

NFPA 105
Installation of
Smoke- and
Draft-Control
Door Assemblies
1985



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NFPA 105

Recommended Practice for the Installation of Smoke- and Draft-Control Door Assemblies

1985 Edition

This edition of NFPA 105, *Recommended Practice for the Installation of Smoke- and Draft-Control Door Assemblies*, was prepared by the Technical Committee on Fire Doors and Windows, released by the Correlating Committee on Building Construction, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 13-17, 1985 in Chicago, Illinois. It was issued by the Standards Council on July 12, 1985, with an effective date of August 2, 1985, and supersedes all previous editions.

The 1985 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 105

This recommended practice is the result of a multi-year 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 is needed to protect against the passage of smoke. This recommended practice was prepared to introduce parameters for door performance which will limit smoke spread through a door opening.

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NFPA 105

Recommended Practice for the Installation of Smoke- and Draft- Control Door Assemblies

1985 Edition

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

Information on referenced publications can be found in Chapter 4.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This recommended practice covers the use of door assemblies in openings where draft control and the passage of smoke are to be governed. Any specific known factors affecting any installations may require more stringent application of the recommendations in this recommended practice.

1-1.2 This recommended practice does not contain an assessment of toxicity. While the use of smoke-control doors will be helpful in reducing the flow of airborne gases, it is not to be assumed that using this recommended practice obviates concern over toxic materials.

1-2* **Purpose.** This recommended practice is intended to assist in the treatment of the problems associated with controlling the flow of smoke and gases through door openings in buildings.

1-3 General.

1-3.1 NFPA 101[®], *Life Safety Code*[®], and building codes include specific requirements for smoke-control door assemblies and should be consulted in every instance. NFPA 80, *Standard for Fire Doors and Windows*, should be followed when fire door assemblies are used as smoke-control doors.

1-3.2 Consideration should be given to the leakage areas of adjacent wall, ceiling and floor assemblies. It is generally considered to be of marginal benefit to install smoke-control doors in locations where adjacent walls, ceilings or floors do not effectively resist the passage of smoke. (For additional information see NBS Handbook 141, *Design of Smoke Control Systems for Buildings*.)

1-3.3 When protecting against smoke migration into spaces of large volume, a reasonably tight-fitting door may be considered adequate because of the relatively long time it would take for such a space to become smokelogged. Conversely, the average 8-ft high by 4- to 6-ft wide corridor, however, can become completely smokelogged in less than 2 minutes as shown in tests conducted in California entitled "Operation School Burning" where doors were neither tight fitting nor gasketed.

1-3.4* When referring to smoke, this recommended practice is primarily concerned with its effect on visibility.

1-3.5 The temperature of smoke at the door is of critical importance. When temperatures get high, the responses of doors and any gasketing materials or sealing systems used can have detrimental effects on the smoke-inhibiting properties of the assembly. According to studies, most gasketing materials will give good protection up to about 175°F (80°C). Some are resistant to temperatures up to about 400°F (204°C) before breakdown begins. Some intumescent materials activate upon reaching temperatures of about 250°F (121°C).

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, permits a 1¾-in. (44-mm) thick door to deflect up to 2% in. (67 mm). This is unacceptable for smoke infiltration protection. Special recommendations are made, therefore, for smoke-control doors used in locations where fire exposure and hot smoke are contemplated.

1-3.6 Smoke Temperatures.

1-3.6.1 Smoke temperatures have been described as ambient (cold), medium (warm), and high (hot). Where one term ends and the other takes effect is not completely clear. For purposes of this recommended practice, certain assumptions are made.

1-3.6.2* **Hot Smoke.** Smoke exposure where the expected temperature of the smoke will be in excess of 400°F (204°C).

1-3.6.3* **Warm Smoke.** Smoke exposure where the expected temperature of the smoke will not exceed 400°F (204°C) but will be greater than 125°F (52°C).

