated by compliance with relevant sections of Chapter 29 of the 2009 IBC.
- 7.2.3.4 Requirements related to fuel gas piping installations, as addressed in the 2009 *International Fuel Gas Code*® (IFGC®), including all references to relevant provisions in other chapters of the 2009 IFC and to all standards incorporated by reference, are deemed-to-comply with the fuel gas piping provisions of the IFC. As such, compliance with the requirements for fuel gas piping systems can be demonstrated by compliance with relevant sections of the 2009 IFGC.

7.3 BUILDING ENVELOPE

7.3.0 OVERVIEW AND KEY CONCEPTS

The building envelope serves several important roles in building performance, including protection against temperature extremes and adverse weather conditions, containment of conditioned air for heating and cooling the interior, natural light penetration into the building, prevention of fire spread along the exterior of the building and prevention of ground water from penetrating the building. This chapter provides guidance on issues associated with the performance of the building envelope (exterior walls) for these situations.

Weather Protection

In addition to issues associated with occupant comfort (e.g., temperature extremes, high speed air movement, etc.), the primary objective of building envelopes with respect to weather protection is to keep moisture from the outside from penetrating and accumulating within the building. As noted in Section 7.2, such internal moisture accumulation can result in negative health effects, but it can also lead to rot, corrosion or other detrimental effects on building structural members and features. As such, it is important that any building plans which aim to provide such exterior barriers against the weather are designed, constructed and maintained in such a way that moisture does not penetrate and accumulate within the building.

Structural Performance

In some cases, building exterior walls provide structural support. In other cases, the exterior walls and roof system are providing protection from the weather, and are simply connected to the building structural system. In these cases, the connections/anchoring of the exterior walls/facade to the structural system is important. The exterior envelope may also need to be designed to withstand high winds, temperature extremes, earthquakes, and other such conditions that are present in the location where the building is constructed. In these situations, particularly high winds and earthquakes, care must be taken to protect people in and around buildings from hazards that may occur should the exterior of the building become damaged. In all cases, the structural design for the exterior envelope needs to comply with requirements for structural design as discussed in Chapter 8.

Fire Performance

While playing an important role in protecting the interior spaces from the effects of weather and climate, the building envelope also provides a critical function in preventing the spread of fire into a building from the outside and along the building exterior from one level to another. The design of the building envelope should therefore take into consideration exterior exposure fires, the combustibility of exterior cladding and façade material, protection of openings which may allow fire to enter into the building, and protection against spread of fire from one floor to another within spaces that may exist between floor/ceiling slabs and the exterior walls. See also Chapter 5 for fire protection measures.

Flood Performance

Although the primary issues associated with flood protection of a building relate to foundations, basements, and associated components, the exterior envelope can play a role in those locations where the exterior envelope extends below design flood levels. In such cases, the exterior envelope needs to be provided with measures to inhibit the entry of flood waters into the building interior. See also Chapter 8 on soils and foundations.

BUILDING ENVELOPE

Summary

Key considerations for performance of the building envelope are outlined below. More detailed discussion on associated design requirements can be found in Section 7.3.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Weather protection	Exterior walls (façade) and roof systems, including openings in exterior envelope. Health and safety impacts to occupants and building components.	Improper design, construction and maintenance could result in moisture penetration, which could lead to adverse health effects (mold, mildew, etc.), corrosion, rot or other degradation of structural elements, interior finishes and other building components.
Structural performance	Exterior walls (façade) and roof systems. Health and safety impacts to occupants and building components.	Improper design, construction and maintenance could result in damage to exterior barrier components under load, which could lead to safety issues for persons inside or outside of the building (e.g., broken and falling glazing or exterior wall material).
Fire performance	Exterior walls (façade) and roof systems, including openings in exterior envelope. Health and safety impacts to occupants and building components.	Improper design, construction and maintenance could result in fire penetration from the outside in, or along exterior surfaces, which could lead to fire impacts on occupants, the structure, the contents and the mission of the facility.
Flood performance	Exterior walls (façade) and roof systems, including openings in exterior envelope. Health and safety impacts to occupants and building components.	Improper design, construction and maintenance could result in moisture penetration, which could lead to adverse health effects (mold, mildew, etc.), corrosion, rot or other degradation of structural elements, interior finishes and other building components.

7.3.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with performance of the building envelope. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 7.3.2. A list of alternate means of verification is provided in Section 7.3.3.

- 7.3.1.1 Building shall be constructed to provide adequate resistance to penetration by, and the accumulation of, moisture from the outside.
 - 7.3.1.1.1 Roofs and exterior walls shall prevent the penetration of water that could cause damage to building elements.
 - 7.3.1.1.2 Walls, floors and structural elements in contact with the ground shall not absorb or transmit moisture in quantities that could cause damage to building elements.
 - 7.3.1.1.3 Concealed spaces and cavities in buildings constructed in a way that prevents external moisture from causing degradation of building elements.
 - 7.3.1.1.4 Excess moisture present at the completion construction shall be capable of being dissipated without permanent damage to the building elements.
- 7.3.1.2 Exterior walls, roof assemblies, and associated openings shall be designed and constructed to safely satisfy the imposed loads addressed in Section 8.1 (Loads and Actions on Structures).
- 7.3.1.3 Exterior walls, roof assemblies, and associated openings shall be designed and constructed to satisfy safely the fire resistance performance addressed in Section 5.5 (Exterior Wall and Roof Assembly Considerations).
- 7.3.1.4 For buildings in flood hazard areas, exterior walls extending below the design flood elevation shall be resistant to flood damage.
- 7.3.1.5 Exterior walls, roof assemblies, slabs, footings and associated openings shall be designed and constructed with adequate thermal insulation to satisfy the energy provisions addressed in Section 7.1.

7.3.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 7.3.2.1 (IBC 1403) PERFORMANCE REQUIREMENTS

7.3.2.1.1 (IBC 1403.2) Weather protection. Exterior walls shall provide the building with a weather-resistant *exterior wall envelope*. The *exterior wall envelope* shall include flashing, as described in IBC Section 1405.4. The *exterior wall envelope* shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a *water-resistive barrier* behind the exterior veneer, as described in IBC Section 1404.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the *exterior wall* assembly shall be provided in accordance with IBC Section 1405.3.

Exceptions:

1. A weather-resistant *exterior wall envelope* shall not be required over concrete or masonry walls designed in accordance with IBC Chapters 19 and 21, respectively.
2. Reserved.
3. Reserved.

7.3.2.1.2 (IBC 1403.3) Structural. *Exterior walls*, and the associated openings, shall be designed and constructed to resist safely the superimposed loads required by IBC Chapter 16.

7.3.2.1.3 (IBC 1403.4) Fire resistance. *Exterior walls* shall be fire-resistance rated as required by other sections of these guidelines with opening protection as required by IBC Chapter 7.

7.3.2.1.4 (IBC 1403.5) Flood resistance. For buildings in flood hazard areas, *exterior walls* extending below the design flood elevation shall be resistant to water damage. Wood shall be pressure-preservative treated in accordance with AWPA U1 for the species, product and end use using a preservative *listed* in Section 4 of AWPA U1 or decay-resistant heartwood of redwood, black locust or cedar.

7.3.2.1.5 (IBC 1403.6) Flood resistance for high-velocity wave action areas. For buildings in flood hazard areas subject to high-velocity wave action, electrical, mechanical and plumbing system components shall not be mounted on or penetrate through exterior walls that are designed to break away under flood loads.

For requirements related to combustible materials on the exterior side of exterior walls see Section 5.5.

SECTION 7.3.2.2 (IBC 1503) WEATHER PROTECTION

7.3.2.2.1 (IBC 1503.1) General. Roof decks shall be covered with *approved* roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed and installed in accordance with these guidelines and the *approved* manufacturer's instructions such that the roof covering shall serve to protect the building or structure.

7.3.2.2.2 (IBC 1503.2) Flashing. Flashing shall be installed in such a manner so as to prevent moisture entering the wall and roof through joints in copings, through moisture-permeable materials and at intersections with parapet walls and other penetrations through the roof plane.

7.3.2.2.2.1 (IBC 1503.2.1) Locations. Flashing shall be installed at wall and roof intersections, at gutters, wherever there is a change in roof slope or direction and around roof openings. Where flashing is of metal, the metal shall be corrosion resistant with a thickness of not less than 0.50 mm (No. 26 galvanized sheet).

7.3.2.2.3 (IBC 1503.3) Coping. Parapet walls shall be properly coped with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall.

7.3.2.2.4 (IBC [P] 1503.4) Roof drainage. Design and installation of roof drainage systems shall comply with Section 7.3.2.2 (IBC Section 1503) and the *International Plumbing Code*.

7.3.2.2.4.1 (IBC 1503.4.1) Secondary drainage required. Secondary (emergency) roof drains or scuppers shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason.

7.3.2.2.4.2 (IBC 1503.4.2) Scuppers. When scuppers are used for secondary (emergency overflow) roof drainage, the quantity, size, location and inlet elevation of the scuppers shall be sized to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 7.3.2.2.4.1 (IBC Section 1503.4.1). Scuppers shall not have an opening dimension of less than 10 cm. The flow through the primary system shall not be considered when locating and sizing scuppers.

7.3.2.2.4.3 (IBC 1503.4.3) Gutters. Gutters and leaders placed on the outside of buildings, private garages and buildings of Type V construction, shall be of noncombustible material or a minimum of Schedule 40 plastic pipe.

For fire resistance classification of roofs see Section 5.5.

SECTION 7.3.2.3 (IBC 1508) ROOF INSULATION

7.3.2.3.1 (IBC 1508.1) General. The use of above-deck thermal insulation shall be permitted provided such insulation is covered with an *approved* roof covering and passes the tests of FM 4450 or UL 1256 when tested as an assembly.

Exceptions:

1. Foam plastic roof insulation shall conform to the material and installation requirements of IBC Chapter 26.
2. Where a concrete roof deck is used and the above-deck thermal insulation is covered with an *approved* roof covering.

7.3.3 ALTERNATE MEANS OF VERIFICATION

- 7.3.3.1 Requirements related to building envelope (exterior walls), as addressed in Chapter 14 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the interior environment provisions of this chapter. As such, compliance with the requirements for building envelope can be demonstrated by compliance with relevant sections of Chapter 14 of the 2009 IBC.

CHAPTER 8 STRUCTURAL DESIGN CONSIDERATIONS

8.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with structural design considerations for office buildings. Given the diversity in structural design approaches throughout the world, driven in part by geographical differences in climate and hazard conditions, difference in material specification, and differences in design philosophy, this chapter presents a general discussion on structural design concepts, and does not detail any specific approaches to structural design, site preparation or material usage.

Using the 2009 *International Building Code*® (IBC®) as the primary reference document, basic structural design concepts are addressed in the following chapters, which generally parallels the IBC:

- 8.1 Loads and Actions on Structures
- 8.2 Soils and Foundations
- 8.3 Materials

Section 8.1 provides an overall discussion of structural design issues. While the focus is on addressing loads and actions on structures, it also provides an overall philosophy for prescriptive and performance design.

Section 8.2 provides general guidance on site preparation and foundation issues. This guidance is limited to recommendations for local geotechnical investigation and the need for foundations which have suitable load bearing capacity and moisture penetration prevention.

Section 8.3 provides general guidance on the need to undertake proper designs using the selected materials in accordance with specific design standards in place in the country where the structure will be built.

8.1 LOADS AND ACTIONS ON STRUCTURES

8.1.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with the structural design of buildings with respect to those loads normally impacting the building during its intended life. It should be recognized that structural design of any specific building is highly dependent upon factors such as the site conditions (e.g., soil conditions, grade, etc.), construction materials (e.g., timber, concrete, steel, masonry), expected climatic and natural hazard conditions (e.g., snow, rain, wind, flooding, seismic loads), design standards and construction methods.

While many of the design considerations are common from one country to another, specific factors associated with material properties, analytical methods, characterization of design loads and actions, hazard conditions, design and construction expertise, and inspection and enforcement capabilities make it challenging and costly to apply specific design approaches from one region to another. For example, the soil conditions and ground motion considerations may be reasonably well understood and addressed in guidelines, codes and standards used in some countries; however, soil conditions, ground motions and associated factors which affect seismic design may be much different in another country, and direct application of data from a specific country (including load and resistance factors, return periods and material properties), methods and approaches would be inappropriate to be used in another country without a clear understanding of building design and performance goals.

In all cases, structural design should be undertaken by a qualified engineer, with suitable experience in the country where the structure will be built and with the design and construction methods and materials appropriate to that country. Information provided in this chapter is for general guidance only. Final responsibility for all structural design decisions, including selection and use of design standards, shall rest with the engineer and the local code authorities.

Structural Design and Performance Concepts¹

The purpose of building codes in general is to safeguard the public health and safety of the community in which they are adopted and used. Structural design provisions of most building codes are generally formulated to achieve two basic objectives: provide adequate strength and serviceability. Strength refers to the ability of the structure to safely resist loads in order to avoid catastrophic failure or collapse under any loading likely to be experienced. Serviceability is achieved by ensuring that a structure has sufficient stiffness to withstand routine loading without experiencing damage, excessive deflection, drift or vibration.

Older prescriptive building codes attempt to achieve these two objectives through the specification of service loads and factors of safety. Engineers designing under such codes proportion the structure for specified design service loads (e.g., dead, live, wind, snow, seismic) that are expected to occur occasionally, if not routinely, throughout the life of a structure. Such loads do not represent maximum possible loads, yet they exceed the level of loading anticipated to be present most of the time. In the strength evaluation, a permissible load carrying capacity is determined by calculating a nominal strength for the structure, assuming all materials and construction conform to minimum specified criteria, and reducing this strength by a factor of safety to a design level. The factor of safety accounts both for the possibility that some materials and workmanship may be substandard, resulting in

¹ This section is excerpted with permission from *Performance-Based Building Design Concepts* (Meacham, 2004) with modifications to meet the scope of these Guidelines.

LOADS AND ACTIONS ON STRUCTURES

somewhat lower strength than desired and also provides reserve strength so that the structure can resist loading larger than the design level without failure or collapse.

About 50 years ago a strength based limit state design method was developed by the concrete industry called Ultimate Strength Design that used factored loads and factored resistances. A similar strength based methodology was later adopted by the structural steel industry and was called Load and Resistance Factor Design (LRFD). The allowable stress design approach described above and prescribed in building codes began to be supplanted by load and resistance factor design (LRFD) methods. Within load and resistance factor methods, strength is typically defined with respect to safely supporting loads in combination [e.g., dead (building), live (occupants, contents), rain, snow, earthquake, etc.] without exceeding the strength limit states for the materials of construction (e.g., timber, steel, concrete, masonry). Serviceability is typically defined in terms of limiting deflections and lateral drift. In such load and resistance factor design methods, traditional factors of safety are replaced by load factors, which account for the variability inherent in the loading, and resistance factors, which account for variability inherent in the strength of construction. These concepts are illustrated in Figure 8.1, which shows, on a common graph, the plot of probability distributions for maximum loading (demand) over the life of a structure as well as strength (capacity).

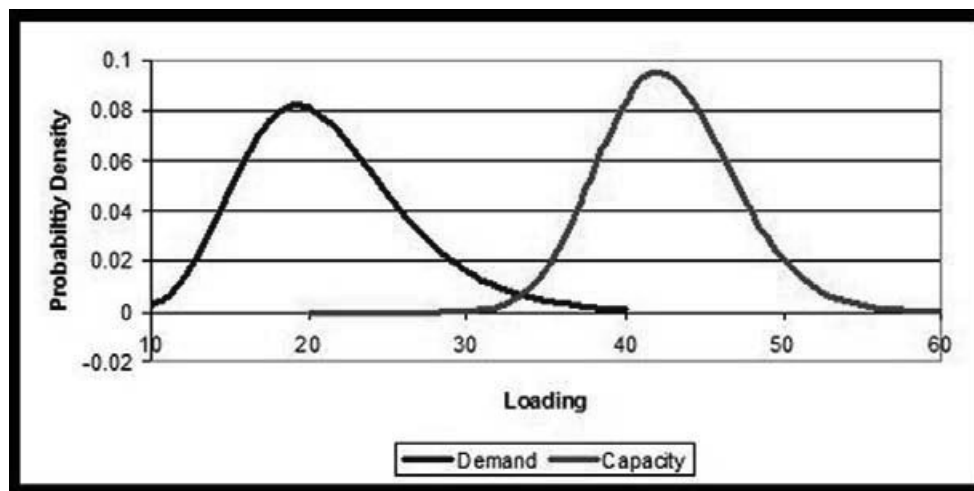


Figure 8.1 Probability Distribution for Structural Demand and Capacity

As can be seen in Figure 8.1 there is a small probability, represented by the overlap of the two distributions shown in the figure, that demand, represented by the distribution on the left, would exceed capacity, and that failure would occur. Specifically, for this structure and the assumed distributions of demand and capacity, it can be shown that the total probability of failure over the structure's life would be less than 1 percent. That is, a designer could be 99 percent confident that a design performed in accordance with these prescriptive criteria would not fail over its lifetime.

A prescriptive building code specifies or *prescribes* design and construction requirements according to particular materials and construction methods, rather than performance criteria. The basic intent of prescriptive building codes is to try to ensure suitably low probabilities of structural failure, at reasonable economic cost. The probability of failure is reduced through specification of design loadings that are near the maximum values of the hazard curve, specification of suitable load factors (or factors of safety), specification of minimum acceptable construction quality, and specification of appropriate load factors. Each of these has a direct and obvious effect on the cost of construction.

Prescriptive criteria contained in building codes have evolved over many years to achieve the desired balance between safety and cost. Under the prescriptive option, the process of ensuring a low probability of structural failure under likely loading is hidden from the designer. The designer, following such provisions, is typically unaware either of the location of the design loading on the hazard curve, or the inherent variability associated with either this loading or the capacity of the structure. Instead, the minimum prescribed loads and associated load and resistance factors, or factors of safety, are accepted and implicitly relied upon to achieve the desired result. This approach is both simple and protective. In the event of structural failure, the designer need only demonstrate compliance with the prescriptive criteria. If failure has occurred, this must be accepted either as inadequacy of the prescriptive criteria, inadequacy of construction relative to the specified requirements, or inadvertent and unlikely structural overload, all of which are outside of the designer's direct control.

Performance codes specify construction requirements according to performance criteria rather than to specific building materials, products, or methods of construction. In the performance-based option, the protection afforded by following prescriptive criteria is rejected and the designer must ensure by other means that the probability of failure for a design is suitably low. Generally, this cannot be achieved by simply adopting the load and resistance factors contained in the prescriptive code requirements, as these factors are inextricably linked to the selection of loading and to the prescriptive design procedures themselves.

Performance-based Structural Design Concepts

The basic process for performance-based structural design is illustrated in Figure 8.2. It consists of the selection of appropriate performance objectives, development of a preliminary design that is believed to be capable of meeting these objectives, verification that the design is actually capable of achieving the objectives, and iterative design revision until an adequate design is achieved.

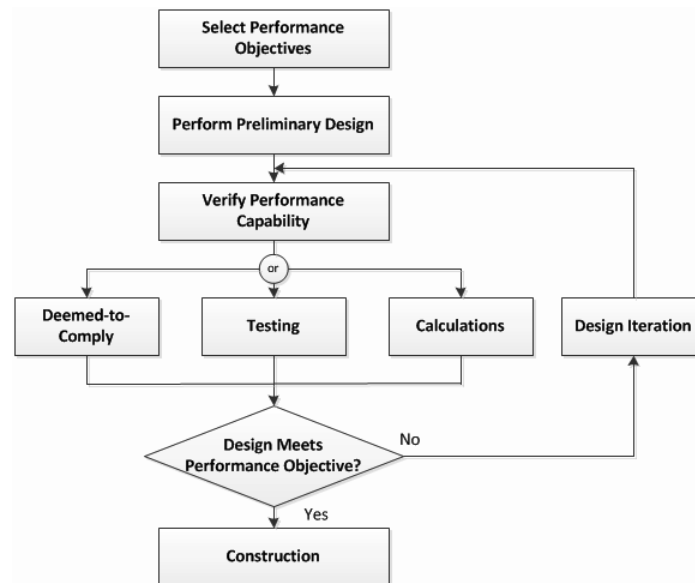


Figure 8.2 Performance-based Structural Design Process

Structural performance objectives are quantified statements of the severity of a design event, its probability of occurrence and the permissible damage given that the event is experienced. The specification of the design event or its probability of occurrence is often defined as the *hazard*. Probabilities of occurrence may be expressed as mean annual recurrence intervals, in years, or annual probabilities of exceedance. The mean annual recurrence

LOADS AND ACTIONS ON STRUCTURES

interval is the average period of time, in years, between repeat occurrence of an event of given or larger magnitude. Thus, a 100-year flood has a 1 percent probability of occurring in any one year. The annual probability of exceedance is the likelihood in any year that a given event will be experienced and can be calculated as the inverse of the mean recurrence interval. Thus, a 100-year flood would have an annual probability of exceedance of 0.01. Typical mean recurrence intervals used for structural design range from about 25 years for snow to as much as several thousand years for earthquake. Development of structural performance objectives is specific to the country where the structure will be built. Hazard maps and other such resources, as developed by cognizant authorities in the country where the structure will be built, should be referenced.

