Code Manual

June 1, 1954

State of New York
Thomas E. Dewey, Governor

CODE MANUAL

for the

STATE BUILDING CONSTRUCTION CODE

STATE OF NEW YORK

Thomas E. Dewey, Governor

New York (State) STATE BUILDING CODE COMMISSION

Chairman Edward J. McGrew, Jr.	New York City
Vice Chairman George Bain Cummings	Binghamton
Commissioner Walker S. Lee	Rochester
Commissioner Ralph A. Lehr	Buffalo
Commissioner William Lescaze	New York City

State Building Code Commission 1740 Broadway New York 19, New York

$3 PER COPY, POSTAGE PAID.

MAKE CHECKS OR MONEY ORDERS PAYABLE TO THE ORDER OF THE STATE BUILDING CODE COMMISSION

Foreword

This Code Manual is a guide prepared for building officials, architects, engineers, builders, owners and others to assist them in the interpretation, application and enforcement of the State Building Construction Code.

The Manual contains standards which are acceptable methods of compliance with the Code. The Code is the law; the Manual is not the law. The inclusion of standards in the Manual does not mean that they are the only acceptable methods of code compliance. All construction methods and materials which meet the performance requirements of the Code are acceptable. Requirements set forth in any standard are to be interpreted as conditions of acceptance under that standard, and not as mandatory requirements excluding other methods of compliance.

The first issue of the Manual, dated November 1, 1951, pertained to the construction of one- and two-family dwellings. This new issue, dated June 1, 1954, pertains not only to one- and two-family dwellings but to multiple dwellings as well. In the first issue the text of the Code was included for the convenience of users. The text has been omitted from the second issue to remove any possible confusion as to the fact that the Code Manual is not the law. The law is now to be found only in the two portions of the Code as presently promulgated.

The Manual is issued in loose-leaf form in order to permit insertion of future pages supplementing or superseding those contained herein. The Commission's technical staff will continue to study construction materials and methods, and will supervise procedures for the issuance of certificates of acceptance of building products, methods of assembly, and construction techniques. It is through this procedure that the Manual will remain an up-to-date instrument for interpretation of Code provisions. The preparation of this Manual in conjunction with the performance Code is a pioneering and logical step in the furtherance of modern building regulations.

The Commission has published as a separate document a list of generally accepted standards which meet the requirements of the Code. This list, which contains the name and address of each organization issuing a particular standard and from whom copies may be obtained, is available, without charge, at the office of this Commission.

CONTENTS

Part 1

Part 2

Part 3

Part 4

Part 5

Illustrations

Part 2

Part 3

Part 4

Part 5

Tables

Part 2

Part 3

Part 4

Part 5

Tables

Part 2

Part 3

Part 4

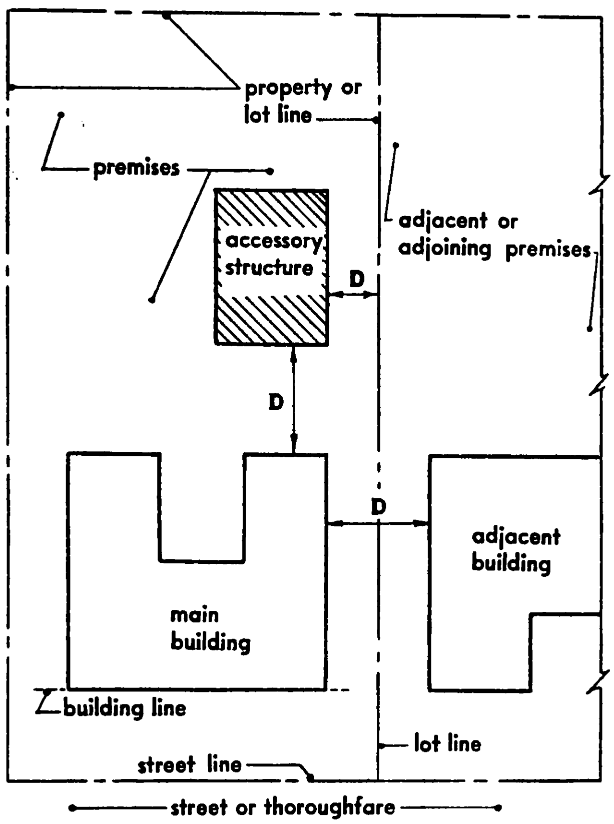
Part 5

part 1

Construction illustrated or described herein is acceptable under the State Building Construction Code, but shall not be interpreted as excluding other construction which meets the requirements of the Code.

Accessory Structure—A building, the use of which is incidental to that of the main building, and which is located on the same premises.

When accessory structures do not exceed one story in height and the area is 100 square feet or less, distance separations are not required.



For required distance separation (D), see sections A 401-3 and B 401-3 of the Code; see also references to distance separations in the index to this Manual.

Attic—Space between top of uppermost floor construction and underside of roof.

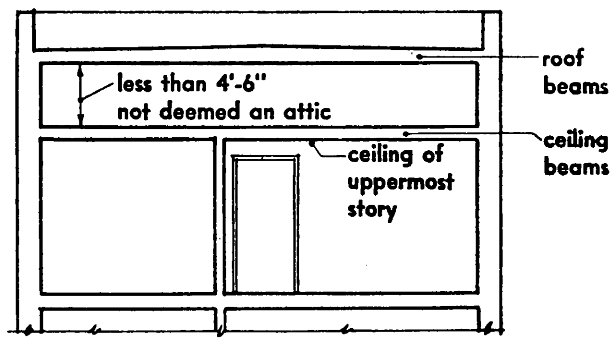
An attic shall not be deemed a story if it is unfinished and accessible only by ladder.

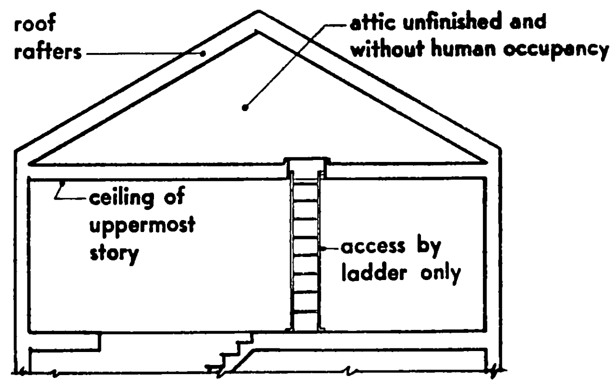
An attic accessible by stairs shall be deemed to be a story, unless maintained unfinished and without human occupancy.

In one- and two-family dwellings, disappearing or folding stairs may be used as access to an attic space, provided that such attic space is not used as a habitable space.

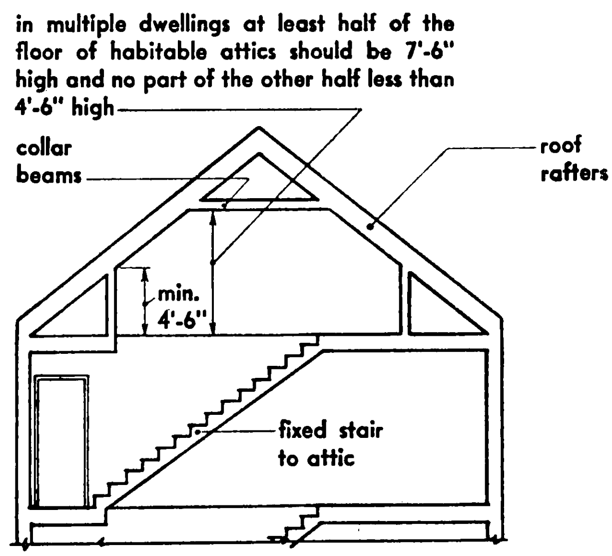
Attic space in a multiple dwelling should be only accessible by a fixed stair.

Space between the top of the uppermost floor construction and the underside of roof which is less than 4 feet 6 inches in height shall not be deemed to be an attic.





ATTIC NOT DEEMED A STORY

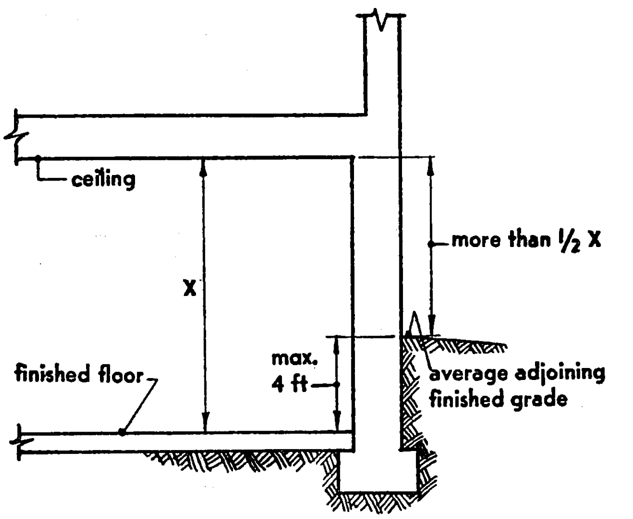


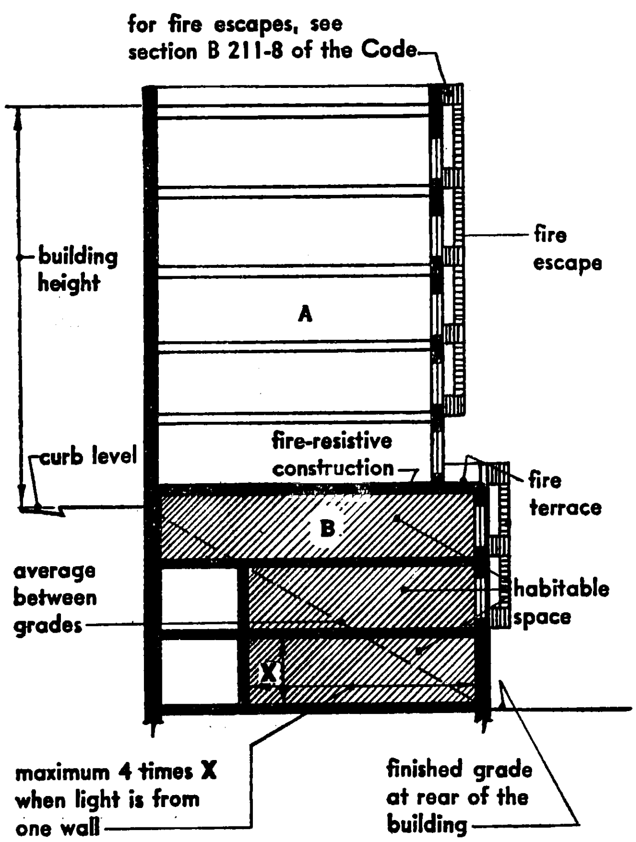
ATTIC DEEMED A STORY

Basement—That space of a building that is partly below grade which has more than half of its height, measured from floor to ceiling, above the average established curb level or finished grade of the ground adjoining the building.

Habitable spaces may be located in a basement provided the floor level of the basement is not more than 4 feet below the average curb level or adjoining finished grade.

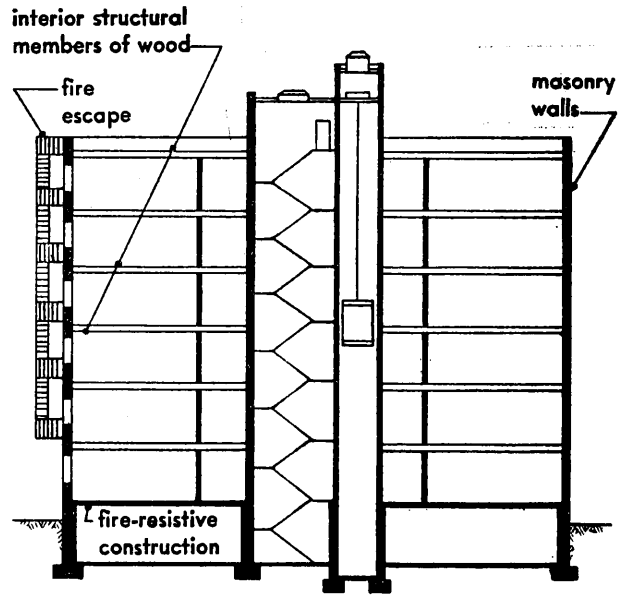
Habitable spaces may be located below the highest curb level as shown in shaded areas. Such spaces, together with yards, courts, and exits, shall comply with the Code.



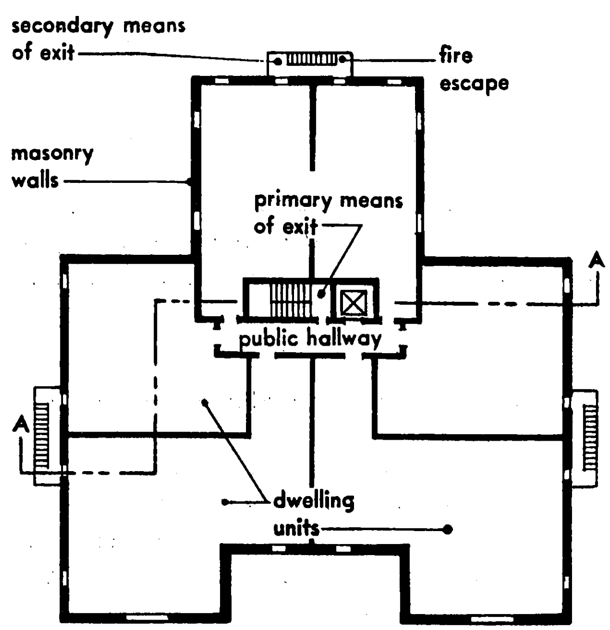


If the superstructure (A) is of type 3, 4, or 5 construction in accordance with limitations of the Code, all of the substructure (B) below the first floor shall be of type 1 or 2 construction.

Construction Classification: Type 4, Ordinary Construction—That type of construction in which the exterior walls are of masonry or other noncombustible materials having equivalent structural stability under fire conditions and a fire-resistance rating of not less than 2 hours, the interior structural members being wholly or partly



SECTION A-A

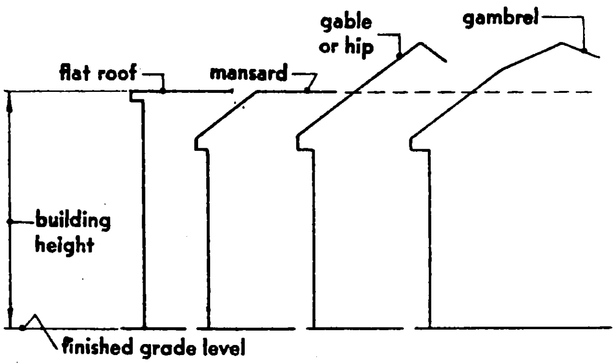


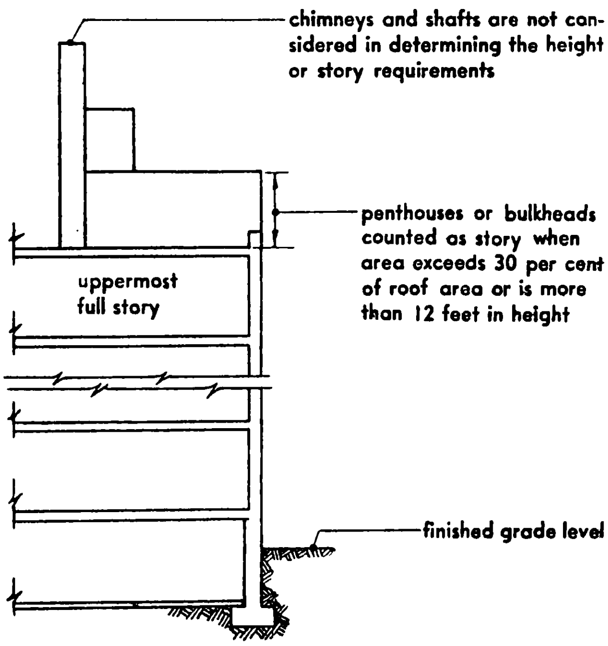
TYPICAL FLOOR PLAN

of wood of smaller dimensions than those required for heavy timber construction. (See part 2, illustrations on classification of buildings by type of construction).

There shall be at least two exits, as remote from each other as practicable, from each story and for each dwelling unit. A fire escape may be substituted for one of the required interior stairways. A second enclosed stairway instead of a fire escape is more desirable as a second required means of exit.

Height, Building—Vertical distance measured from curb or grade level to the highest level of a flat or mansard roof, or to the average height of a pitched, gabled, hip or gambrel roof, excluding



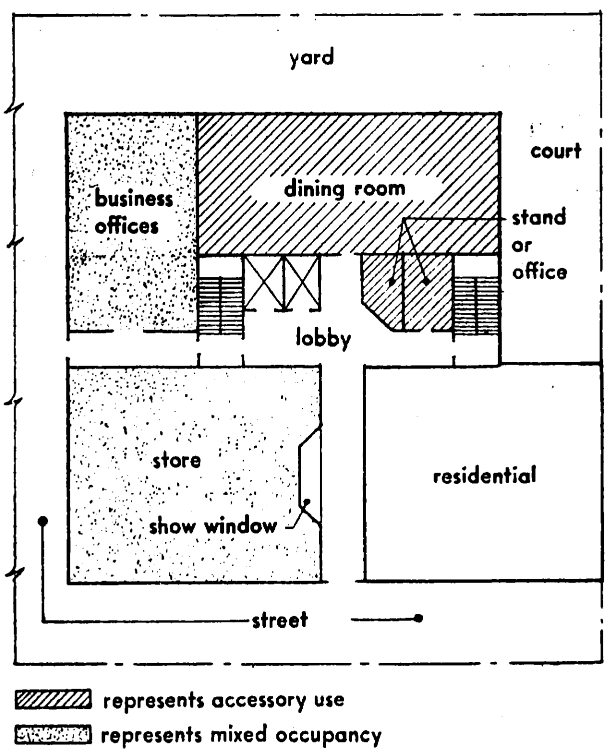


ROOF CONSTRUCTION COUNTED
AS PART OF HEIGHT

bulkheads, penthouses and similar constructions enclosing equipment or stairs, providing they are less than 12 feet in height and do not occupy more than 30 per cent of the area of the roof upon which they are located.

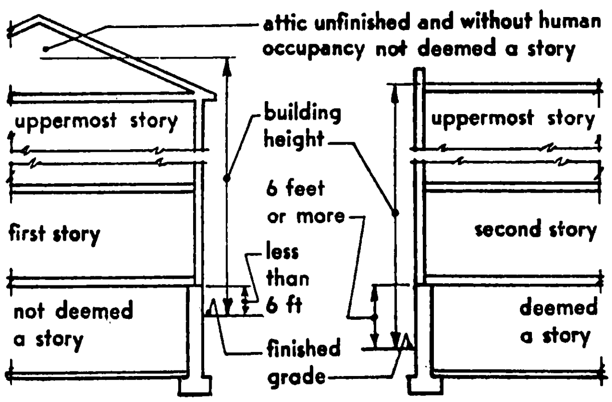
Mixed Occupancy—Occupancy of a building in part for residential use and in part for some other use not accessory thereto.

Separations horizontally and vertically between the mixed occupancy and the residential occupancy shall be in conformity with the State Building Construction Code applicable to Multiple Dwellings.



Business offices and stores in a multiple dwelling, such as those indicated in floor plan above, constitute a mixed occupancy; rooms or space incidental to the residential occupancy such as kitchen, dining room, office for the building management and cigar stand, constitute an accessory use, not mixed occupancy. See definition of accessory use *in the Code.*

Story—Portion of a building which is between one floor level and the next higher floor level or



the roof. If a mezzanine floor area exceeds one third of the area of the floor immediately below, it shall be deemed to be a story. A basement shall be deemed to be a story when its ceiling is 6 or more feet above the finished grade. A cellar shall not be deemed to be a story. An attic shall not be deemed to be a story if unfinished and without human occupancy.

Miscellaneous Definitions

Building Line—Line established by law, ordinance, or regulation, beyond which no part of a building, other than parts expressly permitted, shall extend.

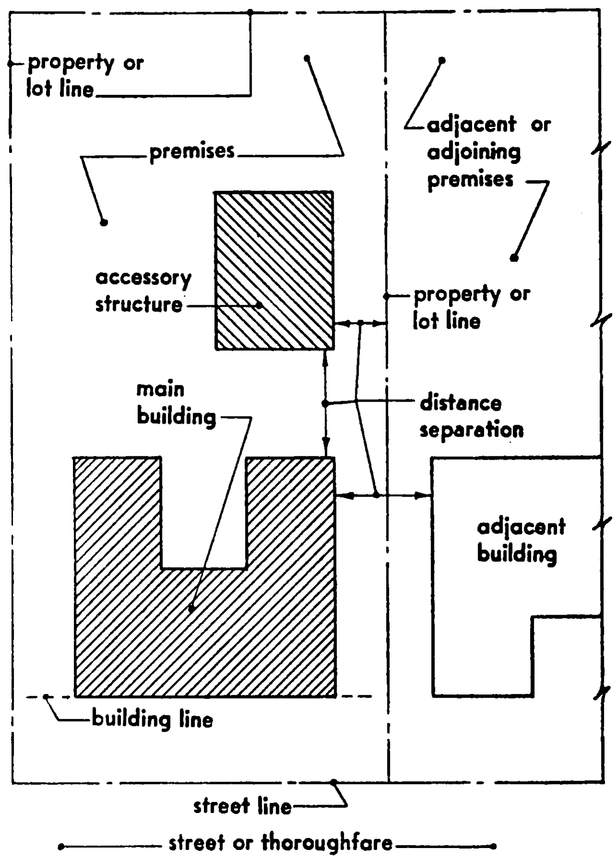
Distance Separation—An open space between buildings or between a building and a line on adjoining premises to which a building may be legally built, provided to prevent the spread of fire.

Lot Line—Line dividing one premises from another, or from a street or other public space.

Premises—A lot, plot, or parcel of land including the buildings or structures thereon.

Property Line—Line establishing the boundaries of premises.

Street Line—Line dividing a lot, plot, or parcel from a street. The street line is the line which divides the premises from the street regardless of any required setback. When a building is built to



the street line, the building line and the street line may coincide.

part 2

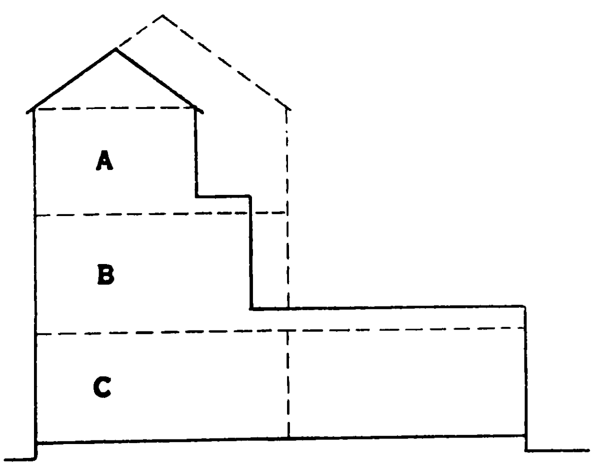
Construction illustrated or described herein is acceptable under the State Building Construction Code, but shall not be interpreted as excluding other construction which meets the requirements of the Code.

Height and Fire Areas Applicable to One- and Two-Family Dwellings

The maximum fire area in a dwelling, within exterior walls, party walls, fire walls, or any combination thereof, shall not exceed those indicated in table below.

MAXIMUM PERMITTED FIRE AREAS
Based on fire-resistance ratings of structural elements

Construction classification	Floor	Other structural elements except exterior and fire walls	Maximum area in square feet
Type 1	2 hr	¾ hr or more	Unlimited
Type 2a Type 2b	¾ hr nc	¾ hr nc	8000 5000
Type 3	¾ hr	¾ hr	5000
Type 4a Type 4b	¾ hr c	¾ hr c	5000 3000
Type 5a Type 5b	¾ hr c	¾ hr c	3000 2500



Example: Assume that the building is of type 5a construction, three stories high. The allowable fire area from table above is 3000 square feet per story, or a total area of 9000 square feet for the three stories. If story C is increased to more than 3000 square feet, then A, or A and B shall be decreased in area so that the total permissible area of 9000 square feet is not exceeded.

Height and Fire Areas Applicable to Multiple Dwellings

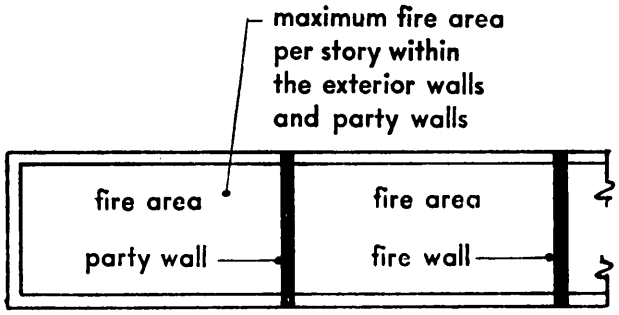
Fire Area—The floor area of a story of a building within exterior walls, party walls, fire walls, or any combination thereof.

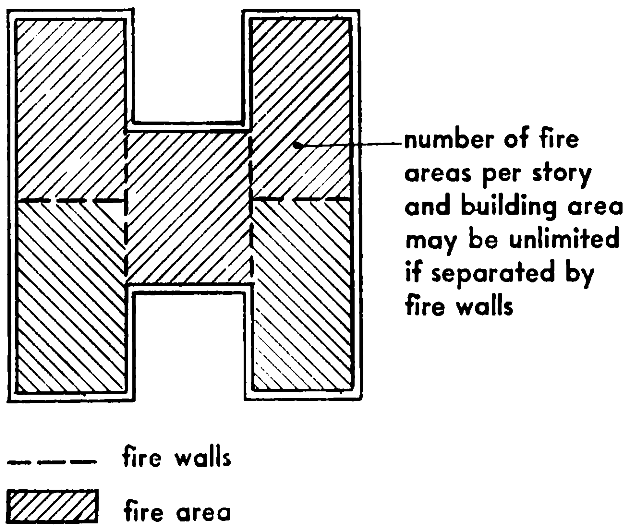
Floor Area—The floor area within surrounding walls of a building, or portion thereof.

When the floor area of a story is subdivided by a fire wall or fire walls, the fire area is that area on each side of such fire wall or fire walls.

When a story of a building is subdivided by fire walls, the fire area is that area between fire walls. The floor area per story of a building is the total of all fire areas on that story.

Fire areas required to conform to the area limitations set forth for its type of construction shall

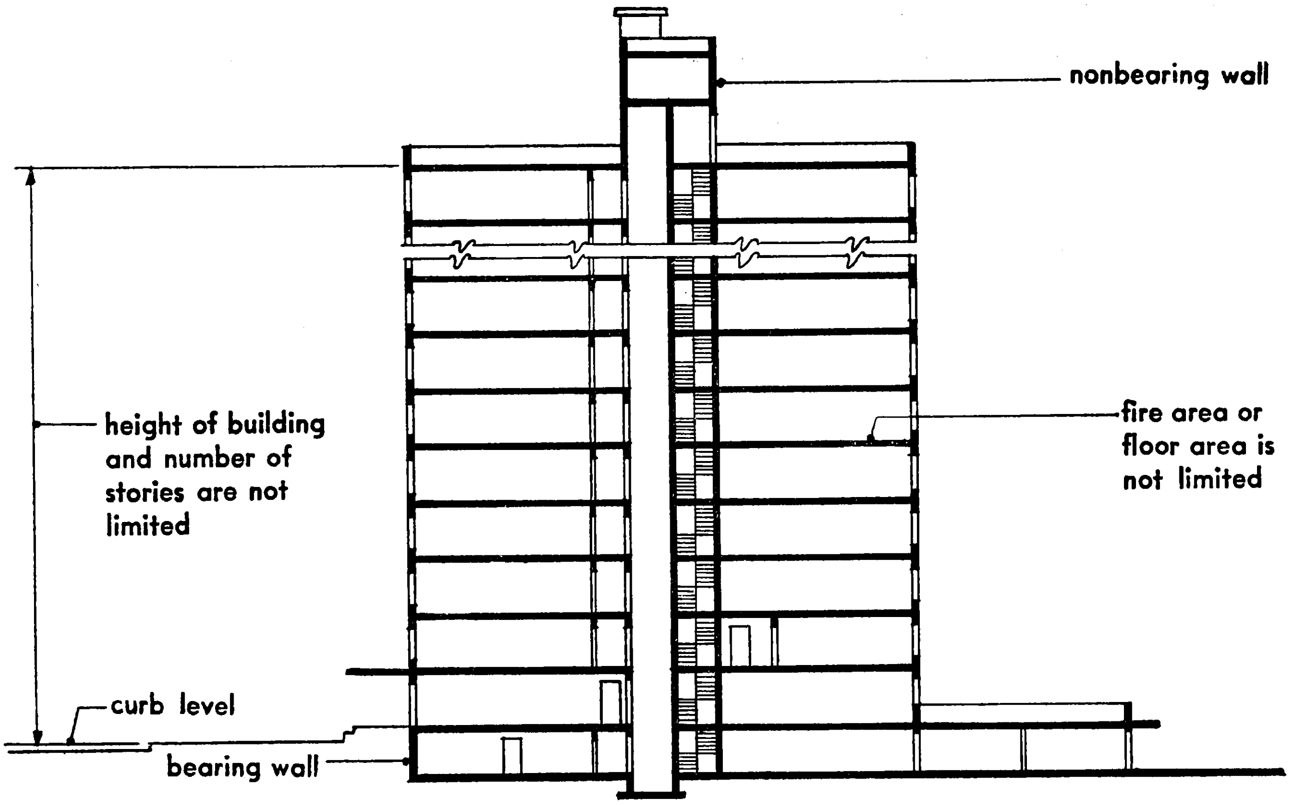




be limited to an area or part of a building as though each such area or part is a separate building.

A party wall separates buildings, when attached. Fire walls subdivide areas within exterior walls, exterior walls and party wall, or exterior walls and party walls.

Example of Type 1 Construction



MINIMUM FIRE-RESISTANCE REQUIREMENTS OF STRUCTURAL ELEMENTS
(Fire-resistance ratings in hours)

Structural element	Construction Classification [1] Type 1 (Fire-resistive) 1a	1b	Remarks
Exterior:			
Bearing walls	4	3	
Nonbearing walls	2	2	
Panel and curtain walls [2]	¾	¾	
Party Walls [3]	4	3	
Interior:			
Fire walls [4]	4	3	
Bearing walls or partitions	4	3	
Partitions enclosing stairways, hoistways, shafts, other vertical openings; and hallways:			
on outside exposure	2 [5]	2 [5]	
on inside exposure	1	1	
Nonbearing walls and partitions separating tenant spaces	1	1	
Columns, beams, girders and trusses (other than roof trusses):			
supporting more than 1 floor	4	3	
supporting 1 floor	3	2	
Floor construction including beams	3	2	
Roof construction including purlins, beams and roof trusses	2 [6]	1 [6]	

Remarks:

[1] For classification of buildings by type of construction, see section B 202–2 of the Code entitled, "Classification by Type of Construction."

[2] For exceptions, see sections B 401–3.3 of the Code entitled, "Construction Limitations Within Fire Limits," and B 401-3.4 entitled, "Construction Limitations Outside the Fire Limits."

[3] For exceptions, see section B 401–8.2 of the Code.

[4] For exceptions, see section B 402–2.2 of the Code.

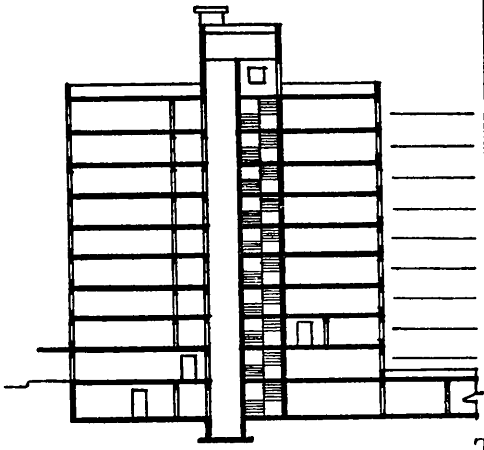
[5] In buildings not more than three stories in height, and with not more than eight dwelling units within a fire area, 1 hour in type 1 construction.

[6] If every part of noncombustible roof truss is more than 20 feet above floor next below, protection of the roof truss is not required. Roof construction shall be of noncombustible material, but is not required to have any rating.

Example of Type 2 Construction

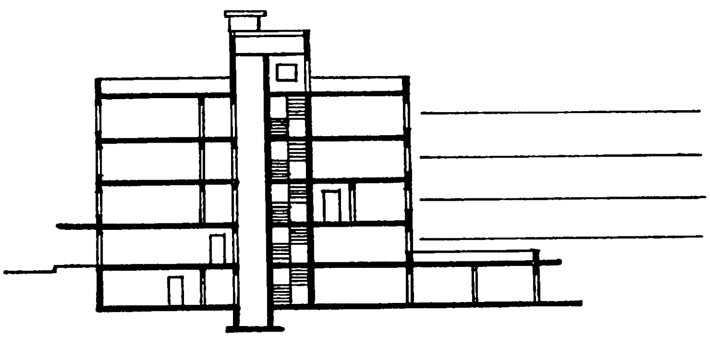
[MAXIMUM FIRE AREA OF HIGHEST STORY DETERMINES MAXIMUM FIRE AREA FOR EACH STORY.]

For Group B1 Occupancy



MAXIMUM FIRE AREA, PER STORY									
Height in feet	Height in stories								
	1	2	3	4	5	6	7	8	9
100									4000
90								5000	4000
80							6000	5000	4000
70						7000	6000	5000	4000
60					8000	7000	6000	5000	4000
50				9000	8000	7000	6000	5000	4000
40			10,000	9000	8000	7000	6000	5000	4000
30		11,000	10,000	9000	8000	7000	6000	5000	4000
15	12,000	11,000	10,000	9000	8000	7000	6000	5000	4000

Type 2a Construction

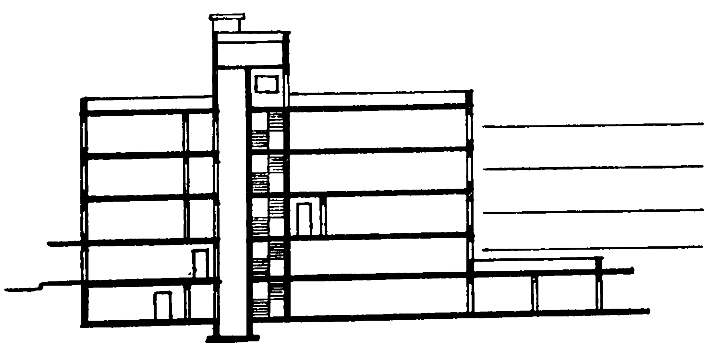


MAXIMUM FIRE AREA PER STORY				
Height in feet[1]	Height in stories[1]			
	1	2	3	4
50				4000
40			5500	4000
30		7500	5500	4000
15	9500	7500	5500	4000

[1] Maximum height permitted, four stories, or 50 feet.

Type 2b Construction

For Group B2 Occupancy



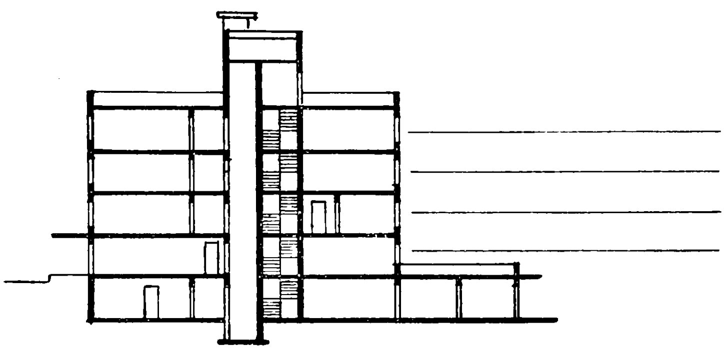
MAXIMUM FIRE AREA PER STORY[1]				
Height in feet[2]	Height in stories[2]			
	1	2	3	4
50				5000
40			6500	5000
30		7500	6500	5000
15	8000	7500	6500	5000

[1] Areas may be increased 100 per cent if sprinkler system is installed throughout building.
[2] Maximum height permitted, four stories, or 50 feet.

Type 2a Construction

Example of Type 2 Construction for Group B2 Occupancy (*Continued*)

[MAXIMUM FIRE AREA OF HIGHEST STORY DETERMINES MAXIMUM FIRE AREA FOR EACH STORY.]



MAXIMUM FIRE AREA PER STORY[1]				
Height in feet[2]	Height in stories[2] 1	2	3	4
50				4000
40			5000	4000
30		6000	5000	4000
15	7000	6000	5000	4000

[1] Areas may be increased 100 per cent if sprinkler system is installed throughout building.
[2] Maximum height permitted, four stories, or 50 feet.

Type 2b Construction

MINIMUM FIRE-RESISTANCE REQUIREMENTS OF STRUCTURAL ELEMENTS
(Fire-resistance ratings in hours)

Structural element	Construction Classification[1] Type 2 (Noncombustible) 2a	2b
Exterior:		
Bearing walls	2	nc
Nonbearing walls	2	nc
Panel and curtain walls[2]	¾	nc
Party Walls[3]	2	2
Interior:		
Fire walls[4]	2	2
Bearing walls or partitions	2	nc[8]
Partitions enclosing stairways, hoistways, shafts, other vertical openings; and hallways:		
on outside exposure	2[5]	2[5]
on inside exposure	¾	¾
Nonbearing walls and partitions separating tenant spaces	¾	¾
Columns, beams, girders and trusses (other than roof trusses):		
supporting more than 1 floor	2	nc
supporting 1 floor	¾	nc
Floor construction including beams	¾[7]	nc[7, 8]
Roof construction including purlins, beams and roof trusses	¾[6]	nc

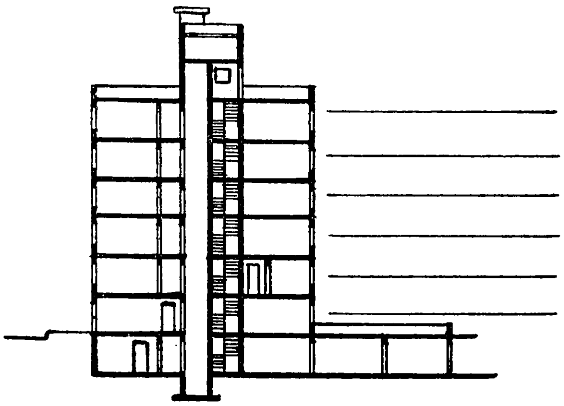
Remarks

[1] For classification of buildings by type of construction, see section B 202–2 of the Code entitled, "Classification by Type of Construction."
[2] For exceptions, see section B 401–3.3 of the Code entitled, "Construction Limitations With in Fire Limits," and B 401–3.4 entitled, "Construction Limitations Outside the Fire Limits."
[3] For exceptions, see section B 401–8.2 of the Code.
[4] For exceptions, see section B 402–2.2 of the Code.
[5] In buildings not more than three stories in height, and with not more than eight dwelling units within a fire area, ¾ hour in type 2 construction.
[6] If every part of noncombustible roof truss is more than 20 feet above floor next below, protection of the roof truss is not required. Roof construction shall be of noncombustible material, but is not required to have any rating.
[7] In buildings of type 2 construction, three or more stories in height, the floor above the cellar, basement, or lowest story and all construction below, shall be same as type 1.
[8] ¾ hour when separating tenant spaces.

Example of Type 3 Construction

[Maximum Fire Area of Highest Story Determines Maximum Fire Area for Each Story.]

For Group B1 Occupancy

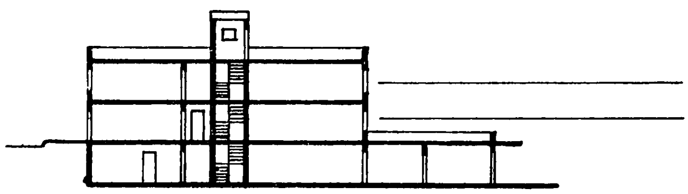


multiple dwellings other than hotels

MAXIMUM FIRE AREA PER STORY						
Height in feet[1]	Height in stories[1]					
	1	2	3	4	5	6
70						3000
60					4000	3000
50				5000	4000	3000
40			6000	5000	4000	3000
30[2]		8000	6000	5000	4000	3000
15	10,000	8000	6000	5000	4000	3000

[1] Maximum height permitted, six stories, or 70 feet.
[2] In hotels, the height shall not exceed two stories, except that if a sprinkler system is installed throughout such buildings, the height may be increased to four stories.

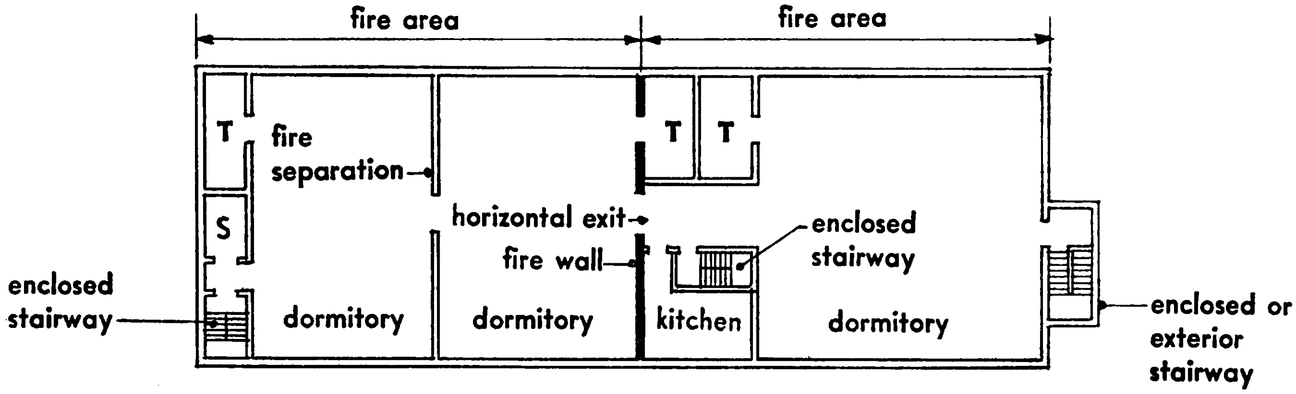
For Group B2 Occupancy



MAXIMUM FIRE AREA PER STORY[1]		
Height in feet[2]	Height in stories[2]	
	1	2
30		3500
15	5000	3500

[1] Areas may be increased 100 per cent, if sprinkler system is installed throughout the building.
[2] Maximum height permitted, two stories, or 30 feet.

Example of Type 3 Construction for Group B2 Occupancy (*Continued*)



PLAN

In Group B2 occupancy, each fire area shall have two exits, one of which may be a horizontal exit in lieu of one enclosed stairway. Horizontal exits shall not be in excess of one half the total required number of exits from any one fire area.

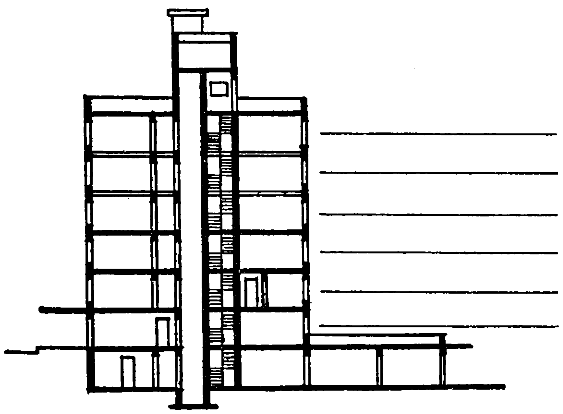
MINIMUM FIRE-RESISTANCE REQUIREMENTS OF STRUCTURAL ELEMENTS
(Fire-resistance ratings in hours)

Structural element	Construction Classification [1] Type 3 (Heavy timber)	Remarks
Exterior:		[1] For classification of buildings by type of construction, see section B 202–2 of the Code entitled, "Classification by Type of Construction." [2] For exceptions, see section B 401–8.2 of the Code. [3] For exceptions, see section B 402–2.2 of the Code. [4] In buildings not more than three stories in height, and with not more than eight dwelling units within a fire area, ¾ hour in type 3 construction. [5] In buildings of type 3 construction, three or more stories in height, the floor above the cellar, basement, or lowest story and all construction below, shall be type 1.
Bearing walls	2	
Nonbearing walls	2	
Party Walls [2]	4	
Interior:		
Fire walls [3]	4	
Bearing walls or partitions	2	
Partitions enclosing stairways, hoistways, shafts, other vertical openings; and hallways:		
on outside exposure	2 [4]	
on inside exposure	¾	
Nonbearing walls and partitions separating tenant spaces	¾	
Columns, beams, girders and trusses (other than roof trusses):		
supporting more than 1 floor	¾	
supporting 1 floor	¾	
Floor construction including beams	¾ [5]	
Roof construction including purlins, beams and roof trusses	¾	

Example of Type 4 Construction

[Maximum Fire Area of Highest Story Determines Maximum Fire Area for Each Story.]

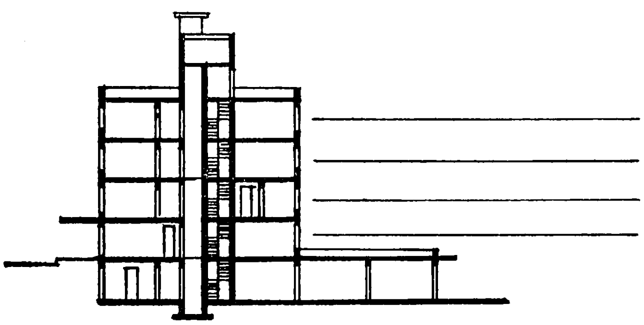
For Group B1 Occupancy



MAXIMUM FIRE AREA PER STORY						
Height in feet[1]	Height in stories[1]					
	1[2]	2[2]	3	4	5	6
70						3000
60					4000	3000
50				5000	4000	3000
40			6000	5000	4000	3000
30[3]		8000	6000	5000	4000	3000
15	10,000	8000	6000	5000	4000	3000

[1] Maximum height permitted, six stories, or 70 feet.
[2] Fire areas shown may be increased 25 per cent for garden apartments and motels.
[3] In hotels, the height shall not exceed two stories, except that if a sprinkler system is installed throughout such buildings, the height may be increased to four stories.

Type 4a Construction

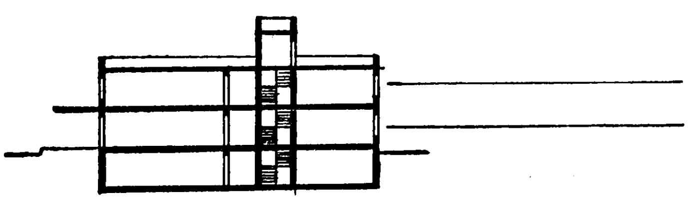


MAXIMUM FIRE AREA PER STORY				
Height in feet[1]	Height in stories[1]			
	1[2]	2[2]	3	4
50				2500
40			3500	2500
30[3]		5500	3500	2500
15	7500	5500	3500	2500

[1] Maximum height permitted, four stories, or 50 feet.
[2] Fire areas shown may be increased 25 per cent for garden apartments and motels.
[3] In hotels, the height shall not exceed two stories, except that if a sprinkler system is installed throughout such buildings, the height may be increased to four stories.

Type 4b Construction

For Group B2 Occupancy



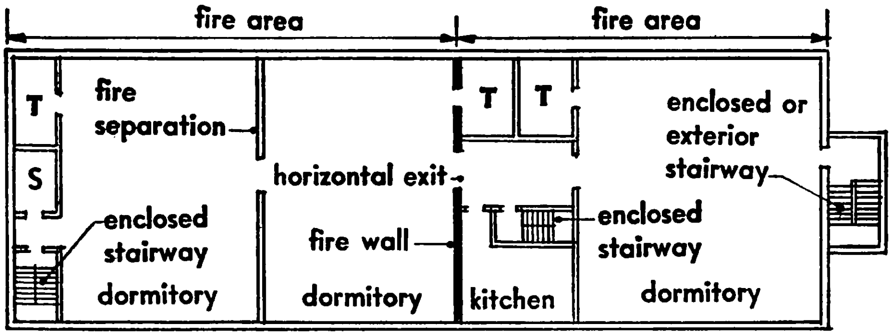
MAXIMUM FIRE AREA PER STORY[1]		
Height in feet[2]	Height in stories[2]	
	1	2
30		3500
15	5000	3500

[1] Areas may be increased 100 per cent, if sprinkler system is installed throughout the building.
[2] Maximum height permitted, two stories, or 30 feet.

Type 4a Construction

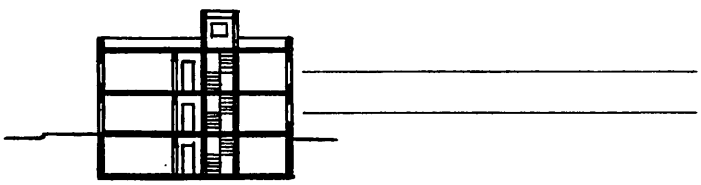
Example of Type 4 Construction for Group B2 Occupancy (*Continued*)

[MAXIMUM FIRE AREA OF HIGHEST STORY DETERMINES MAXIMUM FIRE AREA FOR EACH STORY.]



PLAN

In Group B2 occupancy, each fire area shall have two exits, one of which may be a horizontal exit in lieu of one enclosed stairway. Horizontal exits shall not be in excess of one half of the total required number of exits from any one fire area.



MAXIMUM FIRE AREA PER STORY[1]		
Height in feet[2]	Height in stories[2]	
	1	2
30		2500
15	3000	2500

[1] Areas may be increased 100 per cent, if sprinkler system is installed throughout the building.
[2] Maximum height permitted, two stories, or 30 feet.

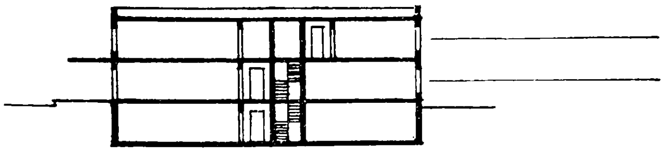
Type 4b Construction

MINIMUM FIRE-RESISTANCE REQUIREMENTS OF STRUCTURAL ELEMENTS
(Fire-resistance ratings in hours)

Structural element	Construction Classification [1] Type 4 (Ordinary) 4a	4b	Remarks
Exterior:			
Bearing walls	2	2	[1] For classification of buildings by type of construction, see section B 202-2 of the Code entitled, "Classification by Type of Construction."
Nonbearing walls	2	2	
Party Walls [2]	2	2	[2] For exceptions, see section B 401-8.2 of the Code.
Interior:			
Fire walls [3]	2	2	[3] For exceptions, see section B 402-2.2 of the Code.
Bearing walls or partitions	¾	c [6]	
Partitions enclosing stairways, hoistways, shafts, other vertical openings; and hallways:			
on outside exposure	2 [4]	2 [4]	[4] In buildings not more than three stories in height, and with not more than eight dwelling units within a fire area, ¾ hour in type 4 construction.
on inside exposure	¾	¾	
Nonbearing walls and partitions separating tenant spaces	¾	¾	
Columns, beams, girders and trusses (other than roof trusses):			[5] In buildings of type 4 construction, three or more stories in height, the floor above the cellar, basement, or lowest story and all construction below, shall be type 1.
supporting more than 1 floor	¾	c	
supporting 1 floor	¾	c	
Floor construction including beams	¾ [5]	nc [5, 6]	[6] ¾ hour when separating tenant spaces.
Roof construction including purlins, beams and roof trusses	¾	nc	

Example of Type 5 Construction for Group B1 Occupancy

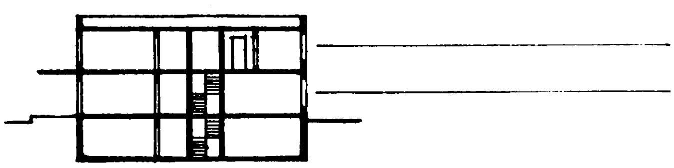
[Maximum Fire Area of Highest Story Determines Maximum Fire Area for Each Story.]



MAXIMUM FIRE AREA PER STORY[1, 2]		
Height in feet[3]	Height in stories[3]	
	1	2
30		4000
15	6000	4000

[1] Areas indicated may be increased 25 per cent for garden apartments less than three stories in height, and motels.
[2] Not more than eight dwelling units in each building or in each part of a building within fire walls.
[3] Maximum height permitted, two stories, or 30 feet.

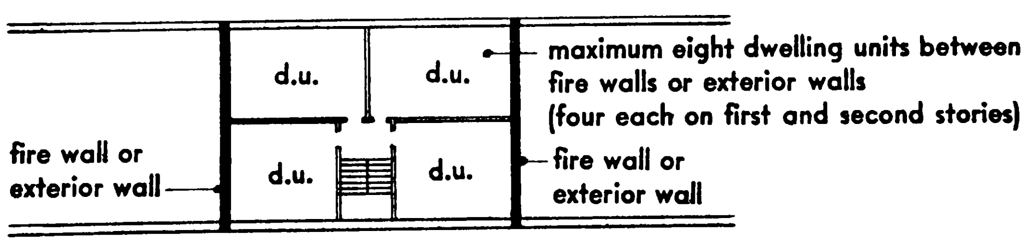
Type 5a Construction



MAXIMUM FIRE AREA PER STORY[1, 2]		
Height in feet[3]	Height in stories[3]	
	1	2
30		3000
15	4000	3000

[1] Areas indicated may be increased 25 per cent for garden apartments less than three stories in height, and motels.
[2] Not more than eight dwelling units in each building or in each part of a building within fire walls.
[3] Maximum height permitted, two stories, or 30 feet.

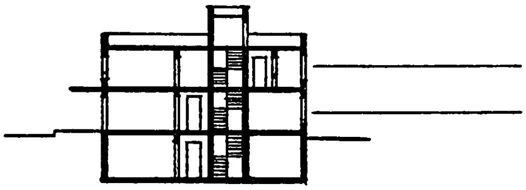
Type 5b Construction



PLAN

Example of Type 5 Construction for Group B2 Occupancy

[MAXIMUM FIRE AREA OF HIGHEST STORY DETERMINES MAXIMUM FIRE AREA FOR EACH STORY.]



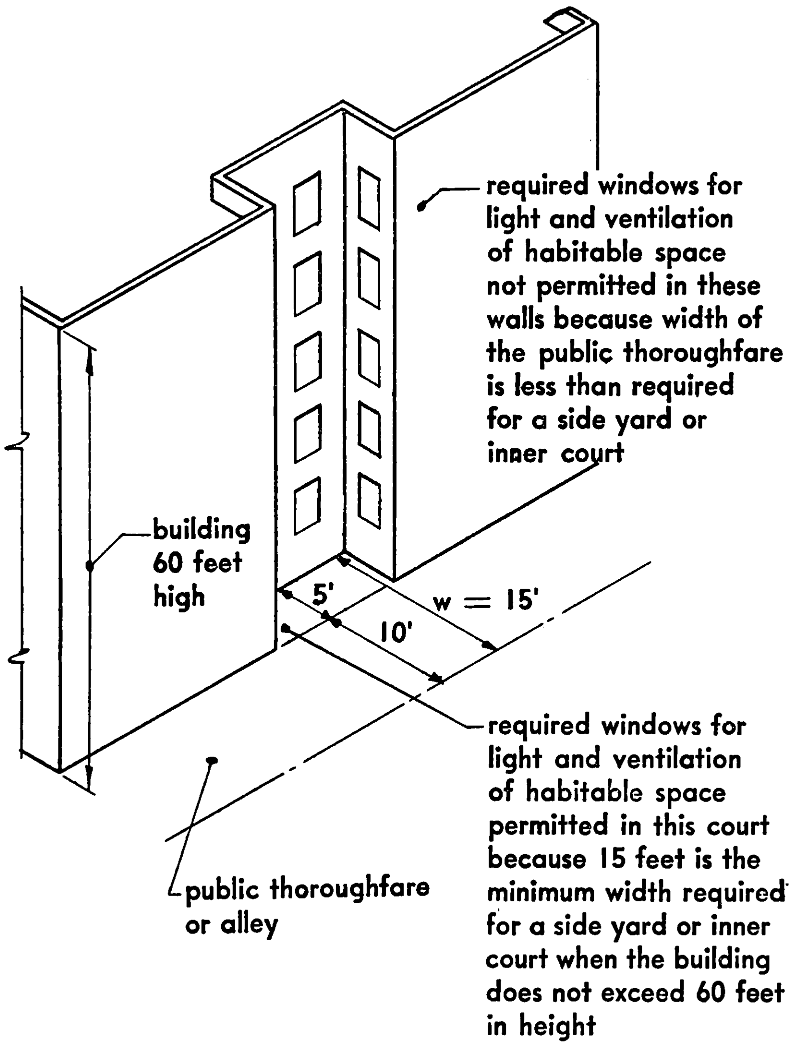
MAXIMUM FIRE AREA PER STORY[1, 2]		
Height in feet[3]	Height in stories[3]	
	1	2
30		2500
15	3000	2500

[1] In type 5a construction, fire areas may be increased 100 per cent if sprinkler system is installed throughout the building.
[2] Not permitted in type 5b construction unless a sprinkler system is installed throughout the building.
[3] Maximum height permitted, two stories, or 30 feet.

MINIMUM FIRE-RESISTANCE REQUIREMENTS OF STRUCTURAL ELEMENTS
(Fire-resistance ratings in hours)

Structural element	Construction Classification[1] Type 5 (Wood frame) 5a	5b	Remarks
Exterior:			
Bearing walls	¾	c	[1] For classification of buildings by type of construction, see section B 202-2 of the Code entitled, "Classification by Type of Construction."
Nonbearing walls	¾	c	
Party Walls [2]	2	2	[2] For exceptions, see section B 401-8.2 of the Code.
Interior:			
Fire walls [3]	2	2	[3] For exceptions, see section B 402-2.2 of the Code.
Bearing walls or partitions	¾	c [4]	[4] ¾ hour when separating tenant spaces.
Partitions enclosing stairways, hoistways, shafts, other vertical openings; and hallways:			
on outside exposure	¾	¾	
on inside exposure	¾	¾	
Nonbearing walls and partitions separating tenant spaces	¾	¾	
Columns, beams, girders and trusses (other than roof trusses):			
supporting more than 1 floor	¾	c	
supporting 1 floor	¾	c	
Floor construction including beams	¾	c [4]	
Roof construction including purlins, beams and roof trusses	¾	c	

Minimum Requirements for Light and Ventilation

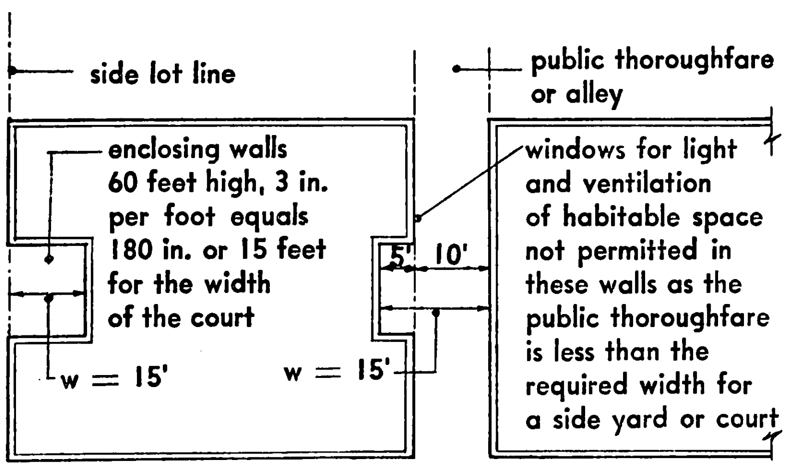


Yards and courts shall be measured from the building outward, shall not begin higher than the floor level of the first habitable story, and in no event begin higher than 23 feet above the curb level or finished grade.

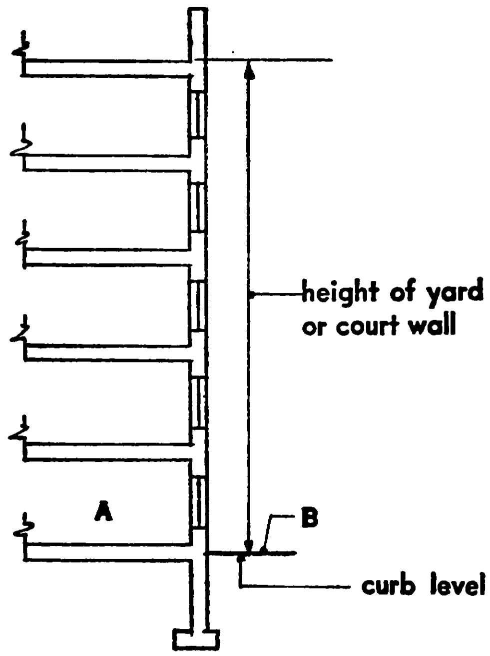
Yards and courts shall be open and unobstructed for their required area and full height, except that window sills, belt courses and other architectural or ornamental projections shall not project more than 4 inches from a wall, nor shall fire escapes project more than 4 feet 6 inches into a yard or court.

For **minimum dimensions** of a yard or court in ratio to the height of the enclosing walls, see section B 204 of the Code, and the following pages of this Manual.

In determining the width (W), in illustrations at the left, a public thoroughfare or alley less in width than that required for a side yard or court for a given height of building may be considered as part of the required width for such yards or courts.

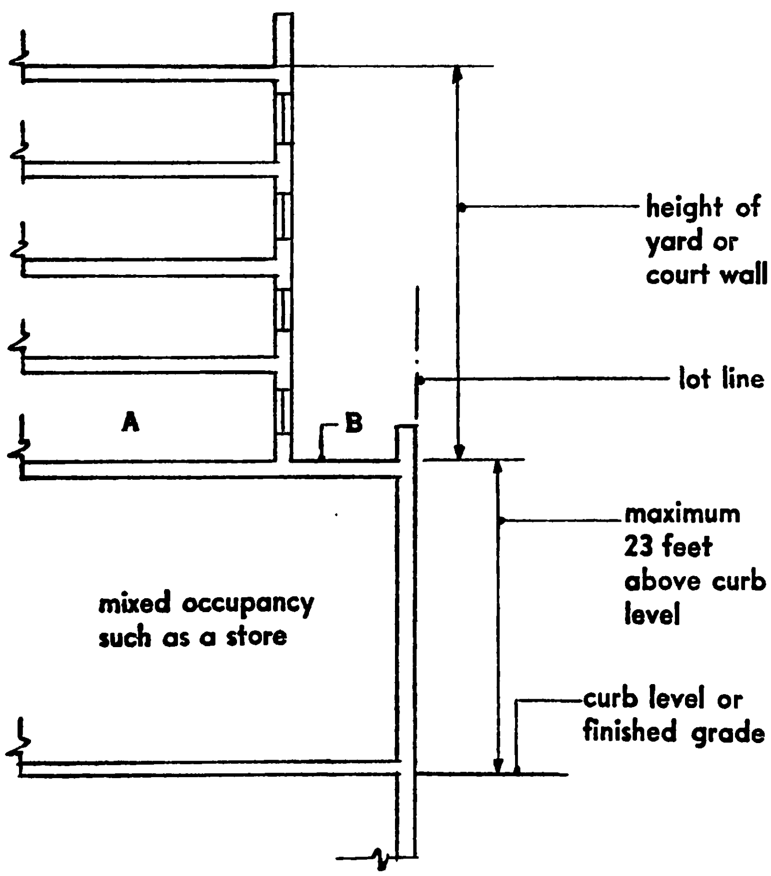


Heights of Enclosing Walls



The height of walls enclosing courts, or adjacent to yards, shall be measured from the grade or curb level. Where permitted by local zoning regulations, yards and courts may begin at the first habitable story which contains openings for natural light and natural ventilation facing on the yard or court. In no event shall they begin higher than 23 feet above curb level or finished grade.

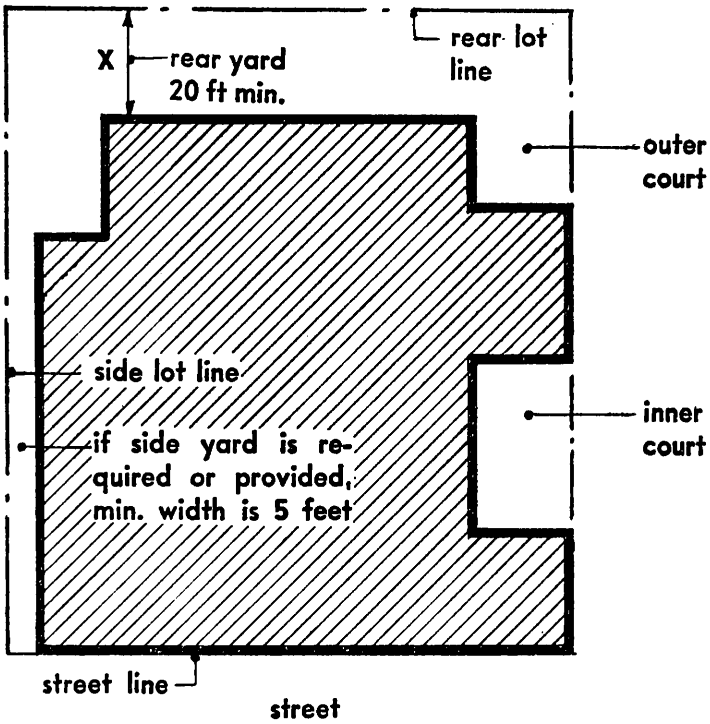
See table B 202-2 of the Code for fire-resistance ratings of enclosing walls based on types of construction.



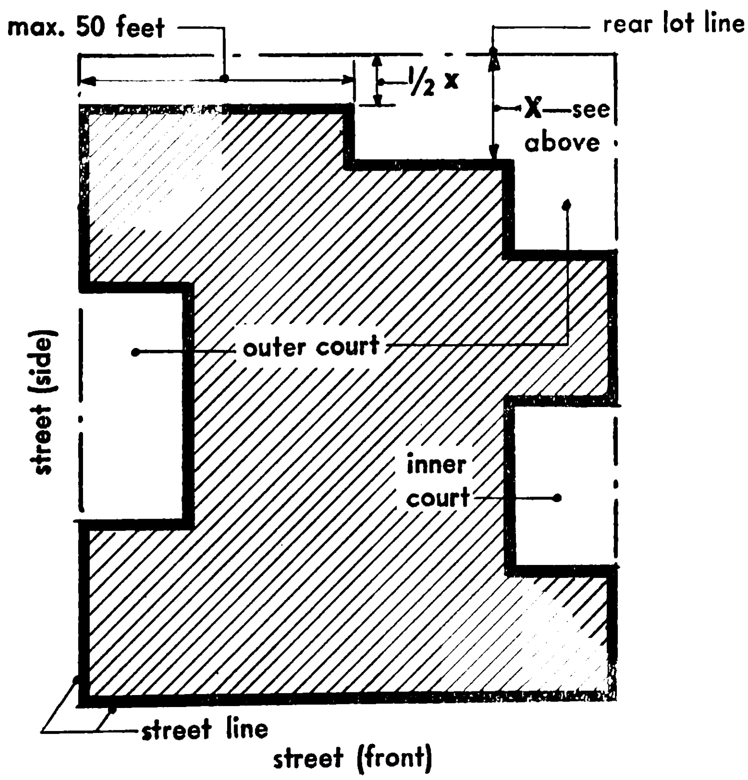
In illustrations on the left, A represents first habitable story having windows for light and ventilation facing on the yard or court.

In illustrations on the left, B represents bottom of yard or court which shall not begin higher than the floor level of the first habitable story (A) and not higher than 23 feet above curb level.

Yards for Buildings not More Than 40 Feet in Height



BUILDING ON INTERIOR LOT



BUILDING ON CORNER LOT

Rear Yard—A rear yard shall be provided at the rear of the building and shall extend along the rear lot line of a lot that abuts other lots or portions of lots. For buildings not more than 40 feet in height, on interior lots, the minimum rear yard depth shall be 20 feet. For each foot that the rear wall of the building or portion thereof exceeds 40 feet in height, measured from the level of the rear yard, the depth of the rear yard shall be increased 3 inches. For such buildings on corner lots, the first 50 feet of the rear yard, measured from the side street line, may be reduced to one half of the depth of the rear yard required on an interior lot.

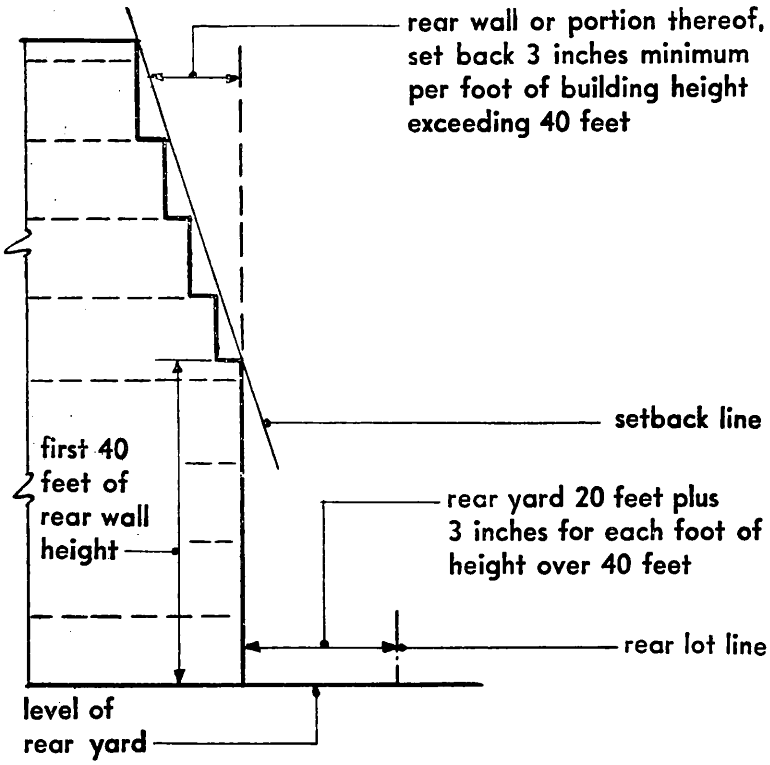
Side Yard—If a side yard is provided or required, it shall be not less than 5 feet in width, at any point. For each foot that the side wall of a building or portion thereof exceeds 30 feet in height, the width of a required side yard shall be increased 2 inches.

Yards for Buildings More Than 40 Feet in Height

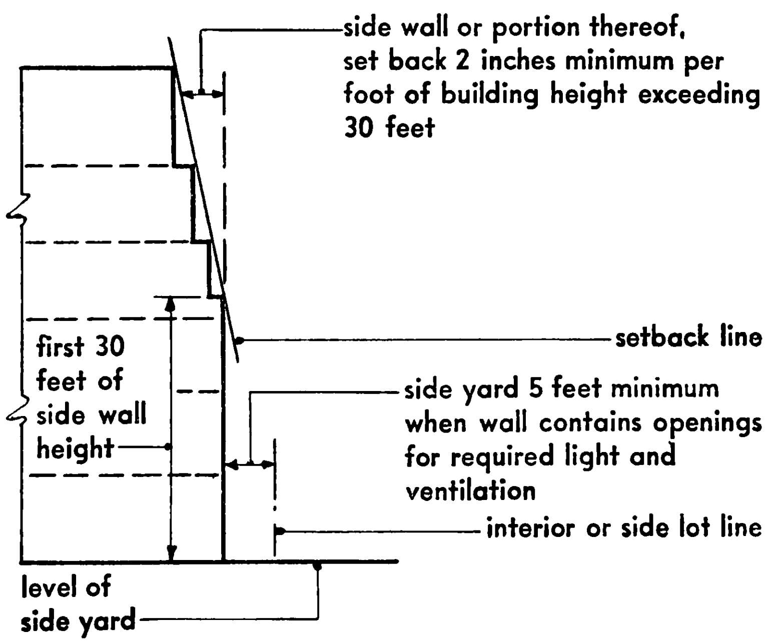
The minimum side and rear yard dimensions are required only when openings for required light and ventilation face such yards.

Yards and courts shall be measured from the building outward, shall not begin higher than the floor level of the first habitable story, and in no event begin higher than 23 feet above the curb level or finished grade.

See section B 204 of the Code for requirements applicable to yards.

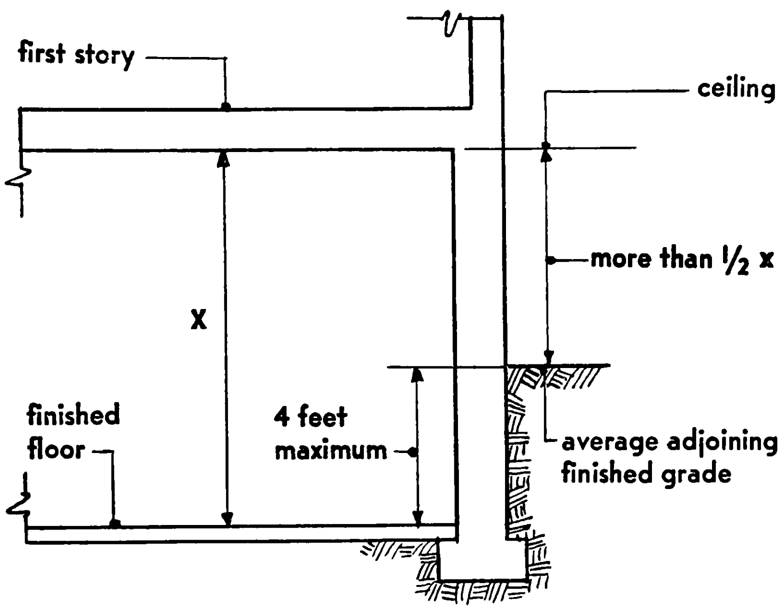


REAR YARD WALLS



SIDE YARD WALLS

Location in Respect to Grade Level

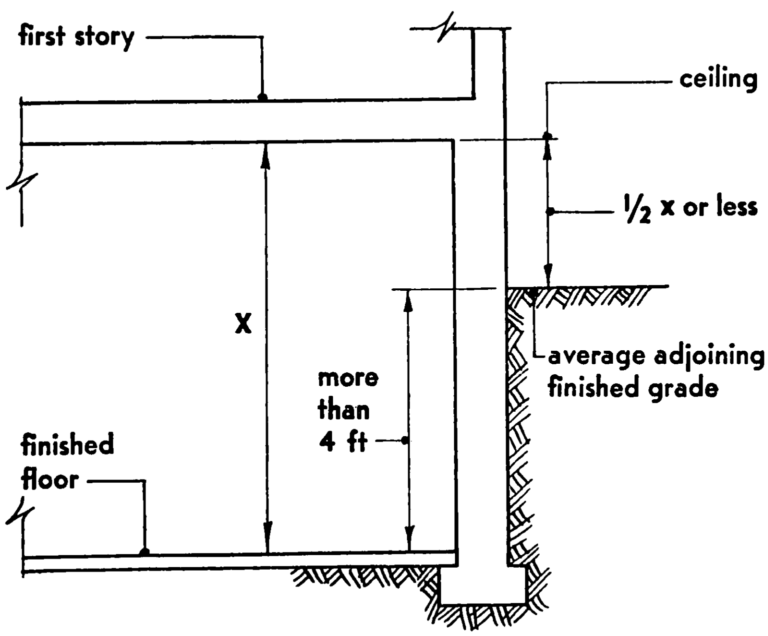


BASEMENT

Basements—Habitable space may be located in a basement provided the floor level of the basement is not more than 4 feet below the average adjoining finished grade.

