

FIRE PROTECTION & LIFE SAFETY DESIGN MANUAL

**SMITHSONIAN INSTITUTION – OFFICE OF SAFETY,
HEALTH AND ENVIRONMENTAL MANAGEMENT**

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INTRODUCTION

The unique nature and significance of the Smithsonian Institution's buildings, collections and operations mandate a higher level of fire protection and life safety than the minimum standards established by the building and fire codes. This Design Manual builds upon current codes, utilizing the latest recommended industry practices and specialized fire protection engineering experience to establish an appropriate level of fire protection and life safety for all Smithsonian facilities and the collections, occupants and operations within. This Design Manual provides for the life safety of Smithsonian staff and visitors through measures which control fire growth and ensure adequate means for egress are available for safe evacuation. This Design Manual also strives to achieve a level of protection from fire and products of combustion that is commensurate with the value of the property and operations being safeguarded. Special attention is given to the protection of collections against fire, smoke, gas, as well as the potential deleterious effects of fire protection systems.

The fire safety solutions outlined in this Design Manual provide a balanced approach to achieving the stated goals. That is, they rely on a number of fire safety systems to achieve a total prevention and protection scheme, while taking into account the need for building functionality and design flexibility. Particular emphasis is on fire safety systems that are simple, reliable, long-lasting, maintenance-friendly, and cost-effective. While active fire systems are key to the success of the overall protection scheme, passive measures also play a significant role by minimizing the impact of a potential fire on occupants, collections, and facility operations.

This manual is divided into 8 chapters. The first six chapters describe common fire protection and life safety requirements to be applied to all projects. Chapter 7 describes requirements associated with special occupancies, such as collection storage, laboratories and animal housing facilities. The final chapter and Appendix A describe exhibit fabrication requirements. This manual established and mandates the use of SI standard fire protection specifications and commissioning standards, which are listed in Appendices B and C, respectively.

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CHAPTER 1 FIRE PROTECTION DESIGN OVERVIEW

1.1 PURPOSE

- A. This Fire Protection Design Manual (Manual) identifies the fire protection and life safety design criteria for new facility designs, upgrades, and modifications to existing facilities and spaces.
- B. This Design Manual provides requirements for protecting all SI occupants and for limiting SI property loss from fire.

1.2 SCOPE

- A. This Design Manual applies to all designs, upgrades, and modifications to SI-owned, occupied, leased, or operated facilities.
- B. These requirements apply to all SI-managed facilities, operations, programs, and activities.
- C. The Director, OSHEM, is the “Authority Having Jurisdiction” for the Smithsonian, as defined and used in the National Fire Codes, and is the designated fire code official (also referred to as the “Fire Marshal”) as defined and used in the International Fire Code.

1.3 CODES & STANDARDS

- A. Minimum Standard: It is SI OSHEM’s position that building and fire codes establish the minimum standard of performance for Smithsonian Institution buildings and facilities. The codes address issues of life safety and property protection; however, they do not adequately address continuity of operations in the form of protection for the collections.
- B. This Design Manual establishes the minimum requirements for SI design projects. The SI Design Manager shall confer with the OSHEM Fire Protection Engineer on the applicable codes and standards and additional requirements.
- C. The most restrictive requirement in this Design Manual and applicable codes and standards shall be followed.
- D. Original Design Codes: The fire protection related codes and standards in effect when facility design commences (code of record) remain in effect for the life of the facility unless a significant hazard that endangers the building occupants or the public is identified or unless the building is modified. In these cases, the facility is upgraded to the current requirements of the applicable code or standard. Note: If the code of record cannot readily be determined, OSHEM shall stipulate the code to be utilized.
- E. Current Codes: When upgrades or modifications are made, the current edition of the code applies to the upgrade or modification. When substantial upgrades or modifications are made on fire protection systems, the entire system is upgraded to the current code or standard.
- F. SI standard Fire Protection Specifications included in Appendix B are to be used in new projects.
- G. SI standard Fire Protection commissioning standards in Appendix C are to be used in new projects.
- H. References:
 - 1. Smithsonian Institution Directive (SD) 419 and SI Safety Manual.

2. International Code Council (ICC) Codes, latest edition:
 - i. International Building Code (IBC)
 - ii. International Fire Code (IFC)
 - iii. International Mechanical Code (IMC)
 - iv. International Plumbing Code (IPC)
3. National Fire Codes, National Fire Protection Association, Latest Version, and their appendices.
4. FM Global Loss Prevention Data Sheets

1.4 EQUIPMENT

- A. All fire protection designs shall use equipment that has been tested and listed or approved by a nationally recognized testing laboratory (e.g., UL) for its intended use.
- B. OSHEM may issue written approval for substitute, equivalent items if no listed or approved item can be procured because the equipment has never been tested for fire protection use.
- C. All equipment components specified in designs shall be compatible with existing equipment and installed as required by the applicable National Fire Protection Association (NFPA) codes and standards and manufacturer's recommendations.
- D. System reliability, longevity, and serviceability shall be included as criteria in specifying fire protection and life safety system components and in design decisions.
- E. Written acceptance tests and/or operating procedures shall be prepared and executed for all new system installations and/or modifications to verify that the systems perform as required. Acceptance test procedures shall be required as a separate submittal from the contractor based on the specified system performance and the specific equipment installed. Any deficiencies noted during the tests shall be documented and tracked until resolved or corrected. Operating procedures shall be required as part of the As-Built documentation submittals.
- F. When site-specific guides or design specifications exist, they shall be included in all fire protection design packages as applicable.

1.5 ABBREVIATIONS

- A. ASTM: American Society for Testing and Materials
- B. FM: FM Global (formerly Factory Mutual)
- C. ICC: International Code Council (Refer to 1.3 G for additional abbreviations)
- D. LSC: Life Safety Code, NFPA 101
- E. MCFL: Maximum Credible Fire Loss
- F. MPFL: Maximum Possible Fire Loss
- G. NFPA: National Fire Protection Association
- H. NRTL: Nationally Recognized Testing Laboratory
- I. OSHEM: Office of Safety, Health and Environmental Management
- J. SI: Smithsonian Institution

K. UL: Underwriters Laboratories

1.6 DEFINITIONS

- A. Fire Protection - A broad term that encompasses all aspects of fire and life safety, including building construction and fixed building fire protection features, fire suppression and detection systems, fire water systems, emergency process safety controls, emergency fire fighting operations (fire department), Fire Protection Engineering (FPE), and fire prevention. Fire protection is concerned with preventing or minimizing the direct and indirect consequences of fire on people, property, and programs. By extension, fire protection also includes aspects of the following perils as they relate to Fire Protection: explosion, natural phenomenon, and smoke and water damage from fire.
- B. Fire Protection Systems - Any system designed and installed to detect, control, or extinguish a fire; to limit fire damage; to alert occupants and/or the fire department that a fire has occurred; or to otherwise enhance life safety or property protection.
- C. Life Safety Systems: Any system designed and installed to alert occupants to a fire condition, provide sufficient capacity and a protected path for egress, provide structural stability, and provide passive defense against the spread of fire and its products. These include, but are not limited to, means of egress components, emergency lighting, exit signage, fire barriers, and structural fire protection.
- D. Maximum credible fire loss (MCFL): The damage to property and/or disruption to operations that would be expected from a fire, assuming that (1) all installed fire protection systems function as designed; and (2) the effect of emergency response is omitted except for post-fire actions such as salvage work, shutting down water systems, and restoring operations.
- E. Maximum possible fire loss (MPFL): The value of property (excluding land) and cost of operations disruption within a fire area, unless a fire hazards analysis demonstrates a lesser (or greater) loss potential. This assumes the failure of both automatic fire suppression systems and manual fire fighting efforts.
- F. Redundant fire protection: Fire protection measures implemented to mitigate the effects of fires or related perils in the event of a partial or total failure of the primary fire protection measures (e.g., two independent fire suppression systems to protect a high risk facility).
- G. Performance-Based Design: An engineering approach to design elements of a building based on agreed-upon performance goals and objectives, engineering analysis and quantitative assessment of alternatives against the design goals and objectives using accepted engineering tools, methodologies and performance criteria.

1.7 FIRE PROTECTION DESIGN ANALYSIS

- A. A fire protection design analysis is required for all designs and must address the fire protection requirements of the project as required by this Design Manual. Summarize the fire protection design analysis and submit it with the Concept submission. The fire protection design analysis shall be separate from other disciplines. Where applicable, discuss the following minimum fire protection provisions (include required vs. provided):
 - 1. Building code analysis (i.e., type of construction, height and area limitations, and building separation or exposure protection)
 - 2. Classification of occupancy,

3. Requirements for fire-rated walls, fire-rated doors, fire dampers with their fire-resistive ratings, smoke compartmentation, smoke barriers
4. Means of egress in accordance with NFPA 101, Life Safety Code (occupant loads, exit capacities, etc.)
5. Analysis of automatic sprinkler systems and other suppression systems and protected areas, including hydraulic analysis of required water demand,
6. Water supplies, water distribution, location of fire hydrants,
7. Smoke control methods and smoke control systems,
8. Fire alarm system (the type of alarm system and location of the fire alarm equipment),
9. Fire detection system (the type of detection system and location of detectors),
10. Standpipe systems and fire extinguishers,
11. Interior finish ratings,
12. Connection to and description of fire alarm supervising system.
13. Identify the various occupancies and hazardous areas associated with the facility,
14. Coordination with security and antiterrorism requirements,
15. Fire Department access.

1.8 PLAN REVIEW REQUIREMENTS

- A. All new projects, renovations, modifications, including associated scopes of work, shall be submitted to OSHM for review and approval.

1.9 SEISMIC CRITERIA

- A. Seismic design for buildings and systems shall be in accordance with the IBC.
- B. Fire protection systems shall be designed and installed to withstand seismic events in accordance with the applicable NFPA standards, except as required by other criteria for safety class equipment.

1.10 ACCESSIBILITY REQUIREMENTS

- A. All SI buildings and facilities shall comply with the requirements in SD 215, Accessibility For People With Disabilities, established by the SI Accessibility Office.

1.11 FIRE SAFETY DURING CONSTRUCTION AND RENOVATION

- A. Coordinate with the facility prior to and concurrent with design.
- B. Separate all occupied areas from demolition, renovation, or construction activities by temporary smoke-tight construction partitions of gypsum board or other approved non-combustible or limited-combustible material in accordance with the requirements of NFPA 241. Barrier design shall be detailed in project documents.

- C. Partitions shall be full height, extending through suspended ceilings to the floor slab or roof deck above and shall be one-hour fire rated, unless sprinklers are installed and are operational on both sides of the temporary partition whereupon the partition may be permitted to terminate at the ceiling in accordance with NFPA 241.