The amount of damage that is permitted, given that a design event is experienced, is sometimes termed a performance level. Specification of performance levels may either be qualitative or quantitative. Qualitative statements of performance often relate to the effect of the damage on disposition of the building after the event has occurred. For example, qualitative statements of performance often relate to whether buildings remain safe for continued occupancy, functional, or operational in their intended service, and whether the safety of occupants is threatened. Quantitative expressions of performance level relate to specific physical states, such as the extent of strength or stiffness loss, amount of energy dissipated, etc. As quantitative expressions of performance are meaningful only to structural engineers, most authoritative documents providing guidelines for performance-based structural design provide both qualitative and quantitative descriptions of performance levels to facilitate communications between structural engineers and the public. An example of the qualitative description of a performance level is as follows (in this case, a high level of performance, or conversely, a low level of impact):

Structural response to the loading is expected to be within the elastic range and it is anticipated that there is no structural damage and the building is safe to occupy. There is no damage to nonstructural systems and components needed for normal building occupancy and function, or for emergency operations. Further, such nonstructural systems are expected to be fully operable and functional. The risk to occupants is minimal, with very low likelihood of injury or life loss. Damage to contents is minimal in extent and minor in cost. There is expected to be a minimal risk of release of hazardous materials to the environment.

A structure may have several performance levels based on the expected loads (hazards), occupancy or risk characteristics, importance factors and related considerations. For example, a small office building with few occupants may be expected to perform well against normal load (hazard) conditions, but would be expected to suffer increasing damage as the load (hazard) increases (e.g., it might withstand a 10-year flood event but not a 200-year flood event). As the office building gets larger, housing more occupants, and perhaps increasing in importance due to other services provided in emergencies (e.g., civil defense shelter), the performance would be expected to be higher (e.g., perhaps being designed to withstand a 200-year flood event). Increasingly, building codes are identifying risk or performance groups by which to group buildings based on such occupancy, risk, and importance characteristics, and defining a range of performance levels (tolerable levels of impact) which reflect the expected performance for buildings within the risk or performance group, given the magnitude of the hazard event [see the 2009 *ICC Performance Code® for Buildings and Facilities* (ICCPC®)].

The preliminary design process carried out under performance-based design is similar to that in prescriptive code approaches to design. The engineer must determine, on the basis of experience or judgment, a configuration, strength, and stiffness for a structure that, on a preliminary basis, he or she believes will be capable of meeting the performance objectives. Once a preliminary design has been developed, it becomes necessary to verify that it is actually capable of meeting the performance objectives. The three classical methods of verifying performance capability are through calculations, through testing, and through compliance with deemed-to-comply standards.

The most common method of performing performance verification is through the use of deemed-to-comply standards. In essence, all buildings that are designed to conform to Chapters 16 through 25 of the 2009 *International Building Code*® (IBC®) or similar building codes have been demonstrated to be capable of complying with the performance objectives contained in that code through conformance with prescriptive deemed-to-comply standards. Performance verification through testing consists of building one or more prototypes of a design, subjecting it to a design or more severe loading, and measuring through observation the performance that is achieved. This option is commonly used in industries that construct many copies of a single design, such as the aircraft and automotive industries. For such applications, verification through testing is both economical and reliable. However, in the building industry, most designs are unique and are used to construct only a single building. In such cases, the costs associated with constructing and then testing a prototype of a design to prove its performance capability is excessively costly and seldom used. There are a few exceptions. One noteworthy exception is the establishment of permissible floor live load ratings for floor systems in existing buildings when there is no documentation available, which is occasionally done by load testing. Another exception is the use of shake table testing of nonstructural components, such as critical data, power, and telecommunications equipment, to demonstrate that these components will be capable of operating after a given level of ground shaking.

Excluding deemed-to-comply approaches, the most commonly used approach for performance verification in structural design is through calculation, sometimes called modeling or simulation. The calculations performed under this option are very different from those that are typically performed in designing to prescriptive standards. In the prescriptive approach to structural design, the code specifies that structures must have minimum specified strength and stiffness. The calculations performed under such procedures are intended to demonstrate that these minimum criteria are complied with but do not directly test the ability of a design to provide desired performance. In the performance-based option, calculations are used as a form of mathematical simulation to predict the response of a structure to specified loading. Rather than predicting strength and stiffness, these calculations are directly used to assess damage caused by the loading event so that adequacy of performance can be assessed. The traditional methods of calculating strength and stiffness of a structure as a means of performance verification are applicable only if the desired performance level is one in which no damage is permitted to occur. Calculations that are intended to simulate damage must generally be nonlinear, and often dynamic, in nature. Such calculations are frequently more complex than those performed to demonstrate compliance with prescriptive building code criteria.

Loads and Actions on Structures

Over the life of a structure, the structure may be subjected to loading from a wide range of events. Loading will include the structure's self-weight (dead load); the weight of occupants and furnishings (live load); soil pressures against buried portions of the structure (lateral earth load); effects of changes in external and internal air temperature (thermal load); as well as loading imposed by rain, snow, wind, earthquake, fire, and blast events.

Prescriptive structural design criteria contained in the building codes generally address dead, live, earth, thermal, rain, snow, wind, and earthquake loads. Fire events are considered by these prescriptive codes; however, typically not in the structural chapters (see Chapter 4 of these guidelines, for example). Blast loads are generally not addressed by the prescriptive criteria contained in building codes and most buildings are not designed to resist such effects.

However, minimum design loads standards (e.g., ASCE 7, 2005; Eurocodes) and performance building codes (e.g., the 2009 ICCPC, *Building Regulations England and Wales*, 2010) require that structures be designed such that they can sustain localized damage without experiencing instability or collapse that is disproportionate with the initiating

LOADS AND ACTIONS ON STRUCTURES

damage. This is one of the key techniques used in designing blast resistant structures and also provides protection against other unintended but highly damaging scenarios. It is generally complied with by providing structures with structural continuity and redundant load paths such that when an element is severely damaged there are alternate means of structural resistance available to continue to provide structural support.

Application of Prescriptive and Performance Approaches

Most buildings are designed by prescriptive rather than performance-based approaches and buildings designed using the performance-based option will typically only use the performance-based approach for one, or perhaps a few, of the load cases considered. Performance-based approaches will be applied only when superior performance to that intended by the prescriptive code criteria is desired, when the prescriptive criteria contained in the code is deemed to be inapplicable to the type of structure being designed, or when it is believed that equivalent performance to that intended by the prescriptive code can be attained more efficiently, economically, or suitably by alternative means.

Performance-based approaches will seldom be used for dead and live load design of superstructures as the performance criteria inherent in the prescriptive code criteria forms an adequately reliable and economical solution for nearly all structures. An exception is the design of floor systems that are sensitive to vibration, such as is common in laboratory and some manufacturing operations. Design of foundations for dead and live load resistance is commonly performance based, as, for example, when pile load testing is used as a basis for ascertaining the adequacy of a deep foundation design.

Performance-based wind design is commonly performed for tall structures and structures placed in unusual exposures. Performance-based earthquake design is commonly used for the design of structures in which superior performance is desired, for the upgrade of existing structures, and when new structural systems are employed to provide a portion of the structure's earthquake resistance. Since there are few prescriptive provisions available for blast resistance, almost all design for blast resistance is performance-based.

Summary

Key considerations for load and actions on structures are outlined below. More detailed discussion on associated design requirements can be found in Section 8.1.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Design approach	Design and construction considerations, such as material selection, analysis techniques, design details, methods of construction.	Selection driven by local regulations, engineering expertise, material availability, units of measure, test and inspection capabilities. Design approach should fit local conditions.
Loads (hazards)	Required strength and serviceability of the structure in delivering collapse prevention, occupant safety, and nonstructural systems operational and functional requirements, and other user-identified performance objectives.	Site preparation. Foundation. Material selection, construction, operation and service. Safety of occupants given various loading conditions or hazard events. Operation of building under various loading conditions or hazard events. Performance should be appropriate to the design loads (hazards) for the location in which the building will be constructed.

8.1.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with loads and actions on structures under the generally expected range of conditions that a structure can be subjected to over its intended life. These guidelines do not address extreme hazard events, particularly deliberate hazard events, which may warrant additional considerations. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 8.1.2. A list of alternate means of verification is provided in Section 8.1.3.

8.1.1.1 The facility shall be designed and constructed to withstand those loads, which can be reasonably expected during construction, alteration, and throughout its intended life, to levels of performance appropriate to the use, occupancy characteristics, risk characteristics and importance of the facility.

8.1.1.1.1 The structure shall remain stable and not suffer collapse disproportionate to design loads during construction, alteration, and throughout its intended life.

8.1.1.1.1.1 The structure shall be designed to sustain local damage, and the structural system as a whole shall remain stable and not be damaged to an extent disproportionate to the magnitude of the event and design performance level.

8.1.1.1.1.2 The structure shall have a low probability of causing damage or loss of function through excessive deformation, vibration or degradation during construction, alteration, and throughout its intended life.

8.1.1.1.2 The structure shall be designed and constructed for all expected loads, and combinations of loads, associated with the load condition or event and its associated magnitude, relative to the design performance level(s). Loads and combinations of loads shall include but not be limited to:

- 8.1.1.1.2.1 Dead loads.
- 8.1.1.1.2.2 Live loads.
- 8.1.1.1.2.3 Impact loads.
- 8.1.1.1.2.4 Explosion (overpressure) loads.
- 8.1.1.1.2.5 Soil and hydrostatic pressure loads.
- 8.1.1.1.2.6 Flood loads.
- 8.1.1.1.2.7 Wind loads.
- 8.1.1.1.2.8 Wind-borne debris loads.
- 8.1.1.1.2.9 Snow loads.
- 8.1.1.1.2.10 Rain loads.
- 8.1.1.1.2.11 Ice loads.
- 8.1.1.1.2.12 Hail loads.
- 8.1.1.1.2.13 Earthquake loads.
- 8.1.1.1.2.14 Thermal loads.

LOADS AND ACTIONS ON STRUCTURES

- 8.1.1.1.3 The structural design shall consider appropriate factors of safety to provide adequate performance from:
 - 8.1.1.1.3.1 Effects of uncertainties resulting from construction activities.
 - 8.1.1.1.3.2 Variation in the properties of materials and the characteristics of the site.
 - 8.1.1.1.3.3 Accuracy limitations inherent in the methods used to predict the stability of the structure.
 - 8.1.1.1.3.4 Self-restraining forces arising from differential settlements of foundations and from restrained dimensional changes due to temperatures, moisture, shrinkage, creep and similar forces.
- 8.1.1.2 Site work, where necessary, shall be carried out to provide stability for the construction on the site, for the structure throughout its intended life, and to avoid the likelihood of damage to adjacent property.
- 8.1.1.3 The alteration or demolition of the structure shall be carried out in a way that avoids the likelihood of premature collapse.

8.1.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 8.1.2.1 (IBC 1604) GENERAL DESIGN REQUIREMENTS

8.1.2.1.1 (IBC 1604.1) General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, *load and resistance factor design*, *allowable stress design*, empirical design or conventional construction methods, as permitted by the applicable material chapters.

8.1.2.1.2 (IBC 1604.2) Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in these guidelines without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other structures, and parts thereof, shall be designed and constructed to support safely the *nominal loads* in load combinations defined in these guidelines without exceeding the appropriate specified allowable stresses for the materials of construction. Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the *building official*.

8.1.2.1.3 (IBC 1604.3) Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift. See Section 12.12.1 of ASCE 7 for drift limits applicable to earthquake loading.

8.1.2.1.3.1 (IBC 1604.3.1) Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 8.1.2.1.3.2 through 8.1.2.1.3.5 (IBC Sections 1604.3.2 through 1604.3.5) or that permitted by Table 8.1.2.1.3 (IBC Table 1604.3).

TABLE 8.1.2.1.3 (IBC TABLE 1604.3)
DEFLECTION LIMITS^{a, b, c, h, i}

CONSTRUCTION	L	S or W^f	$D + L^{d, e}$
Roof members: ^e			
Supporting plaster ceiling	$l/360$	$l/360$	$l/240$
Supporting nonplaster ceiling	$l/240$	$l/240$	$l/180$
Not supporting ceiling	$l/180$	$l/180$	$l/120$
Floor members	$l/360$	—	$l/240$
Exterior walls and interior partitions:			
With brittle finishes	—	$l/240$	—
With flexible finishes	—	$l/120$	—
Farm buildings	—	—	$l/180$
Greenhouses	—	—	$l/120$

- For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed $l/60$. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed $l/150$. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed $l/90$. For roofs, this exception only applies when the metal sheets have no roof covering.
- Interior partitions not exceeding 1.850 m in height and flexible, folding and portable partitions are not governed by the provisions of this section.
- For wood structural members having a moisture content of less than 16% at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.
- The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 8.1.2.8 (IBC Section 1611) for rain and ponding requirements and Section 7.3.2.2.4 (IBC Section 1503.4) for roof drainage requirements.
- The wind load is permitted to be taken as 0.7 times the “component and cladding” loads for the purpose of determining deflection limits herein.
- For steel structural members, the dead load shall be taken as zero.

(continued)

LOADS AND ACTIONS ON STRUCTURES

TABLE 8.1.2.1.3 (IBC TABLE 1604.3)—corrections
DEFLECTION LIMITS^{a, b, c, h, i}

- h. For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed $l/60$. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed $l/175$ for each glass lite or $l/60$ for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed $l/120$.
- i. For cantilever members, l shall be taken as twice the length of the cantilever.

8.1.2.1.3.2 (IBC 1604.3.2) Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

8.1.2.1.3.3 (IBC 1604.3.3) Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI S100, ASCE 3, ASCE 8, SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

8.1.2.1.3.4 (IBC 1604.3.4) Masonry. The deflection of masonry structural members shall not exceed that permitted by TMS 402/ACI 530/ASCE 5.

8.1.2.1.3.5 (IBC 1604.3.5) Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

8.1.2.1.3.6 (IBC 1604.3.6) Limits. Deflection of structural members over span, l , shall not exceed that permitted by Table 8.1.2.1.3 (IBC Table 1604.3).

8.1.2.1.4 (IBC 1604.4) Analysis. *Load effects* on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral-force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements assumed not to be a part of the lateral-force-resisting system are permitted to be incorporated into buildings provided their effect on the action of the system is considered and provided for in the design. Except where diaphragms are flexible, or are permitted to be analyzed as flexible, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral-force-resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter. See Section 8.1.2.6 (IBC Section 1609) for wind loads, Section 8.1.2.7 (IBC Section 1610) for lateral soil loads and Section 8.1.2.10 (IBC Section 1613) for earthquake loads.

8.1.2.1.5 (IBC 1604.6) In-situ load tests. The *building official* is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with IBC Section 1714.

8.1.2.1.6 (IBC 1604.7) Preconstruction load tests. Materials and methods of construction that are not capable of being designed by *approved* engineering analysis or that do not comply with the applicable material design standards listed in IBC Chapter 35, or alternative test procedures in accordance with IBC Section 1712, shall be load tested in accordance with IBC Section 1715.

8.1.2.1.7 (IBC 1604.8) Anchorage.

8.1.2.1.7.1 (IBC 1604.8.1) General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.

8.1.2.1.7.2 (IBC 1604.8.2) Walls. Walls shall be anchored to floors, roofs and other structural elements that provide lateral support for the wall. Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces specified in this chapter but not less than the minimum strength design horizontal force specified in Section 11.7.3 of ASCE 7, substituted for “E” in the load combinations of Section 8.1.2.2.2 or 8.1.2.2.3 (IBC Section 1605.2 or 1605.3). Concrete and masonry walls shall be designed to resist bending between anchors where the anchor spacing exceeds 1.20 m. Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Section 8.1.2.6 (IBC Sections 1609) for wind design requirements and Section 8.1.2.10 (IBC Section 1613) for earthquake design requirements.

8.1.2.1.7.3 (IBC 1604.8.3) Decks. Where supported by attachment to an *exterior wall*, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. Connections of decks with cantilevered framing members to exterior walls or other framing members shall be designed for both of the following:

1. The reactions resulting from the dead load and live load specified in Table 8.1.2.4.1 (IBC Table 1607.1), or the snow load specified in Section 8.1.2.5 (IBC Section 1608), in accordance with Section 8.1.2.2 (IBC Section 1605), acting on all portions of the deck.
2. The reactions resulting from the dead load and live load specified in Table 8.1.2.4.1 (Table 1607.1), or the snow load specified in Section 8.1.2.5 (IBC Section 1608), in accordance with Section 8.1.2.2 (IBC Section 1605), acting on the cantilevered portion of the deck, and no live load or snow load on the remaining portion of the deck.

8.1.2.1.8 (IBC 1604.9) Counteracting structural actions. Structural members, systems, components and cladding shall be designed to resist forces due to earthquake and wind, with consideration of overturning, sliding and uplift. Continuous load paths shall be provided for transmitting these forces to the foundation. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

8.1.2.1.9 (IBC 1604.10) Wind and seismic detailing. Lateral-force-resisting systems shall meet seismic detailing requirements and limitations prescribed in these guidelines and ASCE 7, excluding Chapter 14 and Appendix 11A, even when wind *load effects* are greater than seismic *load effects*.

SECTION 8.1.2.2 (IBC 1605) LOAD COMBINATIONS

8.1.2.2.1 (IBC 1605.1) General. Buildings and other structures and portions thereof shall be designed to resist:

1. The load combinations specified in Section 8.1.2.2.2, 8.1.2.2.3.1 or 8.1.2.2.3.2 (IBC Section 1605.2, 1605.3.1 or 1605.3.2),
2. The load combinations specified in IBC Chapters 18 through 23, and
3. The load combinations with overstrength factor specified in Section 12.4.3.2 of ASCE 7 where required by Section 12.2.5.2, 12.3.3.3 or 12.10.2.1 of ASCE 7. With the simplified procedure of ASCE 7 Section 12.14, the load combinations with overstrength factor of Section 12.14.3.2 of ASCE 7 shall be used.

Applicable loads shall be considered, including both earthquake and wind, in accordance with the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero.

Where the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7 apply, they shall be used as follows:

1. The basic combinations for strength design with overstrength factor in lieu of Equations 16-5 and 16-7 in Section 8.1.2.2.1 (IBC Section 1605.2.1).
2. The basic combinations for *allowable stress design* with overstrength factor in lieu of Equations 16-12, 16-13 and 16-15 in Section 8.1.2.2.3.1 (IBC Section 1605.3.1).
3. The basic combinations for *allowable stress design* with overstrength factor in lieu of Equations 16-20 and 16-21 in Section 8.1.2.2.3.2 (IBC Section 1605.3.2).

8.1.2.2.1.1 (IBC 1605.1.1) Stability. Regardless of which load combinations are used to design for strength, where overall structure stability (such as stability against overturning, sliding, or buoyancy) is being verified, use of the load combinations specified in Section 8.1.2.2.2 or 8.1.2.2.3 (IBC Section 1605.2 or 1605.3) shall be permitted. Where the load combinations specified in Section 8.1.2.2.2 (IBC Section 1605.2) are used, strength reduction factors applicable to soil resistance shall be provided by a *registered design professional*. The stability of retaining walls shall be verified in accordance with IBC Section 1807.2.3.

8.1.2.2.2 (IBC 1605.2) Load combinations using strength design or load and resistance factor design.

8.1.2.2.2.1 (IBC 1605.2.1) Basic load combinations. Where strength design or *load and resistance factor design* is used, structures and portions thereof shall resist the most critical effects from the following combinations of factored loads:

$$1.4(D+F) \quad \text{(Equation 16-1)}$$

$$1.2(D + F + T) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-2)}$$

$$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (f_1 L \text{ or } 0.8W) \quad \text{(Equation 16-3)}$$

$$1.2D + 1.6W + f_1 L + 0.5(L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-4)}$$

$$1.2D + 1.0E + f_1 L + f_2 S \quad \text{(Equation 16-5)}$$

$$0.9D + 1.6W + 1.6H \quad \text{(Equation 16-6)}$$

$$0.9D + 1.0E + 1.6H \quad \text{(Equation 16-7)}$$

where:

f_1 = 1 for floors in places of public assembly, for live loads in excess of 4.8 kPa, and for parking garage live load, and

= 0.5 for other live loads.

f_2 = 0.7 for roof configurations (such as saw tooth) that do not shed snow off the structure, and

= 0.2 for other roof configurations.

Exception: Where other factored load combinations are specifically required by the provisions of these guidelines, such combinations shall take precedence.

8.1.2.2.2.2 (IBC 1605.2.2) Flood loads. Where flood loads, F_a , are to be considered in the design, the load combinations of Section 2.3.3 of ASCE 7 shall be used.

8.1.2.2.3 (IBC 1605.3) Load combinations using allowable stress design.