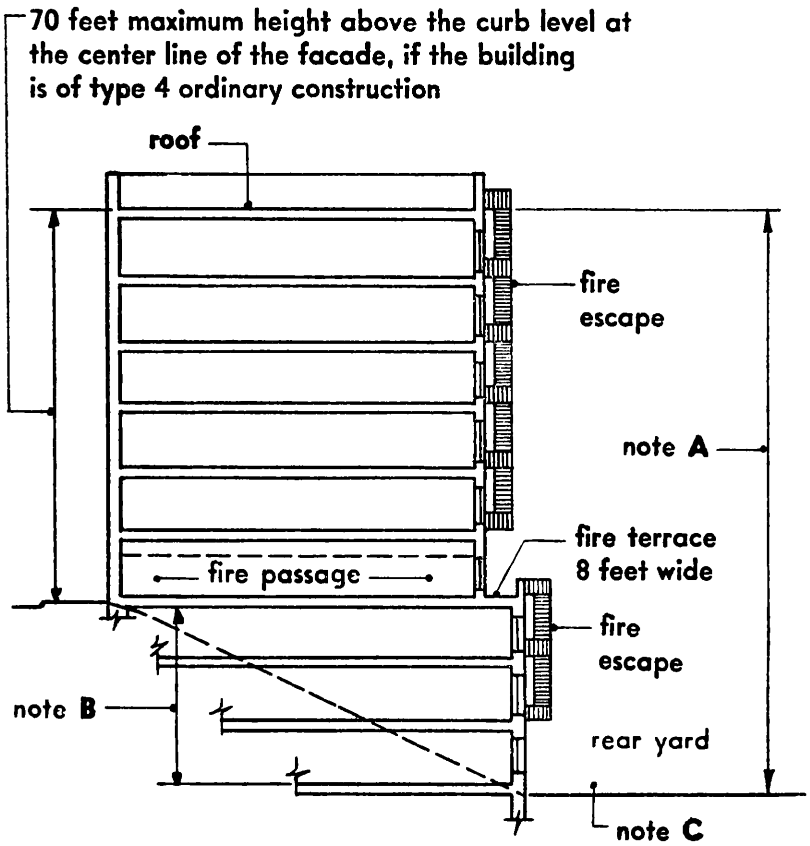
Cellars—Habitable space shall not be located in any cellar. A recreation room may be located in a cellar.

See also sections B 205 and B 402 of the Code for basement and cellar requirements in multiple dwellings.

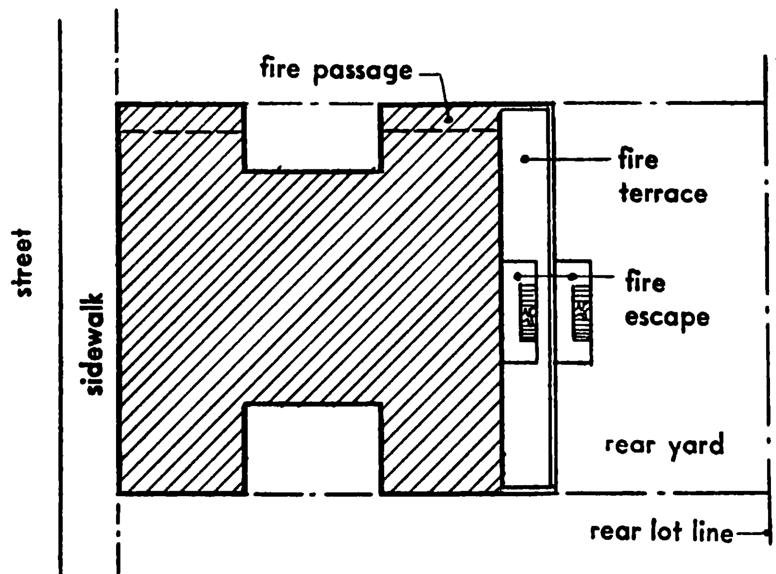


CELLAR

Buildings on Sloping Site with Rear Yard



SECTION



PLAN

Note A: Over-all height of rear wall. Fire terrace required if building is of type 4 construction and more than 80 feet in height.

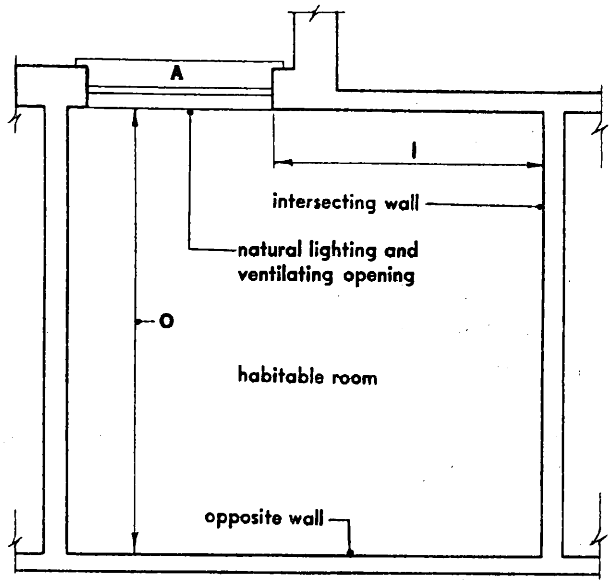
Note B: Habitable space in subgrade stories of type 1 or 2 construction. The exterior foundation walls and soil-supported floor waterproofed.

Note C: Yards shall conform with the requirements set forth in section B 204 of the Code entitled, "Yards and Courts," except that computation of rear yard shall be based on the mean height of the rear wall of the building. Computation of side yard width shall be based on the mean height of the wall abutting the side yard.

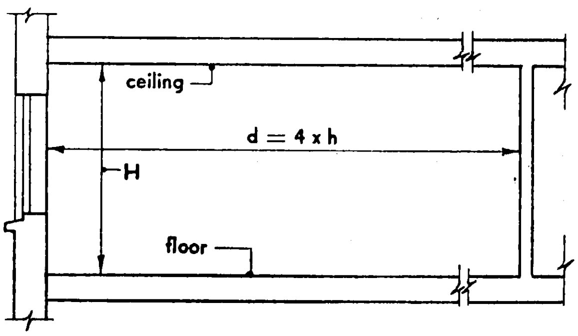
Passageway—Passageway of fire-resistive construction shall be provided at the fire-terrace level, and connected directly to a street or yard. Such passageway shall have a minimum dimension of 3 feet and a cross-sectional area of 20 square feet, and shall be unobstructed throughout.

Fire terrace and passageway not required in buildings of type 1 and 2 construction, or in buildings of type 4 construction that front on three or more streets or are located on corner lots.

Light and Ventilation Opening Requirements



PLAN



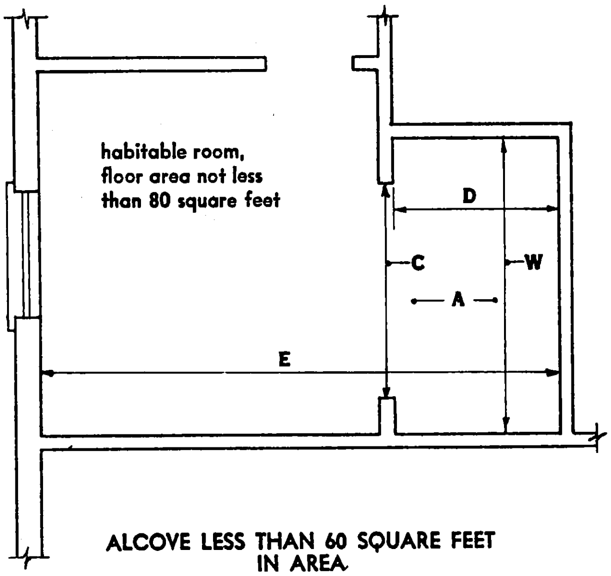
SECTION

Natural Light for Habitable Space—Natural light-transmitting area for habitable space is specified in terms of clear glass equal in area to 10 per cent of the floor area of the habitable space. Increase lighting area (A), in illustration at left, to 12½ per cent of floor area of the habitable space if distance (O) is more than 15 feet, or if distance (I) is more than 9 feet.

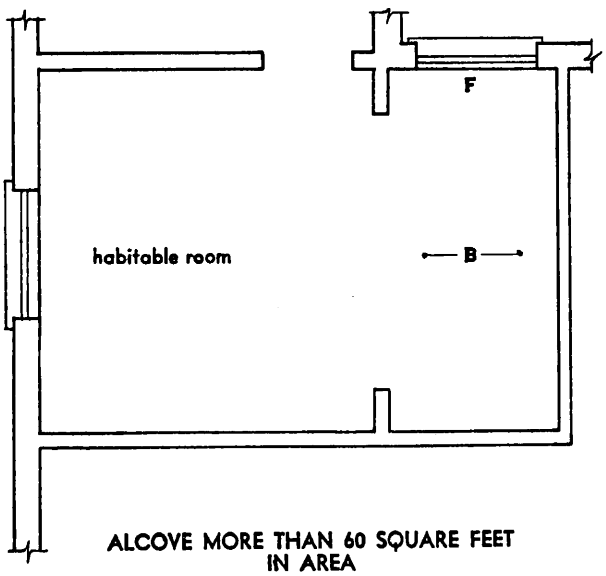
Natural Ventilation for Habitable Space—Natural ventilation shall be provided through openable parts of windows or other openings in exterior walls that face legal open spaces; openable parts of the openings shall be equal in area to not less than 5 per cent of the total floor area of each habitable space. The openable ventilating area shall be increased to 6¼ per cent of the floor area if distance (O) is more than 15 feet, or if distance (I) is more than 9 feet. No part of a habitable room shall be more than four times its clear height distant from the ventilating opening.

Mechanical ventilation for all spaces shall conform with the requirements of part 5 of the Code.

Alcoves



ALCOVE LESS THAN 60 SQUARE FEET IN AREA



ALCOVE MORE THAN 60 SQUARE FEET IN AREA

(A) Alcove less than 60 square feet in area, deemed to be part of a habitable room. Floor area of alcove added to floor area of room to determine light and ventilation requirements.

(B) Alcove more than 60 square feet in area.

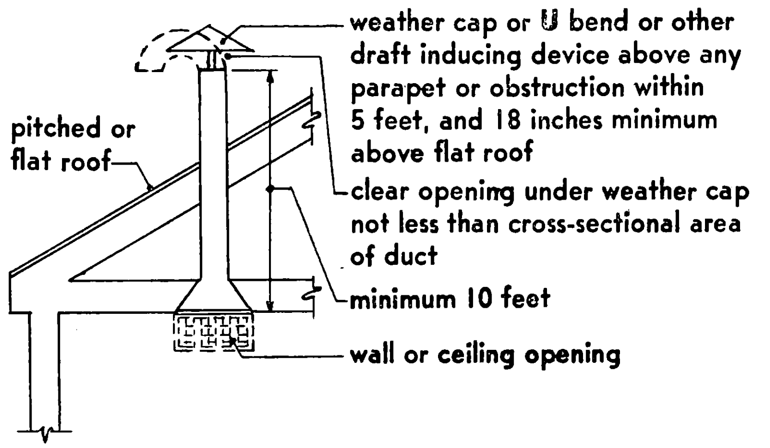
(C) Area of opening at least 80 per cent of wall area on alcove side, but not less than 40 square feet.

(D) Depth of alcove (D) shall not exceed half its width (W).

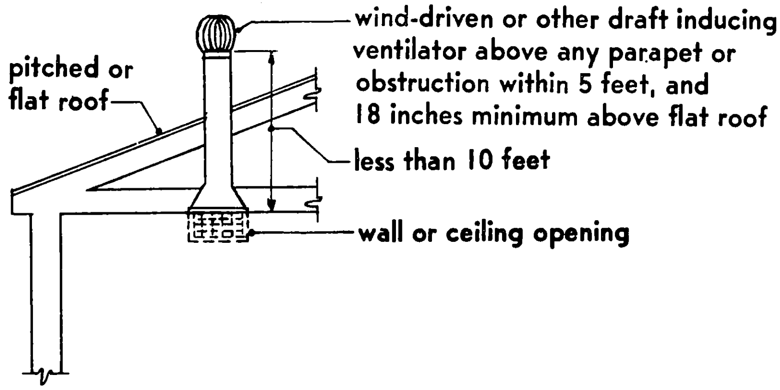
(E) No part of a habitable room shall be more than four times its clear height distant from the natural lighting or ventilating opening.

(F) Alcove more than 60 square feet in area, but less than area required for a habitable room (80 square feet) shall be separately lighted and ventilated as required for habitable space in addition to opening in partition, shown at C.

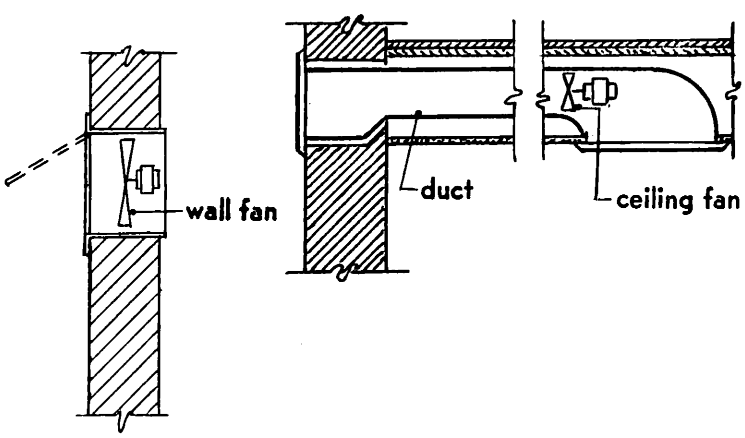
Ventilation of Kitchens, Kitchenettes, Bathrooms and Toilet Rooms



DUCT 10 FEET OR MORE IN HEIGHT



DUCT LESS THAN 10 FEET IN HEIGHT



MECHANICAL VENTILATION

Duct Sizes, Gravity Type—In kitchens and kitchenettes, ducts shall have a minimum cross-sectional area of 144 square inches.

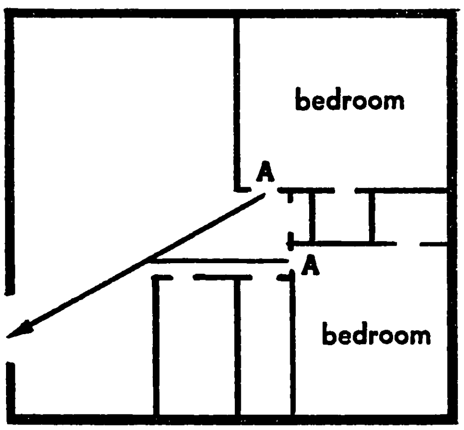
In bathrooms and toilet rooms, ducts shall have a minimum cross-sectional area of 36 square inches. Minimum cross-sectional dimension, 3 inches.

Duct Material—Ducts shall be of noncombustible material resistant to corrosion. Acceptable material shall include: 26 U.S. gage galvanized iron, noncorrodible metal of equivalent stiffness, asbestos, and noncombustible lath and plaster.

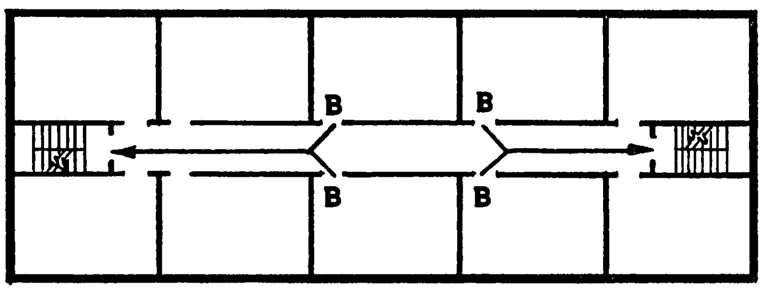
Ventilators—Ducts less than 10 feet in height shall be equipped at the outlet with wind-driven or other draft-inducing ventilators or similar devices which will exhaust the required cubic feet of air per minute in such ducts whenever such ventilators or similar devices are subjected to a wind velocity in excess of 3 miles per hour.

Replacement Air—Replacement air may be obtained from outdoors or from indoor spaces supplied directly with outdoor air. Air intake may be provided by permanent louvers or by allowing space between bottom of door and floor. Clear opening shall be equal to cross-sectional area of exhaust duct.

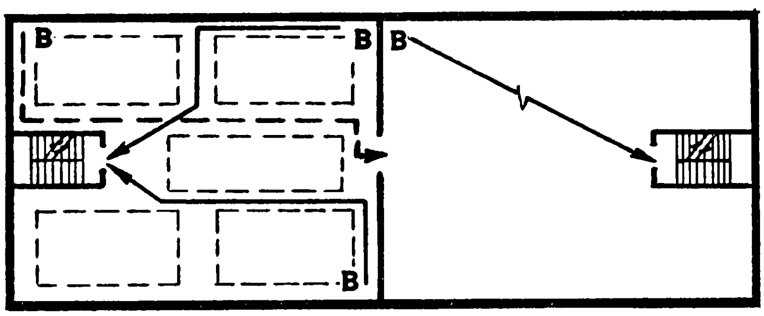
Maximum Distance of Travel to Exits



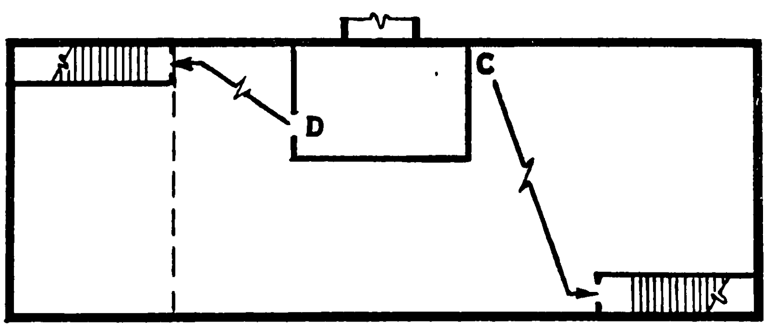
DWELLING UNIT



MULTIPLE DWELLING FLOOR (MORE THAN THREE STORIES)



DINING OR BALLROOM FLOOR



BASEMENT OR BELOW-GRADE STORY

(A) Maximum distance of travel from door of any room in any dwelling unit to a door opening into an exit passageway on the same story shall not exceed 50 feet.

(B) Maximum distance of travel from main entrance door of any dwelling unit or any room or any part of a fire area not so divided, in a story above the grade story, to a passageway to a door opening into an exit stairway or horizontal exit on the same story: 100 feet in buildings of type 1 or 2 construction; 50 feet in buildings of type 3, 4 and 5 construction. When such buildings have a sprinkler system installed throughout, distance may be increased to 100 feet.

(C) Maximum distance of travel from door of any room or any point in a fire area not divided, in a basement or below grade story, to a door opening into an exit stairway or legal open space, or horizontal exit, shall not exceed 75 feet.

(D) Maximum distance of travel from doors of below-grade rooms enclosing equipment as set forth in section B 211 of the Code entitled, "Exits," to a door opening into exit stairway leading to a legal open space, shall not exceed 20 feet.

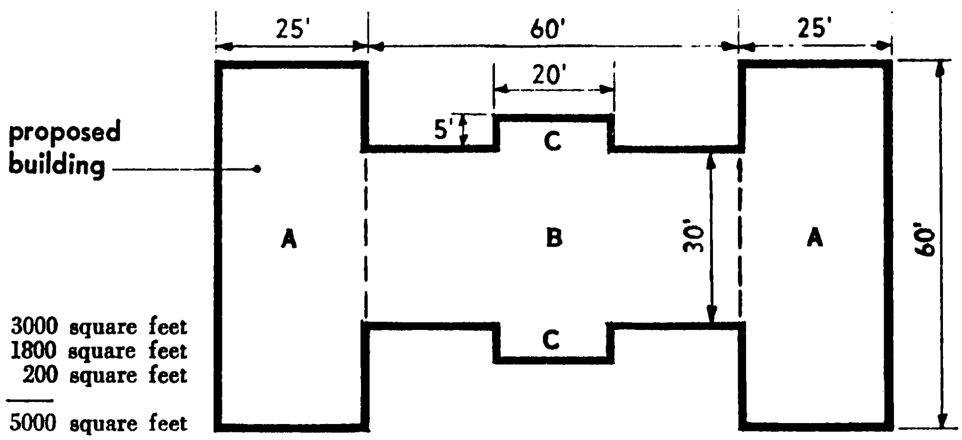
Methods of Determining Exits for Group B1 Occupancy

After determining the type of construction for the proposed building and then establishing the maximum area permissible for the type of construction from table B 203-1a of the Code entitled, "Maximum Height and Fire Area for Group B1 Occupancy," the designer then determines the maximum area per floor.

Example: In a building of type 4 construction, not more than four stories or 50 feet in height, the maximum floor area permitted is 5000 square feet per floor, with-

FLOOR AREA PER OCCUPANT

Space or occupancy	Square feet of area per occupant		
	Below-grade floor areas	First-story floor areas	Floor areas above first floor
Habitable space			
Group B1	200	125	125
Group B2	200	100	75
Public space			
Dining rooms	10	10	10
Lecture rooms, auditoriums	6	6	6
Gymnasiums	15	15	15
Recreation rooms	40	40	40
Nonhabitable space			
Storage	300	300	300
Motor vehicle garage on same premises with or in a multiple dwelling	300	300	300
Service	100	100	100



A=25'x60'x2	3000 square feet
B=30'x60'	1800 square feet
C=5'x20'x2	200 square feet
Total	5000 square feet

in exterior walls, or within exterior walls and a fire or party wall.

Since the area of the proposed building does not exceed the maximum area permitted per story for this type of construction, no fire walls are required and the exits can be determined on the basis of one fire area.

Now refer to the following table for the occupancy group and determine the square feet of area per occupant.

Taking the total floor area of 5000 square feet, divide this figure by the floor area above first floor, or: 5000 divided by 125 equals 40 occupants per floor.

Next determine the minimum permitted width of the exits from the table entitled, "Minimum Required Width of Exits."

Note that for one to forty persons per floor a minimum exit width of 36 inches is required. Therefore, width of exit passageway and exit stairway must be at least 36 inches.

Next, determine the number of stairways or exits from the table entitled, "Required Minimum Number of Exits." From this table, it is noted that for group B1 occupancy two stories or more in height, two exits are required for the building, story and fire area. In the proposed building with no fire walls, two exits will meet any and all of these requirements. Having established the minimum number of exits as two, next determine the type of required exits from the following text:

The required number of exits shall consist of enclosed stairways, except that in buildings of group B1 occupancy not exceeding six stories or 70 feet in height, one fire escape or exterior stairway, accessible from each dwelling unit, is permitted in lieu of one enclosed exit stairway, or one horizontal exit is permitted in lieu of one enclosed stairway. Horizontal exits shall not be in excess of one half the total required number of exits from any one fire area.

In buildings more than three stories in height, stairways are required to be separately enclosed.

Since the building in this example is more than three stories, but less than six stories or 70 feet in height, the exits indicated in any of the schemes illustrated on the following page are acceptable.

Note: Elevators and escalators may not be substituted for, nor be considered as, required exit stairway. Passenger elevators are required in group B1 occupancy exceeding four stories in height and in group B2 occupancy exceeding three stories in height. Requirement for arrangement, loads, enclosure, and construction are set forth in parts 3 and 5 of the Code.

MINIMUM REQUIRED WIDTH OF EXITS

Doorway to passageway, or horizontal exit		Stairway or ramp	
Number of persons	Width in inches [1, 2]	Number of persons	Width, in 22-inch units
1– 85	36	1– 40	([4])
86–115	37– 44	41– 50	2
116–145	45– 55	51– 60	2½
146–175	56– 66	61– 70	3
176–205	67– 77	71– 80	3½
206–235	78– 88	81– 90	4
236–265	89– 99	91–100	4½
266–295	100–110	101–110	5
296–325	111–121	111–120	5½
326–355	122–132 [3]	121–130	6 [5]

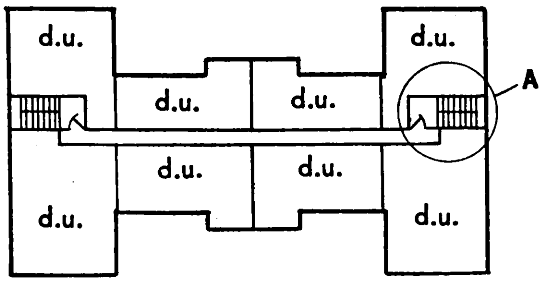
[1] Width of doorway shall be the clear distance between jambs; stops shall not reduce door opening by more than 1½ inches.
[2] Doorways shall comply with section B 211–4d.
[3] If more than 132 inches wide, exit shall be arranged into two or more openings.
[4] 36 inches.
[5] If more than six 22-inch units, exit shall be arranged into two or more stairways.

REQUIRED MINIMUM NUMBER OF EXITS

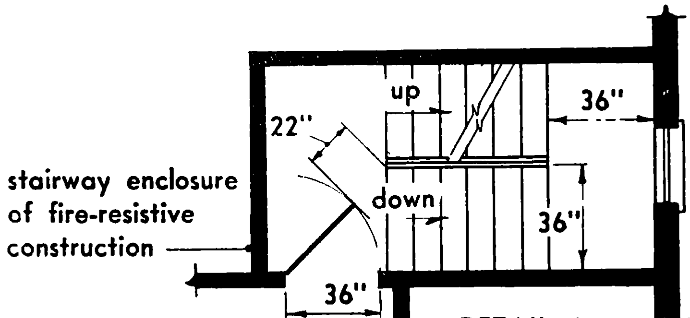
Exit from—	Group B1 1 story	Group B1 2 stories or more	Group B2 any number of stories
Building	1	2 [2]	2
Story	1	2 [2]	2
Cellar or basement [1]	2	2	2
Fire area	1	2 [3]	2
Dwelling unit	1	2 [2, 4]	2
Room, other than in dwelling unit	1	1	1
Public space	2	2	2
Mezzanine, for each 100 persons	1	1	1
Garage	2	2	2

[1] Every area containing equipment as set forth in section B 211–6b, shall be provided with an emergency exit.
[2] In buildings not more than two stories in height, one means of exit permitted from habitable space which has access to a window or other opening which is 14 feet or less above grade directly below.
[3] One exit for each fire area in type 1 construction not more than three stories in height, with not more than four dwelling units within fire area on each story, provided the exit stairs continue to a flat roof, from which there is access to another exit stairs similarly arranged, leading to a legal open space.
[4] One exit in type 1 and 2 construction.

Acceptable Schemes for Exits

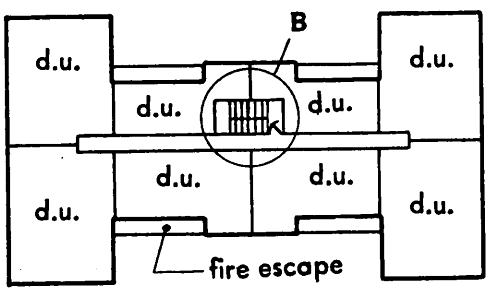


SCHEME A

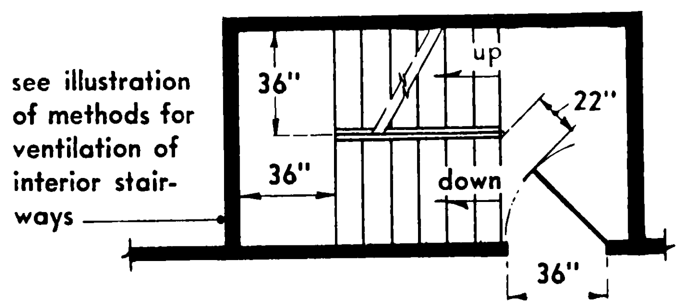


DETAIL A

Two interior stairways 36 inches wide located at each end of a public hallway not exceeding 100 feet in length, 36 inches in width, throughout the line of travel.

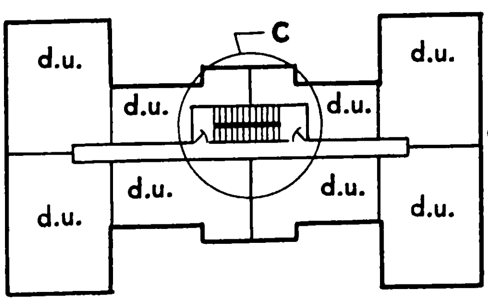


SCHEME B

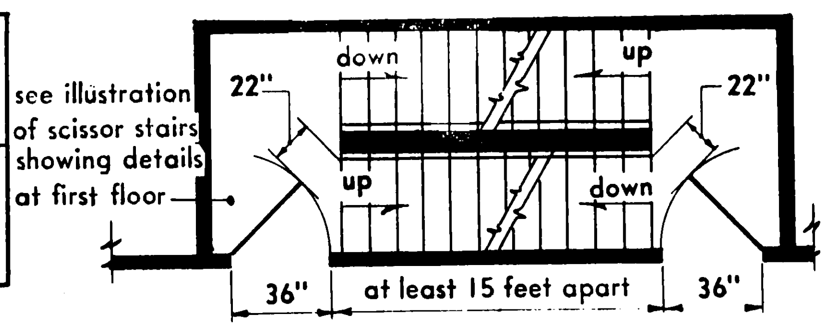


DETAIL B

One interior stairway 36 inches wide, public hallway not exceeding 100 feet in length, 36 inches in width throughout the line of travel and a fire escape accessible from each dwelling unit.



SCHEME C

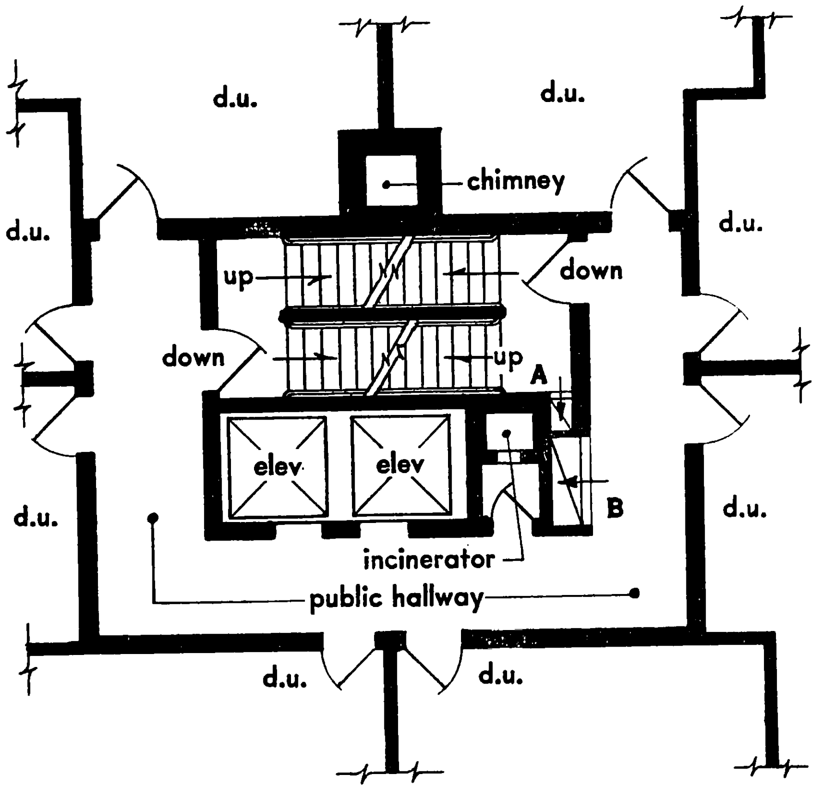


DETAIL C

Two interior stairways 36 inches wide, in an enclosed shaft with door to each stairway separated at least 15 feet; public hallway not exceeding 100 feet in length, 36 inches in width throughout the line of travel.

Typical Arrangement of Public Hall in Type 1 and 2 Construction

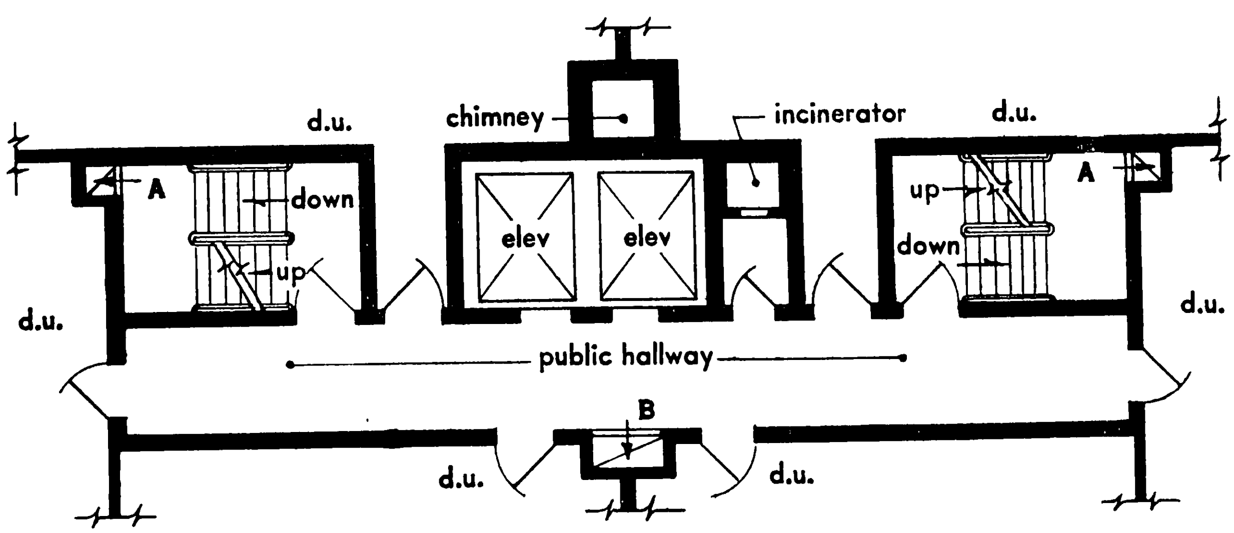
Exits in multiple dwellings shall be plainly marked with directions to a designated termination at a place of safety, and shall be lighted at all times by natural or artificial light of intensity sufficient for safe travel. See section B 505 of the Code entitled, "Electrical Wiring and Equipment."



SCISSOR STAIRS

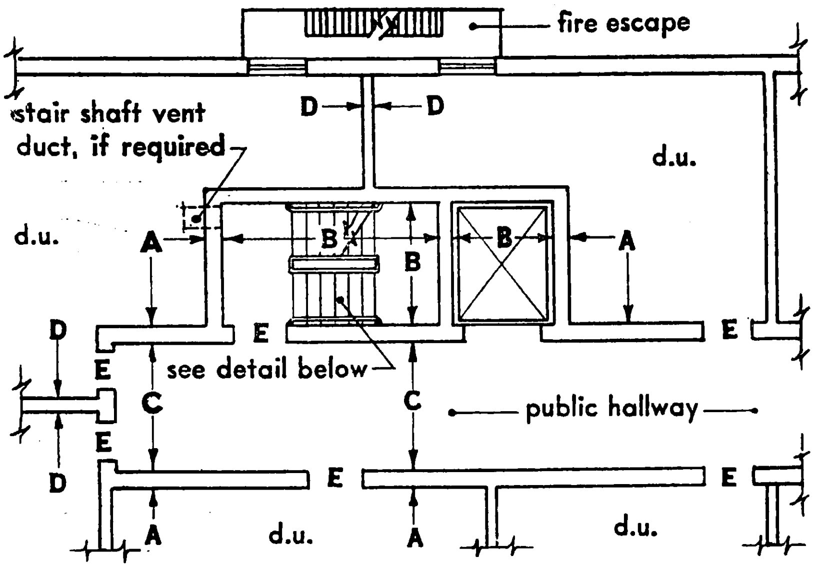
(A) in illustration indicates stair vent duct.

(B) in illustration indicates hall vent duct.



TYPICAL STAIRS

Enclosure Requirements



PLAN

See table B 202-2 of the Code entitled, "Minimum Fire-Resistance Requirements of Structural Elements."

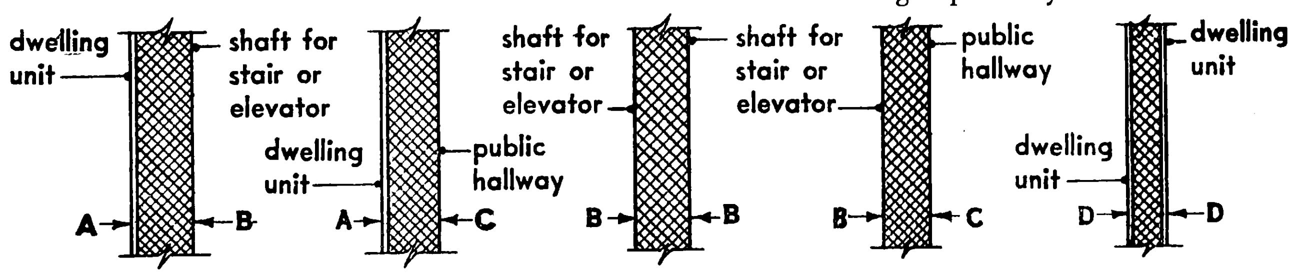
(A) Outside shaft, hall or passageway exposure (dwelling unit side).

(B) Inside shaft exposure (stairs, dumbwaiters, and elevators).

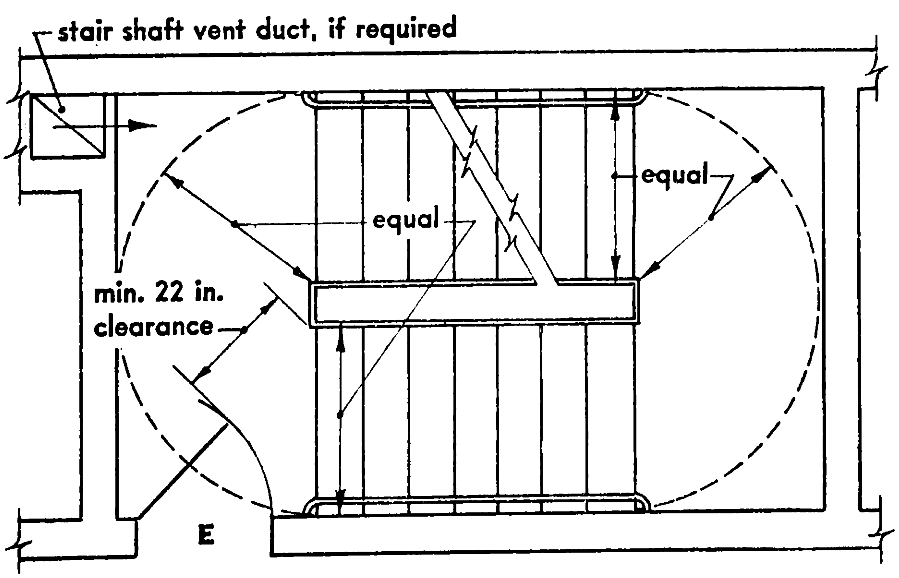
(C) Partitions enclosing public halls or passageways.

(D) Partitions separating dwelling units.

(E) Exit doors and other doors from any floor area or occupied space shall be equipped with self-closing opening protectives of fire-resistance rating required by table B 402-4.8.

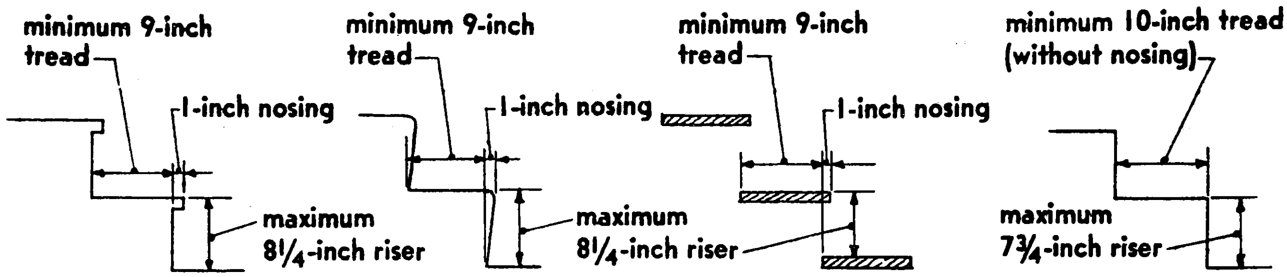


SECTIONS

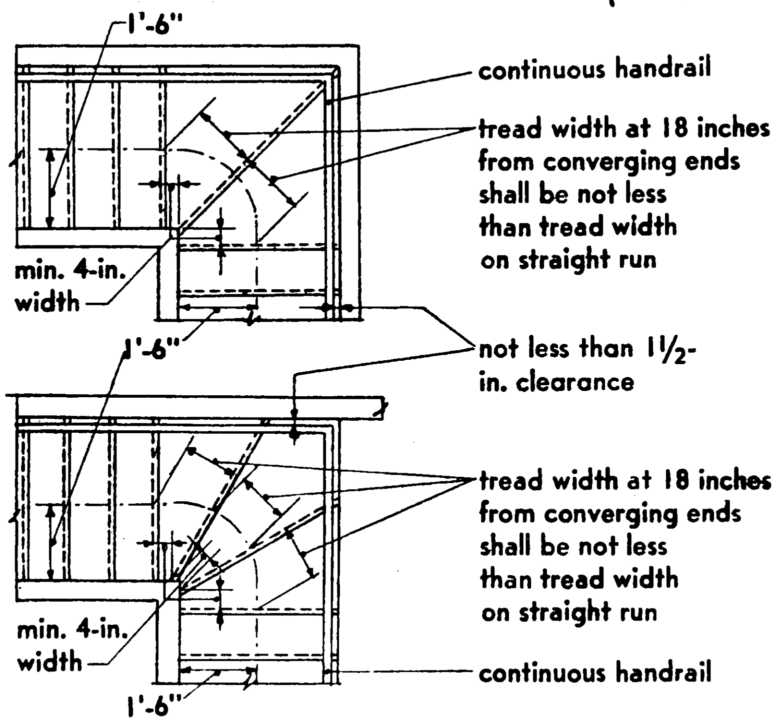


PLAN OF TYPICAL INTERIOR EXIT STAIR

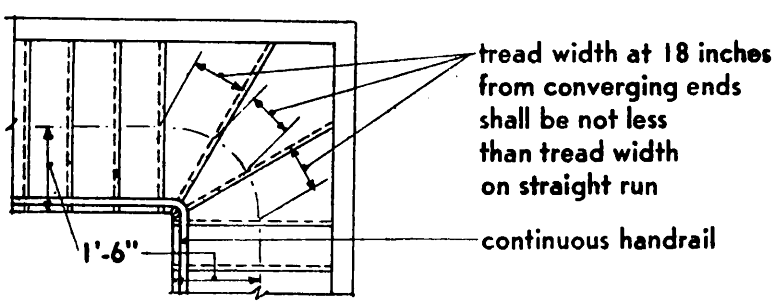
Treads, Risers and Winders



RISERS AND TREADS (SEE EXCEPTIONS IN CODE)



WINDERS NOT GUARDED BY HANDRAIL



WINDERS GUARDED BY HANDRAIL

Winders—At converging ends of winders, winder treads, exclusive of minimum 1-inch nosings, shall be not less than 4 inches wide unless the winders are guarded at the converging ends by continuous handrails which prevent walking where the tread widths, exclusive of minimum 1-inch nosing, are less than 6 inches. Where winder treads are without minimum 1-inch nosings, the tread widths in these locations shall be not less than 5 inches, and 7 inches, respectively.

Winder tread widths at distance of 18 inches from the converging ends shall be not less than the tread widths in straight portions of the same run.

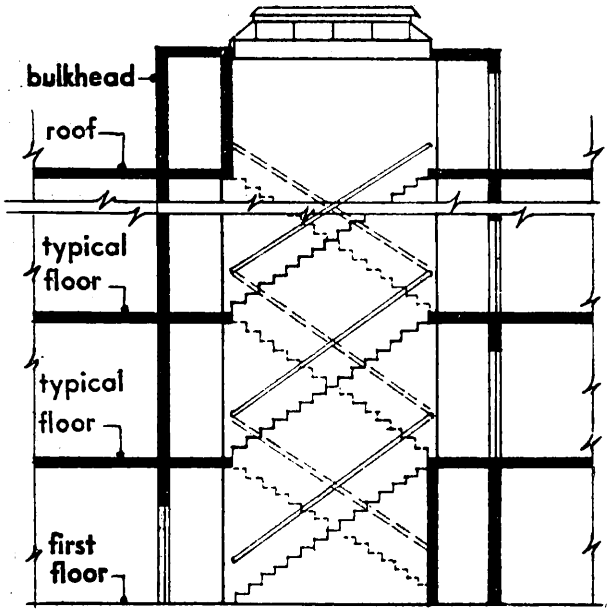
Stair Width—Width of stairs between habitable spaces at different floor levels shall be not less than 2 feet 8 inches between handrails or between handrail and a wall surface, except that such stair width, for stairs from a second story to a third story occupied by not more than five persons, and stairs to a basement and a cellar, shall be not less than 2 feet 4 inches.

Scissor Stairs

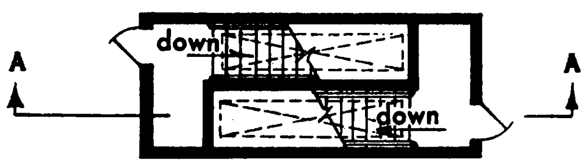
Every passageway and enclosed stairway which serves as an exit or part thereof shall be enclosed with fire-resistive construction as set forth in table B 202-2 of the Code entitled, "Minimum Fire-Resistance Requirements of Structural Elements."

In multiple dwellings more than three stories in height, exit stairways shall be separately enclosed. Openings in such construction shall be provided with opening protectives as set forth in section B 402 of the Code entitled, "Prevention of Interior Fire Spread."

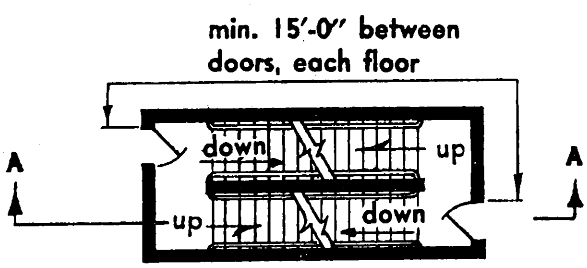
For ventilation of stair shafts, see section B 402 of the Code entitled, "Prevention of Interior Fire Spread."



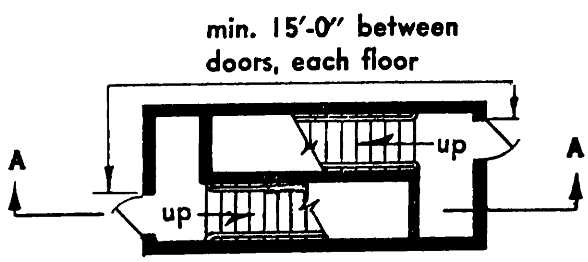
SECTION A-A



ROOF BULKHEAD PLAN

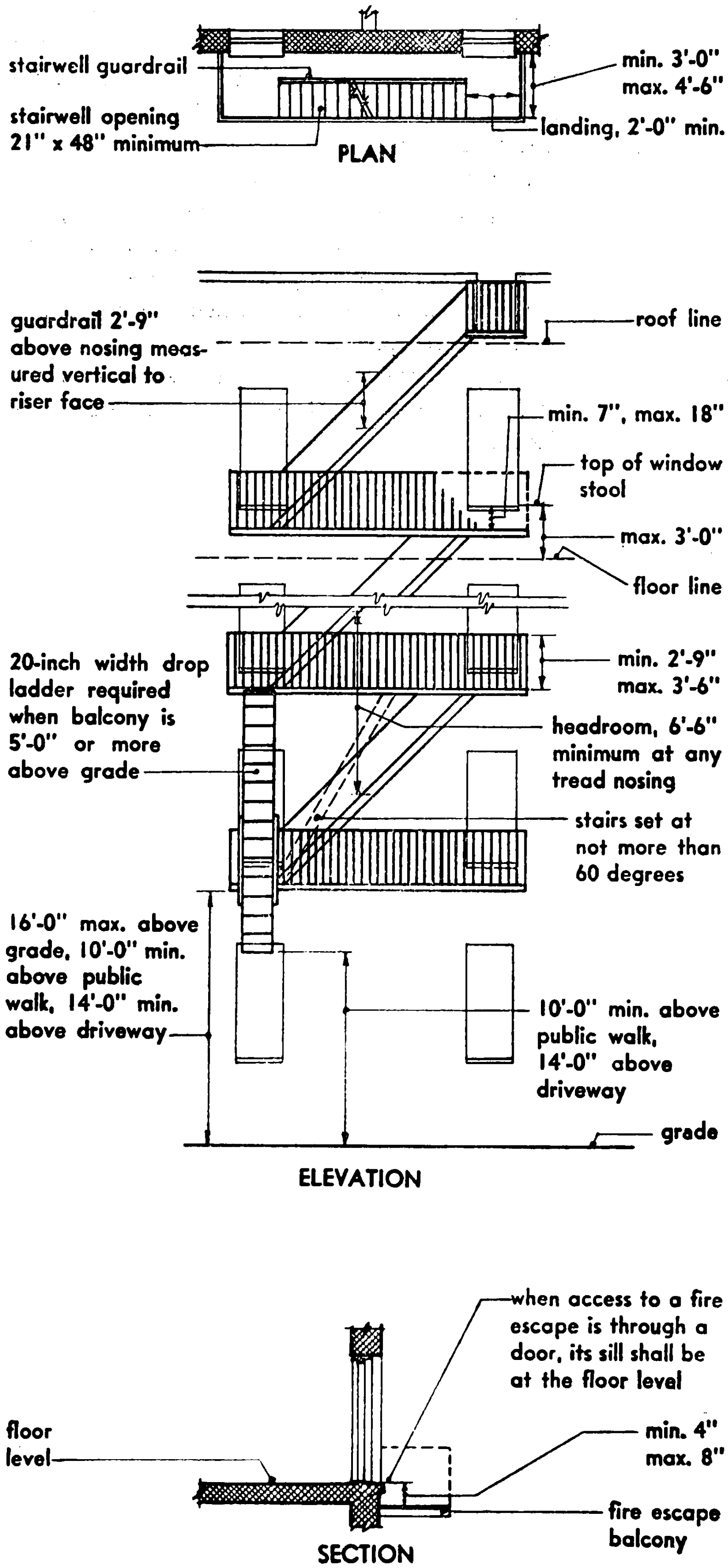


TYPICAL FLOOR PLAN



FIRST FLOOR PLAN

Fire Escapes



Fire escapes which serve as a required second means of exit from a dwelling unit or roof, shall be located, arranged and constructed in such manner that a safe unobstructed and continuous passage is provided to a safe landing place on a legal open space or fire terrace, as set forth in section B 211-8.1 of the Code.

Access to Fire Escapes—Access shall be as remote as practicable from the principal exit of the dwelling unit or other area served.

Access from dwelling units shall be through unobstructed windows or doors to a fire escape balcony; access from other habitable space shall be by way of passageways, hallways, or corridors to a fire escape.

Access shall not be through a bathroom window; if through a kitchen, access shall not be obstructed by sinks or other fixtures.

Access shall not be from or through a public stairway.

Fire escapes on buildings more than three stories in height shall continue to the roof, except when located on the front of building, or when the slope of the roof exceeds 15 degrees.

Openings for Emergency Escape

General Requirements—The Code requires as an emergency escape an additional opening to the exterior of the building from habitable space three stories or less in height, and from recreation rooms located in basements or cellars, should the main means of egress be blocked by fire or smoke.

Emergency escape openings to the exterior should be on sides or buildings facing a street or alley, or facing yards or courts which are directly accessible from the street or legal open space. Emergency escape openings should be located as remote as practicable from primary exit.

The following are acceptable emergency escapes:

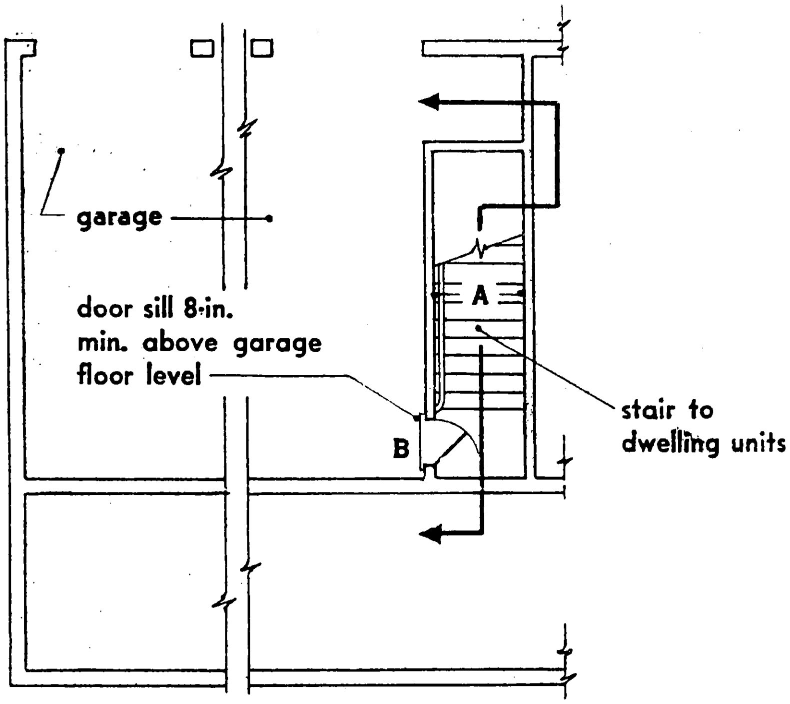
From first story: Additional exterior door of adequate height and at least 24 inches wide to porch or grade, remote from main means of egress; or exterior window or panel with opening at least 5 square feet in area with a minimum dimension of 16 inches and with bottom of opening not more than 36 inches above floor; or interior door of adequate height and at least 24 inches wide through a fire wall or fire separation, affording access to a safe place of refuge from which there is ready egress to the street or legal open space.

From second story: Exterior door of adequate height and at least 24 inches wide to porch or balcony; or second stairway at least 24 inches wide to first floor; or exterior window or panel with opening at least 5 square feet in area with a minimum dimension of 16 inches, and with bottom of opening not more than 36 inches above floor; or interior door of adequate height and at least 24 inches wide through a fire wall or fire separation, affording access to a safe place of refuge from which there is ready egress to the street or legal open space.

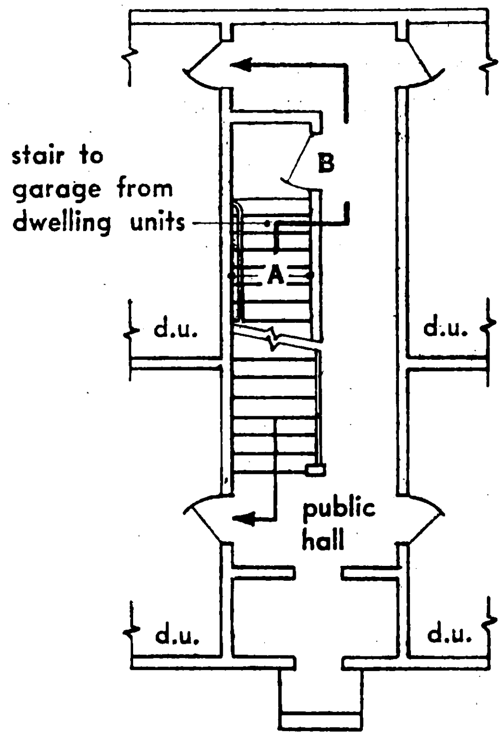
From third story or attic: Exterior door of adequate height and at least 24 inches wide to porch or balcony; or second stairway at least 24 inches wide to first floor; or exterior window or panel with opening at least 5 square feet in area with a minimum dimension of 16 inches, and with bottom of opening not more than 36 inches above floor; or interior door of adequate height and at least 24 inches wide through a fire wall or fire separation, affording access to a safe place of refuge from which there is ready egress to the street or legal open space.

From recreation rooms in basements or cellars: Interior or exterior second stairway at least 24 inches wide with access to grade; or exterior window or panel with opening at least 5 square feet in area with a minimum dimension of 16 inches, with sill not more than 4 feet 6 inches above floor, affording access to grade or to open areaway with access to grade; or interior door of adequate height and at least 24 inches wide through a fire wall or fire separation, affording access to a safe place of refuge from which there is ready egress to the street or legal open space.

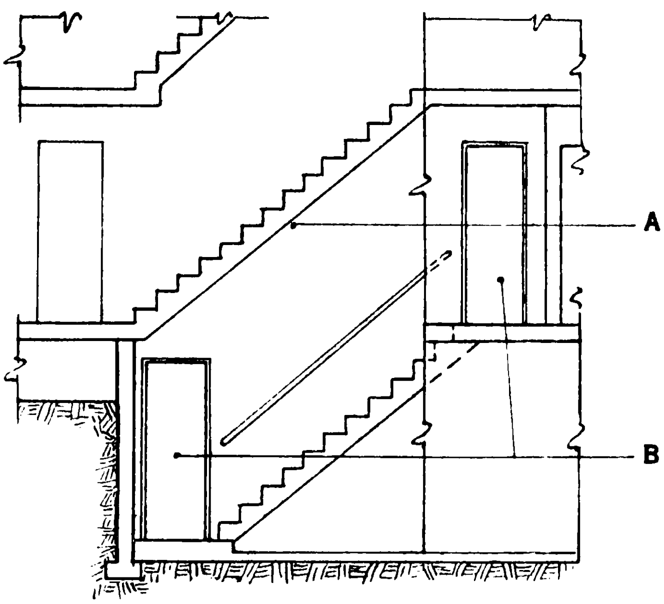
Separation when Garage Area is Less Than 1000 Square Feet



BASEMENT PLAN



FIRST FLOOR PLAN



SECTION

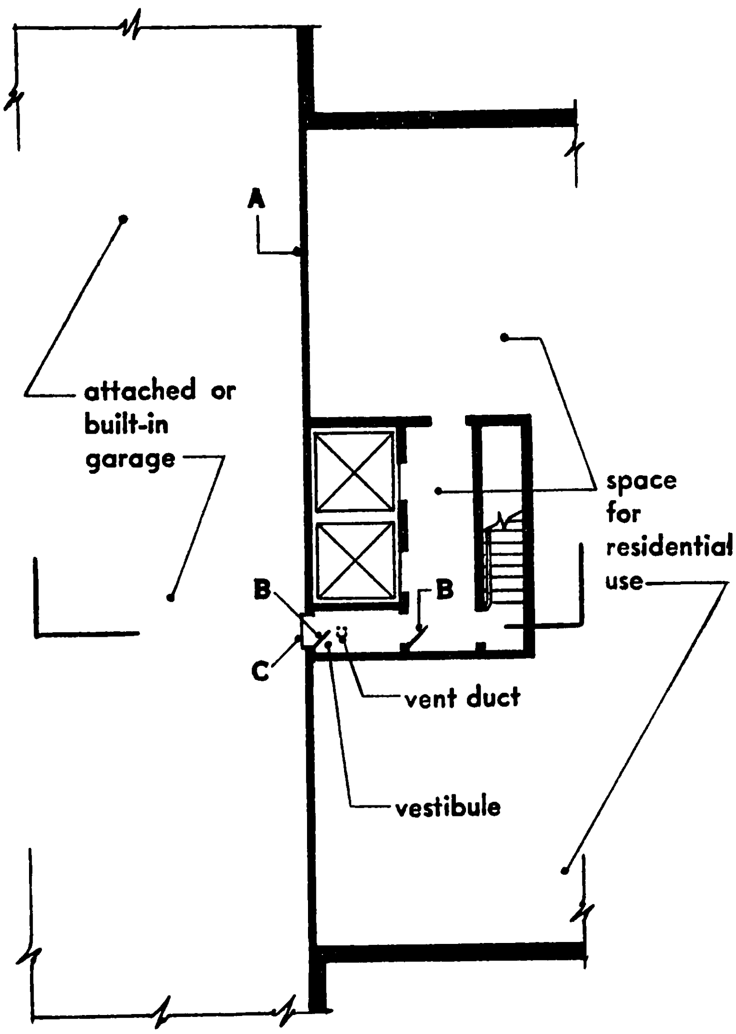
(A) Construction of stair enclosure and vertical and horizontal separation of garage from multiple dwelling to be in conformity with part 4 of the Code.

(B) Self-closing opening protectives to be in conformity with part 4 of the Code.

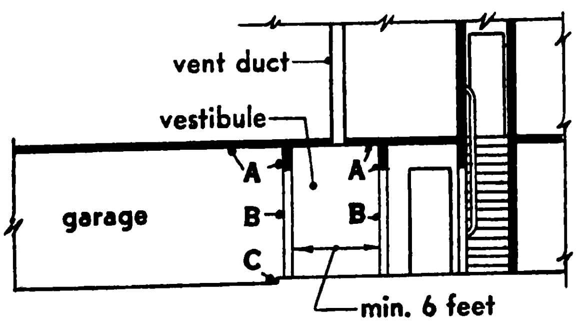
See section B 212-2 of the Code entitled, "Garages in, or Attached to, Multiple Dwellings."

See section B 402 of the Code entitled, "Prevention of Interior Fire Spread."

Separation when Garage Area is More Than 1000 Square Feet



PLAN



SECTION

(A) Garages and garage vestibules in, or attached to, a multiple dwelling shall be separated from other space in the multiple dwelling by noncombustible construction having a fire-resistance rating in conformity with part 4 of the Code.

(B) Openings for passage between garage and space for residential use should be protected by a ventilated vestibule with at least 6 feet between doors. Such doors should be self-closing with each door having a fire-resistance rating in conformity with part 4 of the Code.

(C) A masonry step or curb at least 8 inches high should be provided in opening between the garage and garage vestibule.

Garage and vestibule between garage and other space for residential use shall be ventilated directly to the outer air as set forth in section B 507 of the Code entitled, "Refrigeration, Air Conditioning, and Mechanical Ventilation."

Each fire area in excess of 1000 square feet of every story of a garage shall be provided with at least two exits. Entrances for vehicles may serve as required exits.

Garages with a fire area of 5000 square feet or more per story shall be provided with a sprinkler system.

part 3

Construction illustrated or described herein is acceptable under the State Building Construction Code, but shall not be interpreted as excluding other construction which meets the requirements of the Code.

Soil Bearing Value, Determination

The requirements for the determination of soil bearing values are to be in accordance with the following data or with the ASA, *Building Code Requirements for Excavations and Foundations.* Where the bearing value of soil is determined by field loading tests, and where other bearing values are established by local practice and experience or because of special conditions, soil bearing values are not to exceed the following, on undisturbed soil:

by other method, so that the bearing material is not disturbed or loosened, the full bearing value of the unloosened material may be assumed.

Foundations on Laterally Supported Soil— The presumptive unit bearing values given below may be increased for load on soil where, because of depth below ground level and permanent lateral support of the bearing soil, greater bearing values are justified. Such greater bearing values may be used only with the approval of the enforcement officer.

PRESUMPTIVE UNIT SOIL BEARING VALUES

Class	Material	Allowable bearing value, tons per square foot [1]
1	Massive crystalline bed rocks, such as granite, gneiss, trap rock, etc.; in sound condition	100
2	Foliated rocks, such as schist and slate, in sound condition	40
3	Sedimentary rocks, such as hard shales, siltstones, or sandstones, in sound condition	15
4	Exceptionally compacted gravels or sands	10
5	Gravel; sand-gravel mixtures; compact	6
6	Gravel, loose; coarse sand, compact	4
7	Coarse sand, loose; sand-gravel mixtures, loose; fine sand, compact; coarse sand, wet (confined)	3
8	Fine sand, loose; fine sand, wet (confined)	2
9	Stiff clay	4
10	Medium stiff clay	2
11	Soft clay	1
12	Fill, organic material, or silt	(2)

1 Presumptive bearing values apply to loading at the surface or where permanent lateral support for the bearing soil is not provided.

2 Where, in the opinion of the enforcement officer, the bearing value is adequate for light frame structures, fill material, organic material, and silt shall be deemed to be without presumptive bearing value. The bearing value of such material may be fixed on the basis of tests or other satisfactory evidence.

Modification of Bearing Value

Variation in Underlying Soils—Where the bearing materials directly under a foundation overlie strata having smaller allowable bearing value, such smaller value may not be exceeded at the top level of such strata. Computation of the vertical pressure in the bearing materials at any depth below a foundation is to be made on the assumption that the load is spread uniformly at an angle of 1 horizontal to 2 vertical.

Loosened Bearing Materials—Wherever bearing material is loosened or disturbed by a flow of water, the bearing value is to be reduced to the allowable bearing value of the loosened material, unless the loosened material is removed. Where the flow of water is controlled by well points, or

Soil Bearing Load Test

Procedure—Tests are to be made and interpreted so as to take into account all significant factors, such as the presence of soft underlying strata, variations in size of footings, and the compressibility of the soils encountered. When there is substantial variation in size of proposed footings, loading tests are to be made on several different sized areas as a guide in determining the allowable bearing values for the various footing sizes.

Tests are to be made where surface water conditions and ground water conditions are representative of the bearing soil, and when the soil tested is free from frost.

The test is to be made on leveled but otherwise undisturbed portions of foundation bearing material. Where tests are made materially below the ground level, any material immediately adjoining the test location is to be removed so as to eliminate effect of surcharge or reinforcing.

The test assembly is to consist of a vertical timber or post, with or without braced timber footing, resting upon the soil to be tested and supporting a platform on which the test loads are to be placed. The exact area resting upon the soil is to be ascertained, and may be not less than 1 square foot for bearing materials of classes 1 to 4 inclusive as indicated in the table entitled, "Presumptive Unit Soil Bearing Values," and not less than 4 square feet for other bearing materials. The platform is to be symmetrical in respect to the post, and as close to the bearing soil as practicable. The post is to be maintained in a vertical position by guys or wedges. Load may be any convenient material which can be applied in the increments required, such as cement or sand in bags, or pig iron or steel in bars. In applying the load, precautions are to be taken to prevent jar or movement of the post.

Settlement readings shall be taken at least once every 24 hours at a point which shall remain undisturbed during the test, and the settlement shall be plotted against time. The proposed allowable load per square foot shall be applied and allowed to remain undisturbed until there has been no settlement for 24 hours. (For performance criteria of soil bearing load test, see part 3 of the Code).

Soil Borings—Generally accepted standards of acceptable combinations of hammer weight, height of drop and size of spoon, for the number of blows to penetrate one foot of soil, are as follows: 300-pound hammer, 18-inch drop, 2½-inch spoon; 140-pound hammer, 30-inch drop, 2-inch spoon.

As a guide to the method for evaluating the allowable bearing value of the soil, the following may be used, based on the spoon soil sample:

Type of soil	Number of blows to advance spoon one foot	Allowable bearing value, tons per square foot
Clay	Up to 10 11 to 30 More than 30	Up to 1 1 to 2 2 to 4
Sand	Up to 15 16 to 50 More than 50	Up to 2 2 to 4 4 to 10

The allowable bearing value of a soil mixture of sand and clay is to be determined from the above table in proportion to the ratio of sand and clay.

Foundations

General—The requirements for foundations, other than piles, are to be in accordance with the following data, or with the ASA standard, *Building Code Requirements for Excavations and Foundations*. The requirements for protection of adjoining property are also to be in accordance with this ASA standard.

Footings

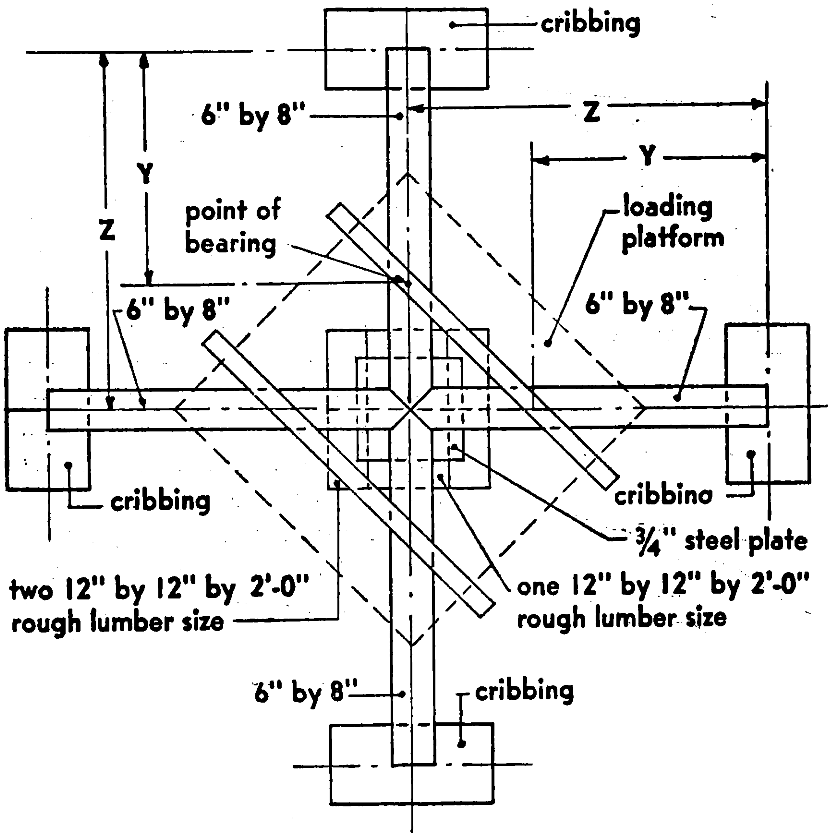
Depth—In all cases, foundations are required to extend to levels of suitable bearing material. Soil bearing values are required to be in accordance with text entitled, "Soil Bearing Value, Determination." On sloping ground, foundations are required to be of sufficient depth so that erosion of the surrounding ground surface will not permit sliding, slippage, or tilting of foundations, and must conform to the requirements in the illustration entitled, "Foundations in, or Adjacent to, Sloping Ground: Stepped Footings."

Where subject to frost action, the bottoms of foundations are required to be not less than 3 feet below the adjoining ground surface, except that the enforcement officer may approve lesser foundation depths for one-story accessory frame structures, such as garages and porches, which in his opinion would not be adversely affected by frost action. In localities where frost penetrates more than 3 feet below the ground surface, the enforcement officer may require that foundations subject to frost action be placed at such greater depth as he establishes from frost penetration records as the safe minimum depth therefor.

Foundation Beds—All beds of foundations are required to be level. Where foundations are supported at different levels or at different levels from foundations of adjacent structures, the effect of such differences in levels must be considered in the design. Foundations may not be placed on frozen bearing material.

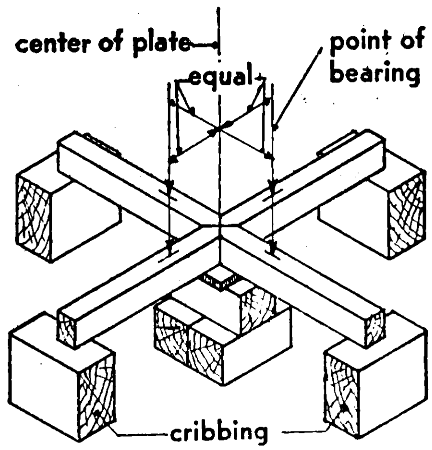
Where Required—Footings are required under all piers and foundation walls of hollow masonry

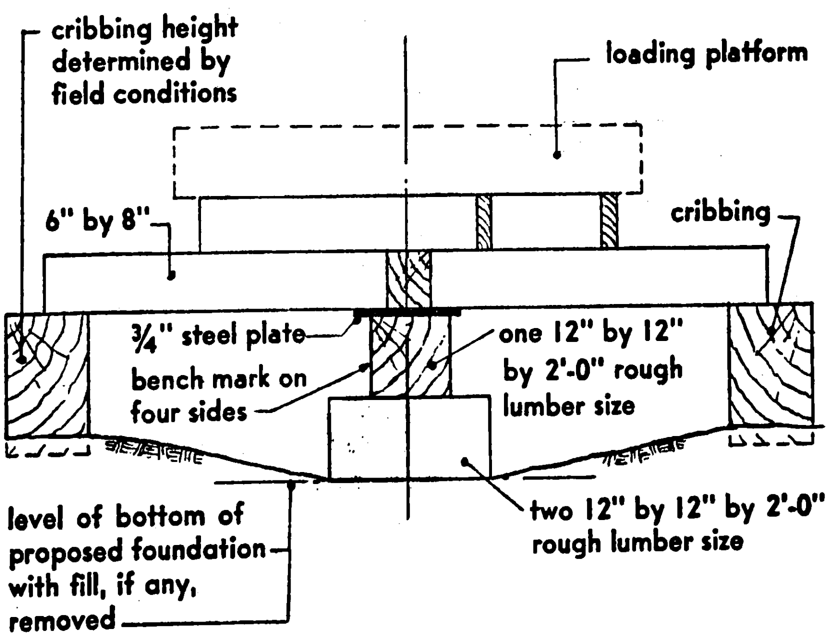
Test Assembly for Bearing Materials of Classes 5 to 12



PLAN

Note: For required bearing area on bearing materials of classes 1 to 4 see text entitled, "Soil Bearing Load Test," on page 3, part 3.

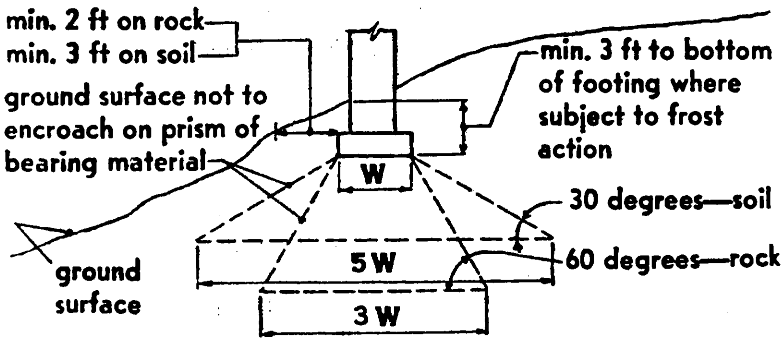




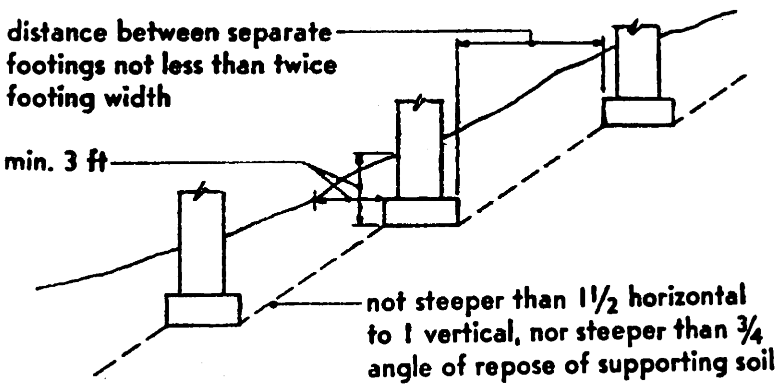
SECTION

Procedure—Apply loads in accordance with the requirements of text entitled, "Soil Bearing Load Test." For the assembly illustrated, the load per square foot on the soil equals one quarter of the load on the platform times Y/Z, plus approximately 500 pounds for the test assembly. Establish the bench mark before steel plate and the 6 x 8's are placed in position, in order to include the weight of the test assembly.

