NFPA® 105

Standard for Smoke Door Assemblies and Other Opening Protectives

2010 Edition

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Standard for

Smoke Door Assemblies and Other Opening Protectives

2010 Edition

This edition of NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, was prepared by the Technical Committee on Fire Doors and Windows and acted on by NFPA at its June Association Technical Meeting held June 8-11, 2009, in Chicago, IL. It was issued by the Standards Council on August 6, 2009, with an effective date of August 26, 2009, and supersedes all previous editions.

This edition of NFPA 105 was approved as an American National Standard on August 26, 2009.

Origin and Development of NFPA 105

This publication is the result of a multiyear project by the Technical Committee on Fire Doors and Windows and is based on the acknowledgment that smoke is the principal killer in destructive fires. Historically, fire doors have been permitted to have such clearances and deflections as would permit the passage of relatively great quantities of smoke. Those fire doors, when properly installed, have proven to be adequate barriers against the passage of fire, but improvement was needed to protect against the passage of smoke. The first edition of the recommended practice was prepared to introduce parameters for door performance that would limit smoke spread through a door opening.

The 1993 edition was the third edition. It made use of new information that recognized that smoke-control doors in buildings protected by automatic sprinklers will have substantially lower pressures created by a potential fire.

The 1999 edition included modifications to address the pressure differentials caused by stack effect in elevator hoistways.

The 2003 edition incorporated formatting updates to comply with the *Manual of Style for NFPA Technical Committee Documents* requirements, as well as formatting requirements for conversion from a recommended practice to a standard. The 2003 edition also included significant modifications to Chapter 4 on installation and testing requirements, and Chapter 5 on maintenance requirements. Annex A contained a considerable amount of new and updated information.

The 2007 edition included the expansion of the scope of the document to include smoke dampers. The title of the document was revised, and new chapters on the installation, inspection, testing, and maintenance of smoke dampers were provided. Other technical changes addressed the retention of maintenance records for smoke door assemblies.

The 2010 edition includes modifications to smoke damper inspection and testing requirements. The title of the document has also been revised.

Technical Committee on Fire Doors and Windows

Bruce G. Campbell, *Chair*
Hughes Associates, Inc., CO [SE]

Calvin A. Banning, AREVA NP, Inc., TX [SE]
Robert M. Berhinig, Underwriters Laboratories Inc., IL [RT]
Daniel R. Bernacki, International Door Association, OH [IM]
David S. Cha, Northwestern Memorial Hospital, IL [U]
Paul R. Coleman, Sisters of Providence Health Care System, OR [U]
Rep. NFPA Health Care Section
William Conner, Bill Conner Associates LLC, IL [SE]
Rep. American Society of Theater Consultants
Jerrold S. Gorrell, Theatre Safety Programs, AZ [IM]
Rep. U.S. Institute for Theatre Technology
Jeffrey E. Gould, FM Approvals/FM Global, MA [I]
Steven C. Hahn, Lawrence Roll-Up Doors, Inc., CA [M]
Rep. Door & Access Systems Manufacturers Association International
Harold D. Hicks, Jr., Atlantic Code Consultants, PA [SE]
Wayne D. Holmes, HSB Professional Loss Control, NC [I]
Thomas R. Janicak, Ceco Door Products, IL [M]
Rep. Steel Door Institute
William E. Koffel, Koffel Associates, Inc., MD [M]
Rep. Glazing Industry Code Committee
Nancy L. Kokesh, Intertek Testing Services, NA Inc., WI [RT]
Keith E. Pardoe, Door and Hardware Institute, VA [M]
Vernon J. Patton, First Energy Corporation, OH [U]
Steven P. Reynolds, The Peelle Company Ltd., Canada [M]
Rep. National Elevator Industry Inc.
(VL to Issue: Elevators)
Ronald Rispoli, Entergy Corporation, AR [U]
Thomas A. Salamone, AKF Engineers, NY [SE]
David A. San Paolo, The Maiman Company, MO [M]
Rep. Window & Door Manufacturers Association
Michael L. Savage, Sr., Middle Department Inspection Agency, Inc., MD [E]
Michael Tierney, Builders Hardware Manufacturers Association, CT [M]
Robert Van Becelaere, Ruskin Manufacturing, MO [M]
Anthony W. Yuen, University of California, CA [U]

