NFPA 221

Standard for Fire Walls and Fire Barrier Walls

2000 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 221

Standard for

Fire Walls and Fire Barrier Walls

2000 Edition

This edition of NFPA 221, *Standard for Fire Walls and Fire Barrier Walls,* was prepared by the Technical Committee on Building Construction and acted on by the National Fire Protection Association, Inc., at its World Fire Safety Congress and Exposition™ held May 14–17, 2000, in Denver, CO. It was issued by the Standards Council on July 20, 2000, with an effective date of August 18, 2000, and supersedes all previous editions.

This edition of NFPA 221 was approved as an American National Standard on August 18, 2000.

Origin and Development of NFPA 221

The Technical Committee on Building Construction undertook a project to develop a new document to govern fire walls in 1991. At the time, no standard existed to assist code authorities, architects, or engineers on the criteria that were necessary to properly design and construct a fire wall. The first edition of NFPA 221 was issued in 1994. It contained information on various types of fire walls including basic design criteria, proper protection of penetrations, and special design practices for exterior protection features.

The 1997 edition of NFPA 221 contained several changes, including the addition of specific criteria for treatment of seismic separation assemblies; additional criteria for proper protection of raceway penetrations; and the addition of several suggested protection schemes for properly protecting an egress door located in a fire wall.

This edition has addressed specific testing criteria for performance of rated assemblies that include expansion, seismic and control joints in fire wall and fire barrier wall assemblies. In addition, a second test protocol has been recognized for tests of through penetrations.

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Committee Scope: This Committee shall have primary responsibility for documents on the design, installation, and maintenance of building construction features not covered by other NFPA committees. This Committee does not cover building code requirements, exits, protection at openings, vaults, air conditioning, blower systems, etc., which are handled by other committees.

Contents

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Fire Walls and Fire Barrier Walls

2000 Edition

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

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Information on referenced publications can be found in Chapter 8 and Appendix B.

Chapter 1 General

1.1 Scope. This standard specifies requirements for the design and construction of fire walls and fire barrier walls.

1.2 Purpose.

1.2.1 This standard prescribes minimum requirements for fire walls and fire barrier walls for use in providing safety to life and protection of property from fire. These requirements apply to walls that are required to separate buildings or subdivide a building to prevent the spread of fire.

1.2.2 Nothing in this standard is intended to prevent the use of alternate materials or devices, provided sufficient technical data is submitted to the authority having jurisdiction to demonstrate that the alternate method of construction or device provides equivalent strength and fire resistance.

1.3 Definitions.

1.3.1* Approved. Acceptable to the authority having jurisdiction.

1.3.2* Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

1.3.3 Damper, Fire. A device, installed in an air distribution system, designed to close automatically upon detection of heat to interrupt migratory airflow and to restrict the passage of flame.

1.3.4* Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire test exposure.

1.3.5 High Hazard Materials. Materials that are combustible or flammable liquids, flammable gases, and combustible dusts.

1.3.6* 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.

1.3.7 Shall. Indicates a mandatory requirement.

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

1.3.9 Wall.

1.3.9.1 Angle Wall. An exterior wall that intersects at an angle of 135 degrees or less at the end of a fire wall.

1.3.9.2 End Wall. An exterior wall that intersects at an angle of more than 135 degrees at the end of a fire wall.

1.3.9.3 Fire Barrier Wall. A wall, other than a fire wall, having a fire resistance rating.

1.3.9.4 Fire Wall. A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability.

1.3.9.5 Non-Load-Bearing Wall. A wall supporting only its own weight and no other vertical loads such as a floor or roof.

Chapter 2 Fire Walls

2.1 Types of Fire Walls. Fire walls shall meet the requirements of Chapters 2, 4, 5, 6, and 7 and shall be one of the following:

(1) Cantilevered/freestanding fire walls
(2) Tied fire walls
(3) Double fire walls

2.2 Structural Stability and Strength.

2.2.1 Fire walls shall be designed and constructed to remain stable after the collapse of the structure due to fire on either side of the wall. Fire walls constructed in compliance with the requirements of Section 2.3, 2.4, or 2.5 shall be deemed to provide the required stability.

2.2.2 Design Loads.

2.2.2.1* All fire walls and their supports shall be designed to withstand a minimum uniform load of 5 lbf/ft^2 (0.24 kPa) from either direction applied perpendicular to the face of the wall. All fire walls shall be non-load-bearing. Structural framing within the plane of the wall shall be permitted to be load-bearing.

2.2.2.2* Where the fire wall or fire protective covering of a structural member is subject to impact damage from moving vehicles or the handling of merchandise or other activity, protection against impact damage shall be provided for an appropriate height but not less than 5 ft (1.5 mm) from the finished floor.

2.3* Cantilevered or Freestanding Fire Walls. Cantilevered or freestanding fire walls shall be entirely self-supported and non-load-bearing. There shall be no connections to the building(s) or contents on either side other than to the flashing. Such walls shall be erected where there is a complete break in the structural framework. The wall shall be secured to the foundation to resist overturning due to design loads.

2.4* Tied Fire Walls. Tied fire walls shall be centered on a single column line or constructed between a double column line. Structural framing on either side of the wall shall line up horizontally and vertically and shall support the roof. The framework on each side of the fire wall shall be continuous or tied together through the wall. The framework on each side shall be designed so that it resists the maximum lateral pull that can be developed due to framework collapse in a fire on the opposite side. Tied fire walls shall be supported laterally by the building framework with flexible anchors. Where centered on a single column line, structural framing (i.e., col-

umns and beams or trusses) at the column line shall have a fire resistance rating of not less than the required fire resistance rating of the fire wall. Where the wall is installed between double column lines, framing along the first column line immediately on each side of the fire wall shall have a fire resistance rating of not less than the required fire resistance rating of the fire wall.

2.5* Double Fire Walls. A double fire wall shall consist of two back-to-back walls. There shall be no connections, other than to the flashing, between the walls.

Each fire wall shall be supported laterally by the building frame on its respective side and shall be independent of the fire wall and framing on the opposite side.

2.6 Fire Walls at Elevation Differences. Where the roofs on opposite sides of a fire wall are not of the same elevation, the fire wall assembly shall be arranged as described in either (a) or (b).

(a) The two buildings shall be separated by a double fire wall.

