

NFPA 909

Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship

2005 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 909

Code for the

Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship

2005 Edition

This edition of NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, was prepared by the Technical Committee on Cultural Resources and acted on by NFPA at its November Association Technical Meeting held November 13–17, 2004, in Miami Beach, FL. It was issued by the Standards Council on January 14, 2005, with an effective date of February 7, 2005, and supersedes all previous editions.

This edition of NFPA 909 was approved as an American National Standard on February 7, 2005.

Origin and Development of NFPA 909

Since the first NFPA document was issued on this subject in 1948 (*Protecting Our Heritage*), the Technical Committee on Cultural Resources has developed a series of recommended practices to govern these specialized buildings and sites. Five separate documents governing libraries, museums, places of worship, historic structures, and historic sites existed in 1996.

In each case, the documents were written as recommended practices or guides. There were a number of reasons why the documents were developed and maintained as such. One reason had to do with the delicate nature of the facilities and sites. Unlike commercial buildings, “new” historic structures are not constructed. In other words, all of the historic structures are existing, making retrofit of many common fire protection systems impractical to install in some cases. In addition, retrofit of fire alarm systems or sprinkler systems can be cost prohibitive for a smaller, historically significant structure. Unfortunately, many of the readily available solutions to correct fire protection problems in other types of existing facilities might not be practical in the case of older, historic buildings.

A number of philosophical issues centered on the methods used to protect cultural resource facilities. One main item dealt with a structured fire prevention program that is carried out by the facility operator. The span of these protection schemes must account for structures ranging from single-family dwellings to public libraries to public museums.

In 1997, work on a comprehensive project to merge the five separate documents was completed. A new standard, NFPA 909, *Standard for the Protection of Cultural Resources, Including Museums, Libraries, Places of Worship, and Historic Properties*, consolidated the fire protection requirements for libraries, museums, and places of worship into one document. This milestone recognized that many traditional fire protection solutions do not work unless significant resources are applied to a given problem or situation. This same philosophy was carried over to the 2001 edition of NFPA 909. A continued focus of the 2001 edition was the need to have a structured fire prevention program that would be carried out by the facility operator.

The status of the 2001 edition was also upgraded to a code, in lieu of a standard, in recognition of the wide range of requirements that exist in NFPA 909. Specifically, sections of NFPA 909 stipulate when and where certain requirements are mandatory. In addition to these changes, the chapter on historic structures and buildings was completely revised. That chapter now defers to the 2001 edition of NFPA 914, *Code for Fire Protection of Historic Structures*, which underwent a complete revision.

The 2005 edition of NFPA 909 has undergone a major reorganization in accordance with the *Manual of Style for NFPA Technical Committee Documents*. Technical changes include the deletion of a previous annex on fire risk assessment in heritage premises in favor of reference to more current approaches on the subject. Other changes include the type of automatic sprinklers to be used in cultural resource properties and the activation of fire dampers. In addition, emergency action checklists and inspection forms have been added for places of worship.

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Committee Scope: This Committee shall have primary responsibility for documents on fire safety for libraries, museums, places of worship, and historic structures and their contents, but shall not overlap the provisions of NFPA 101®, *Life Safety Code*®.

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NFPA 909**Code for the****Protection of Cultural Resource Properties —
Museums, Libraries, and Places of Worship****2005 Edition**

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for mandatory extracts are given in Chapter 2 and those for nonmandatory extracts are given in Annex G. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex G.

Chapter 1 Administration**1.1 Scope.**

1.1.1 This code describes principles and practices of fire safety for cultural resource properties (museums, libraries, and places of worship) and for those who operate, use, or visit them.

1.1.2 This code covers ongoing operations and rehabilitation and acknowledges the need to preserve culturally significant and character-defining building features and sensitive, often irreplaceable, collections and to provide continuity of operations.

1.2 Purpose.

1.2.1 This code shall prescribe minimum requirements for the protection of cultural resource properties and their contents from fire through a comprehensive fire protection program.

1.2.2 Because of the special nature of cultural resource properties, this code shall supplement existing codes and standards to apply specifically to buildings or portions of buildings devoted to such use.

1.3* Application. This code shall apply to culturally significant structures, spaces within other buildings used for culturally significant purposes, and their contents.

1.3.1 New Cultural Resource Property Occupancies. The requirements of this code shall apply to the following:

- (1) New buildings or portions thereof used as a cultural resource property occupancy
- (2) Additions made to a cultural resource property
- (3) Alterations, modernizations, or renovations to existing properties
- (4) Existing buildings or portions thereof upon change of occupancy to a cultural resource property occupancy

1.3.2 Existing Cultural Resource Property Occupancies.

1.3.2.1 An existing building in which a cultural resource property occupancy is housed that was established prior to the effective date of this code shall be permitted to be approved for continued use if it conforms to or is made to conform to the provisions of this code to the extent that, in the opinion of the authority having jurisdiction, reasonable life safety against the hazards of fire and explosion is provided and maintained.

1.3.2.2 Libraries, museums, and places of worship housed in historic structures shall also comply with the requirements of NFPA 914, *Code for Fire Protection of Historic Structures*.

1.4 Equivalency.

1.4.1 Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, or effectiveness, provided that the following conditions are met:

- (1) Technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency or superiority.
- (2) The system, method, or device is acceptable to the authority having jurisdiction.

1.4.2 Cultural resource properties or portions of such structures that do not strictly comply with this code shall be considered to be in compliance if it is shown that equivalent protection is provided or that no specific hazard is created or continued through noncompliance.

1.4.3 A designer capable of applying more complete and rigorous analysis to evaluate and address special or unusual problems shall have latitude in the development of the applicable design.

1.4.3.1 In such cases, the designer shall be responsible for demonstrating the validity of the approach.

1.4.3.2 This code shall not eliminate the need for competent engineering judgment.

1.4.3.3 This code shall not be intended to be used as a design handbook.

1.5 Compliance Options.

1.5.1 General. Building design and fire protection features and programs meeting the life safety, collection preservation, building preservation, and continuity of operations goals and objectives of Chapter 4 shall be provided in accordance with either of the following:

- (1) Prescriptive-based provisions of 1.5.2
- (2) Performance-based provisions of 1.5.3

1.5.2 Prescriptive-Based Options. A prescriptive-based design shall be in accordance with Chapters 1 through 8 and Chapters 11 through 17 of this code.

1.5.3 Performance-Based Options. A performance-based design shall be in accordance with Chapters 1 through 7 and Chapters 9, 11, 13, and 14 of this code.

1.5.4 Management Operational Systems. Management operational systems complying with Chapter 10 of this code shall be permitted as an element of a prescriptive- or performance-based solution.

1.6 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. (See Annex F for sample wording for enabling legislation.)

1.6.1 Organization. The governing body shall designate a fire safety manager who shall administer and enforce this code.

1.6.2 Approvals by Other Authorities Having Jurisdiction. The fire safety manager shall require that the laws, rules, and regulations of all other regulatory agencies having jurisdiction shall be met when not in conflict with this code.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Uniform Fire Code*TM, 2003 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2003 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2003 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, 2001 edition.

NFPA 42, *Code for the Storage of Pyroxylin Plastic*, 2002 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2004 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 70, *National Electrical Code*[®], 2005 edition.

NFPA 72[®], *National Fire Alarm Code*[®], 2002 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment*, 2003 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2002 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2004 edition.

NFPA 101[®], *Life Safety Code*[®], 2003 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2002 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2003 edition.

NFPA 232, *Standard for the Protection of Records*, 2000 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2004 edition.

NFPA 703, *Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials*, 2000 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 edition.

NFPA 914, *Code for Fire Protection of Historic Structures*, 2001 edition.

NFPA 1123, *Code for Fireworks Display*, 2000 edition.

NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, 2002 edition.

NFPA 5000[®], *Building Construction and Safety Code*[®], 2003 edition.

2.3 Other Publications.

2.3.1 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*, 2000 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction 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 that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Addition. An extension or increase in the building area, aggregate floor area, height, or number of stories of a structure.

3.3.2 Alternative Calculation Procedure. A calculation procedure that differs from the procedure originally employed by the design team but that provides predictions for the same variables of interest. [101, 2003]

3.3.3 Analysis.

3.3.3.1 Sensitivity Analysis. An analysis performed to determine the degree to which a predicted output will vary given a specified change in an input parameter, usually in relation to models. [101, 2003]

3.3.3.2 Uncertainty Analysis. An analysis performed to determine the degree to which a predicted value will vary. [5000, 2003]

3.3.4 Arson. The crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion. [921, 2004]

3.3.5 Barrier.

3.3.5.1 Fire Barrier. A continuous vertical or horizontal assembly, such as a wall or floor, that is designed and constructed with a specified fire resistance rating to limit the spread of fire and that also will restrict the movement of smoke. Such barriers might have protected openings.

3.3.5.2 Smoke Barrier. A continuous assembly, or an assembly with discontinuities created by protected openings, where such assembly is designed and constructed to resist the movement of smoke.

3.3.6 Book Stack. Area dedicated to the storage of library media.

3.3.6.1* Multitier Book Stack. A system of back-to-back metal (steel or wrought iron) bracket shelving stacked by being bolted together into multiple levels or tiers at approximately 7 ft (2.1 m) intervals to form a book stack with walkways for each tier suspended from the posts or columns supporting the bracket shelving sections in each range.

3.3.6.2 Single-Tier Book Stack. Freestanding bracket, cantilever, or case shelving enclosed on one level by a fire compartment.

3.3.7* Building. Any structure used or intended for supporting or sheltering any use or occupancy. [101, 2003]

3.3.8 Character-Defining Feature. A prominent or distinctive aspect, quality, or characteristic of a cultural property that contributes significantly to its physical character.

3.3.9 Collections. Prehistoric and historic objects, works of art, scientific specimens, religious objects, archival documents, archaeological artifacts, library media, and cultural materials assembled according to a rational scheme and maintained for the purpose of preservation, research, study, exhibition, publication, or interpretation.

3.3.10 Collections Storage Room. An enclosure providing a safe and secure environment for collections, including vaults and book stacks.

3.3.11* Compact Storage Module. An assembly of shelving sections mounted on carriages with the arrangement of carriages on tracks so as to provide one moving aisle serving multiple carriages between fixed end ranges.

3.3.12* Compact Storage System. A storage installation composed of multiple compact storage modules.

3.3.13 Compartment. See 3.3.24, Fire Compartment.

3.3.14 Compliance. Adherence or conformance to laws and standards. [914, 2005]

3.3.15 Conservation. The professional practice of examination, documentation, treatment, and preventative care devoted to the preservation of cultural property.

3.3.16* Cultural Resource Properties. Buildings, structures, sites, or portions thereof that are culturally significant or that house culturally significant collections for museums, libraries, and places of worship.

3.3.17 Damage Limitation Plan. Written procedures that outline and prioritize the actions to take following a disaster to minimize property damage and loss.

3.3.18 Data Conversion. The process of developing the input data set for the assessment method of choice. [101, 2003]

3.3.19 Design Specifications. Building characteristics and other conditions that are under the control of the design team. [914, 2001]

3.3.20 Design Team. A group of stakeholders including, but not limited to, representatives of the architect, client, and any pertinent engineers and other designers. [101, 2003]

3.3.21 Exposure Fire. A fire that starts at a location that is remote from the area being protected and grows to expose that which is being protected. [101, 2003]

3.3.22 Fire Alarm System. A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. [72, 2002]

3.3.23 Fireblock. A material, barrier, device, or construction installed in concealed spaces to prevent the extension of fire for an unspecified period of time. [5000, 2003]

3.3.24 Fire Compartment. A space within a building that is enclosed by fire barriers on all sides, including the top and bottom. [101, 2003]

3.3.25 Fire Hazard. Any situation, process, material, or condition that, on the basis of applicable data, can cause a fire or explosion, or provide a ready fuel supply to augment the spread or intensity of a fire or explosion, all of which pose a threat to life or property. [914, 2005]

3.3.26 Fire Model. Mathematical prediction of fire growth, environmental conditions, and potential effects on structures, systems, or components based on the conservation equations or empirical data. [805, 2001]

3.3.27 Fire Protection System. Any fire alarm device or system or fire extinguishing device or system, or their combination, that is designed and installed for detecting, controlling, or extinguishing a fire or otherwise alerting occupants, or the fire department, or both, that a fire has occurred. [1141, 2003]

3.3.28 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*. [220, 1999]

3.3.29 Fire Resistive. Properties or designs to resist the effects of any fire to which a material or structure can be expected to be subjected.

3.3.30 Fire Retardant. A liquid, solid, or gas that tends to inhibit combustion when applied on, mixed in, or combined with combustible materials. [1, 2003]

3.3.31* Fire Safety Manager. The person designated by the governing body or responsible party of a cultural resource property with the duties and responsibilities of providing and ensuring reliability of fire protection for that facility or institution.

3.3.32 Firestop. A specific system, device, or construction consisting of the materials that fill the openings around penetrating items such as cables, cable trays, conduits, ducts, pipes, and their means of support through the wall or floor openings to prevent the spread of fire. [5000, 2003]

3.3.33 Fuel Load. The total quantity of combustible contents of a building, space, or fire area, including interior finish and trim, expressed in heat units or the equivalent weight in wood. [921, 2004]

3.3.34 Goal. A nonspecific overall outcome to be achieved that is measured on a qualitative basis. [101, 2003]

3.3.35 Governing Body. The board of directors, trustees, or other body charged with governance and fiduciary responsibility of a cultural resource property.

3.3.36* Hazardous Area. An area of a structure or building that poses a degree of hazard greater than that normal to the general occupancy of the building or structure. [5000, 2003]

3.3.37 Historic Fabric. Original or added building or construction materials, features, and finishes that existed during the period that is deemed to be most architecturally or historically significant, or both.

3.3.38 Historic Site. A place, often with associated structures, that has historic significance.

3.3.39* Historic Structure. A building, bridge, lighthouse, monument, pier, vessel, or other construction that is designated or that is deemed eligible for such designation by a local, regional, or national jurisdiction as having historical, architectural, or cultural significance. [914, 2005]

3.3.40 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [51B, 2003]

3.3.41* Impairment. Ashutdown of a system or portion thereof. [25, 2002]

3.3.42 Incapacitation. A condition under which humans do not function adequately and become unable to escape untenable conditions. [101, 2003]

3.3.43 Initiating Device. A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. [72, 2002]

3.3.44 Input Data Specification. Information required by the verification method. [101, 2003]

3.3.45* Library. Any building or place in which books and other media are kept for reading, reference, research, or lending.

3.3.45.1* Secondary Storage Facility. Warehouse facilities established to house books and other collections.

3.3.46 Means of Egress. A continuous and unobstructed way of travel from any point in a building or structure to a public

way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. [101, 2003]

3.3.47* Museum. An institution that acquires, conserves, researches, communicates, and exhibits material evidence of people and their environment for purposes of study, education, and enjoyment.

3.3.48 Noncombustible. Not capable of supporting combustion.

3.3.49 Notification Appliance. A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs, or any combination thereof. [72, 2002]

3.3.50 Objective. A goal that is achieved through the attainment of a skill, knowledge, or both, and that can be observed or measured. [472, 2002]

3.3.51 Occupancy. The purpose for which a building or other structure, or part thereof, is used or intended to be used. [5000, 2003]

3.3.52 Occupant Characteristics. The abilities or behaviors of people before and during a fire. [101, 2003]

3.3.53 Occupant Load. The total number of persons that might occupy a building or portion thereof at any one time. [5000, 2003]

3.3.54 Performance-Based Design Approach. A design process where fire safety solutions are designed to achieve a specified goal for a specified use or application. [914, 2001]

3.3.55 Performance Criteria. Threshold values on measurement scales that are based on quantified performance objectives. [101, 2003]

3.3.56 Place of Worship. Any building that functions primarily as a group meeting place for the practice of religion, including, but not limited to, churches, synagogues, cathedrals, temples, mosques, and meeting halls.

3.3.57 Plenum. A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. [90A, 2002]

3.3.58 Prescriptive-Based Document. A code or standard that prescribes fire safety for a generic use or application. [914, 2001]

3.3.59 Preservation. The act or process of applying measures necessary to sustain the existing form, integrity, and materials of a historic building or structure.

3.3.60 Private. Intended for or limited to the use of some particular person(s) or group.

3.3.61 Process Team. A group of stakeholders including, but not limited to, representatives from architects, clients, engineers and designers, authorities having jurisdiction, and preservation specialists. [914, 2001]

3.3.62 Proposed Design. A design developed by a design team and submitted to the authority having jurisdiction for approval. [101, 2003]

3.3.63 Protected Premises. The physical location protected by a fire alarm system, fire suppression system, or both.

3.3.64 Protection. Measures and actions taken to prevent or minimize loss from fire, arson, vandalism, theft, and similar hazards to persons and property.

3.3.65 Protective Systems, Equipment, or Apparatus. Automatic sprinklers, standpipes, carbon dioxide systems, clean agent systems, automatic covers, and other devices used for extinguishing fires.

3.3.66 Public. Of, pertaining to, or affecting a population or a community as a whole; open to all persons.

3.3.67 Rehabilitation. The act or process of returning a structure to a state of utility through repair or alteration that makes possible an efficient contemporary use, including the preservation of those portions or features of the structure that are significant to its historical, architectural, or cultural value.

3.3.68 Restoration. The act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods of its history, reconstruction of missing features, and repair of damaged or altered features from the restoration period. [914, 2001]

3.3.69 Safe Location. A location remote or separated from the effects of a fire so that such effects no longer pose a threat. [101, 2003]

3.3.70 Safety Factor. A factor applied to a predicted value to ensure that a sufficient safety margin is maintained. [101, 2003]

3.3.71 Safety Margin. The difference between a predicted value and the actual value where a fault condition is expected. [101, 2003]

3.3.72 Scenario.

3.3.72.1 Design Fire Scenario. A fire scenario used for evaluation of a proposed design. [914, 2001]

3.3.72.2* Fire Scenario. A set of conditions that defines the development of fire, the spread of combustion products throughout a building or portion of a building, the reactions of people to fire, and the effects of combustion products. [101, 2003]

3.3.73 Smoke Detector. A device that detects visible or invisible particles of combustion. [72, 2002]

3.3.74* Special Event. Any activity outside the normal daily operations.

3.3.75 Sprinkler System. For fire protection purposes, an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The installation includes one or more automatic water supplies. The portion of the sprinkler system above ground is a network of specially sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The valve controlling each system riser is located in the system riser or its supply piping. Each sprinkler system riser includes a device for actuating an alarm when the system is in operation. The system is usually activated by heat from a fire and discharges water over the fire area. [13, 2002]

3.3.76 Stakeholder. An individual, or representative of same, having an interest in the successful completion of a project. [101, 2003]

3.3.77* Utilities. Building service control and distribution systems and their associated equipment, pipes, ducts, wires, and cables.

3.3.78 Verification Method. A procedure or process used to demonstrate or confirm that the proposed design meets the specified criteria. [101, 2003]

3.3.79 Vertical Opening. An opening through a floor or roof. [101, 2003]

Chapter 4 Goals and Objectives

4.1 General. Fire safety goals and objectives shall be adopted that reflect the level of loss and interruption of service to the client community that those responsible for the cultural resource property are willing to accept as a result of a fire.

4.2 Goals.

4.2.1 Life Safety. The life safety goal of this code shall be to provide an environment in which its occupants are reasonably protected from death or injury resulting from fire and similar perils as follows:

- (1) Protection of occupants not intimate with the initial fire development
- (2) Improvement of the survivability of occupants intimate with the initial fire development

4.2.2 Property Protection.

4.2.2.1 Collection Preservation. The collection preservation goal of this code shall be to provide a reasonable level of protection against damage or loss to collections from fire, products of combustion, and fire suppression agents and activities.

4.2.2.2 Building Preservation. The building preservation goal of this code shall be to provide a reasonable level of protection against damage or loss to the buildings, their unique characteristics, and their contents from fire, products of combustion, and fire suppression agents and activities.

4.2.3 Continuity of Operations. The continuity of operations goal of this code shall be to provide a reasonable level of protection against disruption of facility operations consistent with the organization's fire safety goals.

4.3 Objectives.

4.3.1 Life Safety.

4.3.1.1 An egress system shall be designed, implemented, and maintained to protect the occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

4.3.1.2 Structural integrity during a fire shall be maintained to protect the occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

4.3.1.3 Building construction and operations necessary to achieve the goals of this code shall be effective, maintained, and operational in perpetuity.

4.3.2 Collection Preservation. Fire safety and fire protection features shall be designed, approved, implemented, and maintained to preserve the original qualities of the collection.

4.3.3 Building Preservation.

4.3.3.1 Fire safety and fire protection features shall be designed, approved, installed, and maintained to preserve the

original qualities or character of a building, structure, site, or environment.

4.3.3.2 Removal or alteration of any distinctive architectural features for the purpose of improving fire protection or life safety shall be minimized.

4.3.4 Continuity of Operations. Fire safety and fire protection features shall be designed, approved, implemented, and maintained to minimize disruption of operations consistent with the organization's fire safety goals.

Chapter 5 Fire Safety Management

5.1 General.

5.1.1 Responsibility.

5.1.1.1 Governing Body.

5.1.1.1.1 The facility's governing body or those responsible for the institution shall establish and maintain plans and programs to protect against the effects of fire.

5.1.1.1.2* As part of developing the fire safety management plan, a fire risk assessment shall be conducted.

5.1.1.2* Fire Safety Manager.

5.1.1.2.1 The facility's governing body or those responsible for the institution shall appoint a fire safety manager who is responsible for the protection of the site from fire.

5.1.1.2.2 The fire safety manager's duties shall include but are not limited to oversight of the following:

- (1) Life safety systems
- (2) Fire prevention
- (3) Fire inspections
- (4) Periodic property surveys
- (5) Operation, maintenance, and testing of fire protection equipment such as fire detection and fire suppression equipment
- (6) Management operational systems (*see Chapter 10*)

5.1.1.2.3 Fire safety review and approval by the fire safety manager shall be a requirement for all displays or exhibits, plans for new construction, and renovations, restorations, or reconfigurations of space.

5.2 Fire Safety Log.

5.2.1* The fire safety manager shall be responsible for maintaining a current file of the cultural resource property's fire protection program.

5.2.2 As a minimum, records of the following shall be kept:

- (1) Training of staff and volunteers, including fire evacuation drills and use of portable fire extinguishers
- (2) Testing, inspection, and maintenance reports for all fire safety equipment and systems, including records of actions taken to correct deficiencies
- (3) "As-built" plans, specifications, wiring and layout diagrams, and acceptance test reports for all fire protection systems (e.g., fire detection and alarm systems, automatic fire suppression systems)
- (4) The facility's fire safety management plan
- (5) Inspection reports by local code enforcement officials, the authority having jurisdiction, local fire service officials, and insurance loss control representatives, including records of actions taken to correct deficiencies identified during each inspection

(6) Fire protection system's actuation and alarm reports complete with the cause of the alarm or activation, response, and corrective action(s) taken

(7) Full reports, including cause, extent of damage, response, and recovery, of all fire incidents

5.3 Planning for Fire Protection.

5.3.1 Fire Safety Goals. Fire safety goals shall comply with Section 4.2.

5.3.2 Fire Hazard Analysis.

5.3.2.1 A survey shall be made to determine existing and potential fire hazards.

5.3.2.2* Fire hazards shall be evaluated and classified based on their severity and the difficulty and cost of abating them.

5.3.2.3 The survey shall include the following:

- (1) Identification of the cultural resource properties and their special hazards and the creation of an action plan to minimize, eliminate, or protect against each of those hazards
- (2) Identification of those fire risks and means of egress problems that can be created by special events and the creation of an internal process and action plan to minimize or eliminate those potential threats for each event
- (3) Assessments of expected increases in public visitation during special events, celebrations, and special exhibitions and the creation of provisions for identifying and taking immediate action to prevent numbers of visitors from exceeding building and means of egress capabilities
- (4) Identification of temporary or special exhibitions that can create special fire protection risks and means of egress problems or that can compromise existing fire protection systems and the creation of an action plan for preventing such problems and implementing immediate corrective actions if problems arise later

5.4* Fire Safety Management Plan.

5.4.1 A fire safety management plan shall be developed for systematic achievement of fire safety goals and shall be updated annually.