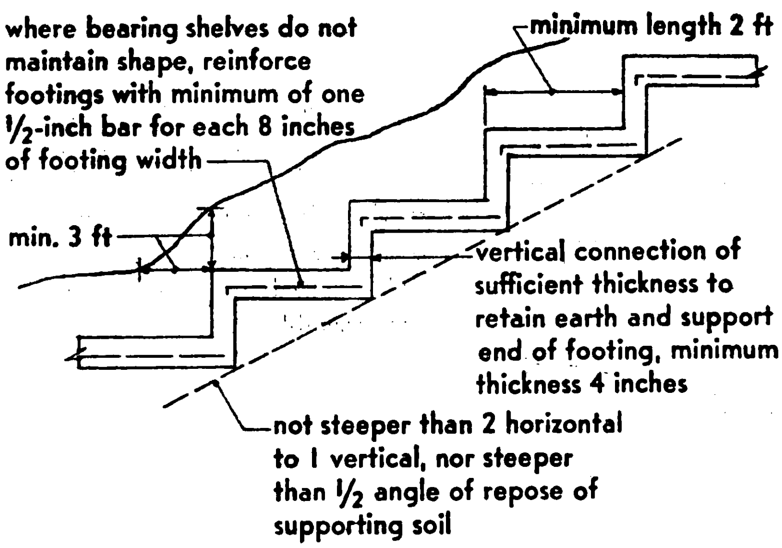
Foundations in, or Adjacent to, Sloping Ground: Stepped Footings



FOOTINGS ADJACENT TO SLOPING GROUND



STEPPING OF ADJACENT FOOTINGS



STEPPING OF CONTINUOUS FOOTINGS

Foundations Adjacent to Sloping Ground—Where the ground surface slopes downward above or adjacent to a foundation, the horizontal distance from the top edge of the foundation to the sloping surface is to be at least 2 feet for rock and 3 feet for soil, and the sloping surface may not encroach upon a prism of bearing material under the foundation that makes an angle with the horizontal of 60 degrees for rock and 30 degrees for soil and has a width three times the width of the foundation bearing for rock and five times the width of the foundation bearing for soil.

Stepped Adjacent Separate Footing: Stepped Continuous Footings—For foundations supported on gravel, sand, or clay, or any combination of these, stepped adjacent separate footings and stepped continuous footings are to be installed within the limitations indicated on this page.

Exceptions—The limitations indicated on this page may be modified by the enforcement officer where adequate permanent provision is made for lateral support of the material supporting the foundation, or where tests or experience indicate that steeper angles of stepping are safe. Where slope of finished grade is not steeper than 4 horizontal to 1 vertical, continuous footings may be sloped, parallelling the finished grade.

units, under columns where column loads are transmitted directly to bearing soil, and wherever elsewhere required to distribute loads to bearing soil. Footings are not required under piers and foundation walls of concrete or solid masonry units, where the area of the bottom of the pier or wall is sufficient to transmit safely the load to rock or bearing soil, provided a suitable mortar bed is placed under the lowest course of masonry units and any cored holes in the lower three courses of masonry units are filled with mortar.

Design—Footings are required to be proportioned and designed so as to distribute imposed loads without substantial differential settlement in accordance with the allowable unit bearing values of the supporting soils, and without exceeding allowable stresses in the materials of the footings. The full dead load, including the weight of the footings, foundations, and overlying fill, and the design live loads reduced as permitted by part 3 of the Code, are required to be considered in proportioning and designing footings. Where footings cross pipe trenches or conduits or otherwise lack stable support, they must be reinforced, supported and proportioned so as to comply with the design criteria of this section.

Materials—Footings are required to be of concrete having a minimum compressive strength at 28 days of 2000 psi; or of solid masonry units laid in type A-1, A-2, or B mortar or grout and with any cored holes filled with mortar or grout. Footings under columns and posts are to be of plain or reinforced concrete. Concrete, mortar, and other materials are to conform to the standards entitled, "Masonry Construction," part 3, page 16, and "Reinforced Concrete," part 3, page 37.

Concrete Footings

Plain Concrete Footings: Depth of plain concrete footings bearing on soil may be not less than 6 inches. The projection of plain concrete footings beyond the line of a foundation wall, pier, chimney, or similar structural element may not exceed one half the footing depth unless reinforcement, to resist bending and shear, is provided.

Reinforced Concrete Footings: A minimum of 6 inches of concrete is required above the reinforcement except that lesser distance above reinforcement may be provided where reinforced sections of footings span over pipes or conduits, and the reinforcement is to be located not less than 3 inches from soil abutting the footing.

Pouring: Unless otherwise approved by the enforcement officer, under specified conditions of approval, concrete footings may not be placed in or under water. In no case may water flow through newly placed concrete, unless a tremie is used for the placing of concrete.

When resting on soil, footings under steel grillage beams or under steel billets are to be of plain or reinforced concrete of 8-inch minimum thickness and designed for the upward acting soil pressure. The beams are to have permanent spacers or diaphragms between them and beams and billets are to be encased in 4-inch minimum of concrete, with the spaces between beams completely filled with concrete or a grout of 1 part Portland cement to 2 parts sand, by volume.

Pile cap footings under grillages or billets are to be of plain or reinforced concrete with the bottom a minimum of 4 inches below and with the top a minimum of 12 inches above the tops of piles; and where piles or parts of piles are not overlapped by a grillage or billet above, they are to be designed for such upward loads.

Any bending moment due to eccentricity which exists between a column and its footing is to be either taken by a grillage or concrete beam connected to an adjacent footing and designed for the eccentric load, or the footing is to be combined with that of an adjacent column or columns so that the center of gravity of the combined footing is in vertical line with the center of gravity of the sum of supported column dead loads and imposed loads reduced as permitted in part 3 of the Code.

Where the pressure on soil due to wind is less than one third of that due to dead load and live load reduced as permitted in part 3 of the Code, such pressure due to wind may be ignored; where it is more than one third, the permissible soil pressure may be increased by one third.

Unit Masonry Footings

Footings of unit masonry are required to have a depth at least twice their projection beyond foundation walls, piers, chimneys, or similar structural elements. Maximum offsets for such footings, when of brickwork, are required to be 1½ inches for one course of brickwork and 3 inches for two courses of brickwork; for other unit masonry the offset is required to be 6 inches or less horizontal to 12 inches vertical. Footings of unit masonry are required to be securely bonded together by alternate stretcher and header courses and are to rest upon full beds of mortar. In multiple dwellings over 35 feet in height, footings of unit masonry are not to be used.

Protection Against Freezing

Footings are required to be protected from freezing until the concrete or mortar of the footings has thoroughly set. When normal Portland cement is used, such protection is to be maintained for at least two days after placing. When approved high early strength Portland cement is used, such protection is to be maintained for at least one day after placing.

Piles

The requirements for piles are to be in accordance with ASA, *Building Code Requirements for Excavations and Foundations,* and as modified herein.

When piles in a pile group support their load by soil friction, the supporting value for each pile in the group is to be multiplied by a factor equal to 1 minus 1/16 times (number of piles in group minus 1), but which need not be less than 0.7 when more than five piles are in the group.

Composite Piles: The allowable stress and the maximum load permitted on the weakest material of the pile, is to govern the load on the pile.

Piles which protrude above the soil level are to be considered fixed at a point 5 feet below the soil level, and designed for bending stresses due to lateral loads, as well as for vertical loads.

Piles in a pile group are to be driven from the center of the group outward.

Every pile is to be braced in two horizontal directions by the pile cap, to at least two other piles in the same footing, or by ties to adjacent footings, with the included angle at any pile to the two bracing piles or footings to be not less than 45 degrees and not more than 90 degrees. Such ties are to have a minimum dimension of 1/20 of the clear span but not less than 8 inches, reinforced as a column with between 2 per cent and 4 per cent of longitudinal steel and ¼-inch minimum ties spaced not more than 12 inches apart. The length of embedment of the longitudinal bars into the pile caps is to be sufficient to develop the strength of the bars in tension, and the bars are to have 3-inch minimum cover.

Where the load on piles due to wind is less than one third of that due to dead load and live load reduced as permitted in the Code, (see illustration entitled, "Reduction of Uniform Live Loads for Vertical Structural Elements," part 3, page 38), such load due to wind may be ignored; where it is more than one third, the capacity of the pile may be increased by one third.

Foundation Piers and Posts

Buildings may be supported on piers or posts, provided that:

a—When extending above grade line, piers and posts are anchored and braced at the top by suitable beams, which may also support the superstructure. When supporting masonry, such beams are to be of reinforced concrete or structural steel.

b—Piers of hollow masonry units are suitably capped with not less than 6 inches of solid masonry units or of concrete.

c—The aboveground height of piers does not exceed limits set forth in the text entitled, "Piers," part 3, page 26, and mortar is of type A-1, A-2, or B, as described in text entitled, "Mortar Proportions by Volume," part 3, page 16. Any portion of such pier which is not laterally supported by soil is to be included in the aboveground height of the pier.

d—The anchorage of superstructure to foundation piers or posts is sufficient to safely resist uplift, and the piers or posts have sufficient cross-sectional area, or are reinforced, to resist tension and bending due to wind loads.

e—Above-grade steel pipes, unfilled or filled with concrete having a minimum compressive strength at 28 days of 2000 psi, have adequate column strength, and have top and bottom plates securely attached to the pipe, with bottom plate secure to the concrete footing. The steel pipe is to conform to the requirements of either ASTM, *Standard Specifications for Welded and Seamless Steel Pipe* or ASTM, *Standard Specifications for Welded Wrought Iron Pipe.*

f—Wood post stresses do not exceed the allowable stresses for the specie and grade of lumber used, and decay-resistant or treated wood is used. (See tables entitled, "Working Stresses for Stress-Grade Lumber," part 3, pages 44 to 47, and text entitled, "Wood Naturally Resistant to Termites," part 3, page 14, and "Below Grade Wood Posts," part 3, page 62).

g—For pier-supported buildings without basement or cellar the space between piers may be left open. Masonry curtain walls may be used to close the space between the piers, up to the first floor level, provided the provisions of the text entitled, "Crawl Spaces," part 3, page 10, are complied with; such curtain walls may not be less than 3½ inches actual thickness and must be ground supported on suitable footings at the level of the bottoms of the foundation piers, or must be supported on suitable corrosion-resistive noncombustible construction located either above the finished grade, or if embedded, below the level of frost penetration.

Foundation Walls

General—Foundation walls are required to conform to applicable provisions included in the text entitled, "Masonry Construction," part 3, page 16. Where single forms are used, concrete may not be poured against frozen ground. Single forms may be used when in the opinion of the local enforcement officer the soil will permit sharp cut and stable earth banks.

Pilasters—In 6-Inch Concrete Foundation Walls: Pilasters, cast integrally with the walls and not less than 12 inches wide and 2 inches thick, are required to be provided where girders frame into 6-inch concrete walls.

Pilasters—In 8-Inch Masonry Foundation Walls: Pilasters of solid masonry units, or of hollow masonry units filled with mortar or concrete, well bonded into the wall and not less than 12 inches wide and 4 inches thick, are required to be provided where girders, whose clear span exceeds 12 feet, frame into 8-inch masonry walls of dwellings two or more stories in height.

Protection Against Ground Water

Variables to be Considered—The extent of protection against penetration of ground water into basements, cellars, and habitable spaces depends upon many variables which can be determined only locally, and sometimes only at the building site. Such variables include:

a—The contour of the ground surface and the extent to which water is directed by it against below-grade construction.

b—The character of the subsoil and the extent to which natural drainage of the subsoil carries away ground water before it accumulates against below-grade construction.

c—The ground water level.

d—Provisions made to remove ground water from the area adjacent to below-grade construction.

e—The character of below-grade construction; whether it is permeable, water resistant, or waterproof.

It is, therefore, impractical to establish hard and fast rules for required protection against penetration of ground water. Acceptability of proposed construction to meet Code requirements is largely a matter for determination by the enforcement officer on the basis of local conditions.

Penetration of Ground Water

The Code requires that ground water not penetrate into habitable spaces, basements, and cellars. This applies only to type of flow commonly known as "leakage," and does not apply to moisture due to condensation, which results from a combination of humidity and temperature, and not from inflow. It does not apply to moderate amounts of surface moisture due to capillarity of the construction. Both condensation and moisture from capillarity are undesirable, but normally do not affect structural safety.

Hydrostatic Pressure

Water which accumulates against below-ground structures creates hydrostatic pressure directly proportionate to the height to which water collects above the level of the structure; and the pressure is uniformly distributed against all parts in contact with, and below the level of the surface of, the water. For each foot of height, the imposed pressure is 62½ psf. If the water level rises 3 feet above a basement floor, the upward pressure on the floor is 187½ psf. This is far more than the weight of the usual 4-inch thick concrete floor (weight approximately 45 psf). Corresponding lateral pressure is exerted wherever ground water collects against foundation walls, the pressure varying with the height of the water above the level under consideration.

Wherever foundations, or basement or cellar floors, are subject to hydrostatic pressure, the affected structural elements are required to be designed to resist safely such pressure. Wherever the weight of a basement or cellar floor, or the inherent lateral stability of a foundation wall, is insufficient to resist such pressure, it is to be reinforced and restrained so that the construction will not be overstressed.

Ground Water Drainage

Where practicable, ground water is to be removed preferably by subsoil drains before it can accumulate and create hydrostatic pressure, or flow into basements or cellars. A customary method is by footing drains, which should be backfilled with coarse fill.

In some cases, in lieu of footing drains, subsoil drains are installed underneath basement or cellar floor construction. Subsoil drains may not be installed where there is no suitable method for disposing of water drained off by them.

Dampproofing

Where conditions are such that water will not exert pressure against the floors and walls of the structure, but moisture exists in the soil in such quantity as would pass through the walls and floors, they are to be dampproofed.

Waterproofing

Where conditions are such that water will exert pressure against floors and walls, they are to be rendered waterproof by the integral method or by the application of waterproofing coatings to the surfaces of floors and walls.

Concrete Slabs on Soil

In dwellings, concrete slabs on soil **at grade** should be constructed in accordance with the illustrations entitled, "Slab on Ground Construction—Floating Slab Foundation," and "Slab on Ground Construction—Perimeter Wall Foundation," part 3, pages 12 and 13. Concrete is to conform to the requirements in text entitled, "Concrete," part 3, page 16. Concrete reinforcement, when of welded wire fabric, is to conform to the requirements of ASTM, *Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement,* and is to consist of a minimum of 20 pounds for every 100 square feet, distributed equally in both directions, and lapped a minimum of 6 inches at all edges; when of plain or deformed bars, reinforcement is to conform to the requirements of ASTM, *Standard Specifications for Billet Steel Bars for Reinforced Concrete,* structural grade or better, and for the slab, is to consist of a minimum of 30 pounds for every 100 square feet, distributed equally in both directions, with bars lapped a minimum of 40 bar diameters. Moisture barrier is to be either membrane waterproofing or roofing felt of 35-pound minimum quality per 108 square feet asphalt or coal tar pitch impregnated, lapped 6 inches at all edges.

In dwellings, slabs on soil **below grade** subject to ground-water accumulation should be waterproofed in accordance with the illustration entitled, "Foundation Dampproofing and Waterproofing," part 3, page 11, and reinforced where hydrostatic pressure exists.

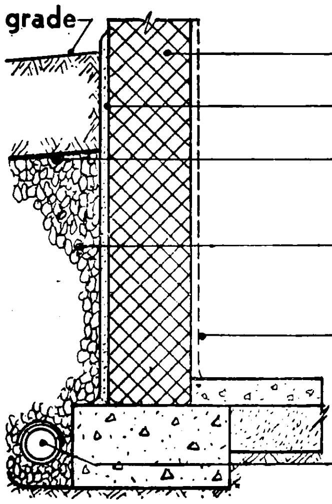
Crawl Spaces

In buildings or parts of buildings without basements or cellars, with first floors constructed of either wood or metal framing, an air space not less than 18 inches in height is required to be provided below the bottom of the floor framing, and access to the crawl space for the inspection of deterioration is to be provided.

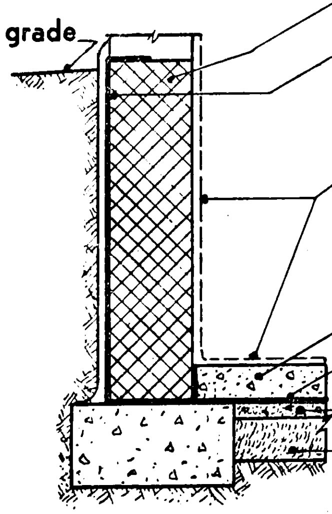
Where subject to water accumulation, the ground area within the air space is to be drained.

For other means of condensation control of crawl spaces, see illustration entitled, "Condensation Control in Buildings—Crawl Spaces," part 3, page 93, or recommendations contained in HHFA, *Condensation Control in Dwelling Construction.*

Foundation Dampproofing and Waterproofing

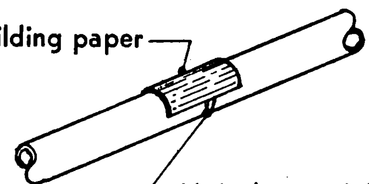


DAMPPROOFING



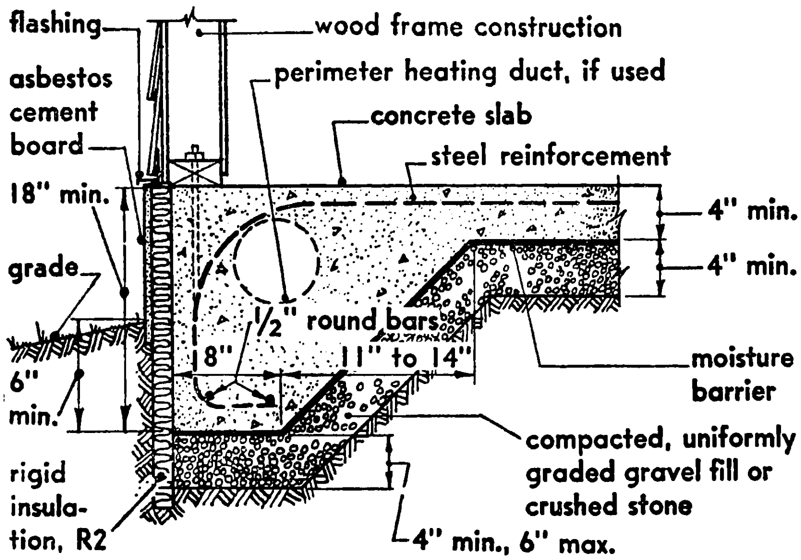
WATERPROOFING

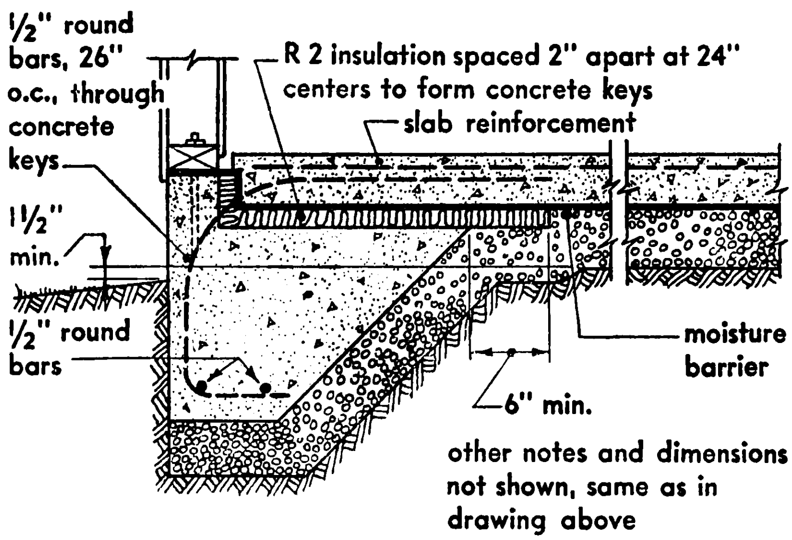
Footing drains of clay tile or concrete, 4 inches to 6 inches in diameter, are to be installed wherever water may accumulate against cellar or basement walls and floors, or flow into cellars or basements, or create hydrostatic pressure. Drains are to be laid with open joints, and protected at the top with building paper. Drains are then to be covered with not less than 12 inches of gravel or other porous material, preferably 1-inch minimum size. Drains are to be connected to tight joint pipe or tile leading to a dry well or sewer or other outlet.

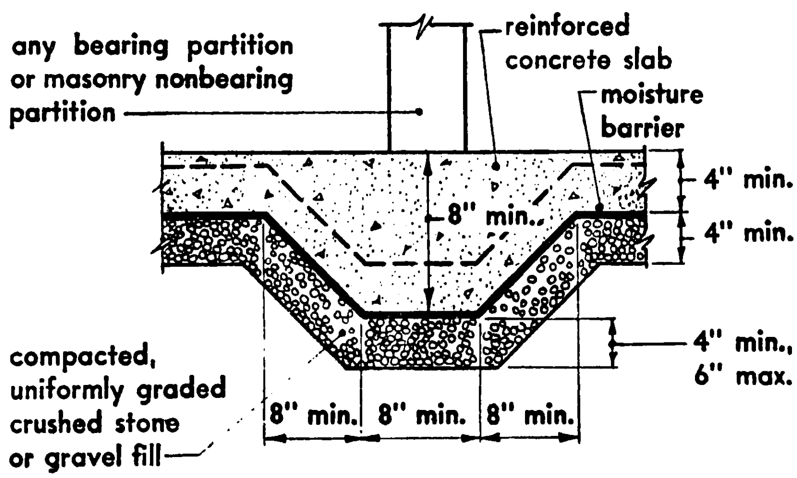


Leveling bed is to be of concrete and may be of lightweight aggregate.

Slab-on-Ground Construction: Floating Slab Foundation







Constructions illustrated are for wood frame buildings with heights of 12-foot maximum from floor to eave and 20-foot maximum from floor to gable peak.

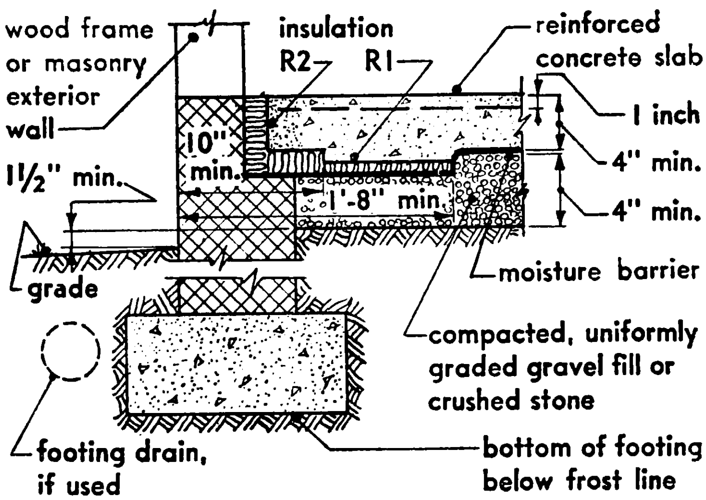
For concrete and concrete reinforcement requirements, see text entitled, "Concrete," part 3, page 16, and "Reinforced Concrete," part 3, page 37.

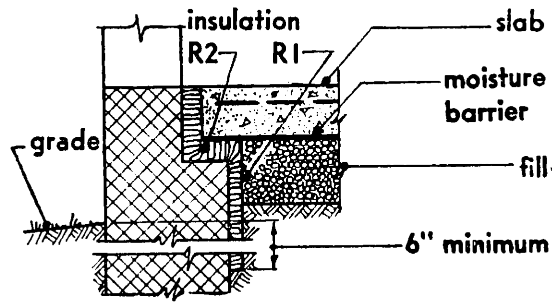
For anchorage of wood sill to foundation, see illustration entitled, "Anchors and Nailing for Exterior Stud Walls," part 3, page 67.

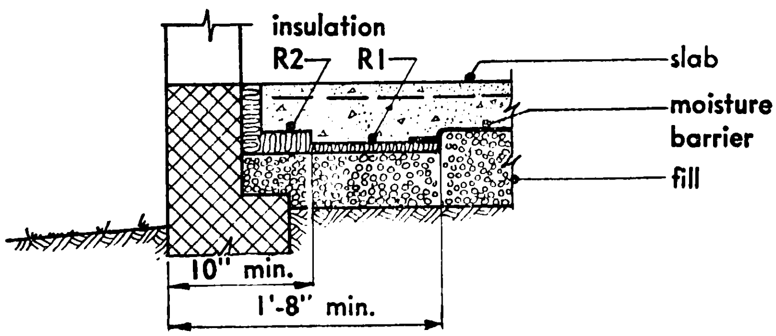
Protection Against Frost Action—The adjoining ground is to slope away from the foundation in all directions, and the underlying soil should preferably be sand or gravel to reduce to a minimum heaving due to frost action. Silty sand or clay soil should be avoided. For perimeter wall foundation, bottom of footing is to be below frost line. If necessary, footing drains or other means that would reduce height of water table below the slab may be installed. For footing drains see illustration entitled, "Foundation Dampproofing and Waterproofing," part 3, page 11.

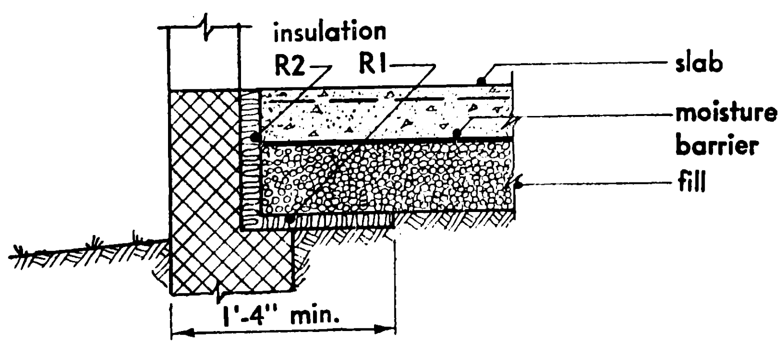
For additional requirements, see text entitled, "Concrete Slabs on Soil," part 3, page 10.

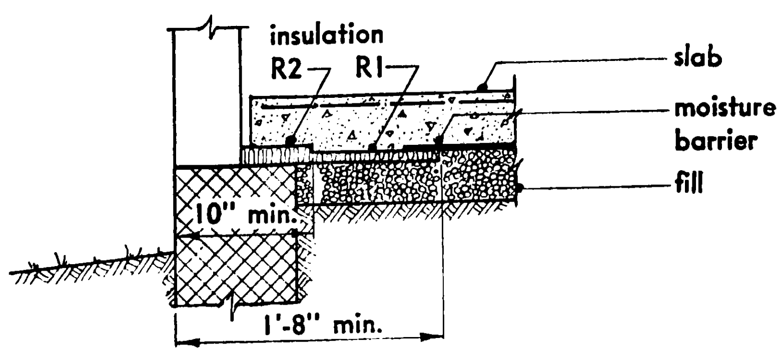
Slab-on-Ground Construction: Perimeter Wall Foundation











Insulation—In dwellings, insulation is to be of the rigid type and the following materials and minimum thicknesses are acceptable:

Cellular glass enclosing sealed-in gas: dipped, after cutting to size, in roofing pitch or asphalt; 2 inches thick for R1 and R2. Use wire ties for attaching to masonry in a vertical position.

Glass fibers with plastic binder: dipped, after cutting to size, in roofing pitch or asphalt; ¾ inch thick for R1 and R2.

Cane or wood fiberboards: dipped, after cutting to size, in roofing pitch or asphalt to form heavy coat; ½ inch thick for R1, 25/32 inch for R2.

Hard cellular rubber enclosing sealed-in gas: ½ inch thick for R1 and R2. For attaching to masonry in a vertical position, coat with asphalt or pitch or use cement keys or metal ties.

(See also text entitled, "Concrete Slabs on Soil," part 3, page 10).

Protection Against Termites

General—Wood structural material and assemblies attacked by termites may become structurally unsound. In localities where such insects are known to exist, suitable protection against infestation and destruction is to be provided.

Drainage: The site of the building should be well drained. Moist soil conditions are favorable to termites.

Foundations: Foundation walls should be without voids through which termites can travel. Poured concrete is the most satisfactory, as long as no cracks develop. Block or brick walls or piers should have all joints well filled with mortar, and should be capped with a continuous slab of reinforced concrete, 6 inches thick. Walls containing voids should be plastered down to the footings with cement mortar.

Wood and Paper Refuse: All wood and paper scraps, wood concrete forms, wood spreaders in concrete walls, and stumps under or adjacent to buildings and accessible to termites, should be removed.

Inspection by Owner: Periodic inspections will reveal termite infestation before damage has been done. Provisions should be made to facilitate such inspection, especially in locations where major structural members are accessible to termites. Spaces under porches should be inspected regularly.

Required Protection—Major structural members, such as wood sills and wood girders, are to be not less than 6 inches above the outside ground surface, and not less than 18 inches above an inside ground surface, such as the ground surface of a crawl space.

Members to be Protected: Protection is to be provided to wood sills, girders, and joists above crawl spaces, and to wood sills which are less than 18 inches above a ground surface; also to wood sills which are in locations accessible to termite shelter tubes, where such tubes cannot be observed readily. Wood sills accessible from ground surface under porches are to be protected.

Acceptable Forms of Protection—Where required, one of the following forms of protection is to be provided: poisoning of the adjoining soil; use of wood inherently termite resistant; use of wood treated to be termite resistant; or use of properly installed metal termite shields.

Soil Poisoning: Soil poisons give protection for five years or more. Acceptable soil poisons are: sodium arsenite, coal-tar creosote, trichlorobenzene, orthodichlorobenzene, pentachlorophenol. Dosage for deep foundations is to be 1 gallon of chemical per linear foot of trench, and, for shallow foundations, ½ gallon of chemical per linear foot of trench, or dosage equivalent to 2 gallons of chemical per 5 cubic feet of soil. Application of soil poisons is to be in accordance with recommendations contained in ARA, *Preventing Damage to Buildings by Subterranean Termites, and Their Control.*

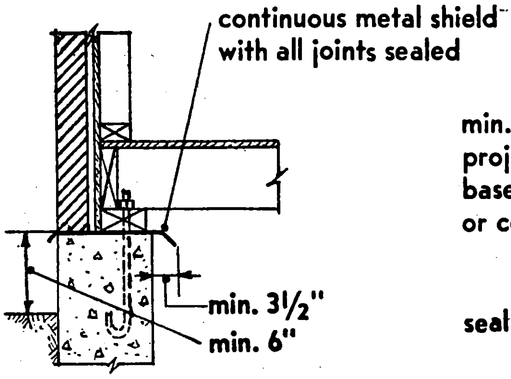
It should be noted that sodium arsenite is extremely poisonous, and that the other chemicals are irritant to the skin. They are also injurious to plants. Chemicals that have strong odors should not be used where food is stored, or in basement apartments, cellars, or other places where there is poor ventilation. They should not be used near a well or other exposed source of drinking water as once the chemicals reach it, the water will absorb their odors and may become unfit for use for a long time. Open packages or containers of soil poisons should not be stored where children or pets can get to them. Soil poisons dissolved in flammable liquids are fire hazardous. Care should be taken to avoid open flames or electric sparks when applying flammable soil poisons, such as mixtures containing fuel oil, in poorly ventilated spaces.

Woods Naturally Resistant to Termites—Woods naturally resistant to termites include the heartwood of foundation-grade redwood, tidewater-red cypress, very pitchy (lightwood) longleaf pine, and western red cedar.

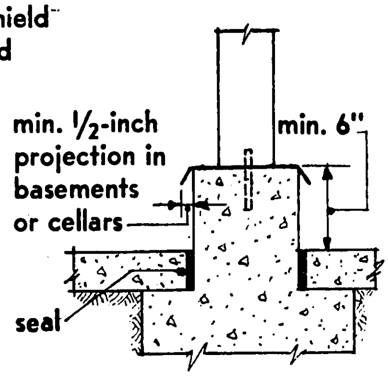
Treated Wood—Treated wood, to be acceptable, is required to be pressure impregnated with wood preservative, as specified for wood not in contact with the ground nor in water, in FS, *Wood Preservatives; Recommended Treating Practice.*

Metal Termite Shields—Metal termite shields are to be installed in accordance with the illustration entitled, "Termite Shields," part 3, page 15, and as recommended in ARA, *Preventing Damage to Buildings by Subterranean Termites, and Their Control.*

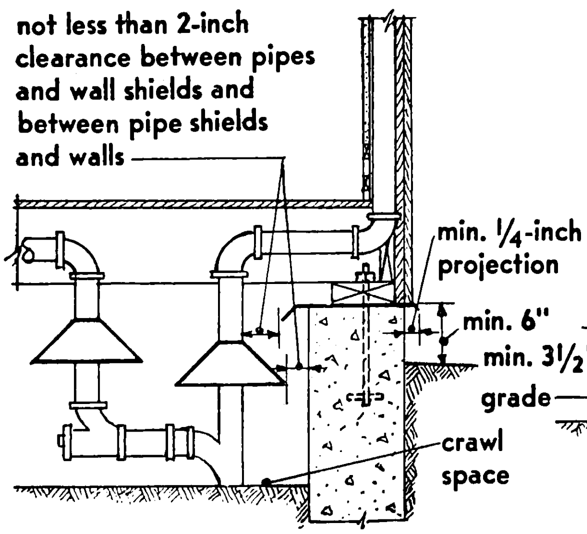
Termite Shields



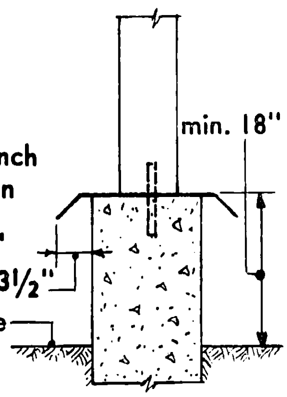
AT WOOD SILLS



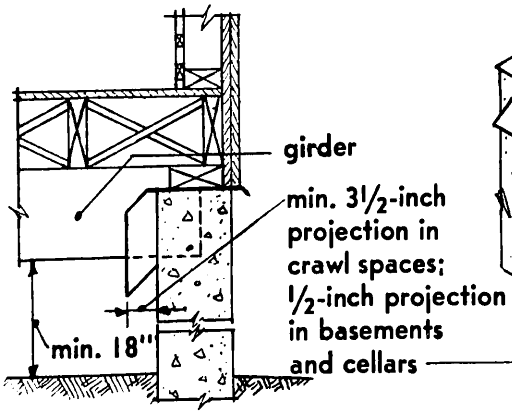
AT POSTS IN CELLARS OR BASEMENTS



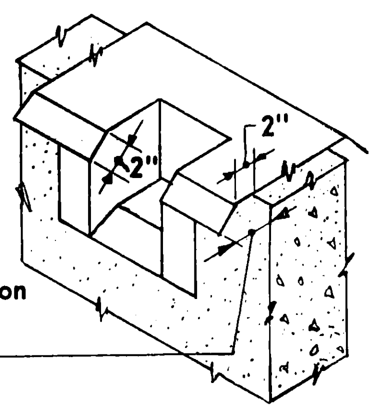
AT PIPES IN CRAWL SPACES



AT POSTS IN CRAWL SPACES



AT GIRDERS



DETAIL

Purpose—To prevent termite shelter tubes from making contact with wood structural members.

Acceptable Materials—Copper, hard temper, minimum 12 ounce; galvanized sheet iron or steel, minimum 26 gage, with heavy zinc coating; tin plate; iron or steel with minimum 40-pound block tin coating and with protective paint on both sides. Copper, minimum 3 ounce, combined with building paper or other suitable reinforcing, used where projection is ½ inch or less.

Installation—All seams to be locked and soldered or otherwise sealed for their entire length. Holes for sill bolts or other purposes to be sealed with suitable material, such as coal-tar pitch, or metal.

Projection—Where not easily accessible to inspection, including all crawl spaces, minimum 3½ inches; accessible at outside surfaces of foundation walls, minimum ¼ inch; in basements and cellars, minimum ½ inch.

Minimum Height of Wood Structural Members Above Ground—Accessible outside surfaces, minimum 6 inches; otherwise minimum 18 inches. In crawl spaces, minimum 18 inches. At wood posts in basements or cellars, minimum 6 inches.

Masonry Construction

The requirements for masonry construction are to be in accordance with the following data or with the ASA, *Building Code Requirements for Masonry*. Unless otherwise indicated in this Manual, masonry materials are required to conform to generally accepted standards.

Standard specifications and conditions of use of various materials comprising masonry units and cementitious materials are indicated in the tables in part 3, pages 20 and 21.

Materials in Combination

General—Materials used in masonry are required to be of good quality conforming to generally accepted practice, and must be durable under the conditions of use. Materials exposed to the weather or to the action of soil are required to be resistant thereto.

Materials are accepted which meet the applicable requirements of the standards specified in the text entitled, "Masonry Construction."

Secondhand materials may be used only when they conform to the requirements of those standards and have been thoroughly cleaned.

Nominal Dimensions—Except as otherwise indicated, dimensions of masonry and masonry units given in this standard are nominal dimensions which may vary from actual dimensions up to ½ inch.

Cement—Cement used in concrete is required to be Portland cement except as noted in the text entitled, "Reinforced Concrete," part 3, page 37. Cement used in mortar is to be as required below under heading, "Mortar."

Water—Water is required to be clean and free from injurious amounts of oils, acids, alkalis, organic materials, or other deleterious substances.

Concrete—Concrete is required to have a minimum compressive strength at 28 days of 2000 psi and shall be either controlled concrete or average concrete. Average concrete is required to be in the proportions of 1 part Portland cement to not more than 6 parts of combined separate volumes of fine and coarse aggregate, and not more than 7½ gallons of water per bag of 94 pounds of cement. Surface water carried by the aggregate must be subtracted from the quantity of water specified. Where mixes other than that specified in the preceding paragraph are used, the enforcement officer is to require acceptable proof that concrete having a minimum compressive strength at 28 days of 2000 psi is being used.

Mortar—Mortar is to be classified in accordance with the following, based on information contained in ASTM, *Tentative Specifications for Mortar for Unit Masonry:*

Mortar Proportions by Volume: Aggregate measured in a damp and loose condition is required to be at least 2¼ times but not more than 3 times the sum of the volume of the cementitious materials, including lime, for the following types of mortar:

Type A-1: 1 part Portland cement to ¼ part (minimum and maximum) hydrated lime or lime putty.

Type A-2: 1 part Portland cement to more than ¼ and not more than ½ part hydrated lime or lime putty.

Type B: 1 part Portland cement to more than ½ and not more than 1¼ parts hydrated lime or lime putty; or 1 part cement meeting specifications for type II ASTM, *Standard Specifications for Masonry Cement.*

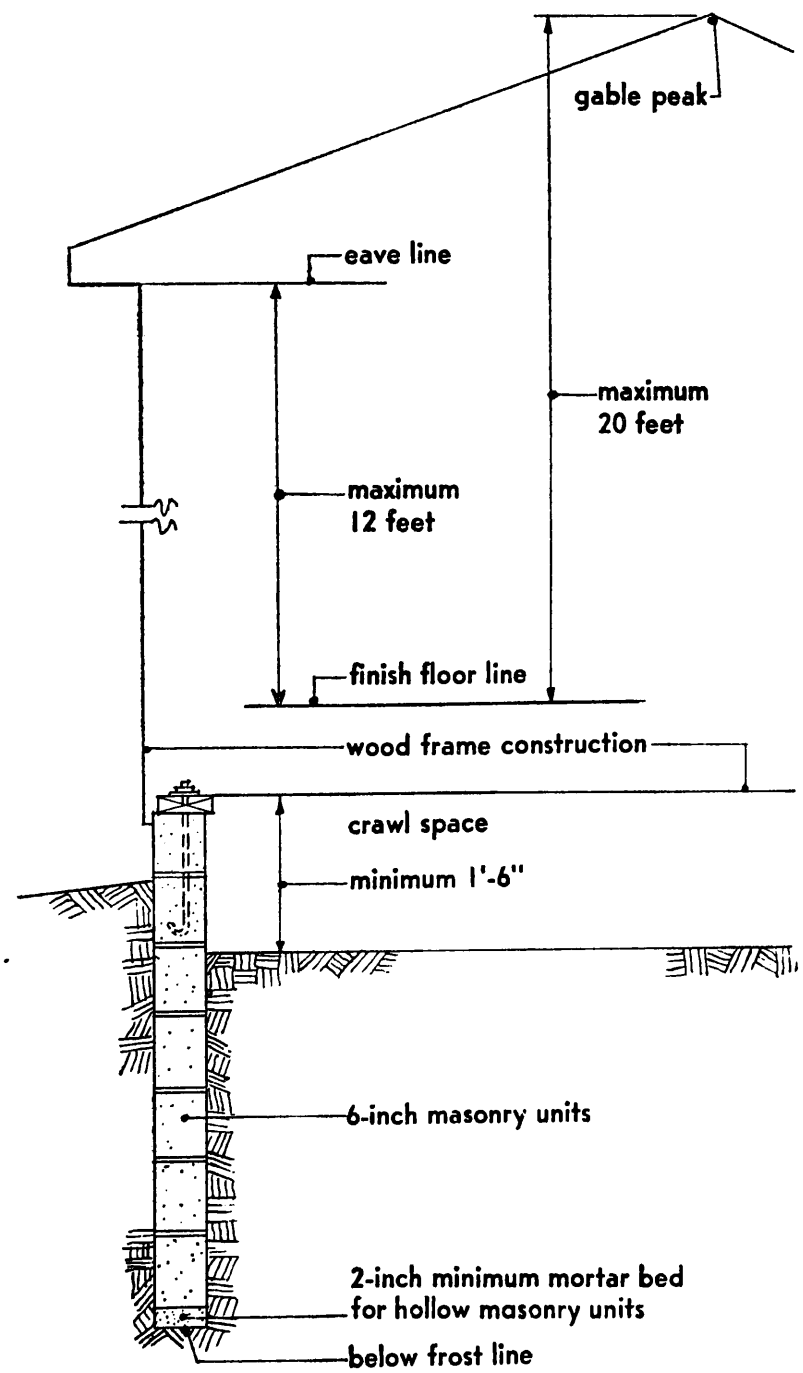
Type C: 1 part Portland cement to more than 1¼ and not more than 2½ parts hydrated lime or lime putty; or 1 part cement meeting specifications for type I ASTM, *Standard Specifications for Masonry Cement.*

Type D: 1 part Portland cement to more than 2½ and not more than 4 parts hydrated lime or lime putty.

The commonly used 1:3 cement mortar, with admixture of only sufficient lime or other plasticizing agent approved by the enforcement officer for workability, would be a type A-1, or a type A-2 mortar, depending upon the quantity of added lime. A 1:¼:3 mix would be a type A-1 mortar, and a 1:½:4 mix a type A-2 mortar. The frequently used 1:1:6 mix is a type B mortar.

Mortar of other ingredients or proportions proposed for use under this standard is required to be classified according to strength and is to have a flow after suction for 1 minute of not less than 70 per cent of that immediately before suction. Laboratory tests for flow after suction are required to be made with *(Continued on page 21)*

6-inch Unit Masonry Foundation Walls for Houses with Crawl Spaces

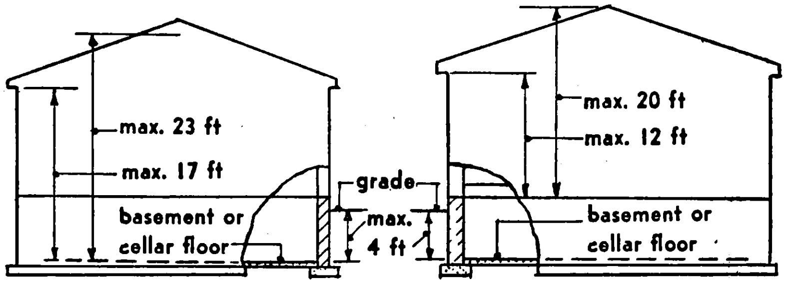


6-inch unit masonry foundation walls may be used under the conditions illustrated, provided that the spans of joists are such that the allowable masonry stresses indicated in the table entitled, "Allowable Stresses for Masonry Bearing Walls," part 3, page 23, are not exceeded. For protection of crawl spaces against ground water see text entitled, "Crawl Spaces," part 3, page 10.

Footings need not be required where the area of the bottom of wall is sufficient to transmit safely the load to rock or bearing soil, provided a suitable mortar bed is placed under the lowest course of hollow masonry units and all cored holes in the lower three courses of hollow masonry units are filled with mortar.

Sill is to bear on a minimum 4-inch top course of solid masonry units whose core holes are completely filled with mortar. Finished grade may be not more than 1 foot above or below the level of the ground in the crawl space.

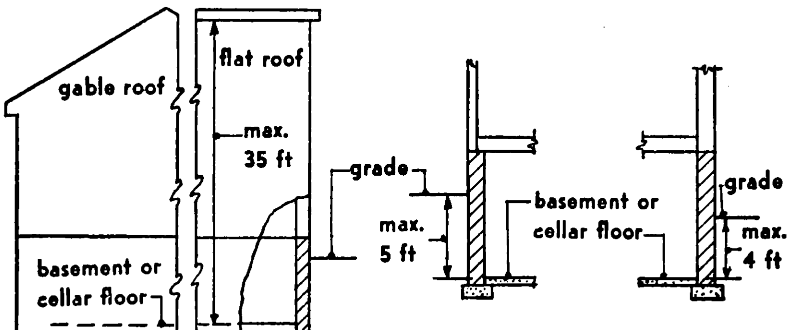
6-Inch and 8-Inch Foundation Walls



BUILDINGS WITH 6-INCH MASONRY WALLS

WOOD FRAMED OR LIGHT METAL FRAMED BUILDINGS

6-INCH CONCRETE FOUNDATION WALLS

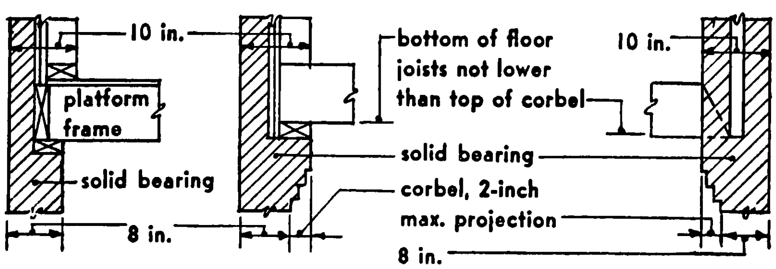


MAXIMUM TOTAL HEIGHT OF 8-INCH WALLS

SOLID MASONRY UNITS

HOLLOW MASONRY UNITS

8-INCH FOUNDATION WALLS



MASONRY VENEER ON FRAME

MASONRY-BONDED HOLLOW OR CAVITY WALL

Corbeling shall be done with solid units resting on solid units. Top corbel courses shall be header courses of headers not less than 6 inches long. Individual corbels shall project not more than one third the height of the corbel unit.

FOUNDATION WALLS LESS IN THICKNESS THAN WALLS SUPPORTED

(For supported walls not exceeding in height 9 feet to eave line and 15 feet to gable peak).

General—Foundation walls are to be of sufficient strength to resist safely lateral pressures from adjacent earth and to support their vertical loads. Foundation walls which are also retaining walls are not to be of hollow wall or cavity wall construction. Foundation walls of rubble stone are to be at least 6 inches thicker than when of solid masonry units.

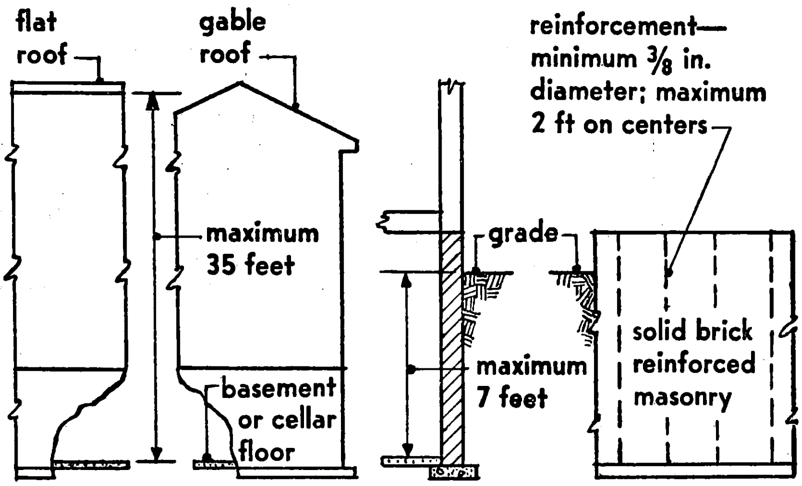
6-inch concrete foundation walls may be used to support 6-inch exterior masonry walls where total height of foundation wall and wall supported does not exceed 17 feet to the eave line and 23 feet to the gable peak; also may be used to support wood framed or light metal framed exterior walls not exceeding in height 12 feet to the eave line and 20 feet to the gable peak. At basements or cellars, the maximum depth below the adjacent grade level of 6-inch concrete foundation walls is to be 4 feet. The concrete is to be vibrated or rodded immediately after placing, to eliminate air pockets and honeycombing.

8-inch foundation walls may be used to a depth not more than 5 feet below adjacent grade level when of solid masonry units; and to a depth not more than 4 feet below adjacent grade level when of hollow masonry units; provided that the total height of foundation wall and the wall supported does not exceed 35 feet. The depths of 4 feet and 5 feet may be increased to 6 feet with the approval of the enforcement officer when he is satisfied that soil conditions warrant such increase. Also see illustration entitled, "8-Inch and 10-Inch Foundation Walls," part 3, page 19.

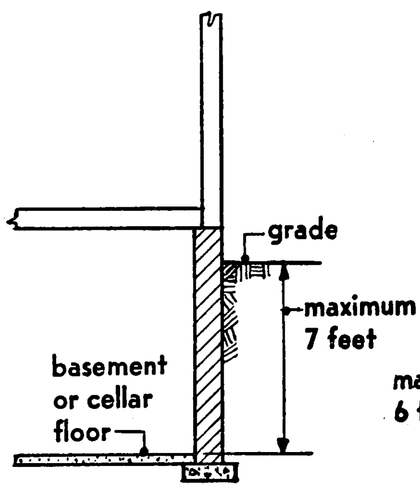
Thickness in Relation to Wall Supported—Foundation walls may be not less in thickness than walls supported, except that 10-inch, nominal, cavity walls and masonry veneered frame walls, not exceeding in height 9 feet to the eave line and 15 feet to the gable peak, may be supported on 8-inch foundation walls when acceptable provisions are made by corbeling or otherwise to support parts projecting beyond foundation walls.

Mortar—The permitted heights, and the depths below adjacent grade level, illustrated on this page, apply to masonry laid in mortars prescribed in this standard.

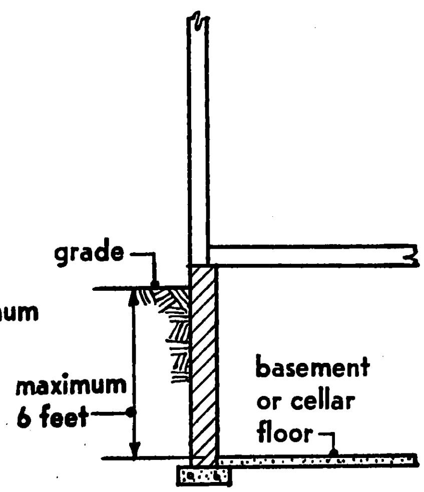
8-Inch and 10-Inch Foundation Walls



8-INCH PLAIN CONCRETE OR REINFORCED SOLID BRICK MASONRY FOUNDATION WALLS



10-INCH FOUNDATION WALLS OF SOLID MASONRY UNITS



10-INCH FOUNDATION WALLS OF HOLLOW MASONRY UNITS

General—Foundation walls are to be of sufficient strength to resist safely lateral pressures from adjacent earth, and to support their vertical loads. Foundation walls which are also retaining walls are not to be of hollow wall or cavity wall construction. Foundation walls of rubble stone are to be at least 6 inches thicker than when of solid masonry units.

Mortar—The permitted heights, and the depths below adjacent grade level, illustrated on this page, apply to masonry laid in mortars prescribed in this standard.

Thickness in Relation to Wall Supported—Foundation walls may be not less in thickness than walls supported, except that 10-inch nominal cavity walls and masonry-veneered frame walls, not exceeding in height 9 feet to the eave line and 15 feet to the gable peak, may be supported on 8-inch foundation walls when acceptable provisions are made by corbeling or otherwise to support parts projecting beyond foundation walls, as indicated in the illustration entitled, "6-Inch and 8-Inch Foundation Walls," part 3, page 18.

8-inch foundation walls may be used to a depth not more than 7 feet below adjacent grade level when of solid brick masonry reinforced with at least one 5/8-inch round deformed bar, continuous from footing to top of foundation wall, for each 2 feet of length of the wall, or when of plain concrete; provided that the total height of the foundation wall and the wall supported does not exceed 35 feet.

10-inch foundation walls may be used to a depth not more than 7 feet below adjacent grade level when of solid masonry units; and to a depth of not more than 6 feet below adjacent grade level when of hollow masonry units.

MASONRY UNITS

Materials	Standard Specifications	Conditions of use
Brick and other solid clay or shale masonry units	ASTM, Standard Specifications for Building Brick (Solid Masonry Units from Clay or Shale)	In contact with soil and subject to frost action, units must conform to requirements of grade SW brick as referred to in the ASTM standards; where subject to action of weather, or in contact with soil but not subject to frost action, units must conform to the requirements of grade MW brick in the ASTM standards; where not subject to action of weather or frost action, and not in contact with soil, units must conform to the requirements of grade NW brick in the ASTM standards, except that grade MW brick having a satisfactory local record of resistance to frost action when in contact with soil may be used where grade SW brick is required.
Sand-lime brick	ASTM, Standard Specifications for Sand-Lime Building Brick	
Concrete brick	ASTM, Standard Specifications for Concrete Building Brick	
Structural clay tile: Hollow clay or shale masonry units	ASTM, Standard Specifications for Structural Clay Load-Bearing Wall Tile, grade LBX	Subject to action of weather or soil
	ASTM, Standard Specifications for Structural Clay Load-Bearing Wall Tile, grade LB or grade LBX	Load-bearing, not subject to action of weather or soil
	ASTM, Standard Specifications for Structural Clay Non-Load-Bearing Tile	Non-load-bearing, not subject to action of weather or soil
Concrete masonry units	ASTM, Standard Specifications for Hollow Load-Bearing Concrete Masonry Units, grade A	Hollow units in load-bearing masonry subject to action of weather or soil
	ASTM, Standard Specifications for Hollow Non-Load-Bearing Concrete Masonry Units	Hollow units in non-load-bearing masonry subject to action of weather or soil
	ASTM, Standard Specifications for Solid Load-Bearing Concrete Masonry Units	Solid load-bearing units
Cast stone	ACI, Specifications for Cast Stone	
Natural stone		Required to be sound and free from loose or friable inclusions, and must have sufficient strength, durability, and resistance to impact for the intended use.
Gypsum partition tile or block	ASTM, Standard Specifications for Gypsum Partition Tile or Block	May not be used for bearing walls, nor where exposed to continuous dampness. Mortar for gypsum tile or block is to be unfibered calcined gypsum, mixed with not more than 3 parts sand, by weight.

CEMENTITIOUS MATERIALS

Materials	Standard specifications
Gypsum	ASTM, Standard Specifications for Gypsum
Hydrated lime	ASTM, Standard Specifications for Hydrated Lime for Masonry Purposes
Hydraulic hydrated lime	ASTM, Standard Specifications for Hydraulic Hydrated Lime for Structural Purposes
Quicklime	ASTM, Standard Specifications for Quicklime for Structural Purposes
Masonry cement	ASTM, Standard Specifications for Masonry Cement
Natural cement	ASTM, Standard Specifications for Natural Cement
Portland cement	ASTM, Standard Specifications for Portland Cement
Air-entraining Portland cement	ASTM, Tentative Specifications for Air-Entraining Portland Cement
Portland blast furnace slag cement	ASTM, Tentative Specifications for Portland Blast Furnace Slag Cement
Ready mix concrete	ASTM, Standard Specifications for Ready Mix Concrete
Aggregate for mortar	ASTM, Standard Specifications for Aggregate for Masonry Mortar
Aggregate for concrete[1]	ASTM, Standard Specifications for Concrete Aggregates; or ASTM, Standard Specifications for Lightweight Aggregates for Concrete
Concrete	ACI, Building Code Requirements for Reinforced Concrete

[1] Maximum size of aggregate and ratio of aggregate to cement are required to be such as to produce a mixture which will work readily into the corners and angles of the forms without segregation of materials and without flow of excess free water to the surface. For concrete not exposed to the weather, the enforcement officer may approve other aggregates shown to be satisfactory for the intended purpose by test or experience.

cementitions materials and aggregates (and admixture, if any) representative of the materials to be used in the construction, and samples are to be made, stored and tested in accordance with the water retention test described in ASTM, *Standard Specifications for Masonry Cement.*

When classified by test, mortar types are required to show the following minimum strengths:

Mortar type	Minimum compressive strength of 2-inch cubes at 28 days (in psi)
A–1	2500
A–2	1800
B	750
C	350
D	150

In making tests, the weight per cubic foot of the materials in the mortar should be assumed to be:

Material	Weight per cubic foot
Portland cement	94 lb
Masonry cement	Weight printed on bag
Hydrated lime	40 lb
Sand, damp and loose	1 cu ft contains 80 lb of dry sand

Grout—Grout may be substituted for mortar in the inner tiers of solid masonry walls. When such substitution is made, the grout is to correspond in type to the mortar for which substitution is made by the addition of water to produce consistency for pouring without segregating the constituents of the mortar. Grout is required to be of type A-1, type A-2, or type B mortar, and shall be known respectively as type A-1, type A-2, and type B grout.

Grouted Masonry—The materials used in grouted masonry are required to conform to those required for masonry laid in mortar, except that the masonry units in either the facing or backing, but not necessarily in both, at the time of laying are required to absorb in 24-hour cold immersion an amount of water weighing at least 5 per cent of the dry weight of the unit.

In grouted masonry, the two outer tiers are required to be laid with full bed joints of type A-1, A-2, or B mortar, and with the bed joints filled with sufficient mortar to form dams to retain the grout. All interior joints are to be filled with grout. One exterior tier may be built up three courses before grouting, but the other exterior tier may not be built up more than one course above the grouting. Grouted vertical joints parallel to the wall faces may not be less than ¾ inch in thickness. If work is stopped for one hour or longer, horizontal construction joints are to be formed by stopping the grout 1½ inches below the top of the exterior tiers.

Allowable Unit Stresses

General—When constructed in conformity with applicable requirements of this standard, the allowable unit stresses in masonry are required to be those given in the table entitled, "Allowable Stresses for Masonry Bearing Walls," part 3, page 23.

Composite Walls—In composite walls or other structural members composed of different kinds or grades of units or mortar, the allowable unit stress in the masonry may not exceed the allowable stress for the weakest of the combinations of units and mortars of which the member is composed.

Grouted Brick Masonry—For grouted brick masonry, the allowable unit stresses may not be more than 1½ times that allowed for corresponding masonry laid in mortar.

Plain Concrete—For plain concrete, the allowable unit stresses may not exceed 25 per cent in compression, nor 3 per cent for tension in extreme fiber in bending, of the compressive strength of the concrete; except that when the ratio of height to thickness of structural members of plain concrete exceeds 10, the percentage for compression is to be reduced proportionately to 19 per cent for a ratio of height to thickness of 22; and except that for cavity walls and hollow walls the allowable unit stresses shall not exceed those contained in the table entitled, "Allowable Stresses for Masonry Bearing Walls," part 3, page 23.

Foundation Walls

Mortar—Mortar used in masonry foundation walls is required to be as follows:

Type of masonry	Mortar type
Solid masonry	A–1, A–2, or B
Hollow masonry 8 inches thick	A–1, or A–2
Hollow masonry 10 inches or more in thickness	A–1, A–2, or B
For masonry other than above	A–1, or A–2

MORTAR — WALLS ABOVE GRADE[1]
(See text on page 23, part 3).

Type of masonry	Mortar type
Solid masonry not less than 12 inches thick and laterally supported at intervals not exceeding 12 times the wall thickness, but not including parapet walls or rubble stone walls	A–1, A–2, B, C, or D
Solid masonry same as above, except either less than 12 inches in thickness or not laterally supported at intervals not exceeding 12 times the wall thickness	A–1, A–2, B, or C
Hollow masonry, load-bearing or exterior	A–1, A–2, or B
Hollow walls or cavity walls	A–1, A–2, or B
Parapet walls; rubble stone walls; isolated piers	A–1, A–2, or B
Glass block masonry	A–1, A–2, or B
Masonry other than above	A–1, A–2, or B

[1] Exceptions: Gypsum mortar is required to be used in laying gypsum partition tile and block; and may also be used in laying nonbearing partitions of hollow masonry units. Gypsum mortar must be composed of 1 part gypsum and not more than 3 parts mortar aggregate, by weight. Fire brick is required to be laid in fire clay or other suitable refractory mortar.

Thickness and Construction—Foundation walls also acting as retaining walls are not to be of hollow wall or cavity wall construction, and are to be designed to resist all lateral loads as well as the vertical loads transmitted by the walls above.

Masonry foundation walls for buildings not exceeding 35 feet in height are required to be of the minimum thicknesses indicated in the following illustrations: "6-Inch Unit Masonry Foundation Walls for Houses with Crawl Spaces," part 3, page 17, "6-Inch and 8-Inch Foundation Walls," part 3, page 18, and "8-Inch and 10-Inch Foundation Walls," part 3, page 19. The length-to-thickness ratios are to conform to values as indicated in the illustration entitled, "Bracing of Interior and Exterior Masonry Walls," part 3, page 30.

In structures over 35 feet in height, foundation wall length-to-thickness ratios are to conform to values in the illustration entitled, "Bracing of Interior and Exterior Masonry Walls," part 3, page 30, and when of solid masonry units or plain concrete, are to be not less than 4 inches thicker

ALLOWABLE STRESSES FOR MASONRY BEARING WALLS
(On Gross Cross-Sectional Area, Except Where Noted)
In pounds per square inch

Type of masonry	Type A-1 mortar		Type A–2 mortar		Type B mortar		Type C mortar		Type D mortar
	Compression	Tension or shear	Compression	Tension or shear	Compression	Tension or shear	Compression	Tension or shear	Compression only
BRICK MASONRY [1]									
Comp. strength of brick:									
8000 psi plus	400	20	350	15	300	15	200	10	100
4500 to 8000 psi	250	20	225	15	200	15	150	10	100
2500 to 4500 psi	175	20	160	15	140	15	110	10	75
1500 to 2500 psi	125	20	115	15	100	15	75	10	50
SOLID CONCRETE MASONRY UNITS									
ASTM Grade A	175	12	150	12	125	12	80	10	..
ASTM Grade B	125	12	115	12	100	12	60	10	..
HOLLOW MASONRY UNITS	85	12 [3]	75	10 [3]	70	10 [3]	..	..	..
STONE MASONRY									
Granite, ashlar	800	12	700	12	640	12	500	10	400
Limestone, ashlar	500	12	450	12	400	12	325	10	250
Marble, ashlar	500	12	450	12	400	12	325	10	250
Sandstone, ashlar	400	12	350	12	320	12	250	10	160
Cast stone, ashlar	400	12	350	12	320	12	250	10	160
Rubble stone, coursed bonded	140	..	125	..	100	..	80	..	..
Rubble stone, random	100	..	85	..	70	..	50	..	..
HOLLOW WALL OR CAVITY WALL [2]									
Solid masonry units	125	12 [3]	115	10 [3]	100	10 [3]	..	..	..
Hollow masonry units	60	12 [3]	55	10 [3]	50	8 [3]	..	..	..
Plain concrete: compression, 300 psi; tension or shear, 30 psi									

[1] The allowable stresses for brick masonry shall apply to all solid masonry of solid masonry units of clay or shale, or of sand-lime brick or concrete brick, having corresponding strengths when tested in the position taken in the masonry. For increased allowable stress values for grouted brick masonry see text entitled, "Grouted Brick Masonry," part 3, page 22.

[2] The inner and outer parts of cavity walls shall be considered as acting independently under vertical load.

[3] On net area.

than the supported masonry nonbearing or bearing wall; when of rubble stone are to be not less than 8 inches thicker than the supported wall; when of reinforced concrete, are to be not less than the thickness of the supported wall. Hollow masonry units are not to be used for foundation walls.

Walls Above Grade

Mortar used in walls above grade is required to be of the types specified in the table entitled, "Mortar—Walls Above Grade," part 3, page 22. For various types of masonry walls and piers, see illustration entitled, "Types of Masonry Wall and Piers," part 3, page 31. Walls for buildings not exceeding 35 feet in height are required to be of the minimum thicknesses indicated in the illustration entitled, "Maximum Height of Above-Grade Walls," part 3, page 29. Walls for buildings exceeding 35 feet in height are required to be of the minimum thickness indicated in the illustration entitled, "Bearing and Nonbearing Walls," part 3, page 28.

Parapet Walls—Parapet walls may not be higher than four times their thickness unless reinforced or laterally supported. Whenever the wall is built of unit masonry, it is to be capped with an approved coping.

Bracing—Thickness of walls in relation to distances between bracing for such walls is to be in the ratios indicated in the illustration entitled, "Bracing of Interior and Exterior Masonry Walls," part 3, page 30. During erection, walls are required to be adequately braced to resist wind and other imposed loads.

Bond

Solid Brick Bearing Walls—Masonry-bonded solid brick bearing walls are required to be bonded so that not less than 16 per cent of the wall surface of each face is composed of full length headers. The distance between adjacent full length headers may not exceed 24 inches either vertically or horizontally. Where solid brick walls are constructed to conform in all respects (except for inner space) to the requirements specified for cavity walls, the inner and outer parts of the walls must be bonded together, and metal ties of size, type, and spacing specified for cavity walls may be used.

Solid Brick Nonbearing Walls—Solid brick nonbearing walls must be bonded as required for bearing walls, or are to be bonded with corrosion-resistant metal ties spaced not farther apart than 24 inches vertically and horizontally.

Walls of Hollow Masonry Units or Large Solid Masonry Units—These walls are required to be bonded as indicated in the illustration entitled, "Bonding Walls of Hollow Masonry Units or Large Solid Masonry Units," part 3, page 32.

Stone Walls—In ashlar masonry, through bond stones uniformly distributed are required to the extent of not less than 10 per cent of the face area. Rubble stone masonry 18 inches or less in thickness is required to have bond stones with a maximum spacing of 3 feet vertically and horizontally.

Faced Walls—Material used for facing may not be less than 2 inches actual thickness, and in no case less in thickness than 1/12 the height of the unit. Brick facing is required to be bonded to the backing as prescribed for masonry bonded solid brick walls.

Ashlar facing of either natural or cast stone is required to have at least 20 per cent of the superficial area extending not less than 4 inches into the backing to form bond stones, which are to be uniformly distributed throughout the wall. Every projecting stone, and, except when alternate courses are full bond courses, every stone not a bond stone, is required to be anchored securely to the backing with substantial corrosion-resistant metal anchors with a cross-section of not less than 3/16 inch by 1 inch, or its equivalent. There is to be at least one anchor to each stone and not less than two anchors for each stone more than 2 feet in length and 3 square feet in superficial area. Facing stones of greater size are to have at least one anchor to each 4 square feet of superficial face area.

Plain Concrete Walls—At openings in concrete walls, reinforcement symmetrically disposed in the thickness of the wall is required to be placed not less than 2 inches and not more than 3 inches above, and not less than 3 inches nor more than 4 inches below, openings; and is to extend not less than 24 inches beyond sides of such openings. Such reinforcement is required to consist of one 5/8-inch deformed round bar for each 6 inches or fraction thereof of wall thickness.

Cavity Walls—Cavity walls are required to be constructed as indicated in the illustrations entitled, "Cavity Wall Construction," part 3, page 33; "6-Inch and 8-inch Foundation Walls," part 3, page 18; and "Maximum Height of Above-Grade Walls," part 3, page 29.

Hollow Walls—Bonding units in hollow walls are required to be spaced generally as required for masonry bonded solid brick walls, and so as to provide equivalent bond.

Glass Block Masonry—Glass block masonry panels are not to support any load other than their own dead weight. In exterior walls the area of panels between edge structural members is not to exceed 120 square feet, and the maximum dimension of panels is to be 12 feet. Minimum thickness of block is to be 4 inches nominal. Provision is to be made for expansion of the panel. For mortar see table entitled, "Mortar—Walls Above Grade," part 3, page 22.

Masonry and Other Veneers

The provisions of this section apply to masonry and other veneers on masonry walls and on frame structures. Veneers may not be considered a part of the wall in computing the strength of bearing walls, nor a part of the required thickness of bearing walls. Veneers may not support any vertical load other than the dead load of the veneer above.

Heights—Veneers may be of the following materials and minimum thickness: Architectural terra cotta, cellular, 3 inches; architectural terra cotta, slabs, 1¼ inches; clay tile, structural, 1¾ inches; clay tile, flat slabs, 1 inch; brick, 2 inches; stone, natural, 2 inches; stone, cast, 1$\frac{9}{16}$ inches; marble, 1 inch; structural glass, $\frac{11}{32}$ inch; aluminum, 0.03 inch; other metals, either corrosion resistant or coated with porcelain enamel, No. 28 U.S.S. gage.

Maximum height between horizontal noncombustible supports is to be:

a—For architectural terra cotta, clay tile, brick, and stone, marble thicker than 1½ inches: at each floor level in skeleton construction; 35 feet otherwise.

b—For architectural terra cotta, clay tile, marble, 1½ inches or less in thickness: at each floor level or 12 feet, whichever is less.

c—For structural glass: supported at all horizontal joints by supports with lips to prevent the outward movement of the glass.

d—For metal: each panel to be supported at all horizontal or vertical joints.

e—Veneer on wood frame buildings: supported only on the foundation wall, and then only to a maximum height of 35 feet.

Attachment—Attachment of masonry veneer may be by anchoring or adhesion as follows:

a—Anchoring for masonry veneer thicker than 1½ inches, other than glass: one metal tie for each 300 square inches of face area.

b—For masonry veneer other than glass, of 1½ inches and less thickness, metal ties to be spaced not further apart than 16 inches horizontally and vertically. (See illustration entitled, "Exterior Masonry Veneers," part 3, page 34). In addition, for marble, spots of bonding cement at each anchor are to be placed between the marble and backing. If desired, after anchoring, the space behind the veneer, other than glass, may be filled with a cement grout, poured into the space as each tier is placed.

c—For glass, spots of mastic cement are to be applied in such quantity and number that when pressure is applied, at least 60 per cent of the area of the glass is bonded to the masonry backing; if the backing is porous, it is to receive a priming coat before application of the mastic cement. The maximum area of a single unit of glass is to be 10 square feet with a maximum dimension of 6 feet. Horizontal joints of glass are to be cushioned with pads of adhesive asphaltic tape.

d—Adhesion for terra cotta slab units of less than 540 square inches of face area and of 1½ inches or less thickness, may be used for attachment, employing types A-1 or A-2 mortars, applied to entire masonry backing and to the unit, with pressure applied to reduce the thickness of mortar to ¾ inches.

When grout or mortar is employed behind the veneer, the wall is to have received its full dead load before the veneer is applied. Over openings in the wall, veneer is to be supported by noncombustible members. When the veneer is glass, provision is to be made for expansion of veneer in a horizontal direction. Ties, anchors and supports are to be of metal, corrosion resistant or of metal coated with a noncorroding metal or other approved protective coating. For electrical continuity and grounding of metal veneer, see text entitled, "Lightning Protection for Metal on Buildings," part 5, page 62.

Drainage—Weep holes for masonry veneers are required to be provided at a maximum spacing of 2 feet 8 inches in the vertical joints at the base of the bottom course and at the base of the course supported on intermediate supports, if any, and flashing or wash similar to the detail for cavity walls is to be installed as indicated in the illustration entitled, "Cavity Wall Construction," part 3, page 33.

Miscellaneous Construction Requirements

Bonding of Intersecting Walls—Masonry walls are required to be securely anchored or bonded at points where they intersect. Where two bearing walls meet or intersect and the courses are built up together, the intersections are to be bonded by laying at least 50 per cent of the units at the intersection in a true bond.

Anchoring of Walls to Floor Construction—Masonry walls are required to be securely anchored to each tier of wood joists or wood beams as indicated in the illustrations entitled, "Anchoring of Masonry Walls to Wood Floors," part 3, page 35, and "Roof Framing," part 3, page 88.

Masonry walls are required to be securely anchored to each tier of steel joists or concrete joists at intervals not to exceed those required for wood joists, by anchors providing area equivalent to those indicated in the illustration entitled, "Anchoring of Masonry Walls to Wood Floors," part 3, page 35.

Bearing plate and anchors are to be provided for all steel girders and steel beams over 4 inches in depth. Plates are to have sufficient area so that allowable stresses of the masonry are not exceeded and the thickness of plate is to be determined by the bending moment incurred, with a minimum thickness of ⅜ inch. The ends of beams and girders are to be anchored to the wall by a bar of ¾-inch minimum diameter, of 18 inches minimum length, passing through the web, by angles attached to the beam and furnishing equivalent area, or by two or more bolts of ¾-inch minimum diameter attaching the beam or girder to the bearing plate.

Chases and Recesses—In 8-inch walls: Chases and recesses in walls from 8 inches to 12 inches in thickness may be constructed as indicated in the illustration entitled, "Chases and Recesses in 8-Inch Masonry Walls," part 3, page 36.

In 12-inch walls: Chases and recesses in walls 12 inches or more in thickness may not be deeper than one third of the wall thickness, and are required to conform to the following limitations: The aggregate area of recesses and chases in any wall may not exceed one fourth of the net area of the face of the wall in any story; there is required to be at least 7¾ inches of masonry between chases or recesses and the jambs of openings; no horizontal chase may exceed 4 feet in length nor may the horizontal projection for the length of any diagonal chase exceed 4 feet; masonry directly over chases or recesses more than 12 inches in width is required to be supported on approved lintels; there may be no chase or recess within the required area of any pier; chases and recesses may not be cut in hollow walls, cavity walls, or walls of hollow masonry units, but where permitted may be built in.

Lintels and Arches—The masonry above openings is required to be supported by arches or lintels of metal or masonry, plain or reinforced, which are to bear on the wall at each end for not less than 4 inches. Arches, lintels, and their end bearings are to be designed to carry the superimposed load without overstress. In arches, provision is to be made to resist lateral thrust.