(b)*A cantilevered fire wall shall be constructed from the foundation to the top of the parapet for the lower roof. The upper wall section shall be permitted to have an exterior fire resistance rating of one hour less than the required fire resistance rating of the lower cantilevered portion but not less than a 2-hour rating. The upper wall shall be connected to the framework of the higher building and shall be structurally independent of the cantilevered wall.

2.7* Clearance.

2.7.1 Clearance to allow for expansion of unprotected structural framework shall be provided. This space shall be provided between cantilevered walls and structural framework on each side and between double walls.

2.7.2 In areas of moderate and high seismic risk, sufficient separation shall be provided between cantilevered walls and adjacent framing on each side and between double walls to allow independent movements of the elements without contact.

2.8 Expansion, Seismic, and Control Joints. Joints shall be provided to prevent cracking due to drying, shrinkage, or normal building temperature change. The integrity of the fire resistance rating of the wall shall be maintained by the protection of these joints. Protection for expansion and seismic joints shall be installed in accordance with tested design specifications. The fire resistance of expansion, seismic, and control joints in fire walls shall be determined in accordance with ANSI/UL 2079, *Tests for Fire Resistance of Building Joint Systems*, or ASTM E 1966, *Standard Test Method for Fire Resistive Joint Systems.*

Chapter 3 Fire Barrier Walls

3.1 Design Requirements. A fire barrier wall shall meet the requirements of Chapter 3, Chapter 4, 5.1.1, and 6.2.1.

3.2 Termination Points. A fire barrier wall shall extend from the foundation or floor below to the underside of the roof or floor deck above. Any voids or gaps created by the meeting of the wall and floor below and the underside of the roof or floor deck above shall be filled with an approved material with a fire resistance rating at least equal to that of the fire wall.

Exception: The fire barrier wall shall be permitted to terminate at the underside of an individually protected structural member in the same plane. The structural member shall have a fire resistance rating of not less than that required for the fire barrier wall and shall prevent the passage of flame and hot gases.*

3.3 Design Loads. All fire barrier walls and their supports shall be designed to withstand a minimum uniform load of 5 lbf/ft^2 (0.24 kPa) from either direction applied perpendicular to the face of the wall.

3.4 Expansion, Seismic, and Control Joints. Joints shall be provided to prevent cracking due to drying, shrinkage, or normal building temperature change. The integrity of the fire resistance rating of the wall shall be maintained by the protection of these joints. Protection for expansion and seismic joints shall be installed in accordance with tested design specifications. The fire resistance of expansion, seismic, and control joints in fire walls shall be determined in accordance with ANSI/UL 2079, *Tests for Fire Resistance of Building Joint Systems,* or ASTM E 1966, *Standard Test Method for Fire Resistive Joint Systems.*

Chapter 4 Fire Resistance

4.1* Wall Materials. The fire resistance rating of the wall assembly shall be as required by the applicable code or standard. Assemblies shall be tested and rated in accordance with NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials.*

Exception: Assemblies calculated to have equivalent fire resistance shall be permitted, provided that the calculations are based on the conditions of acceptance and the fire exposure specified in NFPA 251.

4.2 Penetration Seals. All through-penetration protection systems shall be tested and rated in accordance with ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops,* or ANSI/UL 1479, *Fire Test of Through Penetration Fire Stops.* The positive pressure difference between the exposed and unexposed surfaces of the test assembly shall not be less than 0.01 in. (2.5 Pa) water gauge. A through-penetration protection system shall have an F rating not less than the required fire resistance rating of the fire wall or fire barrier wall.

Exception: Concrete, mortar, or grout shall be permitted with maximum 6-in. (153-mm) nominal diameter steel or copper pipe or steel conduit. Concrete, mortar, or grout shall be the thickness required to maintain the required fire resistance rating of the wall being penetrated. The maximum opening size shall be 144 in.^{2} (0.094 m^2).

4.3 Double Wall Assemblies. Double wall assemblies shall be considered to have a combined assembly fire rating as specified in Table 4.3.

Table 4.3 Fire Resistance Ratings for Double Wall Assemblies

Fire Resistance Rating of Each Wall	Equivalent to Single Wall
3 hours	4 hours
2 hours	3 hours
1 hour	2 hours

Chapter 5 Protection of Openings

5.1 General.

5.1.1* All openings in fire walls and fire barrier walls shall be protected in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*. The aggregate width of openings in each floor level shall not exceed 25 percent of the wall length.

5.1.2* Fire walls having a required fire resistance rating of 4 hours shall have each opening protected with two fire door assemblies, each having a minimum 3-hour fire resistance rating.

5.2* Double Fire Walls. Openings in double fire walls shall be protected using one fire door in each separate wall or two fire doors in a freestanding, fire-resistive vestibule.

Chapter 6 Penetrations

6.1* Pipes, Raceways, and Cables. Pipes, raceways, and cable trays (regardless of size) penetrating fire walls having a required 3-hour or greater fire resistance rating shall be positioned to pass through the wall no more than 3 ft (1.0 m) above the finished floor level. A steel sleeve of a size to allow an approximate 1-in. (25-mm) clearance between the sleeve and the pipe or raceway shall be provided for each pipe or raceway. The space between the sleeve and penetrating item (annular space) shall be filled as required in Section 4.2. Joint reinforcement shall be provided in the horizontal mortar joints immediately above and below sleeves in concrete masonry walls, and all hollow spaces of concrete masonry walls immediately adjacent to the sleeve shall be filled with concrete, mortar, or grout.

6.1.1 The center-to-center spacing between adjacent pipes or raceways shall be not less than three times the larger pipe or raceway outside diameter.

6.1.2 Horizontal clear space between adjacent openings for cable trays shall be not less than three times the width of the opening.

6.1.3 Vertical clear space between adjacent openings for cable trays shall be not less than three times the height of the opening.

Exception: The limitation on the height of penetrations above the floor and other requirements of Section 6.1 shall not apply where the structural framework of the building has a fire resistance rating equal to or greater than the required fire resistance rating of the fire wall; only compliance with Section 4.2 shall be required.

6.2 Heating, Ventilating, and Air-Conditioning Systems.

6.2.1 Fire dampers shall be installed and maintained in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

6.2.2 Fire walls having a required fire resistance rating of 4 hours shall be protected with two minimum 3-hour-rated fire damper assemblies.

6.2.3 One fire damper shall be provided in each wall assembly with a required fire rating for each wall of a double fire wall, and a slip joint connecting the sleeves between the walls shall be provided. The minimum fire resistance rating of each damper shall be $1^1/_2$ hours.