5.4.2 The fire safety management plan shall include a yearly comprehensive facility inspection procedure with a documentation and corrective action process to ensure that all problems and hazards identified during the inspection are recorded and corrected as soon as possible. (*See Annexes J and K for additional information.*)

5.4.3* Emergency Management Plan. The fire safety management plan shall include an emergency management plan.

5.4.3.1 An annual exercise shall ensure that management and staff can implement and work with the plan and incorporate lessons learned from the exercise into an updated plan.

5.4.3.2 The plan shall include provisions for notifying the fire department of the type and location of the emergency and directing first responders to the site once they arrive.

5.4.3.3 Emergency telephone numbers shall be posted on or be adjacent to all telephones.

5.4.4 Emergency Evacuation Plan.

5.4.4.1 The fire safety management plan shall include an emergency evacuation plan prepared in cooperation with the local fire department and other applicable authorities.

5.4.4.2 The emergency evacuation plan shall be updated annually and shall include the following:

- (1) Fire safety precautions for special events and celebrations in which conditions vary substantially from normal operating conditions
- (2) Fire safety precautions incorporating necessary adjustments for temporary and special exhibits
- (3) Modification of staff training and drills to adjust for altered circumstances and larger visitation that can be created by special events and exhibits
- (4) Provisions to notify the local fire service of special events that involve increased hazards or that are expected to require adjustments to the emergency evacuation plan

5.4.5 Fire Exit Drills. Fire exit drills shall be conducted at intervals identified in the approved fire safety management plan but not less than annually.

5.4.6 Damage Limitation Plan.

5.4.6.1 The fire safety management plan shall include a damage limitation plan prepared in cooperation with the fire department, applicable occupants, police, specialist contractors, and insurance representatives.

5.4.6.2 The damage limitation plan shall be updated annually and shall include the following:

- (1) Procedures to identify and prioritize collections and other valuable materials in accordance with the facility's policy
- (2) A list of salvage equipment suppliers (e.g., pumps, generators, freezing equipment, storage facilities, and other similar suppliers) and tradespeople
- (3) A current list of disaster recovery specialists for damaged fine art, collections, and archives, such as conservators from museums, archives, and other cultural resource properties willing to lend mutual aid assistance
- (4) A list of people assigned to assist with salvage operations, including staff to deal with the press, fire authorities, police, and authorities that can restrict entry following a fire of suspicious origin
- (5)*Measures to maintain up-to-date copies of important documents in a secure, off-site location
- (6) Procedures to identify and handle hazardous materials, such as asbestos, solvents, or PCBs, that can cause a health hazard or contaminate the structure or contents after a fire
- (7) Procedures to impound fire-fighting water where it poses a hazard to the environment
- (8) Stockpiles of resources and equipment for emergency on-site conservation

5.4.7 Property Conservation Plan. The fire safety management plan shall include a plan to conserve the building and contents after a fire.

5.4.7.1 Employees and others with a role in the property conservation plan shall receive additional training in the activities necessary to fulfill their designated role.

5.4.7.2 Training shall be reinforced by annual drills.

5.5 Training.

5.5.1 Requirements.

5.5.1.1 The facility's governing board and its fire safety manager shall ensure that all staff, including volunteers and interns, receive initial and annual training pertinent to their assigned emergency responsibilities at the facility, which can include the following:

- (1) Fire protection plan
- (2) Emergency evacuation plan
- (3) Property conservation plan
- (4) Fire protection and detection systems, including the use of portable fire extinguishers

5.5.1.2 Training shall be reinforced by annual drills.

5.5.2 Training shall include emergency evacuation of mobility-impaired individuals and others (e.g., children) who need special assistance.

5.5.3 A record shall be maintained of all fire and damage limitation training.

Chapter 6 Security

6.1* General.

6.1.1 Arson. Arson prevention shall be included in the cultural resource property's fire safety goals required in Chapter 4.

6.1.2 Fire Hazard Analysis.

6.1.2.1 The fire hazard analysis required in Chapter 5 shall include an evaluation of conditions that increase the risk of arson.

6.1.2.2* A fire hazard analysis that includes evaluation of conditions that increase the threat of arson shall be completed prior to commencement of construction, alteration, or renovation projects.

6.1.3* Fire Protection Plan.

6.1.3.1 Security practices, procedures, operations, and systems to reduce the threat of arson shall be integrated into the cultural resource property's fire protection plan.

6.1.3.2 The fire protection plan shall include screening all personnel, including part-time employees and volunteers, against records of known fire setters.

6.1.4* Book Returns. Book returns shall be constructed to prevent the spread of fire and smoke from the return into the rest of the building, or the book return shall be located in an outside receiving bin away from the exterior walls of the building.

6.2 Locking Devices.

6.2.1 Where permitted by the authority having jurisdiction, delayed egress locking devices shall comply with the provisions of 11.2.1.6 of *NFPA 5000, Building Construction and Safety Code*.

6.2.2 Delayed egress locking devices shall be tested regularly, but not less than quarterly, and a written record of the test and the results shall be kept.

6.3* Construction Areas.

6.3.1 Access to construction areas shall be restricted to personnel authorized by the owner or the contractor.

6.3.2* Security officers assigned to construction areas shall receive daily updates on the status of fire protection equipment; special hazards, including hot work; modified access routes; and emergency procedures.

6.4 Access Control. Procedures shall be implemented to screen and identify official visitors, contractors, and other persons who have access to nonpublic areas of the cultural resource property.

Chapter 7 Process

7.1* General. The process by which this code shall be applied is shown in Figure 7.1.

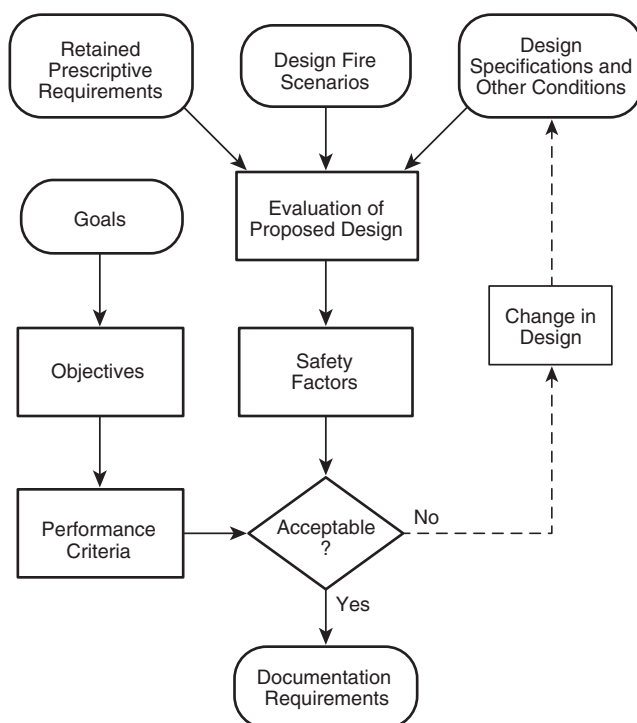


FIGURE 7.1 Process Flow Chart. (See Sections 4.2, 4.3, and 9.2 through 9.8.)

7.2* Process Team.

7.2.1 The governing body shall identify a process team to oversee application of the code to the cultural resource property.

7.2.2 The team shall include persons with expertise in cultural resource property preservation and fire protection.

7.3* Assessment. A detailed assessment or survey of the facility's fire safety features, the culturally significant features of the structure and collection, and the parameters of the facility's operation shall be completed.

7.3.1 Identification of Culturally Significant Elements, Features, and Collections.

7.3.1.1 Documentation.

7.3.1.1.1 The governing body and the fire safety manager shall have a demonstrated knowledge and understanding of the culturally significant elements of the structure and its contents.

7.3.1.1.2* All persons involved with the design of the building, exhibits, and other aspects of the project shall have a demonstrated knowledge of the cultural significance of the structure, the collection, or both.

7.3.1.1.3* All persons involved with the construction process shall be thoroughly briefed on the significance and importance of the structure, spaces, character-defining features, and collections prior to the beginning of the work.

7.3.1.2 Structure.

7.3.1.2.1* Exterior. The building survey shall identify those character-defining features and finishes that make the exterior of the building significant.

7.3.1.2.2* Interior. The building survey shall identify all significant interior spaces, floor plan organization, and character-defining features and finishes in the building.

7.3.1.3* Construction. The building survey shall determine primary and secondary significance of all character-defining features and facades.

7.3.1.4 Collections. The building survey shall identify all significant collections, archives, and other contents of cultural significance, their location, and any unique vulnerability to damage or loss.

7.3.1.5 Operations. The building survey shall identify the facility's client community and the effect of a disruption of operations on the delivery of service to that community.

7.3.2 Prioritization of Significant Elements, Collections, and Operations.

7.3.2.1 The building survey shall determine primary and secondary significance of all culturally significant elements, collections, or both, and the primary and secondary operational priorities for the facility.

7.3.2.2 Modifications or additions shall be completed in a manner to minimize the impact to culturally significant elements, collections, and the operation.

7.3.3 Identification of Fire Safety Issues.

7.3.3.1 Code, Standard, and Regulation Compliance.

7.3.3.1.1 The building survey of existing conditions shall include a review of all fire safety-related requirements to determine if and where the cultural resource property is deficient with respect to applicable codes.

7.3.3.1.2 Alternative methods that offer equivalent or greater protection while preserving the character-defining spaces, features, finishes, and collections of the cultural resource property shall be permitted.

7.3.3.2 Fire Hazards and Safety Deficiencies. The building survey shall identify known conditions that could contribute to the start or spread of a fire or to the endangerment of people, collections, or property by fire.

7.3.3.3 Fire Spread. The building shall be evaluated to determine potential paths of fire spread, both internal and external, that are inherent to its design.

7.3.3.4 Means of Egress.

7.3.3.4.1 Life safety aspects of the building shall be evaluated in accordance with the requirements of NFPA 101, *Life Safety Code*.

7.3.3.4.2 The building survey shall identify egress systems and any deficiencies.

7.3.3.4.3 An evaluation of the means of egress shall be completed that includes a review of life safety-related items, including, but not limited to, numbers of exits, exit capacity, exit fire resistance, smoke control, dead-end corridors, travel distances, and unenclosed stairs.

7.4 Options.

7.4.1 Structures that are found to satisfy the objectives of both life safety and cultural resource property preservation of this code shall be subject to the compliance audit required by Section 7.9.

7.4.2 Where structures are found to have life safety deficiencies, preservation needs, or both, a plan of correction shall be developed that satisfies one of the following:

- (1) Prescriptive compliance, including equivalencies, alternatives, and modifications
- (2) Risk-indexing compliance (*see 8.1.3*)
- (3) Performance-based compliance
- (4) Any combination of items 7.4.2(1) through 7.4.2(3)

7.5 Option Appraisal and Selection.

7.5.1* Selection Criteria.

7.5.1.1 An appraisal of the available options shall be made by the process team, and a method of application of the code shall be selected.

7.5.1.2 The method of application shall be from the prescriptive-based approach, the performance-based approach, or a combination of both.

7.5.2 Prescriptive-Based Option. Prescriptive solutions shall meet the requirements of Chapters 1 through 8 and Chapters 10 through 17, including any exceptions contained within the referenced prescriptive codes and standards.

7.5.3 Performance-Based Option. Performance-based solutions shall be developed in accordance with Chapters 1 through 7 and Chapters 9, 11, 13, and 14.

7.6 Design Review. The process team shall review and approve the preferred design approach for achieving compliance.

7.7 Initial Compliance Audit. On completion of the implementation phase, an initial compliance audit shall be performed by the process team to ensure compliance with the selected design approach.

7.8 Approval. The authority having jurisdiction shall make the final determination as to whether compliance has been achieved.

7.9 Compliance Audit.

7.9.1 A compliance audit shall be conducted by the authority having jurisdiction or its designee at intervals identified in the approved fire safety management plan but not less than annually.

7.9.2 Additional compliance audits shall be conducted prior to special events (*see Chapter 15*).

7.9.3 Exit Interview.

7.9.3.1 The authority having jurisdiction or its designee shall conduct an exit interview with the fire safety manager and the owner or governing body of the cultural resource property upon completion of the periodic compliance audit.

7.9.3.2 The exit interview shall identify all areas of noncompliance with the approved fire safety management plan.

7.9.3.3 Following the periodic compliance audit, any deficiencies shall be addressed, with corrective action taken and documented in the fire safety log.

Chapter 8 Prescriptive-Based Option

8.1 General.

8.1.1* Application.

8.1.1.1 Prescriptive requirements of the applicable codes shall be applied with the intent of achieving the goals and objectives of Chapter 4.

8.1.1.2 Application of prescriptive requirements shall include alternatives, equivalencies, modifications, or any combination thereof.

8.1.2* Alternatives. Prescribed alternative methods of compliance with the applicable code shall be identified.

8.1.3* Equivalency.

8.1.3.1 The authority having jurisdiction shall approve other fire safety approaches, systems, methods, or devices that are equivalent or superior to those prescribed by this code, provided adequate documentation is submitted to demonstrate equivalency.

8.1.3.2* Approaches, systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this code.

8.1.4* Modification of Requirements.

8.1.4.1 The requirements of the applicable codes shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, but only where it is also clearly evident that a reasonable degree of safety is provided.

8.1.4.2 The modifications allowed, and any additional requirements imposed as a result, shall be documented in the fire safety management plan.

8.2* Compensatory Features. Where equivalencies or modifications to existing requirements are proposed, the following fire safety features shall be considered as compensatory:

- (1) Noncombustible or limited-combustible construction materials
- (2) Noncombustible or fire retardant-treated interior finish materials
- (3) Noncombustible or fire retardant-treated materials for furnishings and contents
- (4) Rated walls and doors that prevent the horizontal spread of fire and smoke, to subdivide building areas or to segregate specific hazards, such as boilers, furnaces, or storage areas, from the remainder of the building
- (5) Enclosure of stairways, ventilation shafts, and other vertical openings with rated construction to prevent the vertical spread of fire and smoke
- (6)*Firestops and fireblocks to prevent the spread of fire within walls, between rafters and joists, and through horizontal and vertical fire barriers
- (7)*Fire-resistive construction using fire-resistive materials
- (8)*Fire detection and alarm systems that sound an alarm within the structure and that transmit an alarm signal to an alarm-monitoring location or to a local fire department
- (9) Automatic suppression systems, manual suppression systems, or a combination of both
- (10) Management and operational controls that meet the requirements of Chapter 8

- (11) Installation of arc-fault circuit-interrupters (AFCIs)
- (12) Height of ceilings, with recognition that a large volume of space above head height provides occupants at floor level additional time to safely exit the room or building

Chapter 9 Performance-Based Option

9.1* General.

9.1.1 Application. The requirements of this chapter shall apply to fire protection systems and life safety systems designed using the performance-based option permitted by 7.5.3.

9.1.2 Goals and Objectives. The performance-based design shall meet the goals and objectives of this code identified in Sections 4.2 and 4.3.

9.1.3* Approved Qualifications. The performance-based design shall be prepared by a person with qualifications acceptable to the authority having jurisdiction. (*See also 9.8.12.*)

9.1.4* Independent Review. The authority having jurisdiction shall be permitted to require review and evaluation of the proposed design by an approved, independent third party.

9.1.5 Sources of Data.

9.1.5.1 The source for each input data requirement that must be met using a data source other than a design fire scenario, an assumption, or a building design specification shall be identified and documented.

9.1.5.2 Such data shall be characterized with regard to the degree of conservatism reflected, and a justification for the source shall be provided.

9.1.6 Final Determination. The authority having jurisdiction shall make the final determination concerning whether the performance objectives have been met.

9.1.7* Maintenance of Design Features.

9.1.7.1 Design features and management programs required for the building to continue to meet the performance goals and objectives of this code shall be maintained for the life of the building.

9.1.7.2 This management program shall include compliance with all documented assumptions and design specifications.

9.1.7.3 Any variations to the management program shall require the approval of the authority having jurisdiction prior to the actual change. (*See also 7.9.1.*)

9.1.8 Special Definitions. The following is a list of special terms used in this chapter:

- (1) Alternative calculation procedure (*See 3.3.2.*)
- (2) Data conversion (*See 3.3.18.*)
- (3) Design fire scenario (*See 3.3.72.1.*)
- (4) Design team (*See 3.3.20.*)
- (5) Exposure fire (*See 3.3.21.*)
- (6) Fire model (*See 3.3.26.*)
- (7) Fire scenario (*See 3.3.72.2.*)
- (8) Fuel load (*See 3.3.33.*)
- (9) Incapacitation (*See 3.3.42.*)
- (10) Input data specification (*See 3.3.44.*)
- (11) Occupant characteristics (*See 3.3.52.*)
- (12) Performance criteria (*See 3.3.55.*)

- (13) Proposed design (*See 3.3.62.*)
- (14) Safe location (*See 3.3.69.*)
- (15) Safety factor (*See 3.3.70.*)
- (16) Safety margin (*See 3.3.71.*)
- (17) Sensitivity analysis (*See 3.3.3.1.*)
- (18) Stakeholder (*See 3.3.76.*)
- (19) Uncertainty analysis (*See 3.3.3.2.*)
- (20) Verification method (*See 3.3.78.*)

9.2 Performance Criteria.

9.2.1 General.

9.2.1.1 A cultural resource property shall meet the performance criteria for life safety, cultural resource property and collection conservation, and continuity of operations.

9.2.1.2 Each design shall meet the objectives specified in Section 4.3 if, for each design fire scenario, assumption, and design specification, the performance criteria in 9.2.2 are met.

9.2.2 Performance Criteria.

9.2.2.1* Life Safety Performance Criteria. No occupants other than those intimate with ignition shall be exposed to instantaneous or cumulative untenable conditions.

9.2.2.2* Cultural Resource Property and Collections Preservation Criteria. Culturally significant features, rooms, spaces, or contents shall not be exposed to instantaneous or cumulative fire effects that would cause irreversible damage.

9.2.2.3 Continuity of Operations Criteria. The cultural institution shall not experience a disruption of routine operations greater than that deemed acceptable in the facility's fire safety management plan required by Chapter 5 and the goals established in Chapter 4.

9.3 Retained Prescriptive Requirements.

9.3.1* Systems and Features. All fire protection systems and features of the building shall comply with the applicable sections of *NFPA 5000, Building Construction and Safety Code*, for those systems and features.

9.3.2 Means of Egress. Features of the means of egress not specifically addressed in the performance criteria shall comply with *NFPA 101, Life Safety Code*.

9.4 Design Specifications and Other Conditions.

9.4.1* Clear Statement. Design specifications and other conditions used in the performance-based design shall be demonstrated to the authority having jurisdiction to be realistic and sustainable.

9.4.2 Assumptions and Design Specifications Data.

9.4.2.1 Each assumption and design specification used in the design shall be accurately translated into input data specifications, as appropriate for the calculation method or model.

9.4.2.2 Any assumptions and design specifications that the design analyses do not explicitly address or incorporate and that are therefore omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

9.4.2.3 Any assumptions and design specifications modified in input data specifications because of limitations in test methods or other data generation procedures shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

9.4.3* Building Characteristics. Characteristics of the building or its contents, equipment, or operations not inherent in the

design specifications but that affect occupant behavior or the rate of hazard development shall be explicitly identified.

9.4.4* Operational Status and Effectiveness of Building Features and Systems. The performance of fire protection systems and building features shall reflect the documented performance of the components of those systems or features unless design specifications are incorporated to modify the expected performance.

9.4.5 Occupant Characteristics.

9.4.5.1* General. The selection of occupant characteristics to be used in the design calculations shall be approved by the authority having jurisdiction and shall provide an accurate reflection of the expected population of building users.

9.4.5.1.1 Occupant characteristics shall represent the normal occupant profile unless design specifications are used to modify the expected occupant features.

9.4.5.1.2 Occupant characteristics shall not vary across fire scenarios except as authorized by the authority having jurisdiction.

9.4.5.2* Response Characteristics. Each of the following basic performance characteristics shall be considered:

- (1) Sensibility
- (2) Reactivity
- (3) Mobility
- (4) Susceptibility

9.4.5.2.1 Estimations of these characteristics shall reflect the expected distribution in a population appropriate to the use of the building.

9.4.5.2.2 The source of data for these characteristics shall be documented.

9.4.5.3 Location. The assumption shall be made that in every normally occupied room or area at least one person will be located at the most remote point from the exits.

9.4.5.4* Number.

9.4.5.4.1 The design shall be based on the maximum number of people that every occupied room or area is expected to contain.

9.4.5.4.2 Where success or failure of the design is contingent on a maximum number of occupants, operational controls shall be used.

9.4.5.5* Staff Assistance. The ability of trained employees to be included as part of the fire safety system shall be identified, and the necessary training and capabilities documented.

9.4.6 Emergency Response Personnel. Design characteristics or other conditions related to the availability, speed of response, effectiveness, roles, and other characteristics of emergency response personnel shall be specified, estimated, or characterized sufficiently for evaluation of the design.

9.4.7* Post-Construction Conditions. Design characteristics or other conditions related to activities during the life of the building that affect the ability of the building to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

9.4.8 Off-Site Conditions. Design characteristics or other conditions related to resources or conditions outside the property being designated that affect the ability of the building to meet the

stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

9.4.9* Consistency of Assumptions. The design shall not include mutually inconsistent assumptions, specifications, or statements of conditions.

9.4.10* Special Provisions. Additional provisions that are not covered by Section 9.4 but are required for the design to comply with the performance objectives shall be documented.

9.5 Design Fire Scenarios.

9.5.1* General.

9.5.1.1 The authority having jurisdiction shall approve the parameters used in design fire scenarios.

9.5.1.2 The proposed design shall be regarded as meeting the goals and objectives if it achieves the performance criteria for each required design fire scenario. (See 9.5.3.)

9.5.2* Evaluation.

9.5.2.1 Design fire scenarios shall be evaluated using a method acceptable to the authority having jurisdiction and appropriate for the conditions.

9.5.2.2 Each scenario shall be challenging, but realistic, with respect to at least one of the following scenario specifications:

- (1) Initial fire location
- (2) Early rate of growth in fire severity
- (3) Smoke generation

9.5.3* Required Design Fire Scenarios.

9.5.3.1 Design fire scenarios shall include but not be limited to those specified in 9.5.3.2 through 9.5.3.9.

9.5.3.1.1 Each scenario shall include a life safety aspect (Part A) and a building protection aspect (Part B) when applicable.

9.5.3.1.2 Scenarios demonstrated by the design team to the satisfaction of the authority having jurisdiction as inappropriate for the building use and conditions shall not be required.

9.5.3.2* Design Fire Scenario 1. Design Fire Scenario 1 shall be an occupancy-specific design fire scenario representative of a typical fire for the occupancy.

9.5.3.2.1 This scenario shall explicitly account for the following:

- (1) Occupant activities, number, and location
- (2) Room size
- (3) Nature and significance of furnishings and contents
- (4) Fuel properties and ignition sources
- (5) Ventilation conditions

9.5.3.2.2 The first item ignited and its location shall be explicitly defined.

9.5.3.3* Design Fire Scenario 2. Design Fire Scenario 2 shall be an ultrafast-developing fire in the primary means of egress with interior doors open at the start of the fire.

9.5.3.3.1 Part A. This design fire scenario shall address reducing the number of available means of egress.

9.5.3.3.2 Part B. This design fire scenario shall address reducing the effects of a rapidly spreading fire on interior finish and structural components.

9.5.3.4* Design Fire Scenario 3. Design Fire Scenario 3 shall be a fire that starts in a normally unoccupied room and that

potentially endangers a large number of occupants in a large room or other area.

9.5.3.4.1 Part A. This design fire scenario shall address a fire that starts in a normally unoccupied room and migrates into the space that can hold the greatest number of occupants in the building.

9.5.3.4.2 Part B. This design fire scenario shall address a fire that starts in an unoccupied space and that potentially can grow and endanger the area of greatest cultural value or the most significant elements of the collections.

9.5.3.5* Design Fire Scenario 4. Design Fire Scenario 4 shall be a fire that originates in a concealed wall or ceiling space adjacent to a large number of occupants in a large room.

9.5.3.5.1 Part A. This design fire scenario shall address a fire that originates in a concealed space that does not have either a detection system or a suppression system and that spreads into the room within the building that potentially can hold the greatest number of occupants.

