

NFPA 101®  
Life Safety Code®

2009 Edition

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

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 D.

## Chapter 1 Administration

### 1.1\* Scope.

**1.1.1 Title.** NFPA 101, *Life Safety Code*, shall be known as the *Life Safety Code*®, is cited as such, and shall be referred to herein as "this Code" or "the Code."

**1.1.2 Danger to Life from Fire.** The Code addresses those construction, protection, and occupancy features necessary to minimize danger to life from the effects of fire, including smoke, heat, and toxic gases created during a fire.

**1.1.3 Egress Facilities.** The Code establishes minimum criteria for the design of egress facilities so as to allow prompt escape of occupants from buildings or, where desirable, into safe areas within buildings.

**1.1.4 Other Fire-Related Considerations.** The Code addresses other considerations that are essential to life safety in recognition of the fact that life safety is more than a matter of egress. The Code also addresses protective features and systems, building services, operating features, maintenance activities, and other provisions in recognition of the fact that achieving an acceptable degree of life safety depends on additional safeguards to provide adequate egress time or protection for people exposed to fire.

**1.1.5\* Considerations Not Related to Fire.** The Code also addresses other considerations that, while important in fire conditions, provide an ongoing benefit in other conditions of use, including non-fire emergencies.

**1.1.6 Areas Not Addressed.** The Code does not address the following:

- (1)\* General fire prevention or building construction features that are normally a function of fire prevention codes and building codes
- (2) Prevention of injury incurred by an individual due to that individual's failure to use reasonable care
- (3) Preservation of property from loss by fire

**1.2\* Purpose.** The purpose of this Code is to provide minimum requirements, with due regard to function, for the design, operation, and maintenance of buildings and structures for safety to life from fire. Its provisions will also aid life safety in similar emergencies.

### 1.3 Application.

**1.3.1\* New and Existing Buildings and Structures.** The Code shall apply to both new construction and existing buildings and existing structures.

**1.3.2 Vehicles and Vessels.** The Code shall apply to vehicles, vessels, or other similar conveyances, as specified in Section 11.6, in which case such vehicles and vessels shall be treated as buildings.

**1.4\* Equivalency.** Nothing in this Code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this Code.

**1.4.1 Technical Documentation.** Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

**1.4.2 Approval.** The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

**1.4.3\* Equivalent Compliance.** Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this Code.

### 1.5 Units and Formulas.

**1.5.1 SI Units.** Metric units of measurement in this Code are in accordance with the modernized metric system known as the International System of Units (SI).

**1.5.2 Primary Values.** The inch-pound value for a measurement, and the SI value given in parentheses, shall each be acceptable for use as primary units for satisfying the requirements of this Code.

**1.6 Enforcement.** This Code shall be administered and enforced by the authority having jurisdiction designated by the governing authority.

## Chapter 2 Referenced Publications

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

- (3) In existing buildings, existing outside stairs serving three or fewer adjacent stories, including the story where the exit discharges, shall be permitted to be unprotected where there is a remotely located second exit.
- (4) The fire resistance rating of a separation extending 10 ft (3050 mm) from the stairs shall not be required to exceed 1 hour where openings have a minimum ¾-hour fire protection rating.
- (5) Outside stairs in existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to be unprotected.

**7.2.2.6.3.2** Wall construction required by 7.2.2.6.3.1 shall extend as follows:

- (1) Vertically from the finished ground level to a point 10 ft (3050 mm) above the topmost landing of the stairs or to the roofline, whichever is lower
- (2) Horizontally for not less than 10 ft (3050 mm)

**7.2.2.6.3.3** Roof construction required by 7.2.2.6.3.1 shall meet the following criteria:

- (1) It shall provide protection beneath the stairs.
- (2) It shall extend horizontally to each side of the stair for not less than 10 ft (3050 mm).

**7.2.2.6.4 Protection of Openings.** All openings below an outside stair shall be protected with an assembly having a minimum ¾-hour fire protection rating as follows:

- (1) Where located in an enclosed court (*see 3.3.46.1*), the smallest dimension of which does not exceed one-third its height
- (2) Where located in an alcove having a width that does not exceed one-third its height and a depth that does not exceed one-fourth its height

**7.2.2.6.5\* Water Accumulation.** Outside stairs and landings, other than existing outside stairs and landings, shall be designed to minimize water accumulation on their surfaces.

**7.2.2.6.6 Openness.** Outside stairs, other than existing outside stairs, shall be not less than 50 percent open on one side. Outside stairs shall be arranged to restrict the accumulation of smoke.