8.1.2.2.3.1 (IBC 1605.3.1) Basic load combinations. Where *allowable stress design* (working stress design), as permitted by these guidelines, is used, structures and portions thereof shall resist the most critical effects resulting from the following combinations of loads:

$$D+F \quad \text{(Equation 16-8)}$$

$$D+H+F+L+T \quad \text{(Equation 16-9)}$$

$$D+H+F+(L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-10)}$$

$$D+H+F+0.75(L+T)+0.75(L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-11)}$$

$$D+H+F+(W \text{ or } 0.7E) \quad \text{(Equation 16-12)}$$

$$D+H+F+0.75(W \text{ or } 0.7E)+0.75L+0.75(L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-13)}$$

$$0.6D+W+H \quad \text{(Equation 16-14)}$$

$$0.6D+0.7E+H \quad \text{(Equation 16-15)}$$

Exceptions:

1. Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 1.5 kPa or less and roof live loads of 1.5 kPa or less need not be combined with seismic loads. Where flat roof snow loads exceed 1.5 kPa, 20% shall be combined with seismic loads.

8.1.2.2.3.1.1 (IBC 1605.3.1.1) Stress increases. Increases in allowable stresses specified in the appropriate material chapter or the referenced standards shall not be used with the load combinations of Section 8.1.2.2.3.1 (IBC Section 1605.3.1), except that increases shall be permitted in accordance with IBC Chapter 23.

8.1.2.2.3.1.2 (IBC 1605.3.1.2) Flood loads. Where flood loads, F_a , are to be considered in design, the load combinations of Section 2.4.2 of ASCE 7 shall be used.

8.1.2.2.3.2 (IBC 1605.3.2) Alternative basic load combinations. In lieu of the basic load combinations specified in 8.1.2.2.3.1 (IBC Section 1605.3.1), structures and portions thereof shall be permitted to be designed for the most critical effects resulting from the following combinations. When using these alternative basic load combinations that include wind or seismic loads, allowable stresses are permitted to be increased or load combinations reduced where permitted by the material chapter of these guidelines or the referenced standards. For load combinations that include the counteracting effects of dead and wind loads, only two-thirds of the minimum dead load likely to be in place during a design wind event shall be used. Where wind loads are calculated in accordance with Chapter 6 of ASCE 7, the coefficient ω in the following equations shall be taken as 1.3. For other wind loads, ω shall be taken as 1. When using these alternative load combinations to evaluate sliding, overturning and soil bearing at the soil-structure interface, the reduction of foundation overturning from Section 12.13.4 in ASCE 7 shall not be used. When using these alternative basic load combinations for proportioning foundations for loadings, which include seismic loads, the vertical seismic *load effect*, E_v , in Equation 12.4-4 of ASCE 7 is permitted to be taken equal to zero.

$$D + L + (L_r \text{ or } S \text{ or } R) \quad \text{(Equation 16-16)}$$

$$D + L + (\omega W) \quad \text{(Equation 16-17)}$$

$$D + L + \omega W + S/2 \quad \text{(Equation 16-18)}$$

$$D + L + S + \omega W/2 \quad \text{(Equation 16-19)}$$

$$D + L + S + E/1.4 \quad \text{(Equation 16-20)}$$

$$0.9D + E/1.4 \quad \text{(Equation 16-21)}$$

Exceptions:

1. Crane hook loads need not be combined with roof live loads or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 1.4 kPa or less and roof live loads of 1.4 kPa or less need not be combined with seismic loads. Where flat roof snow loads exceed 1.4 kPa, 20% shall be combined with seismic loads.

8.1.2.2.3.2.1 (IBC 1605.3.2.1) Other loads. Where F , H or T are to be considered in the design, each applicable load shall be added to the combinations specified in Section 8.1.2.2.3.2 (IBC Section 1605.3.2).

SECTION 8.1.2.3 (IBC 1606) DEAD LOADS

8.1.2.3.1 (IBC 1606.1) General. Dead loads are those loads defined in IBC Section 1602.1. Dead loads shall be considered permanent loads.

8.1.2.3.2 (IBC 1606.2) Design dead load. For purposes of design, the actual weights of materials of construction and fixed service equipment shall be used. In the absence of definite information, values used shall be subject to the approval of the *building official*.

LOADS AND ACTIONS ON STRUCTURES

SECTION 8.1.2.4 (IBC 1607) LIVE LOADS

8.1.2.4.1 (IBC 1607.1) General. Live loads are those loads defined in IBC Section 1602.1.

8.1.2.4.2 (IBC 1607.3) Uniform live loads. The live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy but shall in no case be less than the minimum uniformly distributed unit loads required by Table 8.1.2.4.1 (Table 1607.1).

8.1.2.4.3 (IBC 1607.4) Concentrated loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 8.1.2.4.2 (IBC Section 1607.3) or the concentrated load, in kilonewtons, given in 8.1.2.4.1 (IBC Table 1607.1), whichever produces the greater *load effects*. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area 76 cm by 76 cm (0.57 m²) and shall be located so as to produce the maximum *load effects* in the structural members.

TABLE 8.1.2.4.1 (IBC TABLE 1607.1)
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o , AND MINIMUM CONCENTRATED LIVE LOADS^f

OCCUPANCY OR USE	UNIFORM (kPa)	CONCENTRATED (kN)
5. Balconies (exterior) and decks ^h	Same as occupancy served	—
13. Elevator machine room grating (on area of 26 cm ²)	—	1.35
25. Office buildings		
Corridors above first floor	3.8	8.9
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—
Lobbies and first-floor corridors	4.8	8.9
Offices	2.4	8.9
29. Roofs		
All roof surfaces subject to maintenance workers		1.35
Awnings and canopies		
Fabric construction supported by a lightweight rigid skeleton structure	0.2 nonreducible	
All other construction	0.96	
Ordinary flat, pitched, and curved roofs	0.96	
Primary roof members, exposed to a work floor		
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs:		
Over manufacturing, storage warehouses, and repair garages		8.90
All other occupancies	Note 1	1.35
Roofs used for other special purposes	2.8	Note 1
Roofs used for promenade purposes	4.8	
Roofs used for roof gardens or assembly purposes		
35. Stairs and exits		
All other	4.8	Note f

f. Minimum concentrated load on stair treads (on area of 26 cm²) is 1.35 kN.

h. See Section 8.1.2.1.7.3 (IBC Section 1604.8.3) for decks attached to exterior walls.

i. Attics without storage are those where the maximum clear height between the joist and rafter is less than 1.05 m, or where there are not two or more adjacent trusses with the same web configuration capable of containing a rectangle 1.05 m high by 0.61 m wide, or greater, located within the plane of the truss. For attics without storage, this live load need not be assumed to act concurrently with any other live load requirements.

8.1.2.4.4 (IBC 1607.9) Reduction in live loads. Except for uniform live loads at roofs, all other minimum uniformly distributed live loads, L_o , in 8.1.2.4.1 (IBC Table 1607.1) are permitted to be reduced in accordance with Section 8.1.2.4.4.1 (IBC Section 1607.9.1) or IBC Section 1607.9.2. Roof uniform live loads, other than special purpose roofs of Section 8.1.2.4.5.1.2 (IBC Section 1607.11.2.2), are permitted to be reduced in accordance with Section 8.1.2.4.5 (IBC Section 1607.11.2). Roof uniform live loads of special purpose roofs are permitted to be reduced in accordance with Section 8.1.2.4.4.1 (IBC Section 1607.9.1) or IBC Section 1607.9.2.

8.1.2.4.4.1 (IBC 1607.9.1) General. Subject to the limitations of Sections 8.1.2.4.4.1.1 through 8.1.2.4.4.1.2 (IBC Sections 1607.9.1 through 1607.9.1.2) and IBC Sections 1607.9.1.3 through 1607.9.1.4, members for which a value of $K_{LL}A_T$ is 37 m² or more are permitted to be designed for a reduced live load in accordance with the following equation:

$$L = L_o \{0.25 + 4.550 \sqrt{K_{LL} A_T}\} \quad \text{(Equation 16-22)}$$

$\sqrt{K_{LL} A_T}$

where:

L = Reduced design live load per square meter of area supported by the member.

L_o = Unreduced design live load per square meter of area supported by the member [see Table 8.1.2.4.1 (IBC Table 1607.1)].

K_{LL} = Live load element factor [see Table 8.1.2.4.4.1 (IBC Table 1607.9.1)].

A_T = Tributary area, in square meters.

L shall not be less than $0.50L_o$ for members supporting one floor and L shall not be less than $0.40L_o$ for members supporting two or more floors.

TABLE 8.1.2.4.4.1 (IBC TABLE 1607.9.1)
LIVE LOAD ELEMENT FACTOR, K_{LL}

ELEMENT	K_{LL}
Interior columns	4
Exterior columns without cantilever slabs	4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs	2
Edge beams without cantilever slabs	2
Interior beams	2
All other members not identified above including: Edge beams with cantilever slabs Cantilever beams One-way slabs Two-way slabs Members without provisions for continuous shear transfer normal to their span	1

8.1.2.4.4.1.1 (IBC 1607.9.1.1) One-way slabs. The tributary area, A_T , for use in Equation 16-22 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

8.1.2.4.4.1.2 (IBC 1607.9.1.2) Heavy live loads. Live loads that exceed 4.8 kPa shall not be reduced.

Exceptions:

1. The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20%, but the live load shall not be less than L as calculated in Section 8.1.2.4.4.1 (IBC Section 1607.9.1).

2. For uses other than storage, where *approved*, additional live load reductions shall be permitted where shown by the *registered design professional* that a rational approach has been used and that such reductions are warranted.

8.1.2.4.4.1.3 (IBC 1607.9.1.5) Roof members. Live loads of 4.8 kPa or less shall not be reduced for roof members except as specified in Section 8.1.2.4.5 (IBC Section 1607.11.2).

8.1.2.4.5 (IBC 1607.11.2) Reduction in roof live loads. The minimum uniformly distributed live loads of roofs and marquees, L_o , in Table 8.1.2.4.1 (IBC Table 1607.1) are permitted to be reduced in accordance with Section 8.1.2.4.5.1 or 8.1.2.4.5.1.2 (IBC Section 1607.11.2.1 or 1607.11.2.2).

8.1.2.4.5.1 (IBC 1607.11.2.1) Flat, pitched and curved roofs. Ordinary flat, pitched and curved roofs, and awnings and canopies other than of fabric construction supported by lightweight rigid skeleton structures, are permitted to be designed for a reduced roof live load as specified in the following equations or other controlling combinations of loads in Section 8.1.2.2 (IBC Section 1605), whichever produces the greater load. In structures such as greenhouses, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof load than specified in the following equations shall not be used unless *approved* by the *building official*. Such structures shall be designed for a minimum roof live load of 0.6 kPa.

$$L_r = L_o R_1 R_2 \quad \text{(Equation 16-25)}$$

where: $0.6 \text{ kPa} \leq L_r \leq 1.0 \text{ kPa}$

L_r = Reduced live load per square meters of horizontal projection, kilonewtons per square meters.

The reduction factors R_1 and R_2 shall be determined as follows:

$$R_1 = 1 \text{ for } A_t \leq 18.50 \text{ m}^2 \quad \text{(Equation 16-26)}$$

$$R_1 = 1.2 - (A_t/93.00) \text{ for } 18.50 \text{ m}^2 < A_t < 55.50 \text{ m}^2 \quad \text{(Equation 16-27)}$$

$$R_1 = 0.6 \text{ for } A_t \geq 55.50 \text{ m}^2 \quad \text{(Equation 16-28)}$$

where:

A_t = Tributary area (span length multiplied by effective width) in square meters, supported by any structural member, and

$$R_2 = 1 \text{ for } F \leq 34 \text{ cm/m} \quad \text{(Equation 16-29)}$$

$$R_2 = 1.2 - (F/1650) \text{ for } 34 \text{ cm/m} < F < 100 \text{ cm/m} \quad \text{(Equation 16-30)}$$

$$R_2 = 0.6 \text{ for } F \geq 100 \text{ cm/m} \quad \text{(Equation 16-31)}$$

where:

F = For a sloped roof, the number of millimeters of rise per meter, or for an arch or dome, the rise-to-span ratio multiplied by 32, and expressed in millimeters per meter.

8.1.2.4.5.1.2 (IBC 1607.11.2.2) Special-purpose roofs. Roofs used for promenade purposes, roof gardens, assembly purposes or other special purposes, and marquees, shall be designed for a minimum live load, L_o , as specified in Table 8.1.2.4.1 (IBC Table 1607.1). Such live loads are permitted to be reduced in accordance with Section 8.1.2.4.4 (IBC Section 1607.9). Live loads of 4.8 kPa or more at areas of roofs classified as Group A occupancies shall not be reduced.

8.1.2.4.6 (IBC 1607.11.3) Landscaped roofs. Where roofs are to be landscaped, the uniform design live load in the landscaped area shall be 1 kPa. The weight of the landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil.

8.1.2.4.7 (IBC 1607.11.4) Awnings and canopies. Awnings and canopies shall be designed for uniform live loads as required in Table 8.1.2.4.1 (IBC Table 1607.1) as well as for snow loads and wind loads as specified in Sections 8.1.2.5 and 8.1.2.6 (IBC Sections 1608 and 1609).

SECTION 8.1.2.5 (IBC 1608) SNOW LOADS

8.1.2.5.1 (IBC 1608.1) General. Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall not be less than that determined by Section 8.1.2.4 (IBC Section 1607).

SECTION 8.1.2.6 (IBC 1609) WIND LOADS

8.1.2.6.1 (IBC 1609.1) Applications. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

8.1.2.6.1.1 (IBC 1609.1.1) Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapter 6 of ASCE 7.

SECTION 8.1.2.7 (IBC 1610) SOIL LATERAL LOADS

8.1.2.7.1 (IBC 1610.1) General. Foundation walls and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 8.1.2.7.1 (IBC Table 1610.1) shall be used as the minimum design lateral soil loads unless determined otherwise by a geotechnical investigation in accordance with Section 8.2.2.1 (IBC Section 1803). Foundation walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top shall be permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Design lateral pressure shall be increased if soils at the site are expansive. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with IBC Sections 1805.4.2 and 1805.4.3.

Exception: Foundation walls extending not more than 2.45 m below grade and laterally supported at the top by flexible diaphragms shall be permitted to be designed for active pressure.

TABLE 8.1.2.7.1 (IBC TABLE 1610.1)
LATERAL SOIL LOAD

DESCRIPTION OF BACKFILL MATERIAL ^c	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD ^a (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	4.70	9.45
Poorly graded clean gravels; gravel-sand mixes	GP	4.70	9.45
Silty gravels, poorly graded gravel-sand mixes	GM	6.30	9.45
Clayey gravels, poorly graded gravel-and-clay mixes	GC	7.05	9.45
Well-graded, clean sands; gravelly sand mixes	SW	4.70	9.45
Poorly graded clean sands; sand-gravel mixes	SP	4.70	9.45
Silty sands, poorly graded sand-silt mixes	SM	7.05	9.45
Sand-silt clay mix with plastic fines	SM-SC	7.05	15.5
Clayey sands, poorly graded sand-clay mixes	SC	9.45	15.5
Inorganic silts and clayey silts	ML	7.05	15.5
Mixture of inorganic silt and clay	ML-CL	9.45	15.5
Inorganic clays of low to medium plasticity	CL	9.45	15.5
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.

b. Unsuitable as backfill material.

c. The definition and classification of soil materials shall be in accordance with ASTM D 2487.

LOADS AND ACTIONS ON STRUCTURES

SECTION 8.1.2.8 (IBC 1611) RAIN LOADS

8.1.2.8.1 (IBC 1611.1) Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow. The design rainfall shall be based on rainfall rates determined from *approved* local weather data.

$$R = (d_s + d_h)/100.0 \quad \text{(Equation 16-35)}$$

where:

d_h = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (i.e., the hydraulic head), millimeters.

d_s = Depth of water on the undeflected roof up to the inlet of secondary drainage system when the primary drainage system is blocked (i.e., the static head), millimeters.

R = Rain load on the undeflected roof, kilopascals. When the phrase “undeflected roof” is used, deflections from loads (including dead loads) shall not be considered when determining the amount of rain on the roof.

8.1.2.8.2 (IBC 1611.2) Ponding instability. For roofs with a slope less than 2 cm/m (1.200 degrees), the design calculations shall include verification of adequate stiffness to preclude progressive deflection in accordance with Section 8.4 of ASCE 7.

8.1.2.8.3 (IBC 1611.3) Controlled drainage. Roofs equipped with hardware to control the rate of drainage shall be equipped with a secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the load of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 8.1.2.8.1 (IBC Section 1611.1). Such roofs shall also be checked for ponding instability in accordance with Section 8.1.2.8.2 (IBC Section 1611.2).

8.1.2.9 (IBC 1612) FLOOD LOADS

8.1.2.9.1 (IBC 1612.1) General. Within *flood hazard areas* all new construction of buildings, structures and portions of buildings and structures, including substantial improvement and restoration of substantial damage to buildings and structures, shall be designed and constructed to resist the effects of flood hazards and flood loads. For buildings that are located in more than one *flood hazard area*, the provisions associated with the most restrictive *flood hazard area* shall apply.

8.1.2.10 (IBC 1613) EARTHQUAKE LOADS

8.1.2.10.1 (IBC 1613.1) Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A.

8.1.3 ALTERNATE MEANS OF VERIFICATION

- 8.1.3.1 Requirements related to design for loads and actions on structures (structural design), as addressed in Chapters 16 through 26 of the 2009 IBC, including all references to provisions in other chapters in the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with this chapter. As such, compliance with the requirements for design for loads and actions on structures can be demonstrated by compliance with applicable sections of Chapters 16 through 26 of the 2009 IBC.
- 8.1.3.2 Where demonstrated to the UN to an acceptable degree, the application of the Eurocodes, in their totality, may be considered as an alternate means of compliance with the functional and performance objectives identified in this chapter. However, it should be noted that use of the Eurocodes does not guarantee that specific levels of performance, as identified by criteria in Section 8.1.2, will be met. There can be no claim that the Eurocodes, the IBC, Chapters 16 through 26, and associated referenced standards are equivalent on all levels of performance as provided in the IBC due to differences in the establishment of load and action relationships, analytical methods and material specifications.

8.2 SOILS AND FOUNDATIONS

8.2.0 OVERVIEW AND KEY CONCEPTS

A building's foundation is essential to carrying the structural load of a building. The design of a foundation depends critically on the building design, as well as on the soil, weather and climatic conditions of the location where the structure will be built. Since soil conditions vary considerably by geographic region—within and between countries—around the world, and hazard and climate conditions vary significantly as well, it is difficult to provide any specific guidance on design of the foundation and preparation of the site based on soil conditions that can be applied consistently in various countries. It is recommended that either a design guide, standard or code approved by a cognizant local authority be applied, or that a geotechnical investigation be conducted to determine requirements for site preparation and to support foundation design by a competent structural design professional. In addition, the site and foundation should be protected against moisture penetration into the building.

Summary

Key soil and foundation considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 8.2.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Load bearing capacity of the foundation based on structural design and soil conditions.	Site needs to be prepared to adequately support a foundation that will carry the structural load of the building given the local soil, hazard, weather and climatic conditions.	A design guide, standard or code approved by a cognizant local authority shall be applied, or a geotechnical investigation shall be conducted to determine requirements for site preparation and to support foundation design by a competent structural design professional.
Protection against moisture penetration.	Site needs to be prepared to adequately divert ground water away from the foundation. The foundation needs to be protected against moisture penetration.	A design guide, standard or code approved by a cognizant local authority shall be applied, or a geotechnical investigation shall be conducted to determine requirements for site preparation and to support foundation design by a competent structural design professional.

8.2.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations for associated soils and foundations. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 8.2.2. A list of alternate means of verification is provided in Section 8.2.3.

8.2.1.1 A design guide, standard or code approved by a cognizant local authority shall be applied for site preparation and design of the building's foundation.

5.2.1.1.1 Where such a guide, standard or code does not exist, a geotechnical investigation shall be conducted to determine requirements for site preparation and to support foundation design by a competent structural design professional.

8.2.1.1.2 Foundation materials shall be appropriate to the soils conditions, hazards, weather and climatic conditions, as well as the load carrying capacity required for the building.

5.2.1.1.3 The building site needs to be adequately prepared to divert ground water away from the foundation.

5.2.1.1.4 The foundation needs to be adequately protected against moisture penetration.

8.2.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 8.2.2.1 (IBC 1803) GEOTECHNICAL INVESTIGATIONS

8.2.2.1.1 (IBC 1803.1) General. Geotechnical investigations shall be conducted in accordance with Section 8.2.2.12 (IBC Section 1803.2) and reported in accordance with Section 8.2.2.1.6 (IBC Section 1803.6). Where required by the *building official* or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a *registered design professional*.

8.2.2.1.2 (IBC 1803.2) Investigations required. Geotechnical investigations shall be conducted in accordance with Sections 8.2.2.1.3 through 8.2.2.1.5 (IBC Sections 1803.3 through 1803.5).

Exception: The *building official* shall be permitted to waive the requirement for a geotechnical investigation where satisfactory data from adjacent areas is available that demonstrates an investigation is not necessary.