Alternates

Scott K. Anderson, FM Global, MA [I]
(Alt. to J. E. Gould)
Brian D. Black, BDBlack Codes, Inc., NY [M]
(Alt. to S. P. Reynolds)
Richard Cookson, The Cookson Company, AZ [M]
(Alt. to S. C. Hahn)
John G. Crowther, AREVA NP, Inc., TX [SE]
(Alt. to C. A. Banning)
James S. Peterkin, Heery International, PA [U]
(Alt. to P. R. Coleman)
Kurt A. Roeper, Ingersoll-Rand Security Technologies, OH [M]
(Alt. to T. R. Janicak)
Thomas M. Rubright, William S. Trimble Company, Inc., TN [M]
(Alt. to K. E. Pardoe)
Emmanuel A. Sopeju, Underwriters' Laboratories of Canada, Canada [RT]
(Alt. to R. M. Berhinig)
Garry Stewart, The Doorman Service Company, Inc., WA [IM]
(Alt. to D. R. Bernacki)
David V. Tomecek, Hughes Associates, Inc., CO [SE]
(Alt. to B. G. Campbell)
John Woestman, Window & Door Manufacturers Association, IA [M]
(Alt. to D. A. San Paolo)

Nonvoting

John G. Degenkolb, Carson City, NV
(Member Emeritus)
Joseph N. Saino, Memphis, TN [SE]
(Member Emeritus)

Kristin Collette, NFPA Staff Liaison

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the installation and maintenance of fire doors, windows, shutters, and other equipment used to restrict the spread of fire, including arrangements for automatic operation in case of fire. This includes installation to protect buildings against external fire and to restrict the spread of fire within buildings. Vault and record room doors are covered by the Technical Committee on Record Protection.

Contents

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope. This standard shall prescribe minimum requirements for smoke door assemblies for use in providing safety to life and protection of property from smoke.

1.2* Purpose. The purpose of this standard shall be to provide a means to restrict the movement of smoke through door assemblies in order to maintain a tenable environment.

1.3* Application. This standard shall regulate the installation, maintenance, and testing of smoke door assemblies.

1.3.1* This standard shall regulate smoke door assemblies that are intended to restrict the passage of smoke at temperatures up to 400°F (204°C).

1.3.2* This standard shall not regulate elevator hoistway doors.

1.4 Retroactivity. This standard is based on product and engineering practices recognized as acceptable at the date of issue. Therefore, the provisions of this standard are not intended to be applied retroactively to installations that were in compliance at the time of installation.

1.5 Equivalency.

1.5.1 This standard shall not prohibit the development of new, modified, or improved devices that meet the intent of these requirements. It shall be the responsibility of the manufacturer to furnish the information necessary to update the requirements pertaining to such new and improved devices.

1.5.2 For devices not described in this standard, the authority having jurisdiction shall request descriptive information from manufacturers that is provided by a testing laboratory concerning acceptable methods for satisfactory field installation based on fire tests and engineering studies for operation and maintenance considerations, where applicable.

Chapter 2 Referenced Publications

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

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

NFPA 72®, National Fire Alarm and Signaling Code, 2010 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2010 edition.

NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences,* 2009 edition.

2.3 Other Publications.

2.3.1 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 1784, *Air Leakage Tests of Door Assemblies*, 2004.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces,* 2009 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic in-

spection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

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

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

3.3 General Definitions.

3.3.1 Smoke Damper. A device within an air distribution system to control the movement of smoke.

3.3.1.1 ***Combination Fire/Smoke Damper.*** A device that meets both the fire damper and smoke damper requirements.

3.3.2 Smoke Door. The door component of a smoke door assembly.

3.3.3 Smoke Door Assembly. Any combination of a door, frame, hardware, and any other accessories that together restrict smoke movement through door openings by limiting the amount of air that can pass through the assembly.

3.3.4 Temperature.

3.3.4.1 ***Ambient Temperature.*** An assumed air temperature at the exposed face of the door at or near 75°F (24°C).

3.3.4.2* ***Elevated Temperature.*** An assumed air temperature at the exposed face of the door in excess of ambient temperature.

3.3.5 Tenable Environment. An environment in which the products of combustion, including toxic gases, particulates, and heat, are limited or otherwise restricted to maintain the impact on occupants to a level that is not life threatening. [**92B,** 2009]

Chapter 4 Testing and Installation

4.1 General. This chapter shall cover the requirements for testing and installation of smoke door assemblies.

4.1.1 Fire door assemblies that are intended for use as smoke door assemblies shall also comply with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

4.1.2 Doors without fire protection ratings shall be permitted to be used as smoke doors in door openings not required to be protected by fire doors.