9.5.3.5.2 Part B. This design fire scenario shall address a fire that originates in a concealed space with neither a detection system or a suppression system and that potentially can grow and endanger the area of greatest cultural value or the most significant elements of the collection.

9.5.3.6* Design Fire Scenario 5. Design Fire Scenario 5 shall be a slow-developing fire that is shielded from fire protection systems and is in close proximity to a high-occupancy area.

9.5.3.6.1 Part A. This scenario shall address a relatively small ignition source that causes a significant fire.

9.5.3.6.2 Part B. This scenario shall address a relatively small ignition source that causes a significant fire that potentially endangers the area of greatest cultural value or the most significant elements of the collection as the result of the delayed suppression of the fire.

9.5.3.7* Design Fire Scenario 6.

9.5.3.7.1 Design Fire Scenario 6 shall be the most severe fire that results from the largest possible fuel load characteristic of the normal operation of the building.

9.5.3.7.2 This scenario shall address the concern of a rapidly developing fire with occupants present.

9.5.3.8* Design Fire Scenario 7.

9.5.3.8.1 Design Fire Scenario 7 shall be an outside exposure fire.

9.5.3.8.2 This scenario shall address a fire that starts remotely from the area of concern and either spreads into the area, blocks escape from the area, or develops untenable conditions within the area.

9.5.3.9* Design Fire Scenario 8. Design Fire Scenario 8 shall be a fire that originates in ordinary combustibles in a room or area with each passive or active fire protection system rendered unavailable one by one.

9.5.3.9.1 This design fire scenario shall address each fire protection system or fire protection feature, considered individually, as being unreliable or unavailable.

9.5.3.9.2* Design Fire Scenario 8 shall not be required for fire protection systems where the level of reliability in conjunction with the design performance in the absence of the system is acceptable to the authority having jurisdiction.

9.5.4 Design Fire Scenario Data.

9.5.4.1 Each design fire scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model.

9.5.4.2 Any design fire scenario specifications that the design analyses do not explicitly address or incorporate and that are therefore omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

9.5.4.3 Any design fire scenario specifications modified in input data specifications because of limitations in test methods or other data generation procedures shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

9.6 Evaluation of Proposed Design.

9.6.1 General.

9.6.1.1 A proposed design's performance shall be assessed relative to each performance objective in Section 4.3 and each applicable scenario in Section 9.5, with the assessment conducted through the use of appropriate calculation methods.

9.6.1.2 The authority having jurisdiction shall approve the choice of assessment methods.

9.6.2 Use. The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives as measured by the performance criteria in light of the safety margins and uncertainty analysis for each scenario given the assumptions.

9.6.3 Input Data.

9.6.3.1 Data.

9.6.3.1.1 Input data for computer fire models shall be obtained in accordance with ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*.

9.6.3.1.2 Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

9.6.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

9.6.3.3* Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

9.6.4* Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios.

9.6.5 Validity. Evidence shall be provided that confirms the validity and appropriateness of assessment methods used for the proposed building, use, and conditions.

9.7* Safety Factors. Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

9.8 Documentation Requirements.

9.8.1* General.

9.8.1.1 All aspects of the design, including those described in 9.8.2 through 9.8.13, shall be documented.

9.8.1.2 The format and content of the documentation shall be acceptable to the authority having jurisdiction.

9.8.2* Technical References and Resources.

9.8.2.1 The authority having jurisdiction shall be provided with documentation to support the validity, accuracy, relevance, and precision of the proposed methods.

9.8.2.2 The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

9.8.3 Building Design Specifications. All details of the proposed building design that affect the ability of the building to meet the stated goals and objectives shall be documented.

9.8.4 Performance Criteria. Performance criteria, with sources, shall be documented.

9.8.5 Occupant Characteristics. Assumptions regarding occupant characteristics shall be documented.

9.8.6 Design Fire Scenarios. Descriptions of design fire scenarios shall be documented.

9.8.7 Input Data. Input data to models and assessment methods, including sensitivity analysis, shall be documented.

9.8.8 Output Data. Output data from models and assessment methods, including sensitivity analysis, shall be documented.

9.8.9 Safety Factors. Safety factors utilized shall be documented.

9.8.10 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

9.8.11* Modeling Features.

9.8.11.1 Assumptions made by the model user and descriptions of models used, including known limitations, shall be documented.

9.8.11.2 Documentation shall be provided that indicates the validity and appropriateness of the assessment methods used to address the design specifications, assumptions, and scenarios.

9.8.12 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

9.8.13 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in ownership or management of the building with notification of the following:

- (1) That the building was approved as a performance-based design with certain specified design criteria and assumptions
- (2) That any remodeling, modification, renovation, change in use, or change in the established assumptions shall require re-evaluation and re-approval
- (3) That all special events shall be reviewed and approved based on the designs developed under this chapter

9.9 Records. Records required in Section 9.8 shall be maintained for the life of the current performance-based design.

Chapter 10 Management Operational Systems

10.1 General.

10.1.1 This chapter shall establish criteria for management operational systems that are acceptable as elements of a prescriptive solution or performance-based approach as provided in Section 1.5.

10.1.2 Other operational control features shall be permitted subject to the approval of the authority having jurisdiction.

10.2 Responsibility/Authority.

10.2.1 The owner, governing board, or other body having custody over the building shall designate a fire safety manager.

10.2.2 The fire safety manager shall have the authority to implement all elements of the fire safety management plan, including, but not limited to, the following:

- (1) Directing the actions of building staff and occupants with regard to fire safety
- (2) Entering into legally binding contractual agreements with the authority having jurisdiction
- (3) Ordering required fire safety drills and exercises
- (4) Halting contractor and maintenance operations that might threaten the fabric or contents of the building

10.2.3 The fire safety manager shall be responsible for implementing all elements of the approved fire safety management plan.

10.2.4 Reporting Fires.

10.2.4.1 All fires, however small, shall be reported to the local fire department and the fire safety manager.

10.2.4.2 When a fire is deemed suspicious, the fire safety manager shall take steps to ensure that the fire scene is secured pending investigation.

10.3 Management Plan.

10.3.1 The fire safety management plan shall consist of required elements as set forth in Chapter 5 and optional elements as agreed to by the fire safety manager and the authority having jurisdiction.

10.3.2 The fire safety management plan shall become effective on approval of the authority having jurisdiction and the fire safety manager.

10.4 Operational Requirements.

10.4.1 Operational controls or a plan of operations shall include special provisions that are granted as part of a performance-based or prescriptive-based approach in evaluating the building as defined by the process team and as approved by the authority having jurisdiction.

10.4.2 Operational controls shall include the special provisions pertaining to the management, operations, and stewardship of the cultural resource property.

10.4.3 Operational controls shall be defined as part of the fire safety management plan.

10.4.4 Procedures for Opening and Closing. The fire safety management plan shall include checklists that identify specific activities required in conjunction with opening and closing the building on a daily basis and for any special events that are held on the property.

10.5 Fire Emergency Response Planning. The fire safety manager and the governing body shall develop and implement an emergency management plan as required in 5.4.3.

10.6 Training.

10.6.1 The fire safety manager, building staff, and volunteers shall be trained as agreed on with the authority having jurisdiction.

10.6.2 At a minimum, training shall include the emergency management plan, emergency evacuation plan, use of fire protection equipment, and other elements of the approved fire safety management plan.

10.6.3 Drills.

10.6.3.1 Drills shall be conducted to reinforce training and to evaluate staff and volunteer preparedness at intervals agreed on by the fire safety manager and the authority having jurisdiction but not less than annually.

10.6.3.2 Where required, the authority having jurisdiction shall be notified in advance of all drills.

10.6.4 Additional training shall be obtained when any of the following conditions occur:

- (1) The use, occupancy, structure, or internal layout of the building changes.
- (2) Drills indicate that staff or volunteers are not sufficiently familiar with the facility's fire safety management plan and fire protection equipment to respond properly under emergency conditions.
- (3) Special events that have unusual occupancies or conditions are scheduled.
- (4) Portable fire extinguishers constitute a part of the fire safety management plan.
- (5) New materials, substances, or products are introduced into the building.

10.7 Record Keeping.

10.7.1 The fire safety manager shall be responsible for maintaining a current fire safety log (*see Section 5.2*).

10.7.2 All records shall be made available to the authority having jurisdiction on request.

10.8 Compliance Audits. Compliance audits shall be conducted in accordance with the requirements of Section 7.9.

10.9 Enforcement. Where a compliance audit reveals non-compliance with the approved fire safety management plan or changes in the use or arrangement of the building, the authority having jurisdiction shall be notified.

10.10 Modification of the Plan. Proposed modifications to the fire safety management plan shall be approved by the authority having jurisdiction.

Chapter 11 Fire Prevention

11.1* General. This chapter shall outline the minimum protection criteria necessary for protection of cultural resource properties.

11.2 Decorations.

11.2.1 Decorative materials used for special events, occasions, and holidays shall be noncombustible or shall be treated with an approved fire-retardant coating.

11.2.2 Decorations shall be kept a minimum of 0.9 m (36 in.) from ignition sources, such as light fixtures, radiators, electric heaters, and other heat-generating devices.

11.2.3 The use of Christmas trees shall be in accordance with Section 10.15 of NFPA 1, *Uniform Fire Code*.

11.3* Fire Spread Control.

11.3.1 Interior doors shall be kept closed when the building is not occupied except as permitted in 11.3.2.

11.3.2 Where doors are required to remain open for interior ventilation, and air movement concerns are critical to the conservation of historic building fabric, collections, or both, or where the interior doors are themselves part of the historic fabric, careful and professional analysis of the open doors' impact shall be performed, and documented alternative methods to control fire spread shall be implemented.

11.4* Housekeeping.

11.4.1 Stairwells, corridors, doorways, and any other portions of the means of egress for a building shall be maintained free of combustibles, trash containers, and other materials.

11.4.2 Attics.

11.4.2.1 Attic spaces shall be kept free of combustibles and locked.

11.4.2.2 Combustible materials shall be permitted to be stored in attics protected by automatic suppression systems designed to allow such storage.

11.4.3* Electrical rooms, mechanical rooms, and telephone closets shall be kept free of combustibles and locked.

11.4.4 Stacks, exhaust ducts, and filters shall be cleaned as frequently as necessary to prevent the buildup of combustible dusts and fibers.

11.4.5 Air plenums and void spaces shall be kept clean and free of combustibles.

11.4.6 Rags, clothing, and waste material contaminated with oils, such as animal or vegetable oils, paints, thinners, wax, furniture polish, and other liquids or compounds that could cause spontaneous heating, shall be isolated from other combustibles and kept in metal containers with tight-fitting metal lids.

11.4.7 Ventilated metal lockers shall be provided for storage of highly combustible supplies and workers' clothing contaminated with combustible or flammable liquids.

11.4.8 Packing Materials.

11.4.8.1 Combustible packing materials, such as shredded paper, Styrofoam™ packing material ("peanuts"), plastic, and excelsior, shall be stored in metal containers with self-closing covers.

11.4.8.2 Where packing materials cannot be protected using metal containers with self-closing covers, dedicated crating and packing areas shall be enclosed in 1-hour fire-resistive construction or shall be equipped with sprinklers.

11.4.9 Trash shall be collected and disposed of at the end of each workday and more often if necessary.

11.4.10 Dumpsters used for bulk collection of trash or recyclable paper shall be constructed of metal with metal covers.

11.4.11 Dumpsters and other large trash containers inside buildings shall be stored in one of the following ways:

- (1) In trash rooms that have both automatic sprinklers and a 1-hour fire resistance rating
- (2) In loading dock areas that are separated from the rest of the building with a 2-hour fire resistance rating or 1-hour fire resistance rating and protected with automatic sprinklers

11.4.12 Trash containers, dumpsters, and other central waste-disposal units located outside shall be a minimum distance of 4.6 m (15 ft) from all parts of a building exterior, including but not limited to windows, doors, roof eaves, and utility controls.

11.5 Smoking.

11.5.1 Smoking shall be prohibited inside buildings except in designated areas that meet the following requirements:

- (1) Smoking areas shall be clearly and publicly identified.
- (2) Smoking areas shall be provided with suitable ashtrays and other receptacles for the disposal of smoking materials.
- (3) Smoking areas shall be physically separated from the rest of the building with a minimum 1-hour fire resistance rating for walls, ceilings, and floors.
- (4) A rated, fully charged, and operable portable fire extinguisher complying with NFPA 10, *Standard for Portable Fire Extinguishers*, shall be located in each designated area.

11.5.2* Smoking shall be permitted only in designated areas.

11.6 Hot Work. Hot work shall not be permitted in or near the premises unless there is no viable alternative.

11.6.1 Hot Work Permit. A hot work permit, issued by the fire safety manager or designee, shall be required to authorize work with any open-flame devices used in soldering, brazing, cutting, welding, or paint removal.

11.6.2 Permit Requirements.

11.6.2.1 The hot work permit shall prescribe measures to protect the collections and ensure life safety.

11.6.2.2 The hot work permit shall include the following requirements as a minimum:

- (1) A person trained in the use of fire extinguishers shall be stationed in the vicinity of the hot work operation for the duration of the work and for 60 minutes thereafter with frequent monitoring during the following 3 hours. Approved fire extinguishers shall be provided adjacent to the work area.
- (2) All combustibles within 11 m (35 ft) of the work site shall be relocated or be covered with noncombustible or fire retardant-coated tarpaulins or otherwise shielded with metal or noncombustible guards or curtains.
- (3) A statement of the work to be performed and the way it is to be carried out shall be required to be provided before the hot work permit is issued.

11.7 Open Flames.

11.7.1 Approval. Use of open flames and flame-producing devices, such as candles, oil lamps, fireplaces, forges, kilns, glass-blowers, cook stoves, and so forth, shall be approved by the authority having jurisdiction.

11.7.2 Precautions. The following precautions shall be taken to control open flame and flame-producing devices:

- (1) All employees working around open flame or flame-producing devices shall be trained in the use and operation of the device and in emergency response procedures.

- (2) Open flames and flame-producing devices shall be monitored constantly by a trained person.
- (3) A fire extinguisher, listed for the purpose, shall be located within 9 m (30 ft) of the area where open flames or flame-producing devices are in use.
- (4) Candles shall be kept a minimum of 1.25 m (4 ft) from combustible window treatments and wall or ceiling hangings.
- (5) Fireplaces shall be covered with a fire screen when not used for cooking or similar demonstrations.
- (6) Open flames within 31 m (100 ft) of the building shall not be left unattended.
- (7) Open flames either inside or outside the building shall be extinguished prior to shutdown of the facility.

11.7.3 Chimneys.

11.7.3.1 Chimneys that serve active fireplaces or stoves shall comply with the requirements of NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.

11.7.3.2 Chimneys that serve active fireplaces or stoves shall be lined, provided with a spark arrester, and maintained in good working order.

11.7.3.3 Chimneys that serve active fireplaces or stoves shall be inspected and cleaned annually by a competent person.

11.8 Electrical Hazards.

11.8.1 Portable electrical appliances shall be connected to a building electrical circuit that is protected with an arc-fault circuit interrupter (AFCI) except as permitted in 11.8.2.

11.8.2 Portable electrical appliances that are provided with thermal and electrical limit controls that will cause the appliances to fail in a safe condition if they malfunction shall be permitted.

11.8.3 Temporary wiring, including extension cords, shall comply with the requirements of NFPA 70, *National Electrical Code*.

11.8.4 Cabling.

11.8.4.1 Communication cabling, such as telecommunications, network, and protective systems cabling, shall comply with the requirements of NFPA 70.

11.8.4.2 When any such cabling passes through fire barriers or fire walls, such penetrations shall be protected in accordance with Chapter 8 of NFPA 5000, *Building Construction and Safety Code*.

Chapter 12 New Construction, Additions, Alterations, and Renovations

12.1* General. New construction, additions, alterations, and renovations shall comply with Chapters 14 and 15 of NFPA 5000, *Building Construction and Safety Code*, as well as the requirements of this chapter.

12.2* Construction Oversight.

12.2.1* Contractor Selection. Contractors selected to work on the project shall have a demonstrated knowledge and experience in working with cultural resource properties.

12.2.2* Initial Meeting/Indoctrination of Contractors.

12.2.2.1 Prior to beginning work on the project, an introductory meeting shall be held with the contractors, subcontractors, and representatives of the institution.

12.2.2.2 All persons involved with the construction process shall be thoroughly briefed on the significance and importance of the structure, spaces, character-defining features, and collections prior to beginning work.

12.2.2.3 The initial meeting shall cover the project fire safety program, including special protection for existing facilities and contents, emergency precautions, notification of both emergency services and curatorial staff, and security issues pertinent to the project.

12.2.3 Supervision During Construction. Management of the cultural institution shall designate their own representative with the authority to specify additional protection requirements for the construction project necessary to safeguard the existing facility, its contents, and fabric.

12.2.3.1 The management representative shall have the authority to enforce the institution's protection requirements and to stop work or other activities when they jeopardize the safety or security of the facility or its contents.

12.2.3.2 This supervision shall include the following:

- (1) Site security and monitoring of contractors and visitors
- (2) Isolation of construction from the existing building and collections
- (3) Location and handling of flammable liquids and gases
- (4) Removal of rubbish and combustibles
- (5) Hot work and other sources of ignition
- (6)*Handling of sprinklers and other fire protection system components
- (7) Location and type of portable extinguishers to be used in the proximity of collections or historic fabric

12.2.3.3* Following suspension of work each day, the representative or designee shall conduct a walk-through of the work area and surroundings to ensure that the site is secured and that hazards are properly addressed.

12.3 Fire Spread Control.

12.3.1 New openings in fire-rated assemblies, such as doorways and pipe and duct penetrations, shall have self-closing or automatic fire doors and automatic fire dampers that have fire resistance ratings in accordance with Chapter 8 of *NFPA 5000, Building Construction and Safety Code*.

12.3.2 Actuation of any automatic fire protection system in a fire area shall close all automatic fire dampers in the fire area served by the system.

12.3.3 Penetrations in fire-rated assemblies around wiring, pipes, ducts, and so forth, shall be sealed with approved materials to maintain the integrity of the fire-rated assembly (see Chapter 8 of *NFPA 5000, Building Construction and Safety Code*).

12.3.4 New elevator shafts, dumbwaiters, stairways, and other vertical openings through the structure shall be constructed in a manner that prevents the spread of fire, smoke, and heat from one level to another.

12.3.5 New doors in fire-rated assemblies that are required to remain in the open position for any reason shall be equipped with approved door-holding devices controlled by a listed smoke detector.

12.4* Fire Protection Systems.

12.4.1 General.

12.4.1.1 Existing Fire Protection Systems. The design and layout of existing fire detection and suppression systems shall be

evaluated by the project design team to ensure that system operation is not compromised.

12.4.1.2 New Construction. Fire protection systems shall be incorporated in all new construction in accordance with the institution's fire protection program and plan.

12.4.2* Design. Automatic fire sprinkler systems or alternative fire suppression systems shall be provided for all new construction.

12.4.3* Fire Detection and Alarm Systems. Fire detection and alarm systems shall comply with the requirements of *NFPA 72, National Fire Alarm Code*.

12.4.3.1 Smoke detectors shall be installed in every area and space where ambient conditions permit.

12.4.3.2 Where ambient conditions would adversely affect the performance, reliability, and normal operation of smoke detectors, other forms of detection technology, such as heat detection, shall be used.

12.4.3.3 Alarm Monitoring.

12.4.3.3.1 Fire detection and alarm systems and automatic fire suppression systems shall transmit alarm condition signals to an approved monitoring facility.

12.4.3.3.2 The monitoring facility and the communications method used for alarm signal transmission shall comply with the requirements of *NFPA 72, National Fire Alarm Code*.

12.4.4 Automatic Fire Sprinkler Systems.

12.4.4.1 Automatic fire sprinkler systems shall comply with the requirements of *NFPA 13, Standard for the Installation of Sprinkler Systems*.

12.4.4.2* Standard-response sprinklers shall be permitted for use in light-hazard areas.

12.4.5 Alternative Fire Suppression Systems. Where other types of fire suppression systems are provided, they shall comply with the requirements of 55.5.1 of *NFPA 5000, Building Construction and Safety Code*.

12.4.6* Standpipe and Hose Systems. Standpipe and hose systems, where required, shall comply with the requirements of *NFPA 14, Standard for the Installation of Standpipe and Hose Systems*.

12.4.7* Portable Fire Extinguishers. Portable fire extinguishers shall be selected, installed, and maintained in compliance with the provisions of *NFPA 10, Standard for Portable Fire Extinguishers*.

12.5 Roof Coverings.

12.5.1 Unlisted combustible roof coverings shall be treated with an approved fire-retardant coating.

12.5.2 The facility shall maintain a record of this treatment, including certificates of approval of retardant, application method, and retreatment schedule.

12.5.3 Fire retardant-coated roof coverings shall be retreated in accordance with the manufacturer's specifications.

12.6 Emergency Power.

12.6.1* Emergency generators, where required, shall comply with the requirements of *NFPA 110, Standard for Emergency and Standby Power Systems*.

12.6.2 Emergency generators shall have sufficient capacity to support critical fire safety functions and fire suppression systems, where required.

12.6.3* Emergency generators that support other functions considered essential shall have sufficient capacity to support all functions with no degradation of fire safety system support.

12.7* Hazardous Areas. Hazardous areas shall be separated from other areas by a fire separation with a minimum 1-hour fire resistance rating.

12.8 Interior Finishes.

12.8.1 Interior finishes that prevent flames from spreading rapidly or generating dangerous amounts of smoke and toxic products of combustion shall be selected.

12.8.2 Interior finish materials shall comply with the requirements of Chapter 10 of *NFPA 5000, Building Construction and Safety Code*.

12.9 Lightning Protection. A lightning protection system, where required, shall be designed, installed, and maintained in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

12.10 Location. A cultural resource property located within or attached to a building or structure classified as industrial or storage or as containing high hazard contents, as defined in Chapter 6 of *NFPA 5000, Building Construction and Safety Code*, shall be separated by walls or partitions and floor or floor-ceiling assemblies having a fire resistance rating in accordance with Table 6.2.4.1 of *NFPA 5000*.

12.11* Protection Against Exposure Fires. An exposed wall shall prevent heat, flames, and smoke from a nearby fire from being transmitted through it.

12.12 Protection from Wildland Fires.

12.12.1 The governing body or party responsible for cultural resource properties located in areas that are wooded or surrounded by fire-prone vegetation or heavy brush shall incorporate the requirements of NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, into the facility's or institution's fire protection program and plan.

12.12.2 Reduction of fuel loading in the landscape surrounding and owned by the cultural resource property shall be implemented in accordance with the requirements of NFPA 1144, *Standard for Protection of Life and Property from Wildfire*.

12.12.3 Where the landscape is historic and either a contributing element to the property's historic designation or designated itself, the governing body or responsible party shall obtain the evaluation and recommendation of a professional historic landscape architect for reducing fire loading that could threaten either the cultural resource property or the historic landscape.

12.12.4 The evaluation shall include an analysis with respect to the requirements of NFPA 1144, *Standard for Protection of Life and Property from Wildfire*.

12.12.5 The resulting recommendations of the evaluation shall be included in the fire protection program and plan.

12.12.6 Access roads shall be maintained and kept fully accessible at all times to accommodate fire service vehicles.

12.13 Water Control. Provisions shall be made for removal of accumulated water from manual and automatic fire-fighting operations.

Chapter 13 Fire Precautions During Alterations, Additions, and Renovations

13.1 Fire Protection Systems.

13.1.1 Alterations, additions, or renovations of fire protection systems shall comply with the provisions of Chapter 55 of *NFPA 5000, Building Construction and Safety Code*, and shall be approved by the authority having jurisdiction.

13.1.2 Impairments. The provisions of 14.3.1.1 shall apply when fire protection systems or equipment is taken out of service.

13.2 Precautions.

13.2.1* Contracts. All construction, alteration, or renovation contracts shall specify methods and responsibility for controlling fire hazards.

13.2.2 Supervision.

13.2.2.1 Responsibility for enforcement of the terms of the contract relating to fire hazards shall be assigned, and authority shall be given to stop work pending correction of hazards.

13.2.2.2 The responsible local authorities, such as fire and building code enforcement departments, shall be consulted.

13.2.3 Separation of Construction Areas. Each construction area shall be isolated by partitions that resist the spread of fire to other parts of the building.