Note: The IBC allows this exception for various conditions where soil investigation is required, but it does not allow this exception for very high seismic areas (in IBC referred to as Seismic Design Category D, E and F).

8.2.2.1.3 (IBC 1803.3) Basis of investigation. Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility, liquefaction and expansiveness.

8.2.2.1.3.1 (IBC 1803.3.1) Scope of investigation. The scope of the geotechnical investigation including the number and types of borings or soundings, the equipment used to drill or sample, the in-situ testing equipment and the laboratory testing program shall be determined by a *registered design professional*.

8.2.2.1.4 (IBC 1803.4) Qualified representative. The investigation procedure and apparatus shall be in accordance with generally accepted engineering practice. The *registered design professional* shall have a fully qualified representative on site during all boring or sampling operations.

8.2.2.1.5 (IBC 1803.5) Investigated conditions. Geotechnical investigations shall be conducted as indicated:

8.2.2.1.5.1 (IBC 1803.5.1) Classification. Soil materials shall be classified in accordance with ASTM D 2487.

8.2.2.1.5.2 (IBC 1803.5.2) Questionable soil. Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in these guidelines is claimed, the *building official* shall be permitted to require that a geotechnical investigation be conducted.

8.2.2.1.5.3 (IBC 1803.5.3) Expansive soil. In areas likely to have expansive soil, the *building official* shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D 4318.
2. More than 10% of the soil particles pass a No. 200 (75 μ m) sieve, determined in accordance with ASTM D 422.
3. More than 10% of the soil particles are less than 5 μ m in size, determined in accordance with ASTM D 422.
4. Expansion index greater than 20, determined in accordance with ASTM D 4829.

8.2.2.1.5.4 (IBC 1803.5.4) Ground-water table. A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 1.50 m below the elevation of the lowest floor level where such floor is located below the finished ground level adjacent to the foundation.

8.2.2.1.5.5 (IBC 1803.5.5) Deep foundations. Where deep foundations will be used, a geotechnical investigation shall be conducted and shall include all of the following, unless sufficient data upon which to base the design and installation is otherwise available:

1. Recommended deep foundation types and installed capacities.
2. Recommended center-to-center spacing of deep foundation elements.
3. Driving criteria.
4. Installation procedures.
5. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity where required).
6. Load test requirements.
7. Suitability of deep foundation materials for the intended environment.
8. Designation of bearing stratum or strata.
9. Reductions for group action, where necessary.

8.2.2.1.5.6 (IBC 1803.5.6) Rock strata. Where subsurface explorations at the project site indicate variations or doubtful characteristics in the structure of the rock upon which foundations are to be constructed, a sufficient number of borings shall be made to a depth of not less than 3.05 m below the level of the foundations to provide assurance of the soundness of the foundation bed and its load-bearing capacity.

8.2.2.1.5.7 (IBC 1803.5.7) Excavation near foundations. Where excavation will remove lateral support from any foundation, an investigation shall be conducted to assess the potential consequences and address mitigation measures.

8.2.2.1.5.8 (IBC 1803.5.8) Compacted fill material. Where shallow foundations will bear on compacted fill material more than 31 cm in depth, a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material.
2. Specifications for material to be used as compacted fill.
3. Test methods to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.
4. Maximum allowable thickness of each lift of compacted fill material.
5. Field test method for determining the in-place dry density of the compacted fill.
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7. Number and frequency of field tests required to determine compliance with Item 6.

8.2.2.1.5.9 (IBC 1803.5.9) Controlled low-strength material (CLSM). Where shallow foundations will bear on controlled low-strength material (CLSM), a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of the CLSM.
2. Specifications for the CLSM.
3. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
4. Test methods for determining the acceptance of the CLSM in the field.
5. Number and frequency of field tests required to determine compliance with Item 4.

8.2.2.1.6 (IBC 1803.6) Reporting. Where geotechnical investigations are required, a written report of the investigations shall be submitted to the *building official* by the owner or authorized agent at the time of *permit* application. This geotechnical report shall include, but need not be limited to, the following information:

1. A plot showing the location of the soil investigations.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.
4. Elevation of the water table, if encountered.
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.
6. Expected total and differential settlement.
7. Deep foundation information in accordance with Section 8.2.2.1.5.5 (IBC Section 1803.5.5).
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 8.2.2.1.5.8 (IBC Section 1803.5.8).
10. Controlled low-strength material properties and testing in accordance with Section 8.2.2.1.5.9 (IBC Section 1803.5.9).

8.2.2.2 (IBC 1808) FOUNDATIONS

8.2.2.2.1 (IBC 1808.2) Design for capacity and settlement. Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. Foundations in areas with expansive soils shall be designed in accordance with the provisions of Section 8.2.2.2.5 (IBC Section 1808.6).

8.2.2.2.2 (IBC 1808.3) Design loads. Foundations shall be designed for the most unfavorable effects due to the combinations of loads specified in Section 8.1.2.2.2 or 8.1.2.2.3 (IBC Section 1605.2 or 1605.3). The dead load is permitted to include the weight of foundations and overlying fill. Reduced live loads, as specified in Section 8.1.2.4.4 (IBC Section 1607.9) and IBC 1607.11, shall be permitted to be used in the design of foundations.

8.2.2.2.2.1 (IBC 1808.3.1) Seismic overturning. Where foundations are proportioned using the load combinations of Section 8.1.2.2.2 or 8.1.2.2.3.1 (IBC Section 1605.2 or 1605.3.1), and the computation of seismic overturning effects is by equivalent lateral force analysis or modal analysis, the proportioning shall be in accordance with Section 12.13.4 of ASCE 7.

8.2.2.2.3 (IBC 1808.4) Vibratory loads. Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

8.2.2.2.4 (IBC 1808.5) Shifting or moving soils. Where it is known that the shallow subsoils are of a shifting or moving character, foundations shall be carried to a sufficient depth to ensure stability.

8.2.2.2.5 (IBC 1808.6) Design for expansive soils. Foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 8.2.2.2.5.1 or 8.2.2.2.5.2 (IBC Section 1808.6.1 or 1808.6.2).

Exception: Foundation design need not comply with Section 8.2.2.2.5.1 or 8.2.2.2.5.2 (IBC Section 1808.6.1 or 1808.6.2) where one of the following conditions is satisfied:

1. The soil is removed in accordance with Section 8.2.2.2.5.3 (IBC Section 1808.6.3); or
2. The *building official* approves stabilization of the soil in accordance with Section 8.2.2.2.5.4 (IBC Section 1808.6.4).

8.2.2.2.5.1 (IBC 1808.6.1) Foundations. Foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

8.2.2.2.5.2 (IBC 1808.6.2) Slab-on-ground foundations. Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils*. Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils*. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

8.2.2.2.5.3 (IBC 1808.6.3) Removal of expansive soil. Where expansive soil is removed in lieu of designing foundations in accordance with Section 8.2.2.2.5.1 or 8.2.2.2.5.2 (IBC Section 1808.6.1 or 1808.6.2), the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil.

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

8.2.2.2.5.4 (IBC 1808.6.4) Stabilization. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 8.2.2.2.5.1 or 8.2.2.2.5.2 (IBC Section 1808.6.1 or 1808.6.2), the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

8.2.3 ALTERNATE MEANS OF VERIFICATION

- 8.2.3.1 Chapter 18 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for soils and foundations can be demonstrated by compliance with Chapter 18 of the 2009 IBC.
- 8.2.3.2 Application of a design guidance, standard or code document for soils and foundations, as approved by a cognizant authority for use and application within the country where the structure will be built, can be considered to meet the requirements of this chapter. Documentation illustrating the acceptability of the design guidance, standard or code document shall be provided to the UN for approval and acceptance.

8.3 MATERIALS

8.3.0 OVERVIEW AND KEY CONCEPTS

The required structural performance of a building can be achieved through the use of a wide range of building materials. In general, the structural performance, regardless of material, needs to comply with Section 8.1, Loads and Actions on Structures. However, as noted in Section 8.1, there are different approaches to structural design (prescriptive and performance) a range of different methods of analysis for design performance, driven by units of measure and design approaches in different parts of the world (e.g., ASCE 7 versus the Eurocodes), and different material properties, construction techniques and related factors that can impact the specific parameters associated with structural design using a given material. As such, it is difficult to provide any specific guidance on structural design of buildings for specific material types (e.g., timber, concrete, masonry and steel). It is recommended that either a design guide, standard or code approved by a cognizant local authority be applied, or that a structural design be developed by a competent structural design professional for structural design of the building.

Summary

Key soil and foundation considerations are outlined in the table below. More detailed discussion on associated design requirements can be found in Section 8.3.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Differences in materials, units, and methods of analysis, design and construction vary by country.	Material selection and appropriate methods of structural analysis and design are dependent upon local requirements, access to materials, units of measure and analysis and design procedures.	A design guide, standard or code approved by a cognizant local authority shall be applied, or that a structural design be developed by a competent structural design professional for structural design of the building.

8.3.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with materials. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 8.3.2. A list of alternate means of verification is provided in Section 8.3.3.

8.3.1.1 A design guide, standard or code approved by a cognizant local authority shall be applied for structural analysis and design for the type of material selected for construction.

8.3.1.1.1 Where such a guide, standard or code does not exist, a structural analysis and design shall be conducted by a competent structural design professional.

8.3.1.2 Building materials shall be appropriate to the hazards, weather and climatic conditions where the structure will be built, as well as the occupant, contents and related load carrying capacity required for the building.

8.3.1.2.1 Building materials shall be certified or otherwise approved for their intended use by a recognized approval, test or certification entity.

8.3.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 8.3.2.1 (IBC 1901) GENERAL (CONCRETE)

8.3.2.1.1 (IBC 1901.2) Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318.

Note: The IBC amends certain sections of ACI 318 and provides that language as revised in IBC Section 1908. This guideline makes reference directly to ACI 318 and does not include any amended language.

8.3.2.1.2 (IBC 1901.3) Source and applicability. The format and subject matter of IBC Sections 1902 through 1907 of this chapter are patterned after, and in general conformity with, the provisions for structural concrete in ACI 318.

8.3.2.1.3 (IBC 1901.4) Construction documents. The *construction documents* for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.
8. Details and location of contraction or isolation joints specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for posttensioning tendons.
11. For structures assigned to Seismic Design Category D, E or F, a statement if slab on grade is designed as a structural diaphragm (see Section 21.12.3.4 of ACI 318).

SECTION 8.3.2.2 (IBC 1904) DURABILITY REQUIREMENTS

8.3.2.2.1 (IBC 1904.1) Water-cementitious materials ratio. Where maximum water-cementitious materials ratios are specified in ACI 318, they shall be calculated in accordance with ACI 318, Section 4.1.

8.3.2.2.2 (IBC 1904.2) Exposure categories and classes. Concrete shall be assigned to exposure classes in accordance with ACI 318, Section 4.2, based on:

1. Exposure to freezing and thawing in a moist condition or deicer chemicals;
2. Exposure to sulfates in water or soil;
3. Exposure to water where the concrete is intended to have low permeability; and
4. Exposure to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater or spray from these sources, where the concrete has steel reinforcement.

8.3.2.2.3 (IBC 1904.3) Concrete properties. Concrete mixtures shall conform to the most restrictive maximum water-cementitious materials ratios and minimum specified concrete compressive strength requirements of ACI 318, Section 4.3, based on the exposure classes assigned in Section 8.3.2.2.2 (IBC Section 1904.2).

MATERIALS

TABLE 8.3.2.2.1 (IBC TABLE 1904.3)
MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c)

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c at 28 days, MPa)		
	Negligible exposure	Moderate exposure	Severe exposure
Basement walls ^c and foundations not exposed to the weather	17.00	17.00	17.00 ^a
Basement slabs and interior slabs on grade, except garage floor slabs	17.00	17.00	17.00 ^a
Basement walls ^c , foundation walls, exterior walls and other vertical concrete surfaces exposed to the weather	17.00	21.00 ^b	21.00 ^b
Driveways, curbs, walks, patios, porches, carport slabs, steps and other flatwork exposed to the weather, and garage floor slabs	17.00	21.00 ^{b,d}	24.00 ^{b,d}

- a. Concrete in these locations that can be subjected to freezing and thawing during construction shall be of air-entrained concrete in accordance with Section 8.3.2.2.4.1 (IBC Section 1904.4.1).
- b. Concrete shall be air entrained in accordance with Section 8.3.2.2.4.1 (IBC Section 1904.4.1).
- c. Structural plain concrete basement walls are exempt from the requirements for exposure conditions of Section 8.3.2.2.3 (IBC Section 1904.3) (see IBC Section 1909.6.1).
- d. For garage floor slabs where a steel trowel finish is used, the total air content required by Section 8.3.2.2.4.1 (IBC Section 1904.4.1) is permitted to be reduced to not less than 3%, provided the minimum specified compressive strength of the concrete is increased to 27.50 MPa.

8.3.2.2.4 (IBC 1904.4) Freezing and thawing exposures. Concrete that will be exposed to freezing and thawing, in the presence of moisture, with or without deicing chemicals being present, shall comply with Section 8.3.2.2.4.1 and 8.3.2.2.4.2 (IBC Sections 1904.4.1 and 1904.4.2).

8.3.2.2.4.1 (IBC 1904.4.1) Air entrainment. Concrete exposed to freezing and thawing while moist shall be air entrained in accordance with ACI 318, Section 4.4.1.

8.3.2.2.4.2 (IBC 1904.4.2) Deicing chemicals. For concrete exposed to freezing and thawing in the presence of moisture and deicing chemicals, the maximum weight of fly ash, other pozzolans, silica fume or slag that is included in the concrete shall not exceed the percentages of the total weight of cementitious materials permitted by ACI 318, Section 4.4.2.

8.3.2.2.5 (IBC 1904.5) Alternative cementitious materials for sulfate exposure. Alternative combinations of cementitious materials for use in sulfate-resistant concrete to those listed in ACI 318, Table 4.3.1 shall be permitted in accordance with ACI 318, Section 4.5.1.

SECTION 8.3.2.3 (IBC 1905) CONCRETE QUALITY, MIXING AND PLACING

8.3.2.3.1 (IBC 1905.1) General. The required strength and durability of concrete shall be determined by compliance with the proportioning, testing, mixing and placing provisions of Sections 8.3.2.3.1.1 through 8.3.2.3.13 (IBC Sections 1905.1.1 through 1905.13).

8.3.2.3.1.1 (IBC 1905.1.1) Strength. Concrete shall be proportioned to provide an average compressive strength as prescribed in Section 8.3.2.3.3 (IBC Section 1905.3) and shall satisfy the durability criteria of Section 8.3.2.2 (IBC Section 1904). Concrete shall be produced to minimize the frequency of strengths below f'_c as prescribed in Section 8.3.2.3.6.3 (IBC Section 1905.6.3). *For concrete designed and constructed in accordance with this chapter, f'_c shall not be less than 17.00 MPa.* No maximum specified compressive strength shall apply unless restricted by a specific provision of these guidelines or ACI 318.

8.3.2.3.2 (IBC 1905.2) Selection of concrete proportions. Concrete proportions shall be determined in accordance with the provisions of ACI 318, Section 5.2.

8.3.2.3.3 (IBC 1905.3) Proportioning on the basis of field experience and/or trial mixtures. Concrete proportioning determined on the basis of field experience and/or trial mixtures shall be done in accordance with ACI 318, Section 5.3.

8.3.2.3.4 (IBC 1905.4) Proportioning without field experience or trial mixtures. Concrete proportioning determined without field experience or trial mixtures shall be done in accordance with ACI 318, Section 5.4.

8.3.2.3.5 (IBC 1905.5) Average strength reduction. As data become available during construction, it is permissible to reduce the amount by which the average compressive strength (f'_c) is required to exceed the specified value of f'_c in accordance with ACI 318, Section 5.5.

8.3.2.3.6 (IBC 1905.6) Evaluation and acceptance of concrete. The criteria for evaluation and acceptance of concrete shall be as specified in Sections 8.3.2.3.6.2 through 8.3.2.3.6.5 (IBC Sections 1905.6.2 through 1905.6.5).

8.3.2.3.6.1 (IBC 1905.6.1) Qualified technicians. Concrete shall be tested in accordance with the requirements in Sections 8.3.2.3.6.2 through 8.3.2.3.6.5 (IBC Sections 1905.6.2 through 1905.6.5). Qualified field testing technicians shall perform tests on fresh concrete at the job site, prepare specimens required for curing under field conditions, prepare specimens required for testing in the laboratory and record the temperature of the fresh concrete when preparing specimens for strength tests. Qualified laboratory technicians shall perform all required laboratory tests.

8.3.2.3.6.2 (IBC 1905.6.2) Frequency of testing. The frequency of conducting strength tests of concrete and the minimum number of tests shall be as specified in ACI 318, Section 5.6.2.

Exception: When the total volume of a given class of concrete is less than 38 m³, strength tests are not required when evidence of satisfactory strength is submitted to and approved by the building official.

8.3.2.3.6.3 (IBC 1905.6.3) Strength test specimens. Specimens prepared for acceptance testing of concrete in accordance with Section 8.3.2.3.6.2 (IBC Section 1905.6.2) and strength test acceptance criteria shall comply with the provisions of ACI 318, Section 5.6.3.

8.3.2.3.6.4 (IBC 1905.6.4) Field-cured specimens. Where required by the building official to determine adequacy of curing and protection of concrete in the structure, specimens shall be prepared, cured, tested and test results evaluated for acceptance in accordance with ACI 318, Section 5.6.4.

8.3.2.3.6.5 (IBC 1905.6.5) Low-strength test results. Where any strength test (see ACI 318, Section 5.6.2.4) falls below the specified value of f'_c the provisions of ACI 318, Section 5.6.5, shall apply.

8.3.2.3.7 (IBC 1905.7) Preparation of equipment and place of deposit. Prior to concrete being placed, the space to receive the concrete and the equipment used to deposit it shall comply with ACI 318, Section 5.7.

8.3.2.3.8 (IBC 1905.8) Mixing. Mixing of concrete shall be performed in accordance with ACI 318, Section 5.8.

8.3.2.3.9 (IBC 1905.9) Conveying. The method and equipment for conveying concrete to the place of deposit shall comply with ACI 318, Section 5.9.

8.3.2.3.10 (IBC 1905.10) Depositing. The depositing of concrete shall comply with the provisions of ACI 318, Section 5.10.

8.3.2.3.11 (IBC 1905.11) Curing. The length of time, temperature and moisture conditions for curing of concrete shall be in accordance with ACI 318, Section 5.11.

8.3.2.3.12 (IBC 1905.12) Cold weather requirements. Concrete to be placed during freezing or near-freezing weather shall comply with the requirements of ACI 318, Section 5.12.

8.3.2.3.13 (IBC 1905.13) Hot weather requirements. Concrete to be placed during hot weather shall comply with the requirements of ACI 318, Section 5.13.

SECTION 8.3.2.4 (IBC 1906) FORMWORK, EMBEDDED PIPES AND CONSTRUCTION JOINTS

8.3.2.4.1 (IBC 1906.1) Formwork. The design, fabrication and erection of forms shall comply with ACI 318, Section 6.1.

8.3.2.4.2 (IBC 1906.2) Removal of forms, shores and reshores. The removal of forms and shores, including from slabs and beams (except where cast on the ground), and the installation of reshores shall comply with ACI 318, Section 6.2.

MATERIALS

8.3.2.4.3 (IBC 1906.3) Conduits and pipes embedded in concrete. Conduits, pipes and sleeves of any material not harmful to concrete and within the limitations of ACI 318, Section 6.3, are permitted to be embedded in concrete with approval of the registered design professional.

8.3.2.4.4 (IBC 1906.4) Construction joints. Construction joints, including their location, shall comply with the provisions of ACI 318, Section 6.4.

SECTION 8.3.2.5 (IBC 2002) MATERIALS

8.3.2.5.1 (IBC 2002.1) General. Aluminum used for structural purposes in buildings and structures shall comply with AA ASM 35 and AA ADM 1. The *nominal loads* shall be the minimum design loads required by IBC Chapter 16.

SECTION 8.3.2.6 (IBC 2101) GENERAL (MASONRY)

8.3.2.6.1 (IBC 2101.1) Scope. This chapter shall govern the materials, design, construction and quality of masonry.

Note: IBC Chapter 21 provides provisions for design and construction of masonry. The primary masonry design standard referenced is the TMS 402/ACI 530/ASCE 5, Building Code Requirements for Masonry Structures. IBC Chapter 21 also provides for 3 design approaches, Allowable Stress Design, Strength Design and Empirical Design.

SECTION 8.3.2.7 (IBC 2205) STRUCTURAL STEEL

8.3.2.7.1 (IBC 2205.1) General. The design, fabrication and erection of structural steel for buildings and structures shall be in accordance with AISC 360.

Note: IBC Chapter 22 also contains additional provisions and considerations for structural steel in various areas of seismic activity.