6.3* Piping or Ductwork for High Hazard Materials.

6.3.1 Piping or ductwork that is used to convey high hazard materials shall not penetrate fire walls that have a required fire resistance rating of 4 hours.

6.3.2 Piping or ductwork that is used to convey high hazard materials and that penetrates fire walls with a required fire resistance rating of less than 4 hours shall be protected with approved devices or with systems designed to terminate the flow or movement of the materials through the fire wall upon fire detection.

Chapter 7 Exterior Protection

7.1* Parapets. Fire walls shall be provided with parapets at least 30 in. (0.76 m) high. The parapet height shall be measured from the top surface of the roof being protected. Roofs sloped greater than $^1/_4$ in. per ft (6 mm per 305 mm) downward toward the wall shall be provided with a minimum 36-in. (0.9-m) parapet.

7.2* Roof Surface Protection.

7.2.1 Built-up roofs shall be surfaced with gravel or slag for at least 25 ft (7.6 m) on both sides of the fire wall. The application rate shall be at least 4 lb/ft^2 (19 kg/m^2).

7.2.2 All single-ply membrane roof coverings shall be protected by noncombustible paver blocks, or No. 3 [nominal 1-in. to 2-in. (2.54-cm to 5.08-cm) diameter] gravel ballast in accordance with ASTM D 448, *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*. Complete membrane coverage shall be provided at a rate not less than 10 lb/ft^2 (48.8 kg/m^2) for at least 25 ft (7.6 m) on both sides of the fire wall.

7.3* Roof-mounted Structures. Combustible structures or equipment such as monitors, penthouses, or cooling towers not more than 20 ft (6.1 m) in height above roofs shall be located at least 50 ft (15.2 m) from fire walls required to have a fire resistance rating exceeding 2 hours. Roof-mounted structures over 20 ft (6.1 m) high shall be provided with a greater separation distance acceptable to the authority having jurisdiction.

7.4 Roof Penetrations. Heat and smoke vents, skylights, and unprotected roof penetrations for air-handling equipment or smoke control systems shall be located at least 25 ft (7.6 m) from fire walls requiring a fire resistance rating of more than 2 hours and at least 4 ft (1.3 m) from fire walls requiring a fire resistance rating of 2 hours or less.

7.5* End Walls.

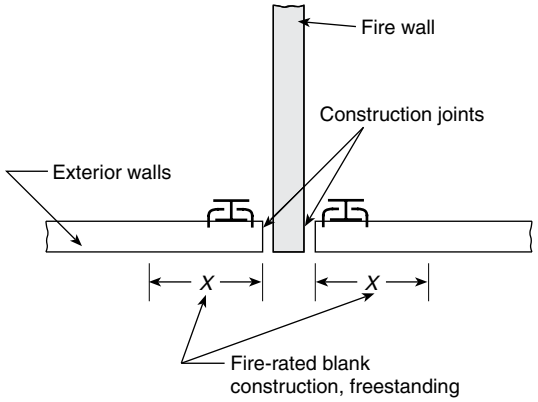
7.5.1 The length and arrangement of end walls shall be in accordance with Table 7.5.1 and Figure 7.5.1(a) or 7.5.1(b). The fire resistance rating of the end walls shall be from the outside and shall be a minimum of 1 hour but shall be not more than two hours less than that of the fire wall.

Table 7.5.1 Length of End Wall Protection

Height of Exposing Area		Length of End Wall Protection	
ft	m	ft	m
Up to 40	12.2	6	1.8
41 to 70	21.3	10	3.1
71 and over	21.6 and over	14	4.3

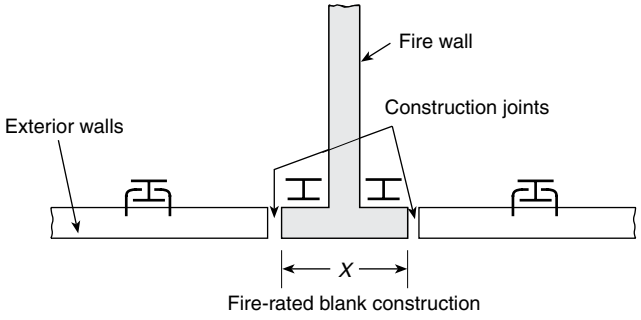
Note: Protection shall consist of blank, fire-rated construction.

FIGURE 7.5.1(a) End wall exposure protection — end walls tied to structural framing.



Note: *X* represents required length of end wall exposure protection.

FIGURE 7.5.1(b) End wall exposure protection — end walls not tied to structural framing.

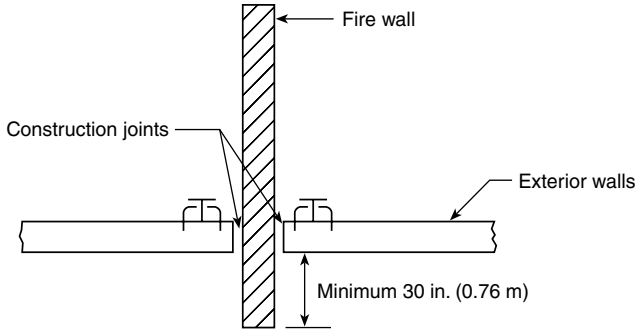


Note: *X* represents required length of end wall exposure protection.

7.5.2 The following alternative to 7.5.1 shall be permitted for light hazard and ordinary hazard (Group 1 or 2) occupancies as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

The fire wall shall extend to a distance of at least 30 in. (0.76 m) beyond the exterior face of the exterior walls, as shown in Figure 7.5.2.

FIGURE 7.5.2 Alternative end wall exposure protection.



7.6 Angle Walls. The length of fire-resistive angle walls, *Y*, as shown in Figure 7.6(a), shall be 20 ft to 35 ft (6.1 m to 10.7 m), depending on the severity of exposure. *(See Table 7.6.)* The fire resistance rating of the angle walls shall be from the outside and shall be not more than 1 hour less than that of the fire wall. In addition, construction of each wall and eave shall be noncombustible beyond the fire-resistive construction for the minimum distances outlined in Table 7.6.

Elevation differences perpendicular to fire walls shall be protected as angle walls, as shown in Figure 7.6(b).