1-3.6.4* **Cold Smoke.** Smoke exposure where the expected temperature of the smoke will not exceed 125°F (52°C).

1-3.7 Door deflection may be a problem when dealing with hot smoke (*see 1-3.5*). Deflection may occur at various temperatures, depending upon the construction of the door. Note that fire doors in the United States and Canada are tested under neutral or even negative pressure, while in typical fires the neutral plane can be close to floor level or approximately 1/3 the room height.

1-3.8* Smoke management systems both affect and are affected by smoke-control doors. Pressurized stair enclosures, for example, are more easily engineered when leakage through the stair doors is reduced. In other areas, pressurization may inhibit smoke flow or dilute amounts of smoke so that reasonably tight-fitting doors unrated for smoke protection may be entirely appropriate.

1-3.9 Smoke-control doors should be used with the entire system taken 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.

1-3.10 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 may 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 with shorter durations appropriate for preceding doors.

This should also be the case with smoke-control doors. This 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, open office plans and industrial occupancies. Areas of this sort may be adequately protected by reasonably tight-fitting doors without specific smoke-control door ratings because of the large volume of space involved.

1-3.11 Criteria for rating smoke-control doors reflect several areas of compliance. Included are: amount of door deflection, limitation of leakage at various temperatures, protection related to specific volumes of space, and duration of protection. Practicality, however, dictates against so many variables as to make each assembly different from another. It is likely then that smoke-control door assemblies for cold and warm smoke protection will be rated on the basis of a simple air infiltration test with a requirement for some sort of on-site verification that materials used are of the same construction as those tested and the installation is appropriate.

While not covered in this recommended practice, a rating for hot smoke protection should be in connection with a fire test and under label service with an in-plant follow-up inspection service.

1-3.12* Complete sealing of doors is not always desirable. A disadvantage of complete sealing is the difficulty to open or close doors because of 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 easily opened.

1-3.13 Twenty-minute smoke- and draft-control door assemblies do not require the hose stream portion of the test called for in NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*. Some 20-minute fire door assemblies have been tested with the hose stream portion of the test. For the purposes of this document, either type of assembly is appropriate for use under Section 2-1.

Chapter 2 Guidelines

2-1 Fire Door Assemblies Used as Smoke-Control Doors.

2-1.1* The installation of fire door assemblies is covered by NFPA 80, *Standard for Fire Doors and Windows*.

2-1.2 The addition of gasketing materials is also covered by NFPA 80, *Standard for Fire Doors and Windows*.

2-1.3 If protection against hot smoke is desired, and deflection of the door during the first 20 minutes of the fire test results in a gap between the door and the frame which will prevent the door from meeting the performance criteria in Section 3-2, then a suitable sealing system or gasketing should be provided that will allow the door to meet the performance criteria.

2-1.4 If gasketing or other sealing system is used and protection against hot smoke is desired, noncombustible gasketing or a suitable sealing system which will not break down under hot smoke conditions for a 20-minute period should be furnished.

2-1.5 Gasketing, if used, should not inhibit the closing and positive latching of the door. Satisfactory closing and latching of the door should be verified after any gasketing has been installed.

2-1.6 For pairs of fire doors used for smoke-control, double egress doors (leaves swinging in opposite directions) are recommended with the use of either overlapping astragals or other tested methods which do not hinder free use of either leaf. These do not hinder the free use of either leaf and a satisfactory seal is provided.

2-1.7 Pairs of fire doors swinging in the same direction should be provided with split or compensating astragals adjusted so that closing and positive latching is not inhibited. Gasketing may also be used if the doors have been so tested. Use of a center mullion is another alternative provided the required units of exit width in the opening are maintained.

2-1.8 If automatic closing fire doors are used in lieu of self-closing fire doors, the release device should be smoke actuated. Delay on closing after actuation should not exceed 10 seconds. Where appropriate, interconnect with other fire alarm, suppression and detection systems.