SECTION 8.3.2.8 (IBC 2301) GENERAL (WOOD)

8.3.2.8.1 (IBC 2301.1) Scope. The provisions of this chapter shall govern the materials, design, construction and quality of wood members and their fasteners.

Note: IBC Chapter 3 contains wood design provisions based on the lumber sizes, grading and species of wood in North America. It provides for Allowable Stress Design, Load and Resistance Factor Design and Conventional Light-Frame Construction methods. The main referenced standards of design in this chapter are the AF&PA NDS, *National Design Specification for Wood Construction* and for design and construction of log structures, the ICC 400, *Standard on Design and Construction of Log Structures*.

8.3.3 ALTERNATE MEANS OF VERIFICATION

- 8.3.3.1 Chapters 19 through 23 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the provisions of this chapter. As such, compliance with the requirements for Materials can be demonstrated by compliance with Chapters 19 through 23 of the 2009 IBC.
- 8.3.3.2 Application of a design guidance, standard or code document for structural design, such as the Eurocodes, which have been approved by a cognizant authority for use and application within the country where the structure will be built, can be considered to meet the requirements of this chapter. Documentation illustrating the acceptability of the design guidance, standard or code document shall be provided to the UN for approval and acceptance.

CHAPTER 9 SAFEGUARDS DURING CONSTRUCTION, ALTERATION AND DEMOLITION

9.0 OVERVIEW AND KEY CONCEPTS

This chapter provides guidance on issues associated with the safety of building users during construction, alteration and demolition works. This chapter does not address worker safety, which is typically addressed under health and safety legislation of a jurisdiction [e.g., the U.S. Occupational Safety and Health Administration (OSHA), the U.K. Health and Safety Executive (HSE), etc.]. Guidelines, standards and regulations of such entities having jurisdiction where the building is located should be consulted. Likewise, fire risk management guidance, as may be found in pertinent fire codes, standards, regulations and guidelines [e.g., 2009 *International Fire Code*® (IFC®), NFPA 241, *Standard for Safeguarding Construction, Alteration and Demolition Operations* (NFPA, 2009), *European Guideline: Fire Prevention on Construction Sites* (CFPA, 2009)] should be consulted.

There will be several times during the life of a building when construction-related works are underway, beginning with preparation of the site, through construction and operation, until the demolition of the building. During these periods, the building will be at various states of completeness and operational capacity. During these periods of construction-related works, the aim of this section is to identify the objectives and measures aimed at safeguarding building occupants and visitors from injury or illness, and to protect property from damage, during these periods of construction-related works.

During site preparation, measures should be implemented to minimize the potential for personnel to be injured as a result of soil conditions, excavations, and operations (e.g., heavy equipment operations). Providing mechanisms and procedures to keep unauthorized persons from the site is an essential starting point. For those authorized to be on site, providing appropriate signage, walkways and training regarding site hazards will help reduce the potential for accidents and injuries. Providing suitable protection of any excavations should be considered for protection of personnel and building components (e.g., shoring excavations with steep slopes and providing fences around the perimeter).

Construction might generally be considered in two phases:¹ initial construction and in-use alteration, renovation, rehabilitation or expansion. During initial construction, the aim is to provide an adequate level of temporary or partial safety measures to provide for the protection of personnel and property until all permanent safety features are in place. This includes providing adequate means of egress, portable manual fire extinguishers, and as appropriate to the building, standpipe and sprinkler systems (particularly high-rise buildings). Protection against weather and natural hazard loads should be as appropriate for expected conditions.

During in-use alteration, renovation, rehabilitation or expansion, fire protection and egress are significant concerns, especially when the building works are in proximity to occupied areas and/or areas through which egress paths traverse (e.g., even though an exit stairway is protected as part of an exit enclosure, if the exit enclosure passes through a floor that is under works, the risk of fire and impact to the stairway is higher in the zone of construction). In addition to having portable fire extinguishers available, safety management procedures, including the need for hot works permits (e.g., for welding), storage of combustible materials, and the use of a fire watch if detection or suppression systems are inactive should be considered. Also see Chapter 10 for existing buildings.

Safety during demolition is much like safety during site preparation and initial construction, ensuring that mechanisms are in place for protection against demolition-related hazards.

¹ Phased occupancy may be permitted in some jurisdictions.

SAFEGUARDS DURING CONSTRUCTION, ALTERATION AND DEMOLITION

Summary

Key considerations for the safety of building users during construction, alteration and demolition works are outlined below. A more detailed discussion on associated design requirements can be found in Section 9.0.2, Performance/ Prescriptive Criteria and Means of Verification. Note that additional detail can be found in other chapters, with safety of user issues associated with fire and natural hazard events being largely addressed in other chapters (e.g., fire protection, Chapter 4; means of egress, Section 6.1; safety of users, Section 6.3; structural, Chapter 8).

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Site security	Keep unauthorized persons off site.	May involve fences, gates, security protocols (IDs/badges, check-in procedures, etc.) and so forth.
Physical safety measures	Provide physical protection and egress measures for building users during operations.	May involve temporary protection measures (guardrails, safety nets, extinguishers, etc.) and partial installation of operable safety systems (e.g., standpipes and sprinklers).
Operational safety measures	Adequate permitting and operational safety procedures.	May involve site inspections, hot work permits, fire watches, security watches, and other such operational measures.

9.0.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with the safety of building users during construction, alteration and demolition works. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 9.0.2. A list of alternate means of verification is provided in Section 9.0.3.

- 9.0.1.1 Proper permits for construction, alteration and demolition works shall be obtained before work commences.
- 9.0.1.2 Provisions are required during construction, alteration and demolition works to protect property off site from damage resulting from falling objects, fire, blasts or any other risk posed by the construction, alteration or demolition operations.
- 9.0.1.3 Provisions are required during construction, alteration and demolition works to prevent the entry of unauthorized personnel to the construction, alteration or demolition site or area.
- 9.0.1.4 Provisions are required during construction, alteration and demolition works to protect authorized personnel in the building or on the building site from injury resulting from falling objects, fire, blasts, tripping or falling, or any other risk posed by the construction, alteration or demolition works.
- 9.0.1.5 Sequencing of tasks, procedural methods and equipment shall be such that personnel are protected from injury and illness attributable to hazards present because of the given operation.
- 9.0.1.6 The structure under construction shall be protected from damage due to wind, rain or other natural hazards likely to occur during construction.
- 9.0.1.7 The structure under construction shall be protected from damage due to fire, explosion or other technological hazards likely to occur during construction.
 - 9.0.1.7.1 Adjacent property is used to limit the accumulation of combustible materials on the site.
 - 9.0.1.7.2 Risks due to combustible material used and stored on site are managed by fire protection equipment, procedures, or both.
 - 9.0.1.7.3 Safeguards and procedures to manage potential sources of ignition on the site.
- 9.0.1.8 Provisions for personnel movement, transport and support shall be such that:
 - 9.0.1.8.1 Personnel are protected from injury due to falling.
 - 9.0.1.8.2 Personnel are protected from injury due to falling objects.
 - 9.0.1.8.3 Personnel are protected from injury that could be caused by the particular operations being conducted.
 - 9.0.1.8.4 Exposure to materials that are known to be health hazards is eliminated.

9.0.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 9.0.2.1 (IBC 3302) CONSTRUCTION SAFEGUARDS

9.0.2.1.1 (IBC 3302.1) Remodeling and additions. Required *exits*, existing structural elements, fire protection devices and sanitary safeguards shall be maintained at all times during remodeling, *alterations*, repairs or *additions* to any building or structure.

Exceptions:

1. When such required elements or devices are being remodeled, altered or repaired, adequate substitute provisions shall be made.
2. When the existing building is not occupied.

9.0.2.1.2 (IBC 3302.2) Manner of removal. Waste materials shall be removed in a manner which prevents injury or damage to persons, adjoining properties and public rights-of-way.

SECTION 9.0.2.2 (IBC 3304) SITE WORK

9.0.2.2.1 (IBC 3304.1) Excavation and fill. Excavation and fill for buildings and structures shall be constructed or protected so as not to endanger life or property. Stumps and roots shall be removed from the soil to a depth of at least 31 cm below the surface of the ground in the area to be occupied by the building. Wood forms which have been used in placing concrete, if within the ground or between foundation sills and the ground, shall be removed before a building is occupied or used for any purpose. Before completion, loose or casual wood shall be removed from direct contact with the ground under the building.

9.0.2.2.1.1 (IBC 3304.1.1) Slope limits. Slopes for permanent fill shall not be steeper than one unit vertical in two units horizontal (50% slope). Cut slopes for permanent excavations shall not be steeper than one unit vertical in two units horizontal (50% slope). Deviation from the foregoing limitations for cut slopes shall be permitted only upon the presentation of a soil investigation report acceptable to the *building official*.

9.0.2.2.1.2 (IBC 3304.1.2) Surcharge. No fill or other surcharge loads shall be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional loads caused by the fill or surcharge. Existing footings or foundations which can be affected by any excavation shall be underpinned adequately or otherwise protected against settlement and shall be protected against later movement.

SECTION 9.0.2.3 (IBC 3305) SANITARY

9.0.2.3.1 (IBC 3305.1) Facilities required. Sanitary facilities shall be provided during construction, remodeling or demolition activities in accordance with the *International Plumbing Code*.

SECTION 9.0.2.4 (IBC 3306) PROTECTION OF PEDESTRIANS

9.0.2.4.1 (IBC 3306.1) Protection required. Pedestrians shall be protected during construction, remodeling and demolition activities as required by this chapter and Table 9.0.2.4.1 (IBC Table 3306.1). Signs shall be provided to direct pedestrian traffic.

9.0.2.4.2 (IBC 3306.2) Walkways. A walkway shall be provided for pedestrian travel in front of every construction and demolition site unless the applicable governing authority authorizes the sidewalk to be fenced or closed. Walkways shall be of sufficient width to accommodate the pedestrian traffic, but in no case shall they be less than 1.20 m in width. Walkways shall be provided with a durable walking surface. Walkways shall be *accessible* in accordance with IBC Chapter 11 and shall be designed to support all imposed loads and in no case shall the design live load be less than 7.2 kPa.

9.0.2.4.3 (IBC 3306.3) Directional barricades. Pedestrian traffic shall be protected by a directional barricade where the walkway extends into the street. The directional barricade shall be of sufficient size and construction to direct vehicular traffic away from the pedestrian path.

9.0.2.4.4 (IBC 3306.4) Construction railings. Construction railings shall be at least 1.05 m in height and shall be sufficient to direct pedestrians around construction areas.

9.0.2.4.5 (IBC 3306.5) Barriers. Barriers shall be a minimum of 2.45 m in height and shall be placed on the side of the walkway nearest the construction. Barriers shall extend the entire length of the construction site. Openings in such barriers shall be protected by doors which are normally kept closed.

9.0.2.4.6 (IBC 3306.6) Barrier design. Barriers shall be designed to resist loads required in IBC Chapter 16 unless constructed as follows:

1. Barriers shall be provided with 5 cm by 10 cm top and bottom plates.
2. The barrier material shall be a minimum of 2 cm boards or 6 mm wood structural use panels.
3. Wood structural use panels shall be bonded with an adhesive identical to that for exterior wood structural use panels.
4. Wood structural use panels 6 mm or 8 mm in thickness shall have studs spaced not more than 61 cm on center (o.c.).
5. Wood structural use panels 1 cm in thickness shall have studs spaced not more than 1.20 m on center provided a 5 cm by 10 cm stiffener is placed horizontally at midheight where the stud spacing exceeds 0.61 m (o.c.).
6. Wood structural use panels 2 cm or thicker shall not span over 2.45 m.

9.0.2.4.7 (IBC 3306.7) Covered walkways. Covered walkways shall have a minimum clear height of 2.45 m as measured from the floor surface to the canopy overhead. Adequate lighting shall be provided at all times. Covered walkways shall be designed to support all imposed loads. In no case shall the design live load be less than 7.2 kPa for the entire structure.

9.0.2.4.8 (IBC 3306.8) Repair, maintenance and removal. Pedestrian protection required by this chapter shall be maintained in place and kept in good order for the entire length of time pedestrians may be endangered. The owner or the owner's agent, upon the completion of the construction activity, shall immediately remove walkways, debris and other obstructions and leave such public property in as good a condition as it was before such work was commenced.

9.0.2.4.9 (IBC 3306.9) Adjacent to excavations. Every excavation on a site located 1.50 m or less from the street *lot line* shall be enclosed with a barrier not less than 1.85 m high. Where located more than 1.50 m from the street *lot line*, a barrier shall be erected when required by the *building official*. Barriers shall be of adequate strength to resist wind pressure as specified in IBC Chapter 16.

**TABLE 9.0.2.4.1 (IBC TABLE 3306.1)
PROTECTION OF PEDESTRIANS**

HEIGHT OF CONSTRUCTION	DISTANCE FROM CONSTRUCTION TO LOT LINE	TYPE OF PROTECTION REQUIRED
2.45 m or less	Less than 1.50 m	Construction railings
	1.50 m or more	None
More than 2.45 m	Less than 1.50 m	Barrier and covered walkway
	1.50 m or more, but not more than one-fourth the height of construction	Barrier and covered walkway
	1.50 m or more, but between one-fourth and one-half the height of construction	Barrier
	1.50 m or more, but exceeding one-half the height of construction	None

SAFEGUARDS DURING CONSTRUCTION, ALTERATION AND DEMOLITION

SECTION 9.0.2.5 (IBC 3307) PROTECTION OF ADJOINING PROPERTY

9.0.2.5.1 (IBC 3307.1) Protection required. Adjoining public and private property shall be protected from damage during construction, remodeling and demolition work. Protection must be provided for footings, foundations, party walls, chimneys, skylights and roofs. Provisions shall be made to control water runoff and erosion during construction or demolition activities. The person making or causing an excavation to be made shall provide written notice to the owners of adjoining buildings advising them that the excavation is to be made and that the adjoining buildings should be protected. Said notification shall be delivered not less than 10 days prior to the scheduled starting date of the excavation.

SECTION 9.0.2.6 (IBC 3310) MEANS OF EGRESSES

9.0.2.6.1 (IBC 3310.1) Stairways required. Where a building has been constructed to a *building height* of 15 m or four *stories*, or where an existing building exceeding 15 m in *building height* is altered, at least one temporary lighted *stairway* shall be provided unless one or more of the permanent stairways are erected as the construction progresses.

9.0.2.6.2 (IBC 3310.2) Maintenance of means of egress. Required *means of egress* shall be maintained at all times during construction, demolition, remodeling or *alterations* and *additions* to any building.

Exception: *Approved* temporary *means of egress* systems and facilities.

SECTION 9.0.2.7 (IBC 3311) STANDPIPES

9.0.2.7.1 (IBC [F] 3311.1) Where required. In buildings required to have standpipes by Section 5.4.2.4.1 (IBC Section 905.3.1), not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed when the progress of construction is not more than 12 m in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairs. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

SECTION 9.0.2.8 (IBC 3312) AUTOMATIC SPRINKLER SYSTEM

9.0.2.8.1 (IBC [F] 3312.1) Completion before occupancy. In buildings where an *automatic sprinkler system* is required by these guidelines, it shall be unlawful to occupy any portion of a building or structure until the *automatic sprinkler system* installation has been tested and *approved*.

9.0.2.8.2 (IBC [F] 3312.2) Operation of valves. Operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by notification of duly designated parties. When the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

9.0.3 ALTERNATE MEANS OF VERIFICATION

- 9.0.3.1 Requirements related to safety to users during construction, alteration or demolition, as defined in Chapter 33 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the safety to users during construction, alteration or demolition provisions of this chapter. As such, compliance with the requirements for safety to users during construction, alteration or demolition can be demonstrated by compliance with relevant sections of Chapter 33 of the 2009 IBC.

CHAPTER 10 EXISTING STRUCTURES

10.0 OVERVIEW AND KEY CONCEPTS

This chapter addresses safety and performance issues for existing buildings as they apply to alterations, repair, addition or change of occupancy, particularly with respect to the performance of the modified building. See Chapter 9 for additional requirements during construction and demolition.

Context

Most building stock that is being used at any given time consists primarily of existing structures, whether one year old or one hundred or more years old. Because buildings are generally constructed to last for a considerable period of time, it is expected that alteration, repair, addition or change of occupancy can occur over the life of the building. It is also reasonable to expect that building codes, design standards, material specifications, and related issues will change over time. While it is generally the aim to have modifications to an existing building meet whatever current regulatory and safety requirements exist at the time of alteration, repair, addition or change of occupancy, that is not always technically or financially practicable. As such, some relaxation of the current building regulatory provisions may be allowed for existing buildings, and alternative means of demonstrating building performance may be required. Nonetheless, basic performance requirements for safety, use and amenity (function) must be attained. The following outlines some key considerations in this regard.

Materials

In general, materials already in use, which comply with requirements or approvals at the time of installation, may remain in use unless they have been determined to be dangerous to health or safety of occupants (e.g., a material that has an unacceptable flame spread characteristic, or which off-gases hazardous materials at unacceptable levels). Materials which comply with the health, safety and performance characteristics for new building construction are acceptable when installed in accordance with requirements for new construction.

Additions

In general, new construction which expands the area of an existing building [e.g., another level, an adjacent space where previously there was none (expansion of the footprint), etc.] is considered an addition. Additions to existing construction should meet all requirements for new construction. Any part of the existing construction, which is necessary to support the addition, shall have the appropriate load bearing capacity to do so. Furthermore, the addition, in combination with the existing construction, should not create an increased hazard to occupants of the existing construction or of the addition above the level that is acceptable for existing construction (e.g., an addition should not result in the need for occupants to exit through an area of higher hazard or risk).

Alterations

In general, an alteration is a modification to an existing building which does not increase the area of the building, and which is not undertaken to repair damage or does not change the building use (e.g., removing walls within an office area to convert from individual office space to open-plan office space would be considered an alteration). Alterations to existing buildings should be such that any changes are no less compliant with the requirements for existing buildings than prior to alterations. Where alterations involve a significant portion of the existing building, modifications should meet the requirements for new construction to the extent practicable.

EXISTING STRUCTURES

Repairs

Repairs refer to those activities undertaken to restore an existing building to its prior state following some type of damage. In general, any repair work to existing buildings should be such that the repaired components are no less compliant with the requirements for existing buildings than prior to the repair. In cases where damage results in significant impact to structural or other safety systems, evaluation shall be undertaken by a competent and licensed design professional to assess the damage and determine the extent and scope of repair that is required and the materials, components and systems to be used. Special care should be taken with respect to requirements for natural hazard loads, such as wind, rain, snow, flood, and seismic loading.

Change of Use

No change of use is permitted without compliance with all performance requirements for the desired use. This is of particular concern when changing from uses which may have less stringent requirements (e.g., a warehouse being converted to an office would have to meet all performance requirements for an office occupancy, including materials, fire protection, egress, accessibility and structural requirements).

Accessibility

Additions, alterations or repairs shall not have the effect of reducing accessibility to the building or portions of the building as required for the building use. Additions, alterations or repairs shall not impose a greater level of accessibility than that which would be required for new construction. Accessibility requirements shall be as outlined in Section 6.2 of these guidelines, unless determined to be technically infeasible or otherwise exempted by the authority having jurisdiction.

Compliance Alternatives

There are essentially two approaches which could be acceptable for demonstrating compliance with the performance requirements for existing buildings: compliance with a recognized alternative compliance method, or successful application of a performance-based analysis and design.

Whereas these guidelines are based on the 2009 *International Building Code*® (IBC®) there are two forms of recognized alternative compliance: application of Chapter 34 of the 2009 IBC or application of the 2009 *International Existing Building Code*® (IEBC®). In general, these approaches use an evaluation and scoring scheme which provides relative weighted values for the various building systems (e.g., materials, fire protection, egress, structural), means to combine the values into a composite score for the occupancy type, and a minimum score value required to achieve minimum performance requirements.

Performance-based approaches are generally available for different types of systems and components, and for different types of hazard protection and related performance objectives. For example, performance-based analysis approaches exist for fire (e.g., SFPE, 2007) and seismic design (FEMA, 2007; PEER, 2010).

Summary

Key considerations for addressing safety and performance issues, and controlling alterations, repair, addition or change of occupancy to existing buildings, are outlined below. More detailed discussion on associated design requirements can be found in Section 10.0.2, Performance/Prescriptive Criteria and Means of Verification. Note that additional detail can be found in other chapters, with safety of user issues associated with the construction activities addressed in Chapter 9.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
Materials	All areas (e.g., fire, structural strength, energy performance, etc.)	Materials, which were compliant at the time of initial building design, can be used for alterations and repairs if they do not present a hazard. Materials which meet current requirements should be used for additions and change of use, and where practicable, for additions and alterations.
Additions	All areas (e.g., fire, structural strength, energy performance, etc.)	Additions to existing construction should meet all requirements for new construction.
Alterations	All areas (e.g., fire, structural strength, energy performance, etc.)	Alterations to existing buildings should be such that any changes are no less compliant with the requirements for existing buildings than prior to alterations. Where alterations involve a significant portion of the existing building, modifications should meet the requirements for new construction to the extent practicable.
Repairs	All areas (e.g., fire, structural strength, energy performance, etc.)	Repair work to existing buildings should be such that the repaired components are no less compliant with the requirements for existing buildings than prior to the repair. In cases of significant damage, evaluation shall be undertaken by competent professionals to assess the damage and determine the extent and scope of repair that is required.
Change of use	All areas (e.g., fire, structural strength, energy performance, etc.)	No change of use is permitted without compliance with all performance requirements for the desired use.
Compliance	All areas (e.g., fire, structural strength, energy performance, etc.)	Demonstration of compliance is possible either through application of a recognized alternative compliance method or by successful application of performance-based analysis and design.