Note: This requirement is due to the inherently greater potential for fire or hazardous materials incidents associated with the combustibles and operations of demolition/construction. This risk is made worse by the likelihood of compromised fire protection systems and fire/smoke resistant construction. This does not obviate the need to provide other protective measures to contain dust and debris as specified under other SI requirements.
- D. Sprinklers are considered to be operational when they are installed in accordance with NFPA 13 (spacing, protection, distance from the ceiling, etc.) and there is a sufficient automatic water supply.
- E. Phase construction as necessary to ensure that exits are not obstructed or reduced in width. If exits must be obstructed during construction, provide alternate exit routes during each phase of construction and identify the alternate routes on the construction drawings.
- F. Minimize or avoid disruptions to fire alarm and sprinkler systems. Delineate phasing of construction to ensure that installations of new systems are expedited, and where possible, maintain existing systems in service until the replacement system is operational. If fire protection systems are to be disrupted, follow the SI fire system impairment procedures to ensure procedures are incorporated to maintain equivalent levels of fire protection and provide formal notification to the facility while systems are down via the fire protection system impairment process (See SI Safety Manual, Chapter 36).
- G. Contractors shall furnish their own fire extinguishers when an area is vacated for renovations. SI-owned fire extinguishers shall be removed from the vacated area and returned (or replaced with new) prior to re-occupation by SI
- H. Hot work operations involving open flames or smoke producing processes shall be conducted in accordance with the requirements of Chapter 14, “Hot Work Management and Permit System”, of the SI Safety Manual.

1.12 PERFORMANCE BASED DESIGN

- A. It is permissible and usually necessary/desirable that performance-based fire safety design methods be applied to the renovation, restoration, remodeling or modernization of existing facilities to address the evaluation of a subsystem, system, or complete building when it is not possible to meet the provided prescriptive requirements for new construction.
- B. Performance-based fire safety design methods must not be used to eliminate the retained prescriptive requirements as described in the Performance-Based chapter of NFPA 101.
- C. Performance-based approaches to meeting the goals and objectives outlined in NFPA 909, *Code for the Protection of Cultural Resource Properties – Museums, Libraries, and Places of Worship* shall be permitted subject to the approval of OSHEM.
- D. Performance-based approaches to meeting the goals and objectives outlined in NFPA 150, *Standard for Fire Protection and Life Safety for Animal Housing Facilities* shall be permitted subject to the approval of OSHEM.
- E. All performance-based design approaches shall be in accordance with the guidelines delineated in NFPA 909 or NFPA 150, as applicable, and shall follow the Society of Fire

Protection Engineers Guide to Performance-Based Fire Protection.

- F. Required design fire scenarios, performance criteria for acceptance, and input parameters for fire models used in the performance-based analysis shall be approved in advance by OSHEM, SI curatorial staff, and other stakeholders.

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CHAPTER 2 BUILDING FEATURES

2.1 TYPES OF CONSTRUCTION

- A. New structures shall be constructed from noncombustible or fire resistive construction, Type I or II as defined in the IBC, unless otherwise approved by OSHEM.
- B. For non-separated mixed-use buildings the construction type shall be the most restrictive type based on the use groups and building height and area in accordance with the IBC.
- C. Alterations, renovations, and additions to existing buildings shall match the existing building construction type, unless the height and area limitations of the IBC would be exceeded. In such case, the building separation requirements of the IBC shall be followed.
- D. Wood used for walls, platforms, blocking, furring, and similar applications shall be fire retardant, pressure impregnated. Fire retardant coatings of intumescent paint or other fire retardant chemicals are not acceptable in lieu of fire retardant treatment.

2.2 USE GROUPS AND OCCUPANCIES

- A. Use groups and occupancies shall be in accordance with the IBC.
- B. The Life Safety Code chapters that correspond to the IBC use group shall be used to determine means of egress requirements and other special occupancy requirements.

2.3 HEIGHT AND AREA LIMITS

- A. Height and area limitations of new buildings shall be in accordance with the IBC.
- B. Where existing buildings undergo additions, the combined area of the existing building and the new addition shall comply with the limits established in the IBC. Where the area of the addition would cause the building to exceed the height and/or area limits of the IBC, fire walls and/or fire barriers are required, as determined by the IBC.

2.4 SITE CONSIDERATIONS

- A. Provide access for emergency vehicles to SI buildings and additions in accordance with NFPA 1.
- B. Design roads, fire lanes, and turn-arounds for the weight and turning radius of fire apparatus. Consult local fire department for fire apparatus requirements. At minimum, one of the long sides of every building shall be accessible to fire department equipment.
- C. Building separation and requirements for rated exterior walls and openings for protection from exposure by adjacent buildings or hazards shall comply with the IBC.
- D. Urban Wildland Interface. Clearances from combustible brush, trees, and other vegetation shall be maintained per the International Wildland-Urban Interface Code (IWUIC).

2.5 FIRE AND SMOKE BARRIERS

- A. Fire and smoke barriers shall comply with the requirements of the IBC, the National Fire Codes, and this Design Manual.
- B. Fire barriers for incidental use areas shall be as required by applicable codes and standards. In each case the most restrictive requirement among the IBC, National Fire Codes, and this Design Manual shall be followed. Refer to Appendix D of this Design

Manual for a summary of requirements for some of the more common spaces.

- C. Comply with the requirements of NFPA 90A for treatment of HVAC duct penetrations, locations of smoke dampers, and smoke detector requirements.
- D. HVAC ducts that penetrate smoke barriers provided to isolate collections storage rooms shall be equipped with listed combination fire/smoke dampers.
- E. Subject to the approval of OSHEM, smoke dampers may be omitted in HVAC ducts that penetrate smoke barriers where the system is designed to perform any of the following functions:
 - 1. Function as an engineered smoke-control system, including the provision of continuous air movement with the air-handling system
 - 2. Provide air to other areas of the building during a fire emergency
 - 3. Provide pressure differentials during a fire emergency

2.6 INTERIOR FINISHES AND DECORATIVE MATERIALS

- A. Interior finish, insulation, and decorative materials shall comply with this Design Manual, Chapter 36, "Fire Protection", of the SI Safety Manual, Exhibit Fabrication Guidelines in Chapter 8 of this Design Manual, and applicable NFPA code requirements.
- B. Wall and ceiling materials, paneling, and acoustical tile shall be Class A or B, unless otherwise noted, with a maximum flame spread index of 75, and maximum smoke developed index of 450 as tested in accordance with ASTM E-84. This test must have been performed by a testing laboratory and certification of the test approved by OSHEM.
 - 1. Exits (interior exit stairways, interior exit ramps and exit passageways) must be Class A (maximum flame spread index of 25, maximum smoke developed index of 450, per ASTM E84).
 - 2. Interior finishes must be Class A in any space where automatic sprinkler protection is not provided.
- C. Wood used for platforms, enclosures, cases over 100 cubic feet (or with heat producing equipment) or for other purposes shall be fire retardant pressure impregnated lumber and markings clearly visible attesting to its fire retardant characteristics.
- D. Fire retardant coatings of intumescent paint or other fire retardant chemicals shall not be used in lieu of fire retardant pressure impregnated treatment unless approved by OSHEM.
- E. No more than 6 inches of floor carpet shall be installed so as to run up the wall unless approved by OSHEM.
- F. All fabrics or other materials used in curtains, draperies, or other window treatments must be certified as flame resistant in accordance with the criteria contained in NFPA 701 – Standard Methods of Fire Tests for Flame Propagation of Textiles and Films and Films.
- G. Decorative materials including: banners, bunting, streamers, fabric, paper, cotton batting, artificial and real vegetation; as well as wall, ceiling, and floor cover for acoustical or other effects shall meet the requirements of NFPA 101.
- H. Textiles or other materials treated with a fire retardant shall be re-treated as per the recommended frequency by the treatment manufacturer. The building manager shall maintain a record of the date and type of treatment for as long as the material is in use.
- I. Artificial rocks, faux environments, and similar construction shall be fabricated of

noncombustible materials to the greatest extent possible. Gypsum, glass fiber, metal lath and other noncombustible materials shall be used in lieu of foamed plastics and other combustibles.

- J. Cellular or foamed plastics, expanded plastics, etc. shall not be used in SI facilities unless they comply with the fire test criteria and limits on quantities in the IBC and in NFPA 101. Data on all such materials shall be submitted to OSHEM for review and approval.
- K. Theater and bench seating materials shall comply with California Technical Bulletin 133.

2.7 ROOF COVERINGS AND ROOF DECKS

- A. Use roof coverings approved and listed by a NRTL. The UL Roofing Materials and Systems Directory lists three Classes (A, B, and C) of acceptable roof coverings based on compliance with UL 790, *Tests for Fire Resistance of Roof Covering Materials* and NFPA 256, *Fire Tests of Roof Coverings*.
- B. Roof deck assemblies must be FM Class I approved, or UL listed as Fire Classified or equal listing or classification by an NRTL.
 - 1. Exception 1: Fully sprinklered buildings.
 - 2. Exception 2: Buildings less than 8,000 ft² (744 m²).

2.8 INSULATION

- A. Use thermal and acoustical insulation with a flame spread index not higher than 25, and a smoke developed index not higher than 450 when tested in accordance with ASTM E84 (NFPA 255), *Standard Method of Test of Surface Burning Characteristics of Building Materials*.
- B. Use of foam plastic insulation shall meet the requirements of IBC Chapter 2603 (Foam Plastic Insulation), including application of thermal barriers.
- C. Cellular foam plastic insulation shall be permitted only for exterior envelope, mechanical piping, and walk-in cool rooms/freezers, subject to the limitations identified in this Section.
- D. Insulation of Mechanical Systems, Ductwork and Piping.
 - 1. Insulation of mechanical systems shall meet the requirements of the International Mechanical Code. All insulating materials, linings and coverings shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50, when tested in accordance with ASTM E84.
 - 2. Cellular foam plastic insulation may be used only on mechanical piping, subject to the following additional requirements:
 - i. These insulations must be approved according to FM Approval Standard 4924 (Approval Standard for Pipe and Duct Insulation, current edition).
 - ii. These insulations may not be used on pipes with a diameter greater than 18 inches (457 mm).
 - iii. Where the insulation thickness and diameter/sectional dimension are further limited according to the listing, these limitations shall be followed.
 - iv. If installed in collection storage spaces, one of the following requirements must also be met:

- (a) FM Approval 4910 (American National Standard for Cleanroom Materials Flammability)
- (b) Pass the optional smoke-sensitive occupancy rating for pipe insulation, as defined in the FM 4924 standard.

2.9 SMOKE CONTROL SYSTEMS

- A. Smoke control systems shall be installed where required by applicable NFPA Codes and Standards.
- B. All smoke control systems shall comply with the requirements of NFPA 92A or NFPA 92B, as applicable.

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CHAPTER 3 MEANS OF EGRESS

3.1 STANDARDS

- A. Means of egress design shall comply with the requirements of NFPA 101.

3.2 BASIC REQUIREMENTS

- A. Unobstructed and adequately marked means of egress shall be provided to ensure safe emergency evacuation.
- B. Security measures or incidental building activities shall not impede exit doors, passageways, or any other part of a means of egress.
- C. Delayed egress doors may be used subject to OSHEM approval.
- D. Utilities such as, but not limited to, wiring, computer (IT) cables, piping, ducts and other systems shall not penetrate through exit enclosures (stairwells and horizontal exits), unless serving only the exit enclosure.
- E. Exit doors shall be arranged so they can be readily opened from the egress side whenever the building is occupied. Locks, if provided, shall not require the use of a key, tool, or special knowledge or effort for operation from the inside of the building, unless permitted by NFPA 101 – Life Safety Code.

3.3 MINIMUM WIDTH

- A. The minimum unobstructed exit access width for aisles or corridors serving as the primary exit shall not be less than 44 inches (1118 mm), and, where deemed necessary by OSHEM, not less than 60 inches (1524 mm) in galleries.
- B. Where special occupancies warrant a larger means of egress width, those requirements shall be followed.