All lintels are required to be of sufficient strength to carry the superimposed load without deflection of more than 1/360 of the clear span. Segmental masonry arches are to have at least 1-inch rise for each foot of span. Jack or flat masonry arches 8 inches in depth are to have a minimum horizontal skewback distance of 1 inch for every foot of span, at each end; when 12 inches in depth, the minimum horizontal skewback at each end is to be 1½ inches per foot of span.

Protection Against Freezing—Masonry is required to be protected against freezing for at least 48 hours after being laid. Unless adequate precautions against freezing are taken, no masonry may be built when the temperature is below 32° F. on a rising temperature, or below 40° F. on a falling temperature, at the place where the work is in progress. No frozen material may be built upon.

Piers—The unsupported height of aboveground piers may not exceed ten times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers supporting beams or girders, the cellular spaces are required to be filled solidly with concrete or type A-1 or A-2 mortar whenever the unsupported height of the pier exceeds six times its least dimension. Loads supported by pier are to be concentric with pier.

When of plain concrete, the stress in compression is not to exceed:

$$0.25 \times f_1 \times \left(1.3 - \frac{H}{20 \times T}\right), \text{ when } H/T \text{ exceeds } 6$$

When of other masonry, the stress in compression is not to exceed:

$$f_2 \times \left(1.3 - \frac{H}{20 \times T}\right), \text{ when } H/T \text{ exceeds } 6$$

in which $f_1 = 28$ days strength of concrete, psi
$f_2 =$ allowable stress in compression (see table entitled, "Allowable Stresses for Masonry Bearing Walls," part 3, page 23).
$H =$ unsupported height of pier, feet
$T =$ least horizontal dimension of pier, feet

Wetting of Masonry Units—Except when added moisture may freeze, bricks (clay or shale), laid in other than type D mortar, are to be wetted when laid unless their gain in weight resulting from partial immersion flatwise in 1/8 inch of water for 1 minute is less than 3/4 ounce per 30 square inches of net area.

Wood Supports Prohibited—Masonry, with the exception of fireplace hearths and bathroom concrete floors, may not be supported on wood beams, wood girders, or other wood construction. Centering of hearth slabs or trimmer arches is not to be left in place.

Existing Walls—An existing masonry wall may be used in the renewal or extension of a building provided that under the new conditions of use it meets the requirements of this standard.

Structurally sound existing masonry walls, which are of insufficient thickness when increased in height, are required to be strengthened by an addition of the same material not less than 8 inches in thickness laid in type A-1 or A-2 mortar. All linings are to be thoroughly bonded into existing masonry by toothings to assure combined action of wall and lining. Such toothings are to be distributed uniformly throughout the wall and are to aggregate in vertical cross-sectional area not less than 15 per cent of the total vertical area of the lining. Stresses in the masonry under the new conditions may not exceed the allowable stresses prescribed for composite walls. The foundations and lateral support are to be equivalent to those required for new walls under similar conditions.

Expansion of Walls—Bearing and nonbearing straight walls of concrete masonry units should have control joints located at a maximum of 40-foot intervals, and walls of brick and of tile masonry should have control joints located at a maximum of 100-foot intervals in order that expansion and contraction may occur without cracking from this cause. A straight vertical joint utilizing half-size units in alternate courses, or a staggered vertical joint filled with nonstaining elastic caulking compound after the wall is finished, may be used. An alternate method is the use of a pilaster or pier into which the wall on one side, or on both sides, can slide approximately 2 inches horizontally, with the joint caulked.

Corbeling—Corbeling is to be done with solid units resting on solid units. For other than chimneys, and except as indicated in the illustrations entitled, "6-Inch and 8-Inch Foundation Walls," part 3, page 18, and "Cavity Wall Construction," part 3, page 33, corbeling is to be done as follows:

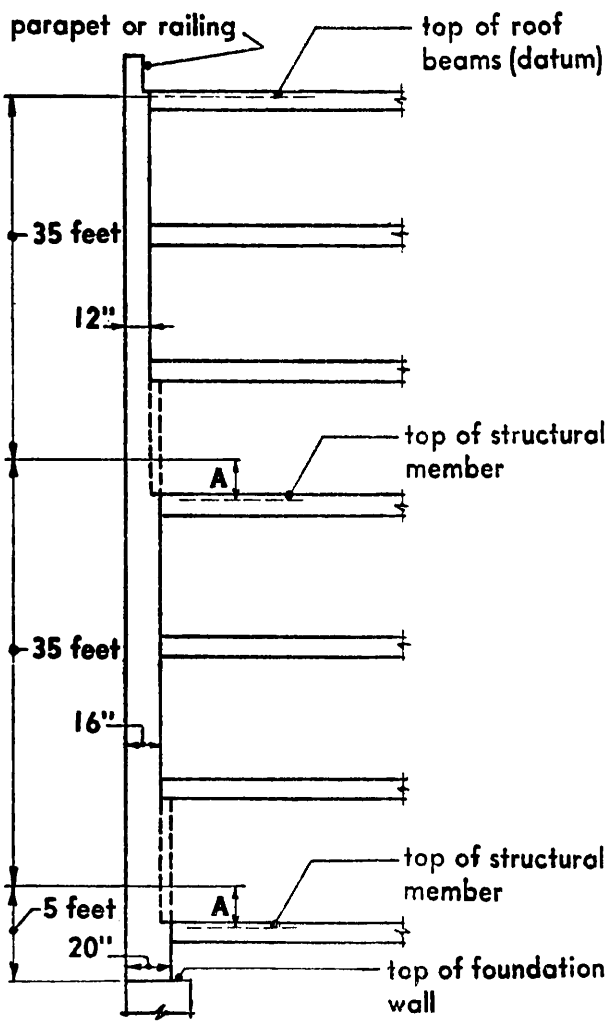
The maximum amount of corbel is not to exceed one half the thickness of wall and the maximum projection of one unit is not to exceed one half the height of the unit, nor one third its width at right angles to the face of wall which is corbeled. The maximum height of wall supported by corbeling is not to exceed 15 feet.

For chimneys, the corbeling is to be done as above with a maximum amount of corbel of 6 inches, and if the wall is less than 12 inches thick, corbeling must project equally on both sides of wall.

Masonry Nonbearing Partitions—Masonry is to be built solidly against the underside of floor construction above and partitions are to have the following thicknesses, exclusive of plaster, for the following heights and lengths:

2 inches, 9 feet high, not over 6 feet in length
3 inches, 12 feet high, not over 20 feet in length
4 inches, 15 feet high, not over 20 feet in length
5 inches, 17 feet high, not over 20 feet in length
6 inches, 20 feet high, not over 20 feet in length
8 inches, 25 feet high, not over 20 feet in length

Bearing and Nonbearing Walls



SOLID BEARING WALLS
OF SOLID MASONRY UNITS

Roof Datum—When roof structural members slope or are at different elevations, the average elevation of the roof members is to be taken as datum for the purpose of determining wall thickness.

(This illustration and text apply to buildings more than 35 feet in height)

General—Where concentrated loads such as tank tower and elevator loads, etc., occur, provision is to be made to distribute the loads in order not to exceed the allowable stresses.

Wall thicknesses shown are minimum and in no case are the allowable stresses (see table entitled, "Allowable Stresses for Masonry Bearing Walls," part 3, page 23), or the L/T ratios (see illustration entitled, "Bracing of Interior and Exterior Masonry Walls," part 3, page 30) to be exceeded.

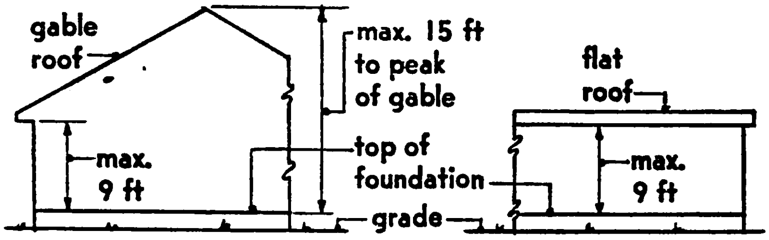
Solid Bearing Walls of Solid Masonry Units—Walls are to be 12 inches thick for the uppermost section of 35 feet in height, and are to increase 4 inches in thickness for each successively lower section of 35-foot height or fraction thereof. When **A** exceeds 1 foot, the thick- of the wall in that full story is to be the greater thickness.

Solid Nonbearing Walls of Solid Masonry Units—Walls may be 4 inches less than the thickness for solid bearing walls of solid masonry units.

Solid Bearing and Nonbearing Walls of Hollow Masonry Units—Walls are to be not less in thickness than corresponding walls of solid masonry units but in no case to exceed 50 feet in height. Where such walls decrease in thickness a course of solid masonry or a 6-inch layer of plain concrete is to be placed between the two wall thicknesses.

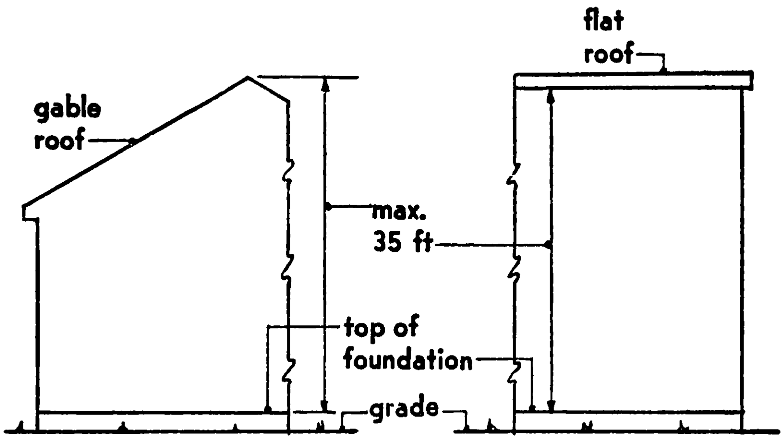
Solid Bearing and Nonbearing Walls of Plain Concrete—Walls may be 2 inches less than for corresponding walls of solid masonry units, but in no case less than 8 inches thick.

Maximum Height of Above-Grade Walls

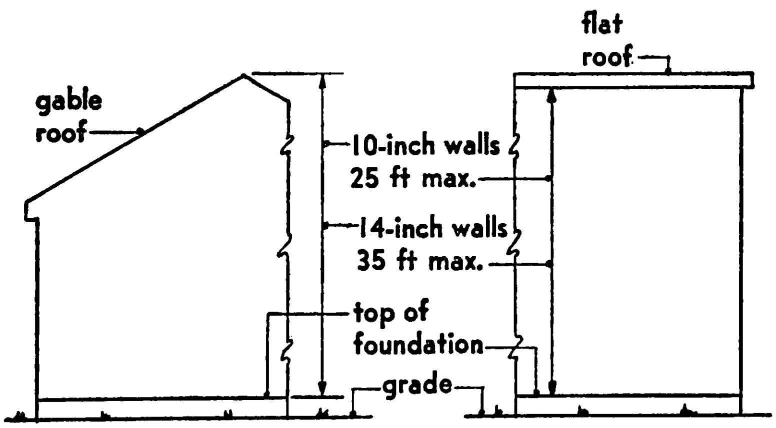


1-STORY BUILDING

6-INCH SOLID WALLS OF SOLID OR HOLLOW MASONRY UNITS, OR PLAIN CONCRETE



8-INCH SOLID WALLS OF SOLID OR HOLLOW MASONRY UNITS, OR PLAIN CONCRETE



CAVITY WALLS AND HOLLOW WALLS OF SOLID MASONRY UNITS

Rubble Stone Walls—The permitted heights illustrated on this page do not apply to rubble stone walls. Rubble stone walls are to be at least 4 inches thicker than the dimensions shown.

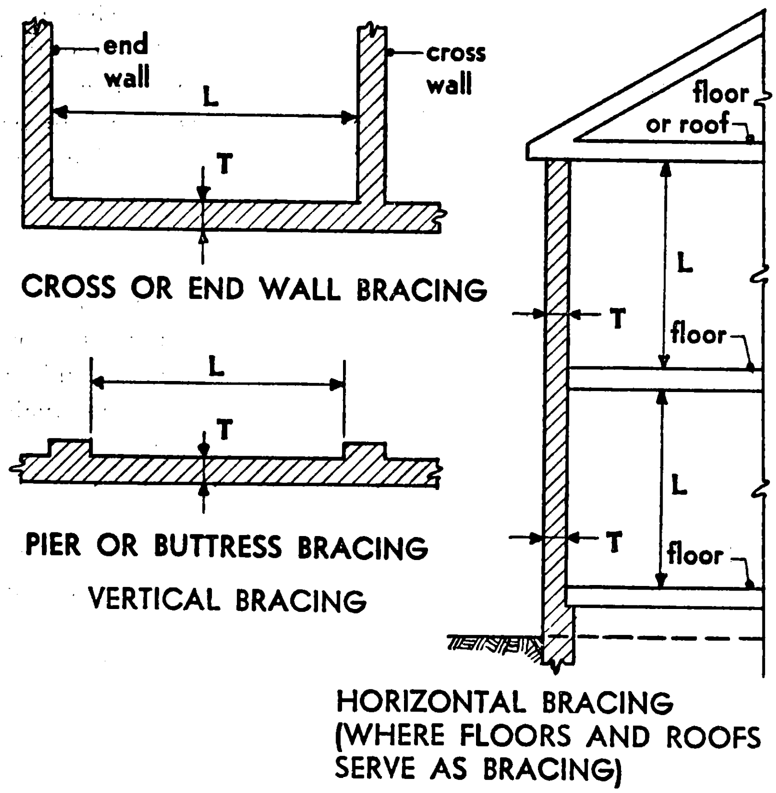
Mortar and Bracing—The permitted heights as determined by considerations of strength, illustrated on this page, apply to masonry laid in mortars and braced at the intervals prescribed in this standard.

Cavity Walls and Hollow Walls of Hollow Masonry Units—The maximum height of such walls, braced at intervals prescribed in this standard, is to be determined by considerations of strength, but in no case are the maximum heights prescribed for cavity walls, and hollow walls, of solid masonry units to be exceeded.

Cavity Walls and Hollow Walls of 14-Inch Nominal Thickness—The inner part of such walls is to have a minimum thickness of 6 inches.

Reinforced Concrete Walls—The maximum height of such walls is to be determined by considerations of strength, designed in conformity with ACI, *Building Code Requirements for Reinforced Concrete.*

Bracing of Interior and Exterior Masonry Walls



Bracing—Except where reinforced brick masonry is used, masonry walls are to be braced, either horizontally or vertically, at such distances that the ratios of distance to wall thickness do not exceed those given in the table.

Bracing may be obtained by cross walls, piers, or buttresses, when the limiting distance is measured horizontally, or by floors or roofs, where the limiting distance is measured vertically.

Sufficient bonding or anchorage is to be provided between the walls and the bracing to resist the design wind load, acting either inwardly or outwardly. Piers, columns, or buttresses relied upon for bracing are to have sufficient strength and stability to transfer the wind force, acting in either direction, to the ground.

When walls are dependent upon floors or roofs for their bracing, provision is to be made in the building to transfer the lateral forces to the ground.

MAXIMUM RATIO OF UNBRACED HEIGHT OR LENGTH (L) TO THICKNESS (T)

Type of masonry	Ratio
Solid masonry (except rubble stone) type A-1, A-2, B, or C mortar	20
Solid masonry (except rubble stone) type D mortar	12
Grouted solid masonry (except rubble stone) type A-1, A-2, or B mortar and grout	22
Hollow walls and walls of hollow masonry units, type A-1, A-2, or B mortar	18
Cavity walls, type A-1, A-2, or B mortar	14 [1]
Plain concrete 2000 psi	22
Rubble stone: coursed and bonded	18
Rubble stone: random	14

[1] Based on sum of inner and outer parts of wall.

Types of Masonry Walls and Piers

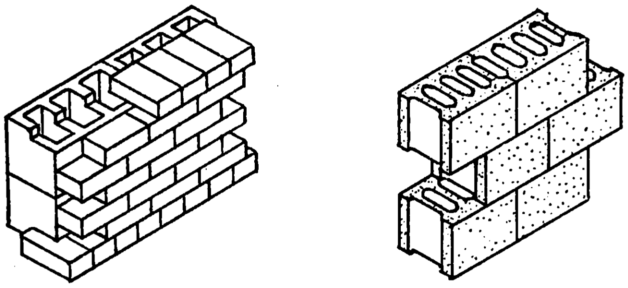


FIG. 1 HOLLOW MASONRY UNITS

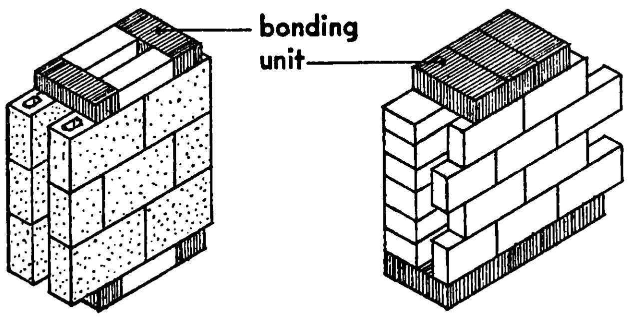


FIG. 2 HOLLOW WALLS

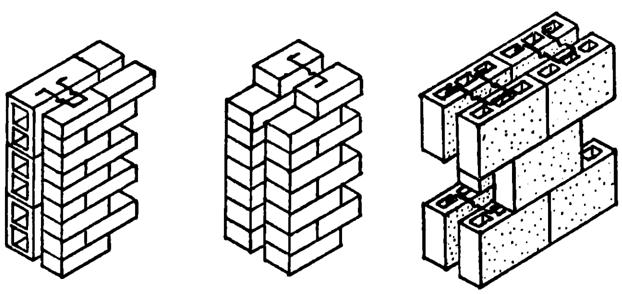


FIG. 3 CAVITY WALLS

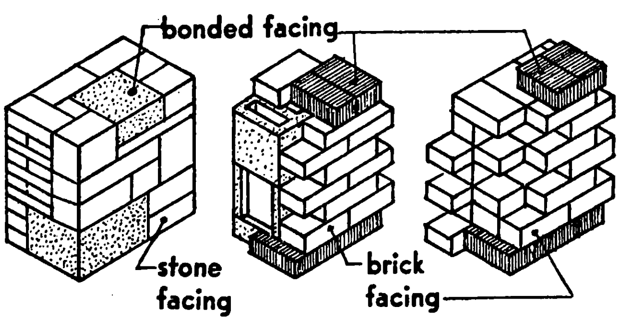
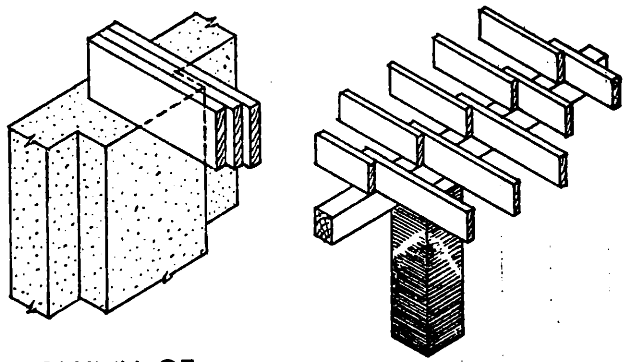


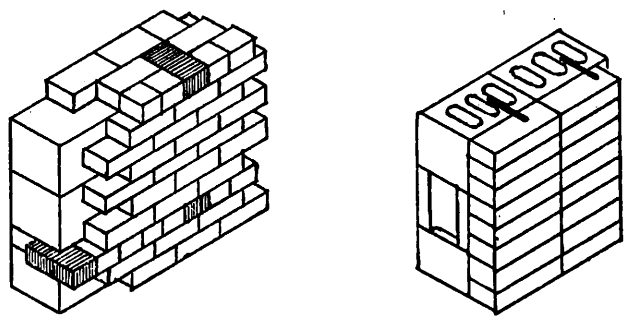
FIG. 4 FACED WALLS



COLUMN OF MASONRY INTEGRAL WITH WALL

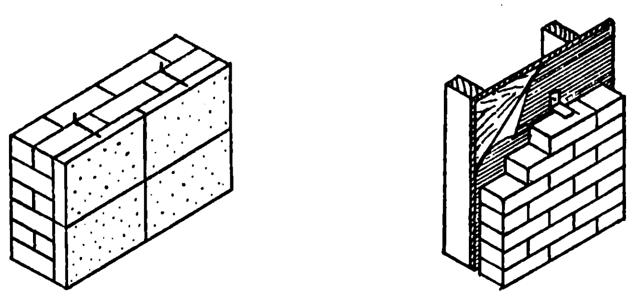
ISOLATED COLUMN OF MASONRY

FIG. 5 PIERS



MASONRY TIES; MASONRY BACKING

METAL TIES; MASONRY BACKING

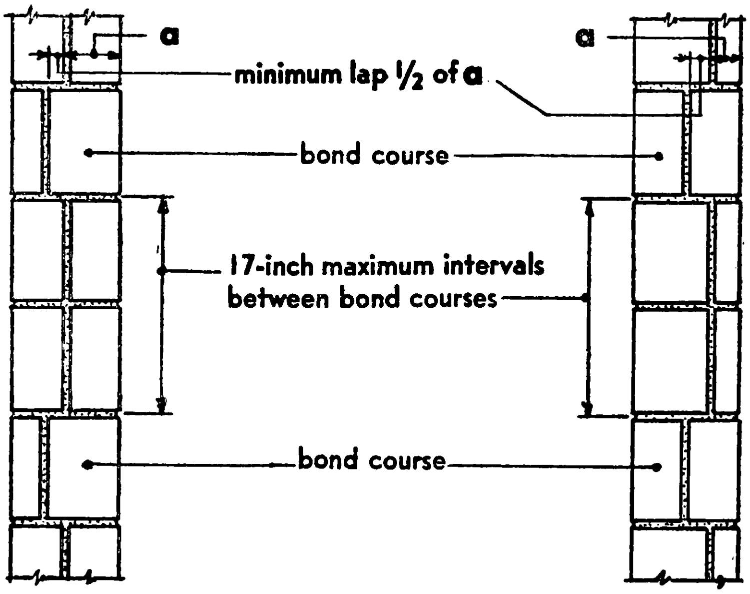


METAL TIES; MASONRY BACKING

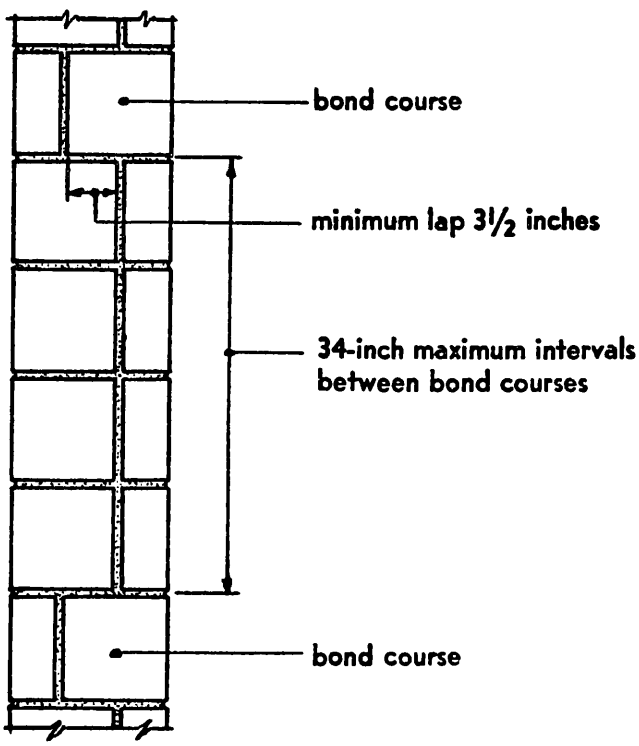
METAL TIES; FRAME BACKING

FIG. 6 VENEERED WALLS

Bonding Walls of Hollow Masonry Units or Large Solid Masonry Units



Bonding courses at least 50 per cent greater in thickness than units below but lapping less than 3½ inches

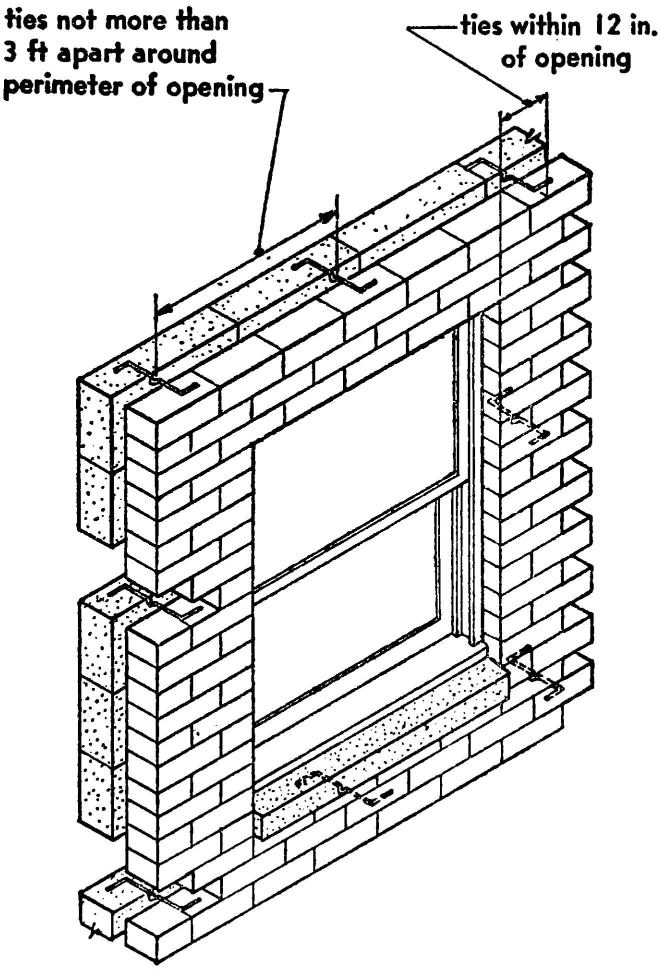


Bonding courses lapping at least 3½ inches over units below

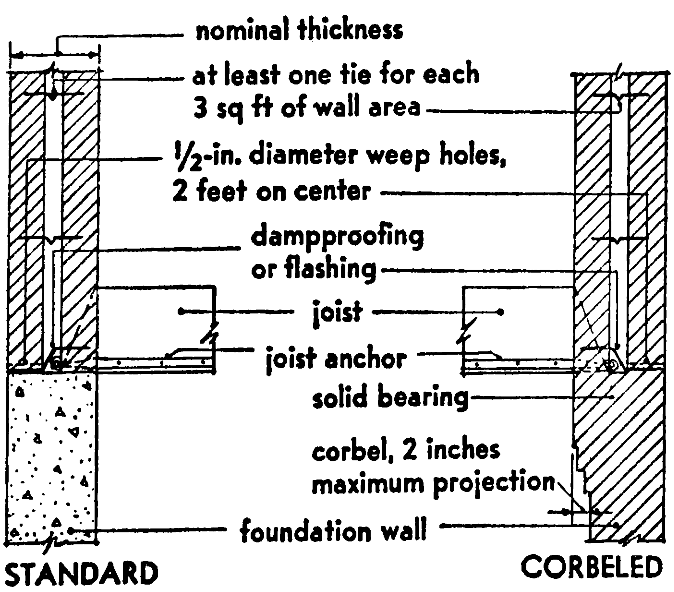
Spacing of Bond Units—Where two or more hollow units, or solid units exceeding brick size, are used to make up the thickness of a wall, and the stretcher courses are bonded by bonding courses lapping at least 3½ inches over the unit below, such bond courses may be spaced up to but not exceeding 34 inches apart. Where the bond courses lap less than 3½ inches over the unit below, the bond units are to be at least 50 per cent greater in thickness than the units below and are to be spaced at vertical intervals not exceeding 17 inches.

Mortar Coverage—Hollow masonry units are to have full mortar coverage of face shells in both the horizontal and vertical joints.

Cavity Wall Construction



OPENING IN CAVITY WALL



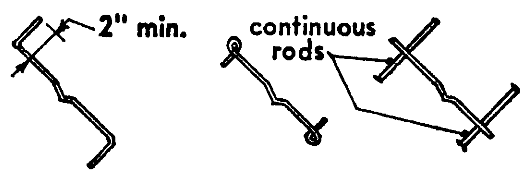
CAVITY WALLS

Construction—Neither the facing nor the backing of cavity walls is to be less than 3½ inches in actual thickness and the cavity may not be less than 2 inches nor more than 3 inches in width. Every effort should be made to keep mortar from falling into the space between parts of wall. Cavity walls are to be laid in type A-1, A-2, or B mortar.

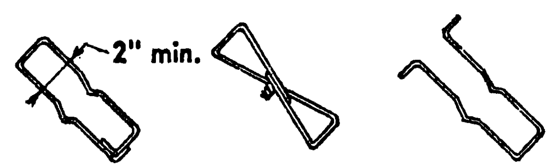
Corbeling is to be done with solid units resting on solid units. Top corbel courses are to be header courses of headers not less than 6 inches long. Individual corbels are to project not more than one third the height of the corbel unit. Walls supported by corbeling are not to exceed in height 9 feet to eave line and 15 feet to gable peak.

Ties—Ties are to be of corrosion-resistant metal, or of metal coated with a noncorroding metal or other approved coating. Ties are to be of material equivalent in stiffness to $\frac{3}{16}$-inch diameter steel rods, spaced apart not farther than 24 inches horizontally or vertically.

In skeleton construction, the backing is to be wedged to the floor construction above, and where only the facing passes the column, it is to be tied to it on 24-inch vertical spacing unless tied to the backing on both sides of the column at the required spacing.

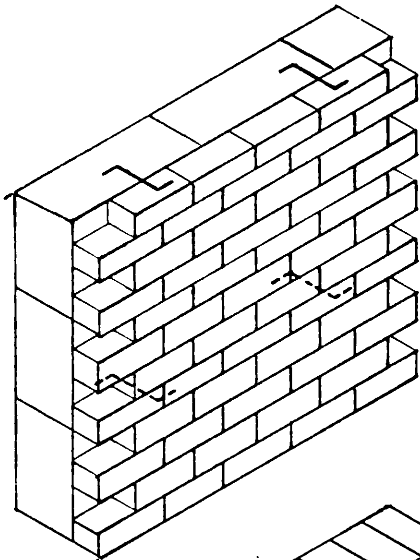


Ties for cavity walls, except where rectangular ties are required.

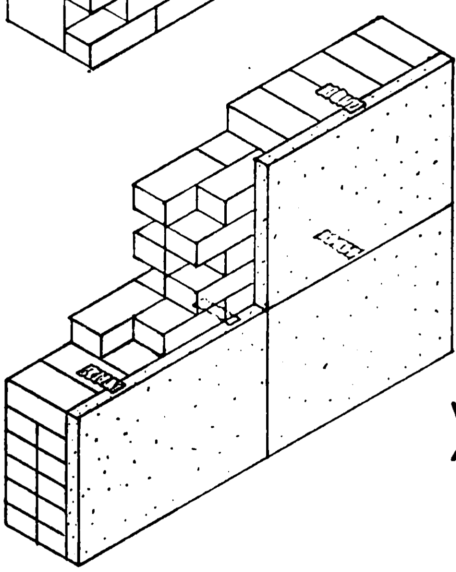


Rectangular ties for bonding facing and backing of cavity walls built of hollow masonry units laid with the cells vertical.

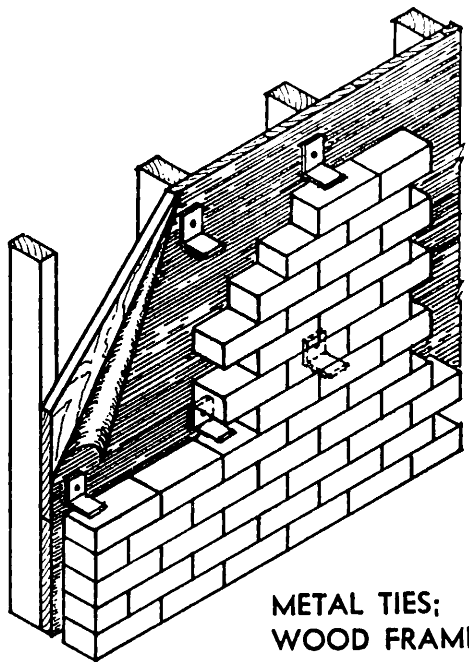
Exterior Masonry Veneers



VENEER THICKER THAN 1½ INCHES

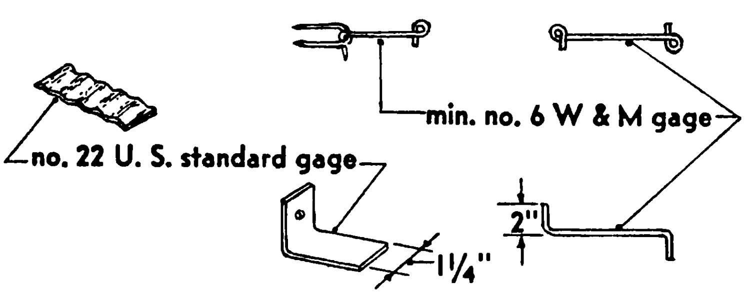


VENEER 1½ INCHES AND THINNER



METAL TIES; WOOD FRAME BACKING

METAL TIES



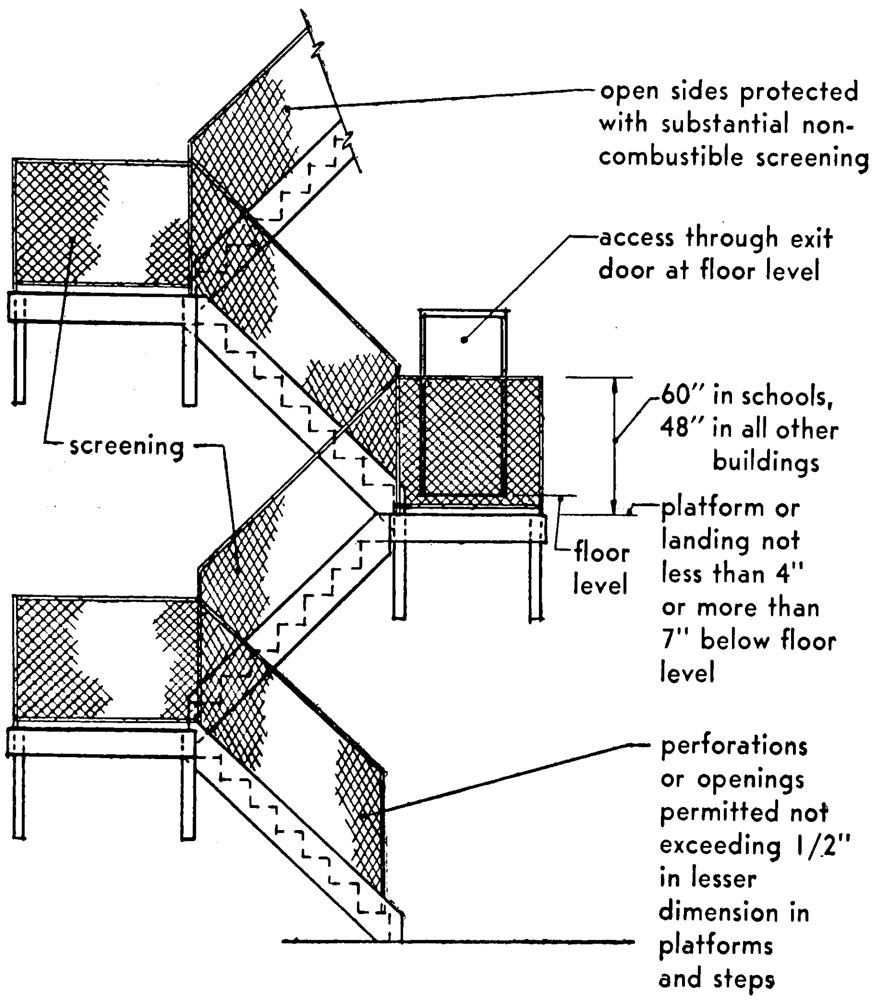
Location of Ties—Veneer thicker than 1½ inches: A metal or masonry tie is to be provided for each 300 square inches of wall surface, and ties may not be farther apart than 25 inches horizontally or vertically.

Veneer 1½ inches and thinner: Ties are to be spaced not farther apart than 16 inches horizontally and vertically.

Metal ties are to be of corrosion-resistant metal or of metal coated with a noncorroding metal or other approved protective coating.

(W & M gage [Washburn and Moen] is the same gage as United States Steel wire gage.)

Exterior Stairways and Steps



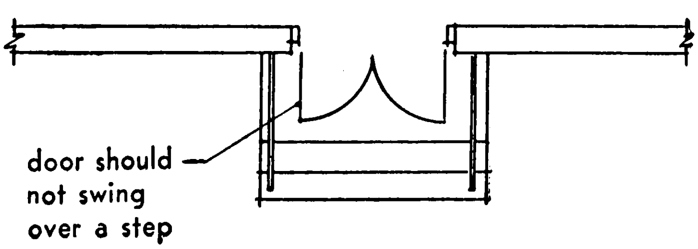
EXTERIOR SCREENED STAIRWAY

Every part of the exterior stairway should be at least 5 feet from any interior lot line.

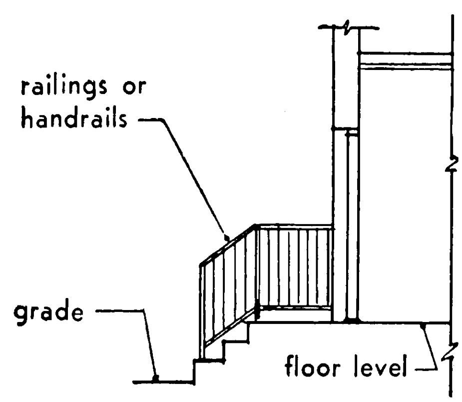
Exterior wall openings within 10 feet of the stairway should be fitted with opening protectives.

Wood exterior stairways are permitted on buildings of type 4 or 5 construction not more than two stories high, provided the occupancy is other than C5, C6.2, or C6.3.

Dimensions of treads, risers, landings, and the location of handrails should be the same as for interior stairways.



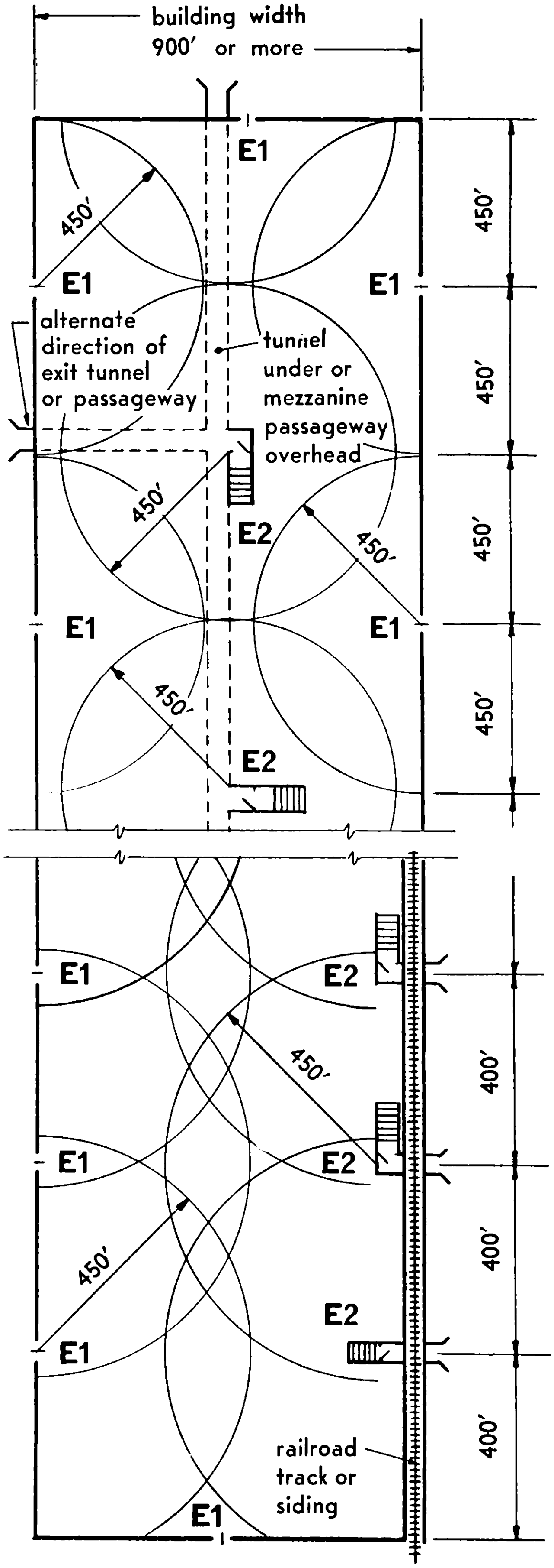
PLAN



ENTRANCE STEPS

SECTION

Examples of Maximum Travel Distance of 450 Feet to Exits



Travel Distance to Exits—The travel distance to exits may be a maximum of 450 feet under these conditions:

1. In sprinklered buildings classified as group C3.1 or C4.1 occupancy, one story in height, and complying with requirements for unlimited fire area, as permitted by table C 203-1a;

2. In nonsprinklered buildings classified as group C3.1 or C4.1 occupancy, one story in height, and complying with the following requirements: no fire load; type 1 or 2 construction; clearance to noncombustible roof truss of at least 35 feet; and roof deck *not* covered with a combustible vapor seal, insulation, or roof covering.

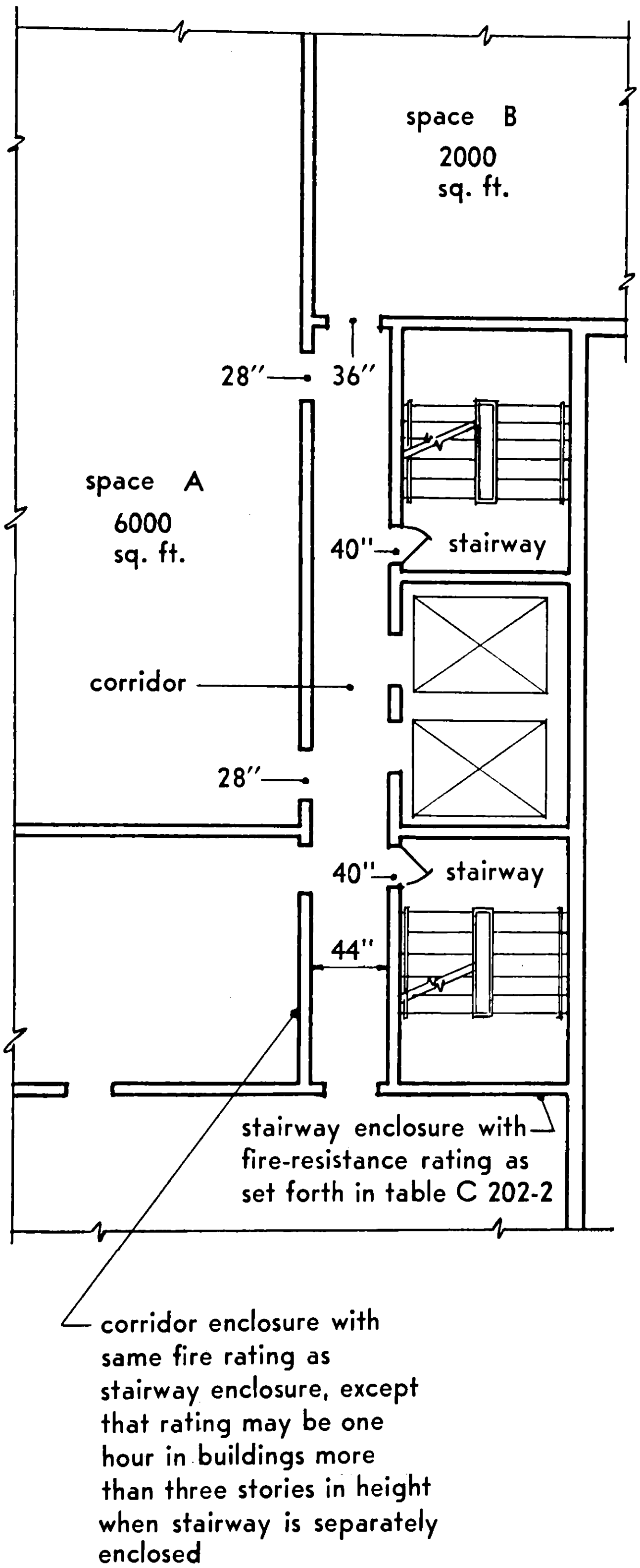
Buildings with Railroad Sidings—Where exit to the exterior is not direct because of the location of a railroad siding or other obstruction, exit by tunnel under, or by mezzanine passageway over, such obstruction should be provided.

Buildings with Tunnel or Mezzanine Passageway Exits—Exit tunnels should be reached either by stairs or ramps, mezzanine passageways by enclosed stairs. Tunnels should discharge to the outside of a building at grade. There should be no stairs inside the tunnel, but stairs or ramps outside the building are acceptable. Mezzanine passageways should discharge by ramps or stairs outside the building, but enclosed ramps or stairs immediately adjacent to the exterior wall, through which such stairs or ramps exit, are acceptable.

Such exit tunnels and passageways should be regularly used for access and egress purposes during normal occupancy of the building.

Key to drawing:
- E1 Exits at grade level
- E2 Entrance to tunnel exit or to enclosed overhead mezzanine passageway

Determination of Exits



UPPER FLOOR OF AN OFFICE BUILDING

If the number of persons for a proposed occupancy is larger than that computed by using table C 212-8a, exits should be provided for the larger number.

Doorway width for space A:

a—In table C 212-8a, 150 sq. ft. per person is the basis for determining exit requirements for group C1 occupancy;

b—Dividing the 6000 sq. ft. area by 150 sq. ft. per person gives 40 persons;

c—Table C 212-8b permits 90 persons for one 22-inch unit width of doorway;

d—Thus, while one unit of width would be sufficient on the basis of occupancy load, section C 212-8a requires two exits because the area exceeds the limits in which one exit is permitted (see table C 212-8d);

e—Section C 212-5.1e calls for a minimum doorway width of 28 inches;

f—Thus, two doorways, each at least 28 inches wide, should be provided.

Doorway width for space B:

a—Area of 2000 sq. ft. divided by 150 sq. ft. per person gives 14 persons;

b—By table C 212-8b, one unit of width would be sufficient on the basis of occupancy load;

c—Table C 212-8d permits one exit for above-grade floor area of C1 occupancy, if area is less than 2500 sq. ft.;

d—Section C 212-5.1e requires the doorway to be at least 36 inches wide where only one exit is provided;

e—Thus, one doorway, at least 36 inches wide, should be provided.

Doorway to stairs:

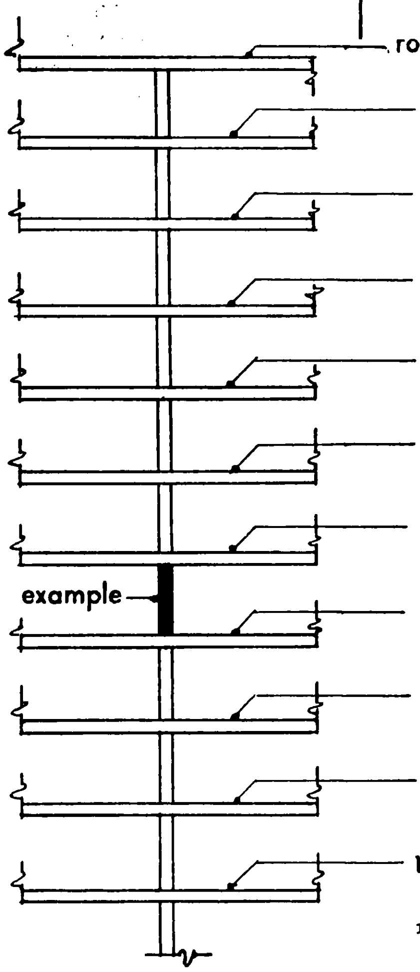
a—Section C 212-1i permits the doorway width to be less than the corridor width on the basis of two inches for each unit of corridor width;

b—According to section C 212-5.1e, a 44-inch width is equal to two units;

c—Thus, the stair doorway should be 44 minus 2 x 2, or 40 inches wide.

Enclosure of Stairways—In buildings more than three stories in height, exit stairways should be separately enclosed as shown at left. (See sections C 212-1d and C 402-4.6i)

Reduction of Uniform Live Loads for Vertical Structural Elements



Roof and floors below roof	Percent of live-load to be used	(See example at bottom of this page)
roof	80	0.80 × 40 = 32[1] 1.00 × (25 + 6) = 31
1	80	.80 × 40 = 32
2	80	.80 × 40 = 32
3	75	.75 × 40 = 30
4	70	.70 × 40 = 28
5	65	.65 × 40 = 26
6	60	.60 × 40 = 24
7	55	.55 × 40 = 22
8	50	.50 × 40 = 20
9	50	.50 × 40 = 20
10	50	.50 × 40 = 20

[1] Larger of two values to be used.

Reduced uniform live loads apply only to columns, girders supporting columns, bearing walls, and foundation walls supporting 150 square feet or more of area per floor or roof when such area is not used for motor vehicle parking. These reductions are permissive, not mandatory.

Note: The live load, by definition, is due to occupancy and does not include snow load or wind load.

Example: Determine the concentric live load that the column supporting the sixth floor below the roof receives. Tributary area is 400 square feet per floor; live load on roof = 40 psf, as a promenade; snow load = 25 psf; wind load on roof = 6 psf; live load on floors = 40 psf.

Solution: Live load = 400 (32 + 32 + 32 + 30 + 28 + 26 + 24) pounds = 400 (204) = 81,600 pounds.

(For the design of the column, to this live load must be added the dead load of the roof and of all floors supported by the column. Eccentricity of loads, if any, must be considered.)

tural Cement, may be used in controlled concrete only, in such proportions that the weight of natural cement used does not exceed 15 per cent of the weight of Portland cement actually used.

Cinder Concrete—Concrete made with a mixture by volume of 1 part cement, 2 parts sand and a maximum of 5 parts clean, well burned cinders (containing a maximum of 40 per cent by weight of unconsumed carbon and a maximum of 1½ per cent by weight of sulphur) and properly reinforced, may be used for floor and roof slabs of limited span when supported by steel beams or joists. Such cinder concrete is to have a minimum compressive strength of 700 psi at 28 days. The slabs are not to exceed 8-foot clear span when the design (dead plus imposed) load exceeds 200 psf, and 10 feet otherwise. The total thickness of slab, t inches, is to be determined as follows, but in no case to be less than 4 inches:

$$t=\left\{\frac{\text{clear span, feet}}{2}\right\}+\left\{\frac{\text{design load psf}-75}{200}\right\}$$

The reinforcement, hooked to or continuous over supports, is to have a minimum concrete cover of ¾ inch and the center of the reinforcement is to be at least 3 inches from the compression face. The required cross-sectional area, A, of the reinforcement in square inches per foot of width of slab, is to be determined as follows:

$$A=\frac{(\text{design load psf})\times(\text{clear span, feet})^2}{3\times C}$$

When steel conforms to requirements for structural grade or better grade in ASTM, *Standard Specifications for Billet Steel Bars for Reinforced Concrete,* bars plain or deformed,

$C = 20{,}000$ psi, when reinforcement is continuous over supports

$C = 14{,}000$ psi, when reinforcement is hooked to one or both supports

When steel conforms to requirements of ASTM, *Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement,*

$C = 26{,}000$ psi when reinforcement is continuous over supports

$C = 18{,}200$ psi when reinforcement is hooked to one or both supports

All other requirements for the concrete are to conform to ACI, *Building Code Requirements for Reinforced Concrete.* The compression face of joist or beam is to be braced laterally by embedment of at least ½ inch into the slab and slab is to be supported in each span by end bearing. All openings larger than 18 inches on a side are to be framed by steel, or reinforced.

Stucco

Stucco is required to be installed in conformity with ASA, *Standard Specifications for Portland Cement Stucco.*

Reinforced Gypsum Concrete

Gypsum concrete construction in conformity with ASA, *Building Code Requirements for Reinforced Gypsum Concrete* as modified herein, is acceptable as in conformity with generally accepted standards.

Allowable Stresses—The allowable stresses given in ASA, *Building Code Requirements for Reinforced Gypsum Concrete,* are to apply only to the use of gypsum concrete in locations where it will be maintained in a dry state and effectively protected against moisture, including moisture which may accumulate within the gypsum concrete because of differential vapor pressure.

Exposure—Gypsum concrete may not be used where exposed directly to the weather or where subject to frequent or continuous wetting, or where exposed to detrimental moisture accumulation within the gypsum concrete, or where for prolonged periods, the temperature on the surface of the gypsum concrete is 250° F. or more. Precautions are required to be taken against saturation and freezing during construction.

Plastering

The lathing and furring for interior walls, studless solid partitions, contact, furred and suspended ceilings are to conform to the requirements of ASA, *Standard Specifications for Interior Lathing and Furring.*

Precast Concrete Joists

Precast concrete joists are to conform to the requirements of ACI, *Minimum Standard Requirements for Precast Concrete Floor Units.*

Steel Joists

Steel joist construction in conformity with ASA, *Building Code Requirements for Steel Joist Construction*, and protected as herein specified, is acceptable as in conformity with generally accepted standards.

Protection—Joists exposed to the weather or to unusual or specially corrosive conditions, including installation in crawl spaces, are to be kept protected by painting or the equivalent, so that corrosion will not occur; when subjected to such exposure or conditions, steel joists of material lighter than 15 U. S. S. gage may be used only with the approval of the enforcement officer under acceptable assurance of proper maintenance.

Structural Steel

Structural steel construction in conformity with AISC, *Specification for the Design, Fabrication and Erection of Structural Steel for Buildings*, and protected as herein specified, is acceptable as in conformity with generally accepted standards.

General—All structural steel is required to be given a shop coat of rust-inhibitive paint and a field coat of protective paint, or equivalent, except that paint or other protection may be omitted from steel inherently rust resistive, and from steel encased in concrete made with noncorrosive aggregates.

Steel beams and columns are not to be supported on wood construction. For a compression member the ratio of its length to radius of gyration is to be considered, above the foundation, only between steel members themselves connected to other steel.

High Tensile Bolted Structural Joints—Bolts, nuts and washers used in such joints are to conform to the requirements of ASTM, *Tentative Specifications for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers.*

Members Encased in Exterior Walls—Structural steel encased in exterior walls, with less than 8 inches of solid masonry between the steel and the exterior face of the wall, or encased in walls of hollow masonry units, is to be protected by mortar parging of the steel, or waterproofing coating of the steel, or of the exterior of the masonry, or equivalent.

Formed Steel Construction

Formed steel construction designed in conformity with AISI, *Light Gage Steel Design Manual*, and AISI, *Steel Regulations* (Reference Bulletin V), insofar as applicable to formed steel construction, and protected as herein specified, is acceptable as in conformity with generally accepted standards.

Protection—All light-gage formed steel is required to be protected with an unbroken film of rust-inhibitive coating. Load-bearing light-gage formed steel construction is to be protected and maintained against corrosion which might cause failure of structural elements or assemblies. Whenever load-bearing light-gage formed steel construction is assembled or located so that moisture due to condensation or from other sources may accumulate on or within the assembly in concealed or not easily accessible locations, and cause corrosion, the surface on which moisture may accumulate is to be thoroughly protected against corrosion by a coating of durable paint or noncorrodible metal, or other protective material approved by the enforcement officer.

Cast Iron

Cast iron for structural members is to conform to the requirements of ASTM, *Standard Specifications for Gray Iron Castings.* Allowable stresses: tension 3,000 psi; shear 3,000 psi; compression in bending 16,000 psi; compression in columns 9,000 psi minus

$$\frac{40 \text{ times (height, inches)}}{\text{radius of gyration r, inches}}$$

with a maximum permissible height/r ratio of 70.

Columns are to be at least 5 inches in diameter, or least dimension and thickness of metal is to be a minimum of $\frac{1}{12}$ of the diameter or least dimension, or $\frac{3}{4}$ inch, whichever is larger. Cast iron bases and tops are to be at least 1 inch thick.

When eccentric loading occurs, no part of the column may be in tension.

Lintels are not to be used when the clear span exceeds 6 feet.

Beams and columns are not to be supported on wood construction.

Wood Construction

Sizes—All wood structural members are required to be of sufficient size and strength and are to be conditioned and used so as to carry their imposed loads safely, without undue deflection.

Unless otherwise specifically noted, sizes given in this standard are nominal sizes. The actual dimension in inches of dressed lumber may not be less than that given in the following table:

Nominal	Actual	Nominal	Actual
1	25/32	6	5 5/8
2	1 5/8	8	7 1/2
3	2 5/8	10	9 1/2
4	3 5/8	12	11 1/2

Nominal sizes may be shown on drawings.

Grade and Quality—Lumber, when graded, is required to be graded under rules applicable thereto in NLMA, *National Design Specification for Stress-Grade Lumber and Its Fastenings*, and ASTM, *Tentative Methods for Establishing Structural Grades of Lumber*. Wherever the ability of lumber to resist stresses or sustain loads depends upon its being of a specific grade, acceptable assurance thereof is to be provided, such as grade marking by an agency or person recognized as being competent. Lumber is to be either stress-grade lumber with the allowable stresses set forth in the table entitled, "Working Stresses for Stress-Grade Lumber," part 3, pages 44 to 47, or yard lumber. When yard lumber has been graded, it is to be allotted the allowable stresses set forth in the table entitled, "Working Stresses for Yard Lumber," part 3, page 43. Where the grade of yard lumber has not been established, such lumber is to be assumed to have the lowest allowable stress accorded to the species, for yard lumber.

No lumber of lower grade than that listed in the table entitled, "Working Stresses for Yard Lumber," part 3, page 43, and none with a slope of grain in the center half of the length exceeding 1 in 8 may be used for members in bending, such as floor or ceiling joists, roof joists, rafters, beams, or girders.

No lumber of obviously unsuitable quality may be used in any construction. All lumber is to be sound and free from rot, decay, and shakes, and other defects which would affect its durability or render it unsafe for the purpose for which it is intended.

Framing lumber 2 inches or less in nominal thickness should not have a moisture content of more than 19 per cent.

Working Stresses

Normal Loading—For conditions of normal loading, working stresses are required to be those given in the tables entitled, "Working Stresses for Yard Lumber," part 3, page 43, and "Working Stresses for Stress-Grade Lumber," part 3, pages 44 to 47.

Short-Time Loading—For short-time loading, including snow, wind, and impact, allowable unit stresses for normal loading, other than the modulus of elasticity, may be increased as follows:

15 per cent for 2 months' duration, as for snow.
25 per cent for 7 days' duration.
33 1/3 per cent for wind.
100 per cent for impact.

Such increases are not cumulative.

Long-Time Loading—For members designed to be fully stressed by unusual fixed concentrated loads to the safe maximum for more than three years, either continuously or cumulatively, allowable unit stresses for normal loading are required to be reduced 10 per cent.

Lumber Alternately Wet and Dry: Lumber Pressure Impregnated—Allowable unit stresses specified in the tables entitled, "Working Stresses

Type of stress, or modulus of elasticity	When lumber is alternately wet and dry; and when lumber has been preservative impregnated under pressure and high temperature; percentage of allowable unit stresses.
Extreme fiber in bending "f" and tension parallel to grain, "t"	85
Horizontal shear, "H"	100
Compression perpendicular to the grain, "C⊥"	75
Compression parallel to the grain, "C"	90
Modulus of elasticity, "E"	100

for Yard Lumber," part 3, page 43, and "Working Stresses for Stress-Grade Lumber," part 3, pages 44 to 47, apply to lumber used under conditions where it is continuously dry or continuously wet, and to the heartwood of a durable species under varying conditions of use. Where these conditions are not met and other approved protective measures are not taken, and for lumber preservative impregnated under pressure and high temperature, the allowable unit stresses for normal loading are required to be multiplied by the reduction factors expressed in percentages as indicated in the table on page 41, part 3.

Maximum Spans of Joists and Rafters—The tables (part 3, pages 48 to 61) give the maximum allowable spans in feet and inches, of floor joists, ceiling joists, and rafters, for the allowable stress, allowable modulus of elasticity, size of joist or rafter surfaced on four sides, spacing of joist or rafter, and the live load or snow zone indicated thereon. The weight of joist or rafter has been based on an assumed density of wood of 40 pounds per cubic foot.

Example for floor joists, *given:*
Span 17′ —0″
Live load 40 psf
Plastered ceiling supported
Allowable unit stress (working stress) 1450 psi, modulus of elasticity 1,600,000 psi

Solution: As regards *stress,* use table A and interpolate between columns headed 1400 and 1500: 3 x 8's, 16 inches on center or closer, may be used; 2 x 10's, 16 inches on center or closer, may be used; 3 x 10's, 24 inches on center or closer, may be used; 2 x 12's, 24 inches on center or closer, may be used, as all of these are good for spans greater than 17′ —0″. As regards *deflection,* use table C and in column headed 1,600,000: 3 x 8's, 16 inches on center are inadequate being good for only 15′ —9″ or less; 3 x 8's, 12 inches on center may be used; 2 x 10's, 16 inches on center or closer, may be used; 3 x 10's, 24 inches on center or closer, may be used; 2 x 12's, 24 inches on center or closer may be used.

Example for ceiling joists, *given:*
Span 17′ —0″
Live load 20 psf
Unplastered ceiling supported
Allowable unit stress (working stress) 1450 psi, modulus of elasticity 1,600,000 psi

Solution: Use table G, and as regards *stress,* interpolate between columns headed 1300 and 1500 under "Unplastered Ceiling": 2 x 6's, 12 inches on center (good for 17′ —2″) may be used; 2 x 8's, 20 inches on center or closer, may be used; 2 x 10's, 24 inches on center or closer, may be used. Use table G, and as regards *deflection,* in column headed 1,600,000 under "Unplastered Ceiling": 2 x 6's, 12 inches on center are inadequate as these are good for only 16′ —3″; 2 x 8's, 24 inches on center or closer, may be used but stress governs; 2 x 10's, 24 inches on center or closer, may be used. (Where part of the joist receives 20 psf and part receives 30 psf, use tables G and H and interpolate between them).

Example for roof rafter, *given:*
Rise-to-run 6-to-12 (26°-30′)
40 snow zone
No ceiling
Wood shingles
Actual length of rafter 15′ —0″
Allowable unit stress (working stress) 1500 psi, modulus of elasticity 1,200,000 psi

Solution: Use table J and as regards *stress,* in column headed 1500: 2 x 6's, 12 inches on center may be used; 2 x 8's, 24 inches on center or closer, may be used; 2 x 10's, 24 inches on center or closer, may be used. Use table J and as regards *deflection,* in column headed 1,200,000: 2 x 6's, 12 inches on center are inadequate; 2 x 8's, 24 inches on center are inadequate but 2 x 8's, 20 inches on center or closer, may be used; 2 x 10's, 24 inches on center or closer, may be used.

Design and Assembly—In the design, preparation, fabrication, and installation of stress-grade lumber, and of yard lumber as applicable thereto, including the use of connectors and other mechanical devices for fastening, the applicable requirements of the Code will be met by conformity with NLMA, *National Design Specification for Stress-Grade Lumber and Its Fastenings.*

Wood Supports Prohibited—Wood construction may not be used to support steel or cast iron beams and columns, reinforced concrete, or masonry, with the exception of fireplace hearths and bathroom concrete floors. Centering of hearth slabs or trimmer arches is not to be left in place.

WORKING STRESSES FOR YARD LUMBER
(In pounds per square inch)

Species	Rules under which graded	Commercial grade name	Stress (psi bending) Depth 4″	6″	8″	10″	12″	Modulus of elasticity (in thousands)
Bald cypress (tidewater red cypress)	SCMA	No. 1 common dimension	700	250	250	500	400	1200
Douglas fir, coast region	WCLA	No. 3 framing, joists, plank	210	450	600	700	650	1600
		No. 1 studding, blocking	850	850	850	850	850	1600
		No. 2 studding, blocking	500	500	500	500	500	1600
Douglas fir, Rocky Mountain region	WPA	No. 1 dimension (or timbers)	650	800	850	950	1050	1200
		No. 2 dimension (or timbers)	180	400	500	600	650	1200
Fir, balsam	NELMA	Selected merchantable	1100	1000	1100	1050	1150	1000
		No. 1	550	750	850	850	1000	1000
Fir, white	WPA	No. 1 dimension (or timbers)	650	800	850	950	1050	1100
		No. 2 dimension (or timbers)	180	400	500	600	650	1100
Hemlock, eastern	NH and HMA	No. 1 common dimension	650	800	850	1050	1050	1100
		No. 2 common dimension	650	750	750	750	750	1100
Hemlock, western (west coast hemlock)	WCLA	No. 3 framing, joists, plank	210	450	600	700	650	1400
		No. 1 studding, blocking	750	750	750	750	750	1400
		No. 2 studding, blocking	450	450	450	450	450	1400
Larch, western	WPA	No. 1 dimension (or timbers)	850	1100	1150	1300	1450	1500
		No. 2 dimension (or timbers)	240	550	700	850	900	1500
Pine, eastern white (northern white pine)	NPMA	No. 1 dimension and timbers	500	650	700	800	850	1000
Pine, western white (Idaho white pine) ponderosa and sugar	WPA	No. 1 dimension (or timbers)	500	650	700	800	850	1000
		No. 2 dimension (or timbers)	140	300	400	500	550	1000
Pine, red (Norway pine)	NH and HMA Also NPMA	No. 1 dimension and timbers	650	800	850	950	1050	1200
Red cedar, western (western red cedar)	WCLA	Select merchantable dimension	900	1000	1100	1100	1150	1000
		No. 1 dimension, plank	500	850	850	850	850	1000
		No. 2 dimension, plank	300	450	550	550	650	1000
		No. 3 dimension, plank	140	300	400	500	450	1000
Spruce, red and white (eastern spruce)	NELMA	Selected merchantable	1350	1250	1350	1300	1400	1200
		No. 1	650	900	1050	1050	1200	1200
Spruce, red and white (eastern spruce)	NH and HMA	No. 1 dimension and timbers	650	800	850	950	1050	1200
Spruce, Engelmann	WPA	No. 1 dimension (or timbers)	450	550	600	650	750	800
		No. 2 dimension (or timbers)	120	250	350	400	450	800
Spruce, Sitka	WCLA	Select merchantable dimension	1100	1250	1350	1400	1400	1200
		No. 1 dimension, framing	650	900	1050	1050	1050	1200
		No. 2 dimension, framing	400	550	650	700	800	1200
		No. 3 dimension, framing	180	400	500	600	550	1200
Tamarack	NH and HMA	No. 1 common dimension	700	850	950	1150	1150	1300

Abbreviations—CRA, California Redwood Association; NELMA, Northeastern Lumber Manufacturers Association; NH and HMA, Northern Hemlock and Hardwood Manufacturers Association; NPMA, Northern Pine Manufacturers' Association; SCMA, Southern Cypress Manufacturers Association; WCLA, West Coast Lumbermen's Association; WPA, Western Pine Association.

WORKING STRESSES FOR STRESS-GRADE LUMBER

[The working stresses below are for normal loading conditions]

1 Species and commercial grade [1]		2 Rules under which graded	3 Extreme fiber in bending "f" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "c⊥"	6 Modulus of elasticity "E"	7 Compression parallel to grain (for solid columns and solid struts) for ratios of length-to-least-dimension (l/d) l/d11 or less "C"	l/d14	l/d17	l/d20	l/d23	l/d26	l/d30	l/d35	l/d40	l/d50
			Allowable unit stresses in pounds per square inch													
ASH, WHITE:																
2150 f Grade	J.&P.		2150	145			1700	1586	1452	1224	932	730				
1900 f Grade	J.&P.—B.&S.		1900	145			1500	1421	1328	1170	932	730				
1700 f Grade	J.&P.—B.&S.		1700	145			1325	1271	1206	1097	926	730				
1450 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1450	120	600	1,500,000	1150	1114	1073	1003	892	730	548	403	308	197
1300 f Grade	B.&S.		1300	120			1050	1023	991	939	855	731				
1450 c Grade	P.&T.		....	....			1450	1379	1295	1154	932	730				
1200 c Grade	P.&T.		....	....			1200	1159	1111	1031	904	730				
1075 c Grade	P.&T.		....	....			1075	1046	1012	954	862	728				
BEECH:																
2150 f Grade	J.&P.		2150	145			1750	1640	1509	1288	995					
1900 f Grade	J.&P.—B.&S.		1900	145			1525	1453	1368	1225	995					
1700 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1700	145			1350	1300	1241	1139	983					
1450 f Grade	J.&P.—B.&S.		1450	120	600	1,600,000	1150	1119	1082	1020	922	779	584	430	329	210
1550 c Grade	P.&T.		....	....			1550	1474	1384	1234	995					
1450 c Grade	P.&T.		....	....			1450	1388	1314	1188	992					
1200 c Grade	P.&T.		....	....			1200	1165	1123	1054	943					
BIRCH:																
2150 f Grade	J.&P.		2150	145			1750	1640	1509	1288	995					
1900 f Grade	J.&P.—B.&S.		1900	145			1525	1453	1368	1225	995					
1700 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1700	145			1350	1300	1241	1139	983					
1450 f Grade	J.&P.—B.&S.		1450	120	600	1,600,000	1150	1119	1082	1020	922	779	584	430	329	210
1550 c Grade	P.&T.		....	....			1550	1474	1384	1234	995					
1450 c Grade	P.&T.		....	....			1450	1388	1314	1188	992					
1200 c Grade	P.&T.		....	....			1200	1165	1123	1054	943					
CHESTNUT:																
1450 f Grade	J.&P.	National Hardwood Lumber Association	1450	120			1200	1110	1003	823						
1200 f Grade	J.&P.—B.&S.		1200	120	360	1,000,000	950	905	852	763	622	486	365	269	205	132
1075 c Grade	P.&T.		....	....			1075	1009	932	802						
CYPRESS, SOUTHERN:																
1700 f Grade	J.&P.—B.&S.		1700	145			1425	1320	1196	986						
1300 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1300	120	360	1,200,000	1125	1072	1011	907	746	583	438	322	247	158
1450 c Grade	P.&T.		....	....			1450	1338	1208	986						
1200 c Grade	P.&T.		....	....			1200	1136	1062	936						
CYPRESS, TIDE-WATER RED:																
1700 f Grade	J.&P.—B.&S.	Southern Cypress Manufacturers Association	1700	145			1425	1320	1196	986						
1300 f Grade	J.&P.—B.&S.		1300	120	360	1,200,000	1125	1072	1011	907	746	583	438	322	247	158
1450 c Grade	P.&T.		....	....			1450	1338	1208	986						
1200 c Grade	P.&T.		....	....			1200	1136	1062	936						

DOUGLAS FIR, COAST REGION:																
Dense Select Structural.[5]	J.&P.[2]—B.&S.[2]		2150	145	455		1550	1474	1384	1234	995	779				
Select Structural....	J.&P.[2]—B.&S.[2]		1900	120	415		1450	1388	1314	1188	992	779				
1700f.—Dense No.1[5]	J.&P.[2]—B.&S.[2]		1700	145	455		1325	1277	1222	1126	977	779				
1450 f.—No. 1.....	J.&P.[2]—B.&S.[2]	West Coast Bureau of Lumber Grades and Inspection	1450	120	390		1200	1165	1123	1054	943	779				
1100 f.—No. 2.....	J.&P.........		1100	110	390		1075	1049	1019	969	889	772	584	430	329	210
Dense Select Structural.[5]	P.&T.........		....	.....	455	1,600,000	1550	1474	1384	1234	995	779				
Select Structural....	P.&T.........		....	.....	415		1450	1388	1314	1188	992	779				
Dense No. 1[5]......	P.&T.........		....	.....	455		1400	1344	1278	1165	990	779				
No. 1.............	P.&T.........		....	.....	390		1200	1165	1123	1054	943	779				
DOUGLAS FIR, INLAND REGION:																
Select Structural[5]...	J.&P.[2]........		2150	145	455	1,600,000	1750	1640	1509	1288	995	779	584	430	329	210
Structural........	J.&P.[2]........		1900	100	400	1,500,000	1400	1336	1260	1133	934	730	548	403	308	197
Common Structural.	J.&P.[2]........	Western Pine Association	1450	95	380	1,500,000	1250	1204	1150	1059	915					
Select Structural[5]...	P.&T.........		....	.....	455	1,600,000	1750	1640	1509	1288	995	779	584	430	329	210
Structural.........	P.&T.........		....	.....	400	1,500,000	1400	1336	1260	1133	934	730	548	403	308	197
Common Structural.	P.&T.........		....	.....	380	1,500,000	1250	1204	1150	1059	915					
ELM, ROCK:																
2150 f Grade.......	J.&P.........		2150	145			1750	1582	1384	1069	808					
1900 f Grade.......	J.&P.—B.&S..		1900	145			1525	1415	1284	1064	808					
1700 f Grade.......	J.&P.—B.&S..	National Hardwood Lumber Association	1700	145			1350	1273	1184	1031	808					
1450 f Grade.......	J.&P.—B.&S..		1450	120	600	1,300,000	1150	1103	1047	952	804	632	475	349	268	170
1550 c Grade.......	P.&T.........		....	.....			1550	1434	1296	1063	808					
1450 c Grade.......	P.&T.........		....	.....			1450	1354	1243	1053	808					
1200 c Grade.......	P.&T.........		....	.....			1200	1146	1082	976	806					
ELM, SOFT:																
1700 f Grade.......	J.&P.........		1700	120			1225	1158	1079	946	746	583				
1450 f Grade.......	J.&P.—B.&S..	National Hardwood Lumber Association	1450	120	300	1,200,000	1050	1007	958	873	739	583	438	322	247	158
1200 f Grade.......	J.&P.—B.&S..		1200	120			875	851	822	773	697	584				
1075 c Grade.......	P.&T.........		....	.....			1075	1030	977	887	746	583				
GUM, BLACK AND RED:																
1700 f Grade.......	J.&P........		1700	120			1225	1158	1079	946	746	583				
1450 f Grade.......	J.&P.—B.&S..	National Hardwood Lumber Association	1450	120	360	1,200,000	1050	1007	958	873	739	583	438	322	247	158
1200 f Grade.......	J.&P.—B.&S..		1200	120			875	851	822	773	697	584				
1075 c Grade.......	P.&T.........		....	.....			1075	1030	977	887	746	583				
HEMLOCK, EASTERN:																
Select Structural....	J.&P.[2]—B.&S.[2]		1300	85			850	824	792	740	656	535	402			
Prime Structural....	J.&P.[2-8]......		1200	60			775	755	732	691	629	536	402			
Common Structural	J.&P.[2-8]......	Northern Hemlock and Hardwood Manufacturers Association	1100	60	360	1,100,000	650	638	624	601	563	508	402	295	226	145
Utility Structural...	J.&P.[2-8]......		950	60			600	590	580	561	532	488	403			
Select Structural....	P.&T.........		....	.....			850	824	792	740	656	535	402			
HEMLOCK, WEST COAST:																
1600f.—Select Structural.	J.&P.[2]		1600	100			1100	1064	1022	951	840	681				
1450 f.—No. 1.....	J.&P.[2]—B.&S.[2]	West Coast Bureau of Lumber Grades and Inspection	1450	100	360	1,400,000	1075	1042	1003	937	834	680	511	376	288	184
1100 f.—No. 2.....	J.&P.[2]........		1100	90			850	834	814	781	730	654				
No. 1 Hemlock Timbers.	P.&T.........		....	.....			1075	1042	1003	937	834	680				

See footnotes at end of table.