Table 7.6 Angle Wall Protection

	Length of Fire-Resistive Angle Walls		Length of Noncombustible Construction Beyond Fire-Resistive Construction	
Occupancy Hazard*	ft	m	ft	m
Light	20	6.1	60	18.3
Ordinary Group 1	30	9.1	75	22.9
Ordinary Group 2	35	10.7	100	30.5
Extra Group 1 and 2	35	10.7	100	30.5

*As defined in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

FIGURE 7.6(a) Angular wall exposure protection.

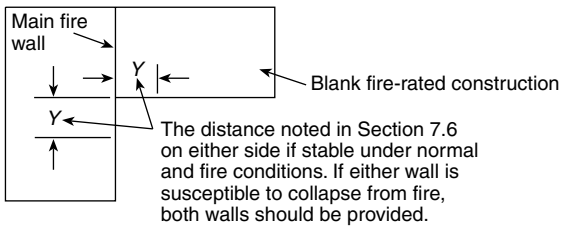
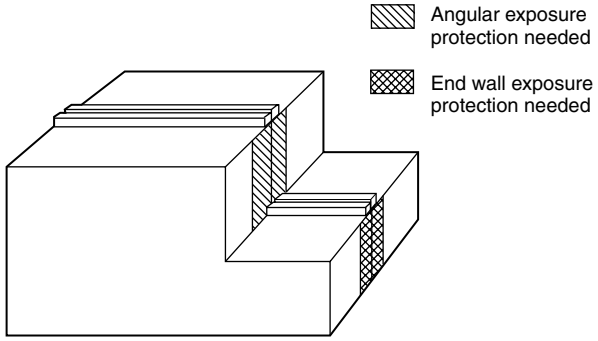


FIGURE 7.6(b) Exterior wall protection.



7.7 Railroad Sidings and Truck Docks. Railroad sidings parallel to end walls and truck dock openings shall not be located within 20 ft (6.1 m) on either side of a fire wall.

Chapter 8 Referenced Publications

8.1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

8.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1999 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 1999 edition.

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials,* 1999 edition.

8.1.2 Other Publications.

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

ASTM D 448, *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*, 1998.

ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, 1997.

ASTM E 1966, *Standard Test Method for Fire Resistive Joint Systems*, 1999.

8.1.2.2 ANSI/UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 1479, *Fire Test of Through Penetration Fire Stops*, 1994.

ANSI/UL 2079, *Tests for Fire Resistance of Building Joint Systems*, 1998.

Appendix A Explanatory Material

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

A.1.3.1 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.1.3.2 Authority Having Jurisdiction. The phrase "authority having jurisdiction" 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.1.3.4 Fire Resistance Rating. The fire test exposure should be established in accordance with the test procedures of NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*. ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and UL 263, *Fire Tests of Building Construction and Materials*, are similar to NFPA 251.

A.1.3.6 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.2.2.2.1 Other loads, such as seismic loads or interior pressure differences due to wind, can govern and should be considered in accordance with local code requirements. Parapets should be designed for wind loads, including appropriate pressure coefficients.

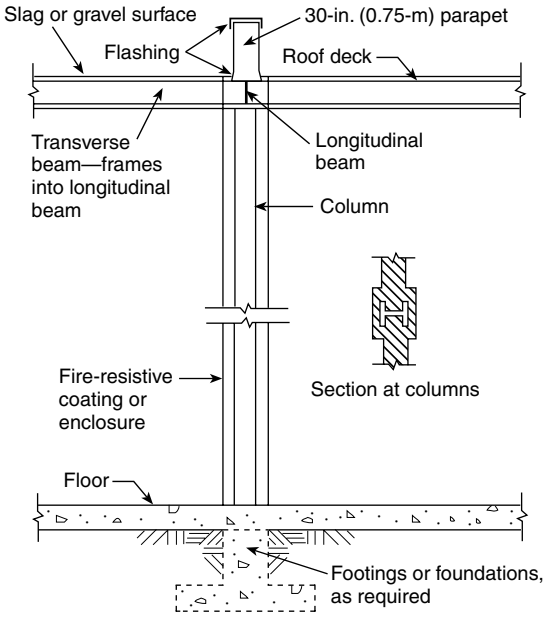
A.2.2.2.2 Where the potential exists for the collapse of building materials or contents or the impact of vehicles on a fire wall requiring a fire resistance rating of 4 hours, the fire wall should be constructed of materials that are of adequate strength.

A.2.3 Walls intended to be used as cantilevered fire walls in the future and used as temporary exterior walls will be vulnerable to wind damage. Such walls should be designed to resist required wind loads. If the future cantilevered wall is tempo-

rarily fastened to the building frame until the additional building is built, care should be taken to ensure that all ties to the wall are fully cut when new construction is completed.

A.2.4 Tied fire walls *[see Figure A.2.4(a)]* are fastened to and usually encase members of the structural frame of the building. To remain stable, the pull of the collapsing structural members on the fire side of the wall must be resisted by the strength of the structure on the other side.

FIGURE A.2.4(a) Typical tied fire wall used with continuous building framework.



Since a fire can occur on either side of the wall, the wall preferably should be located at the center of strength of the building frame. The center of strength is the plane within the building frame in which the structural framing on either side has equal resistance. In small structures, the center of strength generally is in the middle of the building. *[See Figure A.2.4(b).]* In large buildings, the center of strength might lie midway between two double-column line expansion joints. *[See Figures A.2.4(c) and A.2.4(d).]* Single-column line expansion joints utilizing beams with slotted connections do not break the continuity of the building frame. *[See Figure A.2.4(e).]*

FIGURE A.2.4(b) A tied wall at the center of a continuous steel frame. The pull from collapsing steel on either side must be resisted by the lateral strength of steel on the other side.

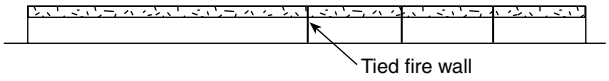


FIGURE A.2.4(c) Tied wall where framing is not continuous throughout the building.

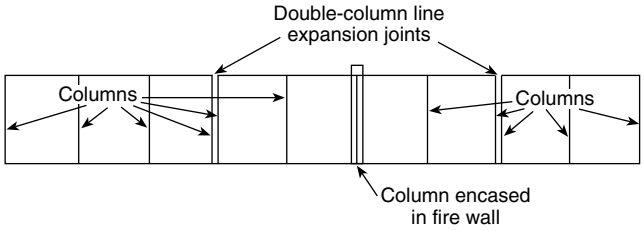


FIGURE A.2.4(d) Double-column line expansion joint.