3.4 EXIT ILLUMINATION

- A. Emergency lighting illumination levels shall meet the requirements of the Life Safety Code. Locations requiring emergency lighting include the following:
 - 1. All galleries.
 - 2. All means of egress.
 - 3. Switchgear, mechanical equipment, emergency equipment and transformer rooms.
 - 4. Security control rooms.
 - 5. Emergency command centers.
 - 6. Exit discharge, including the path to a public way..

3.5 EXIT MARKING

- A. Mark means of egress in accordance with NFPA 101. Internally illuminated signs must be light emitting diode (LED) type, electroluminescence (LEC), or cold cathode type. Incandescent fixtures are not permitted except existing fixtures, which may remain in use.
- B. Where deemed necessary by OSHEM, approved floor proximity exit signs and egress path marking shall be provided.

- C. Radioluminous exit signs shall not be used without prior approval by OSHEM.
- D. Photoluminescent exit signs and egress path marking is permitted only where provided with a reliable external illumination (charging) source providing a minimum illumination of 54 lux (5 foot-candles) of unfiltered fluorescent light.

3.6 ACCESSIBLE MEANS OF EGRESS

- A. All accessible means of egress shall comply with the IBC and Life Safety Code.

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CHAPTER 4 WATER SUPPLY FOR FIRE PROTECTION

4.1 PRIVATE SYSTEMS

- A. Private water distribution systems and water supplies such as found at Fred L. Whipple Observatory, STRI, Silver Hill Facilities, and SERC shall be installed in accordance with NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection, NFPA 22 – Standard for Water Tanks for Private Fire Protection, and NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

4.2 SUPPLY DURATION AND MAIN SIZE CRITERIA

- A. The water supply for fire protection shall have a minimum supply duration of 2-hours. New primary distribution mains shall in no case be smaller than 12 inches (300 mm), building/facility loops shall be 8 inches (200 mm) or larger, and fixed suppression feeds shall, in no case, be smaller than 6 inches (150 mm).

4.3 DISTRIBUTION SYSTEM

- A. Fire protection water supply distribution systems for all new installations shall be looped to provide two-way flow, with sectional valves arranged to provide alternate water flow paths to any point in the system.
- B. A single feed is allowed, provided the system is reviewed and approved by OSHM.
- C. Underground plastic pipe meeting the requirements of NFPA 24 is acceptable.

4.4 INDEPENDENT SOURCES

- A. Facilities having an MPFL in excess of \$50 million shall have two independent sources of fire protection water.

4.5 HYDRANTS

- A. Fire hydrants shall be UL listed, FM approved, or listed or classified by an NRTL and must have two 2-1/2-inch (65 mm) hose outlets and one 4-1/2-inch (115 mm) suction connection with national standard fire hose threads in accordance with NFPA 24 and NFPA 1963, *Fire Hose Connections*. Hydrant connections shall meet the standards of the local municipal water authority/fire department.
- B. Wet-barrel or California-type hydrants are preferable in areas where there is no danger of freezing. Dry barrel or traffic-type hydrants must be used in areas where there is a danger of freezing. Hydrants must be aboveground type.
- C. Hydrants must be installed adjacent to paved areas, accessible to fire department apparatus. Hydrants must not be closer than 3 feet (1 m) nor farther than 7 ft (2.1 m) from the roadway shoulder or curb line. Hydrants must be installed with not less than 6-inch (65 mm) connection to the supply main, and valved at the connection. Barrels must be long enough to permit at least 18-inch (450 mm) clearance between the center of the 4-1/2-inch (115 mm) suction connection and grade. The ground must be graded so that any surface drainage is away from the hydrant.
- D. Installation must be in accordance with NFPA 24. Suction connection should be perpendicular to the street to allow straight lined connection to the pumper.
- E. A sufficient number of hydrants must be provided so that hose stream demand can be met without taking more than 1,250 gpm (4,740 L/min) from any single hydrant. Hydrants must also be spaced in accordance with the following requirements:

1. All parts of the building exterior must be within 350 ft (106 m) of a hydrant with consideration given to accessibility and obstructions. Hydrants must be located with consideration given to emergency vehicle access.
2. At least one hydrant must be located within 150 ft (45 m) of the fire department connection.
3. Hydrants protecting storage facilities are to be spaced a maximum of 300 ft (91 m) apart.
4. Hydrants located adjacent to parking areas or other vehicle traffic areas, must be protected by bollards. The bollards must be located so they are not directly in front of an outlet.

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CHAPTER 5 FIRE EXTINGUISHING SYSTEMS

5.1 GENERAL

- A. Design of new, and modifications to existing building, exhibits, and facilities shall be in accordance with the requirements of this Design Manual and the master specification and commissioning appendices (B and C) to this Design Manual, which describe specific fire protection design criteria. Design is to incorporate redundant fire protection concepts, employing active fire protection through automatic fire suppression and detection systems, passive fire barrier features, and limiting combustible fuel load within the SI buildings in order to control and minimize potential injury to SI staff and losses to collections, mission, and infrastructure.
- B. Complete automatic fire suppression systems are to be provided and installed in accordance with the applicable International Building Code (IBC) and National Fire Protection Association (NFPA) standards for all projects (regardless of funding sources) where the maximum credible fire loss (MCFL) without automatic fire suppression would result in the loss of use of a vital structure or equipment for a period longer than that considered as acceptable by the program director.
- C. In addition to the above requirement, fire extinguishing systems shall be provided where required by the IBC and/or applicable NFPA standards.
- D. When the criteria above does not apply, automatic fire suppression and/or detection may still be warranted based on any of the following factors:
 - 1. Programmatic importance
 - 2. Effects on operations
 - 3. Cost vs. benefit
 - 4. Exposure
 - 5. Future conditions

5.2 SPRINKLER SYSTEMS

- A. Fire Sprinkler System design criteria for SI facilities shall comply with NFPA 13 – Standard for the Installation of Sprinkler Systems, but shall be designed for no less than Ordinary Hazard Group 2 criteria (0.20 gpm/sf over 1500 sq ft (8.1 mm/min over 139 m²)).
- B. The following minimum design criteria shall be met:
 - 1. Hydraulic calculations must be used for design. Pipe schedule design will not be accepted.
 - 2. Reductions in the hydraulically most remote area allowed in NFPA 13 with the use of quick response sprinklers are not permitted.
 - 3. Variation in discharge from individual sprinkler heads in the hydraulically most remote area shall be between 100 and 120 percent of the specified density.
 - 4. The calculated pipe velocity shall not exceed 20 ft/sec (6.1 m/sec).
 - 5. Safety margin: The total demand water flow and pressure must be at least 10% less than the available water flow and pressure.

6. Pipe schedule: Schedule 40 or greater must be used for all sprinkler piping less than 4 inches (100 mm). Schedule 10, 40, or greater must be used for sprinkler piping 4 inches (100 mm) and larger.
 7. Dry and preaction sprinkler systems must use galvanized piping and fittings.
 8. Butterfly valves may be used only on piping 4 inches (100 mm) and less.
 9. Gate valves must be OS&Y style.
 10. Use of restrictive orifices, reducing flanges, unions, and plain-end fittings will not be permitted.
 11. Branch outlet mechanical fittings and clamp-type fittings will not be permitted.
- C. Automatic sprinkler systems used to protect compact storage units (mobile shelving) shall meet the design requirements of Section 7.11.
 - D. See Automatic Sprinkler Systems, Section 211313 for complete sprinkler specification criteria.

5.3 STANDPIPE SYSTEMS

- A. When required, standpipe systems must be installed in accordance with NFPA 14, *Installation of Standpipe and Hose Systems*.
- B. Residual pressure requirements may be omitted for buildings under 150 ft (45 m) in height where fire department apparatus are expected to boost pressure in standpipe systems. Piping for standpipe systems must be designed by hydraulic calculation to show that the fire department pumper, connected to a fire department connection, can deliver the needed flow and pressure at the topmost hose connections.
- C. Class I standpipe systems must be provided in exit stairways of buildings four stories or more in height. These systems must not include hose. 2-1/2" by 1-1/2" (63.5 by 38mm) reducers, with caps, shall be provided at all fire department valves.
- D. Class I standpipe systems must also be provided in non-sprinklered facilities where all portions of the building cannot be reached with 200 feet of fire fighting hose lines extended from the exterior of the building, regardless of building height. Locate FD hose connections such that all portions of the building can be reached with 100 ft. (30.5m) of hose plus 30 ft. (9.14m) of hose stream.
- E. Class II and Class III standpipes are not permitted.

5.4 CLEAN AGENT EXTINGUISHING SYSTEMS

- A. Application
 1. Clean agent fire extinguishing systems are suitable for protection of certain types of special occupancies, hazards, and facilities. Clean agent fire extinguishing systems are not a substitute for required automatic sprinkler systems.
- B. Design Requirements
 1. Clean agent fire extinguishing systems must conform to NFPA 2001, *Clean Agent Fire Extinguishing Systems*.
 2. Provide stand-alone (not dependent upon the building fire alarm system for operation) control panels that are listed for releasing device service and monitored by the building fire alarm system.

3. Careful consideration must be given to compartment under/over-pressurization during the discharge of total flooding clean agent systems. Pressure relieving vents, located near the finished ceiling, may be necessary to regulate rapid pressure changes during discharge. Comply with the manufacturer's recommended procedures relative to enclosure venting.
4. The commissioning standard for Clean Agent Systems is in Appendix C.

5.5 COOKING EQUIPMENT SUPPRESSION SYSTEMS

- A. All commercial grease hood and ducts shall meet the requirements of NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, and NFPA 17A – Standard for Wet Chemical Extinguishing Systems (as appropriate).
- B. Grease ducts shall be protected by approved products, designed with clearance reduction methods and installed as fire rated enclosures.
- C. The commissioning standard for Kitchen Hood Systems is in Appendix C.

5.6 PORTABLE FIRE EXTINGUISHERS

- A. Portable fire extinguishers are to be provided in SI facilities based on occupancy, length of travel between extinguishers, and hazard as required per NFPA 10 – Standard for Portable Fire Extinguishers, and this attachment.
- B. OSHEM shall be consulted as to the appropriate type of extinguishers for the occupancy.
- C. Clean gas or water-mist extinguishers rated for Class A:C fires are to be purchased and placed in any area with collections (i.e. all exhibit areas, collection storages rooms, conservations labs, etc.) unless waived by OSHEM. Areas with wet collections shall be provided with fire extinguishers appropriate for alcohol-based flammable liquid fires.
- D. Kitchens using deep fat fryers or other appliances utilizing combustible liquids shall have the appropriate size class K fire extinguishers located within 30 ft of such appliances.
- E. Additional requirements on the type and sizes of fire extinguisher for special areas are listed in Chapter 7, Special Occupancy Requirements.

5.7 FIRE PUMPS

- A. Rooms containing fire pumps in non-high-rise buildings shall be 2-hour rated or 1-hour rated in a fully-sprinklered building, per IBC Table 508.2.5.
- B. Rooms containing fire pumps in high-rise buildings shall be 2-hour rated per IBC Table 508.2.5.

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CHAPTER 6 FIRE ALARM SYSTEMS

6.1 PURPOSE

- A. Complete smoke detection coverage shall be provided throughout SI facilities where early detection of fire can improve life safety or limit damage to collections and property (leased or owned) or where required by IBC and/or applicable NFPA codes.
- B. Omission of smoke detectors shall be approved by SI OSHEM.