WORKING STRESSES FOR STRESS-GRADE LUMBER

[The working stresses below are for normal loading conditions]

1 Species and commercial grade [1]		2 Rules under which graded	Allowable unit stresses in pounds per square inch: 3 Extreme fiber in bending "f" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "c⊥"	6 Modulus of elasticity "E"	7 Compression parallel to grain (for solid columns and solid struts) for ratios of length-to-least-dimension (l/d): l/d11 or less "C"	l/d14	l/d17	l/d20	l/d23	l/d26	l/d30	l/d35	l/d40	l/d50
LARCH:																
Select Structural [5]	J.&P.[2]		2150	145	455		1750	1582	1384	1069						
Structural	J.&P.[2]		1900	120	415		1450	1354	1243	1053						
Common Structural	J.&P.[2]	Western Pine Association	1450	120	390	1,500,000	1325	1252	1167	1023	808	632	475	349	268	170
Select Structural [5]	P.&T.		...	...	455		1750	1582	1384	1069						
Structural	P.&T.		...	...	415		1450	1354	1243	1053						
Common Structural	P.&T.		...	...	390		1325	1252	1167	1023						
MAPLE, HARD:																
2150 f Grade	J.&P.		2150	145			1750	1640	1509	1288	995					
1900 f Grade	J.&P.—B.&S.		1900	145			1525	1453	1368	1225	995					
1700 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1700	145			1350	1300	1241	1139	983					
1450 f Grade	J.&P.—B.&S.		1450	120	600	1,600,000	1150	1119	1082	1020	922	779	584	430	329	210
1550 c Grade	P.&T.		...	...			1550	1474	1384	1234	995					
1450 c Grade	P.&T.		...	...			1450	1388	1314	1188	992					
1200 c Grade	P.&T.		...	...			1200	1165	1123	1054	943					
OAK, RED AND WHITE:																
2150 f Grade	J.&P.		2150	145			1550	1483	1362	1190	932	730				
1900 f Grade	J.&P.—B.&S.		1900	145			1375	1315	1243	1122	932	730				
1700 f Grade	J.&P.—B.&S.		1700	145			1200	1159	1111	1031	904	730				
1450 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1450	120	600	1,500,000	1050	1023	991	939	855	731	548	403	308	197
1300 f Grade	B.&S.		1300	120	..		950	930	906	866	804	712				
1325 c Grade	P.&T.		...	...			1325	1271	1206	1097	926	730				
1200 c Grade	P.&T.		...	...			1200	1159	1111	1031	904	730				
1075 c Grade	P.&T.		...	...			1075	1046	1012	954	862	728				
PINE, NORWAY:																
Prime Structural	J.&P.[2-8]	Northern Hemlock and	1200	75			900	874	842	790	707	583	438			
Common Structural	J.&P.[2-8]	Hardwood Manufacturers	1100	75	360	1,200,000	775	758	738	704	650	572	438	322	247	158
Utility Structural	J.&P.[2-8]	Association	950	75			650	640	628	608	577	531	439			
PINE, SOUTHERN:[4]																
Dense Select Structural.[5]	J.&P.—B.&S.		2400	120[7]	455		1750	1640	1509	1288	995	779				
Dense Structural [5]	J.&P.—B.&S.		2000	120[7]	455		1400	1344	1278	1165	990	779				
Dense Structural S.E.&S.[5]	J.&P.—B.&S.		1800	120[7]	455		1300	1255	1202	1112	971	779				
Dense No. 1 Structural.[5]	J.&P.—B.&S.		1600	120[7]	455		1150	1119	1082	1020	922	779				
No. 1 Dense 1400f[9-5]	J.&P.—B.&S.		1400	140	455		1400	1344	1278	1165	990	779				
No. 1 1200F [5]	J.&P.—B.&S.		1200	120	390		1200	1165	1123	1054	943	779				
No. 1 Dense [5]	J.&P.[8]		1700	150	455		1400	1344	1278	1165	990	779				
No. 1	J.&P.[8]	Southern Pine Inspection Bureau	1450	125	390	1,600,000	1200	1165	1123	1054	943	779	584	430	329	210
No. 2 Dense [5]	J.&P.[8]		1250	100	455		1025	1003	977	934	865	764				
No. 2	J.&P.[8]		1100	85	390		875	861	845	817	774	711				
Dense Select Structural.[5]	P.&T.				455		1750	1640	1509	1288	995	779				

Dense Structural[5]	P.&T.				455		1400	1344	1278	1165	990	779				
Dense Structural S.E.&S.[5]	P.&T.				455		1300	1255	1202	1112	971	779				
Dense No. 1 Structural.[5]	P.&T.				455		1150	1119	1082	1020	922	779				
No. 1 Dense 1400f [9-5]	P.&T.		1400	140	455		1400	1344	1278	1165	990	779				
No. 1 1200F [9]	P.&T.		1200	120	390		1200	1165	1123	1054	943	779				
PINE, SOUTHERN LONGLEAF:[4]																
Select Structural Longleaf.[5-6]	J.&P.—B.&S.		2400	120[7]			1750	1640	1509	1288	995	779				
Prime Structural Longleaf.[5-6]	J.&P.—B.&S.		2000	120[7]			1400	1344	1278	1165	990	779				
Merchantable Structural Longleaf.[5-6]	J.&P.—B.&S.		1800	120[7]			1300	1255	1202	1112	971	779				
Structural S.E.&S. Longleaf.[5]	J.&P.—B.&S.		1800	120[7]			1300	1255	1202	1112	971	779				
No. 1 Structural Longleaf.[5]	J.&P.—B.&S.	Southern Pine Inspection Bureau	1600	120[7]	455	1,600,000	1150	1119	1082	1020	922	779				
No. 1 Longleaf 1400f [9-5]	J.&P.—B.&S.		1400	140			1400	1344	1278	1165	990	779				
No. 1 Longleaf [5]	J.&P.[8]		1700	150			1400	1344	1278	1165	990	779	584	430	329	210
No. 2 Longleaf [5]	J.&P.[8]		1250	100			1025	1003	977	934	865	764				
Select Structural Longleaf.[5-6]	P.&T.		....	.....			1750	1640	1509	1288	995	779				
Prime Structural Longleaf.[5-6]	P.&T.		....	.....			1400	1344	1278	1165	990	779				
Merchantable Structural Longleaf.[5-6]	P.&T.		....	.....			1300	1255	1202	1112	971	779				
Structural S.E.&S. Longleaf.[5]	P.&T.		....	.....			1300	1255	1202	1112	971	779				
No. 1 Structural Longleaf.[5]	P.&T.		....	.....			1150	1119	1082	1020	922	779				
No. 1 Longleaf 1400f [9-5]	P.&T.		1400	140			1400	1344	1278	1165	990	779				
POPLAR, YELLOW:																
1500 f Grade	J.&P.		1500	110			1200	1126	1038	889	684					
1250 f Grade	J.&P.—B.&S.	National Hardwood Lumber Association	1250	110	300	1,100,000	950	913	869	794	678	535	402	295	226	145
1075 c Grade	P.&T.		....	.....			1075	1021	958	851	684					
REDWOOD:																
Dense Structural[5]	J.&P.[2]—B.&S.[2]		1700	110			1450	1338	1208	986						
Heart Structural	J.&P.[2]—B.&S.[2]	California Redwood Association	1300	95	320	1,200,000	1100	1051	994	897	746	583	438	322	247	158
Dense Structural[5]	P.&T.		....	.....			1450	1338	1208	986						
Heart Structural	P.&T.		....	.....			1100	1051	994	897						
SPRUCE, EASTERN:																
1450 f Structural Grade.	J.&P.[2]	Northeastern Lumber Manufacturers Association, Inc.	1450	110			1050	1007	958	873	739					
1300 f Structural Grade.	J.&P.[2]		1300	95	300	1,200,000	975	941	901	833	726	583	438	322	247	158
1200 f Structural Grade.	J.&P.[2]		1200	95			900	874	842	790	707					

[1] Abbreviations: J.&P., joists and planks; B.&S., beams and stringers; P.&T., posts and timbers; S.E.&S., square edge and sound.

[2] The allowable stresses for tension and compression parallel to grain given for these joist and plank and beam and stringer grades are applicable when graded according to paragraph 34b of ASTM, *Tentative Methods for Establishing Structural Grades of Lumber.*

[4] According to 1948 Standard Grading Rules, including Supplement No. 1.

(From Supplement No. 1, 1953, NLMA, *Wood Structural Design Data*, volume 1, 1948

[5] These grades meet the requirements for density.

[6] These grades are based on requirements for heartwood.

[7] The grading rules provide a basis for obtaining higher shearing stresses of 140, 160 and 180 pounds per square inch when specified.

[8] These grades are applicable to 2-inch thickness only.

[9] These grades are applicable only in sizes 3 inches and thicker.

TABLE A.—MAXIMUM ALLOWABLE SPANS OF FLOOR JOISTS

Dressed lumber surfaced 4 sides
Supporting plastered ceiling Live load 40 psf
Spans determined by stress only

Nominal size in inches	Spacing in inches c. to c.	Allowable unit stresses, psi														
		2400	2200	2000	1800	1600	1500	1400	1300	1200	1100	1000	800	600	400	200
2x6	12	15′–3″	14′–7″	13′–11″	13′–3″	12′–7″	12′–3″	11′–10″	11′–5″	10′–11″	10′–5″	9′–11″	8′–10″	7′–8″	6′–3″	4′–5″
	16	13–3	12–8	12–1	11–5	10–9	10–5	10–1	9–9	9–4	8–11	8–6	7–7	6–6	5–4	3–9
	20	12–0	11–6	11–0	10–5	9–10	9–6	9–2	8–10	8–5	8–0	7–8	6–10	5–11	4–10	3–5
	24	11–0	10–6	10–0	9–6	9–0	8–9	8–6	8–2	7–10	7–6	7–1	6–4	5–6	4–6	3–2
2x8	12	20–6	19–7	18–8	17–9	16–9	16–3	15–8	15–1	14–6	13–11	13–3	11–10	10–3	8–4	5–11
	16	18–0	17–3	16–5	15–7	14–8	14–2	13–8	13–2	12–8	12–2	11–7	10–4	9–0	7–4	5–2
	20	16–2	15–6	14–9	14–0	13–2	12–9	12–4	11–11	11–5	10–11	10–5	9–4	8–1	6–7	4–8
	24	14–5	13–10	13–2	12–6	11–10	11–6	11–2	10–9	10–4	9–10	9–4	8–4	7–2	5–11	4–1
3x8	12	25–6	24–5	23–4	22–1	20–10	20–2	19–6	18–10	18–1	17–4	16–6	14–9	12–9	10–5	7–5
	16	22–3	21–4	20–5	19–4	18–3	17–8	17–1	16–6	15–10	15–2	14–5	12–11	11–2	9–1	6–5
	20	20–0	19–2	18–3	17–4	16–4	15–10	15–4	14–9	14–2	13–6	12–8	11–6	10–0	8–2	5–10
	24	18–8	17–10	17–0	16–2	15–3	14–9	14–3	13–9	13–3	12–8	12–1	10–10	9–4	7–7	5–5
2x10	12	25–7	24–7	23–6	22–5	21–1	20–5	19–8	18–11	18–2	17–5	16–7	14–10	12–10	10–6	7–5
	16	22–5	21–6	20–6	19–5	18–4	17–9	17–2	16–7	15–11	15–3	14–6	13–0	11–3	9–2	6–6
	20	20–0	19–2	18–3	17–4	16–4	15–10	15–4	14–9	14–2	13–6	12–9	11–6	10–0	8–2	5–10
	24	18–8	17–10	17–0	16–2	15–3	14–9	14–3	13–9	13–3	12–8	12–1	10–10	9–4	7–7	5–5
3x10	12	32–0	30–7	29–2	27–8	26–2	25–4	24–6	23–6	22–7	21–8	20–8	18–6	16–0	13–1	9–3
	16	28–1	26–10	25–7	24–3	22–11	22–3	21–6	20–8	19–11	19–0	18–2	16–3	14–1	11–5	8–2
	20	25–4	24–4	23–2	21–11	20–8	20–0	19–4	18–8	17–11	17–2	16–4	14–7	12–8	10–4	7–4
	24	23–2	22–3	21–3	20–1	18–11	18–4	17–8	17–0	16–4	15–8	14–11	13–5	11–7	9–6	6–7
2x12	12	31–0	29–8	28–3	26–10	25–4	24–6	23–8	22–10	21–11	21–0	20–0	17–11	15–6	12–8	8–11
	16	27–0	25–11	24–8	23–4	22–0	21–4	20–8	20–0	19–3	18–5	17–6	15–8	13–7	11–1	7–10
	20	24–0	23–0	21–11	20–9	19–6	18–11	18–4	17–8	16–11	16–2	15–5	13–10	12–0	9–10	6–11
	24	22–4	21–4	20–4	19–3	18–2	17–7	17–0	16–4	15–8	15–0	14–4	12–10	11–1	9–0	6–5

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by stress table and by appropriate deflection table.

Values above 30′–0″ long are in general unobtainable but are included for purposes of interpolation.

Erratum: Table B, part 3, page 49, second line under title:
add "__Not__" before "Supporting plastered ceiling"

Nominal size in inches	Spacing in inches c. to c.	2400														
2x6	12	16′–9″														
	16	14 –7														
	20	13 –3														
	24	12 –2														
2x8	12	22 –5														
	16	19 –4														
	20	17 –6														
	24	15 –10														
3x8	12	27 –7														
	16	24 –5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	20	21 –11	21 –0	20 –0	19 –0	17 –11	17 –4	16 –9	16 –2	15 –6	14 –10	14 –2	12 –8	11 –0	9 –0	6 –5
	24	20 –6	19 –8	18 –9	17 –9	16 –9	16 –3	15 –9	15 –2	14 –7	13 –11	13 –3	11 –11	10 –3	8 –4	6 –0
2x10	12	27 –8	26 –7	25 –5	24 –2	22 –8	21 –11	21 –2	20 –4	19 –6	18 –8	17 –10	16 –0	13 –11	11 –5	7 –11
	16	24 –6	23 –6	22 –5	21 –3	20 –1	19 –5	18 –9	18 –1	17 –5	16 –8	15 –11	14 –3	12 –4	10 –1	7 –1
	20	22 –0	21 –1	20 –1	19 –1	18 –0	17 –5	16 –10	16 –2	15 –6	14 –10	14 –2	12 –8	11 –0	9 –0	6 –5
	24	20 –6	19 –8	18 –9	17 –9	16 –9	16 –3	15 –9	15 –2	14 –7	13 –11	13 –3	11 –11	10 –3	8 –4	6 –0
3x10	12	34 –10	33 –4	31 –10	30 –2	28 –5	27 –6	26 –7	25 –8	24 –9	23 –8	22 –6	20 –2	17 –5	14 –2	10 –1
	16	30 –7	29 –4	28 –0	26 –7	25 –2	24 –4	23 –6	22 –8	21 –9	20 –10	19 –10	17 –9	15 –4	12 –6	8 –10
	20	27 –6	26 –4	25 –1	23 –9	22 –4	21 –7	20 –10	20 –1	19 –3	18 –5	17 –6	15 –8	13 –8	11 –2	7 –9
	24	25 –5	24 –5	23 –3	22 –0	20 –9	20 –1	19 –5	18 –8	17 –11	17 –2	16 –4	14 –8	12 –8	10 –5	7 –3
2x12	12	33 –10	32 –4	30 –9	29 –2	27 –7	26 –8	25 –9	24 –10	23 –11	22 –11	21 –10	19 –6	16 –11	13 –9	9 –9
	16	29 –6	28 –3	27 –0	25 –7	24 –2	23 –4	22 –6	21 –8	20 –10	20 –0	19 –1	17 –1	14 –9	12 –1	8 –6
	20	26 –8	25 –6	24 –4	23 –1	21 –10	21 –2	20 –5	19 –8	18 –11	18 –1	17 –3	15 –5	13 –4	10 –11	7 –9
	24	24 –6	23 –5	22 –4	21 –2	20 –0	19 –4	18 –8	18 –0	17 –3	16 –6	15 –9	14 –1	12 –2	9 –11	7 –1

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by stress table and by appropriate deflection table.

Values above 30′–0″ long are in general unobtainable but are included for purposes of interpolation.

TABLE B.—MAXIMUM ALLOWABLE SPANS OF FLOOR JOISTS

Dressed lumber surfaced 4 sides
Not Supporting plastered ceiling Live load 40 psf
Spans determined by stress only

Nominal size in inches	Spacing in inches c. to c.	Allowable unit stresses, psi														
		2400	2200	2000	1800	1600	1500	1400	1300	1200	1100	1000	800	600	400	200
2x6	12	16'-9"	16'-1"	15'-4"	14'-7"	13'-10"	13'-5"	13'-0"	12'-6"	12'-0"	11'-6"	10'-11"	9'-9"	8'-5"	6'-10"	4'-10"
	16	14-7	13-11	13-3	12-7	11-11	11-6	11-1	10-8	10-3	9-10	9-4	8-4	7-2	5-10	4-1
	20	13-3	12-8	12-1	11-5	10-10	10-6	10-1	9-8	9-3	8-10	8-5	7-6	6-6	5-4	3-9
	24	12-2	11-7	11-1	10-6	9-11	9-8	9-5	9-1	8-8	8-3	7-10	7-0	6-1	4-11	3-6
2x8	12	22-5	21-6	20-6	19-6	18-5	17-10	17-2	16-6	15-10	15-2	14-6	13-0	11-3	9-2	6-6
	16	19-4	18-6	17-8	16-9	15-10	15-4	14-10	14-4	13-9	13-1	12-5	11-1	9-7	7-9	5-6
	20	17-6	16-9	16-0	15-2	14-4	13-11	13-5	12-11	12-5	11-11	11-4	10-2	8-10	7-2	5-1
	24	15-10	15-2	14-6	13-9	13-0	12-8	12-3	11-10	11-4	10-10	10-3	9-2	7-11	6-6	4-6
3x8	12	27-7	26-6	25-4	24-1	22-7	21-10	21-1	20-3	19-5	18-7	17-9	15-11	13-10	11-4	7-10
	16	24-5	23-5	22-4	21-2	20-0	19-4	18-8	18-0	17-4	16-8	15-10	14-2	12-3	10-0	7-1
	20	21-11	21-0	20-0	19-0	17-11	17-4	16-9	16-2	15-6	14-10	14-2	12-8	11-0	9-0	6-5
	24	20-6	19-8	18-9	17-9	16-9	16-3	15-9	15-2	14-7	13-11	13-3	11-11	10-3	8-4	6-0
2x10	12	27-8	26-7	25-5	24-2	22-8	21-11	21-2	20-4	19-6	18-8	17-10	16-0	13-11	11-5	7-11
	16	24-6	23-6	22-5	21-3	20-1	19-5	18-9	18-1	17-5	16-8	15-11	14-3	12-4	10-1	7-1
	20	22-0	21-1	20-1	19-1	18-0	17-5	16-10	16-2	15-6	14-10	14-2	12-8	11-0	9-0	6-5
	24	20-6	19-8	18-9	17-9	16-9	16-3	15-9	15-2	14-7	13-11	13-3	11-11	10-3	8-4	6-0
3x10	12	34-10	33-4	31-10	30-2	28-5	27-6	26-7	25-8	24-9	23-8	22-6	20-2	17-5	14-2	10-1
	16	30-7	29-4	28-0	26-7	25-2	24-4	23-6	22-8	21-9	20-10	19-10	17-9	15-4	12-6	8-10
	20	27-6	26-4	25-1	23-9	22-4	21-7	20-10	20-1	19-3	18-5	17-6	15-8	13-8	11-2	7-9
	24	25-5	24-5	23-3	22-0	20-9	20-1	19-5	18-8	17-11	17-2	16-4	14-8	12-8	10-5	7-3
2x12	12	33-10	32-4	30-9	29-2	27-7	26-8	25-9	24-10	23-11	22-11	21-10	19-6	16-11	13-9	9-9
	16	29-6	28-3	27-0	25-7	24-2	23-4	22-6	21-8	20-10	20-0	19-1	17-1	14-9	12-1	8-6
	20	26-8	25-6	24-4	23-1	21-10	21-2	20-5	19-8	18-11	18-1	17-3	15-5	13-4	10-11	7-9
	24	24-6	23-5	22-4	21-2	20-0	19-4	18-8	18-0	17-3	16-6	15-9	14-1	12-2	9-11	7-1

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by stress table and by appropriate deflection table.

Values above 30'-0" long are in general unobtainable but are included for purposes of interpolation.

TABLE C.—MAXIMUM ALLOWABLE SPANS OF FLOOR JOISTS

Dressed lumber surfaced 4 sides
Deflection for plastered ceiling   Live load 40 psf
Spans determined by deflection only

Nominal size in inches	Spacing in inches c. to c.	Modulus of elasticity, E, psi							
		1,600,000	1,500,000	1,400,000	1,300,000	1,200,000	1,100,000	1,000,000	800,000
2x6	12	11′–3″	11′–0″	10′–9″	10′–6″	10′–3″	9′–11″	9′–7″	8′–10″
	16	10–2	9–11	9–8	9–5	9–2	8–11	8–7	8–0
	20	9–5	9–3	9–1	8–10	8–7	8–4	8–1	7–6
	24	8–10	8–8	8–6	8–4	8–1	7–10	7–7	7–0
2x8	12	14–11	14–7	14–3	13–11	13–7	13–2	12–9	11–10
	16	13–6	13–3	12–11	12–7	12–3	11–11	11–7	10–9
	20	12–6	12–3	12–0	11–9	11–5	11–1	10–9	9–11
	24	11–9	11–6	11–3	11–0	10–9	10–5	10–1	9–4
3x8	12	17–5	17–1	16–9	16–4	15–11	15–6	15–0	13–11
	16	15–9	15–5	15–1	14–9	14–5	14–0	13–7	12–7
	20	14–9	14–5	14–1	13–9	13–5	13–0	12–7	11–8
	24	13–10	13–7	13–4	13–0	12–8	12–3	11–10	10–11
2x10	12	18–11	18–7	18–2	17–9	17–3	16–9	16–3	15–2
	16	17–3	16–11	16–7	16–3	15–10	15–4	14–10	13–9
	20	16–0	15–8	15–4	15–0	14–8	14–3	13–10	12–10
	24	15–1	14–9	14–5	14–1	13–9	13–4	12–11	12–0
3x10	12	22–3	21–10	21–4	20–10	20–3	19–8	19–1	17–9
	16	20–3	19–10	19–4	18–10	18–4	17–10	17–3	16–1
	20	18–9	18–5	18–0	17–7	17–2	16–8	16–2	15–0
	24	17–8	17–4	17–0	16–7	16–2	15–9	15–3	14–2
2x12	12	23–1	22–7	22–1	21–6	20–11	20–4	19–9	18–5
	16	20–10	20–5	19–11	19–5	18–11	18–5	17–11	16–9
	20	19–5	19–0	18–7	18–2	17–8	17–2	16–8	15–6
	24	18–3	17–10	17–5	17–0	16–7	16–2	15–8	14–7

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by deflection table and by appropriate stress table.

TABLE D.—MAXIMUM ALLOWABLE SPANS OF FLOOR JOISTS

Dressed lumber surfaced 4 sides
Deflection for no ceiling or unplastered ceiling Live load 40 psf
Spans determined by deflection only

Nominal size in inches	Spacing in inches c. to c.	Modulus of elasticity, E, psi							
		1,600,000	1,500,000	1,400,000	1,300,000	1,200,000	1,100,000	1,000,000	800,000
2x6	12	12′-10″	12′-7″	12′-4″	12′-1″	11′-9″	11′-4″	10′-11″	10′-1″
	16	11 -7	11 -4	11 -1	10 -10	10 -6	10 -2	9 -10	9 -2
	20	10 -9	10 -7	10 -4	10 -1	9 -10	9 -7	9 -3	8 -7
	24	10 -1	9 -11	9 -9	9 -6	9 -3	9 -0	8 -8	8 -0
2x8	12	17 -0	16 -8	16 -4	15 -11	15 -6	15 -1	14 -7	13 -7
	16	15 -6	15 -3	14 -11	14 -6	14 -1	13 -8	13 -3	12 -4
	20	14 -4	14 -1	13 -9	13 -5	13 -1	12 -8	12 -3	11 -4
	24	13 -6	13 -3	13 -0	12 -8	12 -4	11 -11	11 -6	10 -8
3x8	12	19 -11	19 -7	19 -2	18 -9	18 -3	17 -9	17 -2	16 -0
	16	18 -2	17 -9	17 -4	16 -11	16 -6	16 -0	15 -6	14 -5
	20	16 -10	16 -6	16 -1	15 -8	15 -3	14 -10	14 -4	13 -4
	24	15 -10	15 -7	15 -3	14 -11	14 -6	14 -1	13 -7	12 -6
2x10	12	21 -8	21 -3	20 -9	20 -3	19 -9	19 -2	18 -7	17 -4
	16	19 -8	19 -4	19 -0	18 -7	18 -1	17 -6	16 -11	15 -8
	20	18 -3	17 -11	17 -7	17 -2	16 -9	16 -3	15 -9	14 -8
	24	17 -3	16 -11	16 -6	16 -1	15 -8	15 -3	14 -9	13 -8
3x10	12	25 -5	24 -11	24 -4	23 -9	23 -2	22 -6	21 -10	20 -3
	16	23 -2	22 -8	22 -1	21 -6	20 -11	20 -4	19 -8	18 -5
	20	21 -5	21 -0	20 -7	20 -1	19 -7	19 -1	18 -6	17 -1
	24	20 -2	19 -10	19 -5	19 -0	18 -6	18 -0	17 -5	16 -2
2x12	12	26 -5	25 -10	25 -3	24 -7	23 -11	23 -3	22 -7	21 -1
	16	23 -10	23 -4	22 -9	22 -2	21 -7	21 -0	20 -5	19 -2
	20	22 -2	21 -9	21 -3	20 -9	20 -2	19 -7	19 -0	17 -8
	24	20 -10	20 -5	19 -11	19 -5	18 -11	18 -5	17 -11	16 -8

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by deflection table and by appropriate stress table.

TABLE E.—MAXIMUM ALLOWABLE SPANS OF FLOOR JOISTS
Dressed lumber surfaced 4 sides
Deflection for plastered ceiling Live load 30 psf
Spans determined by deflection only

Nominal size in inches	Spacing in inches c. to c.	Modulus of elasticity, E, psi							
		1,600,000	1,500,000	1,400,000	1,300,000	1,200,000	1,100,000	1,000,000	800,000
2x6	12	12′–5″	12′–2″	11′–10″	11′–6″	11′–2″	10′–10″	10′–6″	9′–9″
	16	11–2	10–11	10–8	10–5	10–1	9–9	9–5	8–10
	20	10–4	10–2	9–11	9–8	9–5	9–2	8–11	8–3
	24	9–9	9–7	9–5	9–2	8–11	8–8	8–4	7–8
2x8	12	16–5	16–1	15–9	15–5	15–0	14–6	14–0	13–0
	16	14–10	14–7	14–3	13–11	13–6	13–1	12–8	11–10
	20	13–9	13–6	13–3	12–11	12–7	12–3	11–10	10–10
	24	12–11	12–8	12–5	12–2	11–10	11–6	11–1	10–3
3x8	12	19–2	18–9	18–4	17–11	17–6	17–0	16–6	15–4
	16	17–6	17–1	16–8	16–3	15–10	15–5	14–11	13–10
	20	16–2	15–10	15–6	15–2	14–9	14–4	13–10	12–10
	24	15–3	15–0	14–8	14–4	13–11	13–6	13–0	12–0
2x10	12	20–11	20–5	19–11	19–5	18–11	18–5	17–10	16–8
	16	18–11	18–7	18–3	17–10	17–4	16–10	16–3	15–1
	20	17–6	17–2	16–10	16–6	16–1	15–8	15–2	14–1
	24	16–6	16–2	15–10	15–6	15–1	14–7	14–2	13–2
3x10	12	24–6	24–0	23–6	22–11	22–4	21–8	21–0	19–6
	16	22–3	21–9	21–3	20–9	20–2	19–7	18–11	17–8
	20	20–7	20–2	19–9	19–4	18–10	18–4	17–9	16–6
	24	19–5	19–0	18–7	18–2	17–9	17–4	16–9	15–7
2x12	12	25–4	24–10	24–3	23–8	23–0	22–4	21–8	20–3
	16	22–10	22–5	21–11	21–5	20–10	20–3	19–8	18–5
	20	21–4	20–11	20–5	19–11	19–5	18–10	18–3	17–0
	24	20–1	19–8	19–3	18–9	18–3	17–9	17–3	16–0

Determine allowable unit stress and modulus of elasticity for the specie and grade of lumber used.

Use smaller span or larger joist or closer spacing as determined both by deflection table and by appropriate stress table.

TABLE F.—MAXIMUM ALLOWABLE SPANS OF CEILING JOISTS

Dressed lumber surfaced 4 sides

Supporting ceiling Live load 10 psf

Nominal size in inches	Spacing in inches c. to c.	Deflection: Plastered ceiling, E, psi		Deflection: Unplastered ceiling, E, psi		Stress: Plastered ceiling, Allowable unit stress, psi			Stress: Unplastered ceiling, Allowable unit stress, psi		
		1,600,000	1,200,000	1,600,000	1,200,000	1500	1300	1100	1500	1300	1100
2x4	12	11′-7″	10′-6″	13′-3″	12′-0″	12′-9″	11′-11″	11′-0″	15′-11″	14′-9″	13′-7″
	16	10-6	9-6	12-0	10-10	11-3	10-6	9-8	13-11	12-11	11-11
	20	9-8	8-9	11-1	10-0	10-0	9-4	8-8	12-7	11-8	10-9
	24	9-2	8-4	10-6	9-6	9-2	8-6	7-11	11-7	10-9	9-11
2x6	12	17-10	16-3	20-5	18-7	19-7	18-3	16-9	23-10	22-1	20-5
	16	16-3	14-9	18-7	16-10	17-3	16-0	14-8	21-0	19-6	18-0
	20	15-1	13-8	17-3	15-8	15-6	14-5	13-3	19-1	17-8	16-3
	24	14-2	12-10	16-3	14-8	14-3	13-3	12-3	17-7	16-4	15-1
2x8	12	23-9	21-9	27-2	24-11	25-7	23-10	21-11	31-0	28-10	26-7
	16	21-9	19-8	24-11	22-6	22-7	21-0	19-3	27-8	25-8	23-9
	20	20-2	18-3	23-1	20-11	20-5	19-0	17-6	25-1	23-4	21-6
	24	18-10	17-2	21-7	19-8	18-10	17-6	16-1	23-4	21-8	20-0
2x10	12	30-3	27-4	34-8	31-3	31-10	29-7	27-2	38-1	35-5	32-7
	16	27-4	24-11	31-3	28-6	28-3	26-3	24-0	34-1	31-8	29-2
	20	25-5	23-4	29-1	26-8	25-7	23-10	21-10	31-1	28-11	26-7
	24	24-0	21-9	27-6	24-11	23-6	21-11	20-1	28-9	26-9	24-7

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger joist, or closer spacing as determined both by stress and by deflection.

Values above 30′-0″ are in general unobtainable but are included for purposes of interpolation.

TABLE G.—MAXIMUM ALLOWABLE SPANS OF CEILING JOISTS

Dressed lumber surfaced 4 sides

Supporting ceiling Live load 20 psf

Nominal size in inches	Spacing in inches c. to c.	Deflection				Stress					
		Plastered ceiling		Unplastered ceiling		Plastered ceiling			Unplastered ceiling		
		E, psi		E, psi		Allowable unit stress, psi			Allowable unit stress, psi		
		1,600,000	1,200,000	1,600,000	1,200,000	1500	1300	1100	1500	1300	1100
2x4	12	9′–2″	8′–4″	10′–6″	9′–7″	10′–2″	9′–5″	8′–7″	11′–6″	10′–8″	9′–8″
	16	8 –4	7 –7	9 –7	8 –8	8 –10	8 –3	7 –6	10 –0	9 –4	8 –6
	20	7 –9	7 –1	8 –10	8 –1	7 –11	7 –4	6 –9	9 –0	8 –4	7 –8
	24	7 –3	6 –7	8 –4	7 –7	7 –3	6 –9	6 –2	8 –3	7 –8	7 –0
2x6	12	14 –2	12 –10	16 –3	14 –9	15 –6	14 –5	13 –3	17 –6	16 –3	14 –11
	16	12 –10	11 –9	14 –9	13 –5	13 –7	12 –8	11 –7	15 –4	14 –3	13 –1
	20	11 –11	10 –10	13 –8	12 –5	12 –3	11 –5	10 –6	13 –10	12 –11	11 –11
	24	11 –3	10 –3	12 –11	11 –9	11 –3	10 –6	9 –7	12 –9	11 –10	10 –10
2x8	12	18 –11	17 –3	21 –8	19 –9	20 –3	18 –10	17 –3	22 –10	21 –3	19 –5
	16	17 –3	15 –8	19 –9	18 –0	17 –8	16 –5	15 –2	19 –11	18 –6	17 –1
	20	15 –10	14 –5	18 –1	16 –6	16 –0	14 –11	13 –9	18 –1	16 –10	15 –6
	24	15 –0	13 –7	17 –2	15 –6	14 –10	13 –9	12 –6	16 –9	15 –6	14 –1
2x10	12	24 –0	21 –10	27 –6	25 –0	25 –6	23 –9	21 –10	28 –6	26 –6	24 –5
	16	21 –10	19 –10	25 –0	22 –8	22 –6	20 –11	19 –1	25 –4	23 –7	21 –6
	20	20 –2	18 –4	23 –1	21 –0	20 –3	18 –10	17 –4	22 –11	21 –4	19 –7
	24	19 –0	17 –3	21 –10	19 –9	18 –7	17 –4	15 –10	21 –0	19 –7	17 –11

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger joist, or closer spacing as determined both by stress and by deflection.

TABLE H.—MAXIMUM ALLOWABLE SPANS OF CEILING JOISTS

Dressed lumber surfaced 4 sides

Supporting ceiling Live load 30 psf

Nominal size in inches	Spacing in inches c. to c.	Deflection				Stress					
		Plastered ceiling		Unplastered ceiling		Plastered ceiling			Unplastered ceiling		
		E, psi		E, psi		Allowable unit stress, psi			Allowable unit stress, psi		
		1,600,000	1,200,000	1,600,000	1,200,000	1500	1300	1100	1500	1300	1100
2x4	12	8′–0″	7′–3″	9′–2″	8′–4″	8′–11″	8′–3″	7′–6″	9′–9″	9′–1″	8′–3″
	16	7–3	6–7	8–4	7–6	7–9	7–2	6–7	8–6	7–11	7–3
	20	6–9	6–2	7–8	7–0	6–11	6–5	5–10	7–7	7–1	6–5
	24	6–4	5–9	7–3	6–7	6–4	5–11	5–5	6–10	6–6	6–0
2x6	12	12–5	11–3	14–3	12–10	13–8	12–9	11–8	14–11	13–11	12–9
	16	11–3	10–3	12–10	11–8	12–0	11–2	10–3	13–1	12–3	11–3
	20	10–5	9–6	11–11	10–10	10–10	10–1	9–3	11–10	11–1	10–3
	24	9–10	8–11	11–3	10–3	9–11	9–3	8–6	10–11	10–2	9–4
2x8	12	16–5	15–0	18–9	17–2	17–11	16–7	15–3	19–7	18–2	16–8
	16	15–0	13–8	17–2	15–7	15–9	14–8	13–6	17–3	16–0	14–9
	20	13–11	12–7	15–11	14–5	14–2	13–2	12–1	15–6	14–5	13–3
	24	13–1	11–11	15–0	13–8	13–0	12–2	11–3	14–3	13–4	12–4
2x10	12	20–10	18–10	23–10	21–6	22–7	21–0	19–3	24–7	22–11	21–0
	16	18–10	17–3	21–6	19–9	19–11	18–6	16–11	21–10	20–2	18–6
	20	17–8	16–1	20–2	18–5	17–10	16–7	15–3	19–6	18–2	16–8
	24	16–7	15–1	19–0	17–3	16–5	15–3	14–0	18–0	16–8	15–4

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger joist, or closer spacing as determined both by stress and by deflection.

TABLE I.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

7 vertical to 12 horizontal (approximately 30° pitch) 40 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	10′–4″	9′–4″	11′–4″	11′–0″	10′–7″	10′–2″	9′–9″	9′–4″	8′–10″
	16	9–4	8–6	9–10	9–6	9–2	8–10	8–5	8–1	7–8
	20	8–8	8–0	8–10	8–7	8–4	8–0	7–8	7–4	7–0
	24	8–2	7–5	8–1	7–10	7–7	7–4	7–0	6–8	6–4
2x6	12	16–0	14–7	17–7	17–1	16–5	15–9	15–1	14–5	13–9
	16	14–7	13–2	15–4	14–10	14–3	13–8	13–1	12–6	11–10
	20	13–6	12–4	13–10	13–5	12–11	12–5	11–10	11–4	10–10
	24	12–8	11–6	12–7	12–2	11–9	11–4	10–10	10–4	9–10
2x8	12	21–5	19–5	23–7	22–10	22–0	21–1	20–3	19–4	18–4
	16	19–5	17–7	20–3	19–8	19–0	18–3	17–6	16–9	15–10
	20	18–0	16–5	18–5	17–10	17–3	16–7	15–11	15–2	14–5
	24	16–11	15–5	17–0	16–5	15–10	15–2	14–6	13–10	13–2
2x10	12	27–1	24–7	29–5	28–5	27–4	26–3	25–1	23–11	22–8
	16	24–7	22–2	25–10	24–11	24–0	23–0	22–1	21–1	20–0
	20	22–10	20–10	23–5	22–7	21–9	20–11	20–1	19–2	18–2
	24	21–5	19–6	21–5	20–8	19–11	19–1	18–4	17–6	16–7

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE J.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

6 vertical to 12 horizontal (approximately 26° pitch) 40 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	9′–10″	9′–0″	10′–3″	9′–11″	9′–7″	9′–2″	8′–9″	8′–4″	7′–11″
	16	9–0	8–2	8–11	8–7	8–3	7–11	7–7	7–3	6–10
	20	8–4	7–7	8–1	7–10	7–7	7–3	6–11	6–6	6–1
	24	7–10	7–1	7–4	7–1	6–10	6–7	6–4	6–0	5–8
2x6	12	15–4	13–10	15–10	15–4	14–9	14–2	13–7	12–11	12–3
	16	13–10	12–7	13–9	13–4	12–10	12–4	11–9	11–2	10–7
	20	12–11	11–9	12–5	12–0	11–7	11–1	10–7	10–1	9–7
	24	12–2	11–0	11–4	11–0	10–7	10–2	9–9	9–3	8–9
2x8	12	20–5	18–6	21–3	20–7	19–10	19–0	18–2	17–4	16–6
	16	18–6	16–10	18–5	17–10	17–2	16–6	15–9	15–0	14–3
	20	17–3	15–8	16–8	16–1	15–6	14–11	14–3	13–7	12–11
	24	16–3	14–9	15–3	14–9	14–2	13–7	13–0	12–5	11–10
2x10	12	25–10	23–6	26–10	25–11	24–11	23–11	22–11	21–11	20–10
	16	23–6	21–4	23–3	22–6	21–8	20–10	19–11	19–0	18–0
	20	21–9	19–9	21–0	20–4	19–7	18–10	18–0	17–2	16–4
	24	20–6	18–7	19–2	18–6	17–10	17–2	16–5	15–8	14–11

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE K.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

5 vertical to 12 horizontal (approximately 22° pitch) 40 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	9′–5″	8′–7″	9′–7″	9′–3″	8′–11″	8′–7″	8′–3″	7′–10″	7′–5″
	16	8 –7	7 –9	8 –4	8 –1	7 –9	7 –5	7 –1	6 –9	6 –5
	20	7 –11	7 –3	7 –6	7 –3	7 –0	6 –9	6 –6	6 –2	5 –10
	24	7 –5	6 –9	6 –10	6 –7	6 –4	6 –1	5 –10	5 –7	5 –4
2x6	12	14 –7	13 –3	14 –10	14 –4	13 –10	13 –3	12 –8	12 –1	11 –6
	16	13 –3	12 –0	12 –10	12 –5	12 –0	11 –6	11 –0	10 –6	10 –0
	20	12 –4	11 –2	11 –8	11 –3	10 –10	10 –5	10 –0	9 –6	9 –0
	24	11 –7	10 –6	10 –7	10 –3	9 –11	9 –6	9 –1	8 –8	8 –3
2x8	12	19 –5	17 –8	19 –10	19 –2	18 –5	17 –8	16 –11	16 –2	15 –4
	16	17 –8	16 –0	17 –2	16 –7	16 –0	15 –4	14 –8	14 –0	13 –3
	20	16 –5	14 –11	15 –7	15 –1	14 –6	13 –11	13 –4	12 –8	12 –0
	24	15 –6	14 –1	14 –2	13 –8	13 –2	12 –8	12 –2	11 –7	11 –0
2x10	12	24 –7	22 –5	25 –0	24 –2	23 –4	22 –5	21 –5	20 –5	19 –5
	16	22 –5	20 –4	21 –7	20 –11	20 –2	19 –5	18 –7	17 –9	16 –10
	20	20 –9	18 –10	19 –8	19 –0	18 –4	17 –7	16 –10	16 –0	15 –2
	24	19 –7	17 –8	17 –11	17 –4	16 –9	16 –1	15 –5	14 –8	13 –11

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE L.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

4 vertical to 12 horizontal (approximately 18° pitch) 40 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	9′–1″	8′–4″	9′–3″	8′–11″	8′–7″	8′–3″	7′–11″	7′–7″	7′–2″
	16	8 –4	7 –6	8 –0	7 –9	7 –6	7 –3	6 –11	6 –7	6 –3
	20	7 –8	7 –0	7 –3	7 –0	6 –9	6 –6	6 –3	5 –11	5 –7
	24	7 –3	6 –7	6 –7	6 –5	6 –2	5 –11	5 –8	5 –5	5 –2
2x6	12	14 –1	12 –9	14 –4	13 –10	13 –4	12 –10	12 –3	11 –8	11 –1
	16	12 –9	11 –7	12 –6	12 –1	11 –7	11 –1	10 –7	10 –1	9 –7
	20	11 –11	10 –10	11 –3	10 –10	10 –5	10 –0	9 –7	9 –2	8 –8
	24	11 –3	10 –2	10 –3	9 –11	9 –7	9 –2	8 –9	8 –4	7 –11
2x8	12	18 –11	17 –1	19 –1	18 –5	17 –9	17 –1	16 –4	15 –7	14 –10
	16	17 –1	15 –6	16 –7	16 –0	15 –5	14 –10	14 –2	13 –6	12 –10
	20	15 –11	14 –5	15 –0	14 –6	14 –0	13 –5	12 –10	12 –3	11 –7
	24	15 –0	13 –7	13 –7	13 –2	12 –9	12 –3	11 –8	11 –1	10 –6
2x10	12	23 –10	21 –9	24 –2	23 –4	22 –6	21 –7	20 –8	19 –8	18 –8
	16	21 –9	19 –8	20 –11	20 –2	19 –5	18 –8	17 –11	17 –1	16 –2
	20	20 –0	18 –3	18 –11	18 –4	17 –8	16 –11	16 –2	15 –5	14 –7
	24	18 –11	17 –1	17 –3	16 –8	16 –1	15 –5	14 –9	14 –1	13 –4

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE M.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

7 vertical to 12 horizontal (approximately 30° pitch) 20 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	11′–7″	10′–7″	12′–10″	12′–5″	12′–0″	11′–6″	11′–0″	10′–6″	10′–0″
	16	10 –7	9 –7	11 –1	10 –9	10 –4	9 –11	9 –6	9 –1	8 –8
	20	9 –10	9 –0	10 –1	9 –9	9 –5	9 –1	8 –9	8 –4	7 –11
	24	9 –4	8 –6	9 –3	8 –11	8 –7	8 –3	7 –11	7 –7	7 –3
2x6	12	18 –2	16 –6	20 –0	19 –4	18 –7	17 –10	17 –1	16 –4	15 –6
	16	16 –6	14 –11	17 –4	16 –9	16 –1	15 –5	14 –9	14 –1	13 –5
	20	15 –3	14 –0	15 –9	15 –3	14 –8	14 –1	13 –6	12 –10	12 –2
	24	14 –5	13 –3	14 –4	13 –10	13 –4	12 –10	12 –4	11 –9	11 –2
2x8	12	23 –10	21 –9	26 –9	25 –10	24 –10	23 –10	22 –10	21 –9	20 –8
	16	21 –9	19 –9	23 –2	22 –4	21 –6	20 –8	19 –9	18 –10	17 –10
	20	20 –3	18 –5	21 –1	20 –4	19 –7	18 –10	18 –0	17 –2	16 –4
	24	19 –0	17 –3	19 –3	18 –7	17 –11	17 –2	16 –5	15 –8	14 –11
2x10	12	30 –2	27 –4	33 –10	32 –8	31 –6	30 –3	29 –0	27 –8	26 –3
	16	27 –4	24 –10	29 –4	28 –4	27 –4	26 –3	25 –1	23 –11	22 –9
	20	25 –5	23 –2	26 –8	25 –9	24 –10	23 –10	22 –10	21 –9	20 –8
	24	24 –1	21 –11	24 –4	23 –6	22 –8	21 –10	20 –11	19 –11	18 –11

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

Values above 30′–0″ long are in general unobtainable but are included for purposes of interpolation.

TABLE N.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

6 vertical to 12 horizontal (approximately 26° pitch) 20 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	11′–7″	10′–7″	12′–4″	11′–11″	11′–6″	11′–1″	10′–7″	10′–1″	9′–7″
	16	10 –7	9 –7	10 –8	10 –4	10 –0	9 –7	9 –2	8 –9	8 –3
	20	9 –10	9 –0	9 –9	9 –5	9 –1	8 –9	8 –4	7 –11	7 –6
	24	9 –4	8 –6	8 –10	8 –7	8 –3	7 –11	7 –7	7 –3	6 –11
2x6	12	18 –2	16 –6	19 –2	18 –6	17 –10	17 –2	16 –5	15 –8	14 –10
	16	16 –6	14 –11	16 –7	16 –0	15 –5	14 –10	14 –3	13 –7	12 –10
	20	15 –3	14 –0	15 –1	14 –7	14 –1	13 –6	12 –11	12 –4	11 –8
	24	14 –5	13 –3	13 –10	13 –4	12 –10	12 –4	11 –10	11 –3	10 –8
2x8	12	23 –10	21 –9	25 –7	24 –9	23 –10	22 –11	21 –11	20 –11	19 –10
	16	21 –9	19 –9	22 –2	21 –5	20 –8	19 –10	19 –0	18 –1	17 –2
	20	20 –3	18 –5	20 –2	19 –6	18 –10	18 –1	17 –4	16 –6	15 –8
	24	19 –0	17 –3	18 –5	17 –10	17 –2	16 –6	15 –10	15 –1	14 –3
2x10	12	30 –2	27 –4	32 –0	30 –11	29 –9	28 –7	27 –4	26 –1	24 –9
	16	27 –4	24 –10	28 –0	27 –0	26 –0	25 –0	24 –0	22 –11	21 –9
	20	25 –5	23 –2	25 –7	24 –8	23 –9	22 –10	21 –10	20 –10	19 –9
	24	24 –1	21 –11	23 –4	22 –6	21 –8	20 –10	20 –0	19 –1	18 –1

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

Values above 30′–0″ long are in general unobtainable but are included for purposes of interpolation.

TABLE O.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

5 vertical to 12 horizontal (approximately 22° pitch) 20 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	11′-5″	10′-5″	12′-2″	11′-9″	11′-4″	10′-11″	10′-5″	9′-11″	9′-5″
	16	10 -5	9 -5	10 -6	10 -2	9 -10	9 -5	9 -0	8 -7	8 -1
	20	9 -8	8 -11	9 -7	9 -3	8 -11	8 -7	8 -2	7 -9	7 -4
	24	9 -2	8 -4	8 -8	8 -5	8 -1	7 -9	7 -5	7 -1	6 -9
2x6	12	17 -11	16 -3	18 -10	18 -3	17 -7	16 -11	16 -2	15 -5	14 -7
	16	16 -3	14 - 8	16 -3	15 -9	15 -2	14 -7	14 -0	13 -4	12 -7
	20	15 -0	13 -9	14 -10	14 -4	13 -10	13 -3	12 -8	12 -1	11 -5
	24	14 -2	13 -0	13 -7	13 -2	12 -8	12 -2	11 -8	11 -1	10 -6
2x8	12	23 -6	21 -5	25 -2	24 -4	23 -5	22 -6	21 -7	20 -7	19 -6
	16	21 -5	19 -5	21 -9	21 -1	20 -4	19 -6	18 -8	17 -9	16 -10
	20	19 -11	18 -1	19 -10	19 -2	18 -6	17 -9	17 -0	16 -2	15 -4
	24	18 -8	16 -11	18 -1	17 -6	16 -11	16 -3	15 -7	14 -10	14 -0
2x10	12	29 -8	26 -10	31 -5	30 -4	29 -2	28 -0	26 -10	25 -7	24 -3
	16	26 -10	24 -4	27 -6	26 -7	25 -7	24 -7	23 -7	22 -6	21 -4
	20	25 -0	22 -9	25 -2	24 -4	23 -5	22 -6	21 -6	20 -6	19 -5
	24	23 -8	21 -6	22 -11	22 -2	21 -4	20 -6	19 -8	18 -9	17 -9

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

Values above 30′-0″ long are in general unobtainable but are included for purposes of interpolation.

TABLE P.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

4 vertical to 12 horizontal (approximately 18° pitch) 20 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	11′-1″	10′-1″	11′-8″	11′-4″	10′-11″	10′-6″	10′-1″	9′-7″	9′-1″
	16	10 -1	9 -2	10 -2	9 -10	9 -6	9 -2	8 -9	8 -4	7 -10
	20	9 -5	8 -8	9 -3	8 -11	8 -7	8 -3	7 -11	7 -6	7 -1
	24	8 -11	8 -1	8 -5	8 -2	7 -10	7 -6	7 -2	6 -10	6 -6
2x6	12	17 -4	15 -9	18 -2	17 -7	17 -0	16 -4	15 -7	14 -10	14 -1
	16	15 -9	14 -3	15 -9	15 -3	14 -8	14 -1	13 -6	12 -11	12 -3
	20	14 -7	13 -5	14 -4	13 -10	13 -4	12 -10	12 -3	11 -8	11 -1
	24	13 -9	12 -8	13 -2	12 -8	12 -2	11 -8	11 -2	10 -8	10 -2
2x8	12	22 -9	20 -9	24 -4	23 -6	22 -8	21 -9	20 -10	19 -10	18 -10
	16	20 -9	18 -10	21 -1	20 -4	19 -7	18 -10	18 -0	17 -2	16 -4
	20	19 -4	17 -7	19 -2	18 -7	17 -11	17 -2	16 -5	15 -8	14 -10
	24	18 -2	16 -6	17 -6	16 -11	16 -4	15 -9	15 -1	14 -4	13 -6
2x10	12	28 -10	26 -1	30 -2	29 -1	28 -0	26 -11	25 -10	24 -7	23 -4
	16	26 -1	23 -8	26 -7	25 -8	24 -9	23 -9	22 -9	21 -9	20 -8
	20	24 -3	22 -1	24 -4	23 -6	22 -7	21 -8	20 -9	19 -9	18 -9
	24	23 -1	20 -11	22 -1	21 -4	20 -7	19 -10	19 -0	18 -2	17 -3

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing as determined both by stress and by deflection.

Values above 30′-0″ long are in general unobtainable but are included for purposes of interpolation.

TABLE Q.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

7 vertical to 12 horizontal (approximately 30° pitch) 60 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	9′-3″	8′-5″	9′-9″	9′-5″	9′-1″	8′-9″	8′-5″	8′-0″	7′-7″
	16	8 -5	7 -7	8 -5	8 -2	7 -11	7 -7	7 -3	6 -11	6 -6
	20	7 -9	7 -1	7 -7	7 -4	7 -1	6 -10	6 -7	6 -3	5 -11
	24	7 -3	6 -8	7 -0	6 -9	6 -6	6 -3	6 -0	5 -9	5 -5
2x6	12	14 -5	13 -2	15 -1	14 -7	14 -0	13 -5	12 -10	12 -3	11 -8
	16	13 -2	12 -0	13 -1	12 -7	12 -1	11 -7	11 -1	10 -7	10 -1
	20	12 -2	11 -1	11 -9	11 -4	10 -11	10 -6	10 -1	9 -8	9 -2
	24	11 -5	10 -5	10 -9	10 -5	10 -0	9 -7	9 -2	8 -9	8 -4
2x8	12	19 -1	17 -4	20 -2	19 -6	18 -10	18 -1	17 -3	16 -5	15 -7
	16	17 -4	15 -10	17 -5	16 -11	16 -4	15 -8	15 -0	14 -3	13 -6
	20	16 -2	14 -9	15 -10	15 -4	14 -9	14 -2	13 -6	12 -10	12 -2
	24	15 -3	13 -10	14 -5	13 -11	13 -5	12 -11	12 -4	11 -9	11 -2
2x10	12	24 -2	21 -11	25 -3	24 -5	23 -6	22 -7	21 -7	20 -7	19 -6
	16	21 -11	19 -9	22 -1	21 -4	20 -7	19 -9	18 -11	18 -1	17 -2
	20	20 -4	18 -5	20 -0	19 -4	18 -8	17 -11	17 -2	16 -4	15 -6
	24	19 -2	17 -5	18 -3	17 -8	17 -0	16 -4	15 -8	14 -11	14 -2

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE R.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

6 vertical to 12 horizontal (approximately 26° pitch) 60 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	8′-9″	8′-0″	8′-8″	8′-5″	8′-1″	7′-9″	7′-5″	7′-1″	6′-8″
	16	8 -0	7 -2	7 -6	7 -3	7 -0	6 -9	6 -5	6 -1	5 -9
	20	7 -4	6 -9	6 -9	6 -7	6 -4	6 -1	5 -10	5 -6	5 -2
	24	6 -10	6 -4	6 -2	6 -0	5 -10	5 -7	5 -4	5 -1	4 -9
2x6	12	13 -8	12 -5	13 -5	13 -0	12 -6	12 -0	11 -6	10 -11	10 -4
	16	12 -5	11 -4	11 -7	11 -2	10 -9	10 -4	9 -11	9 -5	8 -11
	20	11 -6	10 -6	10 -6	10 -2	9 -9	9 -4	8 -11	8 -6	8 -1
	24	10 -10	9 -10	9 -7	9 -3	8 -11	8 -7	8 -2	7 -9	7 -4
2x8	12	18 -1	16 -5	17 -11	17 -4	16 -8	16 -0	15 -4	14 -8	13 -11
	16	16 -5	15 -0	15 -6	15 -0	14 -5	13 -10	13 -3	12 -8	12 -1
	20	15 -4	14 -0	14 -0	13 -6	13 -0	12 -6	12 -0	11 -6	10 -11
	24	14 -5	13 -1	12 -9	12 -4	11 -11	11 -5	10 -11	10 -5	9 -11
2x10	12	22 -10	20 -9	22 -8	21 -11	21 -1	20 -3	19 -5	18 -6	17 -7
	16	20 -9	18 -8	19 -8	19 -0	18 -3	17 -6	16 -9	16 -0	15 -3
	20	19 -3	17 -5	17 -9	17 -2	16 -6	15 -10	15 -2	14 -6	13 -9
	24	18 -2	16 -6	16 -2	15 -8	15 -1	14 -5	13 -10	13 -3	12 -7

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE S.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

5 vertical to 12 horizontal (approximately 22° pitch) 60 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	8'-4"	7'-7"	8'-1"	7'-10"	7'-7"	7'-4"	7'-0"	6'-8"	6'-4"
	16	7-7	6-10	7-0	6-10	6-7	6-4	6-1	5-9	5-5
	20	7-0	6-5	6-4	6-2	6-0	5-9	5-6	5-3	4-11
	24	6-7	6-0	5-9	5-7	5-5	5-3	5-0	4-9	4-6
2x6	12	13-0	11-11	12-7	12-2	11-9	11-3	10-9	10-3	9-9
	16	11-11	10-10	10-11	10-7	10-2	9-9	9-4	8-11	8-5
	20	11-0	10-0	9-10	9-6	9-2	8-10	8-5	8-0	7-7
	24	10-4	9-5	8-11	8-8	8-4	8-0	7-8	7-4	6-11
2x8	12	17-3	15-8	16-9	16-3	15-8	15-0	14-4	13-8	13-0
	16	15-8	14-3	14-6	14-1	13-7	13-0	12-5	11-10	11-3
	20	14-7	13-4	13-1	12-8	12-2	11-8	11-2	10-8	10-2
	24	13-9	12-6	11-11	11-7	11-2	10-9	10-3	9-9	9-3
2x10	12	21-10	19-9	21-2	20-5	19-8	18-11	18-2	17-4	16-5
	16	19-9	17-10	18-4	17-9	17-1	16-5	15-9	15-0	14-3
	20	18-4	16-8	16-6	15-11	15-4	14-9	14-2	13-6	12-10
	24	17-3	15-9	15-1	14-7	14-1	13-6	12-11	12-4	11-8

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

TABLE T.—MAXIMUM ALLOWABLE SPANS OF RAFTERS

4 vertical to 12 horizontal (approximately 18° pitch) 60 snow zone No ceiling
Roofing material 2.5 psf (shingles, copper sheets, copper tile, 3-ply ready roofing)
Span is actual length of rafter between supports

Nominal size in inches	Spacing in inches c. to c.	Deflection		Stress						
		E, psi		Allowable unit stress, psi						
		1,600,000	1,200,000	1500	1400	1300	1200	1100	1000	900
2x4	12	8'-1"	7'-4"	7'-8"	7'-5"	7'-2"	6'-11"	6'-7"	6'-3"	5'-11"
	16	7-4	6-7	6-8	6-5	6-2	5-11	5-8	5-5	5-2
	20	6-9	6-2	6-0	5-10	5-7	5-4	5-1	4-10	4-7
	24	6-4	5-10	5-5	5-3	5-1	4-11	4-8	4-5	4-2
2x6	12	12-7	11-5	11-11	11-6	11-1	10-8	10-3	9-9	9-3
	16	11-5	10-5	10-4	10-0	9-8	9-3	8-10	8-5	8-0
	20	10-7	9-8	9-3	9-0	8-8	8-4	8-0	7-8	7-3
	24	9-10	9-1	8-5	8-2	7-11	7-7	7-3	6-11	6-7
2x8	12	16-7	15-1	15-11	15-5	14-10	14-3	13-8	13-0	12-4
	16	15-1	13-9	13-9	13-4	12-10	12-4	11-10	11-3	10-8
	20	14-1	12-10	12-5	12-0	11-7	11-2	10-8	10-2	9-7
	24	13-3	12-1	11-4	11-0	10-7	10-2	9-9	9-3	8-9
2x10	12	21-1	19-1	20-1	19-5	18-9	18-0	17-3	16-5	15-7
	16	19-1	17-3	17-4	16-10	16-3	15-7	14-11	14-3	13-6
	20	17-9	16-1	15-8	15-2	14-7	14-0	13-5	12-10	12-2
	24	16-8	15-2	14-3	13-10	13-4	12-10	12-3	11-8	11-1

Determine allowable unit stress and modulus of elasticity E for the specie and grade of lumber used.

Use smaller span, or larger rafter, or closer spacing, as determined both by stress and by deflection.

Protection Against Detrimental Conditions

General—Wood used structurally under conditions which might result in decay or destruction is required to be selected or protected to prevent eventual failure. Acceptable conditions of installation are described in this section. (See also text entitled, "Protection Against Termites," part 3, page 14, "Protection Aganist Ground Water," part 3, page 9, as well as illustrations entitled, "Condensation Control in Buildings—Crawl Spaces," part 3, page 93, "Condensation Control in Buildings—Exterior Walls, Attics and Flat Roofs," part 3, page 94, and recommendations in HHFA, *Condensation Control in Dwelling Construction.*

Below-Grade Wood Posts—Wood posts used as columns in basements or cellars, and in below-grade crawl spaces or air spaces are permitted when they bear on concrete, masonry, or other approved impermeable bases extending not less than 3 inches above the floor or paving level.

Members Embedded in Below-Grade Exterior Masonry—The embedment or resting of wood members within below-grade exterior masonry is permitted when the wood members are the heartwood of a durable species; or the wood members are pressure impregnated in an approved manner with an approved preservative; or the parts within the masonry are given a minimum of two brush coats of an approved preservative.

Floor Sleepers Exposed to Moisture—The installation of wood sleepers or other wood members embedded in or laid on masonry or concrete that is in direct contact with earth is permitted when the wood members are the heartwood of a durable species; or the wood members are pressure impregnated in an approved manner with an approved preservative, and any unavoidable cut surfaces are given a minimum of two brush coats of an approved preservative.

Detrimental Vapor Condensation—The installation of thermal insulating materials between wood structural members under conditions where differential vapor pressure may cause condensation to occur within the thermal insulation is permitted when vapor migration into the thermal insulation is prevented by a vapor-resistant barrier, and vapor movement outward from the thermal insulation under vapor pressure of 1 inch of mercury is possible at a rate of 5 grains of moisture or more per square foot per hour. Under the same vapor pressure, the vapor-resistant barrier may not pass more than 1 grain of moisture per square foot per hour. For acceptable means of controlling condensation, see illustrations entitled, "Condensation Control in Buildings—Crawl Spaces," and "Condensation Control in Buildings—Exterior Walls, Attics, and Flat Roofs," part 3, pages 93 and 94.

Splicing—Structural framing members may not be spliced between bearing points unless approved provisions are made for transferring stress at the splice.

Exterior Stud Walls and Bearing Partitions—Exterior stud walls and stud-bearing partitions are required to be designed to carry safely all loads, including loads due to wind or other lateral forces.

Stud framing is to be of studs not less than 2 by 4 inches, spaced not more than 16 inches on centers for two- and three-story construction. For construction less than two stories in height, properly braced and assembled so that the assembly provides adequate rigidity, spacing may be increased up to 24 inches on centers. Studs are to be set with the larger cross-sectional dimension at right angles to the wall or bearing partition unless designed as individual columns.

Stud framing having an unsupported height of more than 10 feet is to have studs bridged or otherwise braced in an approved manner at intervals not exceeding 8 feet.

Sills are to be anchored to foundations as indicated in the illustration entitled, "Anchors and Nailing for Exterior Stud Walls," part 3, page 67.

Diagonal or corner braces are to be installed as indicated in the illustrations entitled, "Diagonal Bracing of Exterior Stud Walls," part 3, page 68, and "Corner Bracing of Exterior Stud Walls," part 3, page 69, at all external corners of exterior stud-framed walls, and securely nailed to all members over which they are applied, except that corner or diagonal braces may be omitted where their omission is specifically authorized in the illustrations entitled, "Diagonal

Wood Sheathing on Exterior Stud Walls," part 3, page 71; "Plywood Sheathing on Exterior Stud Walls," part 3, page 72; "Fiberboard Sheathing on Exterior Stud Walls," part 3, page 73; and "Gypsum-Board Sheathing on Exterior Stud Walls," part 3, page 74.

Sills and girders supported on top of foundation walls or piers are to be leveled and grouted with Portland cement grout. Wood may not be used for permanent shims. Sills and girders on foundation walls and piers of hollow unit masonry are to bear on a minimum of 4 inches of solid masonry units whose core holes have been filled with mortar. On foundation walls and piers of solid unit masonry, the top course is to have all core holes filled with mortar.

Studs are to be doubled at the sides of openings in exterior stud walls and bearing partitions, the inner stud extending in one piece from bearing to header and nailed to the outer stud; except that equivalent solid members may be used in lieu of double studs or, where allowable stresses in single studs are not exceeded and approved formed metal or other supports and fastenings are provided at lintels, openings may be framed with single studs. For lintels in exterior stud-bearing walls, see illustration entitled, "Lintels in Exterior Stud-Bearing Walls," part 3, page 75.

All lintels are to be designed to support the superimposed load and are to have bearing of at least 1½ inches.

Plates of exterior stud walls and of stud-bearing partitions may be not less than two 2-inch members of the same width as the studs, lapped at corners and intersecting partitions; except that where bearing members are placed directly above studs below, a single top plate may be used. Where plates are cut for piping or duct work, an approved tie is to be provided, as indicated in the illustration entitled, "Ties for Plates Cut for Passage of Ducts or Pipes," part 3, page 76.

Sill members of bearing partitions may be not less than 2 inches in thickness. If properly fire-stopped, studs may run through floors and rest on girders or on partition plates.

In frame construction of two or three stories, where diagonal sheathing is not provided and the exterior studs are not continuous from sill to roof, other sheathing or connections so designed and arranged as to supply adequate structural continuity between the first and second stories, and between the second and third stories, are to be provided.

Ribbon boards used to support joists may be not less than 1 by 4 inches, and cut into the studs and securely nailed to each stud with not less than two 10-penny nails. The ends of joists adjoining studs are to be securely spiked to the studs. Wood blocking is to be inserted at the ends of joists not adjoining studs, and the joists nailed to the blocking, and the blocking to the studs.

Notching of Studs: In bearing walls or partitions no stud is to be cut more than one third its depth to receive piping or duct work, or for other purposes, unless approved supplementary framing or supports are provided.

Wall Sheathing and Unsheathed Walls

General—Exterior finish which may be installed directly on studs includes the following:

a—Exterior type plywood ⅜-inch thick on 16-inch stud centers, ½-inch thick on 20-inch stud centers, ⅝-inch thick on 24-inch stud centers, provided that vertical joints occur over studs, horizontal joints are supported on blocking between studs, and the maximum spacing of nails along edges is 6 inches, and is 12 inches at intermediate bearings.

b—Three-coat Portland cement stucco, back plastered on metal lath supported ¼ inch from stud face and extending back between studs at least ¼ inch, provided diagonal bracing or corner bracing is installed.

c—Mill-matched wood siding ⅝ inch or more in actual thickness, provided diagonal bracing or corner bracing is installed.

Sheathing, where approved exterior finish is incapable of supplying adequate bracing and weather protection, is required to be installed on all exterior stud framed walls in back of the exterior finish. Exterior wall sheathing is to consist of either wood boards, plywood, fiberboard, or gypsum board, conforming to the requirements hereinafter included.

Wood Sheathing—Wood sheathing is to be installed as indicated in illustrations entitled, "Horizontal Wood Sheathing on Exterior Stud Walls," part 3, page 70, and "Diagonal Wood

Sheathing on Exterior Stud Walls," part 3, page 71. Wood sheathing, when used, is to be applied horizontally under stucco finish. All other types of exterior finish may be nailed directly to wood sheathing, using noncorrodible nails.

Plywood Sheathing—Plywood sheathing is to be installed as indicated in illustration entitled, "Plywood Sheathing on Exterior Stud Walls," part 3, page 72.

Wood shingles applied over plywood sheathing less than 3/8-inch thick are to be fastened to wood or other approved nailing strips, but nailing strips may be omitted if barbed nails or other approved fastenings are used. Nails are to be noncorrodible.

Asbestos-cement siding and shingles, applied over plywood sheathing less than 3/8-inch thick, are to be fastened with barbed nails or other approved fastenings. Nails are to be noncorrodible.

Fiberboard Sheathing—Fiberboard sheathing is to be installed as indicated in illustration entitled, "Fiberboard Sheathing on Exterior Stud Walls," part 3, page 73.

Gypsum-Board Sheathing—Gypsum-board sheathing is to be installed as indicated in illustration entitled, "Gypsum-Board Sheathing on Exterior Stud Walls," part 3, page 74.

Sheathing Paper—Except as provided in the following paragraph, water-resistant building paper or asphalt-saturated felt is to be applied over all exterior wall sheathing. Whenever conditions are such that moisture due to condensation may accumulate within the wall assembly, the water-resistant sheathing paper is to be vapor permeable.

Exceptions: The enforcement officer may approve the omission of sheathing paper where the exterior finish is metal, and in other instances where it is not deemed necessary by him for the protection of the sheathing or structure; and sheathing paper need not be required between exterior finish and either plywood sheathing or sheathing that has been covered or treated in an approved manner to render it water repellent, provided that the sheathing material is closely fitted, and cut ends which expose an absorbent core to moisture are sealed by caulking or covered with water-resistant building paper or asphalt-saturated felt.

Metal Siding—When metal siding is used, it is to be electrically grounded as required in the text entitled, "Lightning Protection for Metal on Buildings," part 5, page 62.

Floors and Roofs

Floor and Roof Framing—All girders, beams, and rafters are required to be adequate to support the loads prescribed by the Code without exceeding the allowable stresses specified in this standard. Members are to be designed so that deflections specified in the Code will not be exceeded.

When supported by masonry, joists are to have ample bearing of not less than 3 inches. When there is masonry above the bearing, the joists are to have a 2-inch minimum cut or bevel.

Masonry walls are to be securely anchored to each tier of wood joists or wood beams and to girders and trusses bearing on them as indicated in the text entitled, "Miscellaneous Construction Requirements," part 3, page 25.

When enclosing walls are of wood, each joist, beam, and girder supported by the wall is to be securely spiked or anchored to the wall construction, so as to remain in place and to resist safely all uplifts and lateral pressures specified as design loads in the Code. Girders are to be fastened to each other where they intersect or abut.

Floor joists framing into the side of wood girders or headers are to be supported on metal joist hangers or on a bearing strip or ledger board of adequate size fastened to the side of the girders or headers or by other approved equivalent support. See illustrations entitled, "Joists Framed Flush With Top of Girders," part 3, page 78; "Joists Notched Over Girders," part 3, page 81; "Framing Trimmers, Headers, and Tail Beams," part 3, page 82.

The ends of joists, whether resting upon girders or bearing partitions, or abutted against girders, are to be either securely tied to the girders or to each other, or lapped and spiked together, on not more than 4-foot centers, so as to resist safely an outward thrust on the walls equal to the assumed wind pressure, or the spreading action of the roof, whichever is greater.

Ties for masonry enclosed buildings are to be provided on each line of joists anchored to enclosing masonry. See illustrations entitled, "Joists Framed Flush With Top of Girders," part 3, page 78; "Joists Tied by Lapping at Plates and Girders," part 3, page 79; "Joist Tie at Butted Joint Over Plate or Girder," part 3, page 80; "Joists Notched Over Girders," part 3, page 81; "Wood Joists Supported by Steel Beams," part 3, pages 83 and 84.

All joists are to be spiked to the bearing when the bearing is of wood.

All joints of solid or built-up girders forming simple spans, except joints in approved glued laminated girders, are to be made over column or pier supports. For girders made up of joists nailed together side by side and continuous on three or more supports, see illustration entitled, "Continuous Built-Up Girders, Three or More Supports," part 3, page 86.

Except where single members are adequate for the load, joists supporting one-story nonbearing partitions which are parallel to the joists are to be doubled and nailed together with 10-penny nails, staggered, 32 inches between nails in a horizontal line. Members supporting nonbearing partitions more than one story in height, or bearing partitions, are to be designed to support safely the superimposed load. Joists supporting a partition parallel to the joists which are spaced apart to permit the passage of piping or duct work are to be blocked on not more than 16-inch intervals to provide support for bearing partitions, and 32 inches for nonbearing partitions. See illustration entitled, "Openings for Pipes or Ducts in Partition Framing Parallel to Joists," part 3, page 77.

Holes may be bored in joists and joists may be notched, as indicated in the illustration entitled, "Notching and Holes in Joists," part 3, page 87. The enforcement officer may approve notches and holes of other sizes and in other locations when he determines that they will not impair the required bearing capacity of the joist.

All framing around openings is to be designed for the loads supported. In general, all headers and trimmers are to be doubled. Framing members at openings, when doubled, are to be supported as indicated in the illustration entitled, "Framing Trimmers, Headers, and Tail Beams," part 3, page 82. Headers 4 feet or less in length may be single members. Trimmers may be single members when header is 4 feet or less in length, and opening occurs in end quarter span of trimmer.

Support of Rafters: Rafters are to be vertically supported or tied as indicated in the illustration entitled, "Roof Framing," part 3, page 88. If the spread of the rafters is prevented by ties not at the plate line, the size of the rafters is to be increased to take care of the additional bending moment induced by the ties. Framing around roof openings, and hip and valley rafters, are to be designed for the loads supported. In general, double rafters and headers are to be used around roof openings unless single members are adequate for the load.

Bridging: Floor and flat-roof joists, ceiling joists, and beams are to be securely bridged as indicated in the illustration entitled, "Bridging for Floor and Flat Roof Joists and Beams," part 3, page 85. Where the required depth of rafters is more than six times the thickness, the rafters are to be bridged as required for floor joists.

Roof Sheathing—Roof sheathing is required to be of wood, or of plywood, or of other approved material providing secure attachment for the roofing.

Wood Roof Sheathing: Wood roof sheathing is to have a minimum nominal thickness of 1 inch. It is to be applied over maximum rafter spacing of 24 inches on centers and nailed with minimum of two 8-penny nails for boards 6 inches and less in width, and minimum of three 8-penny nails for wider boards. Joints are to be over rafters unless end-matched boards are used; if end-matched boards are used, no two adjoining boards are to break joints over the same rafter space, and each board is to bear on at least two rafters.

Plywood Roof Sheathing: Plywood roof sheathing is to be applied with the grain of the outer plies at right angles to the rafters, and is to have thickness not less than that given in the following table:

Type of roof and roofing materials	Rafter spacing, inches	Minimum plywood thickness in inches	
		Wood shingles; no cut-in blocking required. Shingles other than wood, with cut-in blocking between rafters	Shingles other than wood, with cut-in blocking omitted between rafters
Pitched roofs: wood, asphalt, or metal shingles...	16 20 24	5/16 3/8 1/2 [1]	3/8 7/16 9/16 [1]
Pitched roofs: slate, tile, or asbestos cement......	16 20 24	1/2 1/2 5/8	9/16 9/16 11/16
Flat roofs: built-up bituminous, or metal.........	16 20 24	3/8 1/2 5/8	7/16 9/16 11/16

[1] Tabular values for 1/2″ and 9/16″ plywood may be reduced to 3/8″ and 1/2″ respectively, provided that snow load on roof sheathing does not exceed 40 psf normal to the roof surface and plywood is continuous over two or more spans.