### 7.2.3 Smokeproof Enclosures.

**7.2.3.1 General.** Where smokeproof enclosures are required in other sections of this *Code*, they shall comply with 7.2.3, unless they are approved existing smokeproof enclosures.

**7.2.3.2 Performance Design.** An appropriate design method shall be used to provide a system that meets the definition of *smokeproof enclosure* (*see 3.3.239*). The smokeproof enclosure shall be permitted to be created by using natural ventilation, by using mechanical ventilation incorporating a vestibule, or by pressurizing the stair enclosure.

**7.2.3.3 Enclosure.** A smokeproof enclosure shall be enclosed from the highest point to the lowest point by barriers having 2-hour fire resistance ratings. Where a vestibule is used, it shall be within the 2-hour-rated enclosure and shall be considered part of the smokeproof enclosure.

**7.2.3.4 Vestibule.** Where a vestibule is provided, the door opening into the vestibule shall be protected with an approved fire door assembly having a minimum 1½-hour fire protection rating, and the fire door assembly from the vestibule to the

smokeproof enclosure shall have a minimum 20-minute fire protection rating. Door leaves shall be designed to minimize air leakage and shall be self-closing or shall be automatic-closing by actuation of a smoke detector within 10 ft (3050 mm) of the vestibule door opening. New door assemblies shall be installed in accordance with NFPA 105, *Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives*.

**7.2.3.5 Discharge.** Every smokeproof enclosure shall discharge into a public way, into a yard or court having direct access to a public way, or into an exit passageway. Such exit passageways shall be without openings, other than the entrance to the smokeproof enclosure and the door opening to the outside yard, court, or public way. The exit passageway shall be separated from the remainder of the building by a 2-hour fire resistance rating.

**7.2.3.6 Access.** For smokeproof enclosures other than those consisting of a pressurized enclosure complying with 7.2.3.9, access to the smokeproof enclosure shall be by way of a vestibule or by way of an exterior balcony.

**7.2.3.7 Natural Ventilation.** Smokeproof enclosures using natural ventilation shall comply with 7.2.3.3 and the following:

- (1) Where access to the enclosure is by means of an open exterior balcony, the door assembly to the enclosure shall have a minimum 1½-hour fire protection rating and shall be self-closing or shall be automatic-closing by actuation of a smoke detector.
- (2) Openings adjacent to the exterior balcony specified in 7.2.3.7(1) shall be protected in accordance with 7.2.2.6.4.
- (3) Every vestibule shall have a net area of not less than 16 ft<sup>2</sup> (1.5 m<sup>2</sup>) of opening in an exterior wall facing an exterior court, yard, or public space not less than 20 ft (6100 mm) in width.
- (4) Every vestibule shall have a minimum dimension of not less than the required width of the corridor leading to it and a dimension of not less than 6 ft (1830 mm) in the direction of travel.

**7.2.3.8 Mechanical Ventilation.** Smokeproof enclosures using mechanical ventilation shall comply with 7.2.3.3 and the requirements of 7.2.3.8.1 through 7.2.3.8.4.

**7.2.3.8.1** Vestibules shall have a dimension of not less than 44 in. (1120 mm) in width and not less than 6 ft (1830 mm) in the direction of travel.

**7.2.3.8.2** The vestibule shall be provided with not less than one air change per minute, and the exhaust shall be 150 percent of the supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate tightly constructed ducts used only for such purposes. Supply air shall enter the vestibule within 6 in. (150 mm) of the floor level. The top of the exhaust register shall be located not more than 6 in. (150 mm) below the top of the trap and shall be entirely within the smoke trap area. Door leaves, when in the open position, shall not obstruct duct openings. Controlling dampers shall be permitted in duct openings if needed to meet the design requirements.

**7.2.3.8.3** To serve as a smoke and heat trap and to provide an upward-moving air column, the vestibule ceiling shall be not less than 20 in. (510 mm) higher than the door opening into the vestibule. The height shall be permitted to be decreased where justified by engineering design and field testing.

**7.2.3.8.4** The stair shall be provided with a damped relief opening at the top and supplied mechanically with sufficient

air to discharge at least 2500 ft<sup>3</sup>/min (70.8 m<sup>3</sup>/min) through the relief opening while maintaining a positive pressure of not less than 0.10 in. water column (25 N/m<sup>2</sup>) in the stair, relative to the vestibule with all door leaves closed.