6.2 GENERAL REQUIREMENTS

- A. When fire protection systems are installed in facilities on SI occupied sites, they are to be compatible with and connected to (where available), the site wide fire alarm monitoring system.
- B. Fire alarm installations shall comply with the requirements and recommendations of NFPA 72, project specifications, and SI requirements.
- C. All new fire alarm systems shall be addressable unless otherwise permitted by OSHEM.
- D. See Section 283111, Addressable Fire Alarm System, for fire alarm specification criteria.
- E. The commissioning standard for Fire Alarm Systems is in Appendix C.

6.3 SPECIAL REQUIREMENTS

- A. Where multiple fire alarm control panels are provided they shall be interconnected in a Class A (Style 6 or 7) network arrangement.
- B. All fire alarm systems shall be monitored by a Smithsonian Institution Proprietary Supervising Station or a Central Supervising Station that meets the requirements of NFPA 72.
- C. All fire alarm circuits shall be installed in conduit (EMT, IMT, or rigid). The use of fire alarm MC cable may be permitted, subject to the approval of OSHEM.
- D. Signaling Line, notification appliance, and power circuits shall each be in separate conduit.
- E. Special fire alarm requirements are listed in Chapter 7 and Chapter 8.

6.4 PUBLIC ADDRESS

- A. Separate public address systems shall be provided for non-emergency communication where desired/needed. Fire alarm systems shall not be used to address the public in non-emergency situations.

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CHAPTER 7 SPECIAL OCCUPANCY REQUIREMENTS

7.1 COLLECTIONS STORAGE FACILITIES GENERAL

- A. The storage of collections and high-value items (including art, artifacts, rare books, archival materials, specimens stored in alcohol solution, live animal collections, and objects of historic value) shall be protected by passive and active fire protection measures. These measures include the following unless determined otherwise by OSHEM:
1. Separate from other areas with minimum 2-hour fire-rated construction. Barriers shall also be constructed as smoke barriers. Higher fire ratings may be required depending on the materials stored and hazard presented, as determined by OSHEM.
 2. Collections stored in remote facilities or buildings may not require fire-rated construction, as physical separation from other facilities or areas may serve as acceptable protection, in lieu of passive features.
 3. The maximum size of any single collection storage space shall be 30,000 ft² (2790 m²). Smaller spaces may be required, depending on the value of collection items stored.
 4. Store as much of the collection as possible inside non-combustible (metal) files or cabinets to provide an additional level of separation and protection between collections and collateral areas. Coordinate protection of these items with SI Security requirements.
 5. Protect with early warning smoke detection
 6. Minimize or eliminate ignition sources within the collection enclosure
 7. Protect with an automatic sprinkler system
 8. Protect with additional fire suppression systems, such as gaseous fire suppression or other approved active systems when deemed necessary
 9. Protect with compatible portable fire extinguishers
- B. Items of extreme value shall be stored in fire-resistive vaults, containers, or safes. Coordinate protection of these items with SI Security requirements.
- C. Fluid-based, flammable liquid collections (i.e. “wet collections”) shall be stored in areas approved by OSHEM and in accordance with SI Safety Manual Chapter 38, “Fire Prevention” (Storage of Hazardous Materials section).
1. Storage areas may include, but are not limited to flammable liquid warehouse areas, flammable liquid cut-off rooms, flammable liquid storage lockers, and approved flammable liquid cabinets.
- D. Wet collections storage spaces less than 500 square feet (46.5 sq m) shall comply with NFPA 30.
- E. Design of wet collections storage facilities greater than 500 square feet (46.5 sq m) shall be closely coordinated with SI OSHEM and shall incorporate some or all of the protection concepts outlined below.
1. Building Construction:

- i. Separate buildings of Type I (4-hour) reinforced concrete construction. Building separation with a 4-hour MFL (Maximum Foreseeable Loss) wall. Exception: IBC requirements for fire separation distance may be followed and may reduce exterior wall fire resistance ratings subject to OSHEM approval.
 - ii. Subdivision of the building into compartments, with each compartment having two-hour walls.
 - iii. Floor-to-floor separation of 4-hours.
 - iv. Bulk alcohol storage rooms shall be constructed with 3-hour walls, a 3-hour ceiling, and explosion-venting panels along the exterior wall.
2. Fire Protection Systems:
- i. Compact Storage Units (Mobile Shelving) or Tank Storage: Sprinkler system design density of 0.60 gpm/sq ft (24.5 lpm/sq m) over an area of 3,400 sq ft (315 sq m) in wet collections areas.
 - (a) The basis of design for protecting this type of arrangement was developed during the design of the POD 5 facility at the Museum Support Center in Suitland, MD. See the Basis of Design document from OFEO Project 0230101 for additional details.
 - ii. Fixed Shelving: Provide sprinkler protection appropriate for the arrangement and container type, per NFPA 13. The *Recommended Fire Protection Practices for Distilled Spirits Beverage Facilities* published by the Distilled Spirits Council of the United States, Inc. (DISCUS) may also be used as a reference in developing fire protection solutions when coordinated with OSHEM.
 - iii. A Class I standpipe system shall be provided.
 - iv. Draft curtains may be used to sub-divide each compartment into smaller areas to aid in sprinkler response and to minimize the area of sprinkler activation.
 - v. Provide high temperature quick-response sprinklers.
3. Spill Containment:
- i. Trench drains shall be located to prevent potential alcohol spills from flowing into corridors or into adjacent compartments and to provide a drainage system for fire protection water. These shall be designed to prevent incidental spills of alcohol from entering the trench; however, if there is a sprinkler system discharge, the trench shall accumulate and discharge the water.
 - ii. The trench drains shall discharge to the exterior of the building, either to the storm system, sanitary system, or to grade. Discharge locations shall be approved by the municipal water/sanitary authority.
4. Fire Alarm System:
- i. Voice evacuation fire alarm system.
 - ii. Fire alarm notification appliances will consist of speakers and strobe lights.

5. Special Detection and Control Systems:
 - i. Hydrocarbon gas detection systems shall be provided. Design basis for the gas detectors shall be based on manufacturer's recommended spacing.
 - ii. The hydrocarbon gas detection system shall be interlocked with the building fire alarm system and the HVAC system to initiate a supervisory alarm and to initiate a 100% purge sequence for the HVAC system serving the wet collections area.
 - iii. All light fixtures and other electrical equipment in the wet collections storage rooms shall be Class I, Division 2.
 - iv. Electrical receptacles are not permitted in the wet collections storage area.
6. Means of Egress
 - i. The wet collections storage areas shall be provided with two remote exit stairs.
 - ii. Within wet collections storage rooms, provide 2-hour separations between individual compartments and the center corridor provide avenues for horizontal exit to meet a travel distance limit of 75 feet (23 m).
- F. Collection/Artifacts that may present an explosion or self-ignition hazard (e.g., munitions, cellulose nitrate film) shall be stored in locations approved by OSHEM. Every attempt should be made to "safe" the collection or artifact prior to storage, in order to mitigate the potential hazard. The collection or artifact must be evaluated by OSHEM and the owner on a case-by-case basis, via risk-assessment, to determine the stability, general condition, and any adverse ramifications if the collection/artifact is exposed to fire or other unfavorable conditions. Storage areas for the collections may include, but are not limited to:
 1. Magazines (permanent, portable, and/or fire resistant);
 2. Fire-rated rooms;
 3. Areas with special provisions, such as explosion venting; or
 4. Remote buildings/facilities/areas that will not expose major facilities or other collections if the artifact/collection become unstable.
- G. Collection storage rooms shall be dedicated for such purpose. Object processing, packing, unpacking, crate and packaging storage, research performed on objects, conservation of objects, etc. shall not be conducted in collection storage rooms. Separate spaces shall be incorporated into the design for these purposes.
- H. Collections process areas or other rooms where collections will be inventoried, processed, restored, cleaned, etc. shall be protected with 1-hour fire-rated construction. Barriers shall also be constructed as smoke barriers. Higher fire ratings may be required depending on the materials in process and hazard present, as determined by OSHEM.
- I. Rack and Compact Shelf Storage
 1. Storage of combustibles within high storage racks shall comply with NFPA 13 – Standard for the Installation of Sprinkler Systems, and/or Factory Mutual Global Loss Prevention Data Sheets.
 2. Aisles between storage racks (excluding compact storage units and library stacks) shall be a minimum of 36 inches (1 m) wide .

3. Storage systems shall be designed with the intent of keeping stored materials at least 24 inches (610 mm) below sprinkler head deflectors. (Storage may exceed this height where OSHEM determines that the sprinkler system coverage is not adversely affected.)
4. Material storage shall not exceed the capabilities of the fire sprinkler system available.
5. A minimum 4 inch (100 mm) clear and unobstructed space shall be maintained in transverse and longitudinal flue spaces in storage racks. Larger spaces may be required based on the depth of shelves and the results of a fire hazard analysis. The method of achieving this required spacing shall be determined as part of the design.
6. Archives and collections stored in compact storage units (mobile shelving) shall meet the design requirements of Section 7.11.

7.2 INFORMATION TECHNOLOGY FACILITIES

- A. In addition to compliance with NFPA 75, mission critical IT spaces, research laboratories, and other operations vital to the SI office's mission and research shall be protected by the following active and passive fire protection measures:
 1. 2-hour fire rated enclosures.
 2. Very early warning smoke detection.
 3. Clean agent fire suppression system or other approved active system.
 4. Clean agent, water mist, or CO₂ portable fire extinguisher and one water extinguisher for class A fires.
 5. A sign shall be located adjacent to each fire extinguisher to plainly indicate the type of fire for which it is intended.
 6. Dry chemical fire extinguishers shall not be permitted.
- B. Combustible storage, such as paper stock, inks, and unused recording media within the computer room shall be restricted to the minimum necessary for efficient operations, and shall be stored in closed metal cabinets.
- C. LAN rooms and similar second tier IT spaces shall be enclosed with 1 hour fire rated construction, be protected with sprinklers and smoke detection, and kept free of combustible storage.
- D. Where trash receptacles are specified as part of the design only non-combustible containers shall be specified.

7.3 UTILITY ROOMS, SHOP AREAS, AND INCIDENTAL USE SPACES

- A. Combustible materials (e.g., lumber, plastic, mounting boards, etc.) shall not be stockpiled in shop areas, but shall be stored in designated storage areas. These areas shall be separated from adjacent spaces by 1-hour fire-rated construction and protected with fire suppression systems designed specifically for the fuel load and storage configuration.
- B. Unsprinklered storage rooms and sprinklered storage rooms over 100 sq. ft. (9.3 sq m) shall be enclosed with 1-hour rated fire barriers.
- C. Incidental Use areas shall be enclosed with rated barriers as required by applicable codes and standards. In each case the most restrictive requirement among the IBC, National

Fire Codes, and this Design Manual shall be followed. Refer to Appendix D of this Design Manual for a summary of requirements for some of the more common spaces.

7.4 TRASH DUMPSTERS

- A. If located inside or within 30 feet (10 m) of a building, trash dumpsters shall be placed within a 2-hour fire-rated room and protected with automatic sprinklers.

7.5 HIGH-RISE BUILDINGS

- A. High-rise buildings shall be defined in accordance with the International Building Code, except that SI buildings with an occupied floor located more than 70 feet (21.3 m) above the lowest level of fire department vehicle access shall be considered a high rise building.