4.1.3 Doors without fire protection ratings shall comply with this standard.

4.2 Test Specimen.

4.2.1 The size of the door to be tested shall be 3 ft × 7 ft (0.9 m × 2.1 m) for a single side-hinged swinging door, and 6 ft × 7 ft (1.8 m × 2.1 m) for a pair of side-hinged swinging doors and all other doors, or shall be representative of the full range of smoke door production for that type of construction as determined by the testing laboratory.

4.2.2 For the air leakage test, fire door assemblies shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

4.2.2.1 Clearances for doors without a fire protection rating shall be in accordance with the manufacturer's specifications.

4.2.3* Doors intended for installation in frames containing transoms, side lights, or side panels shall be tested with such frames.

4.2.4 Specimens of door assemblies shall be tested as they are intended to be installed.

4.3 Air Leakage Test.

4.3.1* Smoke door assemblies shall have an air leakage rating not greater than 3 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) of door opening when tested in accordance with ANSI/UL 1784, *Air Leakage Tests of Door Assemblies.*

4.3.2 Smoke door assemblies intended to be installed where pressurization is provided to control smoke movement shall not have an artificial bottom seal installed during the test.

4.3.3* Where data exists to verify that tests at ambient temperature result in a higher leakage rate, additional tests at elevated temperature shall not be required.

4.3.4* The test shall only be required to be performed at a pressure differential of 0.1, 0.2, or 0.3 ± 0.005 in. of water (25, 50, or 75 ± 1.25 Pa).

4.4 Labeling. Smoke door assemblies shall bear an "S" label indicating a maximum air leakage rate of 3 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) and the tested pressure differential of 0.1, 0.2, or 0.3 in. of water (25, 50, or 75 Pa).

4.5 Installation.

4.5.1 Smoke doors shall be self-closing or automatic closing in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

4.5.2 Automatic closing smoke door assemblies shall be activated by smoke detection installed in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

4.5.3 Devices for the release of smoke doors shall be permitted to be part of an overall system, such as a fire alarm or an automatic extinguishing system, that shall release the door and shall be installed and tested in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

4.5.4 Fixed sealed transoms, side lights, side panels, or door vision lights shall be permitted in listed assemblies without additional testing.

4.5.5 Transoms, side lights, side panels, or door vision panels that are not fixed and sealed shall be installed in accordance with the smoke door listing.

4.5.6 The opening between the bottom edge of the smoke door and the sill when the door is in the closed position shall not be required to be provided with a means to seal the opening.

4.5.6.1 Smoke door assemblies installed where pressurization is provided to restrict smoke movement shall be required to have a bottom seal.

4.5.7 Louvers shall not be installed in smoke door assemblies unless otherwise tested and listed.

Chapter 5 Maintenance

5.1 General. This chapter shall cover the care and maintenance of smoke door assemblies.

5.1.1 Removal of Smoke Doors. Where a door or opening is no longer in use, the opening shall be filled with construction equivalent to that of the wall.

5.1.2 Operability. Doors shall be operable at all times.

5.1.2.1 The doors shall be kept closed or arranged for automatic closing.

5.1.2.2 Where required, the doors shall be latched.

5.1.3 Replacement. Where it is necessary to replace all or part of a smoke door assembly, replacement components shall be installed to meet the requirements of this standard and the manufacturer's instructions.

5.1.4* Repairs. Damage and impairments to smoke door assemblies shall be corrected.

5.1.4.1 Damaged glazing material shall be replaced.

5.1.4.2 Replacement glazing material shall be installed in accordance with its individual listing, where required, and the manufacturer's listing.

5.1.4.3 When holes are left in a door or frame due to changes or removal of hardware or plant-ons, the holes shall be repaired by either of the following methods:

(1) Installation of steel fasteners that completely fill the holes
(2) Filling of the screw or bolt holes with the same material as the door or frame

5.2 Specific Requirements.

5.2.1* Inspections.

5.2.1.1 Smoke door assemblies shall be inspected annually.

5.2.1.2 Doors shall be operated to confirm full closure.

5.2.1.3 Hardware and gaskets shall be inspected annually, and any parts found to be damaged or inoperative shall be replaced.