#### 7.2.3.9 Enclosure Pressurization.

**7.2.3.9.1\*** Smokeproof enclosures using pressurization shall use an approved engineered system with a design pressure difference across the barrier of not less than 0.05 in. water column (12.5 N/m<sup>2</sup>) in sprinklered buildings, or 0.10 in. water column (25 N/m<sup>2</sup>) in nonsprinklered buildings, and shall be capable of maintaining these pressure differences under likely conditions of stack effect or wind. The pressure difference across door openings shall not exceed that which allows the door leaves to begin to be opened by a force of 30 lbf (133 N) in accordance with 7.2.1.4.5.

**7.2.3.9.2** Equipment and ductwork for pressurization shall be located in accordance with one of the following specifications:

- (1) Exterior to the building and directly connected to the enclosure by ductwork enclosed in noncombustible construction
- (2) Within the enclosure with intake and exhaust air vented directly to the outside or through ductwork enclosed by a 2-hour fire-resistive rating
- (3) Within the building under the following conditions:
  - (a) Where the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by a 2-hour fire-resistive rating
  - (b) Where the building, including the enclosure, is protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7, and the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by not less than a 1-hour fire-resistive rating

**7.2.3.9.3** In all cases specified by 7.2.3.9.2(1) through (3), openings into the required fire resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire protection-rated devices in accordance with 8.3.4.

#### 7.2.3.10 Activation of Mechanical Ventilation and Pressurized Enclosure Systems.

**7.2.3.10.1** For both mechanical ventilation and pressurized enclosure systems, the activation of the systems shall be initiated by a smoke detector installed in an approved location within 10 ft (3050 mm) of each entrance to the smokeproof enclosure.

**7.2.3.10.2** The required mechanical system shall operate upon the activation of the smoke detectors specified in 7.2.3.10.1 and by manual controls accessible to the fire department. The required system also shall be initiated by the following, if provided:

- (1) Waterflow signal from a complete automatic sprinkler system
- (2) General evacuation alarm signal (*see* 9.6.3.6)

**7.2.3.11 Door Leaf Closers.** The activation of an automatic-closing device on any door leaf in the smokeproof enclosure shall activate all other automatic-closing devices on door leaves in the smokeproof enclosure.

**7.2.3.12 Emergency Power Supply System (EPSS).** Power shall be provided as follows:

- (1) A Type 60, Class 2, Level 2 EPSS for new mechanical ventilation equipment shall be provided in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*.
- (2) A previously approved existing standby power generator installation with a fuel supply adequate to operate the equipment for 2 hours shall be permitted in lieu of 7.2.3.12(1).
- (3) The generator shall be located in a room separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.

**7.2.3.13 Testing.** Before the mechanical equipment is accepted by the authority having jurisdiction, it shall be tested to confirm that it is operating in compliance with the requirements of 7.2.3. All operating parts of the system shall be tested semiannually by approved personnel, and a log shall be kept of the results.

#### 7.2.4 Horizontal Exits.

##### 7.2.4.1 General.

**7.2.4.1.1** Where horizontal exits are used in the means of egress, they shall conform to the general requirements of Section 7.1 and the special requirements of 7.2.4.

**7.2.4.1.2\*** Horizontal exits shall be permitted to be substituted for other exits where the total egress capacity and the total number of the other exits (stairs, ramps, door openings leading outside the building) is not less than half that required for the entire area of the building or connected buildings, and provided that none of the other exits is a horizontal exit, unless otherwise permitted by 7.2.4.1.3.

**7.2.4.1.3** The requirement of 7.2.4.1.2 shall not apply to the following:

- (1) Health care occupancies as otherwise provided in Chapters 18 and 19
- (2) Detention and correctional occupancies as otherwise provided in Chapters 22 and 23

##### 7.2.4.2 Fire Compartments.

**7.2.4.2.1** Every fire compartment for which credit is permitted in connection with a horizontal exit(s) also shall have at least one additional exit, but not less than 50 percent of the required number and capacity of exits, that is not a horizontal exit, unless otherwise provided in 7.2.4.2.1.2.

**7.2.4.2.1.1** Any fire compartment not having an exit leading outside shall be considered as part of an adjoining compartment with an exit leading to the outside.

**7.2.4.2.1.2** The requirement of 7.2.4.2.1 shall not apply to the following:

- (1) Health care occupancies as otherwise provided in Chapters 18 and 19
- (2) Detention and correctional occupancies as otherwise provided in Chapters 22 and 23

**7.2.4.2.2** Every horizontal exit for which credit is permitted shall be arranged so that there are continuously available paths of travel leading from each side of the exit to stairways or other means of egress leading to outside the building.