7.6 LABORATORIES

- A. Design of laboratories shall be in accordance with the requirements of the IBC, NFPA 45 and this Design Manual.
- B. To the extent that the requirements of the IBC and NFPA 45 converge, both references shall be followed.
- C. All designs for laboratory spaces shall follow the lab unit approach as defined in NFPA 45. Where quantities of hazardous materials stored within lab units can be shown to also comply with the control area requirements of the IBC, both references shall apply.
- D. Where the quantities of hazardous materials and/or the number of lab units on a given level of a building exceed the limitations established in the IBC, the requirements of NFPA 45 shall govern the design.
- E. In all cases the sprinkler system requirements of NFPA 45 shall be followed for laboratories.
- F. Limitations on allowable quantities of corrosives, toxic chemicals, and other hazardous materials, not addressed by NFPA 45 shall comply with the requirements of the IBC.

7.7 ATRIUMS AND OTHER VERTICAL OPENINGS

- A. Atriums and other vertical openings shall be in accordance with the requirements of NFPA 101.

7.8 FLAMMABLE AND COMBUSTIBLE LIQUIDS

- A. The storage and handling of flammable and combustible liquids shall comply with Chapter 19, "Chemical Handling and Storage", of the SI Safety Manual, NFPA 30 Flammable and Combustible Liquids Code, and the following requirements:
 - 1. Flammable liquid storage areas shall be separated from other areas by barriers having a minimum 2-hour fire rating.
 - 2. In sprinklered flammable/combustible liquids storage areas, containment measures for the anticipated sprinkler system discharge shall be considered, in addition to the requirements of diking, remote impounding, and other containment measures, as per Chapter 38, "Fire Prevention", of the SI Safety Manual.

7.9 MARINE OPERATIONS

- A. Marine craft shall comply with United States Coast Guard regulations and NFPA 302 – Fire Protection Standard for Pleasure and Commercial Motor Craft.

- B. All boats and docking areas shall be equipped with portable fire extinguishers. The number and type of extinguishers shall be as specified in NFPA 302.
- C. Smoke detectors shall be provided on boats having sleeping quarters.
- D. All inboard-powered boats with an enclosed engine compartment shall have a fire suppression system in the engine space.
- E. Water supply for fire protection in marinas, piers, and boatyards shall be provided in accordance with the latest editions of NFPA 13 – Standard for the Installation of Sprinkler Systems, NFPA 14 – Standard for the Installation of Standpipes and Hose Systems, and NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
- F. Standpipes shall be provided for piers or marine docks where the hose lay from the responding fire apparatus is in excess of 150 feet long per NFPA 303 – Fire Protection Standard for Marinas and Boatyards, or where deemed necessary by OSHM.

7.10 ANIMAL HOUSING FACILITIES

- A. All Animal Housing Facilities shall comply with NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities*.
- B. A Fire Protection/ Life Safety Basis of Design narrative shall be prepared for each renovation and new construction project that affects animal housing facilities. This narrative shall describe how the fire and life safety systems comply with NFPA 150.
- C. Means of egress shall be designed to meet the special requirements of animals and/or equipment necessary for egress.
- D. All fire protection designs shall take into consideration the animals' ability to reach the equipment, potentially harming the animal or the animal damaging the equipment.
- E. All fire alarm systems shall take into account the need for a push-button that silences the fire alarm notification appliances in the animal areas only, but that activates a silent red beacon to indicate that the system is still in alarm.
- F. Smoke exhaust systems shall be performance-based and shall take into consideration toxicity levels, the temperature, the smoke layer height based on the animal breathing zone, and the risks of exposure to the animals during a fire condition.

7.11 COMPACT STORAGE UNITS (MOBILE SHELVING)

- A. General.
 - 1. Compact (mobile) storage systems present a high fire protection challenge as they combine large fire fuel loads with severe and variable obstructions to the sprinkler system. This section outlines requirements for proper protection of compact shelving systems for general or collections storage use.
 - 2. In order to provide proper protection, design of the automatic sprinkler system must be considered together with the design of the shelving system.
 - 3. The design options presented here include those protection options outlined in the Annexes of NFPA 909 - Code for the Protection of Cultural Resources Properties, Museums, Libraries, and Places of Worship.
- B. Summary of Design Options.
 - 1. The options listed below do not include all detailed design requirements. See

- Appendix E for all sprinkler system and compact shelving design requirements.
2. Enclosed Shelving.
 - i. Appropriate for collections storage.
 - ii. Fully-enclosed metal cabinets on compact shelving frames.
 - iii. Standard SI sprinkler requirements.
 - iv. Minimum clearance between compactor units is 0 inches.
 3. Moderate-density sprinkler system with wide spacing.
 - i. Appropriate for collections storage consisting of books, file archives, and other similar types of storage.
 - ii. Compact shelving must have a solid metal canopy top, full-height metal longitudinal divider, and full-height metal transverse divider every 20 feet.
 - iii. Automatic sprinkler density of 0.3 gpm/ft² over 1500 ft².
 - iv. Minimum 4-inch spacing between compactor units.
 4. High-density sprinkler system with close spacing.
 - i. Appropriate for collections storage consisting of books, file archives, and other similar types of storage.
 - ii. Compact shelving must have a full-height metal longitudinal divider and full-height metal transverse divider every 15 feet. The units must not have a canopy top.
 - iii. Automatic sprinkler density of 0.7 gpm/ft² over the shelving area.
 - iv. Minimum 1-inch spacing between compactor units.
 5. Ultra-high density sprinkler system with close spacing and no shelving dividers.
 - i. Not appropriate for collections storage.
 - ii. Compact shelving must have shelves that are at least 50% open. The units must not have a canopy top.
 - iii. Automatic sprinkler density designed according to FM data sheet 8-9 for solid pile storage of appropriate commodity (typically will be 1.0 to 2.0 gpm/ft² over the shelving area).
 - iv. Minimum 1-inch spacing between compactor units.
 6. NFPA 13 Design
 - i. For general storage of non-archival/collections items consisting of paper files, magazines, books and similar documents in folders and miscellaneous supplies with no more than 5 percent plastic, compact shelving may be installed according to the requirements and limits stated in the NFPA 13 section on Compact Storage of Commodities (20.6 in the 2013 edition). Per NFPA 13, the shelving area is limited to 250 ft².
 - ii. The design sprinkler density is still required to be Ordinary Hazard II, though this section of NFPA 13 discusses Light Hazard application.
 7. Other Designs

- i. Designs that are based on successful full-scale fire tests may be utilized subject to OSHEM review and approval. The design FPE shall provide for OSHEM review a copy of the fire test report, along with a summary of the storage configuration and sprinkler system design basis criteria.
- ii. Designs may utilize the design objectives stated in NFPA 909 – Code for the Protection of Cultural Resources Properties, Museums, Libraries, and Places of Worship.

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CHAPTER 8 EXHIBIT FABRICATION GUIDE

8.1 GENERAL

- A. This chapter sets forth the appropriate fire protection and safety requirements for organizations planning or engaging in exhibit construction, improvement and alteration projects.
- B. The Smithsonian Institution shall ensure that the established fire protection and life safety requirements outlined in the Smithsonian Safety Manual and this Design Manual are carried out in the planning and design of all exhibit construction, improvement, and alteration projects.
 - 1. This consists of the codes and standards cited in this Design Manual, including, but not limited to:
 - i. IBC (International Building Code)
 - ii. IFC (International Fire Code)
 - iii. NFPA 101 (Life Safety Code)
 - iv. OSHA Standards Part 1910, Occupational Safety and Health Standards for General Industry
 - v. OSHA Standards Part 1926, Safety and Health Regulations for Construction
- C. Because of the broad scope of concern, the Office of Safety, Health and Environmental Management (OSHEM) should be consulted in the earliest stages of planning, and development or design for all projects to ensure adequate consideration of all necessary requirements within the project time constraints.
 - 1. The SI office responsible for organizing, planning, or engaging in any exhibit construction, improvement and alteration project is responsible for ensuring OSHEM is consulted in the earliest stages of the exhibit planning.
 - 2. The Office of Safety, Health and Environmental Management (OSHEM) Director is responsible for directing and implementing fire protection, life safety, and occupational safety and health functions.
 - 3. OSHEM will provide technical supervision, assistance, review, and approval during the design process.
- D. A checklist to aide exhibit design and fabrication with respect to Smithsonian Institution fire and life safety requirements and standards is provided in Appendix A of this Design Manual.

8.2 EXHIBIT DESIGN DRAWINGS

- A. General
 - 1. Exhibit design and construction plans and specifications shall be submitted for OSHEM for review and approval at all contract submission milestones.
 - 2. Plans shall be approved by OSHEM prior to the start of any construction or alteration activities.
 - 3. The following general notes shall be included in each exhibit design drawing set:

- i. The language presented in Section 8.5 – Materials of Construction, Items C through H shall be included verbatim.
 - ii. “Protective covers for fire detection and suppression devices shall be provided during dust-creating construction and painting operations. Protective covers shall be removed at the end of each workday.”
- B. Key Plan
 - 1. A key plan shall be provided showing the location of the project area in relation to the building floor plan.
- C. Floor Plans
 - 1. Plans shall indicate all new and existing wall, floor, and ceiling construction.
 - 2. Areas where work is to be accomplished shall be labeled and the occupancy of the areas in close proximity to the project site (e.g. gallery, office, corridor, exit stair, collection storage) identified.
 - 3. All new, relocated, and existing fire safety equipment on both the demolition and new work plans must be shown and labeled appropriately.
 - i. This equipment includes but is not limited to: sprinkler heads, smoke detectors, heat detectors, pull stations, standpipes/hose cabinets, fire extinguishers, bells/horns/ speakers, strobe lights, remote indicator lights, exit signs, emergency lights, air supply and return ducts, fire-rated partitions, and fire doors.
 - 4. Plans shall indicate exit details such as location, paths of access/egress, door swing, and width of passageways and doors.
 - 5. Plans shall indicate the hourly rating of new and existing fire doors and frames and shall include details of new fire door assemblies which show the area of any glass and construction material.
- D. Sections
 - 1. Sections must be properly presented to indicate location and viewing position.
- E. Existing Conditions
 - 1. Show locations of all existing fire alarm devices. Indicate make and model number, and type of existing equipment. Ensure devices will not be obstructed by new work.
 - 2. Show locations of all existing automatic sprinkler heads. Indicate height above the floor (if it varies) and sprinkler type (pendent, upright, or sidewall).
- F. Special Operations and Hazardous Materials
 - 1. Any special operations to be performed or hazardous materials to be used in the work area or nearby spaces shall be noted on the drawings. Examples include: electrical hazards, use of flammable or toxic materials, special cleaning operations.
- G. Exhibited Objects
 - 1. Drawings shall include adequate information about the objects on display to assess their impact on the level of fire protection and life safety. Plans are to

include the dimensions, exact location and type of materials used to construct large objects not enclosed within vitrines.

2. Objects or exhibit construction shall provide necessary details to demonstrate that hazards such as sharp edges, tip-over, moving parts, etc. are properly mitigated.