5.2.1.4 Tin clad and Kalamein doors shall be inspected regularly for dry rot.

5.2.1.5 A written record shall be maintained and shall be made available to the authority having jurisdiction.

5.2.1.6 Records shall be maintained for not less than 3 years.

5.2.2 Prevention of Door Blockage.

5.2.2.1 Door openings and the surrounding areas shall be kept clear of anything that could obstruct or interfere with the free operation of the door.

5.2.2.2 Blocking or wedging of doors in the open position shall be prohibited.

5.2.3 Maintenance of Closing Mechanisms.

5.2.3.1 Self-closing and automatic closing devices shall be kept in working condition at all times.

5.2.3.2 Care shall be taken to prevent paint accumulation on any movable parts such as, but not limited to, stay rolls, gears, and closing mechanisms.

Chapter 6 Installation, Testing, and Maintenance of Smoke Dampers

6.1* General. This chapter covers the requirements of the installation, testing, and maintenance of smoke dampers and combination fire and smoke dampers.

6.2 Definitions.

6.2.1 Smoke Damper. A device within an air distribution system to control the movement of smoke.

6.2.2 Combination Fire/Smoke Damper. A device that meets both the fire damper and smoke damper requirements.

6.3 Installation.

6.3.1 Dampers.

6.3.1.1 Smoke dampers shall be installed within 24 in. (610 mm) of the partition and before any branch line or opening other than access panel and shall be installed in accordance with the manufacturer's installation instructions and the listing.

6.3.1.2 Damper actuator and linkage to operate the smoke damper shall be supplied and installed at the factory.

6.3.2 Dampers equipped with fusible links and/or internal operators shall be provided with an access door that is not less than 12 in.^{2} (7742 mm^2) or provided with a removable duct section.

6.3.2.1 Dampers that are installed behind registers, diffusers, or grilles shall be serviceable by removal of these covers.

6.3.2.2 A smoke damper access panel shall be labeled with the words "Smoke Damper" in letters not less than 1 in. (25.4 mm) in height. External insulation shall not conceal any access panel unless there is a label attached to the insulation clearly indicating the exact location of the access panel and the insulation is installed for ease of removal or ease of removal with the access panel.

6.3.2.3 Unobstructed access shall be provided through a ceiling or wall for inspection and service of the damper's working parts.

6.3.2.4 Installation of combination fire/smoke dampers shall be in accordance with the installation of fire dampers in NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, Section 19.2.

6.3.2.5 Smoke detectors used to control smoke dampers or fire/smoke dampers shall be spaced and installed per the requirements of *NFPA 72, National Fire Alarm and Signaling Code.*

6.4 Operational Test.

6.4.1 Smoke and Combination Fire/Smoke Dampers. An operational test shall be conducted after the building's HVAC system has been balanced.

6.4.1.1 The test shall be adequate to determine that the damper has been installed and functions as intended.

6.4.1.2 The operational test shall be conducted under normal HVAC airflow conditions as well as static flow conditions. The damper shall fully close/seal under both test conditions.

6.4.1.3 The operational test shall verify that there are no obstructions to the operation of the dynamic combination damper.

6.4.1.4 The operational test shall verify that there is full and unobstructed access to the dynamic combination damper and all appurtenances.

6.4.1.5 All indicating devices shall be verified to work properly and report to the intended location.

6.4.1.6 Combination fire/smoke dampers shall also meet the testing requirements contained in NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, Section 19.3.

6.5 Periodic Inspection and Testing.

6.5.1 Smoke dampers for dedicated and non-dedicated smoke control systems shall be inspected and tested in accordance with NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*.

6.5.2* Each damper shall be tested and inspected one year after installation. The test and inspection frequency shall then be every 4 years, except in hospitals, where the frequency shall be every 6 years.

6.5.3 Care shall be exercised that all tests are completed in a safe manner wearing the appropriate personal protective equipment.

6.5.4 Full unobstructed access to the damper shall be verified and corrected as required.

6.5.5 Where a fusible link is installed on a combination fire/smoke damper, the fusible link shall be removed for testing the damper for full closure simulating a fire condition per the requirements and frequencies of 19.5.4 of NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

6.5.6 The test shall be conducted with normal HVAC airflow.

6.5.7 The operation of the damper shall verify that there is no damper interference due to rust or bent, misaligned, or damaged frame or blades, or defective hinges or other moving parts.