2-1.9 Because louvers are normally subject to leakage, they should not be used (*see NFPA 80, Standard for Fire Doors and Windows, paragraph 1-3.2*).

2-2 Non-Fire Door Assemblies Used as Smoke-Control Doors.

2-2.1 Doors used should be substantial and may include glazing.

2-2.2 Frames used should be smoke resistant and of sufficient strength to support an operating door.

2-2.3 Non-fire doors should only be used for controlling cold and warm smoke. Non-fire doors used for controlling warm smoke should not be equipped with materials that would adversely affect the performance of the smoke-control door at temperatures less than 400°F (204°C).

2-2.4* Doors should be self-closing or automatic closing upon smoke detection.

Exception: It is recognized that some codes call for the use of 20-minute fire doors or their equivalent and waive the requirement for a door closer. These doors are still desired even though a label cannot be provided because of the omission of a required fire door assembly component. These doors are usually in room-to-corridor locations where protection against hot or warm smoke may be desired.

2-2.5 Doors should be hinged in accordance with NFPA 80, *Standard for Fire Doors and Windows*.

Exception: If double-acting doors are used, they should only be used for protection against cold smoke. Gasketing at the door edge or frame will provide a degree of smoke control.

2-2.6 Latches should be provided unless the anticipated pressures are such that the performance criteria (see Section 3-2) of the door assembly can be achieved without latching.

2-2.7 Gasketing, if used, should be of a type covered in NFPA 80, *Standard for Fire Doors and Windows*, and should not inhibit the closing and positive latching of the door. Satisfactory closing and latching of the door should be verified after any gasketing has been installed.

2-2.8 Pairs of doors should be installed in accordance with the recommendations in 2-1.6 or 2-1.7.

2-2.9 Because louvers are normally subject to leakage, they should not be used (see NFPA 80, *Standard for Fire Doors and Windows*, paragraph 1-3.2).

2-2.10 Operating transoms should not be used. Fixed solid transom panels are satisfactory.

2-2.11 Glazing should be sealed in place and be smoke tight. If glazing is used for doors described in the exception to 2-2.4, it should be wired glass labeled for fire protection and no larger than that tested in the door.

Chapter 3 Recommended Test

3-1 Air Leakage.

3-1.1* It is acknowledged that a nationally recognized test specifically related to smoke does not exist. However, it is believed that limiting door deflection and requiring a tight fit or, if necessary, using gasketing materials will do much to provide the protection desired. Testing in accordance with the test method described in ASTM E283, *Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors*, should give satisfactory results when these other factors are also considered.

3-1.2 Each side of a smoke- and draft-control door assembly should be tested in accordance with ASTM E283, *Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors*. This test procedure is based on a static pressure applied over the entire door assembly.

3-1.3 Temperature has a direct effect on pressure. When protecting against warm or hot smoke infiltration, this test method in itself may not be completely appropriate but it provides a uniform and repeatable test method. It also provides a standard evaluation of an assembly for a pressurized application.

3-2 Performance Criteria.

3-2.1* To provide reasonable levels of performance for the door application indicated, air leakage rates should not exceed the values provided in Table 3-2.1 per sq ft of door opening.

Table 3-2.1
Allowable Air Leakage

Door Installation	Draft Control (cfm/sq ft door opening)	Smoke Control ⁽²⁾ (cfm/sq ft door opening)
Room to Corridor ⁽¹⁾	5	1
Area of Refuge ⁽¹⁾	5	1
Cross-Corridor	1	2
Stair	11	5

(1) Includes elevator lobbies and similar areas.

(2) When installed for smoke control only, the bottom seal provided in the test may be omitted due to the neutral pressure plane being located in a fire condition approximately $\frac{1}{3}$ up from the bottom of the door.

3-2.2 When an engineering evaluation is performed and the volume of space to be protected is known, the values in Table 3-2.1 for smoke control may be modified to restrict smoke infiltration.