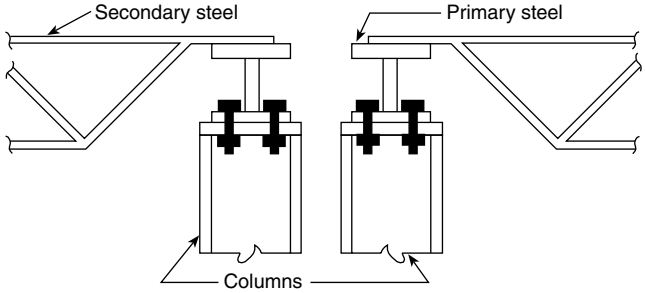
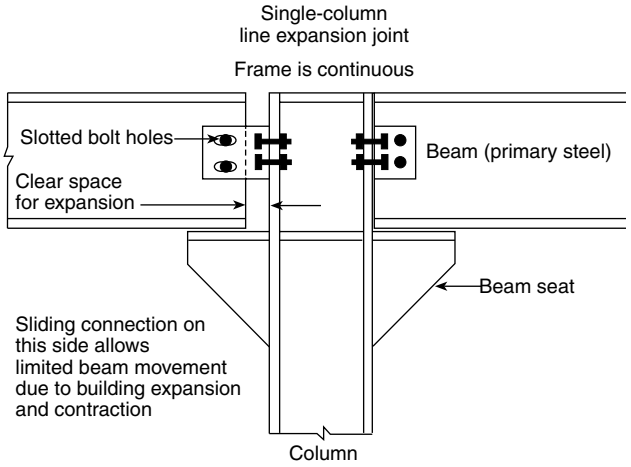
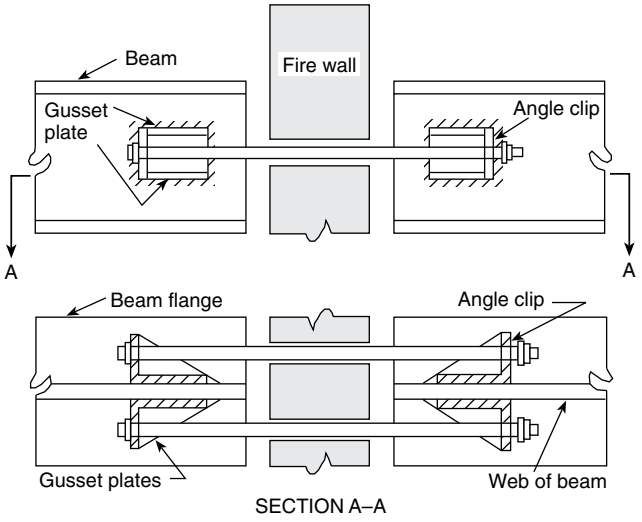


FIGURE A.2.4(e) Single-column line expansion joint frame is continuous.



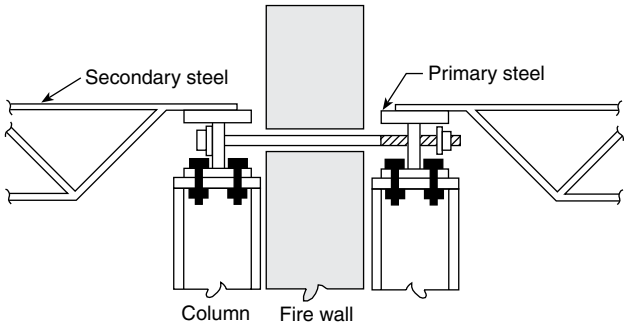
Bolts with nuts and washers are permitted to be used to tie framework across a double-column line. In order to prevent the defeat of the purpose of the expansion joint created by the double-column line, nuts should be backed off slightly about $^{3}/_{4}$ in. (19 mm). Where the primary roof framing is perpendicular to the fire wall, two bolts should tie the roof framing together over each column to provide concentric load distribution. Where the primary roof framing is parallel to the fire wall, single bolts are permitted to be used; however, intermediate ties might be needed between column lines. A registered civil or structural engineer should be consulted to provide more exact details. *[See Figures A.2.4(f) and A.2.4(g).]*

FIGURE A.2.4(f) Through-wall tie — primary roof framing perpendicular to wall.



Note: Columns are needed but not illustrated.

FIGURE A.2.4(g) Through-wall tie — primary steel parallel to fire wall.



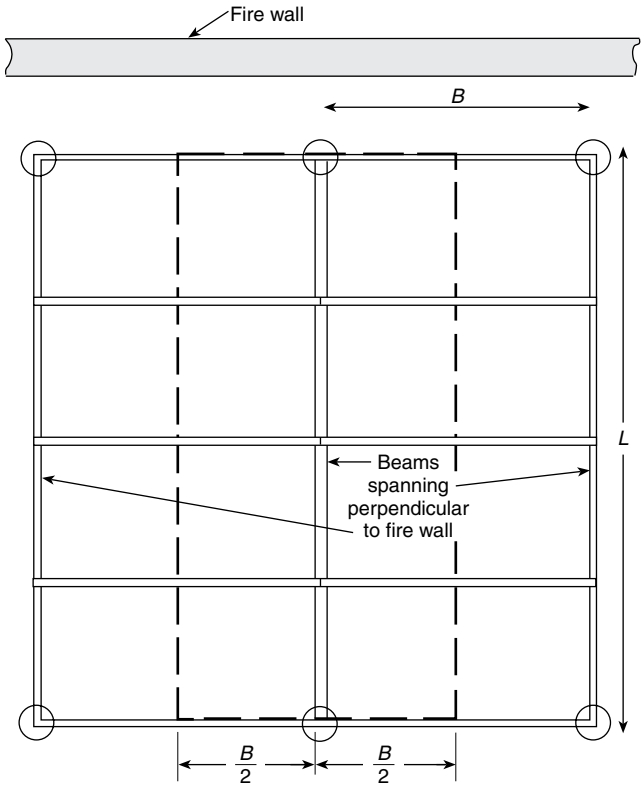
If the wall is not located at the center of strength, the lateral resistance of the frame on either side of the wall should be sufficient to resist the maximum horizontal component of the force that could result from collapsing structural framework on the opposite side. The horizontal force at each tie should be computed by using the following formula.

$$H = \frac{wBL^2}{8S}$$

where:

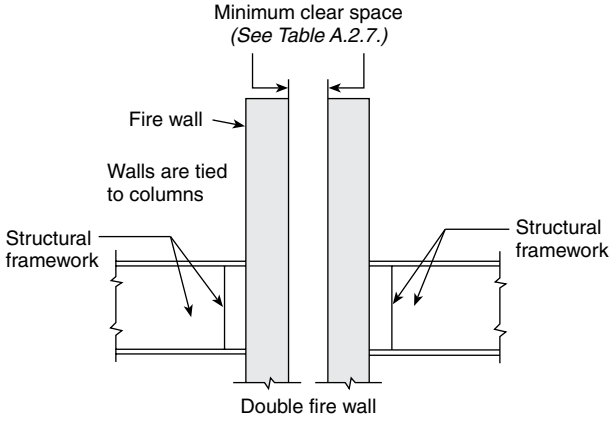
H = horizontal pull per tie [lb (kg)]
w = dead load plus 25 percent of the live load of the roof [lb/ft^2 (kg/m^2)]
L = span of the structural member running perpendicular to the wall [ft (m)]
B = distance between ties [ft (m)]
S = sag in ft (m) that can be assumed as
0.07L for open-web trusses
0.09L for solid beams
0.06L for wood trusses
[See Figure A.2.4(h).]

FIGURE A.2.4(h) Tied fire wall with ties at each beam.



A.2.5 Figures A.2.5(a), A.2.5(b), and A.2.5(c) provide three configurations for construction of a double fire wall.

FIGURE A.2.5(a) Double fire wall — no connections.



Where there is an uncontrolled fire on either side of a double wall, one building frame will collapse, pulling the wall on that side with it. The other wall, supported by structural framework on the protected side, will remain in place to stop the spread of fire.

FIGURE A.2.5(b) Double fire wall — separate horizontal and vertical flashing sections.

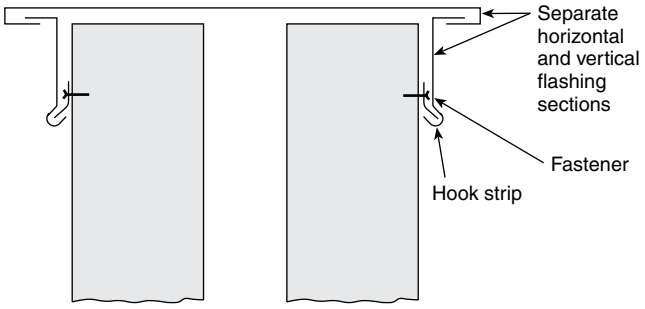
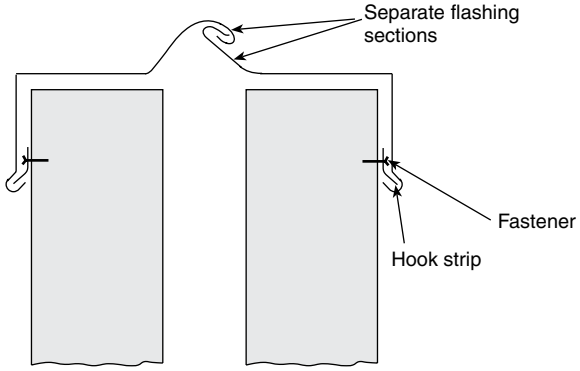


FIGURE A.2.5(c) Double fire wall — separate flashing sections.



Since there should be no connections between the walls, particular attention should be paid to the details at openings in the walls.

A double fire wall is most adaptable where an addition to a plant requires a fire wall between an existing structure and a new building. The existing wall, which is secured to the building frame, is altered, if necessary, to provide the proper fire resistance. Another fire wall is then constructed adjacent to the existing one and secured to the new building frame.

A.2.6(b) The exterior fire-rated wall above the cantilevered wall should not overlap the cantilevered wall on the side of the lower building. It can be installed above the cantilevered wall or overlap the cantilevered wall on the side of the higher building *[see Figures A.2.6(a) and A.2.6(b)]*. In either case, the integrity of the fire resistance rating of the fire wall should be maintained by protecting the joint between the cantilevered wall and the exterior fire wall attached to the higher building. In some cases, the parapet can be omitted from the higher wall only; however, such a judgment should consider the severity of exposure from the occupancy in the lower building and the elevation difference between the exposure and the top of the higher wall.

A.2.7 Table A.2.7 is based on steel framework. This table provides clearances that are conservative for other types of framework materials. It is based on an average temperature of 800°F (427°C) in two adjacent bays.

FIGURE A.2.6(a) Fire wall arrangement at elevation difference (double wall).

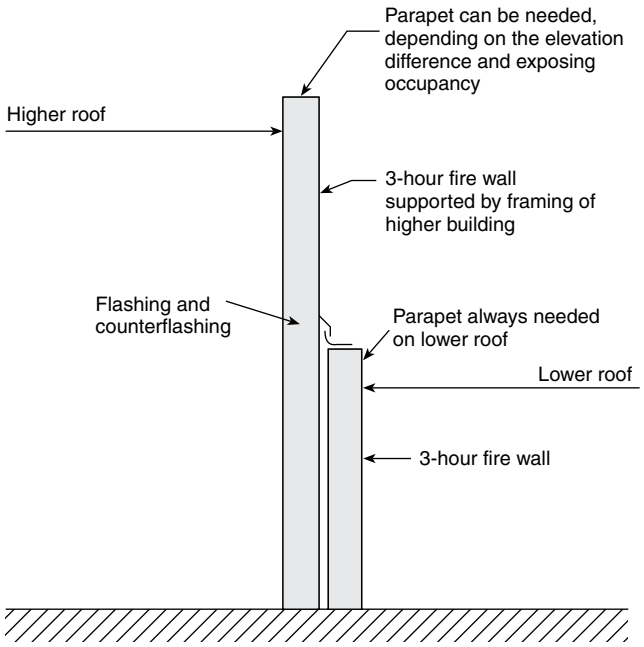
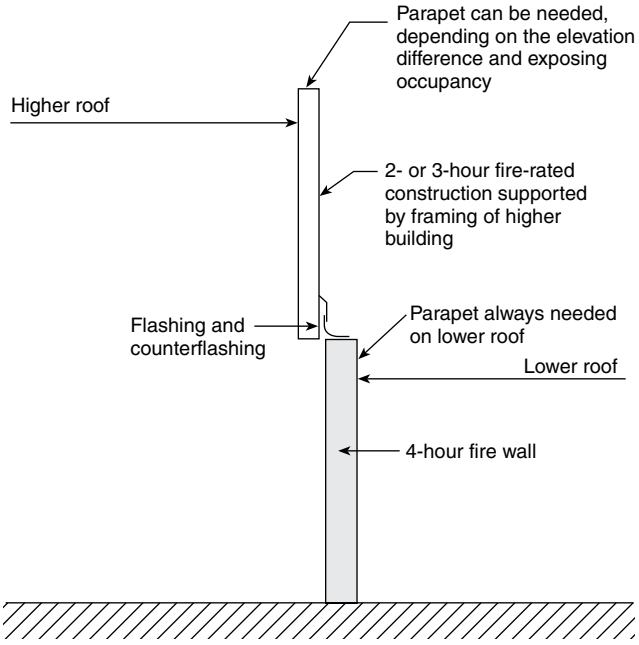