13.2.3.1 Tarpaulins or plastic sheeting, if used, shall be non-combustible or of a fire-retardant variety.

13.2.3.2 Required exits and normal guard routes shall be maintained or supplementary routes provided.

13.2.3.3 Where construction blocks an exit route, adjoining spaces shall also be closed, as necessary, to avoid excessive crowding in common paths of travel or dead ends.

13.2.3.4 Fire extinguishers, listed for the purpose, shall be accessible and protected from accidental damage.

13.2.4 Ignition Sources.

13.2.4.1 Hot work operations shall comply with Section 11.6.

13.2.4.2 Portable heating appliances shall comply with 13.4.2.

13.2.4.3 On-site recharging of gas cylinders shall be prohibited.

13.2.4.4 Temporary lighting and wiring shall comply with the requirements of Section 14.4 of *NFPA 5000, Building Construction and Safety Code*.

13.2.4.5 Smoking shall be prohibited or restricted to designated areas. (See 13.4.8.)

13.2.4.6 Gasoline-powered engines, such as those used in compressors and hoists, shall not be permitted inside the building.

13.2.5 Housekeeping. Housekeeping shall comply with 13.4.9.

13.2.6 Flammable and Combustible Liquids. No more than a 1-day supply of paint thinners, solvents, and other flammable and combustible liquids used in the project shall be kept in the building.

13.2.6.1 Flammable liquids shall be stored in approved safety cabinets and containers.

13.2.6.2 Quantities of flammable and combustible liquids in excess of those necessary to complete a day's work shall be stored at least 15 m (50 ft) away from the main construction project.

13.2.7 Fire Protection Systems.

13.2.7.1 Fire Detection Systems. Handling of impairments to fire detection systems shall be in accordance with Section 14.3.

13.2.7.2 Fire Suppression Systems.

13.2.7.2.1 Automatic fire suppression systems shall be kept in working order during the project to the extent consistent with the nature of the construction.

13.2.7.2.2 Disconnected or shutoff standpipes or fire suppression systems shall be restored to service as soon as it is practical.

13.2.7.2.3 Inspections of standpipe and sprinkler valves shall be conducted and recorded in accordance with the provisions of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

13.2.7.2.4 Fire hydrants, sprinklers, standpipes and sprinkler fire department connections, and hose outlet valves shall not be obstructed by building materials, debris, or shrubbery and shall be maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

13.2.8 Electrical Systems. Installations and modifications to electrical systems shall be made by licensed or registered electricians.

13.3 Temporary Construction and Equipment.

13.3.1 Construction Offices, Trailers, and Sheds.

13.3.1.1 Construction offices, trailers, sheds, and other temporary facilities of combustible construction shall comply with Section 4.1 of NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

13.3.1.2 Heating devices used in construction offices, trailers, and sheds shall be listed for the purpose.

13.3.1.3* A minimum clearance of 1 m (39 in.) shall be maintained around stoves and heaters and a minimum clearance of 152 mm (6 in.) shall be maintained around all chimney and vent connectors to prevent ignition of adjacent combustible materials.

13.3.1.4 Structures, equipment, and materials shall not impede egress of occupants or workers from the building or hinder access by fire apparatus to the building and hydrants.

13.3.1.5 The areas beneath all temporary offices and other facilities shall not be used for the storage of construction materials, equipment, or supplies, and measures shall be put in place to ensure that no combustible waste matter is allowed to accumulate in these areas.

13.3.2 Construction Equipment and Materials.

13.3.2.1 Equipment.

13.3.2.1.1 Internal combustion engine-powered air equipment, such as compressors, hoists, derricks, and pumps, shall

be placed so the exhaust discharges away from combustible materials and air intakes for the building heating, ventilation, and air-conditioning (HVAC) system.

13.3.2.1.2 A minimum clearance of 150 mm (6 in.) shall be maintained between equipment exhaust piping and combustible materials.

13.3.2.1.3 Service areas, fuel storage, and flammable gas storage for construction equipment shall not be located inside the building.

13.3.2.2* Materials.

13.3.2.2.1* Flammable and combustible liquids shall comply with 13.2.6.

13.3.2.2.2 Combustible construction materials stored inside the building shall be strictly limited to those necessary for that day's work.

13.3.2.2.3 Where steel construction is present, combustible storage shall not be placed in areas where specified fire-resistive coatings have not been applied to structural members.

13.3.2.2.4 Storage of highly combustible materials such as foam, plastic, and rubber products shall not be permitted inside the building.

13.3.2.2.5 Storage of construction materials shall not impede egress from buildings or access of fire apparatus to hydrants or to the building.

13.4 Construction Processes and Hazards.

13.4.1 Cutting and Welding Operations. Cutting and welding operations shall comply with the requirements of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

13.4.1.1 The person designated to be in charge of fire protection shall issue a hot work permit each day that cutting, welding, and other hot work operations are being conducted, as required by Section 11.6.

13.4.1.2* At the close of the work day, the person responsible for fire protection on the site shall inspect areas where welding, cutting, or other hot work operations have been conducted for hot metal or smoldering combustible materials.

13.4.1.3 Flammable gas cylinders used in the welding or cutting process shall be protected from vehicle damage and high temperatures.

13.4.2 Temporary Heating Equipment.

13.4.2.1 Temporary heating equipment shall be listed for the purpose and used and installed in accordance with the listing.

13.4.2.2 Temporary heating equipment shall comply with Chapters 50 and 53 of NFPA 5000, *Building Construction and Safety Code*.

13.4.2.3 Temporary heating equipment shall be used only on a stable surface in a protected location where the equipment will not be overturned.

13.4.2.4 Portable equipment using oil or liquefied petroleum gas as fuel shall be moved to a well-ventilated area away from combustible material and allowed to cool prior to refueling.

13.4.2.5* A portable fire extinguisher, listed for the purpose, shall be located within 9 m (30 ft) of all portable heating devices.

13.4.2.6 Chimney or vent connectors from direct-fired heaters, where required, shall be maintained at least 457 mm (18 in.) from combustible materials.

13.4.2.7 Temporary heating equipment shall be attended and maintained by trained personnel.

13.4.3 Flammable and Combustible Liquids. The use and storage of flammable and combustible liquids shall be controlled and monitored. (See 13.2.6.)

13.4.4 Roofing.

13.4.4.1 Tar Kettles.

13.4.4.1.1 Tar kettles used in roofing shall comply with Section 16.7 of NFPA 1, *Uniform Fire Code*.

13.4.4.1.2* Fire extinguishers, listed for the purpose, shall be located as required in 16.7.1.6 of NFPA 1, *Uniform Fire Code*.

13.4.4.2 Liquefied Petroleum Gas (LPG).

13.4.4.2.1 Cylinders or containers used for fueling tar kettles shall be protected against tampering and vandalism.

13.4.4.2.2 Containers shall be kept 6 m (20 ft) from combustible materials or spare containers.

13.4.4.2.3 When possible, cylinders and containers shall be placed in a secure area for protection against tampering.

13.4.4.2.4 Cylinders or containers that cannot be secured in a protected area shall have the dome covers locked and secured or the valve handle shall be removed or secured in the off position.

13.4.4.2.5 Storage of LPG cylinders on rooftops shall not be permitted.

13.4.4.3 Used roofing mops shall not be stored inside the building.

13.4.5 Plumbing.

13.4.5.1 Plumbing work involving open flames shall be conducted only under the supervision of the person in charge of fire protection and shall require a hot work permit reissued each day.

13.4.5.2 The provisions of 13.4.1 shall apply for cutting and welding operations.

13.4.6 Demolition Work.

13.4.6.1 Gas supplies shall be shut off at a point outside the affected area and shall be capped.

13.4.6.2 Electrical service shall be reduced or eliminated in the affected area.

13.4.6.3 Hot work shall not be permitted in combustible buildings except as outlined in Section 11.6.

13.4.6.4 Fire walls, fire doors, cutoffs, and other fire separation assemblies shall be maintained intact where possible.

13.4.7 Other Hazardous Operations. The fire safety manager shall conduct a hazard assessment of operations that introduce fire hazards to determine whether the risk is consistent with the facility's fire safety objectives.

13.4.7.1 Paint-stripping operations that involve heat-producing devices shall not be permitted.

13.4.7.2 Floor sander dust accumulation bags shall be emptied into closed metal containers outside the building before the close of the day.

13.4.8 Smoking.

13.4.8.1 Smoking shall be prohibited inside any building or building space under construction, renovation, or repair.

13.4.8.2 Where smoking is allowed, the governing body or responsible party for the institution or property shall designate a smoking area outside the work area where contractors and workers are permitted to smoke.

13.4.8.2.1 The designated smoking area shall be clearly and publicly identified and shall be located a sufficient distance away from all combustible and flammable materials or liquids to prevent a fire from starting.

13.4.8.2.1.1 Receptacles for spent smoking materials shall be provided in the designated smoking area.

13.4.8.2.1.2 A portable fire extinguisher, in compliance with the provisions of NFPA 10, *Standard for Portable Fire Extinguishers*, shall be located at each designated smoking area.

13.4.8.2.2 If located inside the cultural resource property, the smoking area shall fully comply with all the requirements of Section 11.5.

13.4.9 Housekeeping.

13.4.9.1 The accumulation of debris or rubbish shall not be permitted inside construction areas or close to a source of ignition.

13.4.9.2 Debris and rubbish shall be removed daily from the site and shall not be burned in the vicinity.

13.4.9.3 Contractors shall provide receptacles for rubbish, papers, and other debris.

13.4.9.4 A chute employed for the removal of debris shall be erected on the outside of the building.

13.4.9.5 Burning waste materials on the premises shall not be permitted.

13.4.10 Electrical.

13.4.10.1 Electrical wiring and equipment shall comply with the requirements of NFPA 70, *National Electrical Code*.

13.4.10.2 Temporary lighting, bulbs, and fixtures shall be installed such that they do not come in contact with combustible materials.

13.4.10.3 Circuit breakers for circuits that are not in use shall be shut off.

13.4.10.4 Temporary wiring shall be removed immediately upon elimination of the need for which the wiring was installed.

13.4.11 Environmental Conditions. Openings in structures susceptible to damage from high winds that could cause skewing and misalignment of the structure, disruption of water supplies, or delivery systems for fire protection shall have secure coverings.

13.5 Fire Protection.

13.5.1 Fire Barriers.

13.5.1.1 Fire walls and exit enclosures required for the completed building shall be given priority during construction.

13.5.1.2 Fire doors with approved closing devices and hardware shall be installed as soon as practical and before combustible materials are introduced.

13.5.1.3 Fire doors shall not be obstructed from closing.

13.5.2 Fire Detection Systems.

13.5.2.1 Existing fire detection and alarm systems shall be maintained in working order during the project to the extent consistent with the nature of the construction.

13.5.2.2 Smoke detectors in the construction area shall be removed or shall be protected from dust, dirt, and extreme temperatures during construction.

13.5.2.3 Smoke detectors in temporary detection systems inside the construction area that are covered to keep out dust and dirt while work is in progress shall be uncovered at the end of each work day.

13.5.2.4 After final construction cleanup by all trades, all smoke detectors shall be cleaned or replaced.

13.5.2.5 Reacceptance testing in compliance with *NFPA 72, National Fire Alarm Code* shall be performed after any adjustment, modification, or repair to any system wiring or component.

13.6 Fire Suppression.

13.6.1* Access.

13.6.1.1 Control Area.

13.6.1.1.1 A suitable location at the site shall be designated as a control area and shall be equipped with floor plans, utility control plans, emergency contact telephone numbers, labeled keys, and appropriate material safety data sheets.

13.6.1.1.2 Where security is of concern, this area shall be locked.

13.6.1.2 Access for heavy fire-fighting equipment to the immediate job site shall be provided at the start of construction and maintained until all construction has been completed.

13.6.1.3 Free access from the street to fire hydrants and to outside connections for standpipes, sprinklers, or other fire-extinguishing equipment, whether permanent or temporary, shall be provided and maintained at all times.

13.6.1.4 Protective pedestrian walkways shall be constructed such that they do not impede access to hydrants, fire department connections, or fire-extinguishing equipment.

13.6.1.5 During construction operations, free access to permanent, temporary, or portable fire-extinguishing equipment and systems shall be maintained.

13.6.1.6 At least one stairway in usable condition shall be provided at all times in multistory buildings.

13.6.2* Water Supply. Water for fire suppression shall be available throughout all phases of construction.

13.6.3 Standpipes.

13.6.3.1 New standpipes that are required or existing standpipes in buildings being altered shall be maintained in accordance with the progress of building activity so that the standpipes are always ready for fire department use.

13.6.3.2 Class I manual dry standpipes shall be permitted where approved by the authority having jurisdiction.

13.6.3.3 Where required by the responding fire department, hose and nozzles shall be provided and maintained ready for use as soon as either a temporary or permanent water supply is available.

13.6.4 Automatic Fire Suppression Systems.

13.6.4.1 Where automatic fire suppression systems are provided, the installation shall be placed in service and monitored as soon as it is practical.

13.6.4.2 Where fire suppression systems existed prior to the rehabilitation project, the system shall be kept in service as long as possible during the rehabilitation work.

13.6.4.3 Where fire suppression systems must be taken out of service for modification, the local fire department shall be notified and the system shall be returned to service as soon as possible.

13.6.5 Portable Fire Extinguishers.

13.6.5.1 Portable fire extinguishers, listed for the purpose, shall be located, mounted, and maintained in compliance with NFPA 10, *Standard for Portable Fire Extinguishers*.

13.6.5.2* At least one portable fire extinguisher, listed for the purpose, shall be accessible on each floor near each usable stairway.

13.7 Emergency Communications.

13.7.1 Prior to beginning any renovations or alterations, workers shall be instructed on emergency communications procedures.

13.7.2 A fixed telephone or equivalent method of summoning the fire service shall be provided and readily available.

13.7.3 The telephone number of the fire service shall be prominently posted on or immediately adjacent to each fixed telephone.

13.7.4 Written instructions shall be posted on how to notify the local fire service of a fire and on actions for security officers or other staff to take after the fire service has been notified.

13.7.5 On activation of a fire alarm or other notification device or identification of an actual fire, personnel shall evacuate the building.

Chapter 14 Inspections, Testing, and Maintenance

14.1* General. This chapter shall establish requirements for critical and regular inspection, testing, and maintenance of fire protection systems and other equipment in cultural resource properties.

14.2 Fire Protection Systems.

14.2.1 All fire protection systems shall be inspected, tested, and maintained in full compliance with the manufacturer's recommendations and the requirements of the following:

- (1) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, for water-based fire protection systems
- (2) Chapter 55 of NFPA 5000, *Building Construction and Safety Code*
- (3) NFPA 72, *National Fire Alarm Code*

14.2.2 Responsibility.

14.2.2.1 The responsibility for maintenance of fire protection systems shall be that of the governing body or responsible party of the cultural resource property.

14.2.2.2 Inspection, testing, and maintenance shall be implemented in accordance with procedures meeting or exceeding those established in the standard for that type of fire protection system and in accordance with the manufacturer's instructions.

14.2.2.3 Personnel who have developed competence through training and experience shall perform inspection, testing, and maintenance of fire protection systems.

14.2.3* Inspection. Inspection and testing frequencies, responsibilities, test routines, and reporting procedures shall comply with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*; Chapter 55 of NFPA 5000, *Building Construction and Safety Code*; and NFPA 72, *National Fire Alarm Code*.

14.2.4 Testing. All fire protection systems shall be tested to verify that they function as intended.

14.2.4.1 Test results shall be compared with those of the original acceptance test (if available) and with the most recent test results.

14.2.4.2 Records shall be retained for the next test and for 1 year thereafter.

14.2.5 Maintenance.

14.2.5.1 Maintenance shall be performed to keep all fire protection systems operable, and necessary repairs shall be made.

14.2.5.2 As-built system installation drawings, original acceptance test records, and device or equipment manufacturer's maintenance bulletins shall be retained by the fire safety manager to assist in developing and maintaining the inspection, testing, and maintenance standards for all fire protection equipment, systems, and components.

14.3 Impairments to Fire Protection Systems.

14.3.1 General. When an emergency or preplanned activity takes any fire protection system out of operational service, measures shall be taken during the impairment to ensure that increased risks are minimized and the extent and duration of the impairment is limited.

14.3.1.1 Where fire protection systems such as sprinkler systems, fire pumps, and fire detection and alarm systems are out of service for 4 hours or more, the fire safety manager shall notify the fire department and post a fire watch.

14.3.1.2 The fire watch shall be provided with an approved means to notify the fire department.

14.3.2 Preplanned Impairments.

14.3.2.1 The fire safety manager shall authorize all preplanned impairments in advance of work.

14.3.2.2 The fire safety manager shall be responsible for verifying that written procedures for impairments are followed before authorizing a system impairment. (See 14.3.3.)

14.3.3 Procedure.

14.3.3.1 A written procedure shall be established and implemented by the fire safety manager to control any emergency or preplanned impairment.

14.3.3.2 This procedure shall include, as a minimum, the following:

- (1) Identification and tagging of all impaired equipment and systems

- (2) Inspection and risk evaluation
- (3) Identification of extent or expected duration of impairment
- (4) Notification of the fire department
- (5)*Notification of other personnel or organizations as appropriate
- (6)*Statement of additional measures deemed necessary for the duration of the impairment of the systems
- (7)*Actions and notifications to be taken when all impaired equipment and systems are restored to operational service
- (8) Prior to a preplanned impairment, assembly of all necessary parts, tools, materials, and labor at the impairment site before the system or equipment is removed from service
- (9) Expedition of all repair work

14.3.4 Restoring Systems to Service. When all impaired systems are restored to operational service, the impairment coordinator shall verify that the following items have been completed:

- (1) All necessary inspections and tests required by the appropriate section of Chapter 55 of NFPA 5000, *Building Construction and Safety Code*, for the fire protection system or equipment involved have been conducted to verify that affected systems and equipment are operational.
- (2) Those individuals notified in accordance with 14.3.3.2(5) have been advised that protection has been restored.
- (3) Impairment tags have been removed.

14.4 Heating, Air-Conditioning, and Cooking Equipment.

14.4.1 Heating, air-conditioning systems, and cooking appliances shall be maintained in accordance with the manufacturer's specifications and shall comply with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*; NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*; and NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.

14.4.2 Heaters and ductwork, including hoods and ducts for ranges, shall be kept free of flammable and combustible deposits.

14.5 Chimneys. Chimneys for active stoves or fireplaces shall be inspected and cleaned annually in compliance with the requirements of NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.

14.6* Electrical Systems. Electrical systems shall be maintained in compliance with NFPA 70, *National Electrical Code*, and the manufacturer's instructions.

14.7 Fire Barriers. The integrity of fire barriers shall comply with Chapter 8 of NFPA 5000, *Building Construction and Safety Code*.

14.8 Fire Retardant-Treated Materials. Applied coatings and treatments shall be maintained in accordance with NFPA 703, *Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials*.

14.9 Fire Extinguishers. Portable fire extinguishers shall be maintained in compliance with NFPA 10, *Standard for Portable Fire Extinguishers*.

Chapter 15 Special Events

15.1 General. Plans for special events shall be reviewed and approved by the fire safety manager.

15.2 Occupant Loading.

15.2.1 The event coordinator shall ensure that the number of occupants admitted to the building is monitored and controlled

so that the occupant load does not exceed the capacity of the means of egress or the number of exits required by NFPA 101, *Life Safety Code*.

15.2.2 Orderly circulation of guests shall be maintained when special events are planned for large groups.

15.3 Egress.

15.3.1 Exits, access to exits, and all other evacuation capabilities shall be maintained.

15.3.2 Tables, plants, stages, or other temporary fixtures shall not visually or physically obstruct an exit, exit sign, or exit access or reduce the width of an exit passage.

15.3.3 Prior to a performance or event, staff (especially temporary or part-time staff), contractor personnel, attendees, and participants shall be notified of the following:

- (1) How fire alarms are annunciated (i.e., audibly, visually, by voice communication, or a combination of these methods)
- (2) Locations of exit routes, exits, and assembly points
- (3) How to safely evacuate the area

15.3.4 Key staff, including event coordinators, volunteers, and security, shall be familiar with exit routes and shall ensure that exits are obvious, operable, and not blocked or restricted in any way.

15.3.5 On activation of the fire alarm, occupants shall be evacuated from the building according to the egress plan.

15.4 Cooking Equipment.

15.4.1 Cooking and food warming shall be undertaken only in facilities built for the purpose, and only electric food-warming equipment shall be used in other areas.

15.4.2 All cooking and food warming shall be closely supervised at all times.

15.4.3 A portable fire extinguisher, listed for the purpose, shall be located within 3 m (10 ft) of any cooking, warming, or related operation and shall be identified clearly.

15.5 Smoking. Smoking shall be prohibited except as permitted in Section 11.5.

15.6 Fireworks. Demonstrations of fireworks shall be held outside the building or structure and shall conform to NFPA 1123, *Code for Fireworks Display*.

15.7 Combustibles.

15.7.1 Tents and canopies shall be noncombustible or certified as having been treated with an approved fire-retardant coating.

15.7.2 Draperies, bunting textiles, wood, and miscellaneous support and decorative materials used inside the building shall be noncombustible, impregnated with an approved fire retardant, or treated with an approved fire-retardant coating.

15.8 Electrical Equipment.

15.8.1 Electrical appliances and equipment, including temporary installations, shall be listed, and wiring shall comply with NFPA 70, *National Electrical Code*.

15.8.2 Exposed electrical wiring and extension cords shall not be placed across travel or exit routes.

15.8.3 A licensed or registered electrician shall verify that electrical circuits do not exceed their rated capacity.

Chapter 16 Museums, Libraries, and Their Collections

16.1 General.

16.1.1 The requirements of Chapters 1 through 15 shall apply to all museums and libraries.

16.1.2 This chapter shall apply to buildings, rooms, or spaces within buildings that store or display museum collections, buildings or spaces within buildings that provide storage for library collections available to the general public or community served by the library, and historic buildings exhibited or used as museums or that have library collections and reading rooms serving the public.

16.1.3 Privately owned library and museum collections not open to the public shall not be required to meet the requirements of this document.

16.1.4* This chapter shall supplement existing codes and standards to apply specifically to buildings or portions of buildings devoted to museum or library use.

16.2* Planning. The governing body of the museum or library and its director or chief executive officer shall be responsible for developing and implementing a fire safety management plan in accordance with Chapter 5.

16.3 Public Areas.

16.3.1 Drapes, Curtains, and Props. Drapes, curtains, props, and similar decorations shall be noncombustible or shall be treated with a listed, approved fire retardant in accordance with the manufacturer's recommendations.

16.3.1.1 Fire-Retardant Treatments.

16.3.1.1.1 The fire safety manager shall maintain records of all chemical fire-retardant treatments.

16.3.1.1.2 Records of fire-retardant treatments shall include the certificate of approval for each fire-retardant coating used, application method, and retreatment schedule.

16.3.2 Decorative materials used for special occasions and holidays shall be used in accordance with Section 11.2.

16.3.3 Carpeting on vertical surfaces shall have a Class A rating and shall comply with the requirements of Chapter 10 of NFPA 5000, *Building Construction and Safety Code*.

16.3.4 Tiered auditorium space structures and other elevated platforms on which people are permitted to sit shall be of noncombustible construction.

16.4* Collection Storage Rooms.

16.4.1 Application. This section shall apply to building areas used for collection storage rooms.

16.4.2 Life Safety.

16.4.2.1 Emergency lighting shall be provided for egress and shall comply with the requirements of NFPA 101, *Life Safety Code*.

16.4.2.2 Fire alarm notification appliances and manual fire alarm boxes shall be provided in every collection storage room.

16.4.3* Fire Prevention.

16.4.3.1 Smoking shall be prohibited in all collection storage rooms.

16.4.3.2 Electrical distribution power panels shall not be installed in collection storage rooms.

16.4.3.3 Utilities other than those supporting fire suppression, fire detection, and security systems or that directly serve the space shall not pass through collection storage rooms.

16.4.3.4 Controls for utilities that serve the collection storage room shall be located outside the space so that access to the controls does not require entry into the collection storage room.

16.4.3.5 Controls for utilities that serve collection storage rooms shall be designed to allow isolation of collection storage room utilities in an emergency.