Wood shingles applied over plywood roof sheathing less than 1/2-inch thick, are to be fastened to wood or other approved nailing strips. Plywood roof sheathing may be not less than sheathing grade for interior type conforming to the requirements for such material in CS, *Douglas Fir Plywood.* Plywood roof sheathing not of the exterior type may have no surface or edge exposed to the weather. Plywood roof sheathing is to be nailed at all edges supported by rafters (and blocking if required in the above table) with nails 6 inches on centers, and to intermediate rafters with nails spaced a maximum of 12 inches on centers. Sixpenny nails minimum are to be used for plywood one-half inch or less in thickness, and 8-penny minimum for plywood more than 1/2-inch thick.

Underlay: Underlay between sheathing and exterior finish is to be provided wherever other than wood shingles or metal roofs are installed.

Metal Roofing—When metal roof is used, it is to be electrically grounded as required in the text entitled, "Lightning Protection for Metal on Buildings," part 5, page 62.

Flooring—In all buildings with wood-framed floor construction, where wood strip finish flooring of less than 1-inch nominal thickness, or other finish, is installed, subflooring is to be provided consisting of either:

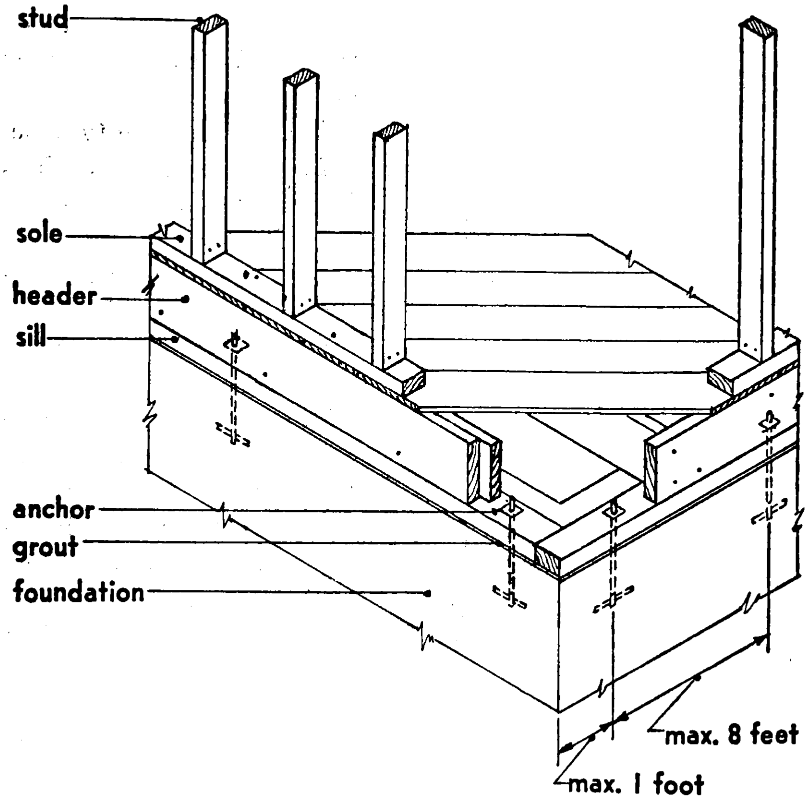
a—Wood of not less than 1-inch nominal thickness laid either at right angles to, or diagonal to, the joists, tongue and groove when supporting linoleum, composition tile or rubber tile, or

b—Plywood with face grain perpendicular to the joists, of 1/2-inch minimum thickness when joists are 16 inches on center; plywood of 5/8-inch minimum thickness when joists are 20 inches on center; plywood of 3/4-inch minimum thickness when joists are 24 inches on center.

The plywood is to be supported at panel edges by wood blocking between joists when the finish floor is other than wood strip, and is to be nailed to joists and blocking on 6-inch centers along edges and 10 inches on centers elsewhere.

Flooring is to be of such thickness that it will safely support design loads with the deflection not exceeding that specified in part 3 of the Code.

Anchors and Nailing for Exterior Stud Walls



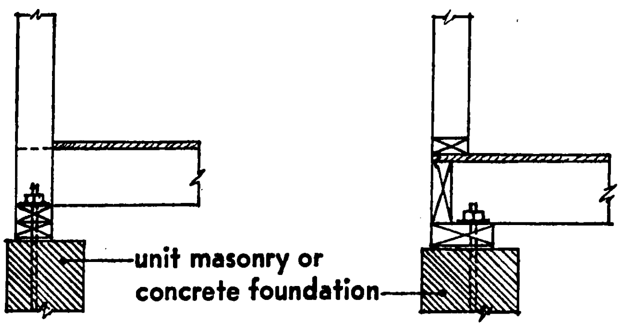
Anchors—Location: 1-foot maximum from each end of sill and 8-foot maximum on centers. Minimum of two anchor bolts in each sill.

Size: Minimum ½-inch round stock, or bolts minimum ½ inch in diameter.

Embedment: Minimum 6 inches in cast-in-place concrete; 15 inches in unit masonry.

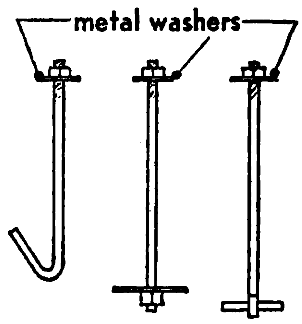
Types: Anchors may be of hooked, plate, or eye-and-pin type, as illustrated below.

Nailing—Studs of exterior walls are to be nailed to a sole with a minimum of three 16-penny nails, or four 8-penny nails. Sole plate to be nailed to joist or header through subflooring with 16-penny nails, staggered.



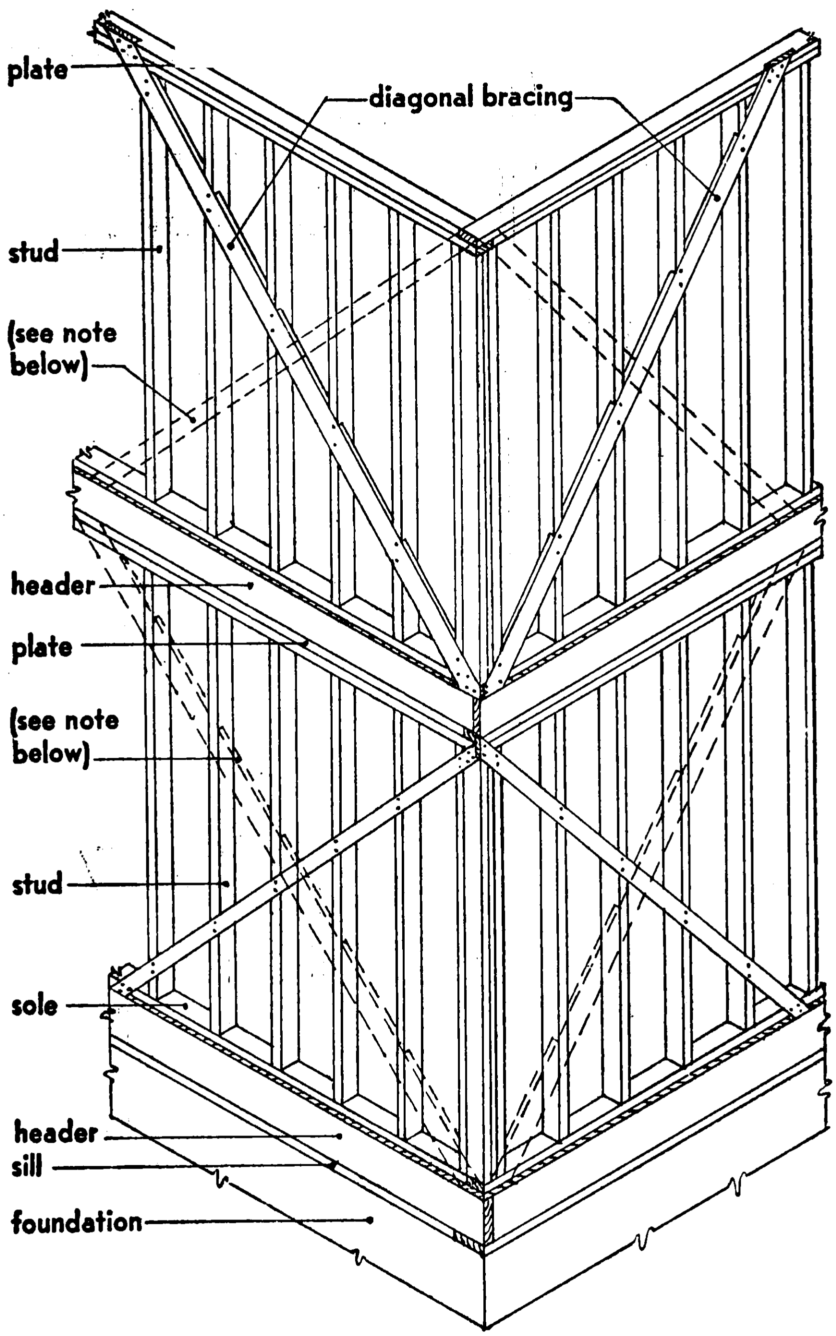
BALLOON FRAME PLATFORM FRAME

SILL DETAILS



TYPES OF SILL ANCHORS

Diagonal Bracing of Exterior Stud Walls

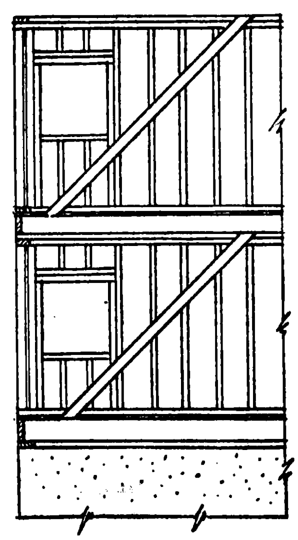


Note: Dotted lines indicate alternate locations of diagonal bracing

Diagonal Bracing—Minimum size: 1 by 4 inches square-edged stock.

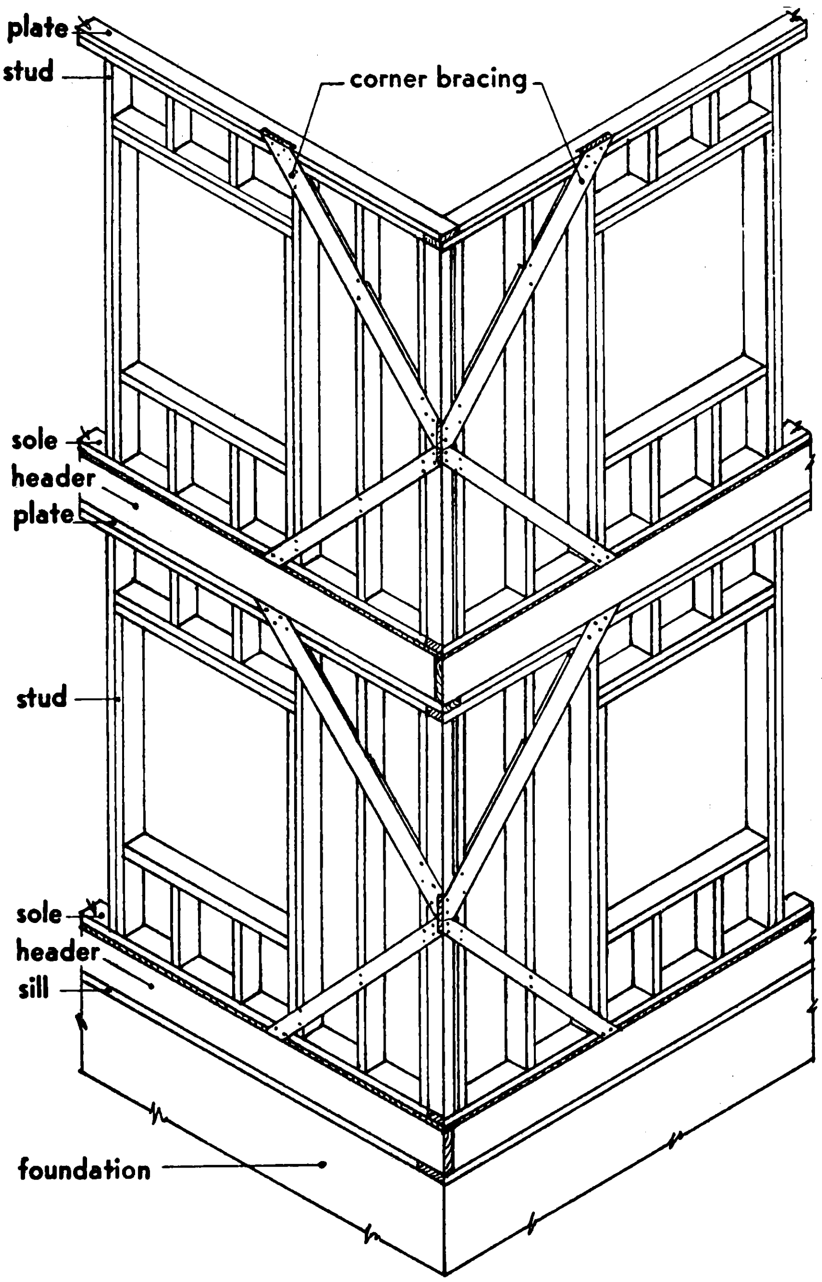
Nailing: Braces are to be let into face of framing members and nailed at each stud crossing with not less than two 10-penny nails, and at ends with not less than three 10-penny nails.

Diagonal bracing is preferable and is to be used unless openings near the corners prevent its use, except that corner and diagonal bracing may be omitted where omission is authorized in the illustrations entitled, "Diagonal Wood Sheathing on Exterior Stud Walls"; "Plywood Sheathing on Exterior Stud Walls"; "Fiberboard Sheathing on Exterior Stud Walls"; "Gypsum-Board Sheathing on Exterior Stud Walls"; part 3, pages 71 to 74.



ALTERNATE DIAGONAL BRACING WHERE OPENINGS OCCUR AT CORNERS

Corner Bracing of Exterior Stud Walls

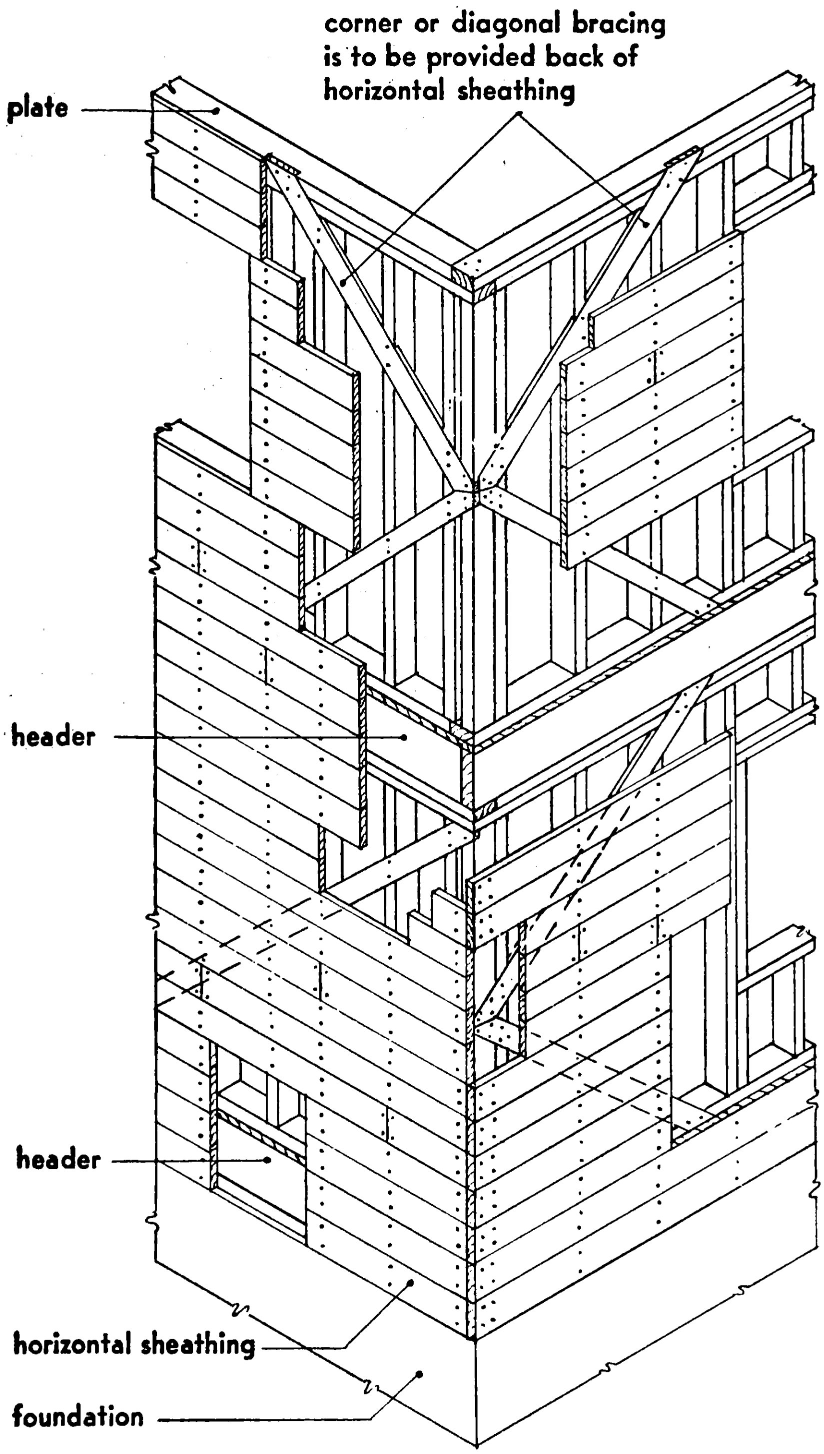


Corner Bracing—Minimum size: 1 by 4 inches square-edged stock.

Nailing: Braces are to be let into face of framing members and nailed at each stud crossing with not less than two 10-penny nails, and at ends with not less than three 10-penny nails.

Note: Corner bracing is to be used where openings which prevent the use of diagonal bracing occur near corners, except that corner and diagonal bracing may be omitted where omission is authorized in the illustrations entitled, "Diagonal Wood Sheathing on Exterior Stud Walls," "Plywood Sheathing on Exterior Stud Walls," "Fiberboard Sheathing on Exterior Stud Walls," "Gypsum-Board Sheathing on Exterior Stud Walls," part 3, pages 71 to 74.

Horizontal Wood Sheathing on Exterior Stud Walls

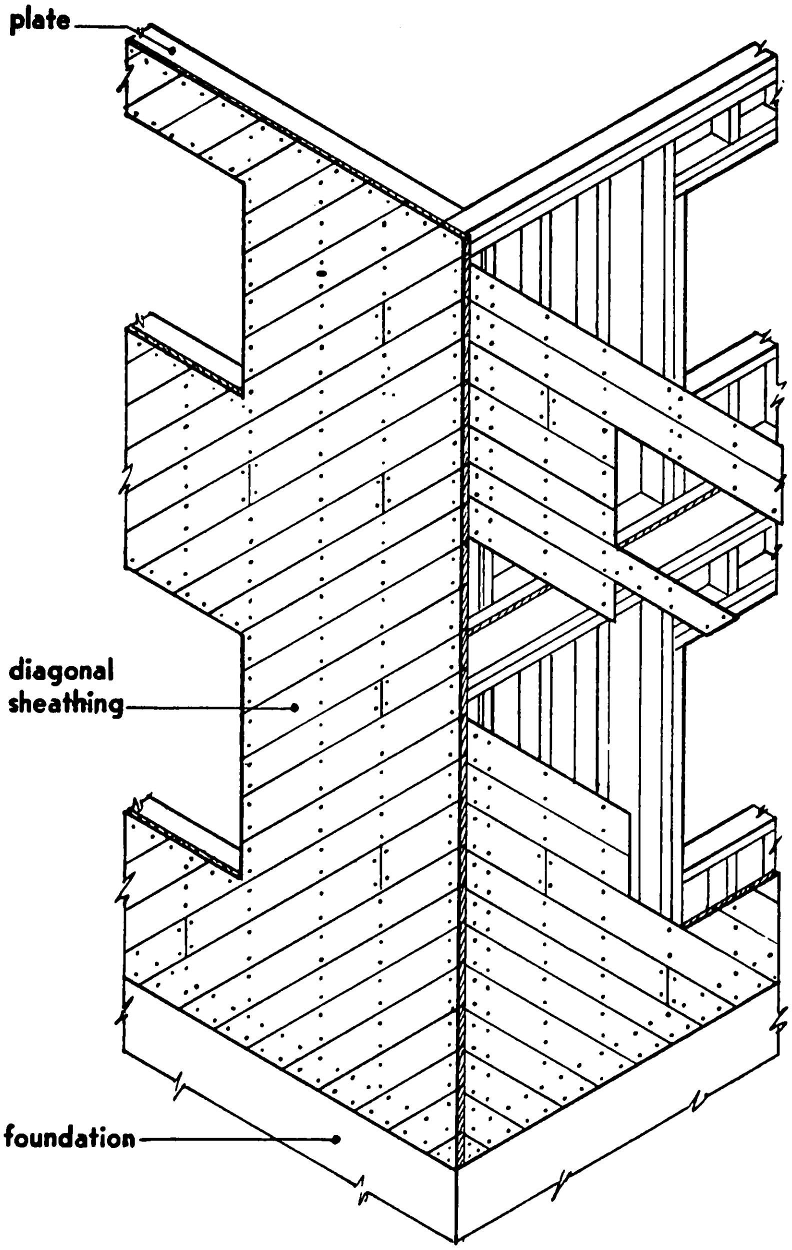


Wood Sheathing—Minimum thickness ⅝ inch, actual.

Nailing: For boards 8 inches or less in width, use two 8-penny nails at each stud crossing. For wider boards use not less than three 8-penny nails at each stud crossing.

Structural Continuity: Sheathing boards are to be of such widths and so placed that junctions between sills and headers and between headers and studs are spanned by boards; or structural continuity for the stud walls is provided by other approved equivalent methods.

Diagonal Wood Sheathing on Exterior Stud Walls



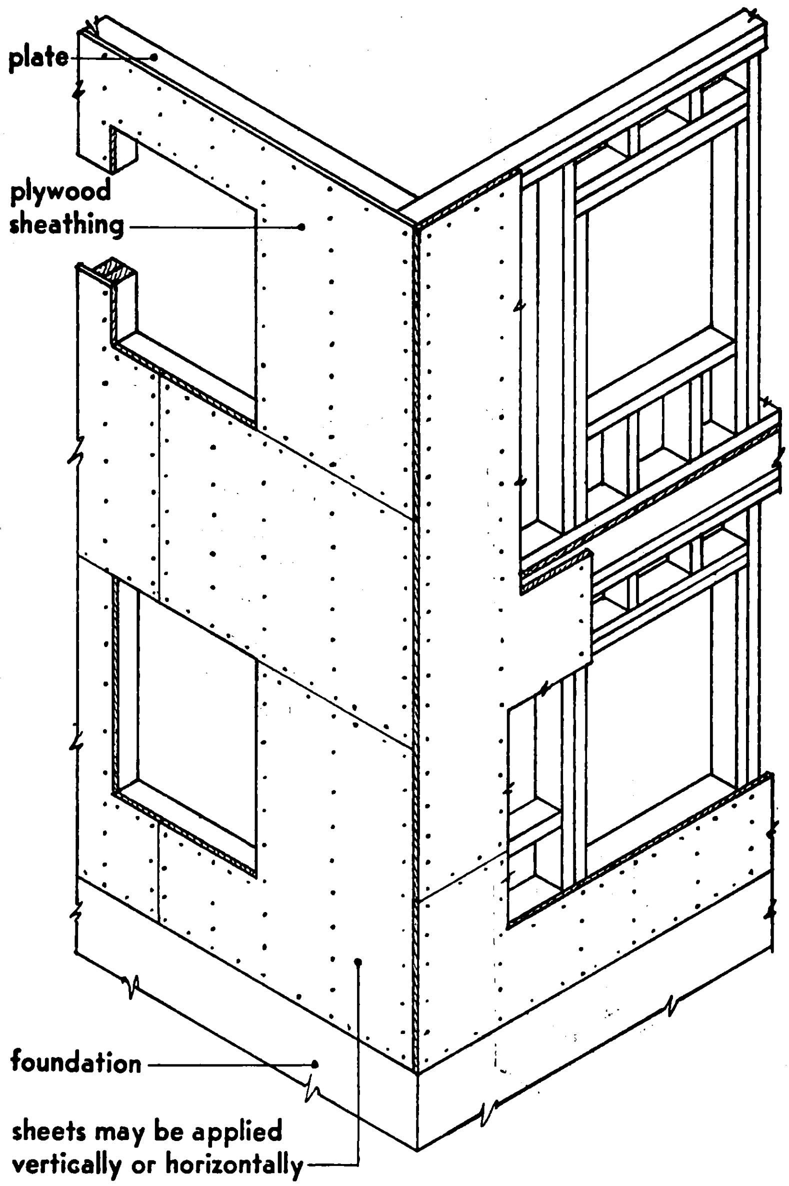
Wood Sheathing—Minimum thickness ⅝ inch, actual.

Nailing: For boards 8 inches or less in width use two 8-penny nails at each stud crossing; for wider boards use not less than three 8-penny nails at each stud crossing.

Joints are to be over studs unless end-matched boards are used. If end-matched boards are used, no two adjoining boards are to have joints over the same stud space and each board is to bear on not less than two studs.

Bracing: Where diagonal wood sheathing is used, corner or diagonal bracing is not required. The sheathing on the two walls meeting at a corner post is to run in opposite directions.

Plywood Sheathing on Exterior Stud Walls



Plywood Sheathing—Minimum thickness $\frac{5}{16}$ inch on studs spaced up to 16 inches on centers; $\frac{3}{8}$ inch on studs spaced up to 24 inches on centers.

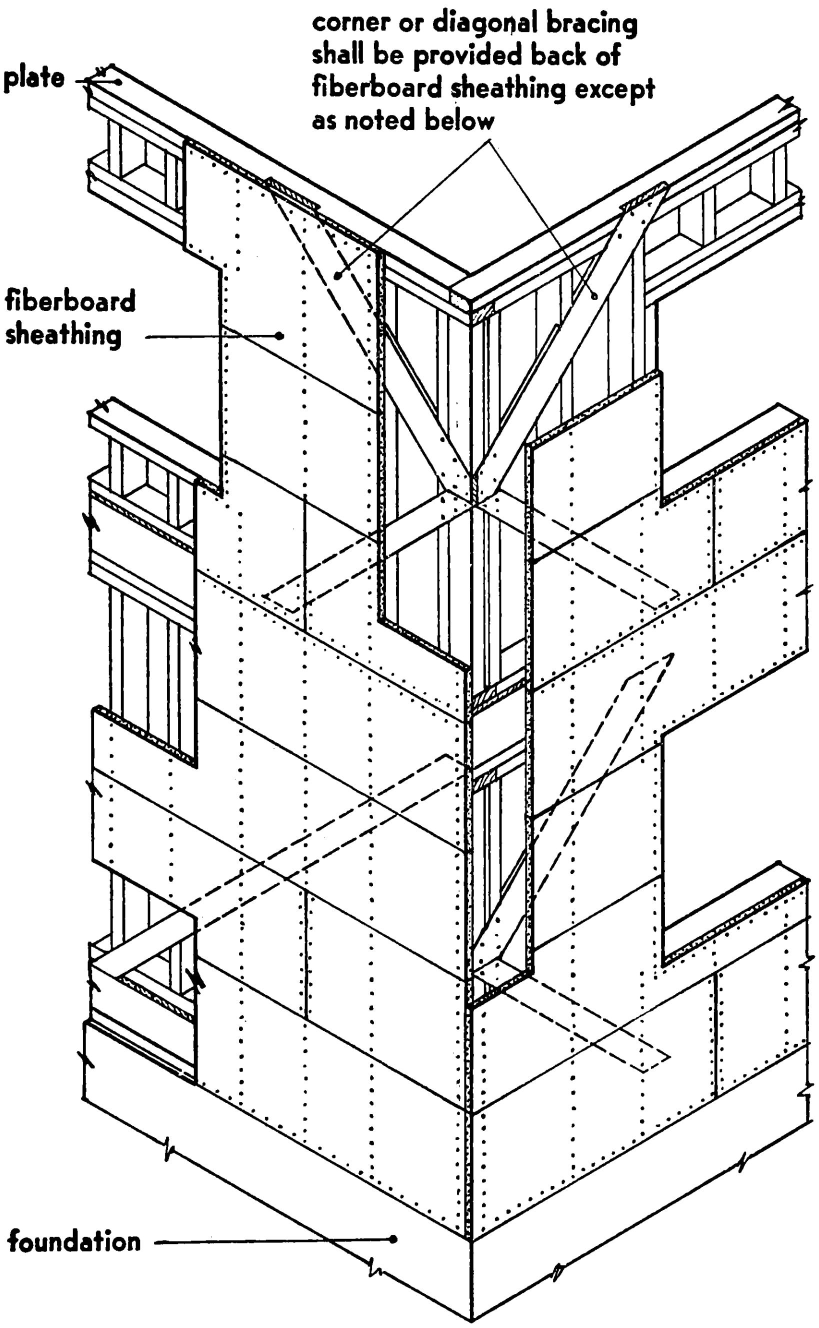
Quality: Conforming to interior type, sheathing grade or approved equivalent in CS, *Douglas Fir Plywood.*

Nailing: Use 6-penny nails located at least $\frac{3}{8}$ inch from edges, and spaced not more than 6 inches apart along edges and not more than 12 inches apart along other bearings; or use approved equivalent fastenings.

Corner or diagonal bracing is not required where plywood sheathing not less than 48 inches wide is used and is nailed on all edges and at intermediate bearings.

Attachment of Exterior Finish: See text entitled, "Plywood Sheathing," part 3, page 64.

Fiberboard Sheathing on Exterior Stud Walls



Fiberboard Sheathing—Minimum thickness ½ inch on studs spaced up to 16 inches on centers; ¾ inch on studs spaced up to 24 inches on centers.

Quality: Conforming to FS, *Fiberboard: Insulating.*

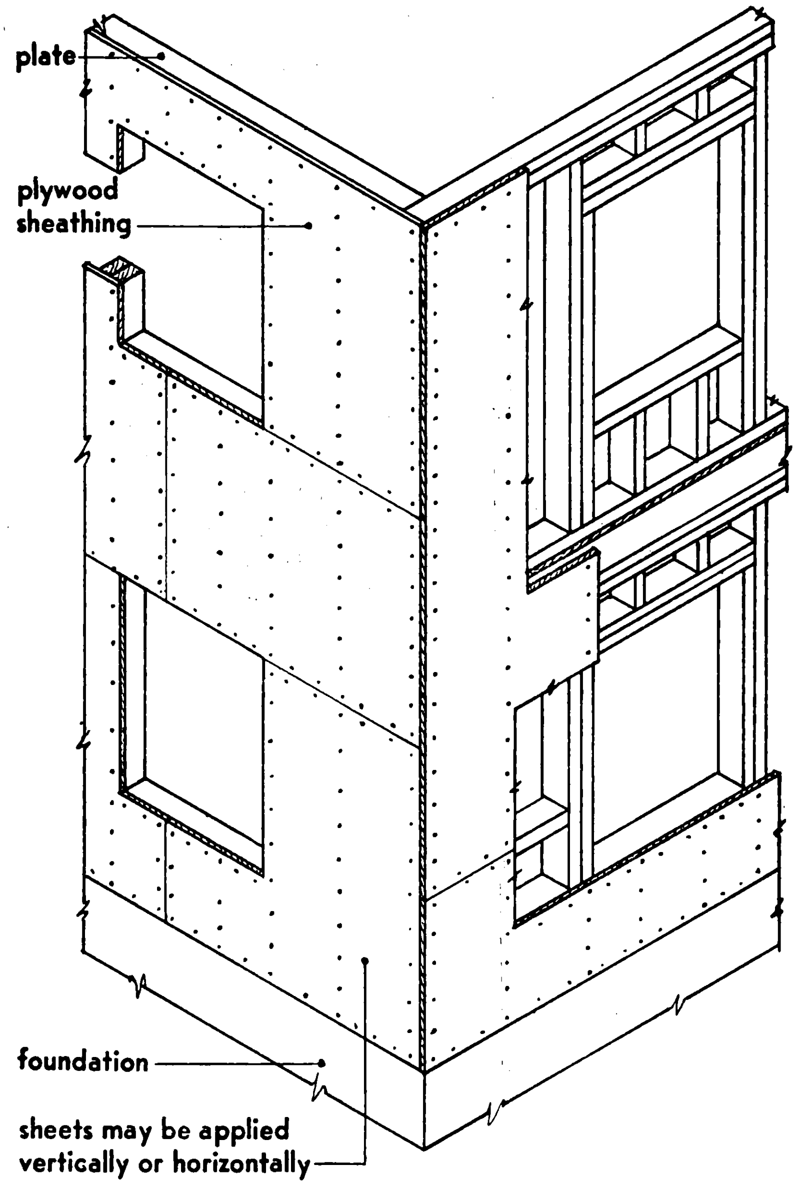
Application: Boards are to be applied with vertical joints staggered. So far as possible, each board is to bear on at least four studs. Where wide boards are used and applied vertically, and ends do not bear on structural members, nailing headers are to be inserted for fastening ends.

Nailing: Use 5-penny nails located at least ⅜ inch from edges; for wide boards applied vertically, space nails 3 inches on centers along edges and 6 inches on centers at other bearings; for narrow boards applied horizontally, space nails 4½ inches on centers on all bearings; or use approved equivalent fastenings; except that where supplemental fastenings are provided by the nailing of wood siding or wood nailing strips, nails for fastening sheathing may be spaced up to 8 inches on centers.

Bracing may be omitted on one-story dwellings, and on the second story of two-story dwellings, where 50 per cent or more of the wall surface is without openings and fiberboard not less than ½-inch thick in sheets 4 feet by 8 feet is applied with the 8-foot dimension vertical.

Attachment of Exterior Finish: Fiberboard sheathing may not be used as a nailing base for the direct attachment of exterior finish and such finish is to be nailed either to the studding through the fiberboard sheathing or attached to wood or other approved nailing strips; except that asbestos shingles or siding may be directly attached, using approved fastening, such as twist nails, hook nails, or self-locking nails. Nails are to be noncorrodible.

Plywood Sheathing on Exterior Stud Walls



Plywood Sheathing—Minimum thickness $\frac{5}{16}$ inch on studs spaced up to 16 inches on centers; $\frac{3}{8}$ inch on studs spaced up to 24 inches on centers.

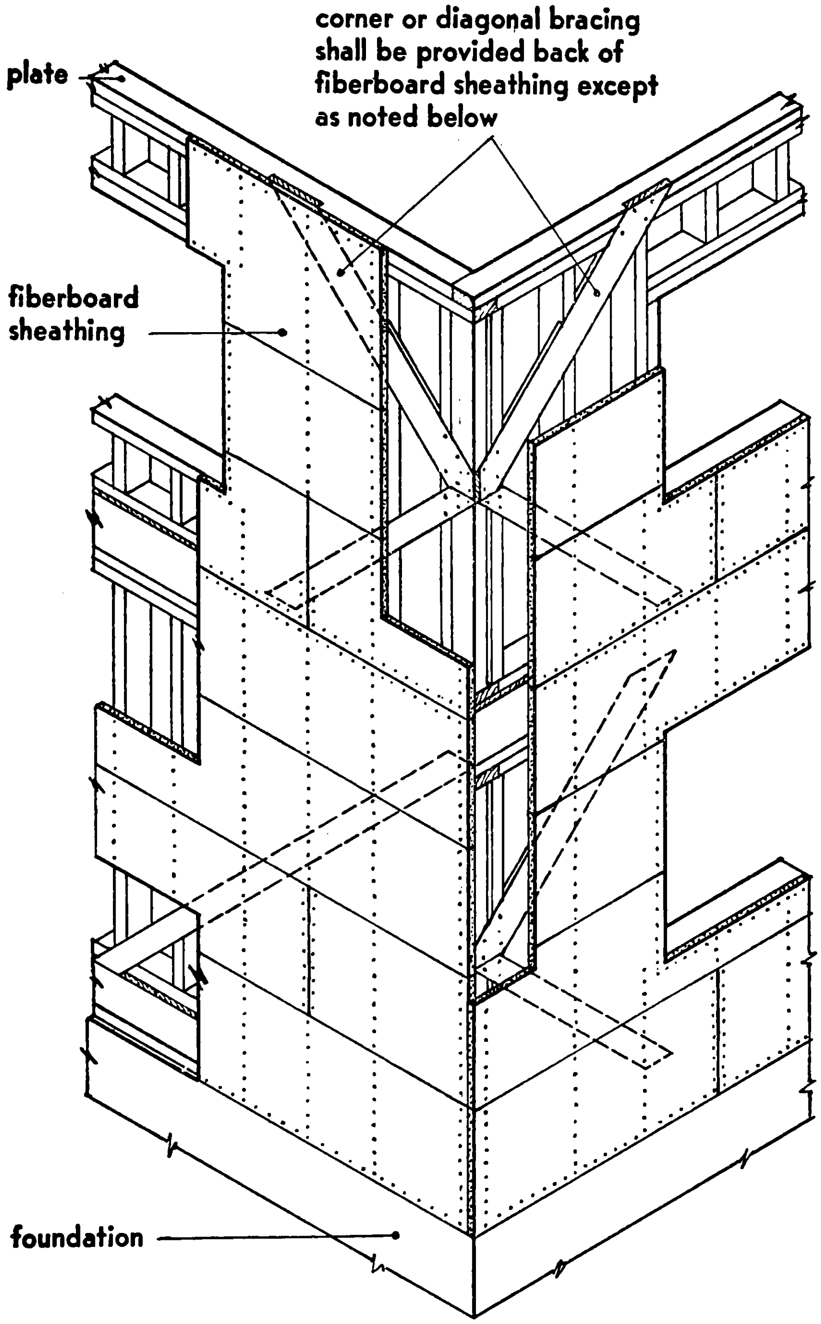
Quality: Conforming to interior type, sheathing grade or approved equivalent in CS, *Douglas Fir Plywood.*

Nailing: Use 6-penny nails located at least $\frac{3}{8}$ inch from edges, and spaced not more than 6 inches apart along edges and not more than 12 inches apart along other bearings; or use approved equivalent fastenings.

Corner or diagonal bracing is not required where plywood sheathing not less than 48 inches wide is used and is nailed on all edges and at intermediate bearings.

Attachment of Exterior Finish: See text entitled, "Plywood Sheathing," part 3, page 64.

Fiberboard Sheathing on Exterior Stud Walls



Fiberboard Sheathing—Minimum thickness ½ inch on studs spaced up to 16 inches on centers; ¾ inch on studs spaced up to 24 inches on centers.

Quality: Conforming to FS, *Fiberboard: Insulating.*

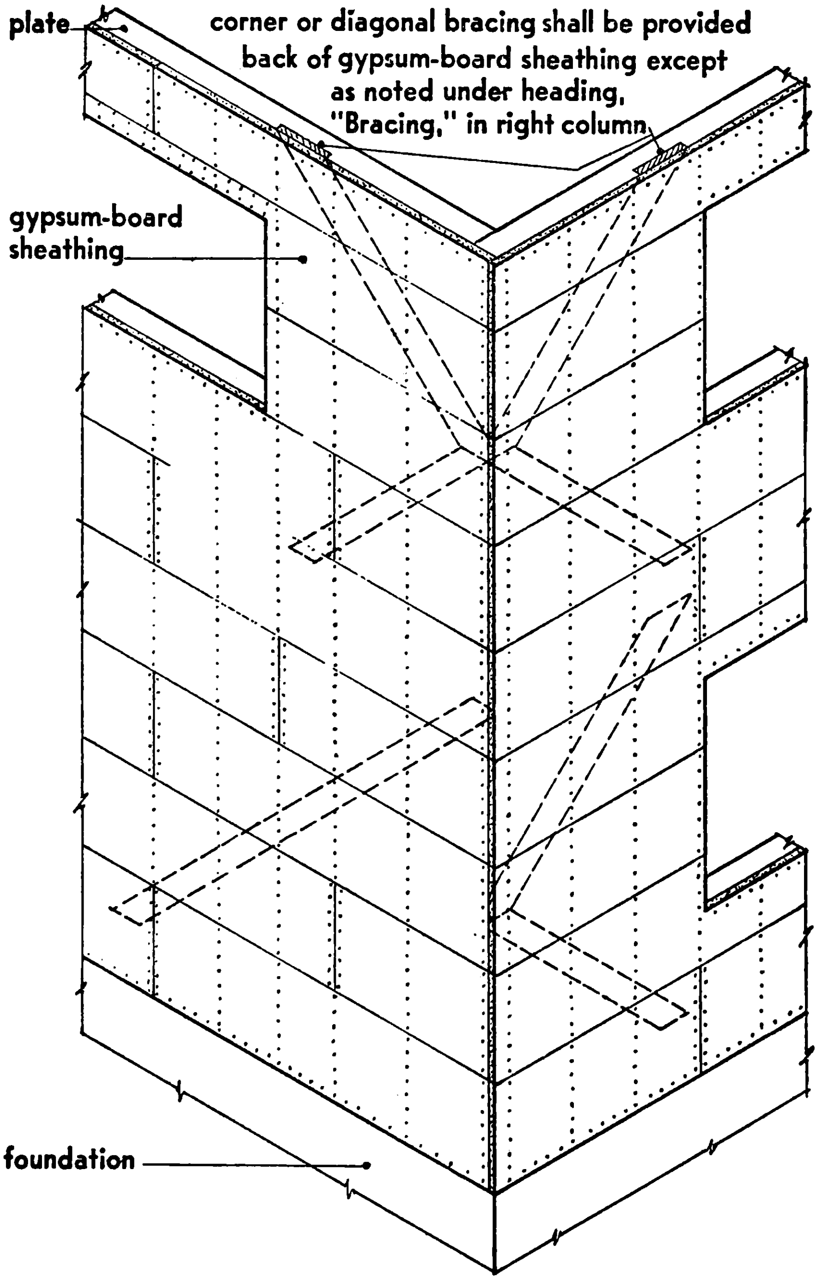
Application: Boards are to be applied with vertical joints staggered. So far as possible, each board is to bear on at least four studs. Where wide boards are used and applied vertically, and ends do not bear on structural members, nailing headers are to be inserted for fastening ends.

Nailing: Use 5-penny nails located at least ⅜ inch from edges; for wide boards applied vertically, space nails 3 inches on centers along edges and 6 inches on centers at other bearings; for narrow boards applied horizontally, space nails 4½ inches on centers on all bearings; or use approved equivalent fastenings; except that where supplemental fastenings are provided by the nailing of wood siding or wood nailing strips, nails for fastening sheathing may be spaced up to 8 inches on centers.

Bracing may be omitted on one-story dwellings, and on the second story of two-story dwellings, where 50 per cent or more of the wall surface is without openings and fiberboard not less than ½-inch thick in sheets 4 feet by 8 feet is applied with the 8-foot dimension vertical.

Attachment of Exterior Finish: Fiberboard sheathing may not be used as a nailing base for the direct attachment of exterior finish and such finish is to be nailed either to the studding through the fiberboard sheathing or attached to wood or other approved nailing strips; except that asbestos shingles or siding may be directly attached, using approved fastening, such as twist nails, hook nails, or self-locking nails. Nails are to be noncorrodible.

Gypsum-Board Sheathing on Exterior Stud Walls



Gypsum-Board Sheathing—Minimum thickness ½ inch; minimum width 2 feet.

Quality: Gypsum core within water-repellent paper.

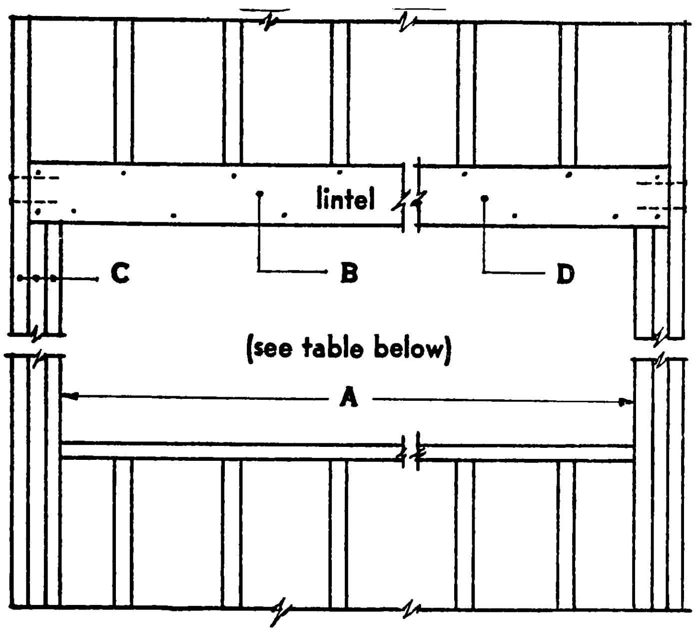
Application: Gypsum-board sheathing is to be applied horizontally over studs spaced not more than 16 inches on centers with ends over supports and with vertical joints staggered. So far as possible, each board is to bear on at least four studs. At openings, water-resistant paper is to be applied to provide a seal between the opening frame and the gypsum-board sheathing.

Nailing: Use galvanized barbed roofing nails, 1¾ inches long, 11 gage, 7/16-inch diameter head, located at least ⅜ inch from edges and spaced not more than 4 inches on centers at all bearings, or use approved equivalent fastenings; except that where supplemental fastenings are provided by the nailing of wood siding or wood nailing strips, nails for fastening sheathing may be spaced up to 8 inches on centers.

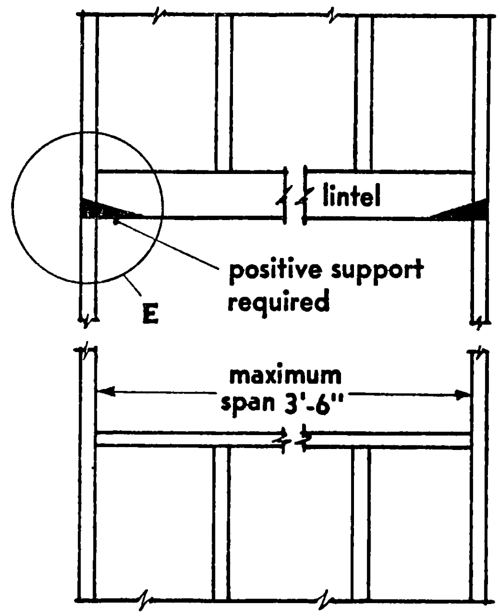
Bracing: On one-story dwellings, and at the second story of two-story dwellings, where 50 per cent or more of the wall surface is without openings, bracing may be omitted.

Attachment of Exterior Finish: Gypsum-board sheathing may not be used as a nailing base for the direct attachment of finish, and such finish is to be nailed either to the studding through the gypsum-board sheathing or is to be attached to wood or other approved nailing strips; except that asbestos shingles or siding may be directly attached, using approved fastenings, such as twist nails, hook nails, or self-locking nails. Nails are to be noncorrodible.

Lintels in Exterior Stud-Bearing Walls



3 STUDS AT EACH SIDE
(2 studs at each side, similar)

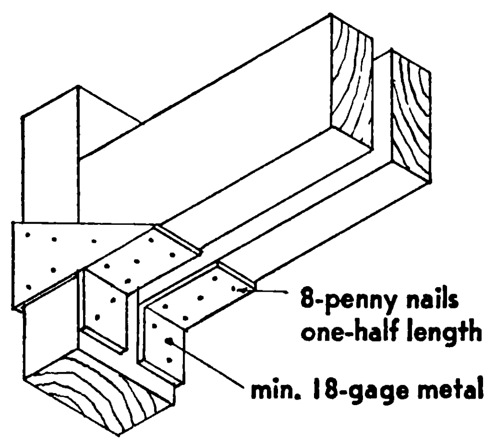


SINGLE STUD AT EACH SIDE

Fastening of Lintels—Continuous long studs abutting ends of lintels are to be nailed through studs to each member of lintel with a minimum of two 10-penny nails. Nail studs together with 12-penny nails, 12 inches on center.

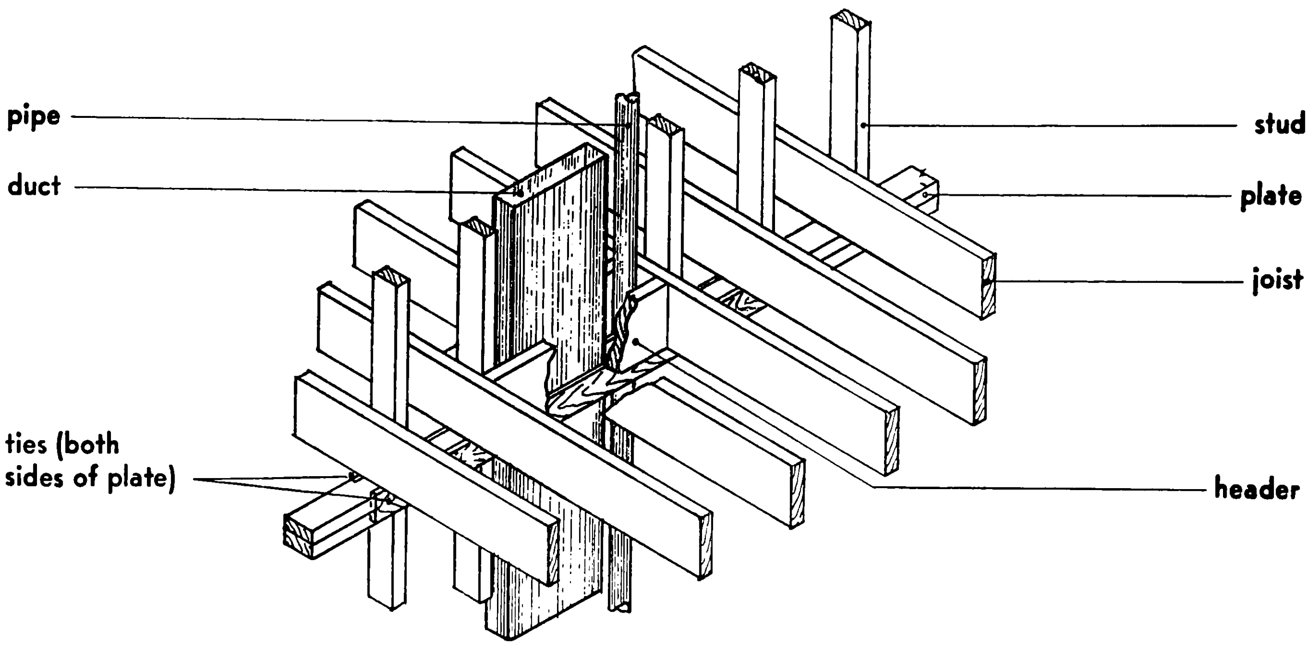
MINIMUM LINTEL SIZES

Span in feet A	Size of lintel B	Minimum number of studs at each side C	Nailing D
Up to 2′–0″	2–2″x4″	1	Two 16-penny nails at each end and staggered 16 inches on centers for length of lintel
2′–0″ to 3′–6″	2–2″x4″	1 or 2	
3′–6″ to 4′–6″	2–2″x6″	2 (1 long, 1 short)	
4′–6″ to 6′–0″	2–2″x8″	2 (1 long, 1 short)	
6′–0″ to 7′–6″	2–2″x10″	3 (1 long, 2 short)	



DETAIL AT E

Ties for Plates Cut for Passage of Ducts or Pipes



INTERIOR BEARING PARTITION

Ties

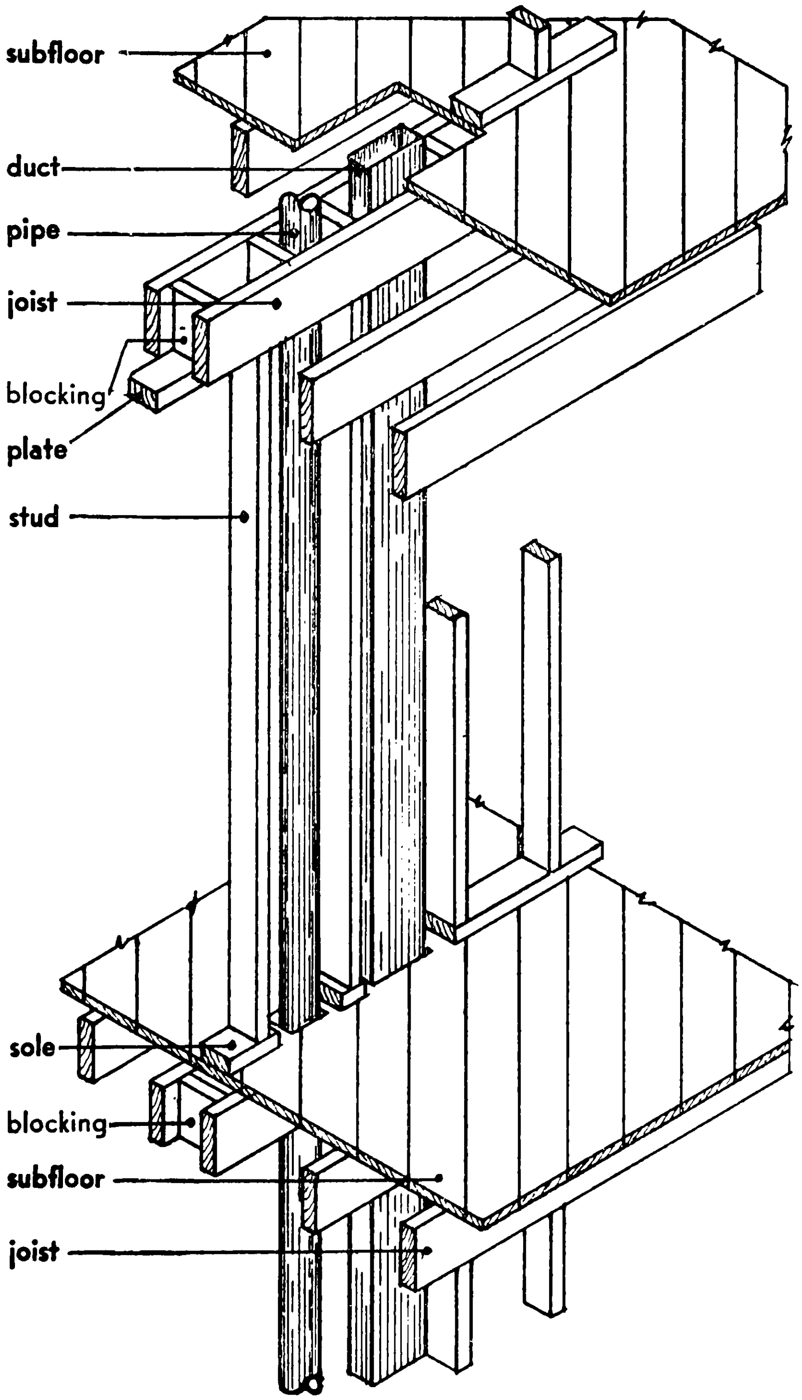
Exterior stud walls—Where a member is cut to permit the passage of ducts and pipes, the space is to be temporarily spanned by a member of the same cross-sectional area to provide structural continuity until the sheathing is installed.

Interior bearing partition minimum cross section—Wood ties to be 1-inch by 4-inch nominal; metal ties, 1/8 inch by 3 inches.

Minimum length—Sufficient to extend on each side at least one stud spacing beyond opening.

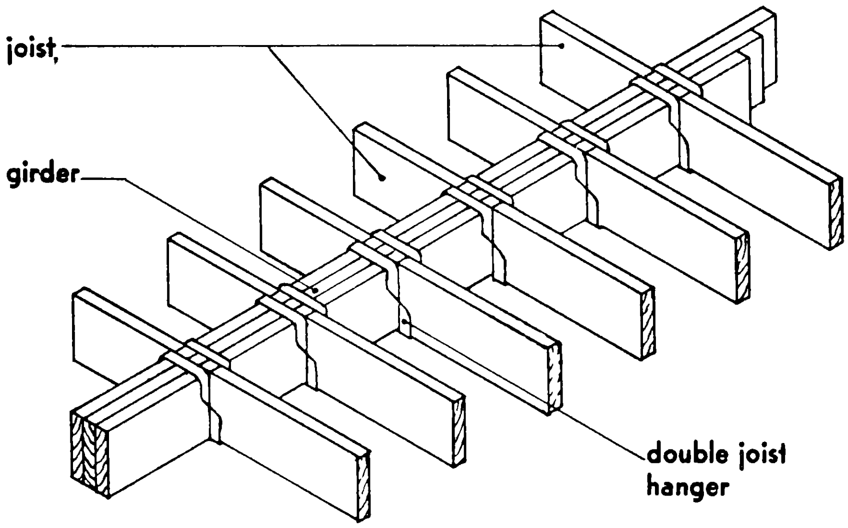
Nailing of ties—Ties are to have a minimum of four 8-penny nails at each side of opening.

Openings for Pipes or Ducts in Partition Framing Parallel to Joists



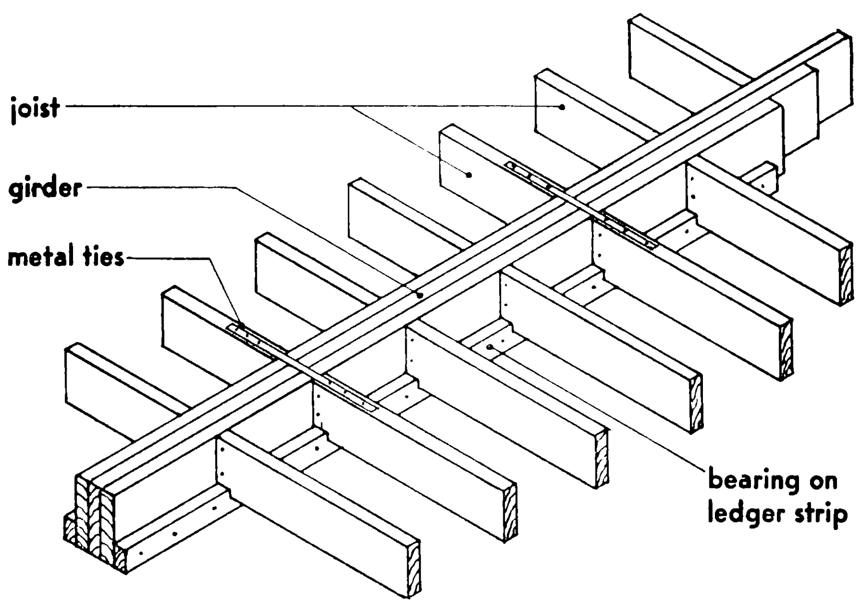
Joists supporting a partition parallel to the joists and spaced apart to permit the passage of piping or duct work are to be blocked on not more than 16-inch intervals for a bearing partition and 32-inch intervals for a nonbearing partition.

Joists Framed Flush with Top of Girders



Metal joist hangers—Minimum $\frac{3}{16}$ inches by $1\frac{1}{4}$ inches.

Nailing—Nail hangers to girders and joists with 16-penny nails.



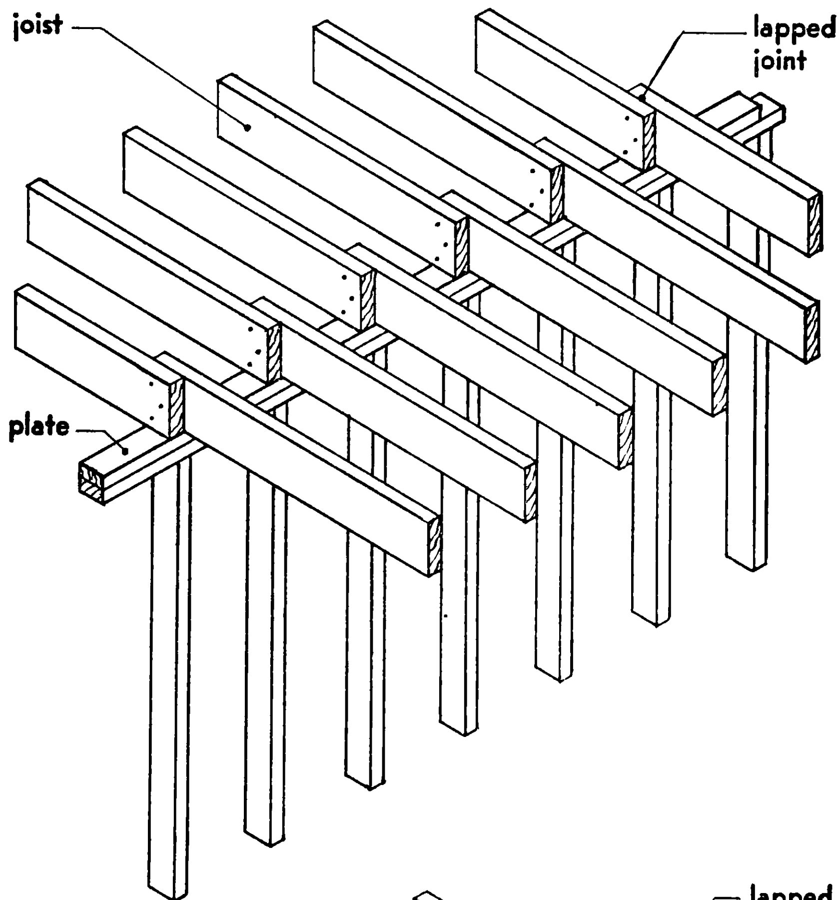
Metal ties—1 inch wide by $\frac{1}{8}$ inch thick by 24 inches long, spaced 4 feet on center maximum and nailed to each joist with three 8-penny nails.

Bearing strips—Not less than 2 inches by 3 inches, spiked to girder with 16-penny nails approximately 6 inches on centers.

Notches—In end of joist over bearing strip not to exceed one quarter of the joist depth, unless a lesser net depth is adequate for the load.

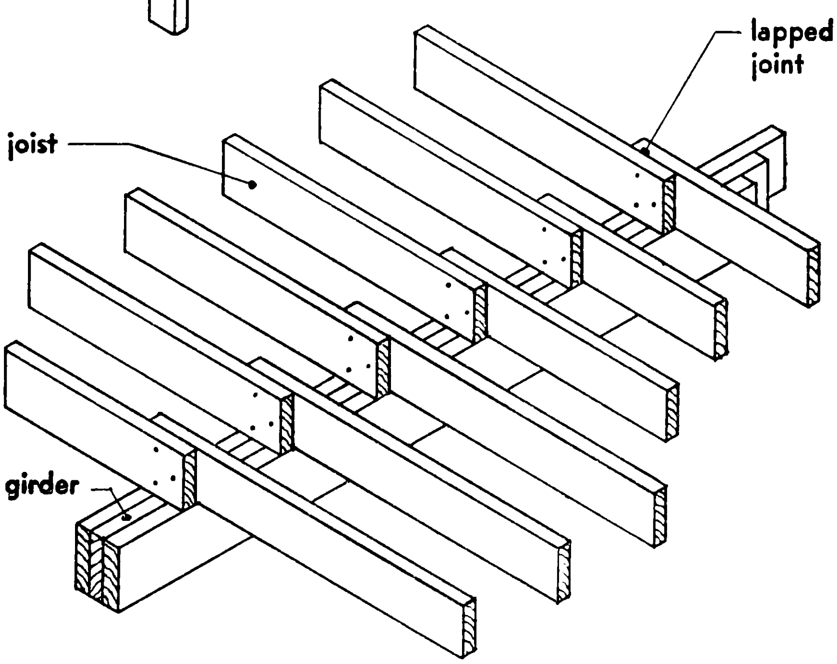
Nailing—Toe-nail joist to girder with a minimum of three 16-penny nails at each joist.

Joists Tied by Lapping at Plates and Girders

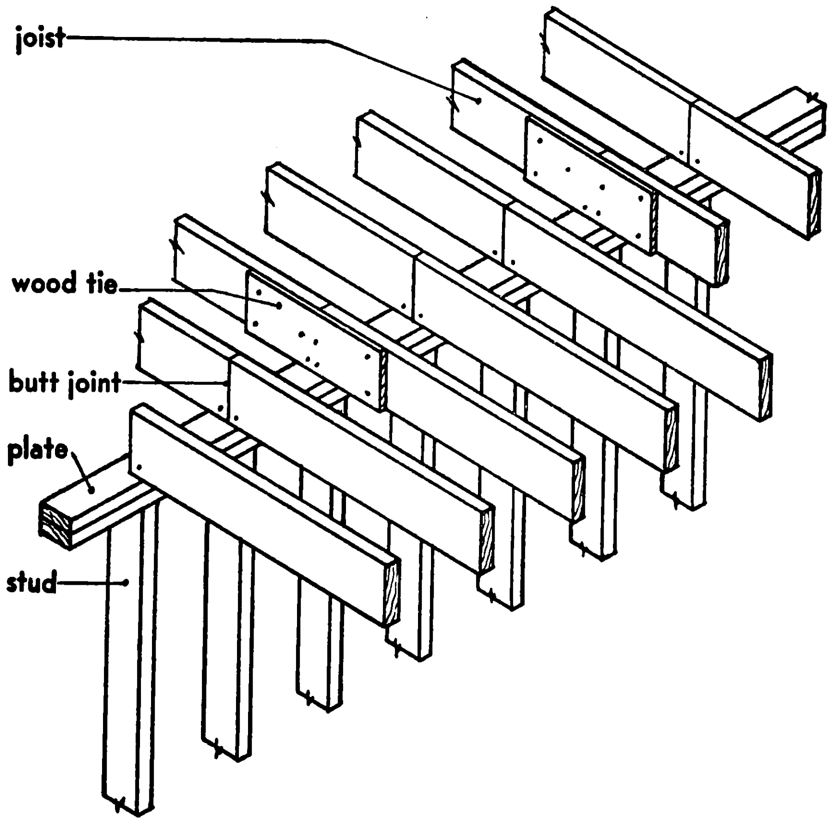


Minimum lap of joists 4 inches.

Nailing—Spike joists together with two 16-penny nails. Toe-nail joists to plate, partition cap, or ledger with one 16-penny nail in each joist.



Joist Tie at Butted Joint over Plate or Girder



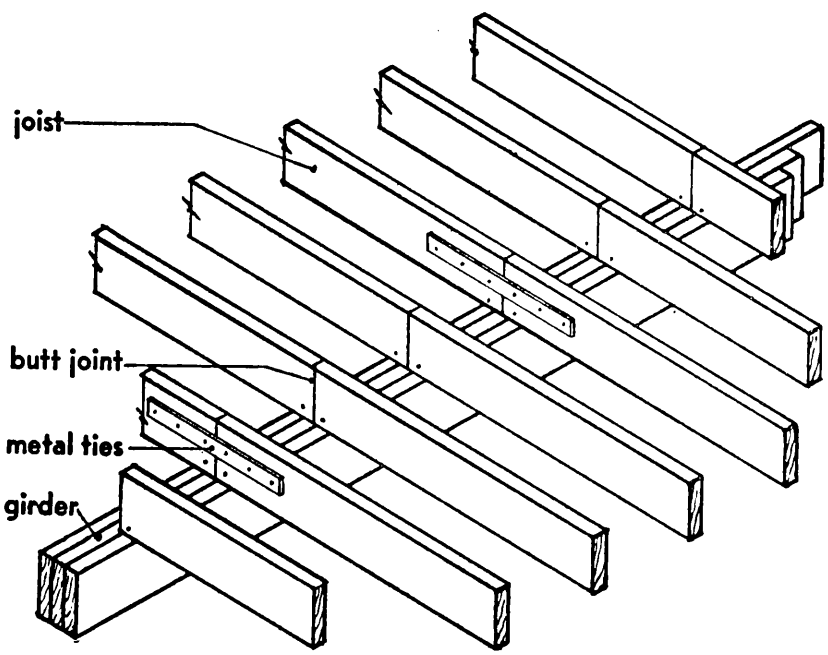
Ties—Size: Wood scabs 1 inch by 24 inches, or metal ties 1 inch wide by 1/8 inch thick by 24 inches long.

Maximum spacing 4 feet on centers.

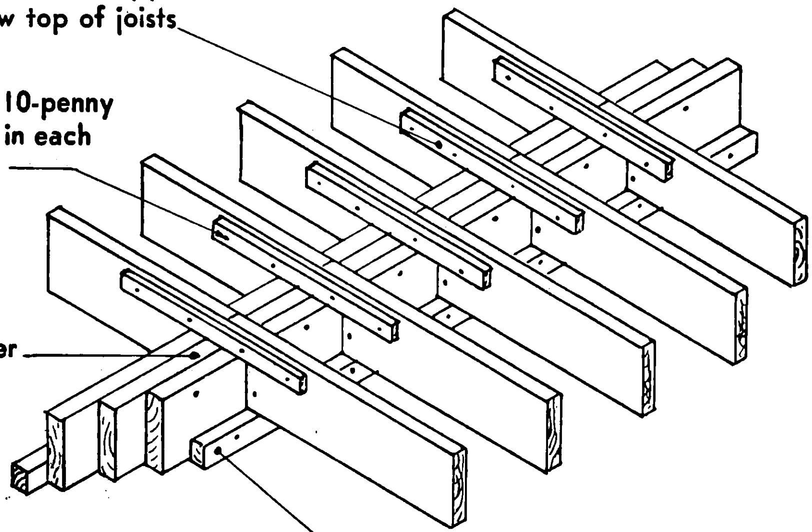
Nailing: Wood ties to be secured to each joist with three 8-penny nails each side of the butt joint.

Metal ties are to be secured to each joist with three 8-penny nails each side of the butt joint.

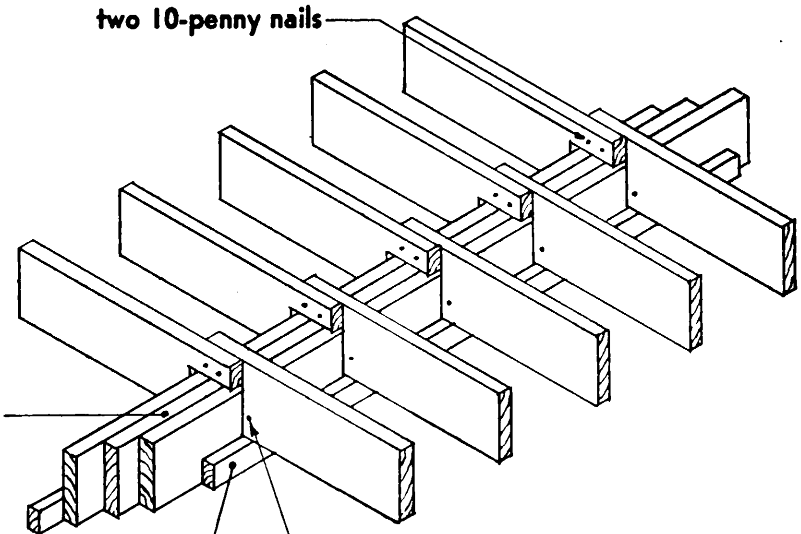
Joists are to be spiked to the plate, partition cap, or girder with at least two 10-penny nails on the near side and at least one on the far side, toe-nailed into the bearing member.



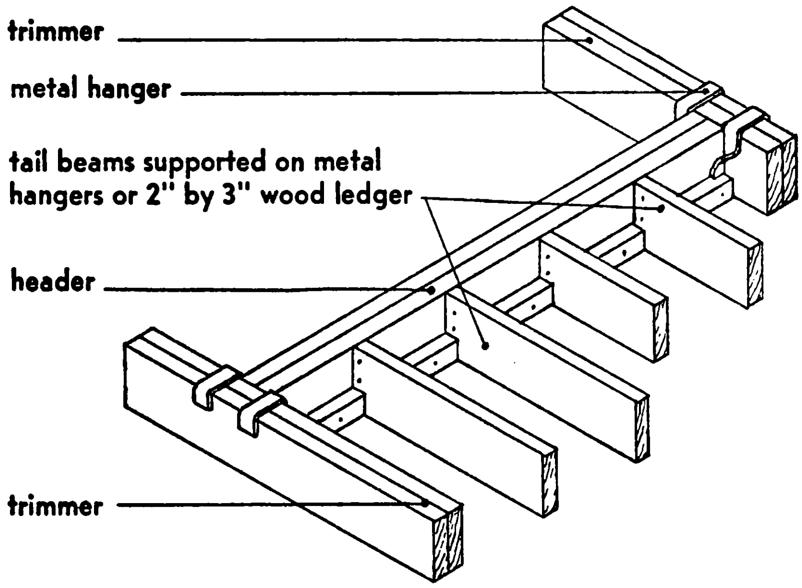
Joists Notched over Girders



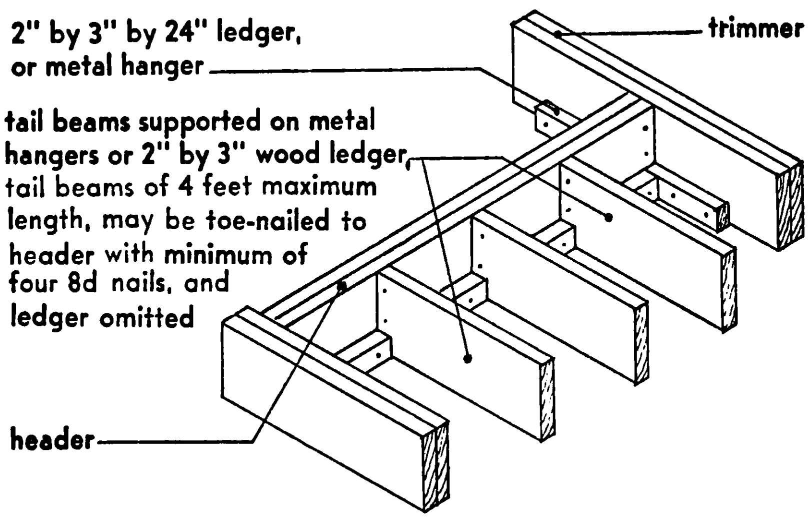
Joists to bear only on ledger strip. Joists and scabs are to have ½-inch minimum clearance over top of girder. Where joists are butted, a scab is to be provided for each pair of joists. Sizes and number of nails, and size of ledger strips, are minimum requirements.



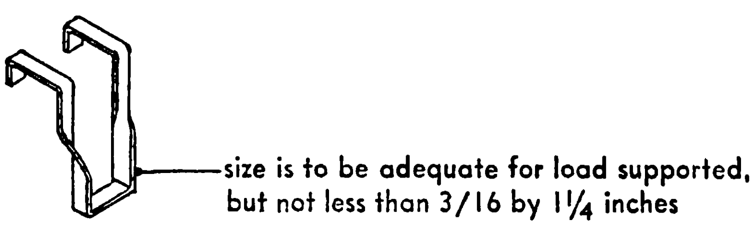
Framing Trimmers, Headers, and Tail Beams



FOUR OR MORE TAIL BEAMS



LESS THAN FOUR TAIL BEAMS



METAL JOIST HANGERS

Framing Around Openings—General: Framing around openings is to be designed for the loads supported.

Large Openings: A trimmer-supported header carrying four or more tail beams is to be supported on metal joist hangers spiked to the trimmer and the header.

Small Openings: A trimmer-supported header carrying less than four tail beams is to be supported on metal joist hangers; or on bearing or ledger strips not less than 2 inches by 3 inches by 24 inches, well spiked to the side of the trimmer.