6.5.8 The damper frame shall not be penetrated by any foreign objects that would affect proper fire damper operations.

6.5.9 The damper shall be verified to not be blocked from closure in any way.

6.5.10 The fusible link shall be reinstalled after testing is complete. If the link is damaged or painted, it shall be replaced with a link of the same size, temperature rating, and load rating.

6.5.11 All inspections and testing shall be documented indicating the location of the damper, date of inspection, name of inspector, and deficiencies discovered. The documentation shall have a space to indicate when and how the deficiencies were corrected.

6.5.12 All documentation shall be maintained by the property owner and available for review by the authority having jurisdiction.

6.6 Maintenance.

6.6.1 Any reports of abrupt changes in airflow or noise from the duct system shall be investigated to verify that it is not related to damper operation.

6.6.2* All exposed moving parts of the damper shall be dry lubricated as required by the manufacturer.

6.6.3 If the damper is not operable, repairs shall begin as soon as possible.

6.6.4 Following any repairs, the damper shall be tested for proper operation in accordance with Section 6.5.

6.6.5 Smoke damper actuation shall be initiated at a time interval recommended by the actuator manufacturer.

6.6.6 All maintenance shall be documented and records shall be retained in accordance with 6.5.11 and 6.5.12.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.2 For the purposes of this standard, smoke can be considered to be airborne particulates and gases resulting from combustion. Therefore, to understand smoke movement it is only necessary to understand air movement. Hot smoke, however, will be buoyant and will be located above the neutral plane in the fire compartment. As it moves away from the fire source, it will cool, lose its buoyancy, and become less stratified. Beyond the immediate influence of the fire, smoke will behave just as warm or cool air would behave. It will be driven by pressure differentials within the building, or it will follow air currents created by the heating, ventilating, and air-conditioning (HVAC) system or smoke management system in the building. Pressure differentials can be the result of the following:

(1) Fire pressure buildup, which would only drive the smoke out of the compartment or area of origin
(2) Stack effect due to temperature differentials between the interior and exterior of the building
(3) Wind
(4) Pressures created mechanically using HVAC systems, exhaust fans, supply or pressurization fans, vents, and smoke management systems

This standard has its beginnings in measurements from test results reported in *Operation School Burning* and from NFPA Technical Paper No. 341, "Factors in Controlling Smoke in High Buildings," where tenable or tolerable smoke concentration lists were established. Since the publication of *Operation School Burning* in 1959, considerable effort in the field of fire protection has been focused upon smoke movement in the built environment. NFPA *101*, *Life Safety Code*, and NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, recognize that smoke control can be either active or passive. The passive approach recognizes the long-standing compartmentation concept, which requires that fans shut down and fire/smoke dampers in ductwork close under fire conditions. The active approach utilizes the building's HVAC systems to create differential pressures to prevent smoke migration from the fire area and to exhaust the products of combustion to the outside. Active smoke-control systems use

passive barrier components that include smoke door assemblies to create zones or areas for effective smoke movement as an essential component.

Smoke management utilizing active and passive methods in combination to modify smoke movement must be engineered into a system and focused on protection of property or people. While passive methods of smoke management do exist *(see* NFPA 204, *Standard for Smoke and Heat Venting),* dynamic smoke-control systems using mechanical equipment to meet design goals dominate. NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*, provides methodologies for determining smoke development in large spaces. NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, is used for the design, installation, testing, operation, and maintenance of systems for smoke control.

Smoke door assemblies are intended to maintain egress, allow for the rescue of the occupants, or allow occupants to remain in an area of refuge. The required duration of smoke protection can be equated with the path of egress. Evacuation typically starts in a room, progresses through a corridor, perhaps passes through a smoke barrier or horizontal exit, and proceeds through an entrance to the exit, which can be a stair enclosure, exit passageway, or the exit discharge. As with fire door assemblies, the longest time of protection is generally required at the entrance to an exit enclosure or horizontal exit, with shorter durations appropriate for preceding doors.

The path of egress arrangement should also be the case with smoke door assemblies. This arrangement is compatible with the protect-in-place concept as occupants are expected to be moved from one compartment to another for protection or, in some cases, protected in rooms other than the room of fire origin.