3-3 Gasketing. Gasketing material has been classified by several independent testing laboratories. Evaluations have indicated that the material investigated does not adversely affect the performance of fire doors. It should be helpful if such materials could also be evaluated according to temperature resistance. Lacking such evaluations, the manufacturer should be requested to indicate maximum temperatures under which its gasket material is effective. Resiliency, durability and cycling should be considerations.

Chapter 4 Referenced Publications

4-1 The following documents or portions thereof are referenced within this recommended practice and should be considered part of the recommendations of this document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

4-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 80-1983, *Standard for Fire Doors and Windows*

NFPA 101-1985, *Life Safety Code*

NFPA 252-1984, *Standard Methods of Fire Tests of Door Assemblies*

4-1.2 Other Publications.

4-1.2.1 ASHRAE Handbook and Product Directory - 1985 FUNDAMENTALS, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329.

4-1.2.2 ASTM E283-83, *Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors*, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

4-1.2.3 Cooper, L.Y., *The Measurement of the Smoke Leakage of Door Assemblies During Standard Fire Test Exposures*, NBSIR 80-2004, Center for Fire Research, National Bureau of Standards, and Fire Materials, Vol. 5, No. 4, p. 135, 1981.

4-1.2.4 Klote, John, et al, *Design of Smoke Control Systems for Buildings*, NBS Handbook 141, Center for Fire Research, National Bureau of Standards.

Appendix A

This Appendix is not a part of the recommendations of this NFPA document, but is included for information purposes only.

A-1-2 The Committee hopes this recommended practice will be of assistance to authorities having jurisdiction and designers of building and smoke management systems when smoke-control door assemblies are used as part of the system.

A-1-3.4 For the purposes of this recommended practice, 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 will follow air currents created by the HVAC system in the building. Pressure differentials may be the result of fire pressure buildup which would only drive the smoke out of the compartment or area of origin, stack effect due to temperature differentials between the interior and exterior of the building, wind, or mechanically created pressures using HVAC systems, exhaust fans, supply (pressurization) fans, vents, etc. Therefore, to control smoke movement a designer needs to control air movement. Leakage rates for smoke control door assemblies can be established for different pressure differentials. Quantity of air movement through a given crack length of door assembly can be determined and performance criteria established for the specific application.

A-1-3.6.2 Hot Smoke. Smoke-control doors used in locations likely to be in close proximity to any fire exposure may be exposed to hot smoke. A door, whether a fire door or not, should restrict the passage of smoke which may be heated in excess of 400°F (204°C) and door

deflection may need consideration. In a fully sprinklered building, protection against hot smoke may not be necessary and the criteria for protection against warm or cold smoke may 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 5 minutes or so after visible flaming is observed. Temperatures immediately drop to almost ambient, 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 may be appropriate to treat smoke as if it were warm or cool. Fewer mitigating measures may be taken 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.

A-1-3.6.3 Warm Smoke. Smoke barriers or horizontal exits intersecting corridors, for example, in a fire condition may be exposed to warm smoke. Since in these locations door deflection probably may not occur, protection against smoke reaching temperatures of up to 400°F (204°C) should be adequate.

A-1-3.6.4 Cold Smoke. Fire door assemblies protecting stair enclosures and vestibules adjacent to stair enclosures, for example, are more likely to be exposed to cold (ambient) smoke providing there are no combustible materials in the enclosure. As in the case of warm smoke exposure, door deflection may not be a factor and protection against smoke reaching temperatures of up to 125°F (52°C) would be appropriate.