**7.2.4.2.3** Wherever either side of a horizontal exit is occupied, the door leaves used in connection with the horizontal

**NFPA 92A****Standard for****Smoke-Control Systems Utilizing Barriers  
and Pressure Differences****2006 Edition**

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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 G. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

**Chapter 1 Administration**

**1.1 Scope.** This standard shall apply to the design, installation, acceptance testing, operation, and ongoing periodic testing of dedicated and nondedicated smoke-control systems.

**1.2 Purpose.**

**1.2.1** The purpose of this standard shall be to establish requirements for smoke-control systems that use pressure differences across barriers to accomplish one or more of the following:

- (1) Inhibit smoke from entering stairwells, means of egress, smoke refuge areas, elevator shafts, or similar areas
- (2) Maintain a tenable environment in smoke refuge areas and means of egress during the time required for evacuation
- (3) Inhibit the migration of smoke from the smoke zone
- (4) Provide conditions outside the smoke zone that enable emergency response personnel to conduct search and rescue operations and to locate and control the fire
- (5) Contribute to the protection of life and to the reduction of property loss

**1.2.2** The requirements specifying the conditions under which a smoke-control system shall be provided are addressed by other codes and standards.

**1.3 Application.**

**1.3.1** This standard shall apply to dedicated and nondedicated smoke-control systems using pressure differences to inhibit smoke movement.

**1.3.2\*** This standard shall not apply to smoke-control systems using airflow to inhibit smoke movement, nor shall it apply to passive systems for smoke and heat venting.

**1.3.3\*** The requirements for standby power are outside the scope of this document.

**1.4 Retroactivity.**

**1.4.1** Unless otherwise noted, it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this document.

**1.4.2** In those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or property, retroactive application of the provisions of this document shall be permitted.

**1.4.3** Where a smoke-control system is being altered, extended, or renovated, the requirements of this standard shall apply only to the work being undertaken.

**1.4.4** Verification is required to assure that new or modified systems do not adversely affect the performance of existing smoke-control systems.

**1.5 Equivalency.** Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

**1.5.1** Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

**1.5.2** The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

**1.6 Units and Formulas. (Reserved)****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 70, *National Electrical Code*<sup>®</sup>, 2005 edition.

NFPA 72<sup>®</sup>, *National Fire Alarm Code*<sup>®</sup>, 2002 edition.

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

NFPA 101<sup>®</sup>, *Life Safety Code*<sup>®</sup>, 2006 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2005 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2006 edition.

**2.3 Other Publications.**

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

UL 555S, *Standard for Smoke Dampers*, 2002.

**2.3.2 Other Publication.**

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

### 5.3 Stairwell Pressurization Systems.

**5.3.1\* General.** The pressure difference between the smoke zone and the stairwell shall be as follows:

- (1) Not less than the minimum pressure difference specified in 5.2.1
- (2) Not greater than the maximum pressure difference specified in 5.2.2 with the number of doors between zero and the design number of doors open

#### 5.3.2 Location of Supply Air Source.

**5.3.2.1** The stairwell pressurization system design shall limit smoke from entering the stairwell through the pressurization fan intake.

**5.3.2.2\*** The supply air intake shall be separated from all building exhausts, outlets from smoke shafts and roof smoke and heat vents, open vents from elevator shafts, and other building openings that might expel smoke from the building in a fire.

#### 5.3.3 Supply Air Fans.

**5.3.3.1\* Propeller Fans.** Roof or exterior wall-mounted propeller fans shall be permitted to be used in single-injection systems, provided that wind shields are provided for the fan.

**5.3.3.2 Other Types of Fans.** Centrifugal or in-line axial fans shall be permitted to be used in single- or multiple-injection systems.

#### 5.3.4\* Single- and Multiple-Injection Systems.

##### 5.3.4.1 Single-Injection Systems.

**5.3.4.1.1\*** The air injection point for a single-injection system shall be permitted to be located at any location within the stairwell.

**5.3.4.1.2\*** Design analysis shall be performed for all single-bottom-injection systems and for all other single-injection systems for stairwells in excess of 100 ft (30.5 m) in height.

**5.3.4.2\* Multiple-Injection Systems.** For system designs with injection points more than three stories apart, a design analysis shall be performed to ensure that loss of pressurization air through open doors does not lead to stairwell pressurization below the minimum design pressure.