16.4.3.6* Fixed space heaters installed in collection storage rooms shall be listed, and the installation shall be approved by the authority having jurisdiction.

16.4.3.7 Portable space heaters shall not be permitted.

16.4.3.8 Housekeeping. Housekeeping shall be maintained as required by Section 11.4.

16.4.4* Fire Protection.

16.4.4.1 Collection storage rooms shall be enclosed by fire barriers having a minimum 1-hour fire resistance rating.

16.4.4.2 Collection storage rooms adjoining incinerator rooms, furnace and boiler rooms, paint shops, and other spaces having a significant fire hazard shall be separated from such spaces by a fire barrier having a 2-hour fire resistance rating.

16.4.4.3 Automatic smoke detection shall be provided in every storage room.

16.4.4.4* An approved automatic fire suppression system shall be provided in collection storage rooms greater than 46.5 m² (500 ft²) unless the space contains only noncombustible collections including packing or crating materials, cabinets, and shelves or where all collections are stored inside approved noncombustible cabinets.

16.4.5* Smoke Control. Approved systems shall be provided to prevent smoke and soot from entering collection storage rooms.

16.4.6 Hazardous Materials.

16.4.6.1* Cellulose Nitrate Film. Storage and handling of cellulose nitrate film shall comply with the requirements of NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*.

16.4.6.2 Pyroxylin Plastic. Storage of materials or media containing pyroxylin plastic shall comply NFPA 42, *Code for the Storage of Pyroxylin Plastic*.

16.4.6.3 Wet Collections.

16.4.6.3.1* Storage of collections preserved in combustible or flammable petrochemical solutions shall comply with the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

16.4.6.3.2 Containers used for storing specimens in combustible, flammable, or toxic liquids shall have tight-sealing lids

that minimize evaporation loss or spillage of contents should the container tip over.

16.4.6.3.3 Only approved containers shall be used in dispensing and topping off operations.

16.4.6.3.4 Carts used to transport storage containers shall be sturdy and designed to carry their loads close to the ground.

16.4.6.3.5 Shelving. Shelving units used to hold wet collections shall meet the following requirements:

- (1) Designed to support the loads placed on them
- (2) Tied together or anchored securely to prevent an earthquake or other event from toppling one or more shelves
- (3) Constructed with raised lips and barriers across all open shelves to prevent containers from falling off the shelves
- (4) Anchored and braced in storage areas that are subject to earthquakes
- (5)*Designed so that anchors and bracing provide shelving with strength equal to or greater than the building structure

16.4.7* Storage of Records. Collection accession and other vital records and archival materials shall be stored and protected in accordance with NFPA 232, *Standard for the Protection of Records*.

16.4.8* Compact Storage.**16.4.8.1 Fire Suppression System.**

16.4.8.1.1 An automatic fire suppression system shall be required for compact storage of collections.

16.4.8.1.2 Where the compact storage system consists entirely of enclosed noncombustible cabinets and no collections or other combustibles are stored outside the enclosed cabinets, automatic fire suppression shall be permitted to be omitted subject to the approval of the authority having jurisdiction.

16.4.8.1.3* The design shall recognize the nature of the hazard from a fire that originates in a compact mobile storage unit, where fuel loads are invariably large and fire growth is significantly different from that in other kinds of storage.

16.4.8.1.4 System Design.

16.4.8.1.4.1* The automatic fire suppression system, the compact storage system, and the storage compartmentalization features shall be designed to limit fire damage in accordance with the facility's fire safety objectives.

16.4.8.1.4.2 Design calculations shall include the number and size of the storage modules, the separation provided between the modules end-to-end and back-to-back, and the type of materials being stored.

16.4.8.1.4.3 Where the automatic suppression is provided by automatic fire sprinkler systems, the systems shall be wet pipe, single interlock pre-action, or single noninterlock pre-action systems.

16.4.8.1.4.4 Dry pipe or double-interlock pre-action systems shall not be installed in compact storage areas.

16.4.8.2 Where compact storage is installed in an existing storage area, the existing automatic fire detection and fire suppression systems shall be modified as required to accommodate the increased fire loading.

16.4.9 Electronic Media.

16.4.9.1 Concealed spaces, combustible electric cable insulation, and storage of paper and records associated with electronic data processing equipment shall comply with the requirements of NFPA 75, *Standard for the Protection of Information Technology Equipment*.

16.4.9.2 Storage of Video, Audiotape, and Computer Media. Bulk storage of video, audio, and computer tapes greater than 500 standard VHS tapes or the equivalent shall meet the following requirements:

- (1) Tapes shall be stored in metal storage cabinets in rooms with a minimum 1-hour fire resistance rating.
- (2) Automatic smoke detection shall be provided in the storage room.

16.4.10* Book Stacks.

16.4.10.1 Utilities Serving Book Stack Spaces. Utilities other than those supporting fire suppression, detection, and security systems or that directly serve book stack spaces shall not pass through book stack spaces.

16.4.10.1.1 Electrical distribution power panels shall not be installed in book stacks.

16.4.10.1.2 Controls for utilities serving book stack spaces shall be located outside the spaces so that access to the controls does not require entry into the book stack.

16.4.10.1.3 Controls for utilities serving book stack spaces shall be designed to allow isolation of book stack utilities in an emergency.

16.4.10.2 Single-Tier Book Stacks.

16.4.10.2.1 An automatic fire detection system designed and installed in compliance with NFPA 72, *National Fire Alarm Code*, shall be installed in single-tier book stacks.

16.4.10.2.2 Where specified to achieve fire safety goals by the fire protection plan required by Chapter 5, an automatic fire suppression system designed and installed in compliance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, or Section 55.5 of NFPA 5000, *Building Construction and Safety Code*, shall be installed in the book stacks.

16.4.10.3* Multitier Book Stacks.

16.4.10.3.1 An automatic fire detection system designed and installed in compliance with NFPA 72, *National Fire Alarm Code*, shall be installed in the book stacks.

16.4.10.3.2 An automatic fire suppression system designed and installed in compliance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, or Section 55.5 of NFPA 5000, *Building Construction and Safety Code*, shall be installed in the book stacks.

16.4.10.3.3 Smoke barriers shall be installed in all vertical openings between tiers or decks.

16.4.10.3.4 The fire load in a fire compartment containing a multitier book stack shall be determined by combining the fuel loading of all levels or tiers in the multitier book stack enclosed by the fire compartment.

16.4.10.3.5 Storage on floor-to-ceiling shelving in multitier book stacks shall be permitted where a sprinkler system, designed in accordance with the requirements for this occupancy in NFPA 13, *Standard for the Installation of Sprinkler Systems*, is installed.

16.4.11 Secondary Storage Facilities.

16.4.11.1 Rack Shelving. Rack storage shelving in excess of 4 m (12 ft) in height shall be protected in compliance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

16.4.11.2 Vertical Fire Barriers.

16.4.11.2.1 Vertical fire barriers shall be installed in the shelf system at intervals not exceeding 15 m (50 ft).

16.4.11.2.2 Other spacing of the vertical fire barriers shall be permitted when acceptable to the authority having jurisdiction.

16.4.11.3 Battery Chargers.

16.4.11.3.1 Battery chargers used by forklift trucks, electrically powered vehicles, and pallet lifters shall be separated from the rack storage area in a fire compartment with a 1-hour fire resistance rating.

16.4.11.3.2 A portable fire extinguisher for use on live electrical equipment in compliance with NFPA 10, *Standard for Portable Fire Extinguishers*, shall be located inside the compartment.

16.4.11.3.3 Charging leads and plugs shall be designed to resist hard wear and shall be inspected weekly by a competent person.

16.4.11.3.4 Ventilation.

16.4.11.3.4.1 The ventilation system in the battery-charging area shall be designed to limit the concentration of hydrogen in the compartment to 1 percent or less by volume.

16.4.11.3.4.2 Where the concentration of hydrogen exceeds 1 percent by volume, the compartment shall be equipped with explosionproof electrical fixtures in compliance with NFPA 70, *National Electrical Code*.

16.5 Ignition Control.

16.5.1* Smoking. Smoking shall be prohibited except as permitted by Section 11.5.

16.5.2 Space Heaters.

16.5.2.1 Portable space heaters are not permitted except as specified in 16.5.2.2.

16.5.2.2 Portable space heaters approved for the purpose by the authority having jurisdiction shall be permitted to be used where the building contents have been removed and the building turned over to the contractor for a construction or renovation project.

16.5.2.3 Listed fixed space heaters shall be permitted.

16.5.2.4 Listed fixed space heaters shall be approved by the authority having jurisdiction and shall be installed in accordance with the listing.

16.5.3 Hot Work and Open Flames.

16.5.3.1 All work with open flame devices used in soldering, brazing, paint removal, cutting, and welding shall be used only as permitted by Section 11.6.

16.5.3.2 Open flame demonstrations shall be in accordance with Section 11.7.

16.6* Housekeeping. Housekeeping shall be maintained as required by Section 11.4.

16.6.1 Shipping and receiving areas shall be kept clear of accumulated combustible packing and crating materials.

16.6.2 Discarded packing materials shall be disposed of daily in accordance with 11.4.8 and 11.4.9.

16.6.3* Safety precautions shall be in place to minimize and control fire hazards.

16.7 New Construction.

16.7.1 Support Areas. Support areas shall comply with Chapter 12.

16.7.2 Collection Storage Rooms. Collection storage rooms shall be in compliance with Section 16.4.

16.8 Alterations and Renovations. Alterations, additions, and renovations shall comply with Chapters 12 and 13.

16.9* Exhibit Design and Construction.

16.9.1 The fire safety manager shall thoroughly review exhibit installation plans to ensure compliance with the fire protection plan and to further ensure that the proposed exhibit will not in any way compromise or adversely affect the following:

- (1) Life safety systems, equipment, and measures in the exhibit, the exhibition area, and the building
- (2) Means of egress from the exhibit, the exhibition area, and the building
- (3) Fire protection systems, including detection, alarms, and automatic suppression, in the exhibit, the exhibition area, and the building
- (4) Fire safety in the exhibit, the exhibition area, and the building
- (5) Emergency lighting systems in the exhibit, the exhibition area, and the building

16.9.2 Special lighting effects in the exhibit and exhibition area shall not reduce illumination below the minimum level specified in NFPA 101, *Life Safety Code*, for egress or create any fire hazard.

16.9.3 The fire safety manager shall be kept fully informed and involved at every stage, including preliminary planning, design, fabrication, and installation, for each and every exhibit mounted or installed.

16.9.4 Exhibit Materials.

16.9.4.1* Exhibits shall be fabricated and constructed using materials that are either noncombustible or fire retardant treated.

16.9.4.2 Exhibit construction or backing materials placed in direct physical contact with or immediate proximity to collection objects shall not be fire retardant treated if such treatment will harm the collection object(s) involved.

16.9.4.3 The provisions of 16.9.4.2 shall apply only on an object-by-object-type basis and shall not be used as a total exemption from the use of fire-resistant or noncombustible materials in an exhibit.

16.9.4.4 Exhibit construction or backing materials treated with a chemical fire retardant shall be retreated with an approved fire retardant in accordance with the manufacturer's specifications.

16.9.4.5 Record of Treatment.

16.9.4.5.1 The fire safety manager shall maintain records of all chemical fire-retardant treatments.

16.9.4.5.2 Records shall include the certificate of approval for each fire-retardant coating used, application method, and retreatment schedule.

16.9.4.6 Combustible materials that cannot be made fire retardant shall be located so as to minimize potential hazards.

16.9.5 Portable extinguishers appropriate for the hazard shall be located in compliance with NFPA 10, *Standard for Portable Fire Extinguishers*.

16.9.6 Electrical Requirements.

16.9.6.1 All electrical wiring and work installed for an exhibit shall comply with the provisions of NFPA 70, *National Electrical Code*.

16.9.6.2* Arc-fault circuit interrupters (AFCIs) shall be required in all new exhibit construction.

16.9.7 Temporary walls and exhibit components, such as cases and dioramas, shall not interfere with the operation of any fire protection system.

16.9.8 Automatic fire suppression systems shall be redesigned or modified to account for increased fuel loads.

16.9.9 When special exhibits are expected to draw large crowds, controls shall be established to ensure that lines and assembly or waiting areas, whether inside or outside the facility, do not impair evacuation capabilities or emergency access and to limit the number of visitors in each area within the facility to the posted maximum occupancy.

16.10 Hazardous Areas.

16.10.1 Hazardous areas shall be separated from other areas by a minimum of 1-hour fire-rated construction and shall have an automatic fire suppression system.

16.10.2* Paint spraying and spray booths shall comply with NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.

16.10.3 Flammable and combustible liquids, such as paints, pesticides, and solvents, used in conservation areas shall be stored in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

16.10.4 Fumigation. Flammable or combustible pesticides used to rid collection objects of insect or mold infestations shall be stored, handled, and used in accordance with the provisions of NFPA 30, *Flammable and Combustible Liquids Code*.

16.10.5* Cellulose Nitrate Film. Cellulose nitrate film shall be projected, stored, handled, or processed for conversion to safety film in compliance with NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*.

16.10.6 Pyroxylin Plastic. Storage of materials or media containing pyroxylin plastic shall comply with NFPA 42, *Code for the Storage of Pyroxylin Plastic*.

16.10.7 Print Shops and Binderies. Low-flash point inks, blanket wash solutions, and adhesives shall be used and stored in compliance with NFPA 30, *Flammable and Combustible Liquids Code*.

16.10.8* Laboratories. Laboratories shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

16.10.8.1 Laboratories shall be protected by an automatic fire suppression system.

16.10.8.2 Flammable or combustible liquids shall be stored and used in compliance with NFPA 30, *Flammable and Combustible Liquids Code*.

16.10.8.2.1 Cabinets or rooms for the storage or dispensing of flammable liquids shall comply with the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

16.10.8.2.2 Listed safety containers shall be provided for the storage and use of flammable and combustible liquids.

16.10.8.2.3 No more than a 1-day supply of flammable or combustible liquids shall be kept in the building except in an approved storage cabinet or room.

16.10.8.3 Where required, explosionproof or intrinsically safe-type lighting fixtures, motors, and switches shall be installed in compliance with NFPA 70, *National Electrical Code*.

16.10.8.4 Appliances. Hot plates and other heat-producing appliances shall be listed for their application.

16.10.8.4.1 Hot plates and other heat-producing appliances shall be maintained in accordance with the manufacturers' instructions.

16.10.8.4.2 Pilot lights at wall switches or on the appliances shall be provided to visually indicate whether the appliance is energized.

16.10.8.5 Waste receptacles shall be self-closing metal containers.

Chapter 17 Places of Worship

17.1* General.

17.1.1 The requirements of Chapters 1 through 15 apply to buildings used as places of worship.

17.1.2* This chapter shall apply specifically to buildings, parts of buildings, or enclosed structures that function as a place of worship.

17.1.3 Protection of areas within or associated with a place of worship that function as a museum to display or store artifacts and areas functioning as libraries, book storage, or document storage shall conform to Chapter 16.

17.2 Planning.

17.2.1 Responsibility. The governing body and leadership of the place of worship shall be responsible for the development and implementation of a fire safety program in accordance with Chapter 5.

17.2.2 Emergency Plan. Following the risk assessment, an emergency plan shall be developed for the worship facility, including provision for emergency evacuation, fire department notification, and protection of critical records and valuable artifacts in accordance with Section 5.3.

17.2.2.1 An emergency evacuation plan shall be developed and filed with the fire department for all assembly areas and shall specifically address evacuation of occupancies such as

Sunday schools, nurseries, and senior citizens' meeting areas where the number of trained staff with respect to the number of individuals needing special assistance is low.

17.2.2.2 The plan shall include provisions for notifying the fire department and directing first responders to the location of the fire once they arrive at the site.

17.2.2.3 Emergency telephone numbers shall be posted on or adjacent to all telephones.

17.2.2.4 The plan shall identify historical records such as marriage, birth, and baptismal certificates, valuable artifacts, and relics of special significance and shall provide for their removal, salvage, or both.

17.2.3 Training.

17.2.3.1 All staff and employees of the place of worship, as well as nursery attendants, instructors, and other key volunteers, shall be trained in the provisions of the emergency evacuation plan and fire department notification.

17.2.3.2 This training shall include emergency evacuation of mobility-impaired individuals and children.

17.3 Fire Prevention.

17.3.1 Draperies and Decorations.

17.3.1.1 All combustible draperies and decorations shall be treated with a fire-retardant compound.

17.3.1.2 Fire-retardant treatment of religious and historically significant fabrics shall not be required where such treatment will cause damage to the fabric.

17.3.1.3 Decorations and draperies shall be kept a minimum of 1.2 m (4 ft) from ignition sources, including candles, censers, light fixtures, radiators, and electric heaters.

17.3.1.4 Decorative materials used for special occasions and holidays shall be noncombustible or shall be treated with a listed and approved fire retardant.

17.3.2* Housekeeping. Housekeeping practices in accordance with Section 11.4 shall be maintained.

17.3.2.1 Concealed spaces in the attic, basement, organ pipe runs, steeples, and beneath stairs and raised altar areas shall be kept free from accumulations of combustible materials.

17.3.2.2 Flammable liquids such as paints, varnishes, cleaning solvents, and floor polishes shall be stored inside an approved flammable liquids storage cabinet.

17.3.2.3 Quantities of flammable liquids stored inside the building shall be stored and used in compliance with NFPA 30, *Flammable and Combustible Liquids Code*.

17.3.2.4 Approved, self-closing trash containers shall be used to house oily rags.

17.3.2.5 Trash disposal shall be performed regularly.

17.3.2.6 Power lawn mowers, snow blowers, and other gas-powered implements shall not be stored within the structure.

17.4 Fire Protection Systems. Fire suppression and detection systems shall be incorporated in all existing construction in accordance with the institution's fire protection program and plan.

17.5 Candles and Censers. The use of all open-flame devices shall comply with 13.7.2 of NFPA 101, *Life Safety Code*, and 20.1.4.2 of NFPA 1, *Uniform Fire Code*.

17.5.1 All lit candles shall be maintained a minimum of 1.2 m (4 ft) from combustible draperies and hangings.

17.5.2 All fixed candles shall be supported to prevent them from tipping over.

17.5.3 Following the extinguishment of all candles and incense fires, an individual shall remain on the premises for 30 minutes to guard against potential reignition.

17.5.4 Incense fires in censers shall be extinguished after use and before the censers are stored.

17.6 Historical Records and Artifacts. Valuable record storage shall be protected in accordance with NFPA 232, *Standard for the Protection of Records*.

17.7 Special Facilities.

17.7.1 Kitchens.

17.7.1.1 Kitchen Maintenance.

17.7.1.1.1 Kitchens shall be maintained in a clean and orderly manner.

17.7.1.1.2 Surfaces and equipment shall be kept free of grease, and food wastes shall be disposed of promptly.

17.7.1.1.3 Means of egress from kitchens shall be maintained free of trash containers and other materials.

17.7.1.2 Household Appliances.

17.7.1.2.1 Listed household/consumer appliances shall be permitted in kitchens and shall be installed and maintained in accordance with their listings.

17.7.1.2.2 Household/consumer cooking appliances shall be provided with a listed household/consumer hood.

17.7.1.3 Commercial Cooking Appliances. Listed commercial cooking appliances shall be provided with a hood and exhaust system, grease-removal devices, auxiliary equipment, and fire-extinguishing equipment in compliance with NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.

17.7.1.4 Use and Maintenance.

17.7.1.4.1 Equipment shall be used, inspected, and maintained in compliance with NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.

17.7.1.4.2 Only nonflammable cleaners shall be used.

17.7.2 Schools.

17.7.2.1 Preschool or nursery school facilities located in a place of worship shall comply with NFPA 101, *Life Safety Code*.

17.7.2.2 The governing body of the place of worship shall consult the local authority having jurisdiction prior to starting a school in their building.

17.7.3 Homeless Shelters.

17.7.3.1 If a place of worship contains sleeping rooms for the homeless, this occupancy shall comply with the requirements of NFPA 101, *Life Safety Code*.

17.7.3.2 The governing body shall consult the local authority having jurisdiction prior to the addition of sleeping facilities to a place of worship.

17.7.4* Sanctuaries, Auditoriums, and Gymnasiums. Sanctuaries, auditoriums, and gymnasiums shall comply with NFPA 101, *Life Safety Code*.

17.7.5 Libraries. Libraries shall be protected in accordance with Chapter 16.

17.7.6 Artifacts and Museum/Exhibit Areas. Museum areas, including artifact and exhibit areas, shall be protected in accordance with Chapter 16.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.3 Such structures include, but are not limited to, buildings that store or display museum or library collections, historic structures, and places of worship. These structures also include spaces within other buildings used for such culturally significant purposes.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a “code” is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.6.1 Multitier Book Stack. The system is usually erected inside a structural shell housing the book stack. Typically, a vertical opening (space gap or “deck slit”) is present between the walkway and the ranges at each tier from the bottom tier to the top tier. [See Figure A.16.4.10.3(a) and Figure A.16.4.10.3(b).]

A.3.3.7 Building. The term *building* is construed as if followed by the words *or portions thereof*. A historic building is one designated by a local, regional, or national jurisdiction as having historical, architectural, or cultural significance. Designation could be in an official existing or future national, regional, or local historic register, listing, or inventory. Properties that meet the criteria for eligibility should be treated as eligible.

This also includes buildings in a historic district that are not architecturally distinguished but whose scale, proportions, materials, and details are consistent with the character of the district.

A.3.3.11 Compact Storage Module. See Figure I.1 and Figure I.3.

A.3.3.12 Compact Storage System. See Figure I.4.

A.3.3.16 Cultural Resource Properties. Such properties include, but are not limited to, museums, libraries, historic structures, and places of worship.

A.3.3.31 Fire Safety Manager. In smaller organizations this role can be combined with that of another position or appointment. In larger institutions, the person’s responsibilities should be permitted to include supervision of other fire protection staff. The authorized person should be an employee of the cultural resource facility or institution who has certification, education, training, and/or experience with generally accepted fire protection practices. Alternatively, cultural resource facilities or institutions should be permitted to designate appropriate outside persons such as consulting fire protection engineers, fire service personnel, insurance company loss control representatives, local code officials, or other individuals with similar fire protection credentials.

A.3.3.36 Hazardous Area. Examples include the following:

- (1) Storage or use of combustibles or flammables
- (2) Storage or use of toxic, noxious, or corrosive materials
- (3) Use of heat-producing appliances

A.3.3.39 Historic Structure. Examples of historic structures can be found in *National Register Bulletin 15, How to Apply the National Register Criteria for Evaluation*, “How to Define Categories of Historic Properties.”

A.3.3.41 Impairment. Impairments can be classified as either of the following types:

- (1) *Emergency*, in which a fire protection system, equipment, or a portion thereof is out of order due to an unexpected occurrence, such as a ruptured sprinkler pipe or device or component failure
- (2) *Preplanned*, in which a fire protection system, equipment, or a portion thereof is out of service due to work that has been planned in advance, such as modifications to the water supply or sprinkler system piping

A.3.3.45 Library. The term *library* covers an extremely wide range of situations: A library can be a small special or valuable collection in a private home or other building, or it can be a separate section in a building used for many purposes. It also can be a multimillion-dollar complex of buildings, the purpose of which is to provide not only storage for books, but also study and reading areas, catalog rooms, workrooms, binderies, art collections, shops, and places of public assembly. However, all libraries have one characteristic in common: ample fuel in the form of books and other library materials, which can include compact discs, microforms, magnetic tapes, phonograph records, and motion picture films (cellulose nitrate as well as “safety” film), which can burn and contribute to a serious fire.

A.3.3.45.1 Secondary Storage Facility. This facility utilizes warehouse rack storage methods exceeding 4 m (12 ft) in height.

A.3.3.47 Museum. The American Association of Museums defines a museum as an organized and permanent nonprofit institution, essentially educational or aesthetic in purpose, with professional staff, which owns and uses tangible objects, cares for them, and exhibits them to the public on some regular schedule.

A.3.3.72.2 Fire Scenario. A fire scenario defines the conditions under which a proposed design is expected to meet the fire safety goals. Factors typically include fuel characteristics, ignition sources, ventilation, building characteristics, and occupant locations and characteristics. Fire scenarios include more than the characteristics of the fire itself but exclude design specifications and any characteristics that do not vary from one fire to another; the latter are called assumptions. The term *fire scenario* is used here to mean only those specifications required to calculate the fire's development and effects, but in other contexts, the term can be used to mean both the initial specifications and the subsequent development and effects (i.e., a complete description of fire from conditions prior to ignition to conditions following extinguishment).