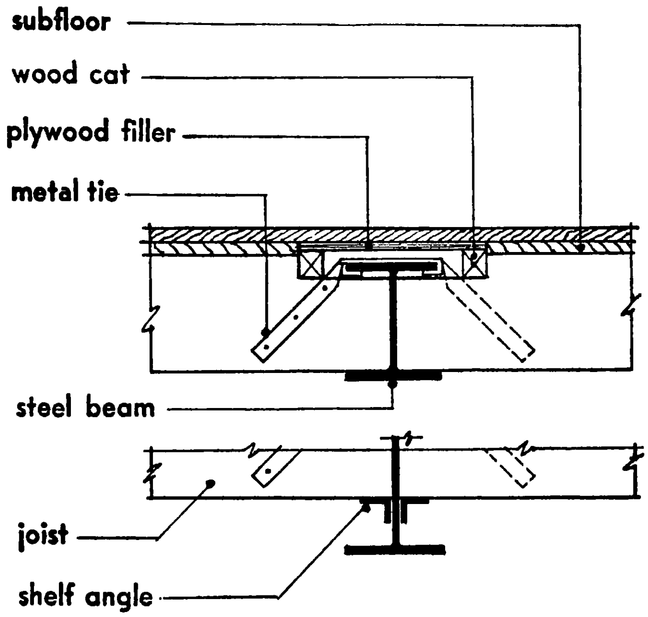
Single Members: Headers 4 feet or less in length may be single. Trimmers may be single when headers are 4 feet or less in length, and opening occurs in the end-quarter span of trimmer.

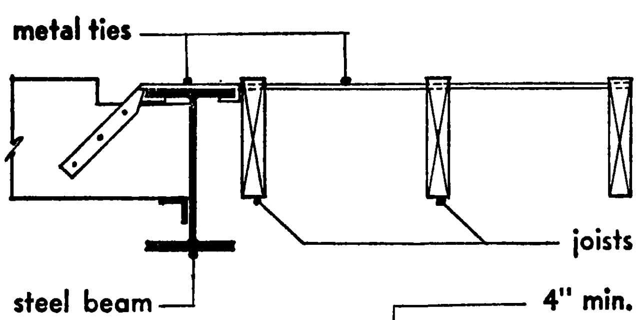
Nailing: When supported on a bearing or ledger strip, headers are to be toe-nailed to the trimmer, and further supported by spikes driven through the trimmer into the headers. Tail beams are to be similarly nailed and spiked to headers. The two joists forming a doubled trimmer or doubled header are to be nailed together with 10-penny nails, staggered, at 32-inch maximum spacing between nails in a horizontal line.

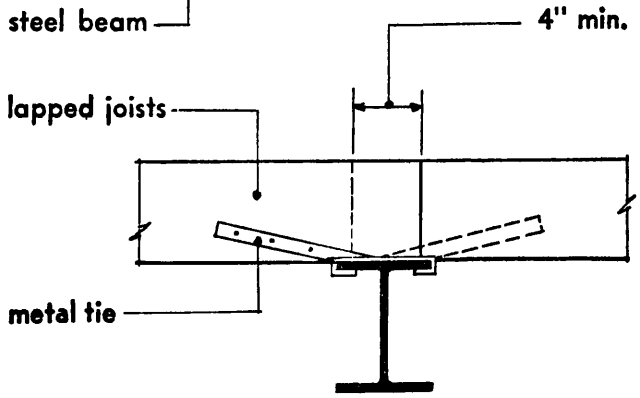
Notches: Notches at the ends of members supported on bearing or ledger strips may in general not exceed one fourth the depth of the member. However, notches of greater depth may be used, provided the remaining depth of tail beam or header is adequate for the load.

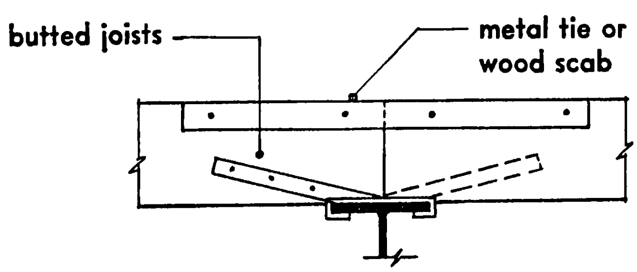
Punching: Hangers are to be punched to permit spiking to the supporting and supported members.

Wood Joists Supported by Steel Beams—1









Bearing for Joists—Minimum bearing for joists to be 2 inches. When bearing on wood blocking, each floor joist to be toe-nailed with a minimum of one 16d nail; roof joists to be toe-nailed with a minimum of two 16d nails.

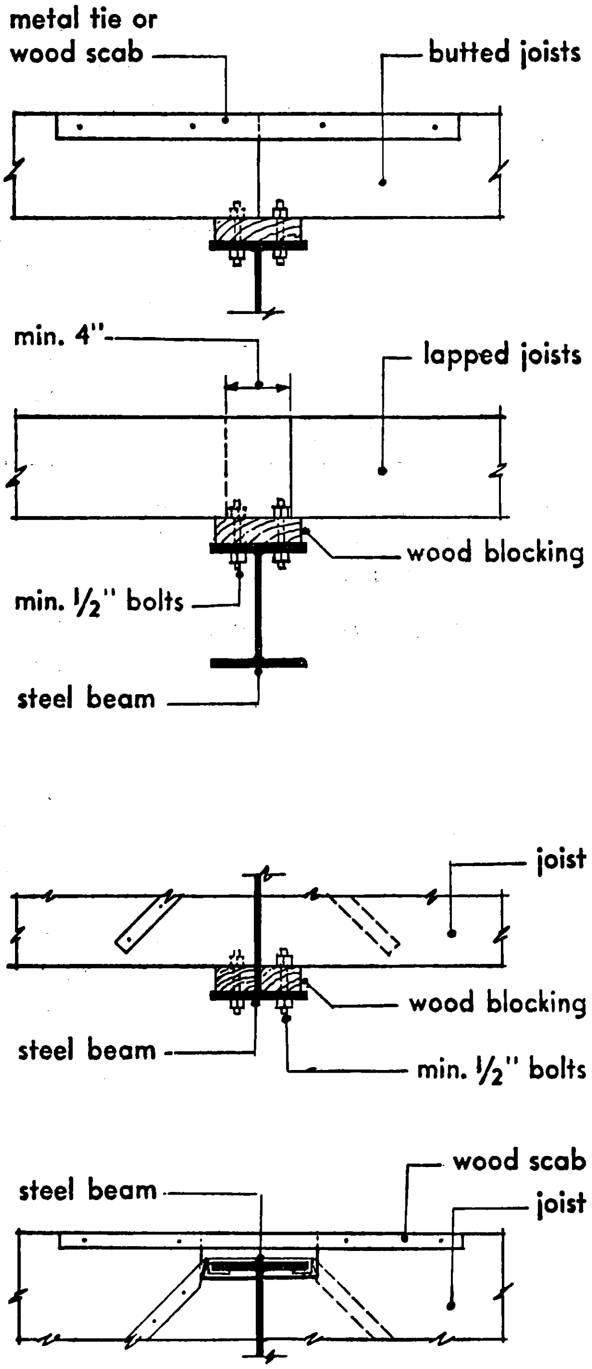
Lapping of Joists—When lapped over supports, minimum lap to be 4 inches. Spike joists together with a minimum of two 16d nails.

Steel Shelf Angles—Steel shelf angles and their attachment to the steel beam are to be adequate for the load. When ½-inch or larger bolts are used on not more than 3-foot centers, angles not smaller than any of the following may be used: 2½ x 2½ x ¼, 2 x 2 x ⅜, 3 x 2½ x ¼, 3 x 2 x ⅜, 2½ x 2 x ⅜, with short leg vertical.

Notching of Joists—Net depth of notched end of joist to be not less than three fourths of full depth of joist, unless smaller net depth is adequate for the load.

Metal Ties—For floor joist perpendicular to steel beams, ties to each side of steel beam are to be 4-foot maximum on centers on each side; for roof joists, these ties are to be at each joist, with each tie nailed to joist with three 8d minimum nails. However, where joists are nailed to blocking bolted to top flange, these ties may be omitted. For joists parallel to steel beam, ties to the steel beam are to be 6-foot maximum on centers with each tie engaging not less than three joists. For butted joists, in lieu of wood scabs, joist-to-joist metal ties 24 inches long, fastened to each joist with three 8d minimum nails, may be used. Metal ties are to have a minimum cross-section of ⅛ inch by 1 inch, and be of steel or iron.

Wood Joists Supported by Steel Beams—2



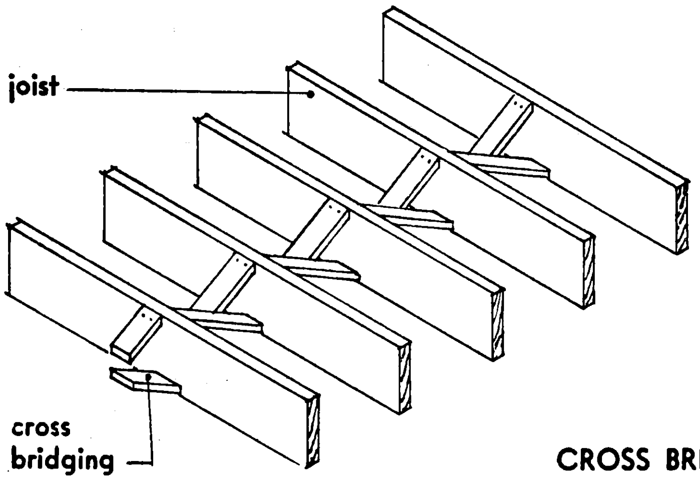
Wood Blocking—Wood blocking on steel beams for the support of wood joists or partitions, to be not less than 2 inches thick. Blocking to be bolted to steel beam with $\frac{1}{2}$-inch minimum bolts. On top flange, bolts to be 4-foot maximum on centers; on bottom flange bolts may be 6-foot maximum on centers. Blocking supported on bottom flange may be bolted to web or to flange. When bolts pass through flanges, staggered spacing of bolts is preferable. Blocking supported on bottom flange may be bolted to web or to flange. When bolts pass through flanges, staggered spacing of bolts is preferable. Blocking of top flange to be notched where metal ties occur.

Wood Scabs—Where joists butt and are supported directly on top flange of steel beam or on blocking bolted to top flange of steel beam, wood scabs or joist-to-joist metal ties are to tie all joists together. Where tops of joists are notched and wood cats are not used, wood scabs are to tie all joists together and provide bearing and nailing surface for subflooring. Scabs are to be of 1-inch or larger wood stock, not less than 1 inch deep and 30 inches long, nailed to each joist with a minimum of two 10d nails. For notched beams, bottom of scab is to clear top of steel beam by $\frac{5}{8}$-inch minimum.

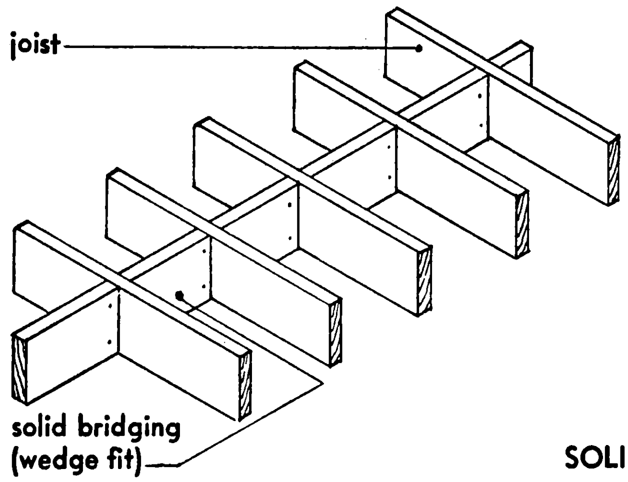
Subflooring on Cats—When subflooring over steel beam is supported on wood cats, the clearance to top of steel beam is to be $\frac{5}{8}$-inch minimum. Cats are to be 2 inches square minimum, continuous and supported on joists. Subflooring may be plywood filler, wood on diagonal, wood parallel to joists, or plywood subflooring, nailed to cats, with no plywood joints parallel to and between cats.

Partitions—Stud-bearing partitions and nonbearing partitions, over steel beams, are to bear on, and be fastened to, wood blocking bolted to top flange.

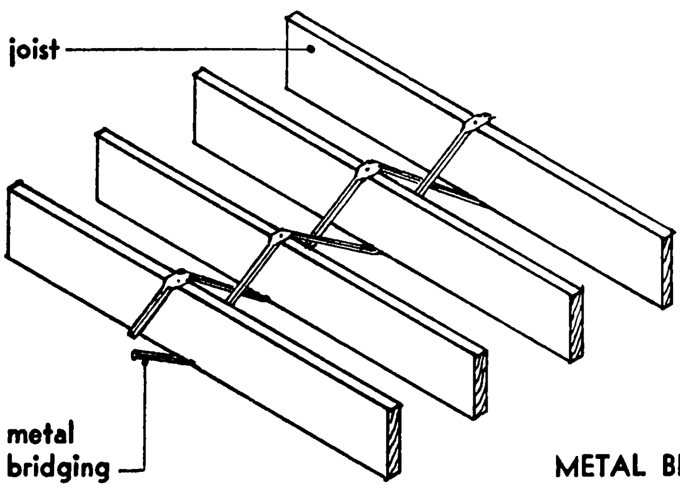
Bridging for Floor and Flat Roof Joists and Beams



CROSS BRIDGING



SOLID BRIDGING



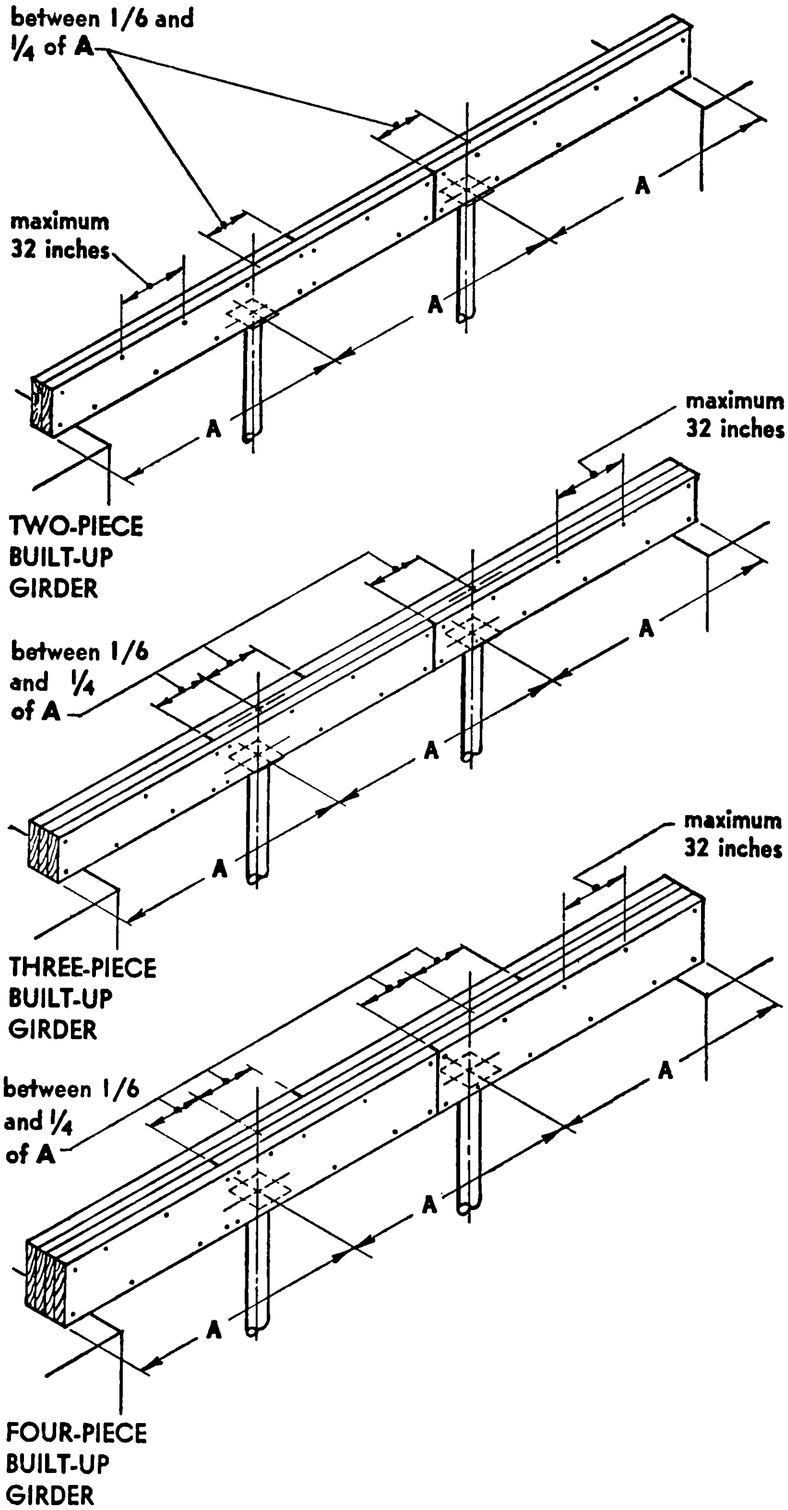
METAL BRIDGING

Minimum Sizes—Wood cross bridging, 1 inch by 3 inches. Solid wood bridging, 2 inches thick, and same depth as members bridged. Metal bridging, minimum 18 gage.

Locations—At intervals not exceeding 8 feet between bridging or between bridging and bearing. Exceptions: Where the required joist depth is more than six times the thickness, joists are to be bridged at intervals not exceeding six times the joist depth; where the joists are not otherwise braced or fastened, they are to be bridged at joist supports. Where walls are of frame construction, bridging is to continue from wall to wall. Where walls are of masonry construction, joists abutting walls are to be anchored as specified in text entitled, "Miscellaneous Construction Requirements," part 3, page 25.

Nailing—Wood cross bridging, two 8-penny nails at each end. Solid wood bridging, toe-nailed to joists with two 10-penny nails at each side. Metal bridging, one 10-penny nail at each point of contact with joists.

Continuous Built-Up Girders, Three or More Supports



Assembly Requirements—When girders made up of joists nailed together side by side are continuous over three or more supports, joints in joists are to be located between one sixth and one quarter the span length from an intermediate support. No two adjoining joists, nor more than one third the total number, are to be jointed on the same side of the support.

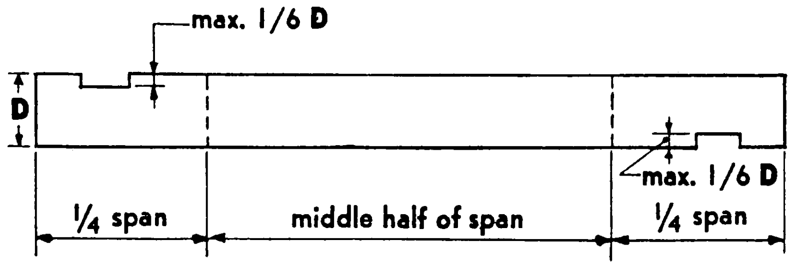
Nailing—Two-piece girders are to be nailed from one side with 10-penny nails, two near each end of each piece, others staggered with a distance of 16 inches between nails in a horizontal line; or girders are to be nailed from each side with 10-penny nails, two near each end of each joist, others staggered with a distance of 32 inches between nails in a horizontal line.

Three-piece girders are to be nailed with 20-penny nails on each side with two near each end of each piece, including intermediate joints, and with the others staggered with a distance of not more than 32 inches between nails in a horizontal line.

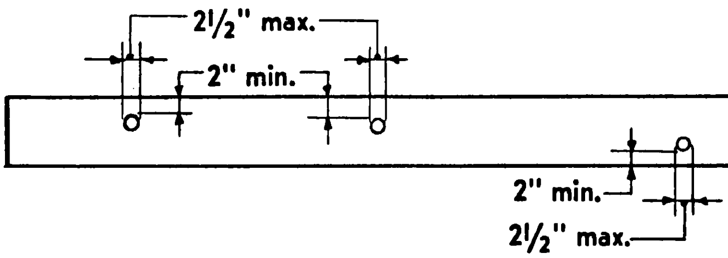
Four-piece girders are to be assembled as shown, and nailed with 20-penny nails as specified for the three-piece girder.

Anchoring—Girders are to be securely anchored to masonry piers, nailed to wood posts or bolted to steel columns.

Notching and Holes in Joists



NOTCHING



HOLES

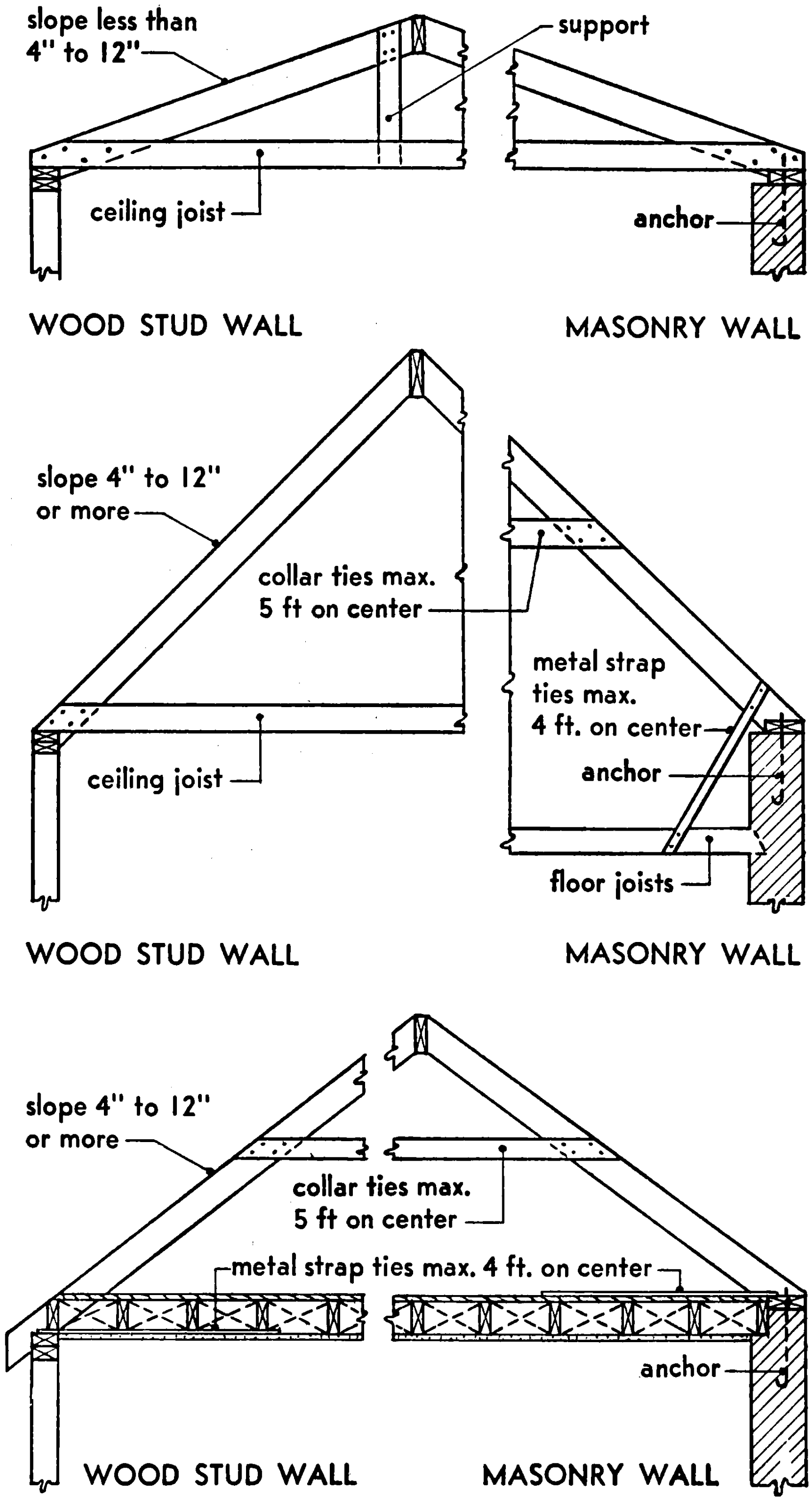
Permitted Notches and Bored Holes—In general, notches and bored holes of the dimensions and locations shown are permitted. However, notches of greater depth and holes of greater diameter may be used provided that:

For notches, the net depth is not less than the depth required for the span and load when the notch is in the middle one-half span, and the net depth is not less than five sixths of the depth required for the span and load when the notch is in the outer one-quarter span; for bored holes, the net depth reduced by 2½ inches is not less than that required for the span and load.

In no case are notches to be placed in both the top and bottom edges if the near sides of such notches are closer than 12 inches horizontally; nor are the near sides of notches and bored holes to be placed closer than 12 inches horizontally; nor are bored holes to be placed near both the top and bottom edges if the near sides of such holes are closer than 12 inches horizontally.

Note: For end-bearing notches, see illustrations entitled, "Framing Trimmers, Headers, and Tail Beams," part 3, page 82, and "Joists Framed Flush with Top of Girders," part 3, page 78.

Roof Framing



Supports—Rafters shall be vertically supported near the ridge where the slope is less than 4 inches per foot.

Ties—Where rafters are not otherwise held against spreading, collar ties spaced not more than 5 feet on centers and not less than 1 inch by 6 inches or 2 inches by 4 inches, or equivalent in size, are to be provided. All walls are to be securely tied or anchored to the roof construction. Metal strap ties are to be minimum ¼ inch by 1¼ inch, or have minimum cross-sectional area of 0.30 square inch.

Plates on Masonry Walls—Plates supported by masonry are to be anchored to the masonry as required for anchoring of wood sills to foundation walls. For cavity and hollow walls, anchors are to be attached to both parts of wall by ¼-inch horizontal plate laid in both joints.

Thrust and Uplift—Rafters are to be so spiked or otherwise fastened to the plate or other members so as to resist safely all thrusts under full load, and the upward lift due to wind.

Nailing—Rafters to plate, minimum three 16-penny nails. Ceiling joist to plate, minimum two 16-penny nails. Ceiling joist to rafter, minimum three 16-penny nails. Collar to rafter, minimum three 16-penny nails.

Strap Ties—Where metal strap ties are used and joists are perpendicular to wall, a minimum of two 16-penny nails at each end of strap is to be used, clinched if possible. Where metal strap ties are used, and joists are parallel to wall, and the roof construction is such that these walls tend to spread, ties are to be fastened to at least four joists, with a minimum of one 16-penny nail at each joist, and two at the plate.

Stressed Plywood Construction

General—The requirements for stressed plywood construction, and the allowable stresses in such construction, given in this standard, are based on tests made by an authoritative agency. Stressed plywood construction assembled as described in this standard is acceptable as in conformity with generally accepted standards.

Material—Plywood exposed to weather or to severe conditions of service shall meet the requirements established for exterior type in CS, *Douglas Fir Plywood,* or for type I in CS, *Hardwood Plywood.*

Plywood for interior use above ground and not subject to severe conditions of service is to meet the requirements established for interior type in CS, *Douglas Fir Plywood,* or for types II or III in CS, *Hardwood Plywood.*

Type A glues are required to maintain satisfactory bond under all conditions of atmospheric moisture and moisture content of assembled parts, and under all temperatures from —10° F. to 120° F.

Glues conforming to the following specifications are classified as type A glues: JAN, *Adhesives, Thermosetting-Resin, Room-Temperature and Intermediate-Temperature Setting, Waterproof (Phenolic, Resorcinol, and Melamine Base) (For Wood);* MIL, *Adhesive; High Temperature Setting Resin (Phenol, Melamine and Resorcinol Base).*

Type B glues are to maintain satisfactory bond under all conditions where the moisture content of the assembled parts does not exceed 18 per cent by weight computed as a percentage of the oven-dry weight of the wood, and under all temperatures from —10° F. to 120° F.

Glues conforming to the following specifications are classified as type B glues: FS, *Glue; Casein Type, Water-Resistant;* FS, *Glue; Resin-Type Liquid and Powder;* Air-Forces Specification: *Glue; Water and Mold Resistant Casein.*

Satisfactory bond is to be determined by test methods for exterior type and interior type plywood, respectively, specified in CS, *Douglas Fir Plywood.*

Working Stresses—Working stresses for plywood are to be established in the manner set forth by FPL, *Approximate Methods of Calculating the Strength of Plywood.*

Working stresses for Douglas fir plywood conforming to CS, *Douglas Fir Plywood,* are to be as shown in the table entitled, "Working Stresses for Douglas Fir Plywood," part 3, page 90.

Plywood Glued to Framing Members—Where used for exterior facing of exterior walls or where subject to severe conditions of exposure, plywood glued to framing members is to be glued with type A glue. Where used for interior walls or ceilings subject to normal conditions of service, plywood glued to framing members is to be glued with type A or type B glue. Either type A or type B glue may be used for floor assemblies where adequate ventilation is provided.

Stressed Skin Construction—Stressed skin construction is to be designed in accordance with principles outlined by FPL, *The Designing for Strength of Flat Panels with Stressed Coverings.* All stressed skin construction is to conform to the following requirements: the plywood laminations are to be well glued together; the plywood coverings are to be securely glued to the frames; the longitudinal members of the frames may be not less than twice as thick (cross-sectional dimension in contact with covering) as the covering; spaced headers for lateral support are to be provided between longitudinal members whose ratio of height to thickness is 2 to 1 or more.

Plywood Gussets and Webs—Plywood used structurally as gussets for truss assemblies, splice plates, or as webs for built-up girders, or for similar purposes, is required to maintain bond of plies under conditions specified for type A glues, and not delaminate under heat or fire or burn more rapidly than solid wood of the same species under comparable conditions of exposure. Plywood glued with type A glue, or with adhesive meeting the performance requirements and fire test specified for exterior type in CS, *Douglas Fir Plywood,* is deemed acceptable for this purpose.

WORKING STRESSES FOR DOUGLAS FIR PLYWOOD
For grades and thicknesses see CS, *Douglas Fir Plywood.*
In bending, tension and compression (except bearing and 45-degree stresses) consider only those plies with their grain direction parallel to the principal stress.
DRY LOCATION

Type of stress	Type and grade of Douglas fir plywood			
	EXT-DFPA·A-A [3]	EXT-DFPA·A-B EXT-DFPA·plyshield·(A-C)	EXT-DFPA·utility·(B-C) EXT-DFPA·sheathing·(C-C) EXT-DFPA·concrete form·(B-B) Plyform·(B-B) Plyscord·(C-D)·	Interior·A-A Interior·A-B Plypanel·(A-D) Plybase·(B-D) (Apply the following percentages to the stresses for the corresponding exterior grade. See example at bottom of page.)
Extreme fiber in bending:				
Face grain parallel to span	2188	2000	1875	100
Face grain perpendicular to span	1875	1875	1875	80
Tension:				
Parallel to face grain (3-ply only [1])	2188	2000	1875	100 [4]
Perpendicular to face grain	1875	1875	1875	80
45° to face grain	337	320	310	85
Compression:				
Parallel to face grain (3-ply only [1])	1605	1460	1375	100 [4]
Perpendicular to face grain	1375	1375	1375	70
45° to face grain	496	472	460	80
Bearing (on face)	405	405	405	100
Shear, rolling, in plane of plies:[2]				
Parallel or perpendicular to face grain	79	72	68	75
45° to face grain	105	96	90	75
Shear, in plane perpendicular to plies:[2]				
Parallel or perpendicular to face grain	210	192	180	85
45° to face grain	420	384	360	85
Modulus of elasticity in bending:				
Face grain parallel to span	1,600,000	1,600,000	1,600,000	100
Face grain perpendicular to span	1,600,000	1,600,000	1,600,000	70

[1] For tension or compression, parallel to grain, in 5-ply or thicker, use values for 3-ply, but in next lower grade.
[2] For certain conditions where stress concentrations exist these working stresses for rolling shear should be reduced by 50 per cent. See table 1, FPL Bulletin, *Approximate Methods of Calculating the Strength of Plywood.*
[3] This abbreviation stands for exterior grade, Douglas Fir Plywood Association.
[4] For 5 or more plies, use 90 per cent.

WET OR DAMP LOCATION

Where moisture content will exceed 16 per cent, decrease by 20 per cent values shown for dry location for following properties: Extreme fiber in bending, tension and compression both parallel and perpendicular to the grain and at 45°, and bearing. (No change in values for shear or modulus of elasticity.)

Example: The working stress in compression parallel for plypanel 5-ply (1238 psi) is found by multiplying the value for EXT-DFPA plyshield 5-ply, 1375 psi, by 90 per cent, the reduction factor shown in the last column and footnotes [1] and [4].
(From 1948 edition, Douglas Fir Plywood Association, *Technical Data on Plywood*).

Flashing and Caulking

Materials which may be used for flashing are metals, nonmetals, or combinations of these. Metals may be sheets of copper, lead-coated copper, galvanized iron, lead, terne plate, zinc, aluminum, copper-bearing galvanized steel, monel. Nonmetals may be kraft paper, flexible plastics, and asphalt-impregnated materials such as canvas, roofing felts and cap sheets, cotton fabric, or those nonimpregnated but laid in mastic. Combinations of metals and nonmetals may be copper-coated fabrics, bitumen-saturated wire mesh, wire mesh coated with asphalt-saturated cotton.

Flashing should be provided whenever the following or similar utilities penetrate the roof surface: pipes and vents, roof drains, dormers, skylights, chimneys, flagpoles, roof ventilators, and the legs of towers, frames, or roof signs.

Flashing should be provided at hips, ridges, valleys, at changes of roof slope, at gable ends, at gravel stops of built-up roofing, at the juncture of roofing and parapet walls, through parapet walls, over cornices, at the heads and sills of windows and outside doors, at steel and concrete spandrel beams, at the tops of foundation walls and at wood water tables.

Contact of dissimilar metals is to be avoided to prevent galvanic action. Slip-joints or similar means are to be employed to prevent stresses due to temperature change in long sections of flashing.

Caulking compounds for masonry-to-masonry applications may be mortar, cement grout, hot bituminous mastic, rope yarn followed by molten lead well pounded in, and should be used at copings. At jambs of windows and outside doors, a plastic material should be used.

For typical details, see illustration entitled, "Typical Flashing Details," part 3, page 92.

Protection of Exterior Wood

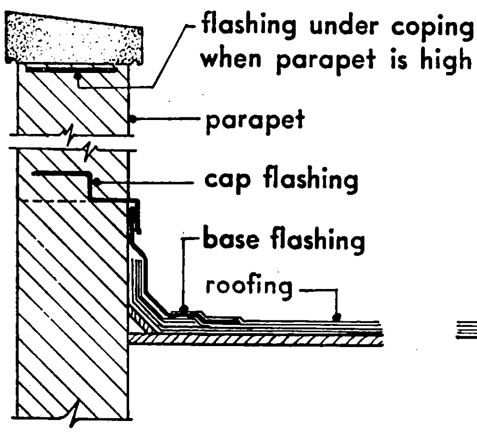
Exterior wood, at points where water or melting snow can collect and cause deterioration, is to be protected by paint in two or three coats applied when the wood is dry.

Priming coat paint is to conform to FS, *Paint; Exterior-Primer, Ready-Mixed, White (Undercoat for Wood)*, and when unthinned as for two-coat work is to be applied at a spreading rate of approximately 450 square feet per gallon; for three-coat work, thin with one pint of mineral spirits per gallon, and apply at a spreading rate of approximately 600 square feet per gallon.

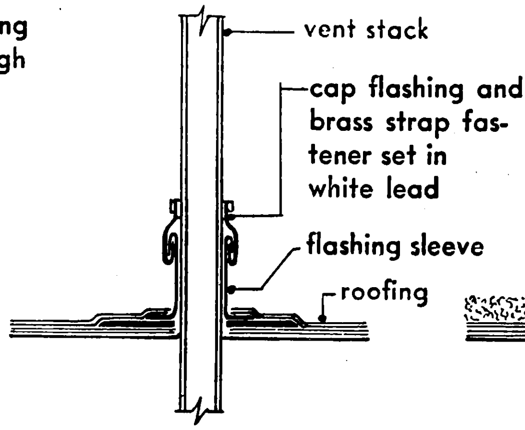
After the priming coat has dried for a minimum of 24 hours in dry weather, putty nail holes and cracks, and perform required caulking of joints.

Finish coat paint is to conform to FS, *Paint; Oil, Exterior, Ready-Mixed, Light-Tints, and White*, and for two-coat work apply at a spreading rate of approximately 550 square feet per gallon; for three-coat work, apply the second and third coats at a spreading rate for each of from 600 to 700 square feet per gallon, with a drying period after the second coat of at least 48 hours in dry weather.

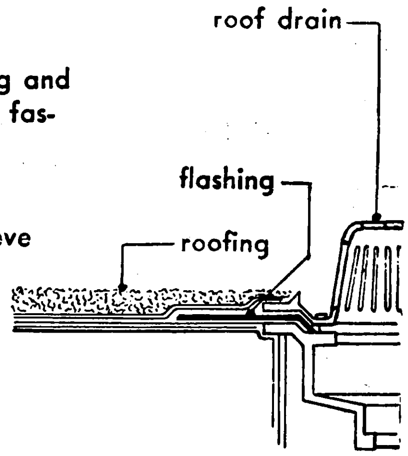
Typical Flashing Details



PARAPET

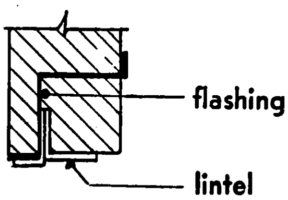


VENT STACK

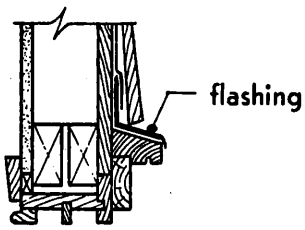


ROOF DRAIN

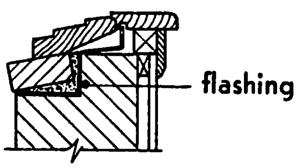
These details represent acceptable methods of flashing for conditions similar to those shown on this page. Materials which may be used for flashing are designated in text entitled, "Flashing and Caulking," part 3, page 91.



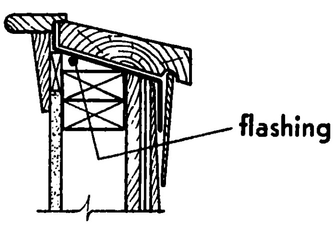
HEAD



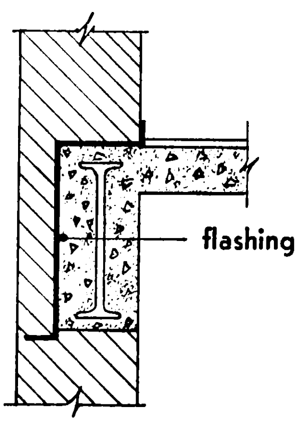
HEAD



SILL

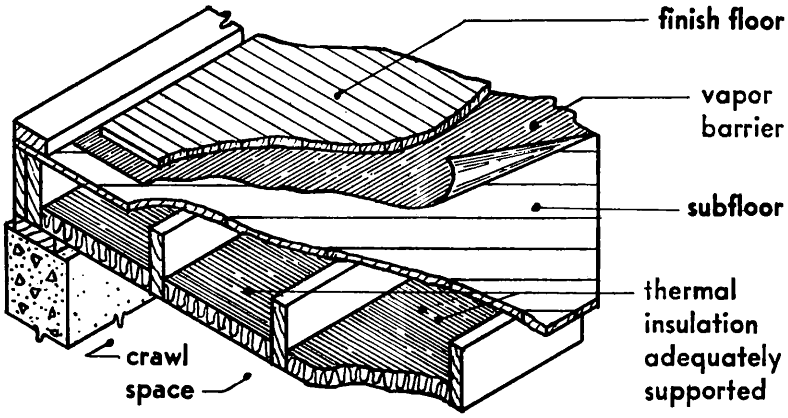


SILL

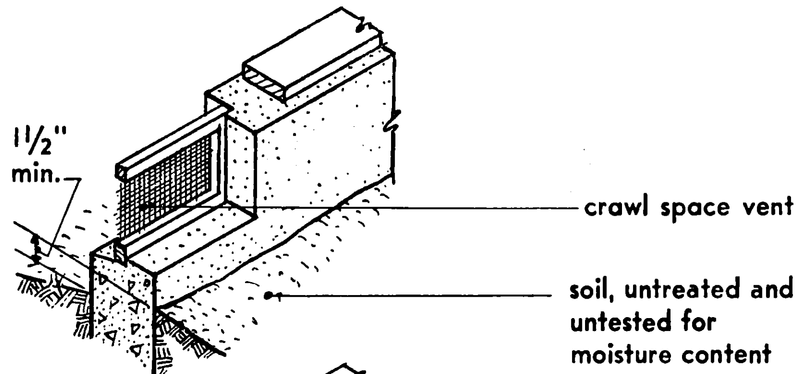


SPANDREL

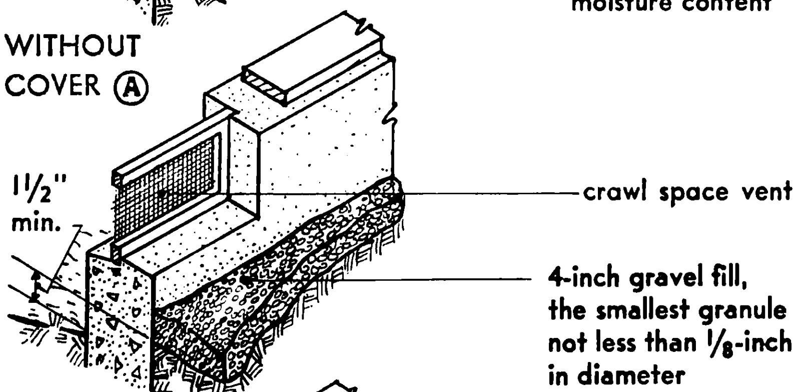
Condensation Control in Buildings—Crawl Spaces



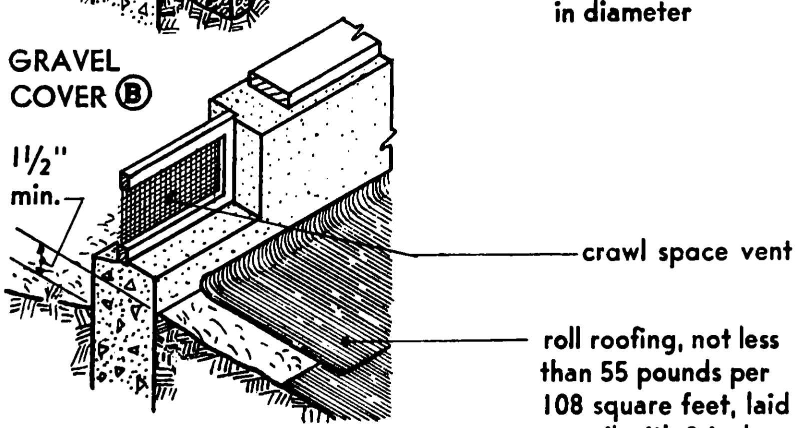
TYPICAL FLOOR CONSTRUCTION OVER CRAWL SPACE



WITHOUT COVER (A)



GRAVEL COVER (B)



ROLL ROOFING COVER (C)

Control of Condensation in crawl spaces is important when the construction immediately above is of wood, metal, or other materials that deteriorate when subject to moisture. This may be accomplished by providing adequate ventilation, with or without a soil cover. A paper of vapor-barrier quality should be placed between the finish floor and subfloor of the thermally insulated construction over a crawl space to protect the finish floor from water vapor originating in the crawl space and to protect the structural elements from water vapor originating in the heated volume of the structure.

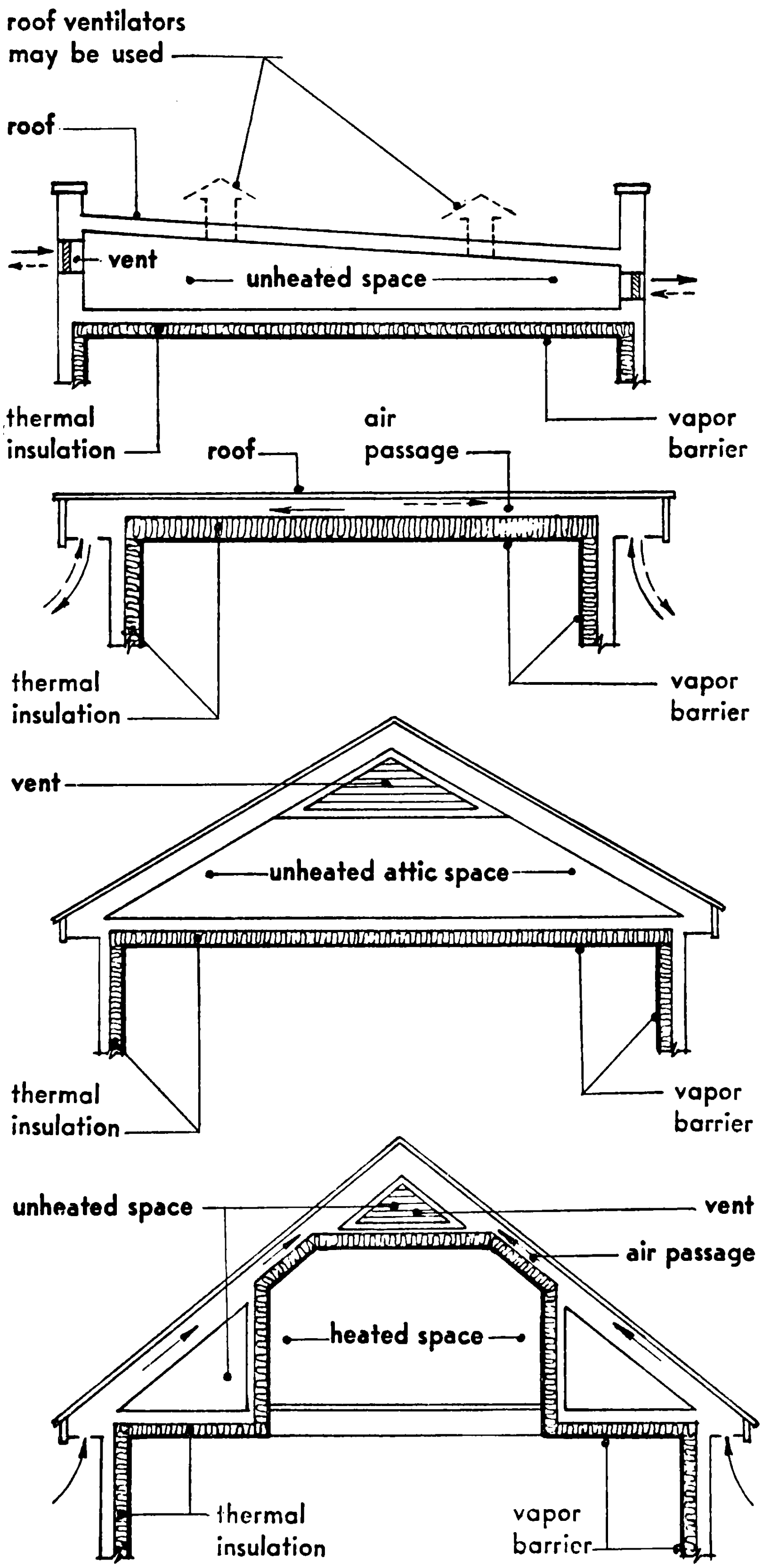
The following requirements are for ventilation of crawl spaces depending on type of soil cover:

(A) Total free ventilation area is to be 2 square feet per 100 linear feet of building perimeter plus one third of one per cent of the crawl space ground area. Provide at least four vents, one located near each corner of building, and so arranged as to provide effective cross ventilation.

(B) Total free ventilation area is to be equal to not less than 50 per cent of A above. Provide at least two vents, located for effective cross ventilation.

(C) Total free ventilation area is to be equal to not less than 10 per cent of (A) above. Provide at least two vents, located for effective cross ventilation.

Condensation Control in Buildings— Exterior Walls, Attics, and Flat Roofs



When thermally insulated framed walls, ceilings, or roofs are constructed of wood, metal, or other materials that deteriorate when subjected to moisture, it is necessary to prevent water vapor developed in the heated volume of the structure from entering the assemblies and condensing therein. Prevention may be accomplished by placing an effective vapor barrier on the warm side of the wall, ceiling, or roof and adequately ventilating unheated attic spaces and flat roofs.

Acceptable vapor barriers are: asphalt impregnated and coated papers having a glossy or bright finish; duplex papers composed of two sheets of 30-pound kraft paper with a 60-pound per 3000 square foot asphalt layer between them; aluminum foil mounted on one or two sides of a paper support; insulation batts or blankets enclosed in such papers or foils; and aluminum paint, oil or rubber base paints, applied in sufficient number of coats to result in a smooth glossy finish.

Vapor barriers described, except paints, should be tacked to supports at 4-inch maximum centers and lapped at supports.

Sheathing paper (on the cold side of the wall), when used, should readily transmit water vapor, yet be resistant to wetting by free water.

Unobstructed openings are to be $1/300$ of attic or flat roof area. Openings, either screened or louvered, are to be $1/150$ of attic or flat roof area. Openings, both screened and louvered, are to be $1/100$ of attic or flat roof area. Ventilation of unheated enclosed spaces is to be provided, with openings located in such manner that a free circulation of air is maintained in such spaces.

Tests

Wall, Partition, Floor and Roof Panels: Tests are to be made in conformity with the procedures specified in ASTM, *Tentative Methods of Conducting Strength Tests of Panels for Building Construction.*

Columns, Piers, and Posts: Compressive Load—The load is to be applied as an eccentric load at the upper end, with the lower end resting as a "flat end" on the platen of the testing machine. If the structural specimen is symmetrical about a longitudinal axis, the eccentric load is to be applied at a distance from the longitudinal axis equal to one third the distance from the axis to the outer fiber of the structural specimen. If the structural specimen is not symmetrical about a longitudinal axis, the centroidal axis of the cross-section of the structural specimen for the least moment of inertia is to be determined, and the eccentric load is to be applied along a line parallel to the centroidal axis, at a distance from it equal to one third the distance from that axis to the more remote extreme fiber of the structural specimen.

Loads are to be applied, and measurements to determine behavior under load are to be taken, as specified for wall panels in ASTM, *Tentative Methods of Conducting Strength Tests of Panels for Building Construction.*

Evaluation of Test Results: The uniformity of test results and of materials tested is to be taken into account in evaluation of test results. Each test is to be made on at least three respective specimens, and the results plotted. The average value derived from such tests is to govern. When there is reasonable doubt that workmanship in the field will be equal to workmanship in test specimens, test results are to be evaluated accordingly.

Each increment of test load is to remain in place for a minimum of 15 minutes, and readings to be taken thereafter. When it is apparent that continued application of load may result in increasing deformation, or in structural damage or structural failure, the test load is to be maintained for a minimum of 24 hours.

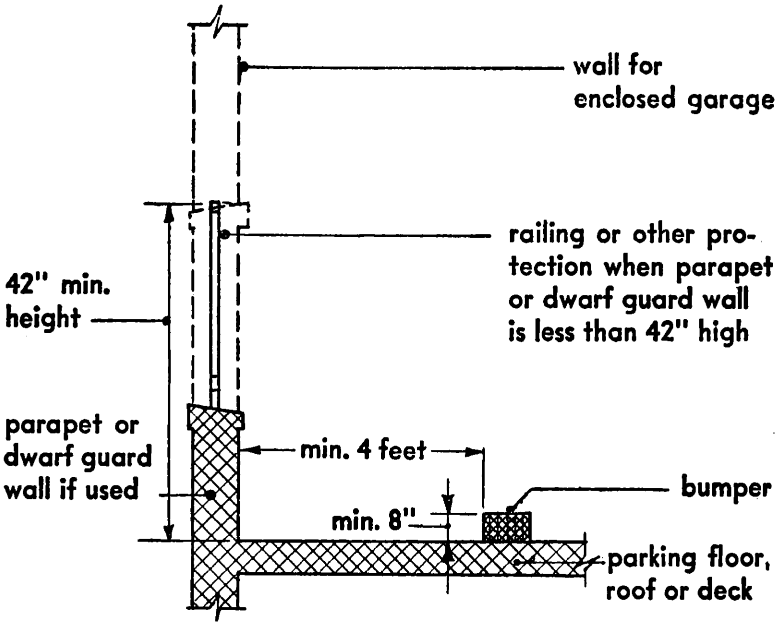
When it is apparent that extremes of temperature or humidity conditions experienced in use, or rapid variations in temperature within the range which may be experienced, may result in greater deformation, or in structural damage or structural failure, test conditions are to simulate, so far as practicable, the most severe conditions of use.

No panel utilized to resist racking loads is to be deemed acceptable which deforms, while under load, more than $1/800$ of the height of the panel under a load of 100 pounds per linear foot of panel.

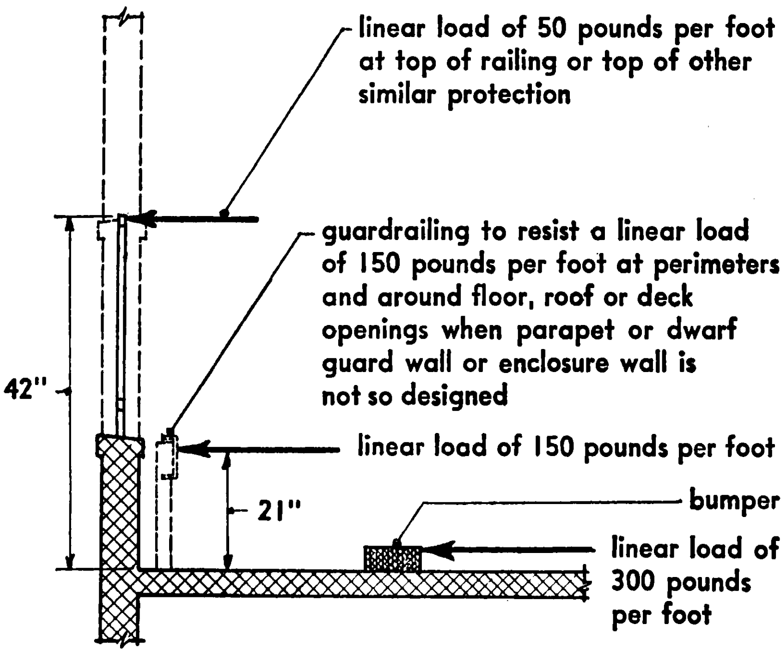
Loads During Construction—The loads imposed during construction are to be resisted if necessary by temporary supports so that the requirements as set forth in this standard with regard to stresses and deflection of floors, and to the stresses and unbraced lengths and heights of walls, may not be exceeded.

Safety During Construction—Safety measures during construction are required by law to conform with IC, *Rules Relating to the Protection of Persons Employed in the Erection, Repair and Demolition of Buildings or Structures.*

Perimeter Protection for Parking Decks and Garages



HEIGHT OF PERIMETER PROTECTION



LOADS ON PERIMETER PROTECTION

Horizontal Impact Loads for Multiple Dwellings—Parapet walls of roof parking decks, dwarf guard walls of open parking deck structures, perimeter walls enclosing above-grade garages, and walls protecting all floor, deck or roof openings, or guardrailings in lieu thereof, shall be designed to resist a minimum linear load of 150 pounds per foot applied 21 inches above the roof or deck. Parapet or dwarf guard walls which are less than 42 inches high, shall be surmounted by a railing to a minimum height of 42 inches above the roof or deck, and the horizontal impact loads, and the maximum size of railing openings, shall be as required in paragraph b of section B 304-9 of the Code. A bumper block at least 8 inches high shall be fastened to the roof, deck or floor, 4 feet or more from the walls, and shall be designed to resist a minimum linear load of 300 pounds per foot.

RECOMMENDED NAILING SCHEDULE

Building Element	Nail Type	Number and Distribution
Stud to sole plate	Common-toe-nail	3—16d
Stud to cap plate	Common-end nail	2—16d
Double studs	Common-direct	10d 12″ o.c. or 16d 30″ o.c.
Corner studs	Common-direct	16d 30″ o.c.
Sole plate to joist or blocking	Common	20d 16″ o.c.
Double cap plate	Common-direct	16d 24″ o.c.
Cap plate laps	Common-direct	3—16d
Ribbon strip, 6″ or less	Common-direct	2—10d each bearing
Ribbon strip, over 6″	Common-direct	3—10d each bearing
Roof rafter to plate	Common-toe-nail	3—16d
Roof rafter to ridge	Common-toe-nail	2—16d
Jack rafter to hip	Common-toe-nail	3—10d
Floor joists to studs (no ceiling joists)	Common-direct	5—10d or 3—16d
Floor joists to studs (with ceiling joists)	Common-direct	2—10d
Floor joists to sill or girder	Common-toe-nail	2—16d
Ledger strip	Common-direct	3—20d at each joist
Ceiling joists to plate	Common-toe-nail	2—16d
Ceiling joists to alternate rafters	Common-direct	3—16d
Ceiling joists (laps over partitions)	Common-direct	3—16d
Collar beam	Common-direct	4—10d
Bridging to joists	Common-direct	2—8d each end
Diagonal brace (to stud & plate)	Common-direct	2—8d each bearing
Tail beams to headers (when nailing permitted)	Common-end	1—20d each 4 sq. ft. floor area
Header beams to trimmers (when nailing permitted)	Common-end	1—20d each 8 sq. ft. floor area
1″ Subflooring (6″ or less)	Common-direct	2—8d each joist
1″ Subflooring (8″ or more)	Common-direct	3—8d each joist
2″ Subflooring	Common-direct	2—20d each joist
1″ Wall sheathing (8″ or less in width)	Common-direct	2—8d each stud
1″ Wall sheathing (over 8″ in width)	Common-direct	3—8d each stud
Plywood sheathing	Common-direct	6d 5″ o.c. exterior edges 6d 10″ o.c. intermediate
1″ Roof sheathing (6″ or less in width)	Common-direct	2—8d each rafter
1″ Roof sheathing (over 6″ in width)	Common-direct	3—8d each rafter
Fiberboard sheathing	Common-direct	8d—3″ o.c. exterior edges 8d—6″ o.c. intermediate
Gypsum sheathing	Large head	7—No. 11 gage x 1¾″ per bearing under shingles
	Corrosion-resistive	4—per bearing, all other cases
Shingles, wood	Corrosion-resistive	2—No. 14 B&S each bearing
Weather boarding	Corrosion-resistive	2—8d each bearing

Shingle nails should penetrate not less than ¾ inches into nailing strips, sheathing or supporting construction, unless approved fastenings are used.

The following table of occupancy loads supplements table C 304-2.2 of the Code. Where unusual concentrations do not occur, structural members should be designed to support the following minimum uniformly distributed loads or the minimum concentrated loads, whichever produce the greater stress.

UNIFORMLY DISTRIBUTED AND CONCENTRATED LIVE LOADS

Occupancy or Use	Uniformly distributed loads, psf	Concentrated loads in pounds
C1 Business		
Greenhouses (commercial)	150	
Office file rooms		
Metal addressing plates	150	
Cards	125	
Letters	80	
C3 Industrial		
Foundries	600	12,000
Printing		
Composing rooms	100	2,000
Linotype rooms	100	2,000
Paper storage	([2])	
Press rooms	150	2,000
Wharfs	600	12,000
C5 Assembly		
Air terminals, barrooms, boathouses, broadcasting studios, cabarets, dining rooms (public), passenger stations, recreation piers	100	
Bowling alleys, billiards	75	
Courtrooms	80	
Spaces common to above occupancies		
Attics		
Non-storage	25	
Storage	80	
Balconies, exterior	100	
Catwalks	25	
Exitways	100	
Fire escapes: treads, balconies	100[14]	
Roofs, for helicopter landings	100	

For footnotes 1 to 13, see General Building Construction Code, Table C 304-2.2.

[2] 50 psf per foot of clear story height.

[14] Stringers of stairs need be designed only for uniform load. For fire escapes, the uniform load is to be applied to the width of stairs times the distance between riser faces.

Application of Table C 304-3 to Truss Design

(Tables A 304-3, B 304-3, and C 304-3 are identical)

Section C 304-3 of the Code gives the snow load perpendicular to the roof, in pounds per square foot of roof surface; for a horizontal roof, this load is the same as the snow zone number.

For inclined roofs, the tabular values have been determined by multiplying the snow zone number by: (a) the square of the cosine of the angle of "Roof slope from horizontal," and (b) a "stay-on" factor varying from unity at 0° roof slope (flat roof) to zero at 60° roof slope.

Table C 304-3 is convenient for the design of simple rafters. In the design of roof trusses it may be more convenient to use the vertical snow load per horizontal foot of truss, obtained as follows: step 1—Determine from Table C 304-3 the tabular value, in a particular snow zone, for a given roof slope; step 2—Determine the ratio of the rafter length to the rafter run; step 3—Multiply this ratio by itself; step 4—Multiply this product by the value obtained in step 1; step 5—Adjust this result for the given spacing of trusses.

FOR EXAMPLE:

Given: In snow zone 40, a truss, 24′ span, 16″ o.c., roof slope from horizontal 30°

Required: The vertical snow load per horizontal foot of truss

SOLUTION:

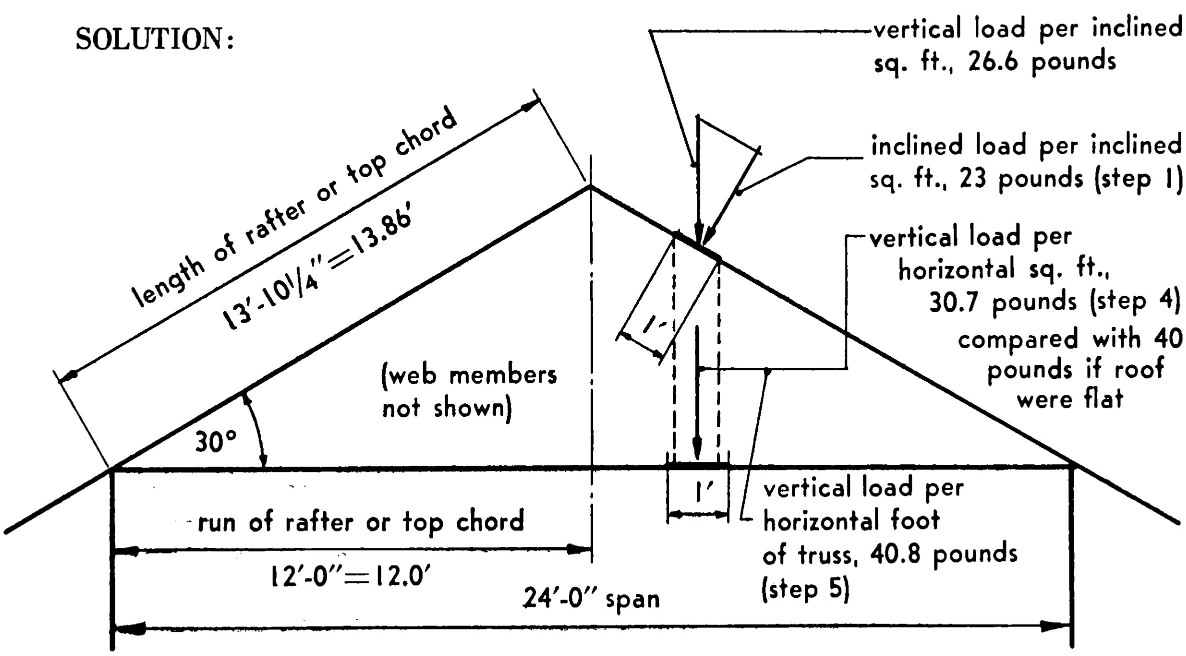


FIGURE 1

Step 1. Table C 304-3 gives 23 pounds for 40 snow zone and 30° slope

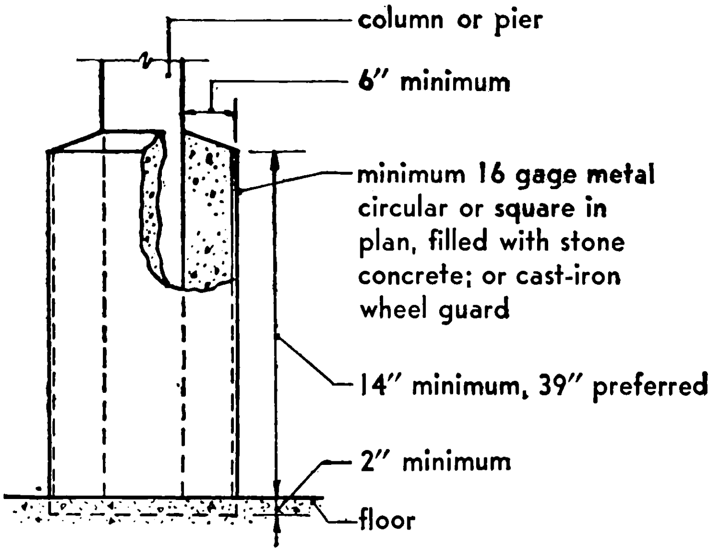
Step 2. From figure 1, the ratio of the rafter length to the rafter run is 13.86′ divided by 12.0′, or 1.155

Step 3. Multiplying 1.155 by 1.155 gives 1.333

Step 4. Multiplying 1.333 by 23 pounds gives 30.7 pounds, compared with 40 pounds if roof were flat

Step 5. Multiplying 30.7 pounds by 16″ o.c. and dividing by 12″ gives 40.8 pounds per horizontal foot of truss

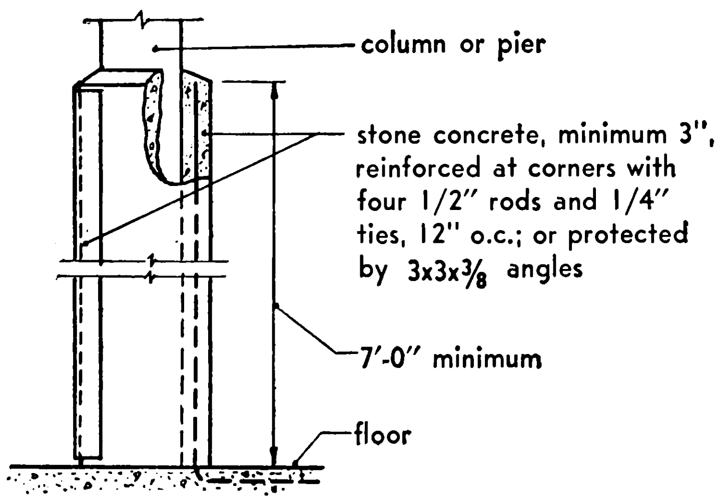
Protection of Columns, Piers, and Walls in All Buildings Except One- and Two-Family Dwellings

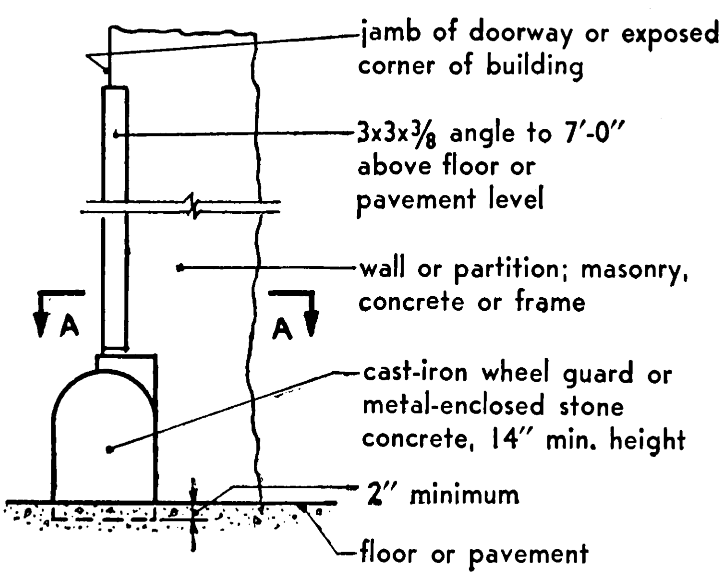


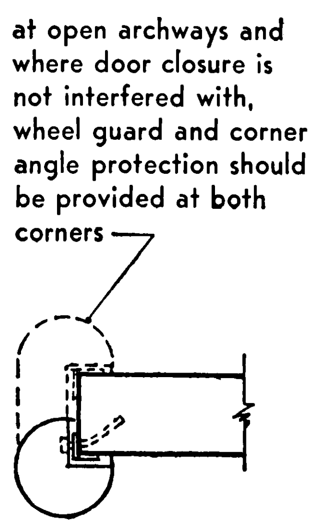
Where columns, piers, doorways, archways, and exposed corners of buildings may be damaged by automobiles, trucks, lift trucks, or other automotive equipment, corners, sides or jambs of such construction should be protected from impact and damage.

Cast-iron wheel guards are preferred for wood columns. Poured concrete protection for wood columns is not recommended unless wood is pressure-impregnated.

The various types of cast-iron wheel guards available commercially may be adapted to suit particular job conditions singly or in combination with other devices in illustrations at left.







SECTION A-A

part 4

Construction illustrated or described herein is acceptable under the State Building Construction Code, but shall not be interpreted as excluding other construction which meets the requirements of the Code.

Distance Separations

Buildings should be separated from each other to prevent the spread of fire. The likelihood of fire spreading from a burning building to other buildings varies according to several factors which include the distance between the buildings, the size and type of construction of the burning building, the types of construction of the buildings exposed to the fire and the characteristics of their exterior wall facings, and the roof covering.

Distance separation is the shortest distance measured between the exterior walls of buildings on the same or adjacent premises, or from a proposed building to a line on adjacent premises to which a building may legally be built. This requirement is interpreted to mean that when a building does not exist on the adjacent premises, a building of the same size and type of construction as the proposed building is assumed, and the distance to the common lot line is one half that required between buildings.

The minimum distance separations between residential and other buildings and their application are indicated in the illustrations entitled, "Relation to Existing Buildings and Common Lot Line," part 4, page 4, "Relation to Height, Area, and Wall Construction," part 4, page 5, and "Relation to Exterior Walls," part 4, page 6.

Distance separations are required between a one- or two-family dwelling and other buildings of any occupancy when either of the buildings has noncombustible exterior walls with a fire-resistance rating to exterior exposure of less than ¾ hour; or combustible exterior walls with noncombustible exterior facings that provide less than ¾-hour protection for the combustible framing; or combustible exterior walls with combustible exterior facings.

Conventional masonry walls, hollow or solid, at least 6 inches thick and constructed in conformity with the structural standards of this Manual, meet the ¾-hour fire-resistance requirement. Sheet-metal wall construction does not meet the ¾-hour fire-resistance requirements unless well insulated. Brick veneering having a nominal thickness of 4 inches provides ¾-hour protection to the combustible framing of exterior walls. Noncombustible facings of slate, asbestos-cement board or shingles, sheet metal, stucco or thin veneers do not give ¾-hour protection.

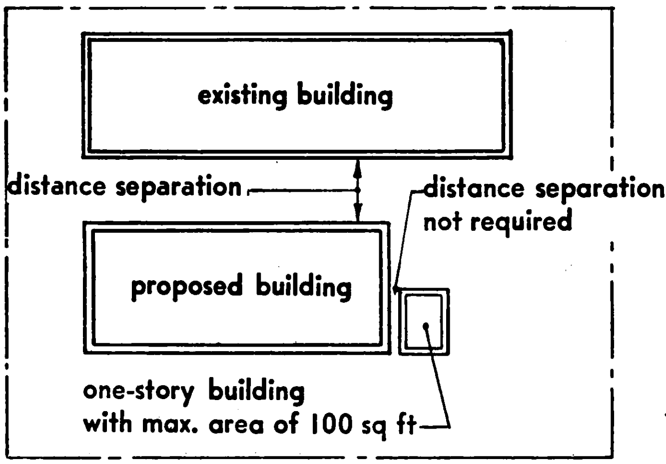
Distance separations are required between multiple dwellings and other buildings of any occupancy when either of the buildings has noncombustible exterior walls with a fire-resistance rating of less than 2 hours; or combustible exterior walls with or without noncombustible exterior facings.

Solid masonry exterior walls at least 6 inches in thickness, or 8-inch walls of hollow masonry units having shells designed for exterior use with or without stucco finish, meet the 2-hour fire-resistance rating requirement.

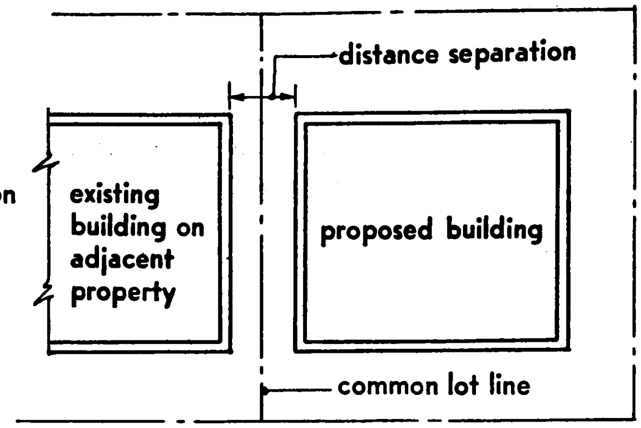
Exterior walls or portions thereof may encroach upon the distance separation required by the type of the construction of the building provided those portions of such walls within the distance separation have a higher fire-resistance rating and protect those portions of the building outside of the minimum distance separation as indicated in the illustration entitled, "Relation to Existing Buildings and Common Lot Line," part 4, page 4. Solid masonry exterior walls are acceptable as protective walls for multiple dwellings and may be built to the lot line. Brick-veneered wood frame exterior walls are acceptable for one- and two-family dwellings.

The minimum distance between a multiple dwelling and a separate garage on the same premises is the same as between a multiple dwelling and any other building. Such minimum distances are indicated in the illustration entitled, "Relation to Exterior Walls," part 4, page 6. The minimum distance between a private garage and a one- or two-family dwelling attached with a breezeway is 5 feet except that a lesser distance is permitted when those portions of the interior of the garage within 5 feet of the dwelling are protected with noncombustible materials, such as plaster, gypsum wallboard or other materials giving at least 10 minutes' protection to combustible framing. Space behind such protective material is required to be firestopped from other space in the garage. Breezeways between garages and dwellings should be firestopped at the garage end. The minimum distance separation between one-story garages with an area not exceeding 750 square feet is 3 feet except that distance separation is not required for garages with exterior walls having a fire-resistance rating of at least ¾ hour.