10.0.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with safety and performance issues, and control for alterations, repair, addition or change of occupancy to existing buildings. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 10.0.2. A list of alternate means of verification is provided in Section 10.0.3.

10.0.1.1 Additions to existing construction should meet all requirements for new construction.

10.0.1.1.1 Any part of the existing construction, which is necessary to support the addition, shall have the appropriate load bearing capacity to do so.

10.0.1.1.2 The addition, in combination with the existing construction, should not create an increased hazard to occupants of the existing construction or of the addition above the level that is acceptable for existing construction.

10.0.1.2 Alterations to existing buildings should be such that any changes are no less compliant with the requirements for existing buildings than prior to alterations. Where alterations involve a significant portion of the existing building, modifications should meet the requirements for new construction to the extent practicable.

10.0.1.2.1 Alterations that cause the removal, relocation or impact of the existing structural elements must be evaluated and analyzed to confirm that the structural integrity of the building or space under consideration is not adversely affected and that all required and imposed loads are safely supported.

10.0.1.3 Repair work to existing buildings should be such that the repaired components are no less compliant with the requirements for existing buildings than prior to the repair.

10.0.1.3.1 In cases where damage results in significant impact to structural or other safety systems, evaluation shall be undertaken by a competent and licensed design professional to assess the damage and determine the extent and scope of repair that is required and the materials, components and systems to be used.

10.0.1.4 No change of use is permitted without compliance with all performance requirements for the desired use.

10.0.1.5 Changes to existing building shall not impact building accessibility.

10.0.1.5.1 Additions, alterations or repairs shall not have the effect of reducing accessibility to the building or portions of the building as required for the building use.

10.0.1.5.2 Additions, alterations or repairs shall not impose a greater level of accessibility than that which would be required for new construction.

10.0.1.6 Materials already in use, which comply with requirements or approvals at the time of installation, may remain in use unless they have been determined to be dangerous to the health or safety of occupants.

10.0.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 10.0.2.1 (IBC 3401) GENERAL (EXISTING BUILDINGS AND STRUCTURES)

10.0.2.1.1 (IBC 3401.4) Building materials. Building materials shall comply with the requirements of this section.

10.0.2.1.1.1 (IBC 3401.4.1) Existing materials. Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building code official to be dangerous to life, health or safety. Where such conditions are determined to be dangerous to life, health or safety, they shall be mitigated or made safe.

10.0.2.1.1.2 (IBC 3401.4.2) New and replacement materials. Except as otherwise required or permitted by these guidelines, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not *permit* their use in buildings of similar occupancy, purpose and location.

SECTION 10.0.2.2 (IBC 3403) ADDITIONS

10.0.2.2.1 (IBC 3403.1) General. Additions to any building or structure shall comply with the requirements of these guidelines for new construction. Alterations to the existing building or structure shall be made to ensure that the existing building or structure together with the *addition* are no less conforming with the provisions of these guidelines than the existing building or structure was prior to the *addition*. An existing building together with its additions shall comply with the height and area provisions of IBC Chapter 5.

10.0.2.2.2 (IBC 3403.2) Flood hazard areas. For buildings and structures in flood hazard areas established in IBC Section 1612.3, any *addition* that constitutes substantial improvement of the *existing structure*, as defined in IBC Section 1612.2, shall comply with the flood design requirements for new construction, and all aspects of the *existing structure* shall be brought into compliance with the requirements for new construction for flood design. For buildings and structures in flood hazard areas established in IBC Section 1612.3, any additions that do not constitute substantial improvement or substantial damage of the *existing structure*, as defined in IBC Section 1612.2, are not required to comply with the flood design requirements for new construction.

10.0.2.2.3 (IBC 3403.3) Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an *addition* and its related alterations cause an increase in design gravity load of more than 5% shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased load required by these guidelines for new structures. Any existing gravity load-carrying structural element whose gravity load-carrying capacity is decreased shall be considered an altered element subject to the requirements of Section 10.0.2.3.2 (IBC Section 3404.3). Any existing element that will form part of the lateral load path for any part of the *addition* shall be considered an existing lateral load-carrying structural element subject to the requirements of Section 10.0.2.2.4 (IBC Section 3403.4).

10.0.2.2.3.1 (IBC 3403.3.1) Design live load. Where the *addition* does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads *approved* prior to the *addition*. If the *approved* live load is less than that required by Section 8.1.2.4 (IBC Section 1607), the area designed for the nonconforming live load shall be posted with placards of *approved* design indicating the *approved* live load. Where the *addition* does result in increased design live load, the live load required by Section 8.1.2.4 (IBC Section 1607) shall be used.

10.0.2.2.4 (IBC 3403.4) Existing structural elements carrying lateral load. Where the *addition* is structurally independent of the *existing structure*, existing lateral load-carrying structural elements shall be permitted to remain unaltered. Where the *addition* is not structurally independent of the *existing structure*, the *existing structure* and its *addition* acting together as a single structure shall be shown to meet the requirements of Sections 8.1.2.6 and 8.1.2.10 (IBC Sections 1609 and 1613).

EXISTING STRUCTURES

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the *addition* considered is no more than 10% greater than its demand-capacity ratio with the *addition* ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 8.1.2.6 and 8.1.2.10 (IBC Sections 1609 and 1613). For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction.

SECTION 10.0.2.3 (IBC 3404) ALTERATIONS

10.0.2.3.1 (IBC 3404.1) General. Except as provided by Section 10.0.2.1.1 (IBC Section 3401.4) or this section, alterations to any building or structure shall comply with the requirements of these guidelines for new construction. Alterations shall be such that the existing building or structure is no less complying with the provisions of these guidelines than the existing building or structure was prior to the *alteration*.

Exceptions:

1. An existing *stairway* shall not be required to comply with the requirements of Section 6.1.2.19 (IBC Section 1009) where the existing space and construction does not allow a reduction in pitch or slope.
2. Handrails otherwise required to comply with Section 6.2.2.7.8 (IBC Section 1009.12) shall not be required to comply with the requirements of Section 6.1.2.20.3 (IBC Section 1012.6) regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.

10.0.2.3.2 (IBC 3404.3) Existing structural elements carrying gravity load. Any existing gravity load-carrying structural element for which an *alteration* causes an increase in design gravity load of more than 5 % shall be strengthened, supplemented, replaced or otherwise altered as needed to carry the increased gravity.

10.0.2.3.2.1 (IBC 3404.3.1) Design live load. Where the *alteration* does not result in increased design live load, existing gravity load-carrying structural elements shall be permitted to be evaluated and designed for live loads *approved* prior to the *alteration*. If the *approved* live load is less than that required by Section 8.1.2.4 (IBC Section 1607), the area designed for the nonconforming live load shall be posted with placards of *approved* design indicating the *approved* live load. Where the *alteration* does result in increased design live load, the live load required by Section 8.1.2.4 (IBC Section 1607) shall be used.

10.0.2.3.3 (IBC 3404.4) Existing structural elements carrying lateral load. Except as permitted by IBC Section 3404.5), where the *alteration* increases design lateral loads in accordance with Section 8.1.2.6 or 8.1.2.10 (IBC Section 1609 or 1613, or where the *alteration* results in a structural irregularity as defined in ASCE 7, or where the *alteration* decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall be shown to meet the requirements of Section 8.1.2.6 or 8.1.2.10 (IBC Sections 1609 and 1613).

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the *alteration* considered is no more than 10% greater than its demand-capacity ratio with the *alteration* ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces per Sections 8.1.2.6 and 8.1.2.10 (IBC Sections 1609 and 1613). For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.

10.0.2.3.4 (IBC 3404.5) Voluntary seismic improvements. Alterations to existing structural elements or additions of new structural elements that are not otherwise required by this chapter and are initiated for the purpose of improving the performance of the seismic force-resisting system of an *existing structure* or the performance of seismic bracing or anchorage of existing nonstructural elements shall be permitted, provided that an engineering analysis is submitted demonstrating the following:

1. The altered structure and the altered nonstructural elements are no less in compliance with the provisions of these guidelines with respect to earthquake design than they were prior to the *alteration*.

2. New structural elements are detailed and connected to the existing structural elements as required by IBC Chapter 16.
3. New or relocated nonstructural elements are detailed and connected to existing or new structural elements as required by IBC Chapter 16.
4. The alterations do not create a structural irregularity as defined in ASCE 7 or make an existing structural irregularity more severe.

10.0.2.3.5 (IBC 3404.6) Means of egress capacity factors. Alterations to any existing building or structure shall not be affected by the egress width factors in Section 6.1.2.2.9 (IBC Section 1005.1) for new construction in determining the minimum egress widths or the minimum number of exits in an existing building or structure. The minimum egress widths for the components of the *means of egress* shall be based on the *means of egress* width factors in the building code under which the building was constructed, and shall be considered as complying *means of egress* for any *alteration* if, in the opinion of the building code official, they do not constitute a distinct hazard to life.

SECTION 10.0.2.4 (IBC 3405) REPAIRS

10.0.2.4.1 (IBC 3405.1) General. Buildings and structures, and parts thereof, shall be repaired in compliance with Section 11.0.2.1.1 (IBC Section 3401.2). Work on nondamaged components that is necessary for the required repair of damaged components shall be considered part of the repair and shall not be subject to the requirements for alterations in this chapter. Routine maintenance required by Section 11.0.2.1.1 (IBC Section 3401.2), ordinary repairs exempt from *permit* and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

10.0.2.4.1.1 (IBC 3405.1.1) Dangerous conditions. Regardless of the extent of structural or nonstructural damage, the building code official shall have the authority to require the elimination of conditions deemed dangerous.

SECTION 10.0.2.5 (IBC 3408) CHANGE OF OCCUPANCY

10.0.2.5.1 (IBC 3408.1) Conformance. No change shall be made in the use or occupancy of any building that would place the building in a different division of the same group of occupancies or in a different group of occupancies, unless such building is made to comply with the requirements of these guidelines for such division or group of occupancies. Subject to the approval of the *building official*, the use or occupancy of existing buildings shall be permitted to be changed and the building is allowed to be occupied for purposes in other groups without conforming to all the requirements of these guidelines for those groups, provided the new or proposed use is less hazardous, based on life and fire risk, than the existing use.

10.0.2.5.2 (IBC 3408.2) Certificate of occupancy. A certificate of occupancy shall be issued where it has been determined that the requirements for the new occupancy classification have been met.

10.0.2.5.3 (IBC 3408.3) Stairways. Existing stairways in an *existing structure* shall not be required to comply with the requirements of a new *stairway* as outlined in Section 6.1.2.19 (IBC Section 1009) where the existing space and construction will not allow a reduction in pitch or slope.

SECTION 10.0.2.6 (IBC 3409) HISTORIC BUILDINGS

10.0.2.6.1 (IBC 3409.1) Historic buildings. The provisions of these guidelines relating to the construction, repair, *alteration*, *addition*, restoration and movement of structures, and change of occupancy shall not be mandatory for *historic buildings* where such buildings are judged by the *building official* to not constitute a distinct life safety hazard.

SECTION 10.0.2.7 (IBC 3303) DEMOLITION

10.0.2.7.1 (IBC 3303.1) Construction documents. *Construction documents* and a schedule for demolition must be submitted when required by the *building official*. Where such information is required, no work shall be done until such *construction documents* or schedule, or both, are *approved*.

10.0.2.7.2 (IBC 3303.2) Pedestrian protection. The work of demolishing any building shall not be commenced until pedestrian protection is in place as required by this chapter.

EXISTING STRUCTURES

10.0.2.7.3 (IBC 3303.3) Means of egress. A party wall balcony or *horizontal exit* shall not be destroyed unless and until a substitute *means of egress* has been provided and *approved*.

10.0.2.7.4 (IBC 3303.4) Vacant lot. Where a structure has been demolished or removed, the vacant lot shall be filled and maintained to the existing grade or in accordance with the ordinances of the jurisdiction having authority.

10.0.2.7.5 (IBC 3303.5) Water accumulation. Provision shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

10.0.2.7.6 (IBC 3303.6) Utility connections. Service utility connections shall be discontinued and capped in accordance with the *approved* rules and the requirements of the applicable governing authority.

10.0.3 ALTERNATE MEANS OF VERIFICATION

- 10.0.3.1 Requirements related to safety and performance issues, and control for alterations, repair, addition or change of occupancy to existing buildings, as defined in Chapter 34 of the 2009 IBC, including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the existing buildings provisions of this chapter. As such, compliance with the requirements for safety and performance issues, and control for alterations, repair, addition or change of occupancy to existing buildings can be demonstrated by compliance with applicable sections of Chapter 34 of the 2009 IBC.
- 10.0.3.2 As an alternative to compliance with Chapter 34 of the 2009 IBC, compliance with applicable sections of the 2009 IEBC, shall be permitted.

CHAPTER 11 OPERATIONS AND MAINTENANCE

11.0 OVERVIEW AND KEY CONCEPTS

This chapter addresses operations and maintenance issues for buildings as they apply to maintaining the intended performance of the building and its systems.

General

In general, buildings and structures, and the parts thereof, should be maintained in a safe and sanitary condition throughout the life of the building. Any feature, system, device or safeguard required by these guidelines to maintain health, safety and amenity should be maintained in accordance with the requirements of these guidelines, including performance verification methods, alternate methods of compliance, including all standards and guidelines incorporated by reference into these documents. The building owner, or owner's designated agent, shall be responsible for maintaining the building. As appropriate, the authority having jurisdiction may require statements of compliance (warranty of fitness) attesting to the operating performance of any feature, system, device or safeguard required by these guidelines to maintain health, safety and amenity, and/or may undertake inspections to assess the conditions of such.

Building Features and Systems Inspection, Test and Maintenance

Most building features, systems and components required for health and safety will have requirements for regular inspection, test and maintenance, as identified in relevant standards or legislation. Details will depend on regulations, codes and standards which are applicable to the building, based on the locale of the building (local requirements) and compliance with these guidelines. For example, a fire sprinkler system, where required by these guidelines, will need to be installed in accordance with NFPA 13 or an equivalent standard (see Section 5.2 of these guidelines). NFPA 13, in turn, identifies inspection, test and maintenance schedules and reporting requirements. In some locations, such as New Zealand, an annual "warranty of fitness" for critical systems is also required. Similar requirements will exist for all safety related features and systems of the building. Health and hygiene issues will typically be regulated by local health departments. In all cases, local requirements must be complied with.

Fire Safety Management

In many countries, a fire safety code (or regulation) exists which regulates the safety performance of buildings in use and operation. They typically address such issues as maximum amounts of hazardous materials that may be present, maintaining safety plans for proper storage of materials (e.g., no storage of combustibles in exit enclosures), and related issues. Compliance with applicable fire safety management codes and regulations is essential in maintaining the safe operation of buildings.

Evacuation and Emergency Response Planning

All buildings should have emergency evacuation and response plans for occupant safety in the event of an emergency. These plans should address a wide range of hazard events as appropriate to the location and mission of the facility, from fire, to natural hazards, to deliberate attacks on the people or the facility. Several sources exist for providing guidance on the creation of such plans based on the hazards and conditions of concern. Plans should be updated and tested regularly to help building occupants remain familiar with the plans and to test plan effectiveness.

OPERATIONS AND MAINTENANCE

Summary

Key considerations for addressing operations and maintenance issues for buildings are outlined below. A more detailed discussion on associated design requirements can be found in Section 11.0.2, Performance/Prescriptive Criteria and Means of Verification.

DRIVING FEATURE	IMPACTED BUILDING PERFORMANCE	CONSEQUENCES OF DESIGN CONSIDERATIONS
General requirements	Any feature, system, device or safeguard required by these guidelines to maintain health, safety and amenity should be maintained in a safe and sanitary condition throughout the life of the building.	Such features should be maintained in accordance with the requirements of these guidelines, including performance verification methods, alternate methods of compliance, including all standards and guidelines incorporated by reference into these documents.
Systems and features	Features, systems and components required for health and safety.	Regular inspection, test and maintenance, as identified in relevant standards or legislation.
Fire safety management	Safety performance of buildings in use and operation, including storage of materials, clear exit paths, etc.	Compliance with applicable fire safety management codes and regulations is essential in maintaining the safe operation of buildings.
Evacuation and response plans	Occupant evacuation and emergency response.	Plans should be updated and tested regularly to help occupants remain familiar with plans and to test plan effectiveness.

11.0.1 FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

These guidelines outline general considerations associated with operations and maintenance issues for buildings. UN-occupied buildings must comply with the following functional objectives and performance requirements. Where additional guidance or detail is necessary or required, more specific information in the form of performance/prescriptive criteria is provided in Section 11.0.2. A list of alternate means of verification is provided in Section 11.0.3.

- 11.0.1.1 Buildings and structures, and the parts thereof, should be maintained in a safe and sanitary condition throughout the life of the building.
 - 11.0.1.1.1 Any feature, system, device or safeguard required by these guidelines to maintain health, safety and amenity should be maintained in accordance with the requirements of these guidelines, including performance verification methods, alternate methods of compliance, including all standards and guidelines incorporated by reference into these documents.
 - 11.0.1.1.2 Any building feature, system or component required for health and safety shall be regularly inspected, tested and maintained in a manner specified in relevant standards, guidelines or legislation.
- 11.0.1.2 Buildings must comply with applicable fire safety management regulations and legislation.
- 11.0.1.3 Buildings should have emergency evacuation and response plans for occupant safety.
 - 11.0.1.3.1 Emergency evacuation and response plans should address a wide range of hazard events as appropriate to the location and mission of the facility, from fire, to natural hazards, to deliberate attacks on the people or the facility.
 - 11.0.1.3.2 Emergency evacuation and response plans should be regularly updated and tested.

11.0.2 PERFORMANCE/PRESCRIPTIVE CRITERIA AND MEANS OF VERIFICATION

The Performance and Prescriptive criteria and the Means of Verification contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

SECTION 11.0.2.1 (IBC 3401) GENERAL (EXITING BUILDINGS AND STRUCTURES)

11.0.2.1.1 (IBC 3401.2) Maintenance. Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices or safeguards which are required by these guidelines shall be maintained in conformance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for the maintenance of buildings and structures. To determine compliance with this subsection, the building official shall have the authority to require a building or structure to be reinspected. The requirements of this chapter shall not provide the basis for removal or abrogation of fire protection and safety systems and devices in existing structures.

SECTION 11.0.2.2 (IBC 106) FLOOR AND ROOF DESIGN LOADS

11.0.2.2.1 (IBC 106.1) Live loads posted. Where the live loads for which each floor or portion thereof of a commercial or industrial building is or has been designed to exceed 2.400 kPa, such design live loads shall be conspicuously posted by the owner in that part of each *story* in which they apply, using durable signs. It shall be unlawful to remove or deface such notices.

11.0.2.2.2 (IBC 106.3) Restrictions on loading. It shall be unlawful to place, or cause or permit to be placed, on any floor or roof of a building, structure or portion thereof, a load greater than is permitted by these guidelines.

SECTION 11.0.2.3 (IBC 116) UNSAFE STRUCTURES AND EQUIPMENT

11.0.2.3.1 (IBC 116.1) Conditions. Structures or existing equipment that are or hereafter become unsafe, insanitary or deficient because of inadequate *means of egress* facilities, inadequate light and ventilation, or which constitute a fire hazard, or are otherwise dangerous to human life or the public welfare, or that involve illegal or improper occupancy or inadequate maintenance, shall be deemed an unsafe condition. Unsafe structures shall be taken down and removed or made safe, as the *building official* deems necessary and as provided for in this section. A vacant structure that is not secured against entry shall be deemed unsafe.

11.0.3 ALTERNATE MEANS OF VERIFICATION

- 11.0.3.1 Requirements related to operations and maintenance issues for buildings, as defined in Chapter 34 of the 2009 *International Building Code*® (IBC®), including all references to provisions in other chapters of the 2009 IBC and to all standards incorporated by reference, are deemed-to-comply with the operations and maintenance provisions of this chapter. As such, compliance with the requirements for operations and maintenance issues for buildings can be demonstrated by compliance with applicable sections of Chapter 34 of the 2009 IBC.
- 11.0.3.2 Requirements related to fire safety management issues for buildings, as defined in the 2009 *International Fire Code*® (IFC®), including all references to provisions in other chapters of the 2009 IFC and to all standards incorporated by reference, are deemed-to-comply with the fire safety management provisions of this chapter. As such, compliance with the requirements for fire safety management issues for buildings can be demonstrated by compliance with the 2009 IFC.