##### 5.3.5 Vestibules.

**5.3.5.1\*** Vestibules shall not be required but shall be permitted as part of the building smoke-control system.

**5.3.5.2\*** Where vestibules are provided, either pressurized or nonpressurized vestibules shall be permitted.

##### 5.3.6\* Doors.

**5.3.6.1** Doors located in smoke barriers shall be self-closing or shall be arranged to close automatically upon the activation of the smoke-control system.

**5.3.6.2\*** Stairwell pressurization systems shall be designed to achieve the required pressure difference with a single door open to the interior of the building.

**5.4\* Elevator Smoke Control.** Where elevator smoke control is required, a separate zone shall be established.

#### 5.5\* Zoned Smoke Control.

##### 5.5.1 Smoke-Control Zones.

**5.5.1.1** When zoned smoke control is to be used, the building shall be divided into smoke-control zones, with each zone separated from the others by smoke barriers.

**5.5.1.1.1\*** A smoke-control zone shall be permitted to consist of one or more floors.

**5.5.1.1.2** A floor shall be permitted to consist of one or more smoke-control zones.

**5.5.1.2** The zoned smoke-control system shall be designed such that when zoned smoke control is active, the pressure differences between the adjacent non-smoke zones and the smoke zone meet or exceed the minimum design pressure differences given in 5.2.1, and at locations with doors, the pressure difference shall not exceed the values given in 5.2.2.

#### 5.5.2 Smoke Zone Exhaust.

**5.5.2.1** The smoke zone exhaust shall discharge to the outside of the building.

**5.5.2.2** The smoke zone exhaust shall be permitted to be either mechanical or natural ventilation.

**5.5.2.3** Design of the smoke zone exhaust system shall include an engineering analysis of the stack and wind effects.

#### 5.6\* Smoke Refuge Areas.

**5.6.1** A non-smoke zone of a zoned smoke-control system shall be permitted to be used as an area intended to protect occupants for the period of time needed for evacuation or to provide a smoke refuge area.

**5.6.2** For areas of refuge adjacent to stairwells or elevators, provisions shall be made to prevent the loss of pressure or excessive pressures due to the interaction between the smoke refuge area smoke control and the shaft smoke control.

**5.7\* Combination of Systems.** Smoke-control systems shall be designed such that where multiple smoke-control systems operate simultaneously, each system will meet its individual design objectives.

## Chapter 6 Building Equipment and Controls

**6.1 General.** Equipment and controls used for smoke-control purposes shall be in accordance with Chapter 6.

#### 6.2\* Heating, Ventilating, and Air-Conditioning (HVAC) Equipment.

**6.2.1 General.** HVAC equipment used for smoke-control purposes shall be permitted to be located within the conditioned space, within adjacent spaces, or within remote mechanical equipment rooms.

**6.2.2 Outside Air.** HVAC systems used for smoke-control purposes shall be provided with outside air for pressurization.

**6.2.3** Where supply and return air systems are interconnected as part of normal HVAC operation, smoke dampers shall be provided to separate the supply and exhaust during smoke-control operation.

**6.3 Smoke Dampers.** Smoke dampers used to protect openings in smoke barriers or used as safety-related dampers in engineered smoke-control systems shall be listed and labeled in accordance with UL 555S, *Standard for Smoke Dampers*.

#### 6.4 Controls.

**6.4.1 Coordination.** A single control system shall coordinate the smoke-control functions provided by the fire alarm system,

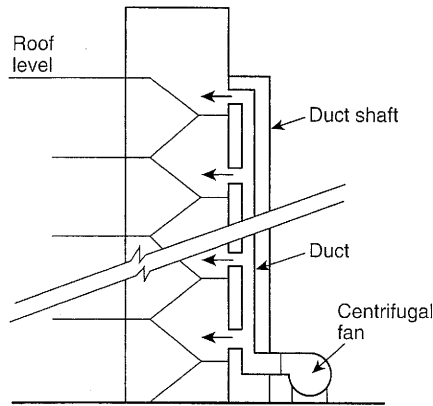


FIGURE A.5.3.4(a) Stairwell Pressurization by Multiple Injection with the Fan Located at Ground Level.