Occupancies not typical of this scenario include atria, malls, and open office plans. Areas of this sort can be adequately protected by reasonably tight-fitting doors without specific smoke door ratings because of the large volume of space involved.

A.1.3 While the use of smoke door assemblies will be helpful in reducing the flow of airborne gases, it is not assumed that using this standard obviates the concern over toxic combustion products.

NFPA *101, Life Safety Code*, and building codes include specific requirements for smoke door assemblies and should be consulted in every instance. NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, should be followed when fire door assemblies are used as smoke door assemblies.

Consideration should be given to the leakage characteristics of adjacent wall, ceiling, and floor assemblies. It is generally considered to be of marginal benefit to install smoke door assemblies in locations where adjacent walls, ceilings, or floors do not effectively resist the passage of smoke. (For additional information, see *Principles of Smoke Management.*)

When protecting against smoke migration into spaces of large volume, a reasonably tight-fitting door can be considered adequate because of the relatively long time it would take for such a space to become untenable due to smoke. Conversely, the average 8 ft (2.4 m) high by 4 ft to 6 ft (1.2 m to 1.8 m) wide corridor can become untenable in less than 2 minutes, as shown in a test conducted in California and documented in *Operation School Burning*, where the fire room door was open.

Tests indicate that listed gaskets, if properly installed and maintained in accordance with manufacturer's instructions, do a good job of reducing the smoke infiltration to a sufficient level to provide protection against smoke infiltration through the door assembly. In a fire condition, there would normally be a room of fire origin, and temperatures would be high in this area. Immediately outside the room of origin there might be warm smoke.

A.1.3.1 Smoke door assemblies used in locations likely to be in proximity to a fire can be exposed to elevated temperatures, including door assemblies separating rooms and corridors. Such door assemblies, whether rated as fire doors or not, should restrict the passage of smoke that can be heated to a temperature of 400°F (204°C). In a fully sprinklered building, protection against elevated-temperature smoke might not be necessary, and the criteria for protection against ambient-temperature smoke might be appropriate.

Mention should be made of the effects of automatic sprinkler protection on smoke. The activation of an automatic sprinkler occurs early in a flaming fire condition, usually within approximately 5 minutes after visible flaming is observed. Temperatures immediately drop to almost ambient, and smoke is driven to the floor and diffused throughout the available space. Smoke production rate is reduced as the fire size decreases and the temperature of the flame plume is reduced. The temperature of the smoke is also reduced to near ambient. Thus, in a sprinklered building it can be appropriate to treat smoke as if it were at or near ambient temperature. Fewer mitigating measures might be needed to control smoke movement since the production rate of smoke will be reduced. However, under a smoldering fire condition, sprinkler activation can be delayed and this, too, should be considered.

Fire door assemblies protecting stair enclosures and vestibules adjacent to stair enclosures, for example, are more likely to be exposed to ambient temperature smoke, provided there are no combustible materials in the enclosure. These doors can form part of a control system involving pressurized stairwells or vestibules. The air leakage characteristics of such door assemblies are an essential part of smoke control design.

A.1.3.2 See NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, for additional information on protection of elevator openings.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at

government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.4.2 Elevated Temperature. Depending on the function of the door, its location in relation to the fire, and the movement of hot gases and air, door assemblies might be exposed to elevated smoke temperatures; warm smoke has an assumed temperature at the exposed face of the door at or near 400°F (204°C); hot smoke has an assumed temperature at the exposed face of the door in excess of 400°F (204°C). A nationally recognized standard test for measuring hot smoke temperature leakage does not exist.

It has been determined from many full-scale fire tests of compartments that the maximum instantaneous pressure differential created by an uncontrolled fire can approach 0.15 in. of water (37.5 Pa). More typically, a pressure differential of 0.06 in. of water to 0.10 in. of water (15 Pa to 25 Pa) is achieved over the period of most intense burning in light fire loading occupancies such as residential, health care, and business (offices).

In sprinklered buildings where the fire will be controlled, it is anticipated that the maximum pressure differential generated should not exceed 0.05 in. of water (12.5 Pa).

Typical stair pressurization systems can often result in pressure differentials as high as 0.25 in. of water to 0.50 in. of water (62.5 Pa to 125 Pa) across the door assembly.