8.3 EXITS

A. Exit Details

1. All public galleries shall have a minimum of two exits, arranged to be remote from one another.
2. Ensure the clear width along all points on the primary egress path is a minimum of 5 feet (1524 mm)
3. Ensure the clear width along all points on the secondary egress paths is a minimum of 44 inches (1117 mm). (In certain situations greater clear width may be required by NFPA 101 and OSHEM.)

B. Exit Signs

1. Location
 - i. Exits shall be properly identified by exit signs. Exit signs shall be listed or approved, readily visible and of a distinctive color which contrasts with the surrounding decor.
 - ii. No display, object or brightly-illuminated signs shall be placed in the line of vision to distract attention from the exit signs.
2. Lettering
 - i. Each exit sign shall have the word, "EXIT" in plain, legible letters not less than 6 inches (150mm) high, with the principal stroke of letters not less than 3/4 inches (19mm) wide.
 - ii. An arrow, indicating the direction of exit travel, shall be used when the direction is not readily apparent. Refer to NFPA 101 for other specific requirements.
3. Illumination
 - i. Exit signs shall be illuminated by either an integral light source or an external light source measuring not less than 5 foot-candles (54 lux) at the illuminated surface under both normal and emergency power.
 - ii. Internally illuminated signs shall be listed in accordance with ANSI/UL 924.
4. Power Supply
 - i. The power shall be supplied by continuous power source with secondary power from an emergency generator or integral battery.

C. Walking Surfaces

1. Changes in Elevation
 - i. Abrupt changes in elevation of walking surfaces shall not exceed 1/4 inch (0.63 cm).

- ii. Changes in elevation exceeding 1/4 inch (0.63 cm), but not exceeding 1/2 inch (1.3 cm) shall be beveled with a slope of 1 in 2.
 - 2. Headroom
 - i. Minimum headroom shall be 6 feet 8 inches (203 cm) at doors or stairwells.
 - 3. Platforms
 - i. Platforms protruding into walk spaces present a "strike the ankle" type hazard. Special lighting, color contrast and padding or 18-inch (45.7 cm) barriers are recommended.
- D. Stairs and Steps
 - 1. Fewer Than Three Risers
 - i. When fewer than three risers are used, measures shall be taken to create awareness of the elevation change. Examples include: special lighting, color contrast, change in floor surface, or barriers.
 - 2. Width and Height Requirements
 - i. Minimum width of stairs and steps shall be 44 inches (112 cm) and clear of all obstructions except handrails. Stair and landings shall not decrease in width along the direction of exit travel.
 - ii. Treads shall not be less than 11 inches (27.9 cm).
 - iii. Risers shall not be less than 4 inches (10.2 cm) nor more than 7 inches (17.8 cm).
 - iv. Variations in width of adjacent treads and height of adjacent risers shall not exceed 3/16 inch (.5 cm). Variation between sizes of the largest and smallest risers or between the largest and smallest tread depths in a flight of stairs shall not exceed 3/8 inch (0.95 cm).
 - 3. Landings
 - i. Doors may not open immediately onto stairs without a landing of at least the width of the door, plus one tread dimension.
 - 4. Handrail Details
 - i. Stairs and ramps shall have handrails 34 to 38 inches (86 to 96 cm) high measured from the leading edge of the tread to the top of the rail.
 - ii. Additional handrails that are lower or higher than the main rail are permitted. For areas where children are the primary users it is recommended that an intermediate handrail be installed.
 - iii. Handrails shall be installed to provide a clearance of at least 2-1/4 inches (56 mm) from the wall to which it is attached.
 - iv. Handrails shall offer no obstruction to a smooth handhold surface along the top and both sides of the rail.
 - v. Handrails shall have a circular cross section with an outside diameter of at least 1-1/4 inches (3.2 cm) and not greater than 2 inches (5 cm).

- vi. Handrails shall extend horizontally at least 12 inches (30.5 cm) beyond the top riser and continue to slope for a depth of one tread beyond the bottom riser.
- vii. Ends of handrails shall be turned into the supporting wall, floor or shall terminate at newel posts.

5. Guard Rails

- i. Guard rails shall be provided at floor openings, open-sided floors, platforms (30 inches (76 cm) or more above the floor or ground level) and ramps. All open sides shall be guarded by railings, except where there is an entrance to a ramp or stairway.
- ii. Guard rails shall have a vertical height of 42 inches (107 cm) measured from the upper surface of the top rail to the floor, platform, or runway.
- iii. Guard rails shall be capable of withstanding a load of at least 200 pounds (90.7 kg) applied in any direction at any point at the top of the rail.

8.4 FIRE-RATED CONSTRUCTION

A. Penetrations Through Fire-Rated Construction

- 1. Penetrations through fire-rated construction (i.e. walls, floors, etc.), not protected by fire dampers or combination fire/smoke dampers, shall be sealed with an approved penetration firestop material that maintains the fire rating.
- 2. All installations shall comply with the manufacturer's installation requirements.

8.5 MATERIALS OF CONSTRUCTION

A. General

- 1. Extreme care must be exercised in the selection of interior finish materials. Some veneers and synthetic J wall, ceiling and floor coverings are dangerously combustible. Flames spread rapidly over them, generating large amounts of smoke and toxic products of combustion. The danger of damage to collections and to the lives of visitors and staff from improperly selected interior finish materials cannot be overemphasized.
- 2. All materials of construction shall be noncombustible or inherently fire retardant. These requirements typically do not apply to artifacts/collections to be exhibited, unless the object presents an appreciable fire risk as evaluated by OSHSEM.

B. Testing

- 1. Testing laboratories, such as Underwriters Laboratories, test and rate the performance of interior finish materials in fire tests designed to show how much fuel a material contributes to a fire, how quickly flame spreads over its surface, and how much smoke it generates.
- 2. The results of the ASTM E-84 and ASTM E-648 tests are given as numerical ratings. For ASTM E-84, the lower the flame spread the better its performance in the test. For ASTM E-648 the higher the critical radiant flux the better its performance in the test.

C. Wall and Ceiling Materials

1. Wall and ceiling materials that are used in exhibit spaces or the means of egress; such as paneling or acoustical tiles; shall have a flame spread rating of 25 or less, and a smoke developed index of 450 or less, as measured in accordance with ASTM E-84, Surface Burning Characteristic of Building Materials.
2. For exhibit spaces protected by an automatic sprinkler system, these materials shall have a flame spread rating of 75 or less.
3. Tests to determine flame spread shall have been performed by a certified testing laboratory.
4. Wall mounted materials which have a surface area exceeding 10% of the wall area, and single pieces over 100 sq ft (9.3 sq m) shall comply with the above requirements for wall and ceiling materials.

D. Wood

1. Wood used for walls, platforms, dioramas, blocking, furring, cases over 100 cubic feet (2.8 cubic m), light attics with electric lighting, and similar applications shall be fire retardant, pressure impregnated.
 - i. Fire retardant coatings of intumescent paint are not acceptable in lieu of fire retardant treatment unless specifically approved by OSHEM Fire Protection Division.
 - ii. This requirement shall not apply to cabinets, showcases or finish trim.
 - iii. Unenclosed spaces beneath table-style cases shall not contribute to overall case volume when considering the 100 cubic foot (2.8 cubic m) limit.

E. Carpeting

1. Carpeting materials shall have a minimum critical radiant flux of 0.45 watts/ cm², when tested in accordance with ASTM E-648, Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
2. Carpeting shall also pass the Methanamine Pill Test, Federal Flammability Standard FF-1-70.
3. For installations specifying carpeting on walls the following criteria shall be used:
 - i. The room shall be protected by an automatic sprinkler system.
 - ii. Materials shall have a Class A rating (flame spread 25 or less and smoke development factor less than 450), as measured by ASTM E-84.

F. Draperies, Bunting or Decorative Textiles

1. All material intended for decorative purposes, such as draperies, scrim or bunting shall be certified flame resistant in accordance with the criteria contained in the current edition of NFPA 701, Standard for Methods of Fire Tests of Flame-Resistant Textiles and Films. Samples and fire test data shall be submitted to OSHEM for evaluation and approval.

G. Plastics, fiberglass, exposed foamed plastics, materials containing foamed plastics

1. Plastics, exposed foamed plastics, and materials containing foamed plastics are prohibited from being used in the exhibit unless the specific criteria in the Life

Safety Code and the IBC for Interior Finish and Furnishings, Decorations, and Scenery have been met.

2. Samples and fire test data shall be submitted to OSHEM for evaluation and approval.
3. Vitrines materials with more than 100 sq ft (9.3 sq m) of exposed vertical surface area shall be in compliance with the interior finish requirements for walls and ceiling materials.
4. Fiberglass must use a fire-retardant resin and pass Class A or B interior finish requirements when tested in accordance with ASTM E-84 in the design thickness.

H. Glass

1. Glass used in vitrines or displays that exceeds 48 inches (1219 mm) in any dimension shall be laminated safety glass.

8.6 FIRE ALARM AND DETECTION SYSTEMS

A. General

1. Fire detectors shall be installed in all areas and shall meet the requirements of the current edition of NFPA 72, National Fire Alarm Code, SI Fire Protection & Life Safety Design Manual, SI Standard Specifications, and the manufacturer's design specifications.
2. When a permanent gallery is closed to install a new exhibit potential fire detection and alarm system upgrades must be evaluated and implemented where practical. Ceiling-mounted notification appliances are preferred to provide maximum flexibility in exhibition design.
3. Fire detectors and notification appliances shall not be field painted.

B. Manual Fire Alarm Stations

1. Manual fire alarm stations shall not be obstructed and shall remain accessible at all times.

C. Placement of Bells, Horns, and Speakers

1. Audible devices shall be installed so that they are at least 15 dB louder than the maximum noise level that normally occurs in the area served.

D. Placement of wall and ceiling mounted strobes.

1. Visual devices (strobes) shall be installed per NFPA 72, and not obstructed from view by exhibit construction.

E. Relocation or Extension of Existing Equipment

1. Determine final location of walls, barriers and ceilings before placing detection and alarm equipment.
2. New equipment shall be compatible with the existing system.

8.7 AUTOMATIC SPRINKLER SYSTEMS

A. General

1. Provide automatic sprinklers in all areas. Sprinkler installations shall meet the requirements of the current edition of NFPA 13, Standard for the Installation of Sprinkler Systems, SI Fire Protection & Life Safety Design Manual, SI Standard Specifications, and the manufacturer's design specifications.
 2. When a permanent gallery is closed to install a new exhibit potential fire protection system upgrades must be evaluated and implemented where practical.
- B. Relocation of Extension of Existing Equipment
1. Determine final location of walls, barriers and ceilings before considering changes to the sprinkler system.
 2. If existing equipment must be extended or relocated, provide a layout showing location and size of existing and proposed piping.
 3. Sprinkler system additions and modifications shall be per the latest edition of NFPA 13, Standard for the Installation, Maintenance and Use of Automatic Sprinkler Systems and designed for Ordinary Hazard Group II Occupancies.
 4. Pipe sizes shall be determined by hydraulic calculation.
- C. Sprinkler heads and concealed sprinkler plates shall not be field painted. Any sprinkler heads or plates coated with paint in the field shall be replaced.