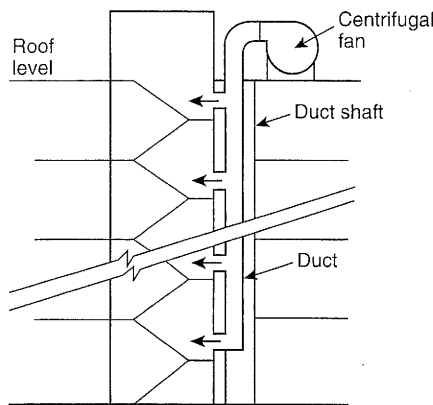


FIGURE A.5.3.4(b) Stairwell Pressurization by Multiple Injection with Roof-Mounted Fan.

In Figure A.5.3.4(a) and Figure A.5.3.4(b), the supply duct is shown in a separate shaft. However, systems have been built that have eliminated the expense of a separate duct shaft by locating the supply duct in the stair enclosure itself. Care should be taken so that the duct does not reduce the required exit width or become an obstruction to orderly building evacuation.

**A.5.3.4.1.1** The most common injection point is at the top of the stairwell, as illustrated in Figure A.5.3.4.1.1.

**A.5.3.4.1.2** Single-injection systems can fail when a few doors are open near the air supply injection point. All the pressurization air can be lost through these open doors, at which time the system will fail to maintain positive pressures across doors farther from the injection point.

Because a ground-level stairwell door is likely to be in the open position much of the time, a single-bottom-injection system is especially prone to failure. Careful design analysis is needed for all single-bottom-injection systems and for all other single-injection systems for stairwells in excess of 100 ft (30.5 m) in height to ensure proper pressurization throughout the stairwell.

**A.5.3.4.2** Many multiple-injection systems have been built with supply air injection points on each floor. These systems represent the ultimate in preventing loss of pressurization air through a few

open doors; however, that many injection points might not be necessary. For system designs with injection points more than three stories apart, the designer should use a computer analysis such as the one in ASHRAE/SFPE, *Principles of Smoke Management*. The purpose of this analysis is to ensure that loss of pressurization air through a few open doors does not lead to substantial loss of stairwell pressurization.

**A.5.3.5.1** Stairwells that do not have vestibules can be pressurized using systems currently available. Some buildings are constructed with vestibules because of building code requirements.

**A.5.3.5.2 Nonpressurized Vestibules.** Stairwells that have nonpressurized vestibules can have applications in existing buildings. With both vestibule doors open, the two doors in series provide an increased resistance to airflow compared to a single door. This increased resistance will reduce the required airflow so as to produce a given pressure in the stairwell. This subject is discussed in detail in ASHRAE/SFPE, *Principles of Smoke Management*.

In buildings with low occupant loads, it is possible that one of the two vestibule doors might be closed, or at least partially closed, during the evacuation period. This will further reduce the required airflow to produce a given pressure.

**Pressurized Vestibules.** Closing both doors to a vestibule can limit the smoke entering a vestibule and provide a tenable environment as a smoke refuge area. The adjacent stairwell is indirectly pressurized by airflow from the pressurized vestibule. However, this pressurization can be lost if the exterior door is open. Also, smoke can flow into the stairwell through any leakage openings in the stairwell walls adjacent to the floor space. Such walls should be constructed to minimize leakages for a stairwell protected by a pressurized vestibule system.

**Pressurized Vestibules and Stairwells.** To minimize the amount of smoke entering a vestibule and stairwell, both the vestibule and stairwell can be pressurized. The combined system will enhance the effectiveness of the stairwell pressurization system. Also, the pressurized vestibule can provide a temporary smoke refuge area.

**Purged or Vented Vestibules.** Purged or vented vestibule systems fall outside the scope of this document. A hazard analysis would be required using the procedures provided in the SFPE *Handbook of Fire Protection Engineering*. An engineering analysis should be performed to determine the benefits, if any, of pressurizing, purging, or exhausting vestibules on the stairwell.

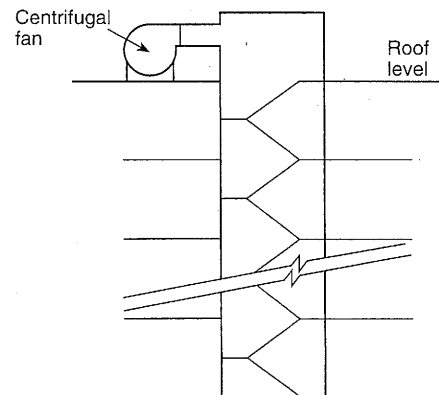


FIGURE A.5.3.4.1.1 Stairwell Pressurization by Top Injection.