FIGURE A.2.6(b) Fire wall arrangement at elevation difference (cantilever wall).



Adequate clearance should be provided between storage and fire walls to prevent damage to the wall that might result from swelling of absorbent materials due to contact with water.

Table A.2.7 Minimum Recommended Clearance for Thermal Expansion Between Unprotected Structural Framework and Fire Walls or Between Double Fire Walls

Length of Bay Perpendicular to the Fire Wall		Minimum Clearance Between Wall and Structural Framework and Between Double Walls	
ft	m	in.	cm
20	(6.1)	$2^1/_2$	(6.4)
25	(7.6)	$3^1/_4$	(8.3)
30	(9.1)	$3^3/_4$	(9.5)
35	(10.7)	$4^1/_2$	(11.4)
40	(12.2)	5	(12.7)
45	(13.7)	$5^3/_4$	(14.6)
50	(15.2)	$6^1/_4$	(15.9)
55	(16.8)	7	(17.8)
60 or longer	(18.3)	$7^1/_2$	(19.1)

Source: FMRC DS 1-22, *Criteria for Maximum Foreseeable Loss Fire Walls and Space Separations.*

A.3.2 Exception. The fire resistance rating of the fire barrier wall is based on specific criteria in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials.* It is based on both structural stability under the fire and hose stream tests and on criteria for temperature transmission through the wall that are designed to prevent ignition of combustible materials on the unexposed side of the wall. The exception recognizes that fire barrier walls can terminate at the underside of an individually protected structural member that has the same fire resistance rating as the wall. In the case where the fire resistance rating for the structural member is the same as that for the wall, no additional temperature transmission criteria are needed to prevent ignition of combustible materials.

However, in the event that the structural member does not have a solid web or solid surface along its length for the full height of the structural member, as with an open-web member, the fire protective covering for the structural member must be continuous for the full height of the structural member, to prevent the passage of flame and hot gases over the top of the fire barrier wall.

A.4.1 Methods for calculating the fire endurance of assemblies can be found in the following publications:

(1) Concrete and masonry

ACI 216R, *Guide for Determining the Fire Endurance of Concrete Elements.*

Concrete and Masonry Industry Firesafety Committee SR267, *Analytical Methods of Determining Fire Endurance of Concrete and Masonry Members — Model Code Approved Procedures*

CRSI, *Reinforced Concrete Fire Resistance*

PCI, *Design for Fire Resistance of Precast Prestressed Concrete*

(2) Steel

AISI, *Designing Fire Protection for Steel Columns*

AISI, *Designing Fire Protection for Steel Beams*

AISI, *Designing Fire Protection for Steel Trusses*

(3) Wood

AFPA, *Design of Fire-Resistive Exposed Wood Members*

UBC, *Methods for Calculating Fire Resistance of Wood-Framed Walls, Floors and Roofs*

A.5.1.1 Where burning liquids can spread to unaffected areas by flowing under fire doors, see NFPA 30, *Flammable and Combustible Liquids Code.*

A.5.1.2 Figures A.5.1.2(a) and A.5.1.2(b) show two methods of arranging a means of egress through a 4-hour fire wall.

FIGURE A.5.1.2(a) Swinging door and sliding door configuration for egress purposes in a fire wall.

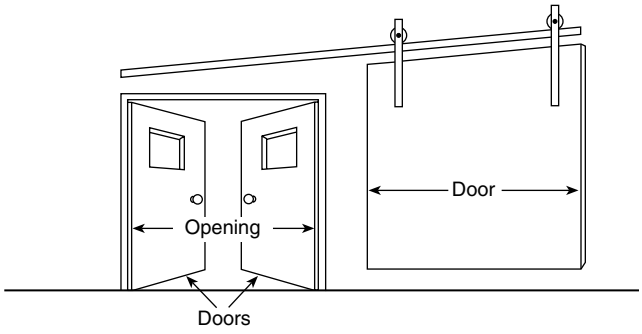
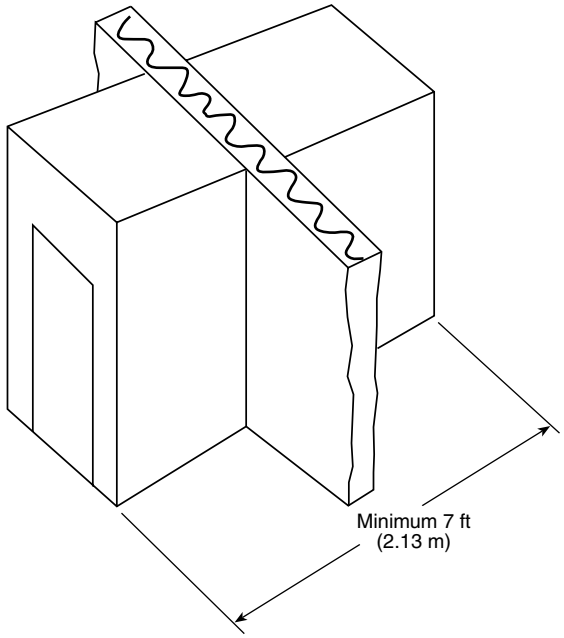
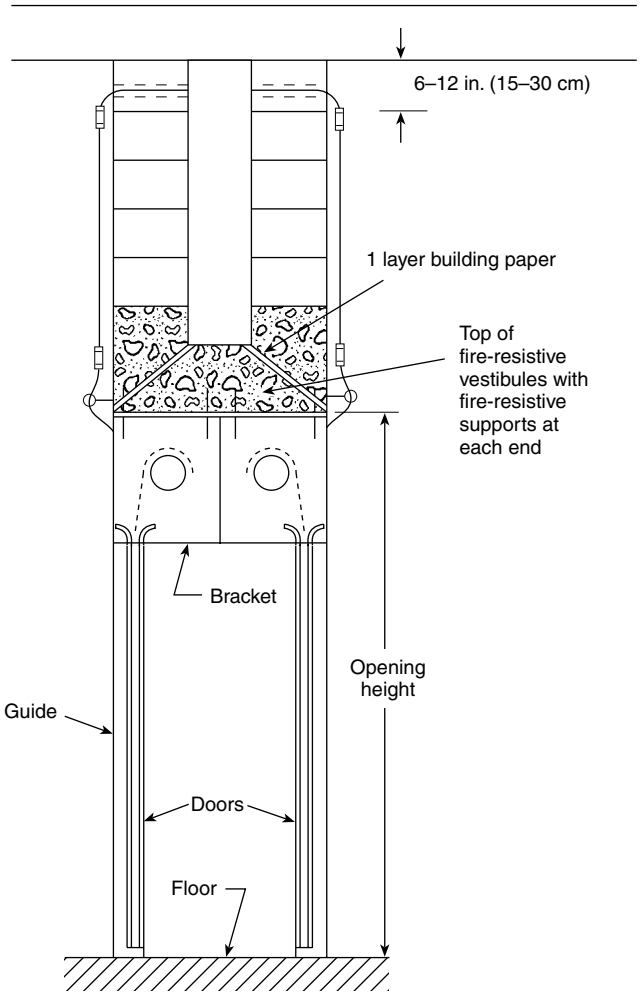