8.8 EMERGENCY LIGHTING

- A. Location
1. Emergency lighting for exhibits spaces shall be provided for all occupied locations including means of egress paths, corridors, stairs, and public and staff areas.
- B. Power
1. The power shall be supplied by a continuous fixed wiring power source with secondary power from either an emergency generator or battery pack.
- C. Illumination
1. Lights shall be located to provide an average level of illumination of 1 foot-candle (10 lux), measured at the floor.
 2. Where lighting dimming control systems are used one of the following conditions must be met:
 - i. Separately controlled emergency egress lighting is provided.
 - ii. Dimming control panel is connected to emergency power circuits and controlled lighting provides an average level of illumination of 1 foot-candle (10 lux) measured at the floor under both normal and emergency power.
- D. Testing
1. Emergency lighting shall be tested prior to the beneficial occupancy of each new exhibit.

8.9 PORTABLE FIRE EXTINGUISHERS

- A. Where portable fire extinguishers are required, each facility shall provide portable fire extinguishers for building protection and other hazards being protected.

- B. Water-mist extinguishers shall be provided in all exhibit halls with exposed collections. Multi-purpose dry chemical extinguishers shall be installed where water-mist are not required.
- C. The minimum classification of extinguishers that are required for building protection is 2A-10BC.
- D. The maximum travel distance to an extinguisher is 75 feet (22.86 m).
- E. Extinguishers may be mounted on hangers or brackets, on shelves, or in cabinets. Extinguishers shall be mounted so that the top is no more than 5 feet (152.4 cm) above the floor and the bottom is at least 4 inches (10.2 cm) from the floor.
- F. Cabinets may be recessed to minimize the aesthetic impact and the door may be opaque, In this case, the cabinet shall be labeled, "FIRE EXTINGUISHER" with minimum 3/4-inch (1.91 cm) letters. At no time shall fire extinguisher cabinets be locked. Break-glass type cabinets are not permitted.
- G. Extinguisher cabinets recessed in fire rated walls must be listed for such purpose.
- H. Extinguishers shall be readily accessible and not hidden from view.

8.10 ELECTRICAL REQUIREMENTS (OTHER THAN FIRE ALARM)

- A. All new or altered electrical work shall be performed by qualified electricians and shall comply with the current edition of the NFPA 70 National Electrical Code as well as existing local electrical codes when specified.
- B. All wiring shall be installed in rigid conduit, EMT or flexible conduit. Aluminum conduit shall not be imbedded in concrete.
- C. Fixed wiring methods shall be metal raceways, nonmetallic raceways encased in not less than two inches of concrete, mineral insulated metal-sheathed cable or Type MC cable. Type AC cable (commercial EX) shall not be permitted.
- D. All new receptacles, switches and equipment shall be U.L. listed or equivalent. Where equivalent items are specified, pertinent features must be listed in the technical specifications and identified in the Special Conditions of the Contract.
- E. The number and placement of receptacles shall be adequate to support the required electrical loads.

8.11 AUDIO VISUAL EQUIPMENT

- A. Open Audio Visual Areas
 - 1. Open Audio Visual Areas shall be defined as those areas constructed within exhibit areas or structures for the purpose of housing audio visual support equipment which are open to above and unobstructed in accordance with NFPA 101 and NFPA 72.
 - 2. All shelves and mounts shall be constructed of noncombustible materials.
 - 3. Clearance from audio visual equipment to any combustible materials shall be at least one foot horizontally, and two feet (61 cm) vertically.
- B. Enclosed Audio Visual Areas
 - 1. Enclosed Audio Visual Areas shall be defined as those areas constructed within exhibit areas or structures for the purpose of housing audio visual support

equipment which are NOT open to above or are obstructed in accordance with NFPA 101 and NFPA 72.

2. Enclosures shall be constructed of fire resistant materials subject to the approval of OSHEM.
3. All shelves and mounts shall be constructed of noncombustible materials.
4. Each projection enclosure shall be provided with a smoke detector connected to the facility fire alarm system.
5. All enclosures housing projection equipment shall be ventilated mechanically to remove excess heat, unless the design proves that mechanical ventilation is not required.

C. Audio Visual Control Rooms

1. Audio Visual Control Rooms shall be defined as those rooms within the facility which house the control equipment for one or more gallery's audio visual exhibit components.
2. Rooms shall be constructed with 1 hour fire rated construction with 45 minute opening protectives.
3. Rooms shall be provided with smoke detectors connected to the facility fire alarm system.

D. Audio Visual Equipment Shutdown

1. Upon general fire alarm evacuation, all audio visual equipment (including interactive displays) shall be designed to cease operation. Where hard shutdown of audio visual equipment may damage the equipment, this requirement may be waived with OSHEM approval when at least one of the following conditions is met:
 - i. Normal audio visual operation can be demonstrated to not interfere with or obscure emergency notification systems.
 - ii. Normal audio visual operation can be replaced with an emergency message upon activation of emergency notification systems.
 - iii. Other remediation approved by OSHEM.
2. Audio visual shutdown is normally initiated via a fire alarm relay with a set of dry contacts (normally open and normally closed are typically both provided on the relay). The exhibit designer must confirm the location of existing fire alarm relays or include new relays in their design as necessary. The use of a shunt circuit breaker tripped by a fire alarm relay is an acceptable shutdown method, but should be discussed with the facility exhibit group since the breaker requires manual resetting.

8.12 INSTALLATION OF EXHIBITS

A. Exit Access

1. Exhibit construction activities shall not block, remove, or otherwise inhibit exit access from galleries or spaces not included in the same project.
2. Exits shall be unobstructed and adequate in number and size.

3. Consideration shall be given to the orderly circulation of visitors and avoiding cul-de-sacs.
- B. Dust Barriers
1. Dust barriers shall be constructed of non-combustible or fire retardant materials that are classified as Class A or B per ASTM E-84, or shall pass NFPA 701, as applicable.
- C. Access to Equipment
1. Fire protection equipment shall not be obstructed or interfered with during exhibit installation.

8.13 FINAL ACCEPTANCE AND APPROVAL

- A. Upon completion of each project, but prior to issuance of the beneficial occupancy permit, the COTR or person responsible for the exhibit construction shall contact OSHEM to conduct a final occupancy inspection/walkthrough of the space, noting any deficiencies or problems.
- B. Prior to beneficial occupancy any fire protection and life safety system changes included in the project must pass final acceptance testing by OSHEM. Final acceptance testing may include any or all of the following:
1. Hydrostatic Testing of Sprinkler Piping
 2. Functional Fire Alarm Testing
 3. Functional Fire Damper Testing
 4. Emergency Lighting Test
 5. Exit Door Opening Force Test
- C. OSHEM may issue partial occupancy certification where necessary for the installation of collections objects by SI Staff.

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APPENDIX A - FIRE AND LIFE SAFETY CHECKLIST FOR EXHIBIT CONSTRUCTION

- A. INTRODUCTION: This checklist is intended to assist exhibit designers and fabricators in approaching the design and construction of exhibits in SI facilities. It does not replace or exclude any of the requirements found in this Design Manual.

EXHIBIT CONSTRUCTION CHECKLIST		Project:	
Element	Requirement	Section	
Exhibit Design Drawings	General Show project area in relation to building floor plan.	8.2.A.1 <input type="checkbox"/>	
	General Show new, relocated, and existing equipment on both demolition and new work plans.	8.2.C.3 <input type="checkbox"/>	
	General Adequate Exhibited Object information included on drawings.	8.2.H.1 <input type="checkbox"/>	
Exits	General Gallery has minimum two exits arranged to be remote from one another.	8.3.A.1 <input type="checkbox"/>	
	General Clear width along primary egress path is minimum 60".	8.3.A.2 <input type="checkbox"/>	
	General Clear width along secondary egress path is minimum 44".	8.3.A.3 <input type="checkbox"/>	
	Signs	Exits properly identified by exit signs.	8.3.B.1.i <input type="checkbox"/>
		No display, object, or bright illumination obstructs exit sign line of vision.	8.3.B.1.ii <input type="checkbox"/>
		Exit signs illuminated with integral light source or continuous external 5 foot-candle minimum.	8.3.B.3.i <input type="checkbox"/>
	Stairs and Steps	Elevation changes made obvious for stairs less than 3 risers.	8.3.C.1.i <input type="checkbox"/>
		Stairs minimum 44" wide and clear of obstructions.	8.3.C.2.i <input type="checkbox"/>
		Minimum headroom is 6'8" at doors and stairwells.	8.3.C.4.i <input type="checkbox"/>
		Stairs and ramps have handrails 34" to 38" above leading edge of tread.	8.3.C.5.i <input type="checkbox"/>
		Handrails offer no obstruction to smooth handhold surface.	8.3.C.5.iv <input type="checkbox"/>
	Guard Rails	Handrails have a circular cross section with an outside diameter between 1-1/4" and 2".	8.3.C.5.v <input type="checkbox"/>
		Guard rails are provided at floor openings, open-sided floors, platforms 30" or more above floor level, ramps, etc. on all open sides except entrances to ramps or stairways.	8.3.C.6.i <input type="checkbox"/>
		Guard rails have a vertical height of 42" measured from the upper surface.	8.3.C.6.ii <input type="checkbox"/>
		Guard rails are capable of withstanding 200 pounds applied in any direction at any point on the top rail.	8.3.C.6.iii <input type="checkbox"/>

Fire Rated Construction	General	Penetrations other than fire dampers through fire-rated construction are sealed with an approved firestop material.	8.4.A.1	<input type="checkbox"/>
		Details provided of new fire door assemblies showing area of glass and construction material.	8.4.B.2	<input type="checkbox"/>
Materials of Construction	General	All materials of construction are noncombustible or inherently fire retardant.	8.5.A.2	<input type="checkbox"/>
		Proof of fire test performance for all materials of construction have been submitted to OSHEM and approved.	8.5.B.2	<input type="checkbox"/>
	Wall and Ceiling Materials	Materials have a flame spread index less than 25 in unsprinklered exhibits or 75 in sprinklered exhibits.	8.5.C.2	<input type="checkbox"/>
		Materials have a smoke developed index less than 450.	8.5.C.1	<input type="checkbox"/>
		Wall mounted materials exceeding either 10% of wall area or single pieces greater than 100 ft ² comply with above.	8.5.C.4	<input type="checkbox"/>
	Wood	Wood used for walls, platforms, dioramas, blocking, furring, cases over 100 ft ³ , and similar is Fire Retardant Pressure Impregnated (does not apply to cabinets, showcases, or finish trim).	8.5.D.1	<input type="checkbox"/>
	Carpeting, Draperies, Bunting and Decorative Textiles	Carpeting has a minimum critical radiant heat flux of 0.45 watts/cm ² .	8.5.E.1	<input type="checkbox"/>
		Carpeting has passed the Methanamine Pill Test.	8.5.E.2	<input type="checkbox"/>
		Carpeting and textiles installed on walls has a Class A rating and is not installed in unsprinklered room.	8.5.E.3	<input type="checkbox"/>
		All materials intended for decorative purposes have passed testing in accordance with NFPA 701.	8.5.F.1	<input type="checkbox"/>
	Plastics	Plastics, exposed foam plastics, and materials containing foam plastics are not used in exhibits unless Life Safety Code and IBC Interior Finish requirements are met.	8.5.G.1	<input type="checkbox"/>
		Vitrine materials other than glass do not exceed 100 ft ² exposed vertical surface area.	8.5.G.3	<input type="checkbox"/>
Fiberglass uses a fire-retardant resin and complies with Class A or B interior finish tests in the design thickness.		8.5.G.4	<input type="checkbox"/>	
Fire Detection and Alarm Systems	General	Manual pull stations and fire alarm notification devices are not obstructed from view or access by exhibit construction.	8.6	<input type="checkbox"/>
		Smoke, heat, and other detectors are not field painted.	8.6.G	<input type="checkbox"/>