A-1-3.8 Many factors must be taken into consideration before smoke management systems can be developed. Fire load, smoke load, rate of heat release, rate of smoke release, geometry, height of building, ambient environmental conditions, HVAC systems, exhaust systems, compartmentation, occupancy type, occupant status, means of egress, volume of spaces, and fire alarm detection system are just some of the factors that must be considered before a designer can develop a total system approach to the smoke problem. A smoke-control door assembly is only one component of a total smoke control and management system. A smoke management system can either be active or passive or a combination of both. Active systems are dynamic and generally use mechanical systems in conjunction with automatic activating devices, i.e., a smoke exhaust system. Passive systems use built-in-place barriers that do not rely on mechanical systems to function, i.e., a smoke-retardant barrier. Both types of systems may be either automatically or manually activated or a combination of both.

A-1-3.12 Door opening force is addressed in various standards on ingress for mobility-impaired people. Ease of egress is equally important. A designer of a smoke management system should be aware of the importance of door opening force and should consider pressure reducing measures such as using vestibules and equalizing pressures through the use of multiple ducts.

A-2-1.1 Latches used on 20-minute smoke- and draft-control doors should be specifically tested and listed for such use.

A-2-2.4 In such situations, it is suggested that the authority having jurisdiction require regular fire drills or staff training sessions where manual closing of the door is a high priority portion of the drill or training session.

A-3-1.1 Tentative test methods have been developed and should be considered. One such draft developed at the National Bureau of Standards' Center for Fire Research, "The Measurement of Smoke Leakage of Door Assemblies During Standard Fire Exposures," should be reviewed.

A-3-2.1 Pressure is certainly important when trying to estimate the amount of air leakage that may occur through a door assembly. The quantity of air movement through an opening can be determined by the general formula $Q = KAP^{1/N}$ where Q is the quantity of air in cfm, K is the orifice coefficient for the crack area around the door perimeter, A is the area of the crack opening in square feet, P is the pressure differential across the door in inches of water column and N is a number between 1 and 2 which can be determined empirically (see *ASHRAE Handbook and Product Directory — FUNDAMENTALS*).

It has been determined from many full-scale fire tests of compartments that the maximum instantaneous pressure difference created by an uncontrolled fire is ap-

proximately 0.15 in. of water column. More typically, a pressure difference of 0.06 - 0.10 in. of water column is achieved over the period of most intense burning in such light fire loading occupancies 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 column.

Typical stair pressurization systems may often require pressure differentials of 0.25 - 0.50 in. of water column at the furthest opening into the stair.

Stack effect may 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 differences between the exterior and unvented shafts can range from virtually nothing to as much as 0.5 - 1.0 in. of water column or more, depending on the location of the building neutral pressure plane, the height of the building and the outside temperature.

Therefore, the ANSI/ISDSI 101, *Air Infiltration Performance Standard for Insulated Steel Door Systems*, test pressure of 0.30 in. of water column may not always be appropriate in determining leakage rates of door assemblies for each design consideration. However, it does offer a standard method of leakage rate measurements upon which engineering judgment may be applied to arrive at the appropriate leakage rates for a particular situation.

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4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.
5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.
6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

- (a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and
- (b) identification of the document, paragraph of the document to which the proposal is directed, and
- (c) a statement of the problem and substantiation for the proposal, and
- (d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 Name John B. Smith Tel. No. 617-555-1212

Address 9 Seattle St., Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) Document Title: Protective Signaling Systems NFPA No. & Year NFPA 72D

b) Section/Paragraph: 2-7.1 (Exception)

2. Proposal recommends: (Check one) new text
 revised text
 deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

Delete exception.

4. Statement of Problem and Substantiation for Proposal:

A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. This Proposal is original material.
 This Proposal is not original material; its source (if known) is as follows: _____

(Note: Original material is considered to be the submitter's own idea based on or as a result of his own experience, thought, or research and, to the best of his knowledge, is not copied from another source.)

I agree to give NFPA all and full rights, including rights of copyright, in this Proposal and I understand that I acquire no rights in any publication of NFPA in which this Proposal in this or another similar or analogous form is used.

Signature

PLEASE USE SEPARATE FORM FOR EACH PROPOSAL

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