FIGURE A.5.1.2(b) Vestibule arrangement for egress purposes in a fire wall.



A.5.2 An example of an arrangement where the alternative of providing two fire doors on a freestanding, fire-resistive vestibule is used and where the opening is not used as part of the means of egress is shown in Figure A.5.2. Where this alternative is used and where the opening is used for egress, the vestibule should be long enough to allow both doors to swing in the same direction and open completely.

FIGURE A.5.2 Double doors on a freestanding vestibule.



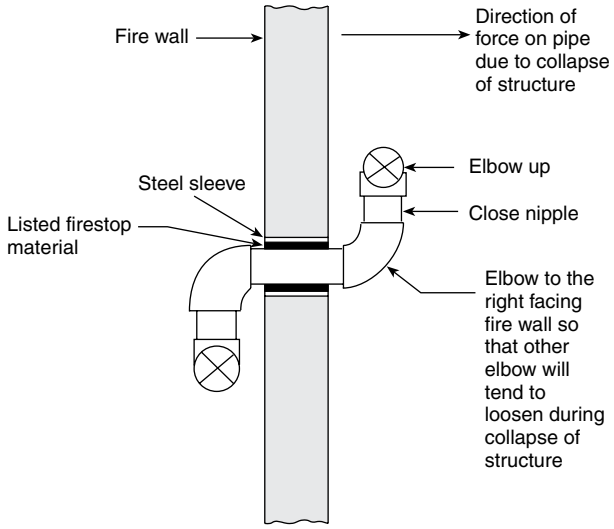
A.6.1 *Location of Combustibles.* Combustibles should be kept at least 1 ft (0.3 m) away from pipes, ducts, plates, and raceways where they penetrate the wall. Alternatively, a penetration seal with a T rating (as defined by ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*) of not less than 1 hour should be provided.

Mechanical connections, such as double-threaded elbows *(see Figure A.6.1)* or flexible-braided steel pipe, that are acceptable to the authority having jurisdiction and that will limit stress on the wall should be considered.

Steel-faced fire walls with gypsum board core or gypsum board on stud fire walls should be provided with a concrete stanchion where pipes, raceways, or cables penetrate fire walls with a required fire resistance rating of 4 hours.

A.6.3 High hazard materials transported by piping or ductwork passing through fire walls have been shown to be a significant avenue of fire propagation across the fire wall and should be avoided. Where necessary for these systems to penetrate a fire wall with a fire resistance rating of less than 4 hours, the flow of the high hazard materials must be interrupted or otherwise protected by engineered devices or systems specifically designed for such purpose and approved by the authority having jurisdiction. Devices that can be used for this protection include, but are not limited to excess-flow valves and fire-safe shutoff valves, pneumatic knife or gate dampers, blower/vacuum shutdown devices, or encapsulation of the piping or ductwork and its supports with material having a fire resistance rating at least equal to that required of the fire wall.

FIGURE A.6.1 Pipe penetration.



High hazard materials include flammable gases and combustible and flammable liquids used in piping systems and combustible dusts used in air-conveying systems.

A.7.1 Where a higher building or higher portion of a building adjoins a lower building at a fire wall, the lower building should always have a minimum 30-in. (0.76-m) high parapet. A parapet can be omitted on the higher building if there is at least a 15-ft to 50-ft (4.6-m to 15.2-m) elevation difference, depending on the severity of the fire exposure from the lower building. *(Also, see NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, Table 2.4.)* Where the parapet is not needed, the exterior fire-rated wall construction should extend at least up to the gravel stop. Gravel surfacing or equivalent is still recommended for at least 25 ft (7.6 m) from the fire wall in each direction on the higher and lower roof.

A.7.2 For existing construction where the roof strength is not adequate to support gravel surfacing, the roof should be structurally reinforced to support the gravel. As an alternative, or for new or existing construction where the roof slope is excessive for gravel, the roof should be coated with an approved, lightweight, exterior grade, fire-resistant coating.

For single-ply roofs, where the roof is not adequate to support the specified weight of the ballast stone or paver blocks, it should be similarly reinforced, or the top surface of the roof should be protected with an approved coating, as described previously, if the roof membrane is totally adhered. Mechanically attached, single-ply roof covers normally flex between fasteners, which could cause cracking of a coating.

A.7.3 Where the specified separation is not practical, a minimum of 25 ft (7.6 m) of separation should be provided, and fire-rated barriers should be constructed on the exposed side of the roof projection. The fire resistance rating should be a minimum of 2 hours if a 4-hour fire wall is required and 1 hour where fire walls of 3 hours or less are required.

A.7.5 An example of such an end wall configuration is a 4-hour fire wall with 2-hour end walls.