CHAPTER 12 REFERENCED STANDARDS

REFERENCED STANDARDS

(The referenced standards included in the list below are the editions referenced in the 2009 IBC.
Newer editions of these standards may be available.)

AA

Aluminum Association
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209

Standard Reference number	Title	Reference in guidelines section
ADM1—05	Aluminum Design Manual	8.1.2.1.3.5 (IBC 1604.3.5), 8.3.2.5.1 (IBC 2002.1)
ASM 35—00	Aluminum Sheet Metal Work in Building Construction	8.3.2.5.1 (IBC 2002.1)

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

Standard Reference number	Title	Reference in guidelines section
318—08	Building Code Requirements for Structural Concrete	8.1.2.1.3.2 (IBC 1604.3.2), 8.3.2.1.1 (IBC 1901.2), 8.3.2.1.2 (IBC 1901.3), 8.3.2.1.3 (IBC 1901.4), 8.3.2.2.1 (IBC 1904.1), 8.3.2.2.2 (IBC 1904.2), 8.3.2.2.3 (IBC 1904.3), 8.3.2.2.4.1 (IBC 1904.4.1), 8.3.2.2.4.2 (IBC 1904.4.2), 8.3.2.2.5 (IBC 1904.5), 8.3.2.3.1.1 (IBC 1905.1.1), 8.3.2.3.2 (1905.2), 8.3.2.3.3 (1905.3), 8.3.2.3.4 (IBC 1905.4), 8.3.2.3.5 (IBC 1905.5), 8.3.2.3.6.2 (IBC 1905.6.2), 8.3.2.3.6.3 (IBC 1905.6.3), 8.3.2.3.6.4 (IBC 1905.6.4), 8.3.2.3.6.5 (IBC 1905.6.5), 8.3.2.3.7 (IBC 1905.7), 8.3.2.3.8 (IBC 1905.8), 8.3.2.3.9 (IBC 1905.9), 8.3.2.3.10 (IBC 1905.10), 8.3.2.3.11 (IBC 1905.11), 8.3.2.3.12 (IBC 1905.12), 8.3.2.3.13 (1905.13), 8.3.2.4.1 (IBC 1906.1), 8.3.2.4.2 (IBC 1906.2), 8.3.2.4.3 (1906.3), 8.3.2.4.4 (1906.4)
530—08	Building Code Requirements for Masonry Structures	8.1.2.1.3.4 (IBC 1604.3.4), 8.3.2.6.1 (IBC 2101.1)

AISC

American Institute of Steel Construction
One East Wacker Drive,
Suite 700
Chicago, IL 60601-18021

Standard Reference number	Title	Reference in guidelines section
360—05	Specification for Structural Steel Buildings	8.1.2.1.3.3 (IBC 1604.3.3), 8.3.2.7.1 (IBC 2205.1)

AISI

American Iron and Steel Institute
1140 Connecticut Avenue
Suite 705
Washington, DC 20036

Standard Reference number	Title	Reference in guidelines section
S100—07	North American Specification for the Design of Cold-Formed Steel Structural Members	8.1.2.1.3.3 (IBC 1604.3.3)

REFERENCED STANDARDS

ANSI

American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036

Standard Reference number	Title	Reference in guidelines section
Z 97.1—04	Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test	6.4.2.1.1.2 (IBC 2406.1.2), 6.4.2.1.2 (IBC 2406.2), Table 6.4.2.1.2(2) [IBC Table 2406.2(2)], 6.4.2.1.3.1 (IBC 2406.3.1), 6.4.2.2.1 (IBC 2407.1), 6.4.2.3.1 (IBC 2409.1), 6.4.2.3.2 (IBC 2409.2), 6.4.2.3.3.1 (IBC 2409.3.1)

ASCE

American Society of Civil Engineers
Structural Engineering Institute
1801 Alexander Bell Drive
Reston, VA 20191-4400

Standard Reference number	Title	Reference in guidelines section
3—91	Structural Design of Composite Slabs	8.1.2.1.3.3 (IBC 1604.3.3)
5—08	Building Code Requirements for Masonry Structures	8.1.2.1.3.4 (IBC 1604.3.4), 8.3.2.6.1 (IBC 2101.1)
7—05	Minimum Design Loads for Buildings and Other Structures	8.1.0, 8.1.2.1.3 (IBC 1604.3), 8.1.2.1.7.2 (IBC 1604.8.2), 8.1.2.1.9 (IBC 1604.10), 8.1.2.2.1 (IBC 1605.1), 8.1.2.2.2 (IBC 1605.2.2), 8.1.2.2.3.1.2 (IBC 1605.3.1.2), 8.1.2.2.3.2 (1605.3.2), 8.1.2.5.1 (1608.1), 8.1.2.6.1.1 (IBC 1609.1.1), 8.1.2.8.2 (IBC 1611.2), 8.1.2.10.1 (IBC 1613.1), 8.2.2.2.2.1 (IBC 1808.3.1), 8.3.0, 10.0.2.3.3 (IBC 3404.4), 10.0.2.3.4 (IBC 3404.5)
8—02	Specification for the Design of Cold-Formed Stainless Steel Structural Members	8.1.2.1.3.3 (IBC 1604.3.3)
24—05	Flood Resistant Design and Construction	6.3.3.1

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Standard Reference number	Title	Reference in guidelines section
A17.1—2007/ CSA B44—07	Safety Code for Elevators and Escalators	6.1.2.22.4 (IBC 1007.4), 6.2.2.9.8.2 (IBC 3411.8.2), 6.3.2.1.5 (IBC 3002.5), 6.3.2.2.2 (IBC [F] 3003.2)
A18.1—2005	Safety Standard for Platform Lifts and Stairway Chairlifts	6.2.2.9.8.3 (IBC 3411.8.3)
B 20.1—2006	Safety Standards for Conveyors and Related Equipment	6.3.3.1
A90.1—03	Safety Standard for Belt Manlifts	6.3.3.1

ASTM

American Society of Testing and Materials
100 Barr Harbor Drive
West Conshohocken, PA 10428-2959

Standard Reference number	Title	Reference in guidelines section
C 1629/ C 1629M—06	Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels	4.2.2.1.1.2.1 (IBC 403.2.3.2), 4.2.2.1.1.2.3 (IBC 403.2.3.4)
D 422—63 (2002)e01	Test method for Particle-Size Analysis of Soils	8.2.2.1.5.3 (IBC 1803.5.3)
D 2487—06	Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)	8.1.2.7.1 (IBC 1610.1), Table 8.1.2.7.1 (IBC Table 1610.1), 8.2.2.1.5.1 (IBC 1803.5.1)

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ASTM—continued

D 2898—07	Test Method for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.....	5.5.2.3.1 (IBC 1505.1)
D 4318—05	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.....	8.2.2.1.5.3 (IBC 1803.5.3)
D 4829—07	Standard Test Method for Expansion Index of Soils	8.2.2.1.5.3 (IBC 1803.5.3)
E 84—07	Standard Test Method for Surface Burning Characteristics of Building Materials	5.3.2.1.1.1 (IBC 803.1.1), 5.3.2.1.2 (IBC 803.9)
E 90—04	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.....	7.1.2.5.1, (IBC 1207.2.1)
E 108—07a	Standard Test Methods for Fire Tests of Roof Coverings.....	5.5.2.3.1 (IBC 1505.1)
E 119—07	Standard Test Methods for Fire Tests of Building Construction and Material	5.2.0, 5.2.2.2.5.5 (IBC 705.8.5), 5.2.2.4.6 (IBC 707.6), 5.2.2.9.3.2 (IBC 712.3.2), 5.2.2.10.1.1 (IBC 713.3.1), 5.2.2.10.2.1.1 (IBC 713.4.1.1), 5.2.2.11.1 (IBC 714.1), 5.2.2.12.2 (IBC 715.2), 5.2.2.12.4.3.4 (IBC 715.4.5), 5.2.2.13.5.2 (IBC 716.5.2), 5.2.2.13.5.3 (IBC 716.5.3), 5.2.2.13.6.1 (IBC 716.6.1), 5.2.2.13.6.2.1 (IBC 716.6.2.1)
E 492—09	Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine	7.1.2.5.2 (IBC 1207.3)
E 736—00 (2006)	Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members	5.2.2.1.11.3.2 (IBC 704.13.3.2)
E 814—06	Standard Test Method for Fire Tests of Penetration Firestop Systems	5.2.2.10.1.1.2 (IBC 713.3.1.2), 5.2.2.10.2.1.1.2 (IBC 713.4.1.1.2)
E 1966—01	Standard Test Method for Fire-Resistive Joint Systems.....	5.2.2.11.3 (IBC 714.3)
E 2307—04e01	Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus.....	5.2.2.11.4 (IBC 714.4)

AWPA

American Wood Protection Association
P.O. Box 361784
Birmingham, AL 35236-1784

Standard Reference number	Title	Reference in guidelines section
C1—03	All Timber Products—Preservative Treatment by Pressure Process.....	5.5.2.3.6 (IBC 1505.6)
U1—07	User Specification for Treated Wood	7.3.2.1.4 (IBC 1403.5)

BHMA

Builders Hardware Manufacturers' Association
355 Lexington Avenue, 17th Floor
New York, NY 10017-6603

Standard Reference number	Title	Reference in guidelines section
A 156.10—06	Power Operated Pedestrian Doors.....	6.1.2.18.1.4.2 (IBC 1008.1.4.2)
A 156.19—02	American National Standard for Power Assist And Low Energy Power Operated Doors	6.1.2.18.1.4.2 (IBC 1008.1.4.2)

CFPA-E

The Confederation of Fire Protection Association Europe
Danish Institute of Fire and Security Technology
Jernholmen 12
DK 2650 Hvidovre

Standard Reference number	Title	Reference in guidelines section
CFPA—09	Fire Prevention on Construction Site.....	9.0.0

REFERENCED STANDARDS

CPSC

Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814-4408

Standard Reference number	Title	Reference in guidelines section
16 CFR Part 1201— (1977),	Federal Safety Standard for Architectural Glazing Materials	5.3.2.2.4.1 (IBC 804.4.1), 6.4.2.1.2 (IBC 2406.2), Table 6.4.2.1.2(1) [IBC Table 2406.2(1)], 6.4.2.1.3.1 (IBC 2406.3.1), 6.4.2.2.1 (IBC 2047.1), 6.4.2.3.1 (IBC 2409.1), 6.4.2.3.2 (IBC 2409.2), 6.4.2.3.3.1 (IBC 2409.3.1)
16 CFR Part 1630— (2000)	Standard for the Surface Flammability of Carpets and Rugs	5.3.2.2.4.1 (IBC 804.4.1)

CSA

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario Canada L4W 5N6

Standard Reference number	Title	Reference in guidelines section
B 44—07	Safety Code for Elevators, and Escalators, Dumbwaiters, Moving Walks, Material Lifts and Dumbwaiters with Automatic Transfer Devices	6.3.2.1.5 (IBC 3002.5), 6.3.2.2.2 (IBC [F] 3003.2), 6.3.3.1

FM

Factory Mutual Global Research
Standards Laboratories Department
1301 Atwood Avenue, P.O. Box 7500
Johnston, RI 02919

Standard Reference number	Title	Reference in guidelines section
4450 (1989)	Approval Standard for Class 1 Insulated Steel Deck Roof— with Supplements through July 1992	7.3.2.3.1 (IBC 1508.1)

ICC

International Code Council, Inc.
500 New Jersey Ave., NW
Washington, DC 20001

Standard Reference number	Title	Reference in guidelines section
ICC/ANSI Standard A117.1—03	Accessible and Useable Buildings and Facilities	6.1.2.10.8 (IBC 1022.8), 6.1.2.14.6.5 (IBC 1010.6.5), 6.1.2.14.9 (IBC 1010.9), 6.2.0, 6.2.2.1.1 (IBC 1101.2), 6.2.2.6.1.2 (IBC 1108.2.2), 6.2.2.6.1.3 (IBC 1108.2.3), 6.2.2.7.2 (1109.2), 6.2.2.7.2.1 (IBC 1109.2.2), 6.2.2.7.2.2 (IBC 1109.2.3), 6.2.2.7.3 (IBC 1109.3), 6.2.2.7.4 (IBC 1109.4), 6.2.2.7.7 (IBC 1109.8), 6.2.2.9.6 (IBC 3411.6), 6.2.2.9.8.2 (IBC 3411.8.2), 6.2.2.9.8.3 (IBC 3411.8.3), 6.2.3.2 7.2.2.2.4 (IBC 2902.4), Appendix A
ICC 300—07	ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands	6.1.2.16.1.1 (IBC 1028.1.1)
ICC 400—07	Standard on Design and Construction of Log Structures	8.3.2.8.1 (IBC 2301.1)
ICC G2—10	Guideline for Acoustics	7.1.1.4, 7.1.3.1, 7.1.3.5
ICC PC—09	Performance Code® for Buildings and Facilities	8.1.0, 6.3.1.1.1, 6.3.1.1.2, 6.3.1.1.3, 6.3.1.1.4, 6.3.1.1.5, 6.3.1.1.6, 6.3.1.4, 6.3.1.5, 6.3.1.6, 6.3.1.7, 6.3.1.8, 6.4.1.3.2, 6.4.1.6.1, 6.4.1.6.2, 6.4.1.6.3, 6.4.1.6.4, 6.4.1.6.5

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ICC—continued

IEBC—09	International Existing Building Code®	10.0.0, 10.0.3.2
IECC—09	International Energy Conservation Code®	7.1.2.8.1 (IBC 1301.1.1)
IFC—09	International Fire Code®	4.2.2.1.3.4 (IBC 403.4.4), 5.2.2.2.5.1 (IBC 705.8.1), 5.2.2.4.1 (IBC 707.1), 5.4.2.1.2 (IBC 901.2), 5.4.2.1.3.2 (IBC 901.6.2), 5.4.2.6.3.2 (IBC [F] 907.2.13.2), 5.4.2.8.3.3 (IBC [F] 912.3.3), 6.4.3.1, 7.1.2.1.2.2 (IBC 1203.4.2), 7.2.3.4, 9.0.0, 11.0.3.2
IFGC—09	International Fuel Gas Code®	7.2.2.2.1 (IBC 2801.1), 7.2.3.4,
IgCC—12	International Green Construction Code™	7.1.0, 7.1.1.7, 7.1.3.3
IMC—09	International Mechanical Code®	5.2.2.5.2 (IBC 708.2), 5.2.2.13.2.2 (IBC 716.2.2), 5.2.2.13.5.3 (IBC 716.5.3), 5.2.2.13.5.4 (IBC 716.5.4), 5.2.2.13.6.1 (IBC 716.6.1), 5.2.2.13.6.2 (IBC 716.6.2), 5.2.2.13.6.3 (IBC 716.6.3), 5.4.2.6.4.1 (IBC [F] 907.3.1), 6.1.2.3.5.1 (IBC 1018.5.1), 6.1.2.8.5 (IBC 1015.5), 6.3.2.3.3.1 (IBC 3004.3.1), 7.1.2.1.1 (IBC 1203.1), 7.1.2.1.2.2 (IBC 1203.4.2), 7.1.2.1.2.2.1 (IBC 1203.4.2.1), 7.2.2.2.1 (IBC 2801.1), 7.2.3.2
IPC—09	International Plumbing Code®	5.4.2.8.5 (IBC [P] 912.5), 7.1.2.4.3.3 (IBC 1206.3.3), Table 7.2.2.3.1 (IBC [P] Table 2902.1), 7.2.3.3, 7.3.2.2.4 (IBC [P] 1503.4), 9.0.2.3.1 (IBC 3305.1)

ISO

International Organization for Standardization
ISO Central Secretariat
1 ch, de la Voie-Creuse, Case Postale 56
CH-1211 Geneva 20, Switzerland

Standard Reference number	Title	Reference in guidelines section
ISO 834	Fire-resistance tests—Elements of building construction— Part 8: Specific requirements for non-loadbearing vertical separating elements	5.2.0

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

Standard Reference number	Title	Reference in guidelines section
13—07	Standard for the Installation of Sprinkler.....	4.1.2.6.2 (IBC 505.2), 4.1.2.6.4 (IBC 505.4), Table 4.1.2.7.4 (IBC Table 508.4), 4.1.2.8.1 (IBC 509.2), 4.2.2.1.2 (IBC 403.3), Table 5.1.2.1.1(1) (IBC Table 601), 5.2.2.2.5.2 (IBC 705.8.2), Table 5.2.2.2.5 (IBC Table 705.8), 5.2.2.2.5.5 (IBC 705.8.5), 5.2.2.3.5 (IBC 706.5), 5.2.2.3.7 (IBC 706.8), 5.2.2.4.6 (IBC 707.6), 5.2.2.5.2 (IBC 708.2), 5.2.2.5.13.1 (IBC 708.14.1), 5.2.2.6.4 (IBC 709.4), 5.2.2.12.4.3.3 (IBC 715.4.4), 5.2.2.12.4.3.3.1 (IBC 715.4.4.1), 5.2.2.13.5.3 (IBC 716.5.3), Table 5.3.2.1.2 (IBC Table 803.9), 5.3.2.1.4.2 (IBC 803.11.2), 5.3.2.2.4.1 (IBC 804.4.1), 5.4.2.4.1 (IBC [F] 905.3.1), 5.4.2.6.1 (IBC [F] 907.2.1), 5.4.2.6.2 (IBC [F] 907.2.2), 5.4.2.6.3.1 (IBC [F] 907.2.13.1), 6.1.2.2.13 (IBC 1014.3), 6.1.2.3.4 (IBC 1018.4), 6.1.2.5.1 (IBC 1016.1), 6.1.2.8.2.1 (IBC 1015.2.1), 6.1.2.15.6 (IBC 1026.6), 6.1.2.16.5.2.3 (IBC 1028.6.2.3), 6.1.2.17.1 (IBC 1027.1), 6.1.2.18.1.9.3 (IBC 1008.1.9.4), 6.1.2.22.2.1 (IBC 1007.2.1), 6.1.2.22.3 (IBC 1007.3), 6.1.2.22.4 (IBC 1007.4), 6.3.2.3.1 (IBC 3004.1), 11.0.0
13R—07	Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height.....	6.1.2.8.2.1 (IBC 1015.2.1), 6.1.2.15.6 (IBC 1026.6), 6.1.2.17.1 (IBC 1027.1), 6.1.2.22.2.1 (IBC 1007.2.1), 6.1.2.22.3 (IBC 1007.3), 6.1.2.22.4 (IBC 1007.4)
20—07	Installation of Stationary Pumps for Fire Protection.....	5.4.2.9.1 (IBC [F] 913.1), 5.4.2.9.2 (IBC [F] 913.2)
70—08	National Electrical Code.....	5.4.2.3.3.1 (IBC [F] 904.3.1), 7.2.2.1.1 (IBC 2701.1)
72—07	National Fire Alarm Code.....	5.4.2.1.3 (IBC 901.6), 5.4.2.3.3.5 (IBC [F] 904.3.5), 5.4.2.6.4 (IBC [F] 907.3), 5.4.2.6.6.2.1.2 (IBC 907.5.2.1.2)

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REFERENCED STANDARDS

NFPA—continued

80—07	Standard for Fire Doors and Other Opening Protectives	4.1.2.7.2.4.2 (IBC 508.2.5.2), 5.2.2.12.4 (IBC 715.4), 5.2.2.12.4.3.5 (IBC 715.4.6), 5.2.2.12.4.3.6.1 (IBC 715.4.7.1), 5.2.2.12.4.3.7.2 (IBC 715.4.8.2), 5.2.2.12.5 (IBC 715.5), 5.2.2.12.5.5 (IBC 715.5.5), 6.1.2.18.1.4.3 (IBC 1008.1.4.3)
101—06	Life Safety Code	6.1.2.16.6.2 (IBC 1028.6.2)
105—07	Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives	5.2.2.8.5.2 (IBC 711.5.2), 5.2.2.12.4.3.1 (IBC 715.4.3.1)
241—09	Standard for Safeguarding Construction, Alteration and Demolition Operations	9.0.0
252—03	Standard Methods of Fire Tests of Door Assemblies	5.2.2.12.3 (IBC 715.3), 5.2.2.12.4.1 (IBC 715.4.1), 5.2.2.12.4.3 (IBC 715.4.3), 5.2.2.12.4.3.6.3.1 (IBC 715.4.7.3.1)
253—06	Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source	5.3.2.2.2 (IBC 804.2), 5.3.2.2.3 (IBC 804.3)
257—07	Standard on Fire Test for Window and Glass Block Assemblies	5.2.2.12.3 (IBC 715.3), 5.2.2.12.4.3.2 (IBC 715.4.3.2), 5.2.2.12.5 (IBC 715.5), 5.2.2.12.5.1 (IBC 715.5.1), 5.2.2.12.5.2 (IBC 715.5.2), 5.2.2.12.5.9.1 (IBC 715.5.9.1),
268—07	Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source	5.5.2.2.2.1 (IBC 1406.2.1), 5.5.2.2.2.1.1 (IBC 1406.2.1.1), 5.5.2.2.2.1.2 (IBC 1406.2.1.2)
286—06	Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	5.3.2.1.1.2 (IBC 803.1.2), 5.3.2.1.2 (IBC 803.9)
288—07	Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies	5.2.2.9.8 (IBC 712.8)