A.3.3.74 Special Event. Special events include receptions, dinners, private viewings, and similar activities held at the cultural resource property for specific groups (e.g., members, boards, outside organizations).

A.3.3.77 Utilities. Utilities can include lighting and electrical power services; telecommunication and security services; electrical control circuits; HVAC distribution control circuits and duct systems; water, steam, wastewater, and drain pipes and services; fire suppression systems, including water based and non-water based; oil, gas, hydraulic, and pneumatic systems; and any other electrical or mechanical building services.

A.5.1.1.1.2 Techniques for preparing a fire risk assessment are presented in the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*; NFPA's *Fire Protection Handbook*, Chapters 3.7, 3.8, and 3.11; and the *SFPE Handbook of Fire Protection Engineering*, Section 5. NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, provides guidance on how to evaluate fire risk assessments.

A.5.1.1.2 The fire safety manager can be an employee of the institution who has certification, education, training, and/or experience with generally accepted fire protection practices. Institutions can also use appropriate outside resources, such as consulting engineers, fire department personnel, insurance company loss control representatives, code officials, or other individuals with similar credentials.

A.5.2.1 Some records should be kept longer than others. The fire safety management plan should specify the retention period for each type of record.

A.5.3.2.2 Competent application of systems analysis is a powerful tool in identifying cost-effective alternatives to achieve fire safety goals. For assistance, see NFPA 550, *Guide to the Fire Safety Concepts Tree*.

A.5.4 The fire safety management plan should address the following topics, as appropriate to the circumstances of a particular building:

- (1) Compartmentation
- (2) Structural analysis

- (3) Alarm and communications
- (4) Means of egress
- (5) Smoke control
- (6) Fire suppression
- (7) Water supply
- (8) Ignition prevention
- (9) Fire department/public protection response
- (10) Fuel control

A.5.4.3 The development of an emergency plan should be in accordance with NFPA 1600, *Standard on Disaster/Emergency Management and Business Continuity Programs*, which provides guidance on managing the emergency condition to minimize loss of life, collections, and property and on planning for recovery from the emergency situation.

A.5.4.6.2(5) Examples of such records include, but are not limited to, the following:

- (1) Collections inventories (e.g., accession, catalog, conservation, and loan documents along with copies of donation and gift forms)
- (2) Historical records, including baptismal and wedding records
- (3) Essential business and insurance records
- (4) Building plans and systems documentation (e.g., drawings, specifications, operating manuals, photographs, photographic surveys, and other visual materials)

A.6.1 It is important to control the threat of arson. Precautions can minimize the likelihood of a serious fire. The most common fire setters are vandals, disgruntled patrons, and employees. They might break in at night or gain legitimate access during normal operating hours. (See *Table B.2* and *Table B.4.1*.) Experience indicates that if an unsuccessful arson fire has occurred, a repeat attempt is likely unless the fire setter is brought to justice. The cultural resource property then becomes a specific target, and extra precautions are warranted. The following special precautions are suggested as recommendations for high-risk properties:

- (1) The strongest deterrent to fire setters is good security. Suggested elements of a sound security plan are as follows:
 - (a) Reasonable surveillance, including use of electronic equipment, of all areas accessible to the public, with spot checks at regular intervals. All nonpublic areas should have controlled access.
 - (b) A background investigation for stability and character should be conducted, to the extent legal restrictions allow, on potential employees, security personnel, and others having free access to the entire facility.
 - (c) All accessible openings, including doors, windows, vents, and roof access hatches, should be properly secured. Fire exits should be arranged to prevent outside entry. Doors, windows, and hatches should be checked to make sure locks are in good repair.
 - (d) Exterior lighting is an effective and often underrated security measure against arsonists and other miscreants. Where not provided by public utilities, lighting should be added at all concealed approaches to the facility.
 - (e) A rigid closing procedure, including supervisory follow-up responsibility, should be established to ensure that all unauthorized people have left the building, that openings are secured, and that fire hazards, including ashtrays and trash receptacles, are checked.

- (f) Many fires have been set in book returns. Book returns should be constructed to prevent the spread of fire and smoke from the return into the rest of the library. A better alternative could be to eliminate the inside book return and provide an outside receiving bin away from the exterior walls of the library building.
- (2) High-risk locations require a higher level of precautions if any of the following conditions exist:
 - (a) Properties in high-crime rate areas
 - (b) Cultural resource properties associated with or connected to social or political causes
 - (c) Locations having previously incurred an arson fire or threat
 - (d) Facilities where seriously strained relations between employees and management exist
- (3) For facilities in high-risk locations, the following precautions should be employed:
 - (a) Security/guard service during idle periods or intrusion alarms connected to a reliable, constantly attended location
 - (b) Cooperative liaison with police and fire departments
 - (c) Closed-circuit television and monitors for remote areas with public access, because the cameras provide a formidable psychological deterrent to arsonists, vandals, and other wrongdoers
 - (d) Supplementary outside lighting with a 2 m (7 ft) wire fence in concealed access areas of the building
 - (e) Cutting back of bushes, shrubs, and other plant materials that could provide cover for an intruder

A.6.1.2.2 The analysis should take into consideration the ways fire can spread and the location and position of the following features:

- (1) Air intakes
- (2) Dumpsters and rubbish bins
- (3) Blind areas adjacent to fire escape doors
- (4) Contractor accommodation and storage areas

A.6.1.3 To minimize the probability and impact of deliberately set fires, consideration should be given to the need for security measures designed to reduce the threat of arson. Such measures include the following:

- (1) Access control systems
- (2) Closed-circuit television and surveillance systems
- (3) Intruder detection and alarm systems
- (4) Security lighting
- (5) Upgraded security features for doors and windows
- (6) Perimeter protection, such as fences
- (7) Enhanced patrols

A.6.1.4 The nature of libraries—their access by the public, with many areas obscured from view of attendants—results in their being an opportune target for arsonists as well as others bent on other forms of malicious damage. The most common fire setters are vandals, disgruntled patrons, and employees. They can break in at night or gain legitimate access during normal operating hours. A frequent method of external attack has been to place burning materials into the book return.

A.6.3 Deliberate and malicious setting of fires is the most common cause of fire incidents in the construction phase of building rehabilitation. Control of access to the property is essential in preventing arson. The practice of good house-keeping will minimize the amount of combustible material

readily available to facilitate an arson fire. If a location has experienced labor management difficulties or has previously sustained a set fire or vandalism, it is established as a target for arson, and additional security should be provided. Arsonists have set fires in museums, libraries, places of worship, and historic buildings with motives ranging from mindless vandalism to attempts to cover crimes such as burglary. Arsonists are usually from the outside but not always (possibly employees or volunteers with a grudge or imagined grievance).

A.6.3.2 A qualified person should be assigned overall responsibility for site security during the project. Welding operations on the work site can result in a fire long after work has stopped for the day. Therefore, if security officers are assigned to the work site, officers on duty should be informed of all locations where welding operations were performed. They should be instructed to thoroughly and carefully check each of these locations during their regular patrols of the work site and to look for evidence of smoldering.

A.7.1 This code gives both prescriptive-based and performance-based approaches to achieving its fundamental objectives. Equivalency is also included as an integral concept to achieve compliance. The code, therefore, provides a specific process chapter to guide the user in its application and to reduce possible confusion in the reading and implementation of the code.

A.7.2 A process team should be interdisciplinary in nature, representing both safety and preservation concerns. Early consultation and coordination at each step of the process is highly desirable and strongly recommended. While every effort should be made to create an interdisciplinary team of players, the code recognizes that there will be times when such a diversity of members is not possible. The code, therefore, suggests but does not require any particular membership of the team. Participants on the team can include the following:

- (1) Design professionals
- (2) Fire protection consultant
- (3) Authorities having jurisdiction, including the following:
 - (a) Preservation officer or review agency
 - (b) Fire code official
 - (c) Building code official or permitting authority
 - (d) Insurance company representative/broker
- (4) Representative contractor
- (5) Building manager
- (6) Fire safety manager
- (7) Building occupants
- (8) Building owner

A.7.3 The assessment is intended to evaluate the relevant culturally significant elements, spaces, contents, and features and the relevant fire safety issues associated with the structure. The extent and depth of the assessment might vary, depending on the cultural significance of the building and its component elements, the size and complexity of the building, changes of occupancy classification, and other factors as appropriate.

A.7.3.1.1.2 Demonstrated knowledge might be evidenced by experience with similar properties or submission of designs and solutions that exhibit an understanding of and sensitivity to the impact of their systems on cultural resource properties. Methods of identifying or ensuring that contractors and personnel have a true understanding of the special needs and concerns of cultural resource properties include interviews and predesign conferences and verified referrals or recommendations from other cultural institutions.

A.7.3.1.1.3 Prequalification of contractors and referrals can be used to find contractors experienced in dealing with culturally significant properties. Project specifications should spell out the special precautions needed for the construction activity. Job site meetings should be used to familiarize laborers as well as craftsmen with these special concerns. Curators and key staff members should take part in these meetings.

A.7.3.1.2.1 Character-defining features include, but are not limited to, sheathing or facade materials, roofing materials, chimneys, skylights, cornices, windows and doors, and porches and railings.

A.7.3.1.2.2 Character-defining features and finishes include, but are not limited to, distinctive architectural details, wainscoting, parquet flooring, picture molding, mantels, ceiling medallions, built-in bookshelves and cabinets, crown molding, and arches, as well as simpler, more utilitarian features, such as plain windows and doors and associated trim. The building survey should establish important characteristics of the building type, style, period, or historic function. The building survey should review significant spaces to establish rooms or other interior locations that are typical of the building type or style or are associated with specific persons or events.

A.7.3.1.3 Required exterior modifications or additions should be located on the less visible and least significant exterior elevations in order to keep the impact on culturally significant structures to a minimum.

A.7.5.1 The selection of the method of application of the code could result from a consideration of the following:

- (1) Extent of deviation of the building from the prescriptive code
- (2) Difficulty in providing remedies in accordance with the prescriptive code
- (3) Cultural significance of features that would be compromised by meeting the prescriptive code

The relative cost of performance-based and prescriptive-based approaches should also be considered, because this information might affect the financial means of the building owner to provide code compliance in the building.

The option appraisal and selection portion of the code can function as a tool to assist in selection of a prescriptive-based or performance-based application. A building need not meet both sets of requirements.

A.8.1.1 The three approaches to compliance with prescriptive requirements—alternatives, equivalencies, and modifications—are presented in order of their legal certitude. Therefore, they should be considered in that order to minimize the need for lengthy negotiations or variance hearings. However, early conversations among interested parties can establish an acceptable level of compliance for a particular case.

A.8.1.2 Alternatives refer to options that are explicitly stated in the requirements of the prevailing code. They are often incorporated in exceptions to specific provisions. A careful reading of the prevailing code could reveal more acceptable options to the standard compliance requirements. Particular attention to alternatives should be given where jurisdictions have adopted model codes but have made exceptions for existing or historic buildings.

A.8.1.3 Equivalency refers to alternative fire safety measures that can be established to provide a level of safety equivalent to

the prevailing code. For example, the installation of fire detection and suppression that is not legally required in place of structurally altering the interior of a building can result in an equivalent level of protection. Less common is the compensation for a code deficiency by operational features, for example, compensating for a dead-end corridor with occupant training.

Equivalency is a common code clause that allows other means of compliance if they can be demonstrated and documented. There are many ways to address the issue of documenting equivalency, such as, in order of complexity, precedents, ad hoc equivalency, risk indexing, and component performance evaluation.

Precedents are continually established in the regulation of fire safety for cultural resource properties and historic buildings. They represent acceptable alternatives that have not been formally incorporated into a regulatory document. The annexes of this document are a unique source of identifying many of these precedents. Others might be available locally.

Ad hoc equivalency can be established by employing subjective logic. One qualitative approach used to evaluate alternative arrangements for equivalent safety is NFPA 550, *Guide to the Fire Safety Concepts Tree*. The tree is a logic diagram that represents all possible means of meeting fire safety objectives. Increasing fire safety measures on one branch of the tree can offset a lack of required measures on another branch, thus establishing an arrangement of equivalent fire protection.

Fire risk indexing is a method that should be permitted to be used to establish conformance to a prevailing code. This process consists of a multi-attribute decision analysis approach to quantitatively balance variables of risk, hazard, and safety to achieve an acceptable level of fire safety. Fire risk indexing is a systematic approach to equivalency that considers the building in its entirety and produces a calculated value to identify the degree of compliance with the intent of a prescriptive code.

The following documents have an established record of meeting code objectives through an indexing approach:

- (1) NFPA 101A, *Guide on Alternative Approaches to Life Safety*, Chapters 4 through 9
- (2) *Wisconsin Historic Building Code*, Subchapter IV, Building Evaluation Method, Chapter ILHR 70

Performance-based fire safety can also be approached on a component basis rather than a systemic basis. Some fire safety components already have a form of performance criteria such as fire resistance. Component performance can also be evaluated on a more ad hoc basis through the use of equivalency clauses in building codes. Codifying more component performance criteria can provide solutions for many problems. For example, establishing measurable fire safety objectives for doors, stairs, fire escapes, dead ends, exit signs, and similar features is particularly useful for dealing with these issues in existing cultural resource properties, particularly in historic buildings.

A.8.1.3.2 Any departure from the prescriptive code should be shown through adequate documentation to provide an equivalent level of protection. The extent of documentation/analysis required to demonstrate equivalency should be commensurate with the complexity of the issue.

Equivalent solutions rely on the prescriptive code or standard as a departure point from strict compliance. Identification is made of the areas where the building deviates from the prescriptive requirement, and an equivalent solution is considered for any nonconforming issue. Equivalent solutions

continue to work within the framework of the prescriptive code and justify departures from the prescriptive requirements, either individually or collectively, with an alternative acceptable to the authorities having jurisdiction. The code provides extensive annex material in an effort to provide a stronger framework of information to authorities having jurisdiction as they form decisions on proposed equivalent alternatives. The code also encourages the identification of still more resources to continue to support authorities having jurisdiction in their role of judging proposed alternatives. Maximum flexibility within the confines of equivalent safety is encouraged at all times.

The intent of the code is that liberal use be made of the annex material and references as a basis for establishing equivalency. These and other materials, commonly consulted to provide documentation for performance-based design approaches, also provide strong guidance and support for equivalency solutions. Other materials and information to be considered can include the identification of precedents and research findings.

Materials located in the annex sections of this code, as well as the referenced documents found in various portions of this code, can be used as sources of information to evaluate design alternatives. The application of specific information from these or other sources must be demonstrated as sound through the performance-based approach requirements described in Chapter 9 of the code. The annex and referenced sources of information are not intended to be exclusive sources of information. Any source of information that can be demonstrated to be credible and valuable to the evaluation of the proposed design can be used in conjunction with this code.

A.8.1.4 In existing cultural resource properties, it is not always practical to strictly apply the provisions of the prevailing code. Physical limitations can require disproportionate effort or expense with little increase in life safety. In such cases, the authority having jurisdiction should be satisfied that reasonable life safety is ensured.

In existing cultural resource properties, especially those classified as historic, it is intended that any condition that represents a serious threat to life be mitigated by application of appropriate safeguards. It is not intended to require modifications for conditions that do not represent a significant threat to life, even though such conditions are not literally in compliance with the prevailing code. Among the means of reasonably modifying prescriptive requirements are tolerances and waivers.

Tolerances allow for flexibility by relaxing the many “magic numbers” in code requirements, for example, 50 people, 813 mm (32 in.) wide, 1-hour fire resistance, and so forth. Reasonable dimensional tolerances should be permitted in applying prescriptive requirements to historic buildings. A 10 percent to 20 percent tolerance in prescriptive criteria might be reasonable if it allows historic preservation objectives to be achieved. In legal jargon, such tolerances are referred to as *de minimis*; that is, they are considered insignificant with respect to the overall safety of the building. Tolerance in strict application of installation standards can also be appropriate, for example, allowing a particularly sensitive room to remain unprotected in an otherwise fully sprinklered building.

Waivers can be another form of *de minimis* code application. Waivers can be appropriate where applying a code requirement in an existing cultural resource property is not reasonable. For example, a requirement that all exit doors need

to swing outward could be unreasonable for some situations in historic buildings.

A.8.2 The subjects discussed in Section 8.2 are intended to be a partial listing of system features or beneficial attributes of a structure that could help compensate or offset one or more prescriptive code deficiencies. These provisions are not mandatory, but should be identified when an argument is made for alternative approaches, equivalencies, or modifications to the prescriptive code requirements.

A.8.2(6) Filling concealed spaces with inert materials, such as mineral wool insulation or other similar fire-resistive materials, can further retard the spread of fire. Care should be taken to ensure that the introduction of fire barriers or fire stopping does not inadvertently result in a disturbance of the building’s microclimate by impeding airflow, which might result in the growth of mold or fungus.

A.8.2(7) The U.S. Department of Housing and Urban Development has developed the “Guideline on Fire Ratings of Archaic Materials and Assemblies” to identify approximate fire resistance qualities of older construction methods.

A.8.2(8) Fire detection systems that can discriminate or identify any number of characteristics of fire (e.g., presence of smoke, critical temperature rise, or infrared/ultraviolet radiation) are also considered to be a compensatory feature. The detection device that offers the fastest response with respect to the type of occupancy should be a primary consideration.

A.9.1 Chapter 9 of this code provides requirements for the evaluation of a performance-based life safety and fire protection design. The evaluation process is summarized in Figure A.9.1.

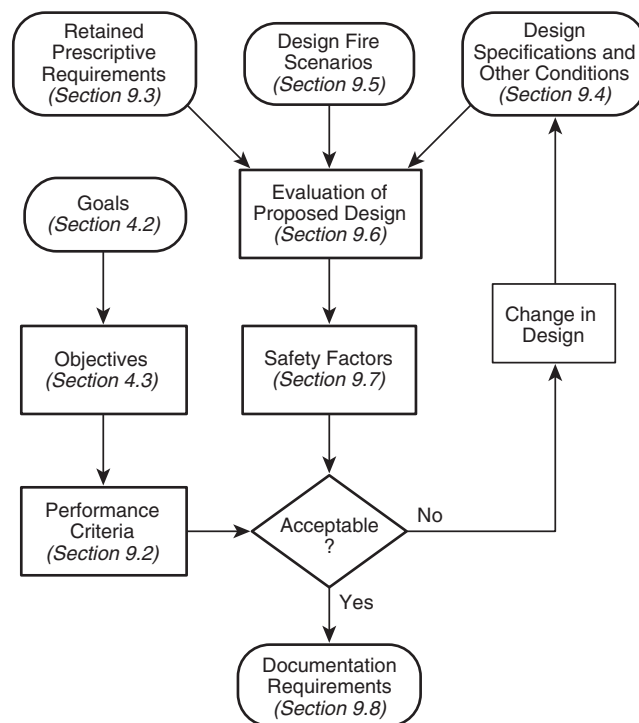


FIGURE A.9.1 Performance-Based Fire Safety Code Compliance Process.

On the left side of Figure A.9.1 is input from the code. The life safety and cultural resource property preservation goals are stated in Section 4.2. The objectives necessary to achieve those goals are stated in Section 4.3. Section 9.2, Performance Criteria, specifies the measures that are to be used to determine whether the objectives have been met.

At the top of Figure A.9.1 is the input necessary to evaluate a fire-safe design. The design specifications need to include certain retained prescriptive requirements as specified in Section 9.3. All assumptions about the life safety design, fire safety design, and the response of the building and its occupants to a fire must be clearly stated as indicated in Section 9.4. Scenarios are used to assess the adequacy of the design as specified in Section 9.5. Eight sets of initiating events are specified for which the ensuing outcomes need to be satisfactory.

Appropriate methods for assessing performance are to be used per Section 9.6. Safety factors need to be applied to account for uncertainties in the assessment as stated in Section 9.7. If the resulting predicted outcomes of the scenarios are bounded by the performance criteria, the objectives have been met and the fire safety design, coupled with the goals of maintaining the culturally significant features of the building under evaluation, is considered to be in compliance with this code. A design that fails to comply can be changed and reassessed as indicated on the right side of Figure A.9.1.

The approval and acceptance of a fire safety design depend on the quality of the documentation of the process. Section 9.6 specifies the minimum set of documentation that needs to accompany a submission.

The performance option of this code establishes acceptable levels of risk to occupants of buildings and structures as addressed in Section 4.2. This risk is also used to evaluate the degree or extent to which the proposed designs will alter or impact the culturally significant features of the property. While the performance option of this code does contain goals, objectives, and performance criteria necessary to provide an acceptable level of risk to occupants, it does not describe how to meet the goals, objectives, and performance criteria. Design and engineering analyses are needed to develop solutions that meet the provisions of this chapter. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* provides a framework for these assessments. Other useful references include the Australian *Fire Safety Engineering Guidelines* and the British *Standard Firesafety Engineering in Buildings*.

A.9.1.3 Qualifications should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods.

A.9.1.4 A third-party reviewer is a person or group of persons chosen by the authority having jurisdiction to review proposed performance-based designs.

A.9.1.7 Continued compliance with the goals and objectives of the code involves many things. The building construction—including openings, interior finish, and fire- and smoke-resistive construction—and the building and fire protection systems need to retain at least the same level of performance as provided for the original design parameters. Performance designs that include features that are related to management operational systems need to include specific instructions related to these features. The use and occupancy should not be allowed to change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained personnel are no longer valid. In addition, action provided by other personnel, such as event

staff or emergency responders, should not be allowed to diminish below the documented assumed levels. Also, actions needed to maintain reliability of systems at the anticipated level need to meet the initial design criteria. If such changes occur, the approach will need to be modified and the plan and design documentation amended to reflect those changes.

A.9.2.2.1 One of the following methods can be used to avoid exposing occupants to untenable conditions:

- (1) The design team could set detailed performance criteria that would ensure that occupants are not incapacitated by fire effects. The *SFPE Engineering Guide to Performance-Based Analysis and Design of Buildings* describes a process for establishing tenability limits.
- (2) The *SFPE Engineering Guide to Performance-Based Analysis and Design of Buildings* references D. A. Puser in the *SFPE Handbook of Fire Protection Engineering*, which describes a fractional effective dose (FED) calculation approach also contained in the 1996 edition of NFPA 269, *Standard Test Method for Developing Toxic Potency Data for Use in Fire Hazard Modeling*. FED addresses carbon monoxide, hydrogen cyanide, carbon dioxide, hydrogen chloride, hydrogen bromide, and anoxia effects. It is possible to use the test data, combined with laboratory experience, to estimate what FED would lead to the survival of virtually all occupants. This value is approximately 0.8.
- (3) There is a relationship between exposures leading to death and those leading to incapacitation. Kaplan found that rodent susceptibility is similar to that of humans and that for the narcotic gases (CO and HCN), human incapacitation occurs at one-third to one-half the lethal exposure. Gann found that carbon monoxide dominates the lethality of fire smoke, since most fire deaths occur remote from the fire room from fires that have proceeded past flashover. Thus, if the FED value of 0.8 were used for nonlethal exposure, an FED of 0.3 would be reasonable for a nonincapacitating exposure.
- (4) If the authority having jurisdiction or the design professional is concerned with potential toxic fire effects other than those addressed by the FED procedure as documented, the calculation procedure can be expanded by adding additional terms to the FED equation, where each term has the form of a ratio. The numerator of the ratio is the cumulative exposure to that fire effect, measured as an integral of the product of instantaneous exposure (concentration for toxic products) and time. The denominator of the ratio is the quantity of cumulative exposure for which FED equals the chosen threshold value (e.g., 0.8 or 0.3) based on that fire effect alone.
- (5) ASTM is actively considering standards that would extend the list of toxic fire effects with standard values.
- (6) If the authority having jurisdiction or the design professional is concerned with potential fire effects other than toxicity, the calculation procedure can be modified to include other fire effects, such as thermal effects.
- (7) For buildings where an unusually large fraction of the occupants would be especially vulnerable, the calculation procedure should be modified to use FED values lower than those cited in A.9.2.2.1 (3) and A.9.2.2.1 (4).
- (8) For each design fire scenario and the design specifications, conditions, and assumptions, the design team could demonstrate that each room or area would be fully evacuated before the smoke and toxic gas layer in that

room descended to a level lower than 1.8 m (6 ft) above the floor. This procedure would require that no occupant be exposed to fire effects. It requires calculation of the locations, movement, and behavior of occupants, because it keeps fire effects and occupants separate by moving the occupants. A level of 1.8 m (6 ft) is often used in calculations, but with that level, a large fraction of the population would not be able to stand, walk, or run normally and still avoid inhalation of toxic gases. They would have to bend over or otherwise move their heads closer to the floor level.