Automatic Sprinkler Systems	General	Sprinkler system has been hydraulically designed for Ordinary Hazard Group II occupancies.	8.7.C.3	<input type="checkbox"/>
		Sprinkler heads are not field painted.	8.7.D	<input type="checkbox"/>
Emergency Lighting	General	Emergency lighting provided in all main circulation and egress paths, corridors, and stairs.	8.8.A.1	<input type="checkbox"/>
		Emergency lighting is supplied by a continuous fixed wiring power source with battery pack or generator backup.	8.8.B.1	<input type="checkbox"/>
		Emergency lighting average illumination levels are a minimum 1 foot-candle measured at the floor.	8.8.C.1	<input type="checkbox"/>
		Dimming control is connected to emergency power and cannot provide less than the required 1 foot-candle illumination.	8.8.C.2.ii	<input type="checkbox"/>
Portable Fire Extinguishers	General	Water-mist extinguishers provided in all exhibit halls with exposed collections.	8.9.B	<input type="checkbox"/>
		Maximum travel distance to an extinguisher is 75'.	8.9.D	<input type="checkbox"/>
		Extinguishers mounted on hangers, brackets, shelves, or in cabinets so that the top is no more than 5' above the floor.	8.9.E	<input type="checkbox"/>
		Cabinets recessed into walls are labeled "FIRE EXTINGUISHER" in appropriately sized lettering.	8.9.F	<input type="checkbox"/>
		Extinguishers are readily accessible and not hidden from view.	8.9.H	<input type="checkbox"/>
Audio Visual Equipment	Open A/V Areas	Shelves and mounts are constructed of non-combustible materials.	8.11.A.2	<input type="checkbox"/>
		Clearance to any combustible materials is at least 1' horizontally and 2' vertically.	8.11.A.3	<input type="checkbox"/>
	Enclosed A/V Areas	Enclosure is constructed of fire resistant materials approved by OSHM.	8.11.B.2	<input type="checkbox"/>
		Shelves and mounts are constructed of non-combustible materials.	8.11.B.3	<input type="checkbox"/>
		Projection enclosures are provided with smoke detectors.	8.11.B.4	<input type="checkbox"/>
	A/V Control Rooms	Projection enclosures are provided with mechanical ventilation.	8.11.B.5	<input type="checkbox"/>
		A/V control rooms are of 1-hr rated construction.	8.11.C.2	<input type="checkbox"/>
	Equipment Shutdown	A/V control rooms are provided with smoke detectors.	8.11.C.3	<input type="checkbox"/>
		A/V equipment is provided with hard or soft shutdown designed to cease operation upon fire alarm activation.	8.11.D	<input type="checkbox"/>

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APPENDIX B - GUIDE SPECIFICATIONS

SECTION 078100	SPRAYED FIRE-RESISTANT MATERIALS
SECTION 078413	PENETRATION FIRESTOPPING
SECTION 081173	ROLLING FIRE DOORS
SECTION 104400	FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES
SECTION 211313	WET PIPE SPRINKLER SYSTEMS
SECTION 211316	DRY PIPE AND PREACTION SPRINKLER SYSTEM
SECTION 213110	FIRE PUMP SYSTEM
SECTION 283111	ADDRESSABLE FIRE ALARM SYSTEM
SECTION 331615	WATER STORAGE STEEL TANKS

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APPENDIX C – FIRE PROTECTION COMMISSIONING STANDARDS

CLEAN AGENT EXTINGUISHING SYSTEMS

EMERGENCY POWER AND STANDBY SYSTEMS

FIRE ALARM SYSTEMS

FIRE AND SMOKE DAMPERS

KITCHEN SYSTEMS

SMOKE CONTROL SYTSEMS

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APPENDIX D - SUMMARY OF ENCLOSURE REQUIREMENTS FOR COMMON USE AREAS

Area	Minimum Fire Barrier Requirements ¹
Incinerator rooms and trash storage rooms	2-hour ²
Paint shops	2-hour
Laundry rooms over 100 sq ft	1-hour
Incidental storage rooms over 100 sq ft	1-hour
Collections storage rooms	2-hour rated fire/smoke barriers
Collections processing areas	1-hour rated fire/smoke barriers.
Wet collections spaces < 500 sq ft	Per NFPA 30
Wet collections space ≥ 500 sq ft	4-hour
Bulk alcohol storage for wet collections	3-hour
Stationary lead-acid battery systems having a liquid capacity of more than 50 gallons used for facility standby power, emergency-power or uninterrupted power	1-hour in Group B, F, M, S and U occupancies. 2-hour in Group A, E, I and R occupancies
Electric closets	1-hour
Mechanical rooms	1-hour
Electrical switchgear and/or transformer rooms	1-hour or 3-hour depending on equipment per NEC
Generator Rooms	2-hour
Telephone/ communication closets	1-hour
IT spaces/closets (non-mission critical)	1-hour
IT spaces (mission critical)	2-hour
Maintenance shops	1-hour
Loading Docks	2-hour (over 100 sq ft used for movement of combustibile materials)
Main Kitchen	1-hour
Fire Pump Room	2-hour
Refrigerant machinery rooms	1-hour

Notes:

1. This table is not intended to be comprehensive. The Design Engineer/Architect is required to confirm these ratings and other special requirements based on the applicable codes and standards.
2. The requirements listed here are for fire resistance ratings. Automatic sprinklers or other type of fire suppression system will be required in accordance with Chapters 5 and 7 of this Design Manual.

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APPENDIX E – COMPACT STORAGE UNITS (MOBILE SHELVING) DESIGN SUPPLEMENT

This design supplement provides detailed requirements for the design and installation of compact shelving and automatic sprinkler systems. The information below identifies those designs which are appropriate for archival and collection storage.

- 1) *Enclosed shelving*. Provide fully enclosed metal cabinet-style compact shelving for all compactors. This effectively eliminates the hazard by compartmentalizing the large, continuous fuel load. Standard SI sprinkler system water density requirements are adequate. Clearance between compactors may be reduced to zero.
- 2) *Moderate-density sprinkler system with wide spacing*. Provide the following sprinkler system capability and shelving design
 - a. Limitations.
 - i. This arrangement is only suitable for books, files, and other similar archival paper-type storage.
 - ii. Minimum clearance of 24” between top of shelving and ceiling (23” from sprinkler deflector to top of shelving).
 - b. Sprinkler system
 - i. Sprinkler density of 0.3 gpm/ft² over 1500ft².
 - ii. Quick-response, 165°F sprinklers
 - iii. Maximum 10 ft x 10 ft spacing.
 - iv. Hose stream allowance of 250gpm
 - c. Shelving system
 - i. Steel construction, 18 ga. minimum
 - ii. Longitudinal vertical divider (18 ga. steel, minimum) along entire length and height of each compactor. May be at the center of each compactor (preferred) or along one face, if the entire width of the shelf is needed for storage. This barrier will slow the progression of fire from one compactor to the next.
 - iii. Transverse vertical divider (18 ga. steel, minimum), along the entire width of each compactor spaced at intervals no greater than 20 ft. If the length of the shelving unit is less than 20 ft, transverse dividers need not be provided. Similar to the longitudinal divider, this divider will slow the progression of fire within a compactor unit.
 - iv. Solid metal canopy tops on each compactor (18 ga. steel, minimum).
 - v. Minimum 4” spacing between compactors in the closed position. Permanent bumpers must be installed to maintain the spacing.
 1. As an alternative to permanent 4” spacing between compactor units (which usually leads to some loss in storage capacity), electric compactor units may be provided that are interfaced with the fire alarm system. When the fire alarm activates, a signal is sent to the electric compactor units which causes them to automatically space themselves apart (to a minimum of 4”). Under normal conditions, the clearance between compactors may be zero.
- 3) *High-density sprinkler system with close spacing*. Provide the following sprinkler system

capability and shelving design.

- a. Limitations.
 - i. This arrangement is only suitable for books, files, and other similar archival paper-type storage.
 - ii. No loose storage of paper is permitted (e.g. newspaper stacks)
 - iii. Ceiling height 7 ft to 10.5 ft.
 - b. Sprinkler system
 - i. Sprinkler density of 0.7 gpm/ft² over the shelving area.
 - ii. Sprinkler density of 0.3 gpm/ft² over 1500 ft² (over the aisle area adjacent to the shelving)
 - iii. Shelving area must be separated from aisle area at ceiling by a draft curtain.
 - iv. Quick-response, 165°F sprinklers
 - v. Maximum 10 ft x10 ft spacing (with 18 in. of clearance, minimum)
 1. For areas of reduced clearance, quick response sidewall sprinklers may be used (clearance from top of shelving to ceiling greater than or equal to 7 in.).
 - a. Distance of sprinkler deflector below ceiling is 4 inches.
 - b. Maximum width of coverage is 15 ft.
 - c. Sidewall sprinklers must be spaced at intervals of 8.5 ft along each side of the protected area. Positioning must be staggered from one side to another, such that sprinklers opposite each other do not line up (i.e. offset by 4.25 ft)
 - vi. Hose stream allowance of 250gpm
 - c. Shelving system
 - i. Steel construction, 18 ga. minimum
 - ii. Open cantilever-style shelving.
 - iii. Longitudinal vertical divider (18 ga. steel, minimum) along entire length and height of each compactor. May be at the center of each compactor (preferred) or along one face, if the entire width of the shelf is needed for storage. This barrier will slow the progression of fire from one compactor to the next.
 - iv. Transverse vertical divider (18 ga. steel, minimum), along the entire width of each compactor spaced at no greater than 15 ft intervals. If the length of the shelving unit is less than 15 ft, transverse dividers need not be provided. Similar to the longitudinal divider, this divider will slow the progression of fire within a compactor unit.
 - v. No canopy tops on each compactor.
 - vi. Minimum 1" spacing between compactors in the closed position. Permanent bumpers must be installed to maintain the spacing.
- 4) *Ultra high-density sprinkler system with close spacing and no longitudinal or transverse dividers in compact shelving.*
- a. Limitation. This arrangement is only suitable for storage that is not considered as collections. This arrangement provides only life safety and possibly building protection. A fire could spread throughout the entire compact shelving array without longitudinal or transverse dividers in the storage system. This is

unacceptable for collections.

- b. Sprinkler system
 - i. Design sprinkler system according to Factory Mutual Data Sheet 8-9 for solid-pile storage of the appropriate type.
 - 1. The minimum design criteria shall be for Class 4 commodities.
 - 2. For ceilings less than 15 ft, the minimum design criteria shall be for cartoned, expanded plastic commodities.
 - ii. Sprinkler densities will vary depending on conditions, but will be in the general range of 1 to 2 gpm/ft².
 - iii. Quick-response, 165°F sprinklers
 - iv. Maximum 10 ft x10 ft spacing.
 - v. Minimum spacing of 8 ft x 8 ft spacing.
 - vi. Hose stream allowance of 250gpm
- c. Shelving system
 - i. Steel construction, 18 ga. minimum
 - ii. No canopy tops on each compactor.
 - iii. Shelving must be at least 50% open.
 - iv. Minimum 1” spacing between compactors in the closed position. Permanent bumpers must be installed to maintain the spacing.