SJI

Steel Joist Institute
1173B London Links Drive
Forest, VA 24551

Standard Reference number	Title	Reference in guidelines section
CJ-1.0—06	Standard Specification for Composite Steel Joists C-J series	8.1.2.1.3.3 (IBC 1604.3.3)
JG-1.1—05	Standard Specification for Joist Girders	8.1.2.1.3.3 (IBC 1604.3.3)
K-1.1—05	Standard Specification for Open Web Steel Joists, K Series	8.1.2.1.3.3 (IBC 1604.3.3)
LH/DLH-1.1—05	05, Standard Specification for Longspan Steel Joists L,H Series and Deep Longspan Steel Joist DLH- Series	8.1.2.1.3.3 (IBC 1604.3.3)

TMS

The Masonry Society
3970 Broadway, Unit 201-D
Boulder, CO 80304-1135

Standard Reference number	Title	Reference in guidelines section
0302—07	Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls	7.1.2.5.1 (IBC 1207.2.1)
402—08	Building Code Requirements for Masonry Structures	8.1.2.1.3.4 (IBC 1604.3.4), 8.3.2.6.1 (IBC 2101.1)



Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

Standard Reference number	Title	Reference in guidelines section
9—00	Fire Tests of Window Assemblies	5.2.2.12.3 (IBC 715.3), 5.2.2.12.4.3.2 (IBC 715.4.3.2), 5.2.2.12.5 (IBC 715.5), 5.2.2.12.5.1 (IBC 715.5.1), 5.2.2.12.5.2 (IBC 715.5.2), 5.2.2.12.5.9.1 (715.5.9.1)
10A—98	Tin Clad Fire Doors—with Revisions through March 2003	5.2.2.12.4 (IBC 715.4)
10B—97	Fire Tests of Door Assemblies	5.2.2.12.4.2 (IBC 715.4.2)
10C—98	Positive Pressure Fire Tests of Door Assemblies	5.2.2.12.4.1 (IBC 715.4.1), 5.2.2.12.4.3 (IBC 715.4.3), 6.1.2.18.1.10.1 (1008.1.10.1)
14B—98	Sliding Hardware for Standard Horizontally-mounted Tin Clad Fire Doors— with Revisions through July 2000	5.2.2.12.4 (IBC 715.4)
14C—06	Swinging Hardware for Standard Tin Clad Fire Doors Mounted Singly and in Pairs	5.2.2.12.4 (IBC 715.4)
263—03	Fire Tests of Building Construction and Materials	5.2.2.2.5.5 (IBC 705.8.5), 5.2.2.4.6 (IBC 707.6), 5.2.2.9.3.2 (IBC 712.3.2), 5.2.2.10.1.1 (IBC 713.3.1), 5.2.2.10.2.1.1 (IBC 713.4.1.1), 5.2.2.11.1 (IBC 714.1), 5.2.2.12.2 (IBC 715.2), 5.2.2.12.4.3.4 (IBC 715.4.5), 5.2.2.13.5.2 (IBC 716.5.2), 5.2.2.13.5.3 (IBC 716.5.3), 5.2.2.13.6.1 (IBC 716.6.1), 5.2.2.13.6.2.1 (IBC 716.6.2.1)
305—07	Panic Hardware	6.1.2.18.1.10.1 (IBC 1008.1.10.1)
555—2006	Fire Dampers	5.2.2.13.3.1 (IBC 716.3.1)
555C—2006	Smoke Dampers	5.2.2.13.3.1 (IBC 716.3.1)
555S—99	Ceiling Dampers	5.2.2.13.3.1 (IBC 716.3.1)
723—03	Test for Surface Burning Characteristics of Building Materials	5.3.2.1.1.1 (IBC 803.1.1), 5.3.2.1.2 (IBC 803.9)
790—04	Standard Test Methods for Fire Tests of Roof Coverings	5.5.2.3.1 (IBC 1505.1)
1256—02	Fire Test of Roof Deck Construction—with Revisions through January 2007	7.3.2.3.1 (IBC 1508.1)
1479—03	Fire Tests of Through-Penetration Firestops	5.2.2.10.1.1.2 (IBC 713.3.1.20), 5.2.2.10.2.1.1.2 (IBC 713.4.1.1.2)
1784—01	Air Leakage Tests of Door Assemblies	5.2.2.5.13.1 (IBC 708.14.1), 5.2.2.8.5.2 (711.5.2), 5.2.2.12.4.3.1 (IBC 715.4.3.1), 5.2.2.12.4.3.5.1 (IBC 715.4.6.1) 5.2.2.12.4.3.5.3 (IBC 715.4.6.3)
2079—04	Tests for Fire Resistance of Building Joint Systems	5.2.2.11.3 (IBC 714.3), 5.2.2.11.6 (IBC 714.6)

APPENDIX A

DEFINITIONS

The definitions contained in this section are excerpted from the 2009 *International Building Code*® (IBC®), a copyrighted publication of the International Code Council, Inc. Reference should be made to the copyright page of these guidelines for a complete copyright notice.

ACCESSIBLE. A *site*, building, *facility* or portion thereof that complies with Section 6.2.

ACCESSIBLE MEANS OF EGRESS. A continuous and unobstructed way of egress travel from any *accessible* point in a building or facility to a *public way*.

ACCESSIBLE ROUTE. A continuous, unobstructed path that complies with Section 6.2.

ADDITION. An extension or increase in floor area or height of a building or structure.

AISLE. An unenclosed *exit access* component that defines and provides a path of egress travel.

AISLE ACCESSWAY. That portion of an *exit access* that leads to an *aisle*.

ALLOWABLE STRESS DESIGN. A method of proportioning structural members, such that elastically computed stresses produced in the members by *nominal loads* do not exceed specified allowable stresses (also called “working stress design”).

ALTERATION. Any construction or renovation to an existing structure other than repair or *addition*.

ANCHOR BUILDING. An exterior perimeter building of a group other than H having direct access to a *covered mall building* but having required *means of egress* independent of the mall.

ANNULAR SPACE. The opening around the penetrating item.

APPROVED. Acceptable to the code official or authority having Jurisdiction.

APPROVED AGENCY. An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

AREA OF REFUGE. An area where persons unable to use *stairways* can remain temporarily to await instructions or assistance during emergency evacuation.

ATTIC. The space between the ceiling beams of the top story and the roof rafters.

AUTOMATIC SPRINKLER SYSTEM. An automatic sprinkler system, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The system includes a suitable water supply. The portion of the system above the ground is a network of specially sized or hydraulically designed piping installed in a structure or area, generally overhead, and to which automatic sprinklers are connected in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the fire area.

BUILDING. Any structure used or intended for supporting or sheltering any use or occupancy.

BUILDING OFFICIAL. The officer or other designated authority charged with the administration and enforcement of the code, or a duly authorized representative.

CIRCULATION PATH. An exterior or interior way of passage from one place to another for pedestrians.

CLINIC, OUTPATIENT. Buildings or portions thereof used to provide medical care on less than a 24-hour basis to individuals who are not rendered incapable of self-preservation by the services provided.

COMMON PATH OF EGRESS TRAVEL. That portion of *exit access* which the occupants are required to traverse before two separate and distinct paths of egress travel to two *exits* are available. Paths that merge are common paths of travel. Common paths of egress travel should be included within the permitted travel distance.

COMMON USE CIRCULATION PATHS. Interior or exterior *circulation paths*, rooms, spaces or elements that are not for public use and are made available for the shared use of two or more people.

CONSTANTLY ATTENDED LOCATION. A designated location at a facility staffed by trained personnel on a continuous basis where alarm or supervisory signals are monitored and facilities are provided for notification of the fire department or other emergency services.

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*.

CORRIDORS. An enclosed *exit access* component that defines and provides a path of egress travel to an *exit*.

COURTS. An open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices.

COVERED MALL BUILDING. A single building enclosing a number of tenants and occupants, such as retail stores, drinking and dining establishments, entertainment and amusement facilities, passenger transportation terminals, offices and other similar uses wherein two or more tenants have a main entrance into one or more malls. For the purpose of this chapter, *anchor buildings* shall not be considered as a part of the *covered mall building*. The term “covered mall building” shall include open mall buildings as defined below.

Mall. A roofed or covered common pedestrian area within a *covered mall building* that serves as access for two or more tenants and not to exceed three levels that are open to each other. The term “mall” shall include open malls as defined below.

Open mall. An unroofed common pedestrian way serving a number of tenants not exceeding three levels. Circulation at levels above grade shall be permitted to include open exterior balconies leading to *exits* discharging at grade.

Open mall building. Several structures housing a number of tenants, such as retail stores, drinking and dining establishments, entertainment and amusement facilities, offices, and other similar uses, wherein two or more tenants have a main entrance into one or more open malls. For the purpose of Chapter 4 of the *International Building Code*, *anchor buildings* are not considered as a part of the open mall building.

DOOR, BALANCED. A door equipped with double-pivoted hardware so designed as to cause a semicounter balanced swing action when opening.

DWELLING UNITS. A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

EMPLOYEE WORK AREA. All or any portion of a space used only by employees and only for work. *Corridors*, toilet rooms, kitchenettes and break rooms are not *employee work areas*.

EXISTING STRUCTURE. A structure erected prior to the date of adoption of the appropriate code, or one for which a legal building permit has been issued.

EXIT. That portion of a *means of egress* system which is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives as required to provide a protected path of egress travel between the *exit access* and the *exit discharge*. Exits include exterior exit

doors at the *level of exit discharge*, vertical *exit enclosures*, *exit passageways*, *exterior exit stairways*, *exterior exit ramps* and *horizontal exits*.

EXIT ACCESS. That portion of a *means of egress* system that leads from any occupied portion of a building or structure to an *exit*.

EXIT ACCESS DOORWAY. A door or access point along the path of egress travel from an occupied room, area or space where the path of egress enters an intervening room, corridor, unenclosed *exit access stair* or unenclosed *exit access ramp*.

EXIT DISCHARGE. That portion of a *means of egress* system between the termination of an *exit* and a *public way*.

EXIT DISCHARGE, LEVEL OF. The *story* at the point at which an *exit* terminates and an *exit discharge* begins.

EXIT ENCLOSURE. An *exit* component that is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a vertical or horizontal direction to the *exit discharge* or the *public way*.

EXIT, HORIZONTAL. A path of egress travel from one building to an area in another building on approximately the same level, or a path of egress travel through or around a wall or partition to an area on approximately the same level in the same building, which affords safety from fire and smoke from the area of incidence and areas communicating therewith.

EXIT PASSAGEWAY. An *exit* component that is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a horizontal direction to the *exit discharge* or the *public way*.

EXTERIOR WALL. A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a *fire wall*, and that has a slope of 60 degrees or greater with the horizontal plane.

EXTERIOR WALL COVERINGS. A material or assembly of materials applied on the exterior side of exterior walls for the purpose of providing a weather-resisting barrier, insulation or for aesthetics, including but not limited to, veneers, siding, exterior insulation and finish systems, architectural *trim* and embellishments such as cornices, soffits, fascias, gutters and leaders.

EXTERIOR WALL ENVELOPE. A system or assembly of *exterior wall* components, including *exterior wall* finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.

FIRE AREA. The aggregate floor area enclosed and bounded by fire walls, *fire barriers*, *exterior walls* or *horizontal assemblies* of a building. Areas of the building not provided with surrounding walls shall be included in the fire area if such areas are included within the horizontal projection of the roof or floor next above.

FIRE BARRIER. A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

FIRE DOOR. The door component of a fire door assembly.

FIRE DOOR ASSEMBLY. Any combination of a fire door, frame, hardware and other accessories that together provide a specific degree of fire protection to the opening.

FIRE PARTITION. A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

FIRE PROTECTION RATING. The period of time that an opening protective will maintain the ability to confine a fire as determined by tests prescribed in Section 5.2.2.12 (IBC Section 715). Ratings are stated in hours or minutes.

FIRE-RESISTANCE RATING. The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in IBC Section 703.

FIRE-RETARDANT-TREATED WOOD. Pressure-treated lumber and plywood that exhibit reduced surface-burning characteristics and resist propagation of fire.

FIRE SEPARATION DISTANCE. The distance measured from the building face to one of the following:

1. The closest interior *lot line*;
2. To the centerline of a street, an alley or public way; or
3. To an imaginary line between two buildings on the property. The distance shall be measured at right angles from the face of the wall.

FIRE WALL. A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

FIRE WINDOW ASSEMBLY. A window constructed and glazed to give protection against the passage of fire.

FLIGHT. A continuous run of rectangular treads, *winders* or combination thereof from one landing to another.

FLOOD HAZARD AREA. The greater of the following two areas:

1. The area within a flood plain subject to a 1-percent or greater chance of *flooding* in any year.
2. The area designated as a *flood hazard area* on a community's flood hazard map, or otherwise legally designated.

GRADE PLANE. A reference plane representing the average of finished ground level adjoining the building at *exterior walls*. Where the finished ground level slopes away from the *exterior walls*, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 1.85 m from the building, between the building and a point 1.85 m from the building.

GUARD. A building component or a system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.

GYPSON BOARD. The generic name for a family of sheet products consisting of a noncombustible core, made primarily of gypsum with paper surfacing.

HABITABLE SPACES. A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

HANDRAIL. A horizontal or sloping rail intended for grasping by the hand for guidance or support.

HISTORIC BUILDINGS. Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law

HEIGHT, BUILDING. The vertical distance from *grade plane* to the average height of the highest roof surface.

HORIZONTAL ASSEMBLY. A fire-resistance-rated floor or roof assembly of materials designed to restrict the spread of fire in which continuity is maintained.

INTERIOR FINISH. *Interior finish* includes *interior wall and ceiling finish* and *interior floor finish*.

LABEL. An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an *approved agency* and that indicates that the representative sample of the product or material has been tested and evaluated by an *approved agency*.

LISTED. Equipment, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed* equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

LOAD AND RESISTANCE FACTOR DESIGN (LRFD). A method of proportioning structural members and their connections using load and *resistance factors* such that no applicable *limit state* is reached when the structure is subjected to appropriate *load* combinations. The term “LRFD” is used in the design of steel and wood structures.

LOAD EFFECTS. Forces and deformations produced in structural members by the applied *loads*.

LOT LINE. A line dividing one lot from another, or from a street or any public place.

MEANS OF EGRESS. A continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a *public way*. A means of egress consists of three separate and distinct parts: the *exit access*, the *exit* and the *exit discharge*.

MEZZANINE. An intermediate level or levels between the floor and ceiling of any story and in accordance with Section 4.1.2.6 (IBC Section 505).

NOMINAL LOADS. The magnitudes of the *loads* specified in Section 8.1 (dead, live, soil, wind, snow, rain, flood and earthquake).

NOSING. The leading edge of treads of *stairs* and of landing at the top of *stairway flights*.

OCCUPANCY CATEGORY. A category used to determine structural requirements based on occupancy.

OCCUPANT LOAD. The number of persons for which the *means of egress* of a building or portion thereof is designed.

OCCUPIABLE SPACE. A room or enclosed space designed for human occupancy in which individuals congregate for amusement, educational or similar purposes or in which occupants are engaged at labor, and which is equipped with means of egress and light and ventilation facilities meeting the requirements of these guidelines.

OPEN PARKING GARAGE. A structure or portion of a structure with the openings as described in IBC Section 406.3.3.1 on two or more sides that is used for the parking or storage of private motor vehicles as described in IBC Section 406.3.4.

PANIC HARDWARE. A door-latching assembly incorporating a device that releases the latch upon the application of a force in the direction of egress travel.

PENTHOUSES. An enclosed, unoccupied structure above the roof of a building, other than a tank, tower, spire, dome cupola or bulkhead.

PERMIT. An official document or certificate issued by the authority having jurisdiction which authorizes performance of a specified activity.

PHOTOLUMINESCENT. Having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed.

PUBLIC ENTRANCES. An entrance that is not a *service entrance* or a *restricted entrance*.

PUBLIC USE. Interior or exterior rooms or spaces that are made available to the general public.

PUBLIC WAY. A street, alley or other parcel of land open to the outside air leading to a street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 3.05 m.

RAMP. A walking surface that has a running slope steeper than one unit vertical in 20 units horizontal (5-percent slope).

REGISTERED DESIGN PROFESSIONAL. An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or *jurisdiction* in which the project is to be constructed.

RESTRICTED ENTRANCES. An entrance that is made available for *common use* on a controlled basis, but not public use, and that is not a *service entrance*.

SCISSOR STAIR. Two interlocking *stairways* providing two separate paths of egress located within one stairwell enclosure.

SEISMIC DESIGN CATEGORY. A classification assigned to a structure based on its *occupancy category* and the severity of the design earthquake ground motion at the site.

SERVICE ENTRANCES. An entrance intended primarily for delivery of goods or services.

SITE. A parcel of land bounded by a *lot line* or a designated portion of a public right-of-way.

SLEEPING UNITS. A room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not sleeping units.

SMOKE BARRIER. A continuous membrane, either vertical or horizontal, such as a wall, floor or ceiling assembly, that is designed and constructed to restrict the movement of smoke.

STAIR. A change in elevation, consisting of one or more risers.

STAIRWAY. One or more *flights of stairs*, either exterior or interior, with the necessary landings and platforms connecting them, to form a continuous and uninterrupted passage from one level to another.

STAIRWAY, EXTERIOR. A *stairway* that is open on at least one side, except for required structural columns, beams, *handrails* and *guards*. The adjoining open areas should be either *yards*, *courts* or *public ways*. The other sides of the exterior stairway need not be open.

STAIRWAY, INTERIOR. A *stairway* not meeting the definition of an *exterior stairway*.

STAIRWAY, SPIRAL. A *stairway* having a closed circular form in its plan view with uniform section-shaped treads attached to and radiating from a minimum-diameter supporting column.

STORIES ABOVE GRADE PLANE. Any *story* having its finished floor surface entirely above *grade plane*, or in which the finished surface of the floor next above is:

1. More than 1.85 m above *grade plane*; or
2. More than 3.65 m above the finished ground level at any point.

STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above. It is measured as the vertical distance from top to top of two successive tiers of beams or finished floor surfaces and, for the topmost *story*, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

THERMALLY ISOLATED. A separation of conditioned spaces, between a sunroom addition and a *dwelling unit*, consisting of existing or new wall(s), doors and/or windows.

THROUGH PENETRATION. An opening that passes through an entire assembly.

TRIM. Picture molds, chair rails, baseboards, handrails, door and window frames and similar decorative or protective materials used in fixed applications.

TYPE X GYPSUM BOARD. As defined in Gypsum Association 18th edition, a gypsum board with special additives to increase the natural fire resistance of regular gypsum board.

WATER-RESISTIVE BARRIER. A material behind an *exterior wall covering* that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the *exterior wall* assembly.

WINDER. A tread with nonparallel edges.

YARD. An open space, other than a *court*, unobstructed from the ground to the sky, except where specifically provided by these guidelines, on the lot on which a building is situated.

APPENDIX B

ACRONYMS

AA: Aluminum Association
ACI: American Concrete Institute
ADA: USA Americans with Disabilities Act
AISC: American Institute of Steel Construction
AISI: American Iron and Steel Institute
ALCTV: Automotive Lifts—Construction, Testing and Validation
ALI: Automotive Lift Institute
ANSI: American National Standards Institute
ASCE: American Society of Civil Engineers
ASME: American Society of Mechanical Engineers
ASTM: ASTM International, formerly American Society of Testing and Materials
AWPA: American Wood Protection Association
BHMA: Builders Hardware Manufacturers' Association
CBTUH: Council on Tall Buildings and the Urban Habitat
CPTED: Crime Prevention through Environmental Design
CPSC: Consumer Product Safety Commission
CSA: Canadian Standards Association
DDA: Australia—Disability Discrimination Act in Australia
EPBR: Energy Performance of Buildings Regulations
HVAC: Heating, Ventilation and Air-conditioning Systems
ICC: International Code Council
ICC-ES: ICC Evaluation Service
ISO: International Organization for Standardization
LEED: Leadership in Energy and Environmental Design
LRFD: Load and Resistance Factor Design
MEP: Mechanical Electrical Plumbing
NFPA: National Fire Protection Association
SAVE: Sustainable Attributes Verification and Evaluation
SFPE: Society of Fire Protection Engineers
SFRM: Sprayed fire-resistant materials

APPENDIX B

SJI: Steel Joist Institute

STC: Sound Transmission Class

TMS: The Masonry Society

TVRA: Threat, Vulnerability and Risk Assessment

UL: Underwriters Laboratories

UN: United Nations

UNCP: United Nations Common Premises

UNDG -TTCP: United Nations Development Group-Task Team on Common Premises

UNDP: United Nations Development Programme

UNDSS: United Nations Department of Safety and Security

UNFPA: United Nations Population Fund

UNICEF: United Nations Children's Fund

WFP: World Food Programme

WHO: World Health Organization

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