Stack effect can also play a major role in determining pressure that must be overcome in order to pressurize shafts, such as elevators and stairs, to prevent smoke infiltration. Pressure differentials between the exterior and unvented shafts can range from virtually nothing to as much as 0.5 in. of water to 1.0 in. of water (125 Pa to 250 Pa) or more, depending on the location of the building neutral pressure plane, the height of the building, and the outside temperature. The ASHRAE/SFPE handbook, *Principles of Smoke Management,* addresses smoke management applications including pressurized stairwells, pressurized elevators, and pressure differentials that designers are likely to encounter.

The quantity of air movement through a door gap can be determined by the following general formula:

$$Q = KAP^{\frac{1}{N}}$$

where:

Q = volume flow rate of air
K = orifice coefficient for the gap around the door perimeter
A = area of the gap
P = pressure differential across the door
N = number between 1 and 2 that can be determined empirically

(For more information, see NFPA's *Fire Protection Handbook*.)

A.4.2.3 Hardware requiring extensive door mortising that could provide considerable air leakage through the door panel should be tested if required by the testing laboratory.

A.4.3.1 Smoke management systems both affect and are affected by smoke door assemblies. Pressurized stair enclosures, for example, are more easily engineered when leakage through the stair doors is reduced. In other areas, pressurization can inhibit smoke flow so that reasonably tight-fitting doors unrated for smoke protection can be entirely appropriate.

Complete sealing of doors is not always desirable. A disadvantage of complete sealing is the difficulty to open or close doors because of the pressure differential. Some smoke management designs call for some areas to be pressurized. A small pressure acting across the full area of a door can exert sufficient force to make opening a door difficult. A seal must be first broken to equalize the pressure on both sides of the door before the door can be opened easily.

Smoke doors should take the entire smoke management system into account. The amount of leakage tolerable will vary according to the degree of compartmentation, whether smoke management systems are used, and whether the building is protected by sprinklers.

An engineering evaluation should be performed when the volume of the space to be protected is known so that the values can be modified to restrict smoke leakage in terms of a specified smoke tenability level. The evaluation should include, but not be limited to, fuel load, pressurization, stack effect, the presence of smoke-control systems, and construction, as well as smoke leakage, in assessing tenability.

A.4.3.3 Test data exists for certain door types demonstrating that air leakage at ambient temperature is greater than warm air temperature leakage. In such instances the air leakage rate for ambient temperature could also apply for warm temperatures when additional data tests are not conducted at elevated temperature.

A.4.3.4 Pressure differentials of at least 0.04 in. of water (10 Pa) are developed in the upper parts of rooms that are involved in fire. Considerably higher pressure differentials can exist in rooms, corridors, and stair enclosures due to the action of air-handling systems, stack effect, and wind.

In sprinklered buildings where the fire will be controlled, it is anticipated that the maximum pressure differential generated should not exceed 0.05 in. of water (12.5 Pa). See pressure differences discussed in NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, and *Principles of Smoke Management*.

A.5.1.4 Where failure of a smoke door could result in greater life risk or property damage due to fire, administrative measures should be developed to provide protection prior to repair.

A.5.2.1 Smoke doors are of no value unless they are properly maintained and are closed at the time of fire. Damage or impairments that affect the proper operation of smoke door assemblies should be corrected immediately. To ensure this, a periodic inspection and maintenance program should be implemented and should be the responsibility of the property management.

A.6.1 Smoke dampers are installed in ducts passing through or air outlet openings terminating at smoke barriers, shaft walls, horizontal exit walls, corridor walls, corridor ceilings, and other fire partitions designed to resist the spread of smoke as required by the model building code and other applicable NFPA codes and standards.

A.6.5.2 The damper may be actuated and cycled as part of the associated smoke detector testing in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

A.6.6.2 Each damper should be examined to ensure that it is not rusted or blocked, with particular attention given to hinges and other moving parts.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 72®, National Fire Alarm and Signaling Code, 2010 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2010 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2009 edition.

NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, 2009 edition.

NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*, 2009 edition.

NFPA *101®, Life Safety Code®*, 2009 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2007 edition.

Operation School Burning, Official Report on a Series of School Fire Tests Conducted April 16, 1959, to June 30, 1959, by the Los Angeles Fire Department, 1959.

NFPA *Fire Protection Handbook*, 18th edition.

NFPA Technical Paper No. 341, "Factors in Controlling Smoke in High Buildings."

B.1.2 Other Publications.

B.1.2.1 ASHRAE Publications. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329-2305.

Principles of Smoke Management, 2002.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)

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