- (9) For each design fire scenario and the design specifications and assumptions, the design team could demonstrate that the smoke and toxic gas layer would not descend to a level lower than 1.8 m (6 ft) above the floor of any occupied room. The advantage of this procedure is that it conservatively requires that no occupant need be exposed to fire effects, regardless of where occupants are or where they move. This option removes the need to make any calculations regarding occupants, including their behavior, movement locations, pre-fire characteristics, and reactions to fire effects. This procedure is even more conservative and simpler than the procedure in A.9.2.2.1(2), because it does not allow fire effects in occupied rooms to develop to a point where people could be affected even after there are no people present to be affected.
- (10) For each design fire scenario and the design specifications and assumptions, the design team could demonstrate that no fire effects would reach any occupied room. The advantage of this procedure is that it removes the need to make any calculations regarding occupants, including their behavior, movement, locations, pre-fire characteristics, and reactions to fire effects. A further advantage is that it also removes the need for some of the modeling of fire effects, because it is not necessary to model the filling of rooms, only the spread of fire effects to those rooms. This method is even more conservative and simple than the procedures in A.9.2.2.1(2) and A.9.2.2.1(3), because it does not allow any fire effects in occupied rooms.

A.9.2.2.2 This evaluation should consider the use of multiple or redundant systems, features, and techniques. Prioritizing what, if any, objects or building features are deemed acceptable to be lost to a fire needs to be evaluated and determined. The following procedures could be potential areas of evaluation for the design team:

- (1) Set detailed performance criteria that will ensure that selected rooms or spaces are protected from flame, heat, or smoke. The *SFPE Engineering Guide to Performance-Based Analysis and Design of Buildings* describes a process of establishing damage limits. The *SFPE Handbook of Fire Protection Engineering* also contains relevant information on thermal damage to various building materials and information on corrosivity of smoke.
- (2) Demonstrate for each design fire scenario and the design specifications, conditions, and assumptions that each room or area will be fully isolated from the fire before the smoke and thermal layer in that room descends to a level where irreversible damage can occur.
- (3) Demonstrate for each design fire scenario and the design specifications, conditions, and assumptions that the smoke and thermal layer will not descend to a level where irreversible damage can occur in any room. The advantage

of this procedure is that it conservatively requires that no culturally significant item need be exposed to fire effects, regardless of where that room or space is located.

- (4) Demonstrate for each design fire scenario and the design specifications, conditions, and assumptions that no fire effects will reach any room or space beyond the room of origin. An advantage of this method is that it also removes the need for some of the modeling of fire effects, because it is not necessary to model the filling of rooms, only the spread of fire effects to those rooms. This method is even more conservative and simple than the procedures in A.9.2.2.2(2) and A.9.2.2.2(3), because it does not allow any fire effects into any rooms with culturally significant features.

A.9.3.1 This requirement applies both to systems and features, including management operational systems required by the code, that reference applicable standards and to any additional systems or features included in the design at the discretion of the design team. The referenced standards are hereby expected to provide positive assurance of an acceptable level of reliability. The referenced standards themselves can be prescriptive or performance based.

A.9.4.1 The design specifications and other conditions form the input to evaluation of proposed design (see Section 9.6). Where a specification or condition is not known, a reasonable estimation can be made. However, the design team needs to take steps to ensure that the estimation is valid during the life of the building. Estimations need to be documented. (See Section 9.8.)

A.9.4.3 These characteristics should extend beyond the normal analysis of building construction features. Elements such as the type of construction, the construction technique, the use of special materials, as well as any unusual design features in the building, should also be explicitly identified.

A.9.4.4 Systems addressed by this requirement include automatic fire suppression systems and fire alarm systems. Performance issues that need to be documented might include response time indexes, discharge densities, and distribution patterns. Calculations should not include an unlimited supply of extinguishing agent if only a limited supply is provided in the actual structure or building.

A.9.4.5.1 Examples of design features that might be incorporated to modify expected occupant characteristics include training, use of staff to assist with notification and movement, or type of notification appliance used.

A.9.4.5.2 The four basic characteristics — sensibility, reactivity, mobility, and susceptibility — comprise a minimum, exhaustive set of mutually exclusive performance characteristics of people in buildings that can affect a fire safety system's ability to meet life safety objectives. The characteristics are briefly described as follows:

- (1) Sensibility to physical cues is the ability to sense the sounding of an alarm. It can also include discernment and discrimination of visual and olfactory cues in addition to auditory emanations from the fire itself.
- (2) Reactivity is the ability to interpret cues correctly and to take appropriate action. Reactivity can be a function of cognitive capacity, speed of instinctive reaction, or group dynamics. Occupants might need to consider the reliability of a decision or the likelihood of a wrong decision, as in the influence of familiarity with the premises on finding one's way.

- (3) Mobility (speed of movement) is determined by individual capabilities as well as by crowding phenomena such as that which results from arching at doorways.
- (4) Susceptibility to products of combustion can affect survivability in a fire environment. Metabolism, lung capacity, pulmonary disease, allergies, or other physical limitations influence the extent to which one is susceptible to products of combustion.

In application, as with the use of computer evacuation models, assumptions can address a larger number of factors that are components of the basic performance characteristics described in Table A.9.4.5.2.

Table A.9.4.5.2 Performance Characteristics

Characteristics	Description
Alertness	Awake/asleep; can depend on time of day
Responsiveness	Ability to sense cues and react
Commitment	Degree to which occupant is committed to an activity underway before the alarm
Focal point	Point at which an occupant's attention is focused (e.g., to front of the classroom, stage, or computer)
Physical and mental capabilities	Can affect ability to sense, respond, and react to cues; can be related to age or disability
Role	Can determine whether occupants will lead or follow others
Familiarity	Can depend on time spent in building or participating in emergency training
Social affiliation	Extent to which an occupant acts/reacts as an individual or as a member of a group
Condition	Over the course of the fire, the effects—both physiological and psychological—of the fire and its combustion products on each occupant

A.9.4.5.4 The number of people expected to be in a room or area should be based on the occupant load factor specified in NFPA 101, *Life Safety Code*, or other approved source.

A.9.4.5.5 For example, in museums and libraries, staff characteristics such as number, location, quality, and frequency of training should be considered.

A.9.4.7 Design proposals need to state explicitly any design specifications or estimations regarding building fire safety plans, inspection programs, or other ongoing programs whose performance is necessary for the building, when occupied and operational or when closed after hours, to meet the stated goals and objectives.

A.9.4.9 This requirement includes assumptions about the interrelations between the performance of building elements and systems, occupant behavior, or emergency response actions that conflict with each other. For each fire scenario, care needs to be taken to ensure that conflicts in actions do not

occur. Typical conflicts could include the following and similar assumptions:

- (1) A fire door will remain closed during the fire event to contain smoke, while occupants use this same door during egress from the area.
- (2) A room door to a culturally significant space is closed at all times, yet the door is normally open for public viewing.
- (3) Fire apparatus will arrive immediately from a distant location to charge fire department connections to provide water.

For example, an assumption that compartmentation blocking the passage of fire and smoke will be maintained at the door from a culturally significant space or to a stairwell cannot be paired with an assumption that evacuation through that door will extend over many minutes.

A.9.4.10 This requirement includes provisions that are in excess of basic requirements covered by referenced codes and standards, typical design requirements, and operating procedures. It includes provisions such as more frequent periodic testing and maintenance to increase the reliability of fire protection systems, redundant systems to increase reliability, on-site staff assistance to enhance detection of fires and aid in fire response procedures, staff training, availability and performance of emergency response personnel, and other factors.

A.9.5.1 Design fire scenarios define the challenge a building is expected to withstand. They also need to define the threat to the culturally significant features or attributes of the building. Design fire scenarios capture and limit value judgments on the type and severity of the fire challenge to which a proposed fire safety system needs to respond. The system includes any or all of the following aspects of the proposed design that are intended to mitigate the effects of a fire:

- (1) Egress system
- (2) Automatic detection and suppression
- (3) Barriers
- (4) Staff training
- (5) Placement of manual extinguishers

Design fire scenarios come from two sources — those that are specified in 9.5.3.2 through 9.5.3.9 and those that are developed by the design team based on the unique characteristics of the building as required by 9.5.2. In most, if not all, cases more than one design fire scenario should be developed to meet the requirements of 9.5.2.

Once the set of design fire scenarios is established — both those specified by 9.5.3.2 through 9.5.3.9 and those that are developed as required by 9.5.2 — they must be quantified into a format that can be used for the evaluation of proposed designs. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process and identifies the tools and references that can be used at each step of this process.

A.9.5.2 The protection systems and features used to meet the challenge of the design fire scenario should be typical of and consistent with those used for other similar areas of the building. They should not be designed to be more effective in the building area addressed than in similar areas not included and that are, therefore, not explicitly evaluated.

A.9.5.3 It is desirable to run a wide variety of fire scenarios to evaluate the complete fire protection and life safety capabilities of the building or structure. Fire scenarios should not be limited to one or two worst-case fire scenarios.

The descriptive terms used to indicate the rate of fire growth for the scenarios are intended to be generic. Use of *t*-squared fires is not required for any scenarios.

A.9.5.3.2 An example of such a scenario for a cultural resource property would involve a public museum or library. A large concentration of occupants could be present. A significant element or feature could be immediately threatened by fire. This is a cursory example in that much of the explicitly required information indicated in 9.5.3.1 can be determined from the information provided in the example. Note that it is usually necessary to consider more than one scenario to capture the features and conditions typical of an occupancy.

A.9.5.3.3 Examples of such scenarios are a fire involving ignition of gasoline as an accelerant in a means of egress or renovation materials or other fuel configurations that can cause an ultrafast fire. The means of egress chosen is the doorway with the largest egress capacity among doorways normally used in the ordinary operation of the building. The baseline occupant characteristics for the property are assumed. Such spaces can also contain building materials or features that are culturally significant. At ignition, doors are assumed to be open throughout the building.

A.9.5.3.4 An example of such a scenario is a fire in a storage or collections room adjacent to the largest occupiable room in the building or adjacent to the room or space with the most cultural significance. The contents of the room of fire origin are specified to provide the largest fuel load and the most rapid growth in fire severity consistent with the normal use of the room. The adjacent occupiable room is assumed to be filled to capacity with occupants. Occupants are assumed to be somewhat impaired in whatever form is most consistent with the intended use of the building. The room contains contents that are vulnerable to minor quantities of heat or smoke. At ignition, doors from both rooms are assumed to be open. Depending on the design, doorways might connect the two rooms, or they might connect via a common hallway or corridor.

For purposes of this scenario, an occupiable room is one that could contain people (i.e., a location within a building where people are typically found).

A.9.5.3.5 An example of such a scenario is a fire originating in a concealed wall or ceiling space adjacent to a large occupied function room or a room or space containing a special collection, furniture, or work of art. Ignition involves concealed combustibles, including wire or cable insulation and thermal or acoustical insulation. The adjacent function room is assumed to be occupied to capacity. The baseline occupant and building characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the building.

A.9.5.3.6 An example of such a scenario is a cigarette fire in a trashcan. The trashcan is close enough to room contents to ignite more substantial fuel sources but is not close enough to any occupant to create an intimate-with-ignition situation or close enough to immediately endanger any of the culturally significant spaces or objects. If the intended use of the property involves the potential for some occupants to be incapable of movement at any time, the room of origin is chosen as the type of room likely to have such occupants, and it is filled to capacity with occupants in that condition. If the intended use of the property does not involve the potential for some occupants to be incapable of movement, the room of origin is cho-

sen to be an assembly or function area characteristic of the use of the property, and the trashcan is placed so that it is shielded from suppression systems. At ignition, doors are assumed to be open throughout the building.

A.9.5.3.7 An example of such a scenario is a fire originating in the largest fuel load of combustibles possible in normal operation in a function or assembly room or a process/manufacturing area characteristic of the normal operation of the property. The configuration, type, and geometry of the combustibles are chosen so as to produce the most rapid and severe fire growth or smoke generation consistent with the normal operation of the property. The baseline occupant characteristics of the property are assumed. At ignition, doors are assumed to be closed throughout the building.

This category includes everything from a couch fire in a small dwelling to a rack fire in combustible liquids stock in a home improvement or wholesale retail store.

A.9.5.3.8 An example of such a scenario is an exposure fire. The initiating fire is the closest and most severe fire possible, consistent with the placement and type of adjacent properties and the placement of plants and combustible adornments on the property. The baseline occupant characteristics for the property are assumed.

This category includes wildland/urban interface fires, exposure from fires originating in adjacent structures, and exterior wood shingle problems, where applicable.

A.9.5.3.9 This scenario addresses a set of conditions with a typical fire originating in the building with any one passive or active fire protection system or feature being ineffective. Examples of this category include unprotected openings between floors or between fire walls or fire barrier walls, rated fire doors that fail to close automatically or are blocked open, sprinkler system water supply shut off, nonoperative fire alarm system, smoke management system not operational, or automatic smoke dampers blocked open. This scenario should represent a reasonable challenge to the other building features provided by the design and presumed to be available.

The concept of a fire originating in ordinary combustibles is intentionally selected for this event. This fire, although it presents a realistic challenge to the building and the associated building systems, does not represent the worst-case scenario of the most challenging fire event for the building.

Examples of fires that originate in ordinary combustibles include the following:

- (1) *Corridor of a historic museum.* Staff is assumed not to close any exhibition space or room doors upon detection of fire. The baseline occupant characteristics for the property are assumed, and the areas or viewing rooms off the corridor are assumed to be filled to capacity with visitors. At ignition, all such doors in the area are not equipped with self-closing devices and are assumed to be open throughout the smoke or fire compartment.
- (2) *Large assembly room or area in the interior of the building.* The automatic suppression systems are assumed to be out of operation. The baseline occupant characteristics for the property are assumed, and the room of origin is assumed to be filled to capacity. At ignition, doors are assumed to be closed throughout the building. A specific or rare collection piece is located in the room of origin.
- (3) *Unoccupied small function room adjacent to a large assembly room or area in the interior of the building.* The automatic detection systems are assumed to be out of operation. The

baseline occupant characteristics for the property are assumed, the room of origin is assumed to be unoccupied, and the assembly room is assumed to be filled to capacity. At ignition, doors are assumed to be closed throughout the building. The room is of particular cultural significance and is vulnerable to potential damage from an undetected fire.

A.9.5.3.9.2 This paragraph applies to each active or passive fire protection system individually and requires two different types of information to be developed by analysis and approved by the authority having jurisdiction. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable performance need not mean fully meeting the stated goals and objectives. It could be possible to meet fully the goals and objectives with a key system unavailable, and yet no system is totally reliable. The authority having jurisdiction will determine what level of performance, possibly short of the stated goals and objectives, is acceptable, given the very low probability (i.e., the system's unreliability probability) that this situation will occur.

A.9.6.3.3 Procedures used to develop required input data need to preserve the intended conservatism of all scenarios and assumptions. Conservatism is only one means to address the uncertainty inherent in calculations and does not remove the need to consider safety factors, sensitivity analysis, and other methods of dealing with uncertainty. The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* outlines a process for identifying and treating uncertainty.

A.9.6.4 An assessment method translates input data, which can be test specifications, parameters or variables for modeling, or other data, into output data that are measured against the performance criteria. Computer fire models should be evaluated for their predictive capability in accordance with ASTM E 1355, *Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models*.

A.9.7 The assessment of precision required in 9.5.4.3 requires sensitivity and uncertainty analysis, which can be translated into safety factors.

The first run a model user makes should be labeled as the base case, using the nominal values of the various input parameters. However, the model user should not rely on a single run to use as the basis for any performance-based fire safety system design. Ideally, each variable of parameter that the model user made to develop the nominal input data should have multiple runs associated with it, as should combinations of key variables and parameters. Thus, a sensitivity analysis should be conducted that provides the model user with data that indicate how the effects of a real fire can vary and how the response of the proposed fire safety design can also vary. The interpretation of a model's predictions can be a difficult exercise if the model user does not have knowledge of fire dynamics or human behavior.

The first thing the model user should try to determine is whether the predictions actually make sense (i.e., they do not contradict intuition or preconceived expectations). Most likely, if the results do not pass this test, an input error has been committed.

Some factors to consider in the interpretation of a model's results are as follows:

- (1) Sometimes the predictions appear to be reasonable but are, in fact, incorrect. For example, a model can predict

higher temperatures farther from the fire than closer to it. The values themselves can be reasonable (e.g., not hotter than the fire), but they do not "flow" down the energy as expected.

- (2) A margin of safety can be developed using the results of the sensitivity analysis, which provides the possible range of when a condition is estimated to occur, in conjunction with the performance criteria.
- (3) Safety factors and margin of safety are two concepts used to quantify the amount of uncertainty in engineering analyses. Safety factors are used to provide a margin of safety and to represent or address the gap in knowledge between the theoretically perfect model (i.e., reality) and the engineering models that can only partially represent reality.
- (4) Safety factors can be applied to either the predicted level of a physical condition or the time that the condition is predicted to occur. Thus, a physical and/or a temporal safety factor can be applied to any predicted condition. A predicted condition (i.e., a parameter's value) and the time it occurs are best represented as distributions. Ideally, a computer fire model predicts the expected or nominal value of the distribution. Safety factors are intended to represent the spread of those distributions.
- (5) Given the uncertainty associated with data acquisition and reduction and the limitations of computer modeling, any condition predicted by a computer model can be thought of as an expected or nominal value within a broader range. For example, an upper-layer temperature of 600°C is predicted at a given time. If the modeled scenario is then tested (i.e., in a full-scale experiment based on the computer model's input data), the actual temperature at that given time could be 640°C or 585°C. Therefore, the temperature should be reported as 600°C (+40°C/-15°C) or as a range of 585°C to 640°C.
- (6) Ideally, predictions are reported as nominal values, with some percentage, or as absolute values. As an example, an upper-layer temperature prediction could be reported as 600°C, $\pm 30^\circ\text{C}$ or as 600°C, ± 5 percent. In this case, the physical safety factor is 0.05 (i.e., the amount by which the nominal value should be degraded and enhanced). Given the state of the art of computer fire modeling, this safety factor is very low. Physical safety factors tend to be on the order of tens of percent; 60 percent is not unheard of.
- (7) Part of the problem with this approach is that it is difficult to state what percentage or range is appropriate. These values can be obtained when the computer model predictions are compared to test data. However, using computer fire models in design mode does not facilitate determination of the range of values, since the room being analyzed has not been built yet, and test scenarios do not necessarily depict the intended design.
- (8) Perform a sensitivity analysis on the assumptions that affect the condition of interest. Develop a base case that uses all nominal values for input parameters. Vary the input parameters over reasonable ranges and note the variation in predicted output. The output variation can then become the basis for physical safety factors.
- (9) The temporal safety factor addresses the issue of when a condition is predicted and is a function of the rate at which processes are expected to occur. If a condition is predicted to occur 2 minutes after the start of the fire, this time frame can be used as a nominal value. A similar process of that described for physical safety factors can

also be employed to develop temporal safety factors. In this case, however, the rates (e.g., of heat release or toxic product generation) will be varied instead of absolute values (e.g., material properties).

- (10) The margin of safety can be thought of as a reflection of societal values and can be imposed by the authority having jurisdiction to that purpose. Because authorities having jurisdiction most likely will focus on the predicted time for a condition (e.g., the model predicts occupants will have 5 minutes to safely evacuate), the margin of safety will be characterized by temporal aspects and tacitly applied to the physical margin of safety.
- (11) Because escaping the harmful effects of fire (or mitigating them) is, effectively, a race, time is the parameter of choice when assessing fire safety system designs based on computer model predictions. When an authority having jurisdiction is faced with the predicted time of untenability, a decision needs to be made regarding whether sufficient time is available to ensure the safety of building occupants. The authority having jurisdiction, in assessing the margin of safety, needs to determine whether time is sufficient to get everyone out safely. If the authority having jurisdiction feels that the predicted egress time is too close to the time of untenability, the authority having jurisdiction can impose an additional time that the designer needs to incorporate into the system design. In this way, the authority having jurisdiction can impose a greater margin of safety than that originally proposed by the designer.

A.9.8.1 The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* describes the documentation that should be provided for a performance-based design.

Proper documentation of a performance-based design is critical to the design acceptance and construction. Proper documentation also ensures that all parties involved understand what is necessary for the design implementation, maintenance, and continuity of the fire protection design. If attention to detail is maintained throughout the documentation, there should be little dispute during approval, construction, startup, and use.

Poor documentation can result in rejection of an otherwise good design, poor implementation of the design, or inadequate system maintenance and reliability, and it provides an incomplete record for future changes or if the design is forensically tested.

A.9.8.2 The sources, methodologies, and data used in performance-based designs should be based on technical references that are widely accepted and used by the appropriate professions and professional groups. Such acceptance is often based on documents that are developed, reviewed, and validated under one of the following processes:

- (1) Standards developed under an open consensus process conducted by recognized professional societies, codes or standards organizations, or governmental bodies
- (2) Technical references that are subject to a peer review process and are published in widely recognized peer-reviewed journals, conference reports, or other publications
- (3) Resource publications, such as the *SFPE Handbook of Fire Protection Engineering*, that are widely recognized technical sources of information

The following factors are helpful in determining the acceptability of a method or source:

- (1) Extent of general acceptance in the relevant professional community. Indications of acceptance include peer-reviewed publications, widespread citations in the technical literature, and adoption by or within a consensus document.
- (2) Extent of documentation of the method, including the analytical method itself, assumptions, scope, limitations, data sources, and data reduction methods.
- (3) Extent of validation and analysis of uncertainties. This includes comparisons of the overall method with experimental data to estimate error rates as well as analysis of the uncertainties of input data, uncertainties and limitations in the analytical method, and uncertainties in the associated performance criteria.
- (4) Extent to which the method is based on sound scientific principles.
- (5) Extent to which the proposed application is within the stated scope and limitations of the supporting information, including the range of applicability for which there is documented validation. Factors such as spatial dimensions, occupant characteristics, ambient conditions, and so forth, can limit valid applications.

In many cases, a method will be built from and include numerous component analyses. These component analyses should be evaluated using the same factors as are applied to the overall method.

A method to address a specific fire safety issue, within documented limitations or validation regimes, might not exist. In such a case, sources and calculation methods can be used outside their limitations, provided the design team recognizes the limitations and addresses the resulting implications.

The technical references and methodologies to be used in a performance-based design should be closely evaluated by the design team, the authority having jurisdiction, and possibly a third-party reviewer. The strength of the technical justification should be judged using criteria presented in A.9.8.2. This justification can be strengthened by the presence of data obtained from fire testing.

A.9.8.11 Documentation for modeling should conform to ASTM E 1472, *Standard Guide for Documenting Computer Software for Fire Models*, although most, if not all, models were originally developed before this standard was promulgated.

A.11.1 Understanding, practicing, and enforcing the basic concepts and principles of fire prevention are some of the most important actions any cultural resource facility or institution can undertake. This chapter presents some of the basic precautions applicable to all types of cultural resources. Subsequent chapters devoted to museums and libraries (Chapter 16) and places of worship (Chapter 17) contribute additional material specific to each type of resource. Historic buildings are specifically addressed by NFPA 914, *Code for Fire Protection of Historic Structures*. (See NFPA 1, *Uniform Fire Code*, for comprehensive fire prevention information.)

A.11.3 In a fire, the prevention of interior spread of flames and smoke is critical to stopping a fire from rapidly growing. The simple act of ensuring that interior doors are kept closed when a building is not occupied is a major positive fire prevention activity. Part of the facility's comprehensive fire protection program and plan should include evaluation and incorporation of procedures for ensuring that interior doors are

closed wherever possible. The governing body or party responsible for the facility and the authority having jurisdiction must understand the potentially dangerous conflict in allowing interior doors to remain open to facilitate interior ventilation and air movement, thereby significantly enhancing the threat of the unimpeded spread of fire and smoke through the facility.

A.11.4 A high standard of housekeeping is one of the most important factors in the prevention of fire. Maintaining this high standard of housekeeping is every employee's responsibility; however, it is the facility director who assumes the final responsibility for this critical activity.

A.11.4.3 Expendable materials (i.e., filters, light bulbs, and refrigerant) that are directly associated with the proper operation or maintenance of equipment found in any of these rooms can be permitted. The supply of these materials should be kept to a minimum. Depending on the quantity of materials and degree of hazard either associated with the equipment or inherent in the materials themselves, the storage of these materials might be further restricted to specialized storage containers (e.g., metal cabinets or other suitable means). Coat closets or other spaces being used for telephone or computer equipment along with general storage need to be evaluated for fire integrity. Enhancement of the fire compartmentation and/or the installation of fire sprinklers might be required.

A.11.5.2 Designated smoking areas should not include any of the following areas:

- (1) Exhibition areas or galleries
- (2) Collections or any other types of storage areas
- (3) Any type of workshop
- (4) Laboratories
- (5) Library reading rooms
- (6) Library book stacks
- (7) Assembly areas such as classrooms, auditoriums, theaters, chapels, or large sanctuaries
- (8) Restrooms
- (9) Mechanical rooms
- (10) Receiving areas or stockrooms
- (11) Projection rooms
- (12) Electronic equipment and telecommunications rooms

A.12.1 The more important general principles for fire-safe construction are set forth in the following paragraphs. Detailed recommendations for good practice are also contained in various NFPA publications. In most localities, building codes and ordinances govern the type of construction to be used.

Codes frequently provide for the safety of persons in the building but not for the protection of the collections or the preservation of the historic fabric of the building or the collections. Therefore, it is critical at the conception of the project to specify the level of fire safety to be achieved in the construction. It is recommended that a professional fire protection engineer be retained to participate in the development of the fire protection specifications and to verify that the specifications are fulfilled satisfactorily.

Design of the automatic fire protection and detection systems and building construction are interrelated. In addition to protecting combustible contents and providing improved safety to life, automatic fire suppression systems can in some cases enable the use of less expensive construction than would be permissible without them.

The following features of building design and engineering should be considered during construction:

- (1) Selection of materials and types of construction that are either noncombustible or fire resistant
- (2) Compartmentation of a building so that fire or smoke can be confined
- (3) Consideration of an engineered smoke management system
- (4) Selection of interior finishes and furnishings

It is desirable to select materials and types of construction that are either noncombustible or fire resistive. Fire-resistive construction is desirable and for multistory structures is essential. Fire-resistive construction is described in NFPA 220, *Standard on Types of Building Construction*, and requires structural members, including walls, partitions, columns, floor, and roof construction, to be of noncombustible materials and have fire resistance ratings from 2 to 4 hours, depending on the structural members.

The contents of a cultural resource facility are valuable, sometimes of very high value or even irreplaceable, and almost always combustible. Therefore, every effort should be made to construct the building to resist the spread of fire. This means that during a fire the walls, roof, floor, columns, and partitions should prevent the passage of flame, smoke, or excessive heat and continue to support their loads. "Fire resistive" is not the same as "noncombustible." Some materials that will not burn lose their strength when exposed to intense heat, which might cause walls or floors to collapse. Iron or steel multistoried book stacks are an example of this type of structure. Many types of construction using various building materials have been tested and rated according to the length of time they will resist fire. The duration of resistance needed by a library depends on the amount of combustible material in the contents of each room as well as in the structure itself. Different structural assemblies have fire resistance ranging from less than 1 hour to more than 4 hours.

NOTE: NFPA 220, *Standard on Types of Building Construction*, classifies and defines various kinds of building construction. Testing laboratories list information on structural assemblies that have been tested in accordance with NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

It is unwise to construct buildings that house cultural resource institutions of materials that will contribute fuel to a fire and that, by the nature of the construction, create combustible concealed spaces. Voids between a ceiling and the floor above are good examples of concealed spaces through which fire can spread rapidly and where access for fire fighting is difficult.

The term *compartmentation* in fire protection is used to mean subdivision of a building into relatively small areas so that fire or smoke can be confined to the room or section in which it originates. This principle can be applied to libraries and museums without restricting the flexibility of arrangement of library collections or the flow of visitors. Compartmentation requires fire-resistive wall and floor construction, with openings provided with self-closing or automatic fire doors having fire resistance ratings in accordance with the fire resistance ratings of the wall or ceiling/floor assemblies they are to protect.

In a similar way, properly enclosed stairways equipped with fire doors will prevent the spread of fire, smoke, and heat from one level to another. Elevator shafts, dumbwaiters, and all

other vertical openings through the structure should be similarly safeguarded. Air-handling systems (ventilation, heating, and cooling) should be constructed and equipped to prevent the passage of smoke, heat, and fire from one area to another or from one level to another as provided in NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

An engineered smoke management system should be considered as one of the means to achieve the fire safety objectives established for the cultural resource institution. Depending on building construction, interior finish, and furnishings and other contents, a substantial level of smoke damage can be sustained from even a relatively small, well-controlled fire. A smoke management system generally should be considered a complement to the protection provided by automatic sprinklers or other fire suppression systems and the barriers that define the fire zones. The smoke management system can assist in limiting smoke from spreading beyond the initial fire zone. See NFPA 92A, *Recommended Practice for Smoke-Control Systems*; NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*; and NFPA 204, *Standard for Smoke and Heat Venting*.

An important consideration is the proper selection of interior finishes and furnishings. Highly flammable wall and ceiling finishes should be avoided. NFPA 101, *Life Safety Code*, and most building codes specify minimum requirements for interior finish materials. Combustible draperies should be avoided. Extra care should be used in regard to the burning characteristics of upholstered furniture, insulating materials, and acoustical materials. Careful selection of interior finishes is always important, especially in the absence of automatic fire suppression or protection.

A.12.2 The cultural resource property is most vulnerable during periods of renovation, alteration, and new construction. Additional hazards, such as smoking by contractors, sources of ignition such as welding and cutting, temporary electrical wiring, and heating, are introduced. Coupled with those hazards are the security risks associated with allowing access to contractors, inspectors, and other outsiders. Incidents of vandalism, arson, and theft increase exponentially during periods of construction. Additionally, construction activities in cultural resource properties require a higher level of supervision and oversight than standard projects because of their potential impact on the existing building, collections, and other culturally significant objects.

A.12.2.1 Knowledge and experience in working with cultural resource properties are critical to ensure that the contractors are sensitive to the value and damageability of the building and its collections. Criteria that can be used in determining whether a contractor is qualified to work on this type of project include the following:

- (1) Education and training in a cultural field
- (2) Experience with similar types of projects of similar size and complexity
- (3) Satisfaction of management at other institutions with the contractor's sensitivity and suitability of result
- (4) Demonstrated success in meeting time, quality, cost, and protection requirements
- (5) References from similar institutions or cultural resource properties
- (6) Proposals that demonstrate sensitivity to the special needs of the institution and its collections

A.12.2.2 It is important that time be spent at the beginning of the project to make sure that all contractors and subcontractors

understand the nature of the project, special building features or collections that require special protection during construction, and other curatorial concerns. A meeting also provides an opportunity for contractors and other workers to ask questions or review alternative approaches that might have an impact on other contractors or better address curatorial concerns. Participants should include all contractors, subcontractors, workers, security staff, and curatorial staff, depending on the size of the institution and the project. Based on items discussed in this meeting, a contract can be drawn up detailing security and protection requirements for the project; as an added measure, each contractor or worker on the project might be asked to sign the contract.

A.12.2.3.2(6) Proper care and handling of sprinklers and other system components are critical in preventing damage or weakening, which can result in accidental discharge after installation. This is especially true for the more fragile quick response sprinklers and those incorporating glass bulbs. The following precautions should be taken when handling sprinklers:

- (1) Store sprinklers in a cool, dry place.
- (2) Protect sprinklers during storage, transportation, and handling and after installation.
- (3) Do not place sprinklers loose in boxes, bins, or buckets.
- (4) Leave protective caps, where provided, attached to sprinklers until after installation.
- (5) Use the designated wrench provided by the manufacturer and specifically designed for installation of each specific type of sprinkler head.
- (6) Do not use a sprinkler deflector to thread sprinklers onto fittings or to torque sprinklers into place.
- (7) Replace sprinklers that become coated with paint, drywall, or other material rather than attempting to clean them.

A.12.2.3.3 Most fires involving construction projects are slow-smoldering fires, which can be detected in their early stages by conducting a walk-through of the facility after operations have ceased for the day. Ideally, these rounds should be conducted every half hour for the first 2 hours, with guard service making rounds on an hourly basis thereafter.

A.12.4 Without automatic fire protection systems, fire-resistive or noncombustible construction can survive, but combustible contents in the fire compartment will not. Fire protection systems should provide for both detection and extinguishment. While these functions are separate, they can and often should be consolidated into one continuous fire protection system that detects a fire, sounds the alarm, alerts the fire service, and initiates automatic extinguishing devices. Smoke detection systems provide an opportunity for occupant action with portable fire extinguishers before fire development activates the automatic sprinkler or other fire suppression system. Careful planning permits the installation of the necessary equipment with a minimal effect on the appearance or use of the public spaces in the cultural resource facility.

Additional descriptions, applications, and limitations of the protective systems mentioned in this chapter are contained in Section D.3, Glossary of Fire Protection Systems.

Planning for the fire protection equipment must also include providing and maintaining an adequate water supply to support standpipe and hose systems for fire service use as well as for automatic sprinkler systems.

A vast selection of makes, models, and styles of fire protection equipment is available today to meet practically any need

a cultural resource institution might have. Choosing a reputable supplier and installer is a crucial decision that a fire protection consultant can assist a library in making. In lieu of a consultant, other valuable information can usually be obtained from the insurer, other businesses in the area, and the local fire department. The cultural resource institution should seek to procure a system for which parts and service are readily available now and will be in the future. In addition, the fire protection equipment and system should be listed or approved.

Many states and jurisdictions require designers and installers of fire protection systems to be licensed and certified by national boards. Prospective installers should be asked to show proof of their qualifications, as well as their experience in installing similar systems, preferably in similar occupancies. Check to see how satisfied these other businesses were with the installation and final product. Libraries generally have special concerns and needs, especially in book-stack areas, which must be discussed in detail with the contractor prior to beginning work. A detailed construction schedule is helpful and should be worked out in advance. The staff should also be made aware of the improvements to take place and how the fire protection systems work.

Once a fire protection system is installed, it is imperative that the system be thoroughly inspected, tested, and maintained to ensure that it functions properly.

A.12.4.2 See NFPA 550, *Guide to the Fire Safety Concepts Tree*, for a method to determine fire protection objectives.

A.12.4.3 Various devices with controlled sensitivity can detect a fire condition from smoke, a critical temperature, or the rate of temperature rise. These detectors can provide the warning needed to get people safely out of the building and start fire-extinguishing action promptly. Fire protection specialists should be consulted to determine what kinds of detectors best fit the conditions in different parts of the building. (See Section D.3, *Glossary of Fire Protection Systems*.)

The fire detection system sounds an alarm to alert the occupants. Detection systems should also transmit signals to a listed or approved central station or a fire department that is staffed or attended 24 hours a day, especially in the case of an unoccupied building. Maintenance and testing of the detection system are important, particularly in any building where it is the only automatic protection system. A number of fires have shown this to be true. Failures of fire detection systems have been due to bad design, poor maintenance, and lack of testing. (See NFPA 72, *National Fire Alarm Code*, and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, for further information on fire detection and alarm systems.)

Operation of any of fire detection or suppression systems or signals from their supervisory systems should cause actuation of an alarm at a constantly attended location. It could also cause actuation of the building alarm system as described in NFPA 101, *Life Safety Code*. The alarm can be bells, horns, a live voice, a prerecorded message, flashing lights, or other suitable means. All alarm systems should be installed and maintained in accordance with the applicable NFPA standards. (See NFPA 72, *National Fire Alarm Code*, Chapter 3, *Emergency Voice/Alarm Communication Systems*, for further information on alarms.)

A.12.4.4.2 Standard-response sprinklers employ more robust operating elements than quick-response sprinklers and can be more appropriate for use in areas where concern for inadvertent water discharge outweighs the advantages of thermal sensitivity.

A.12.4.6 Where standpipes and hose lines are required or installed to provide reliable and effective fire streams in the shortest possible time, they shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. Training and skill in the use of hose streams are essential to avoid personal injury and unnecessary property damage. Occupants should not attempt to use a fire hose unless they are part of an organized fire brigade that has received training in compliance with OSHA regulations. It must be emphasized that the use of standpipe hose lines, as with the use of fire extinguishers, should not be allowed to delay the transmission of alarms to the fire department.

A.12.4.7 Portable extinguishers are important items of fire protection equipment and should be installed in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. They permit the use of a limited quantity of extinguishing agent on a small fire at the moment someone discovers it. Therefore, they should be present in adequate numbers. The extinguisher should be of a kind intended for the class of fire anticipated. Multiclass portable extinguishers are available that remove any doubt whether the correct extinguisher is being used. Extinguishers should be properly located and inspected regularly so they will be in working order when needed. Personnel should know the locations of and be instructed in the proper use of fire extinguishers. It must be emphasized that the use of fire extinguishers should not be allowed to delay the transmission of alarms to the fire department.

A.12.6.1 Emergency generators provide enhanced levels of protection and should be incorporated in all heritage buildings unless the reason for their omission is valid.

A.12.6.3 Examples are temperature and humidity control to a particular storage vault, essential data processing equipment, or critical research projects.

A.12.7 Wet-specimen storage rooms, workshops, display shops, conservation laboratories, paint rooms, kitchens, and rooms containing central heating equipment such as boilers and furnaces are considered hazardous areas.

A.12.11 Exposure protection for walls can include fire windows with wired glass, fire doors, exterior automatic sprinklers, water curtains, automatic fire shutters, or a combination of these. (See NFPA 80, *Standard for Fire Doors and Fire Windows*.)

A.13.2.1 See NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

A.13.3.1.3 See NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

A.13.3.2.2 Construction materials stored inside the building or structure should be kept to a minimum. Materials not immediately needed should be stored away from the structure to minimize fuel loading and to reduce the likelihood that excess materials will block egress routes. Where possible, equipment and materials should be stored in secured areas with a functional fire suppression system, or materials should be subdivided and stored in secured noncombustible structures. Equipment too large to be stored in such areas should be stored in secured fenced yard areas.

A.13.3.2.2.1 Storage for excess quantities of flammable and combustible liquids should be located downgrade from the project when possible. The storage site should also be a sufficient distance away from heavy traffic areas to minimize the exposure to personnel and others.

A.13.4.1.2 If security officers are not assigned to the work site, all welding or cutting operations should stop a minimum of 3 hours before the end of the normal work day to allow sufficient time for any fire conditions to be found in areas where hot work was performed.

A.13.4.2.5 See NFPA 10, *Standard for Portable Fire Extinguishers*.

A.13.4.4.1.2 See NFPA 10, *Standard for Portable Fire Extinguishers*.

A.13.6.1 Pre-fire plans should be updated periodically with the local fire service. For large projects, a fire safety coordinator for the site should be appointed who should ensure that all procedures, precautionary measures, and safety standards are clearly defined in writing and are understood and complied with by all personnel on the construction site.

A.13.6.2 The local fire service should verify by on-site testing whether the water supply is capable of sustaining adequate pressure and flow rates for fire-fighting operations as anticipated in their pre-fire plan for the building. Where underground water mains are to be provided, they should be installed, tested, and placed in service prior to other construction work.

A.13.6.5.2 The code official or site manager might require additional portable fire extinguishers, based on specific hazards.

A.14.1 History has shown that the performance reliability of fire protection systems and equipment increases where comprehensive inspection, testing, and maintenance procedures are enforced. Diligence during inspections is important.

A.14.2.3 Inspection and testing determine what, if any, maintenance actions are required to maintain the operability of fire protection systems.

A.14.3.3.2(5) The authority having jurisdiction, the insurance carrier, the central station or alarm company monitoring impaired systems, and supervisory staff in areas of the facility affected by the impairment should be notified.

A.14.3.3.2(6) It might be necessary to post a fire watch.

A.14.3.3.2(7) Notify the same personnel and organizations as in A.14.3.3.2(5).

A.14.6 Electrical systems should be maintained in accordance with NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*.

A.16.1.4 While this chapter prescribes minimum requirements for the protection of museums, libraries, and their collections from fire, additional guidance in fire prevention, fire protection, and fire loss contingency planning is provided in this annex for trustees, chief librarians, museum directors, and other staff officers who are responsible for the fire safety of the building(s) and the collections therein and for the life safety of those persons who visit or work in the buildings. It emphasizes the responsibility of all such officials to protect against fire hazards in their properties by using qualified personnel and consultants to present an analysis of the fire risk embodied in the collections, building(s), and operations. This

analysis should also include an assessment of the impact of the loss or interruption that fire would impose on the facility's service to the community.

A.16.2 The hazard analysis required by 5.3.2 must include those special hazards often created by museum and library operations. Such hazards include but are not limited to the following:

- (1) Conservation laboratories and areas where collections are treated using a variety of combustible and flammable materials
- (2) Special types or classes of collections as follows:
 - (a) Scientific specimens stored in alcohol
 - (b) Cellulose nitrate negatives and motion picture film
 - (c) Military weaponry, arms, or artifacts that must be checked to ensure that they are not "live"
 - (d) Rare objects or specimens composed of unstable and combustible material(s)
 - (e) Objects that the demonstration or use of which can create a potential fire hazard, such as historic electrical equipment, steam engines, forging machinery, and fireplaces
- (3) Special historic, artistic, and/or scientific processes that can be demonstrated to the public or used to recreate objects, such as the following:
 - (a) Cooking demonstrations
 - (b) Silver, gold, and pewter casting
 - (c) Blacksmithing and similar craft demonstrations
 - (d) Artillery and weaponry demonstrations
 - (e) Historic manufacturing processes of all types
 - (f) Art demonstrations and/or classes that use flammable solvents or materials
 - (g) Glass blowing and glass molding
- (4) Concentrations of combustible collections on exhibit, in book stacks, or in storage, which by their very concentration can create a fire hazard through increased fire loading, as follows:
 - (a) Historic building fragments and representative parts often retained by historic properties as documentary collections. These collections, while important, can create heavy fire loading if they are not stored selectively and carefully.
 - (b) Scientific specimens stored in alcohol or other flammable liquids.
 - (c) Large quantities of combustible objects, for example, historic wooden molds and patterns used to cast metal machine parts or components of an iron building (like a greenhouse). Numbering in the thousands, these items are sometimes stored in bulk containers rather than individually, creating an increase in hazard. (Source: Burklin and Purington, *Fire Terms: A Guide to Their Meaning and Use*)
- (5) Exhibit fabrication and construction areas and workshops in which combustible and flammable materials, paints, and solvents are frequently present
- (6) Maintenance workshops, combustible supply storage areas, boiler and mechanical equipment rooms, and other support areas

The facility's governing board and its fire safety manager must understand that the specific fire hazards within their institution might differ considerably from the examples given. These are offered only as examples of the types of hazards often found in museums and libraries.

A.16.4 Cultural resource institutions are using more plastic-based storage containers than ever before. Plastic is used for film storage, magazine dividers, storage boxes and bins, clothing bags, and various covers. Staff members need to realize that the presence of plastic-based materials can increase the risk of direct and indirect damage to the building, contents, and collections of a cultural resource institution. Most plastic, when burned, produces thick, acrid, black products of combustion (smoke). As plastic burns, it degrades to its original petrochemical form, resulting in fire conditions similar to combustible liquid spill fires with a very high rate of heat release. Smoke from burning plastic can be very damaging, both in the area of fire origin and throughout a facility. Past experience has demonstrated that plastic covers and bags have a tendency to attract smoke particles to clothing and other fabrics.

Staff should also consider the impact that plastic will have on the design of the fire protection systems protecting an area in a facility. Significant quantities of plastic usually require higher levels of fire protection than do similar quantities of ordinary combustibles (e.g., paper, wood, cardboard, textiles). Thorough fire protection planning and design require that consideration be given to how smoke from a fire will be removed from the facility. Depending on the design, size, and compartmentalization of a facility, smoke removal can often be easily accomplished by the local fire department using portable fans. Larger facilities with few openings or windows to the outside should consider ventilation system designs that will enable manually operated exhaust systems to ventilate smoke from the areas without relying on direct openings to the outside. In these types of facilities, fire departments might not be able to properly evacuate smoke in a timely fashion with the equipment typically available.

A.16.4.3 The primary goal of this subsection is to separate the fuel from ignition sources and other sources of risk. Padding, dust covers, humidity buffering materials, and other materials having a high surface-to-mass ratio should be noncombustible or treated with an approved fire-retardant coating.

A.16.4.3.6 All sources of ignition should be excluded from the book stacks. Fixed space heaters should be permitted only under rigidly controlled conditions, as approved by the authority having jurisdiction.

A.16.4.4 Proper clearance should be maintained between fire protection system nozzles and stored material.

A.16.4.4.4 Such collections include bronze sculptures, ceramics, and minerals.

A.16.4.5 Smoke control systems should comply with the requirements of NFPA 92A, *Recommended Practice for Smoke-Control Systems*; NFPA 92B, *Guide for Smoke Management Systems in Malls, Atria, and Large Areas*; and NFPA 204, *Standard for Smoke and Heat Venting*.

A.16.4.6.1 The current editions of NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, and NFPA 42, *Code for the Storage of Pyroxylin Plastic*, do not specify requirements for cellulose nitrate film negatives.

A.16.4.6.3.1 The Society for the Preservation of Natural History Collections (SPNHC) in a publication titled *Storage of Natural History Collections: A Preventative Conservation Approach*, and the Distilled Spirits Council of the United States have fire protection guidelines that deal strictly with alcohol and provide additional information on the use of glass containers in

excess of 1 gallon (3.8 L). Many specimens can fit only in containers much larger than 1 gallon (3.8 L) in size.

A.16.4.6.3.5(5) Seismic protection design typically includes a combination of the following:

- (1) Rack design: shelving constructed to meet seismic strength requirements.
- (2) Bottom bracing: shelving secured to the floor with fasteners of adequate strength to resist the anticipated shear and tension forces.
- (3) Top bracing: sway bracing at the top of the racks to provide horizontal strength adequate to resist the expected seismic forces. In most cases, bracing is tied to structural members of the building to provide a path for the horizontal forces.

A.16.4.7 Consideration should be given to storing valuable or sensitive records and collections closer to (but not on) the floor, as fire and its by-products are more likely to damage collections closer to the ceiling, even those remote from the fire. Items subject to water damage should not be stored directly on the floor, but should be skidded or raised to reduce their exposure to damage from water or flooding. NFPA 232, *Standard for the Protection of Records*, provides additional information on the storage and protection of archival material. In addition, consideration should be given to creating duplicate records and storing them at an off-site location.

A.16.4.8 Compact storage systems present a severe fire challenge that requires engineering solutions specifically designed for each installation.

A.16.4.8.1.3 The automatic fire suppression system, the compact storage system, and the storage compartmentation features should be designed to limit fire damage in accordance with the facility's fire safety objectives (e.g., confine fire growth to the compact storage module of origin). Significant factors to consider include the number and size of the storage modules, the separation provided between the modules (end-to-end and back-to-back), and the type of materials being stored. In general, double-interlock pre-action systems and dry pipe systems are inappropriate for compact storage, because of the additional delay they introduce, coupled with the delays in activation resulting from the compact storage units themselves.

Other protection features, which should be considered to limit the extent of potential fire damage, include the following:

- (1) Very high density sprinkler systems
- (2) Quick-response sprinklers
- (3) Early-warning smoke detection
- (4) Spacers between carriages or, for automated systems, automatic park mode to increase flue spaces between carriages upon activation of a fire alarm or during idle periods
- (5) Metal vertical barriers in the middle of the shelf
- (6) Open-top shelving

A.16.4.8.1.4.1 The system should be designed to confine fire growth to the compact storage module of origin or the shelving range of origin.

A.16.4.10 With potential fire durations of more than 8 hours, fuel loads in book stacks can range from numbers more comparable to warehouse occupancies than to business occupancies.