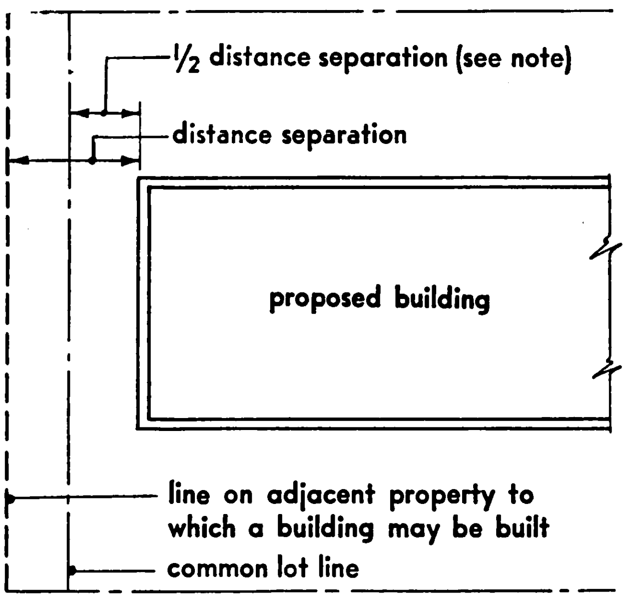
Relation to Existing Buildings and Common Lot Line



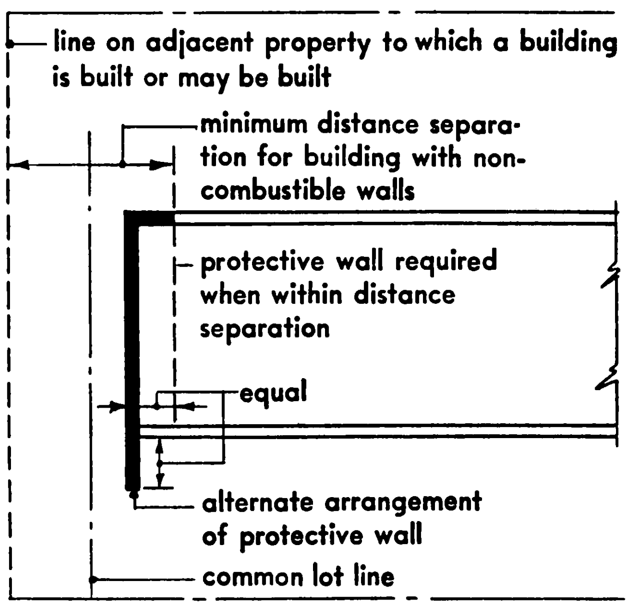
SEPARATION BETWEEN BUILDINGS ON THE SAME PREMISES



SEPARATION BETWEEN EXISTING BUILDING ON ADJACENT PROPERTY AND PROPOSED BUILDING



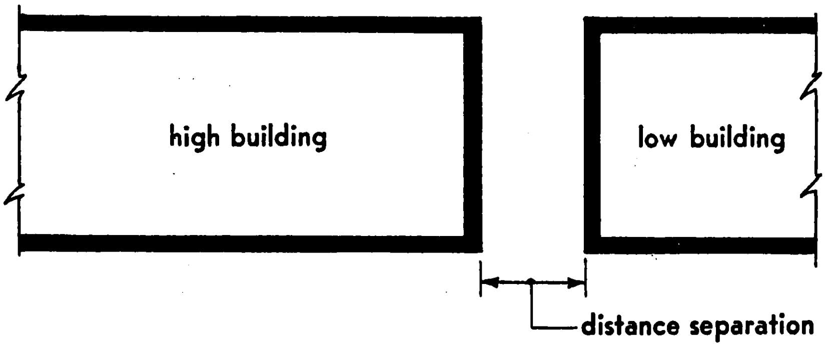
SEPARATION TO LINE ON ADJACENT PREMISES TO WHICH BUILDING MAY LEGALLY BE BUILT



REDUCTION OF DISTANCE SEPARATION BY USE OF PROTECTIVE WALL

Note: When there is no building on adjacent property, the distance from the proposed building to the common lot line shall be one half of the distance separation, but not less than 3 feet.

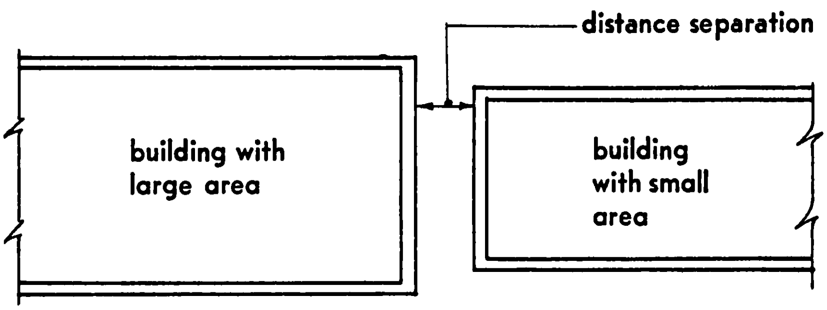
Relation to Height, Area, and Wall Construction



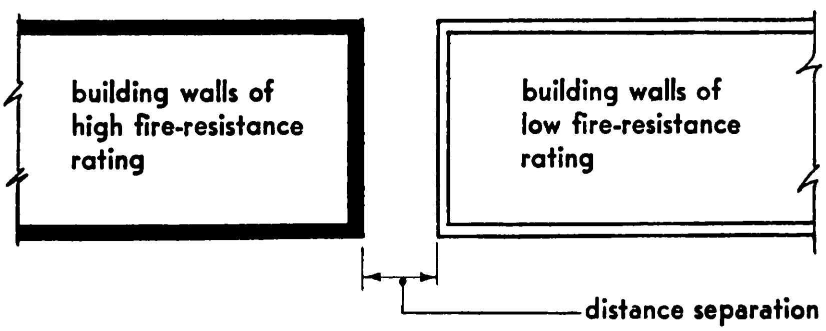
SEPARATION REQUIRED FOR BUILDING WITH GREATEST NUMBER OF STORIES APPLIES

Applicable Distance Separations—When the height or construction of the exterior walls of the proposed and existing building is not the same, the applicable distance separation shall be that set forth in the Code for the higher building or for the building having exterior walls with the lower fire-resistance rating, whichever is the greater. The distance separations set forth in the Code applicable to one- and two-family dwellings are for dwellings having an area not exceeding 1000 square feet. When the areas are increased, the distance separations shall be increased as follows:

Dwelling area in square feet	Increased separation, per cent
1001 to 1500	25
1501 to 2000	50
2001 to 2500	75
More than 2500	100

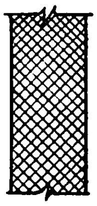
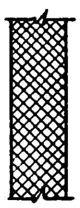
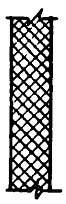
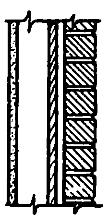
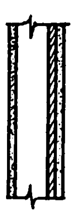


SEPARATION REQUIRED FOR BUILDING WITH LARGEST AREA APPLIES



SEPARATION REQUIRED FOR BUILDING WITH WALLS OF LOWEST RATING APPLIES

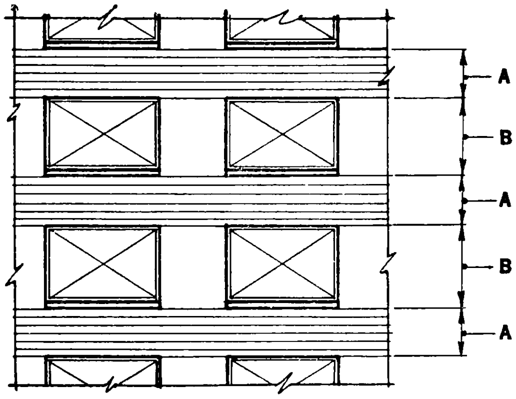
Relation to Exterior Walls

	Exterior wall	Building height in stories	Minimum distance separation in feet			
			One- and two-family dwelling		Multiple dwelling	
			Within fire limits	Outside fire limits	Within fire limits	Outside fire limits
	Noncombustible wall, at least 2-hour rating	1	0	0	0	0
		2	0	0	0	0
		3 or more	0	0	0	0
	Noncombustible wall, less than 2-hour rating, but at least ¾-hour	1	0	0	10	10
		2	0	0	20	10
		3 or more	0	0	30	15
	Noncombustible wall, less than ¾-hour rating	1	5 [1]	3	15	10
		2	8 [2]	5	25	15
		3 or more	np	8	30	20
	Combustible wall, with noncombustible facing giving at least ¾-hour protection	1	5	0	np	10
		2	8	0	np	15
		3 or more	np	0	np	np
	Combustible wall, with noncombustible facing giving less than ¾-hour protection	1	np	5	np	10
		2	np	8	np	20
		3 or more	np	10	np	np
	Combustible wall, with combustible facing	1	np	8	np	10
		2	np	10	np	20
		3 or more	np	12	np	np

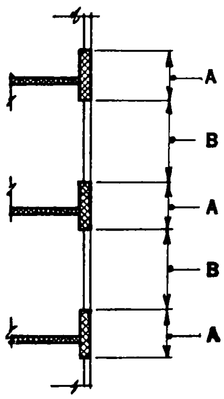
[1] Within fire limits A, 10-foot separation required.

[2] Not permitted within fire limits A.

Fire Resistance of Nonbearing Exterior Walls



ELEVATION



SECTION

(A) Three-foot separating wall of at least 1-hour fire-resistance rating.

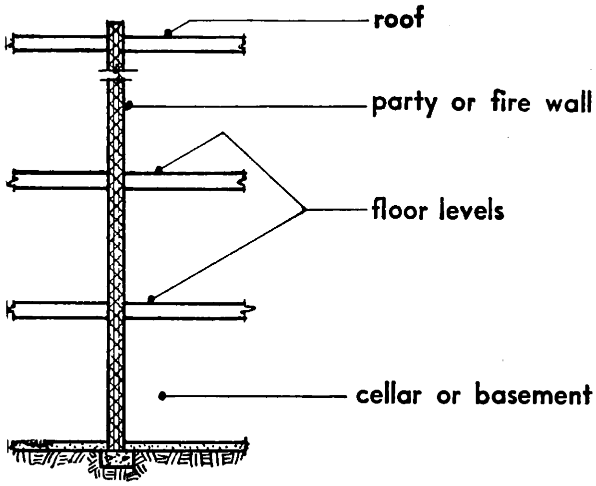
(B) Noncombustible wall with no required fire-resistance rating. May have windows unlimited in horizontal dimensions.

Exterior nonbearing walls with a 3-foot high vertical separation or spandrel having a fire-resistance rating of at least 1 hour, as illustrated on this page, are not required to have a fire-resistance rating except when they are a part of an exit enclosure or are within the distance separations required for buildings with noncombustible exterior walls having a fire-resistance rating of less than ¾ hour.

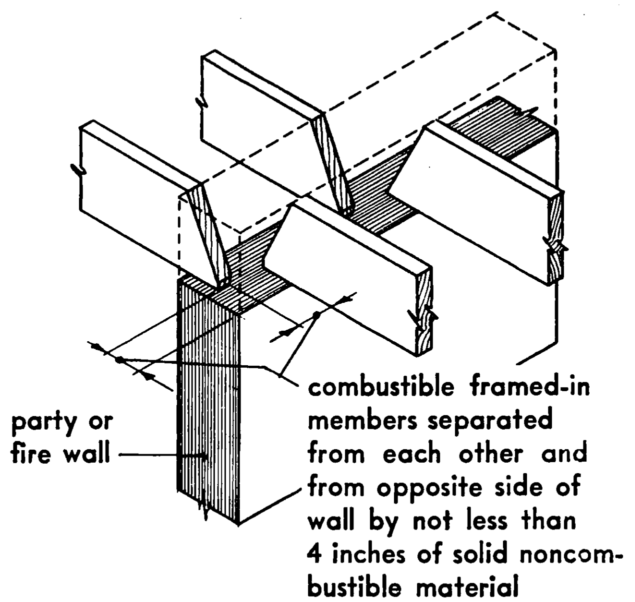
Multiple dwellings of two stories with noncombustible exterior walls having ratings of less than ¾ hour are required to have distance separations of 25 and 15 feet, within and outside the fire limits, respectively. When three or more stories high, such buildings are required to have distance separations of 30 and 20 feet, within and outside the fire limits, respectively.

Panel and curtain walls which do not meet the requirements set forth above are required to have a fire-resistance rating of at least ¾ hour.

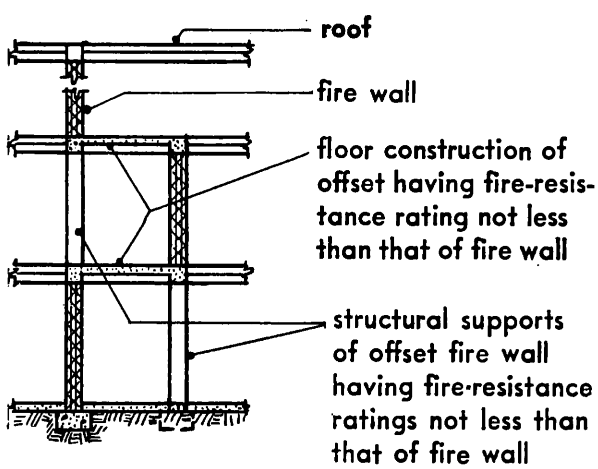
Arrangement and Construction of Party and Fire Walls



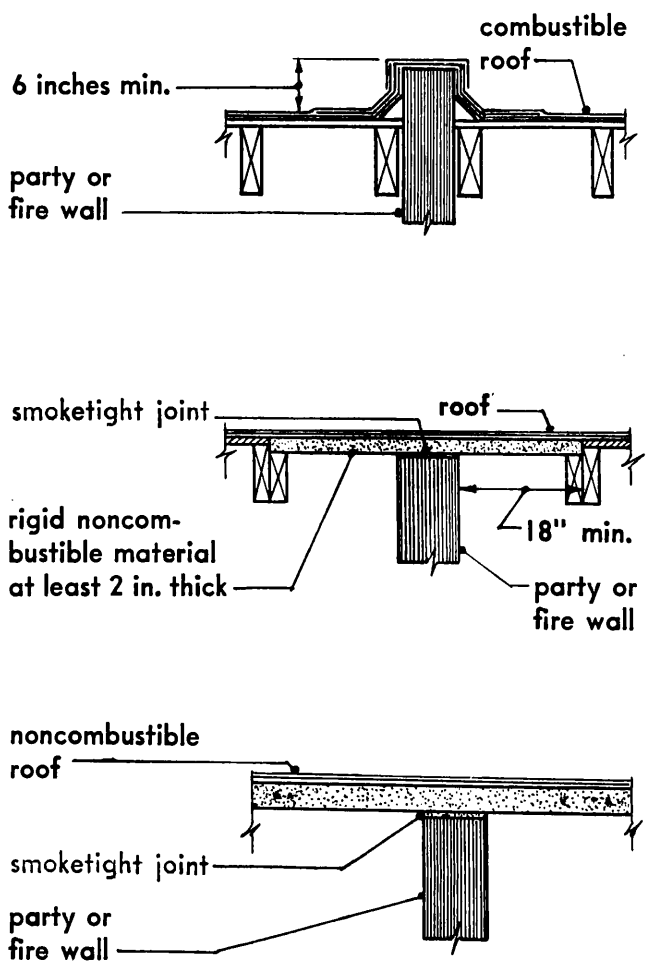
CONTINUOUS PARTY OR FIRE WALL



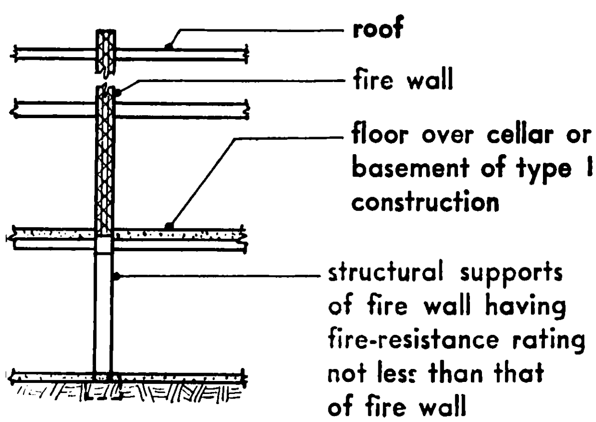
COMBUSTIBLE FRAMING



OFFSET FIRE WALL (permitted only in buildings of type I construction.)

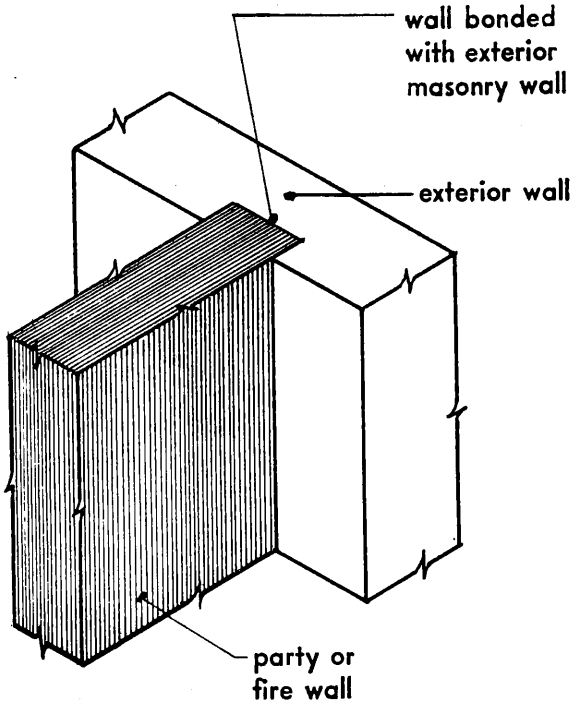


JUNCTIONS WITH ROOF

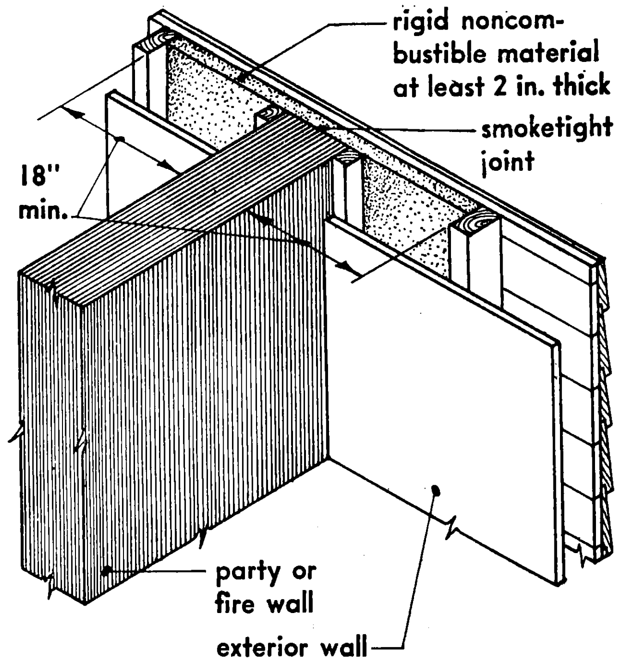


FIRE WALL EXTENDING FROM FIRST FLOOR CONSTRUCTION

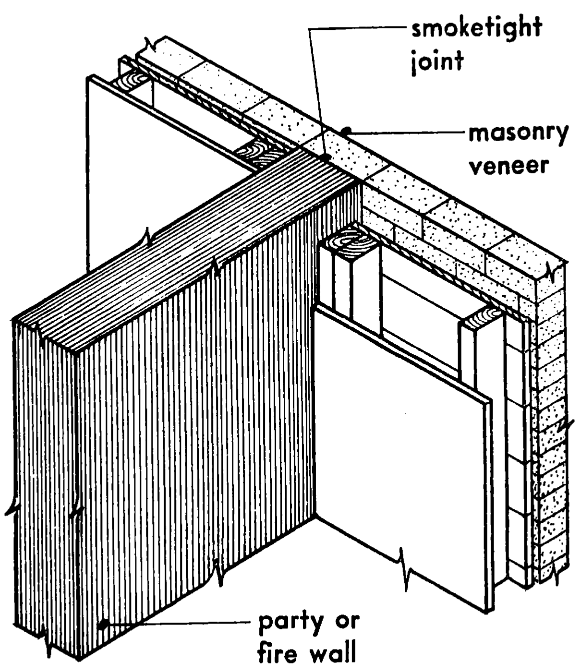
Junctions of Party or Fire Walls with Exterior Walls



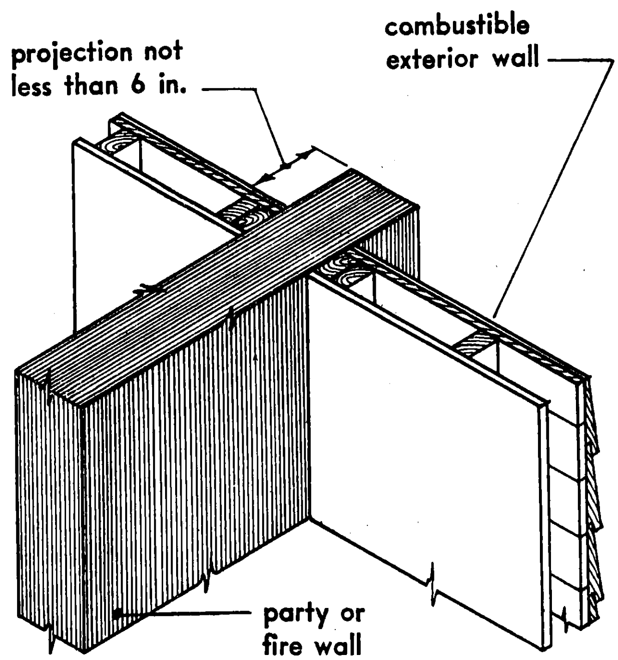
NONCOMBUSTIBLE EXTERIOR WALL



COMBUSTIBLE EXTERIOR WALL



COMBUSTIBLE EXTERIOR WALL WITH MASONRY VENEER



FIRE WALL PROJECTING BEYOND COMBUSTIBLE EXTERIOR WALL

Classification of Roof Coverings

Roof coverings are divided into four classes, designated 1, 2, 3 and 4. The classification is that for which the roof covering gives satisfactory performance in all of the three following tests: **brand** test, that is, resistance to ignition from flying brands; **flame-exposure** test, that is, resistance to flame from adjacent burning buildings; and **flame-spread** test, that is, resistance to spread of flame over the roof surface.

Roof coverings labeled by the Underwriters' Laboratories as class A, B and C, respectively, are acceptable under Code classifications as class 1, 2 and 3. Some noncombustible roof coverings, such as slate, tile, and concrete, are not classified by the Underwriters' Laboratories. Certain other materials, such as wood shingles and lightweight felt roll roofings, which do not meet the test requirements for class 4 roof coverings, are not classified under the Code.

Roof coverings are acceptable as having the following classifications when applied as set forth in the text entitled, "Application of Roof Coverings," beginning in part 4, page 11.

Class 1

Clay or concrete deck tile, or reinforced concrete not less than 1-inch thick, laid in cement or in asphalt or tar mastic.

Clay or concrete roof tile with underlay.

Slate not less than $\frac{3}{16}$-inch thick.

Asbestos protected sheet metal.

Asphalt asbestos-felt smooth surfaced sheet roofing made of four plies of asphalt and asbestos materials, laid in single thickness with 2-inch end lap and with 6-inch wide strips beneath butted edges of sheet to have a weight of not less than 80 pounds per 100 square feet of roof surface.

Five layers of type 15 asphalt-saturated asbestos-felt or equivalent, cemented together with asphalt, and surfaced with asphalt paint.

Four layers of type 15 asphalt- or tar-saturated asbestos-felt or rag-felt or equivalent, cemented with asphalt or tar, and finished with gravel, stone, or slag in asphalt or tar.

Three layers of type 15 asphalt-saturated rag-felt or equivalent, cemented with asphalt, and finished with asphalt roof tile or with $\frac{1}{2}$-inch asphalt impregnated fibrous board applied with mastic asphalt.

Class 2

Asbestos-cement shingles not less than $\frac{3}{16}$-inch thick, laid to provide one or more thicknesses over underlay.

Asphalt asbestos-felt smooth surfaced sheet roofing made of three plies of asphalt and asbestos materials, laid in single thickness with 2-inch end lap and with 6-inch wide strips beneath butted edges of sheet to have a weight of not less than 60 pounds per 100 square feet of roof surface.

Asphalt asbestos-felt shingles, surfaced with granular materials, laid to have a weight of not less than 180 pounds per 100 square feet of roof surface.

Asphalt mastic shingles surfaced with granular materials.

Sheet roofing of copper, galvanized iron, or tin-coated iron with underlay.

Tile or shingle pattern roofing of copper, galvanized iron, or tin-coated iron with underlay.

Four layers of type 15 asphalt- or tar-saturated asbestos-felt or rag-felt or equivalent, cemented with asphalt, and finished with asphalt cement.

Three layers of type 15 asphalt- or tar-saturated rag-felt or equivalent, cemented with asphalt, and finished with gravel, stone, or slag in asphalt or tar cement.

Class 3

Asphalt asbestos-felt smooth surfaced sheet or roll roofing laid in single thickness with laps to have a weight of not less than 48 pounds per 100 square feet of roof surface.

Asphalt asbestos-felt granular-surfaced sheet or roll roofing laid in single thickness to have a weight of not less than 85 pounds per 100 square feet of roof surface.

Asphalt rag-felt granular-surfaced sheet or roll roofing, laid in double thicknesses with laps to have a weight of not less than 80 pounds per 100 square feet of roof surface.

Asphalt rag-felt individual or strip shingles surfaced with granules, laid with lap to have a weight of not less than 180 pounds per 100 square feet of roof surface.

Sheet roofing of copper, galvanized iron, or tin-coated iron, without underlay or with underlay of rosin-sized paper.

Tile or shingle-pattern roofing of copper, galvanized iron, or tin-coated iron, without underlay or with underlay of rosin-sized paper.

Three layers of type 15 asphalt-saturated rag-felt or equivalent, cemented with asphalt, and finished with asphalt cement.

Class 4

Asphalt rag-felt smooth surfaced roll roofing, laid in single thickness with laps to have a weight of not less than 45 pounds per 100 square feet of roof surface.

Asphalt rag-felt granular-surfaced roofing, laid in single thickness with laps to have a weight of not less than 80 pounds per 100 square feet of roof surface.

Two layers of type 15 asphalt- or tar-saturated rag-felt, cemented with asphalt or tar, or such other combinations of roofing felts that do not meet the requirements of class 3 built-up roofing.

Wood Shingles

Wood shingles are not classified. They should comply with the requirements of CS, *Wood Shingles, (Red Cedar, Tidewater Red Cypress, California Redwood).* (Fourth edition). Five shingles should have a combined thickness of not less than 2 inches measured at the butts. Exposure to the weather should not exceed 5 inches for 16-inch shingles, 5½ inches for 18-inch shingles, and 7½ inches for 24-inch shingles, when used on roofs of greater than one-third pitch, nor 4 inches for 16-inch shingles, 4½ inches for 18-inch shingles, and 6½ inches for 24-inch shingles, when used on roofs of less than one-third pitch. Wood shingles should not be used on roofs of less than one-quarter pitch.

Unclassified Roof Coverings

When the classification of a roof covering is not known it should be subjected to classification tests in conformity with the following:

Test assembly: Representative samples of roof coverings for tests are applied over wood decks. The details of the test assembly and the test brands are indicated in the illustration entitled, "Test Brands and Test Panels," part 4, page 12.

Brand test: Brands are thoroughly ignited and individually applied to the roof covering. The brands should not cause the roof coverings to burn to such an extent that they give off flaming or glowing pieces or slip from position on the deck. For classes 1 and 2 roof coverings, not more than one of three brands of the prescribed sizes shall cause flames on the underside of the deck. For classes 3 and 4 roof coverings, not more than three of the nine brands of the prescribed sizes shall cause flames on the underside of the deck.

Flame-exposure test: A luminous gas flame spreading across the width of the test panel and adjusted so that it will extend from the bottom edge to near the upper edge of the test panel is applied intermittently with 2-minute intervals between each application. The flame should not cause the roof covering to flame or give off brands for: class 1, after fifteen 2-minute applications; or class 2, after eight 2-minute applications; or class 3, after three 1-minute applications. Roof coverings that flame and give off brands after only two 1-minute applications of flame are placed in class 4.

Flame-spread test: Flame similar to that used for the flame-exposure test is adjusted so that when first applied it will extend only to the top edge of the lower panel of the test panel. The performance is deemed satisfactory for: class 1 when the spread is less than 9 feet upward from the lowest edge of the assembly after a 10-minute continuous application of flame; or class 2 when the spread is less than 13 feet upward from the lower edge of the assembly after a 10-minute application of flame; or class 3 when the spread is less than 13 feet upward from the lower edge of the test assembly after a 4-minute application of flame; or class 4 when the spread is less than 13 feet upward from the lower edge of the test assembly after a 3-minute application of flame.

Application of Roof Coverings

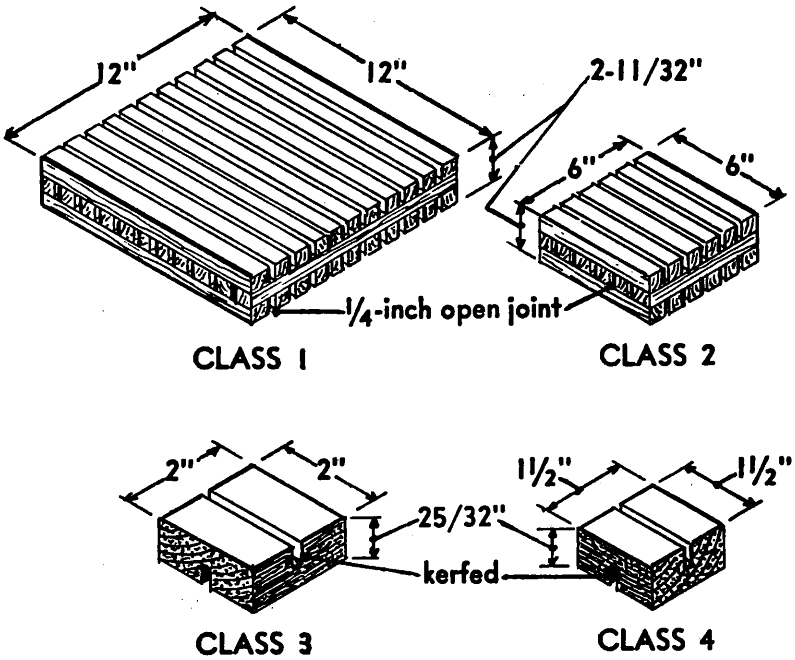
Roof coverings should be assembled and applied in conformity with the following:

Shingles, including slate and tile, sheet or roll roofing, shall be applied with sufficient lap to give the required number of thicknesses, and shall be sealed with cementing material where necessary to render the roofing weathertight.

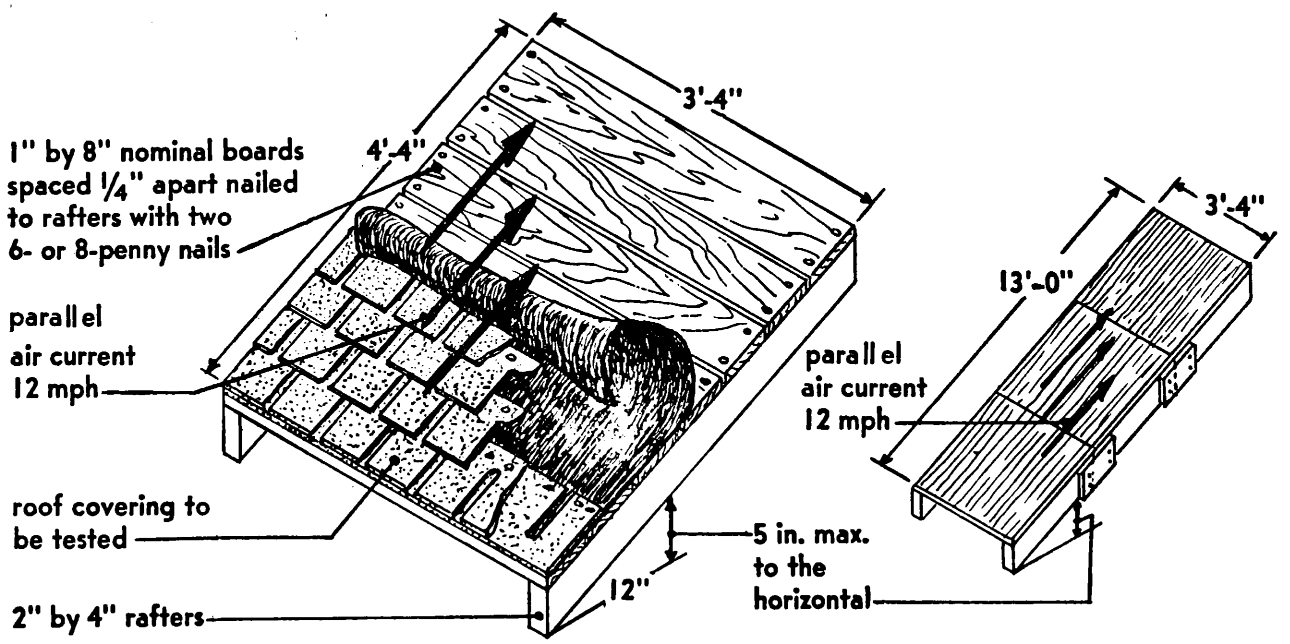
Nailing for shingle or tile roofing shall be in conformity with the manufacturer's specifications, or shall be with corrosion-resistant 12-gage nails having not less than ⅜-inch diameter heads, and

Test Brands and Test Panels

Brands—For class 1 and class 2 roof coverings, 1-inch nominal square wood strips, surfaced four sides, fastened together as indicated so that brand can be handled as a unit. For class 3 and class 4 roof coverings, kerfed wood blocks of the sizes indicated.



TEST BRANDS



ASSEMBLY FOR BRAND AND FLAME-EXPOSURE TESTS

ASSEMBLY FOR FLAME-SPREAD TEST

TEST PANELS

be long enough to penetrate the sheathing ¾ inch.

Underlay for use with tile, shingle, or sheet metal roofing shall consist of one layer of type 15 asphalt-saturated asbestos-felt or of two layers of type 15 asphalt-saturated asbestos-felt or of two layers of type 15 asphalt-saturated rag-felt or equivalent.

Shingle-type roofings shall be limited to inclines exceeding 4 inches per horizontal foot.

Asphalt-asbestos sheet roofing shall be limited to inclines exceeding 4 inches but not exceeding 12 inches per horizontal foot.

Built-up roof coverings shall be of the required number of layers of type 15 felt weighing, for each layer, approximately 15 pounds per 100 square feet of roof surface, or of 30-pound or heavier felt providing that not more than one layer of heavier material is substituted for each two layers of type 15 felt.

Built-up roofing shall be mopped solidly between layers with not less than 20 pounds of hot asphalt, or 30 pounds of hot coal-tar pitch, or 1½ gallons of cold bituminous compound per 100 square feet of roof surface.

Base sheets for built-up roofing shall be applied to roof sheathing by nailing or by mopping the entire surface with cementing material of the same kind and amount of cement material as used between the layers.

Nailing for base sheets of built-up roofing shall be with corrosion-resistant 12-gage nails with 9⁄16-inch diameter or larger heads long enough to penetrate the roof sheathing ¾ inch, using one nail to each 1⅓ square feet of roof surface.

Gravel, stone, or slag surfacing materials shall be of ¼-inch to ⅝-inch size, and approximately 400 pounds of gravel or stone, or 300 pounds of slag, shall be used to each 100 square feet of roof surface.

Built-up roofing, without surfacing or surfaced with asphalt or other cement, shall be limited to inclines not exceeding 5 inches per horizontal foot; those surfaced with gravel, stone, or slag shall be limited to inclines not exceeding 3 inches per horizontal foot.

Opening Protectives

When openings are used in exterior walls under the conditions shown in the illustration entitled, "Protection of Openings in Exterior Walls," part 4, page 16, they shall be equipped with opening protectives.

Openings in fire walls and fire separations shall be equipped with opening protectives having fire-resistance ratings commensurate with the fire resistance of the walls or separations as follows:

Rating of fire wall or fire separation, in hours	Rating of opening protective, in hours
3 or more	3
2	1½
1 or ¾	¾

Acceptable Opening Protectives

Doors—Solid core wood doors, battened built-up wood doors or protected panel doors, not less than 1⅜ inch thick, may be used as opening protectives in one- and two-family dwellings.

Solid core wood doors 1¾ inch thick are deemed to meet the ¾-hour fire-resistance rating requirement when used in fire separations which are not required to be of noncombustible material.

Doors labeled by the Underwriters' Laboratories for use in class A, B, and C openings are deemed to meet the requirements of the Code for interior opening protectives required to have fire-resistance ratings, respectively, of 3, 1½, and ¾ hour. Doors labeled by the Underwriters' Laboratories for use in class D and E openings are deemed to meet the requirements of the Code for exterior doors required to have fire-resistance ratings, respectively, of 1½ and ¾ hour.

Doors other than those described above are deemed to meet the fire-resistance requirements of the Code if they give acceptable performance when subjected to fire tests made in conformity with generally accepted standards. To give acceptable performance for a specified fire-resistance rating, the fire effects on a test door subjected to fire exposure of a duration equal to the desired rating shall not cause:

a——A movement of any part of the edges greater than the thickness of the door during the first half of the exposure, nor more than 1½ times the thickness during the entire exposure and the application of the hose stream, or

b——A single swing door to separate more than ½ inch at the latch location, or

c——A pair of swing doors to separate more than ¾ inch at the latch location, or

d——Doors mounted on the face of a wall to separate from the wall a distance equal to the thickness of the door at the point of separation, or

e——Doors mounted in guides to release from the guides or the guides from their fastenings, or

f——Openings through the assembly other than the washing-out of small portions of glass panels by the hose stream.

Vision panels of ¼-inch wired glass with an area of not more than 100 square inches and neither dimension more than 12 inches may be used in 1½-hour doors in fire separations. Wired glass should not be used in doors in fire walls except that vision panels of the size given above may be used when such doors serve as horizontal exits. Panels of ¼-inch wired glass may be used in doors required to have a fire-resistance rating of ¾ hour providing the area does not exceed 720 square inches when used in exterior doors or 1296 square inches when used in interior doors. The greatest dimension of such panels should be not more than 54 inches.

Windows—Windows conforming to the following requirements are deemed to have a fire-resistance rating of ¾ hour and to be suitable for opening protectives:

Size of opening for single sash: Maximum area of 35 square feet with greatest dimension not more than 10 feet.

Size of opening for double sash: Maximum area of 70 square feet with the greatest dimension not more than 10 feet.

Frames: Noncombustible, firmly anchored in the wall opening and providing rigid support for the glass panels. Window frames labeled by the Underwriters' Laboratories or approved by other recognized laboratories are deemed to meet the requirements of the Code.

Glazing: Wired glass not less than ¼-inch thick with area of lights not more than 2916 square inches and greatest dimension not more than 54 inches, except that such area should not exceed 720 square inches when the window is in an exit enclosure.

Glass Block Panels—Glass block panels conforming to the following requirements are deemed to have a fire-resistance rating of ¾ hour when used as opening protectives but not when used as walls or partitions which are required to have a fire-resistance rating.

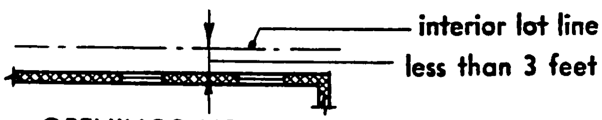
Size of opening: Maximum area of 120 square feet with the greatest dimension not more than 12 feet.

Size of block: Nominal size not to exceed 4 by 8 by 8 inches.

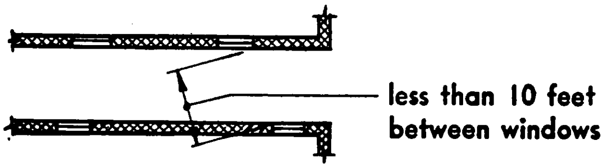
Construction: Blocks laid with ¼- to ⅜-inch joints using type B mortar. The horizontal mortar joints should be reinforced for their full length with Nos. 9 and 14 AWG galvanized wire mesh except between the two top rows. The panel should extend approximately 1½ inches into 2½-inch deep grooves at the edges and top of the wall opening. The remaining space in the grooves should be filled with glass or mineral wool to permit expansion of the panel. Such grooves may be in the masonry walls or formed with steel shapes.

Glass block walls may be used in lieu of ¾-hour fire separations provided they are protected with sprinklers arranged as described in the illustration entitled, "Separation Between Kitchens and Public Dining Rooms," part 4, page 29.

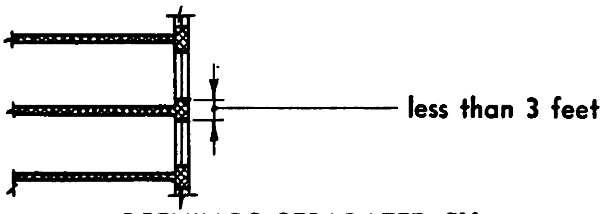
Protection of Openings in Exterior Walls



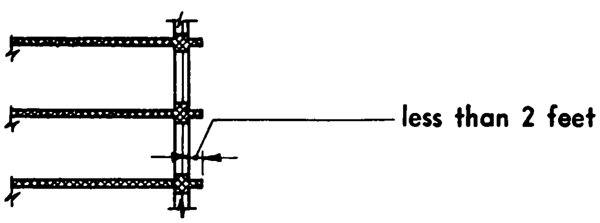
OPENINGS NEAR INTERIOR LOT LINE



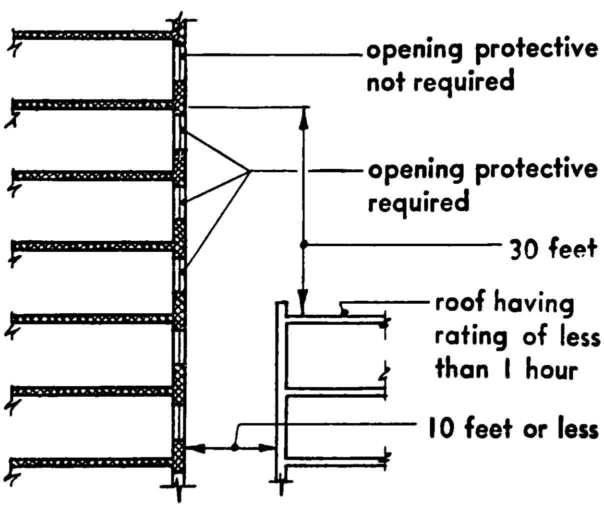
FACING OPENINGS IN
ADJACENT BUILDINGS
PLANS



OPENINGS SEPARATED BY
VERTICAL DISTANCE



OPENINGS SEPARATED BY
HORIZONTAL CONSTRUCTION



OPENINGS ABOVE ROOFS
SECTIONS

Exterior wall openings less than 3 feet, measured horizontally, from an interior lot line, or less than 10 feet from an opening in an adjacent building, shall be provided with opening protectives; except that protectives shall not be required for openings in one- and two-family dwellings which are 1½ feet or more from the interior lot line.

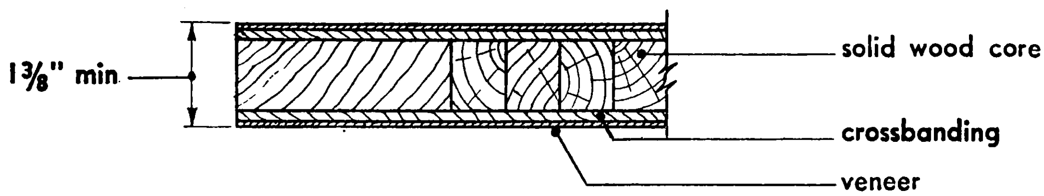
An exterior wall opening directly above another opening in the same wall shall be equipped with an opening protective, except when the vertical separation between the openings is at least 3 feet, or when the two openings are separated by horizontal fire-resistive construction extending outward at least 2 feet from the wall. The above requirement shall not be deemed to be applicable to dwellings of type 5 construction.

Exterior wall openings less than 30 feet above the roof of an extension or an adjacent building located within a horizontal distance of 10 feet, shall be equipped with opening protectives, unless the roof construction of such extension or the adjacent building has a fire-resistance rating of 1 hour or more.

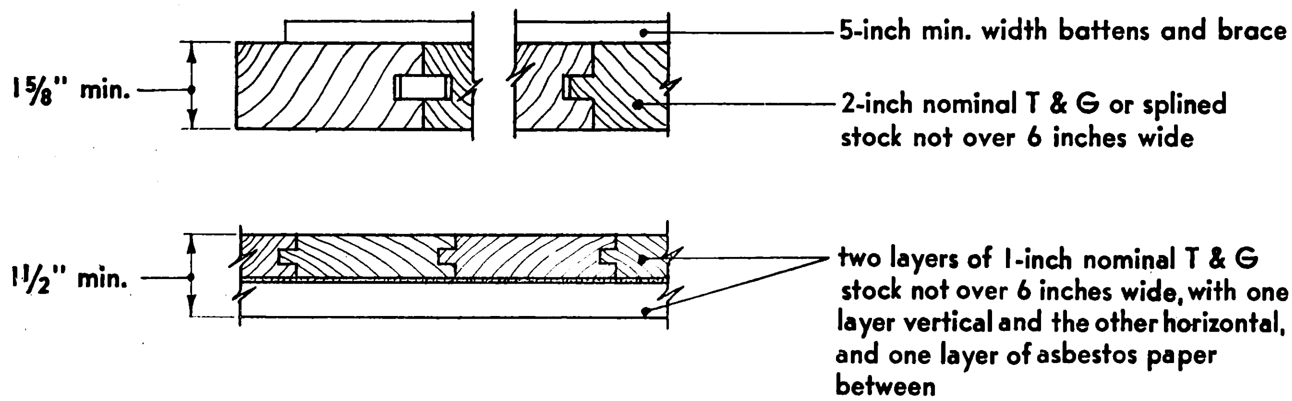
Doors and windows with wired-glass panels shall be deemed acceptable opening protectives for the locations illustrated on this page.

Opening Protectives: Wood Doors

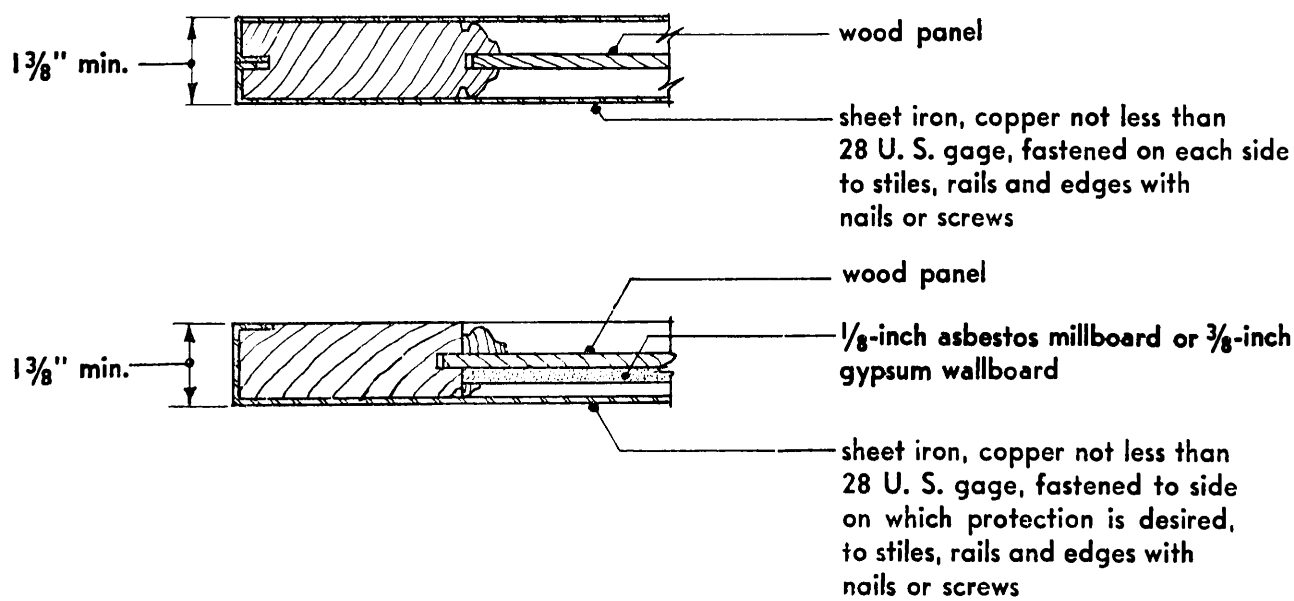
Doors illustrated on this page, when used with frames and hardware shown in part 4 illustration entitled "Frames and Hardware for Wood Doors," are acceptable for use in one-and two-family dwellings.



SOLID WOOD CORE FLUSH DOORS

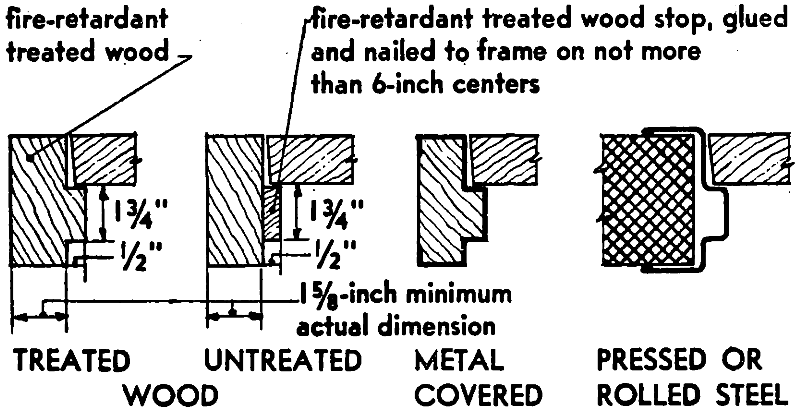


BATTENED DOORS

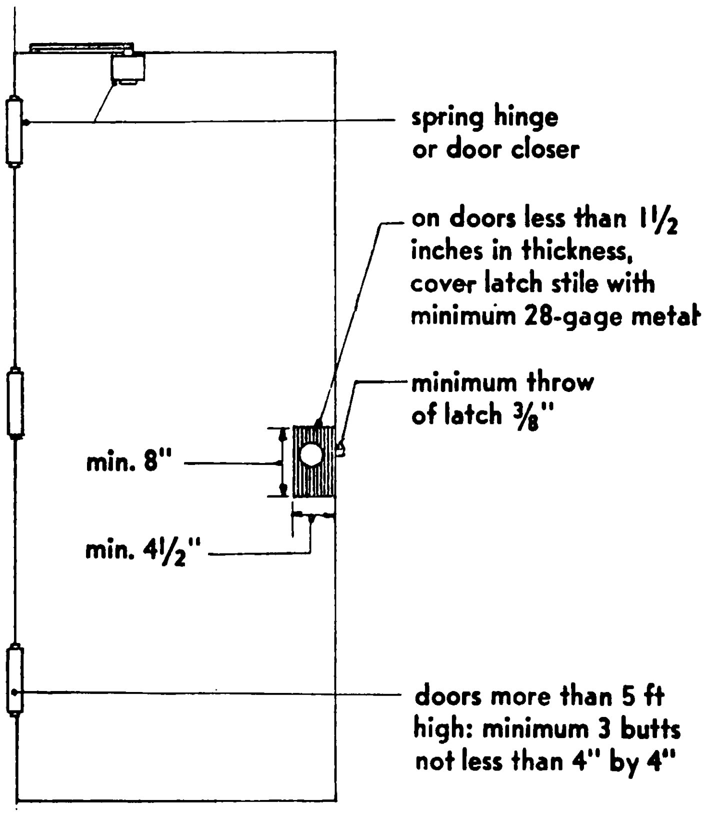


PROTECTED PANEL DOORS

Frames and Hardware for Wood Doors



FRAMES



HARDWARE

Frames—Frames shall be of fire-retardant treated wood, of untreated wood with fire-retardant treated stops of dimensions illustrated, of metal-covered wood, or of pressed or rolled steel.

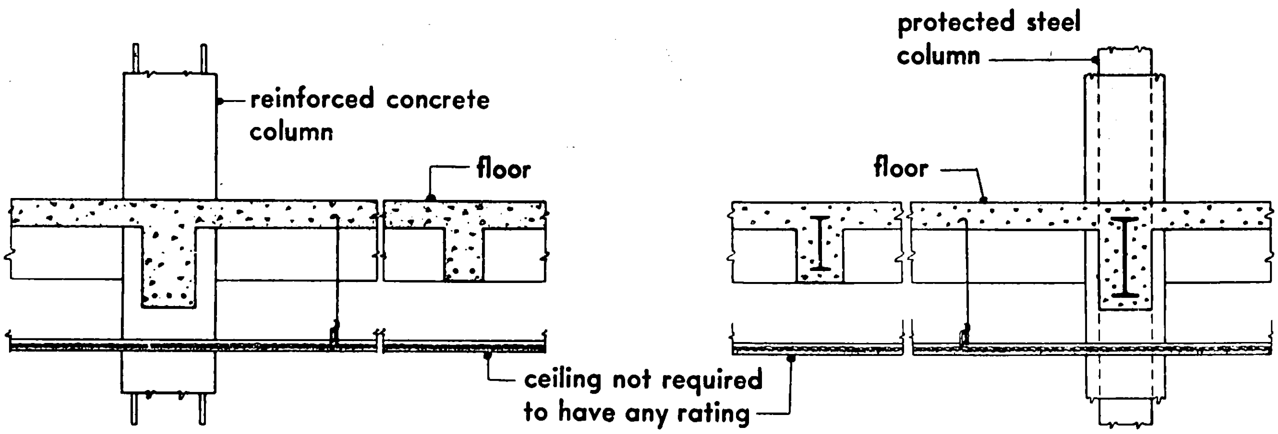
Hardware—Butts shall be not less than 4 inches by 4 inches, or equivalent, with not less than one butt for each 2-foot 6-inch height of door.

Self-closing devices shall automatically close and latch the door.

Rectangular latch cases shall not exceed ¾ inch in thickness; tubular latch cases shall not exceed 1 inch in diameter; throw of latch shall be not less than ⅜ inch.

Where door stile containing latch is less than 1½ inches in thickness, the stile shall be covered at the latch in minimum 28-gage sheet iron or copper.

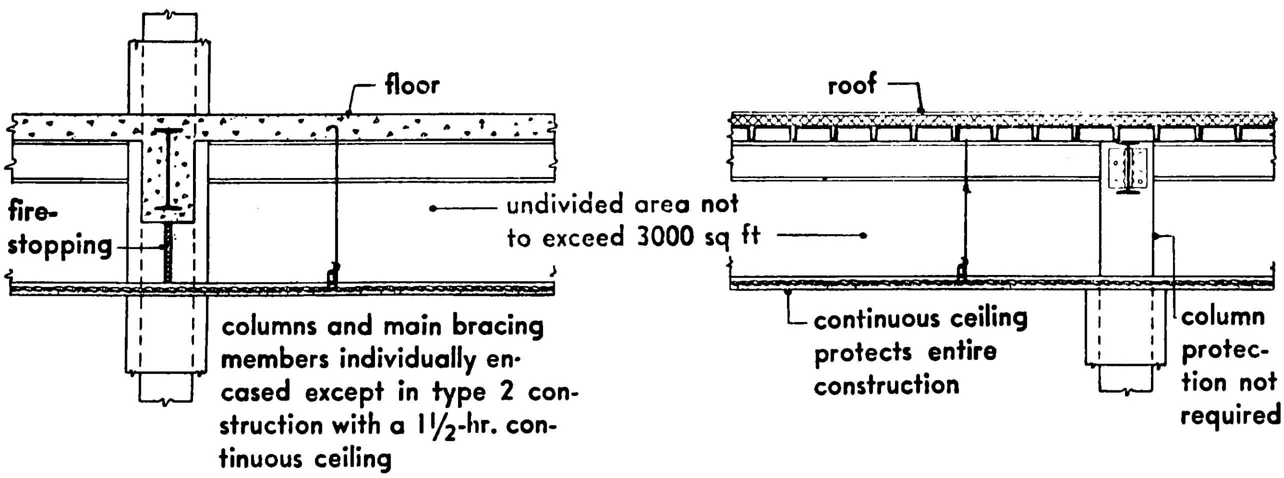
Protection of Columns, Beams, and Girders—1



REINFORCED CONCRETE CONSTRUCTION

STEEL FRAME CONSTRUCTION

COLUMNS, BEAMS AND GIRDERS INDIVIDUALLY PROTECTED

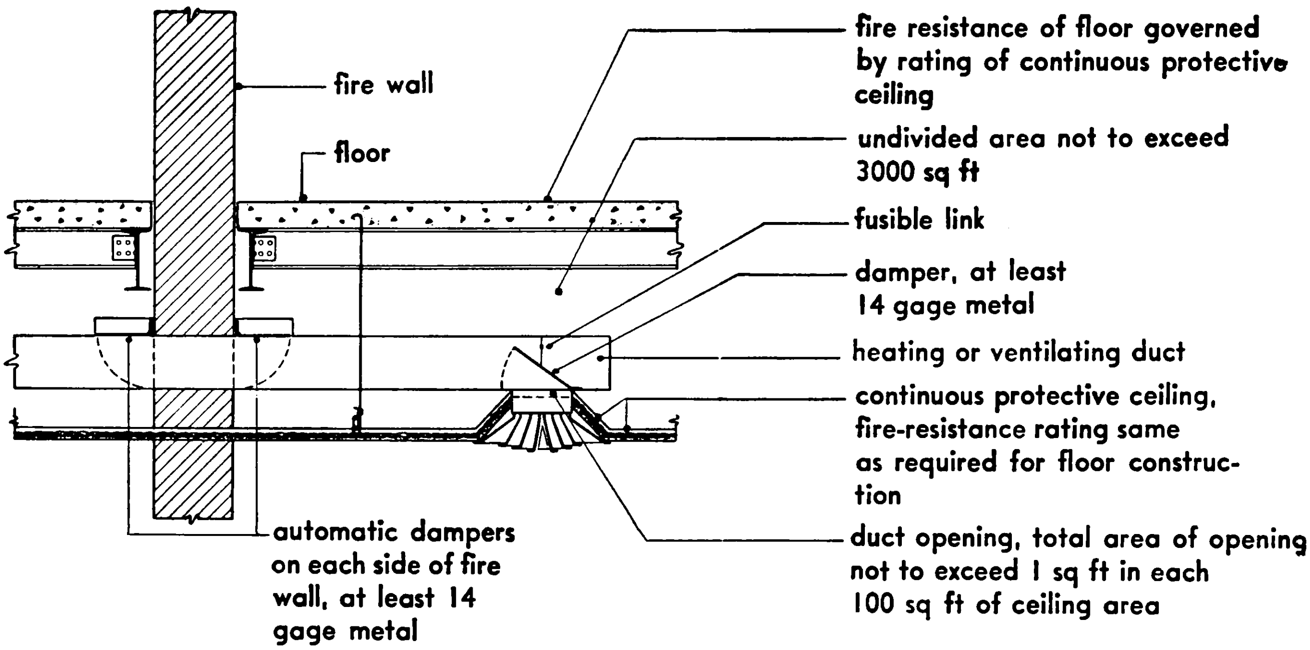


COLUMNS SUPPORTING MORE THAN ONE FLOOR

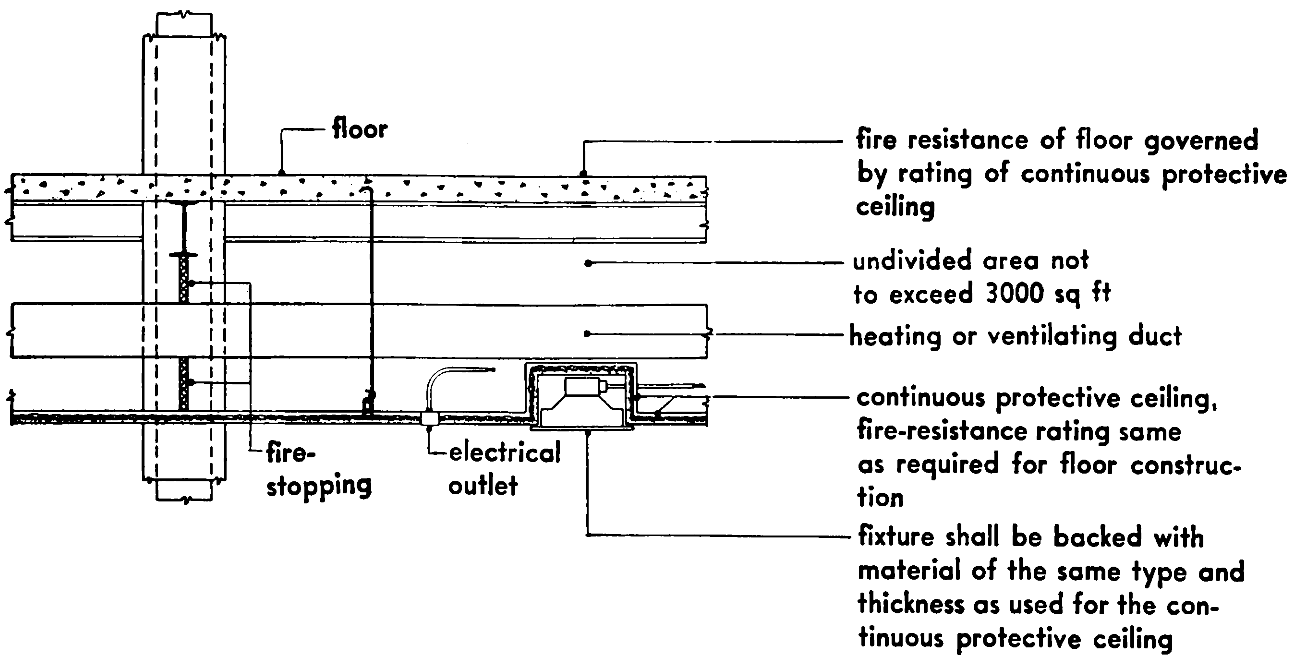
COLUMNS SUPPORTING ROOF OR ONE FLOOR AND ROOF

COLUMNS, BEAMS AND GIRDERS PROTECTED BY CONTINUOUS CEILING

Protection of Columns, Beams, and Girders—2

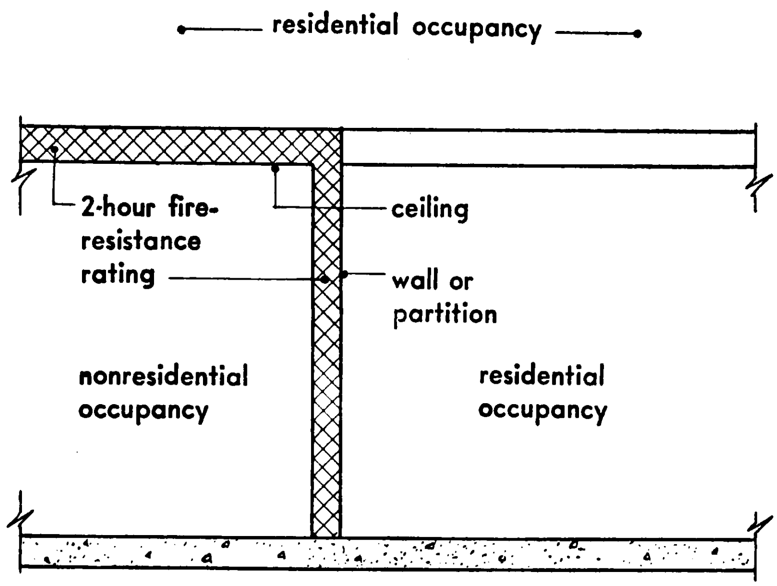


CONTINUOUS PROTECTIVE CEILING WITH OPENINGS

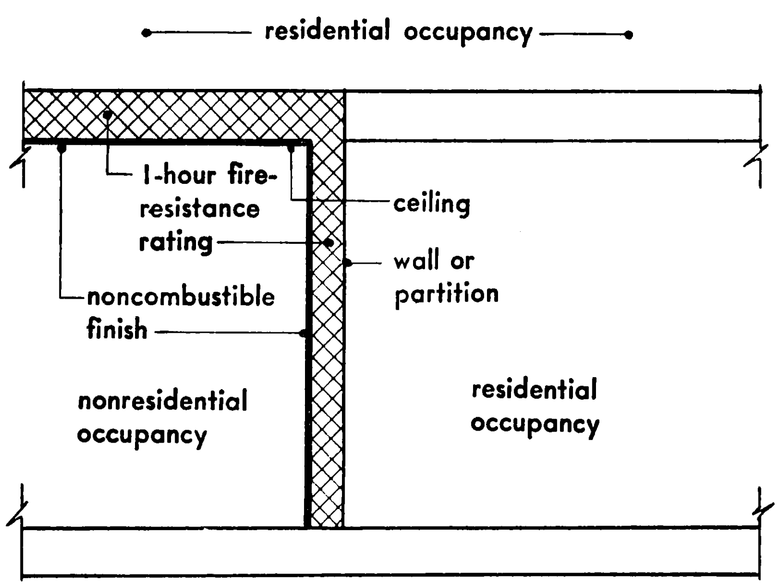


CONTINUOUS PROTECTIVE CEILING WITH ELECTRICAL FIXTURES

Mixed Occupancies



TYPE 1 AND 2 CONSTRUCTION



TYPE 3 AND 4 CONSTRUCTION

SECTIONS

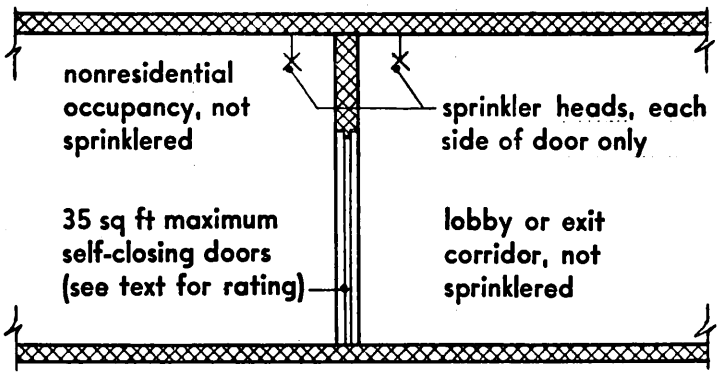
Nonresidential occupancies within a multiple dwelling, not accessory thereto, shall be separated from the residential occupancy by fire separations having a fire-resistance rating of at least 2 hours; except that in buildings of types 3 and 4 construction the horizontal fire separation may have a rating of 1 hour providing the ceiling of the nonresidential occupancy is finished with noncombustible material. The above requirement shall be deemed to apply to the vertical separation as well as the horizontal separation.

The requirements for the fire-resistance ratings of the fire separations are based on nonresidential occupancies of no greater fire hazard than that of the residential occupancy. When the fire hazard of the nonresidential occupancy is greater than that of the residential occupancy, the fire resistance of the fire separation should be commensurate with the higher fire hazard.

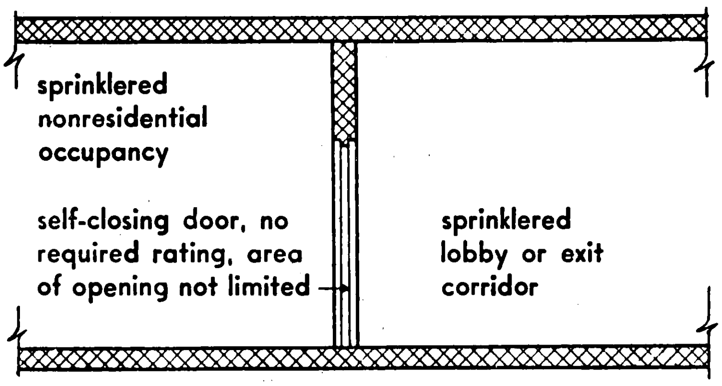
Openings shall not be permitted in fire separations between nonresidential and residential occupancies except when such opening is to a lobby or to an exit corridor and is protected in the manner indicated in the illustration entitled, "Protection of Openings in Mixed Occupancy Separations," part 4, page 22.

Mixed occupancies are not permitted in buildings of type 5 construction.

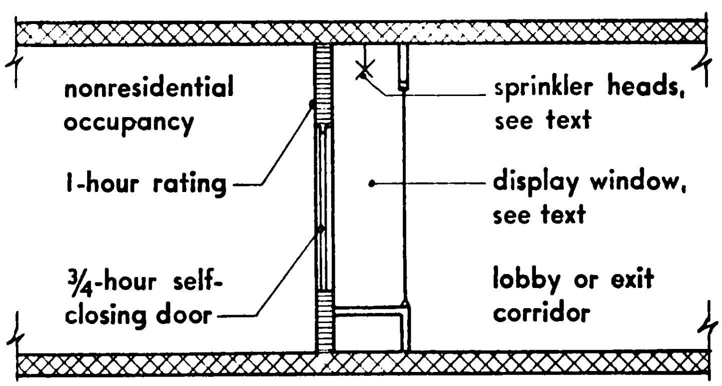
Protection of Openings in Mixed Occupancy Separations



NONRESIDENTIAL OCCUPANCY AND LOBBY OR EXIT CORRIDOR, NOT SPRINKLERED



NONRESIDENTIAL OCCUPANCY AND LOBBY OR EXIT CORRIDOR, SPRINKLERED



PROTECTION OF DISPLAY WINDOW IN LOBBY

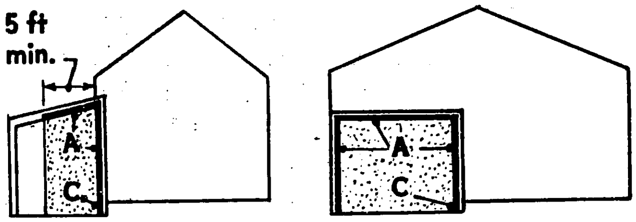
SECTIONS

Fire separations between nonresidential occupancies are required to have fire-resistance ratings as indicated in the illustration entitled, "Mixed Occupancies," part 4, page 21. Openings not exceeding 35 square feet in area are permitted in fire separations between residential occupancies and lobbies or exit corridors providing they are equipped with 1½-hour self-closing doors in types 1 and 2 buildings and with ¾-hour self-closing doors in types 3 and 4 buildings and protected with sprinkler heads located above the opening and arranged as indicated in the illustration entitled, "Separation Between Kitchens and Public Dining Rooms," part 4, page 29.

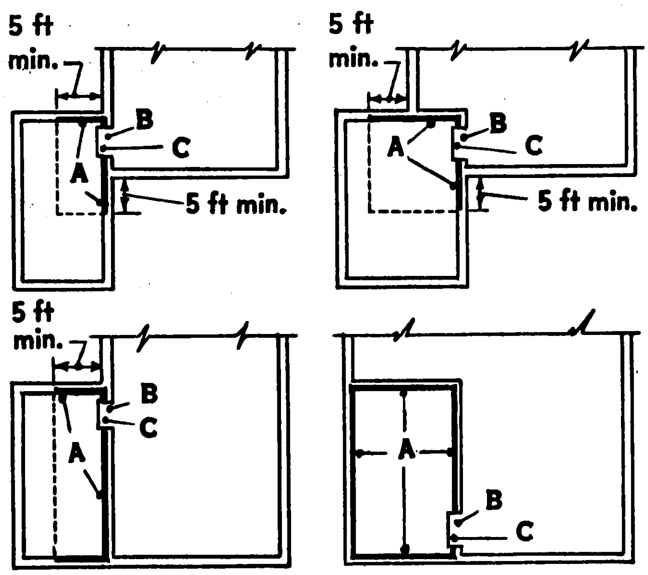
When the nonresidential occupancies and the lobby or exit corridor are equipped with a sprinkler system, the additional sprinkler heads above the opening are not required.

Display windows in lobbies and exit corridors of multiple dwellings should be equipped with sprinkler heads arranged as indicated above for door openings. Such display windows should be protected from the nonresidential occupancy by fire separations having a fire resistance of at least 1-hour rating. Openings in such fire separations should be equipped with ¾-hour self-closing doors.

Garages and One- and Two-Family Dwellings



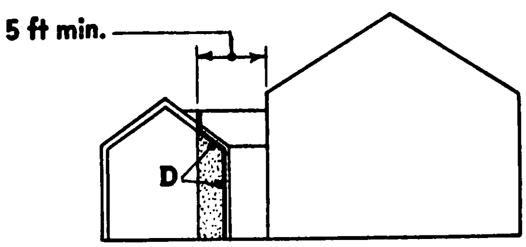
DIAGRAMMATIC SECTIONS



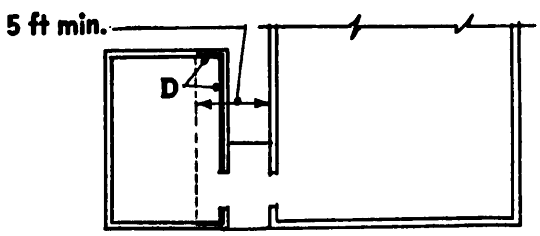
PLANS

ATTACHED

BUILT-IN



DIAGRAMMATIC SECTION



PLAN

ATTACHED BY BREEZEWAY

Garages exceeding 1000 square feet in area should not be attached to, or built into, one- or two-family dwellings.

Attached or built-in garages should be fire protected as follows:

(A) Noncombustible finish providing at least 10-minute protection against ignition to combustible parts of structure. Those parts of walls, floors, and ceilings of garages that are in common with walls, floors and ceilings of dwellings should have, in addition to the noncombustible garage side finish, an over-all fire-resistance rating of 30 minutes or more.

(B) Self-closing door equivalent to those indicated in illustration entitled, "Opening Protectives: Wood Doors," part 4, page 17.

(C) Masonry or concrete steps or curb at least 8 inches high at communicating doorway. Such curb should be used under all walls, other than of masonry, in common with the garage and dwelling.

(D) Noncombustible finish providing minimum 10-minute protection against ignition to combustible parts of the garage within 5 feet of the dwelling.

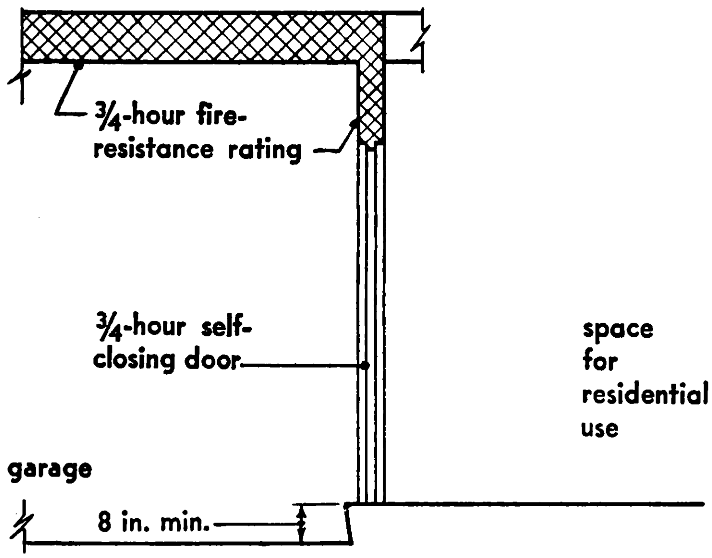
When an attached garage is 5 feet or more from a dwelling, the breezeway roof space should be firestopped at the garage end with materials as set forth in illustration entitled, "Firestopping Details—3," part 4, page 34.

Garages and Multiple Dwellings

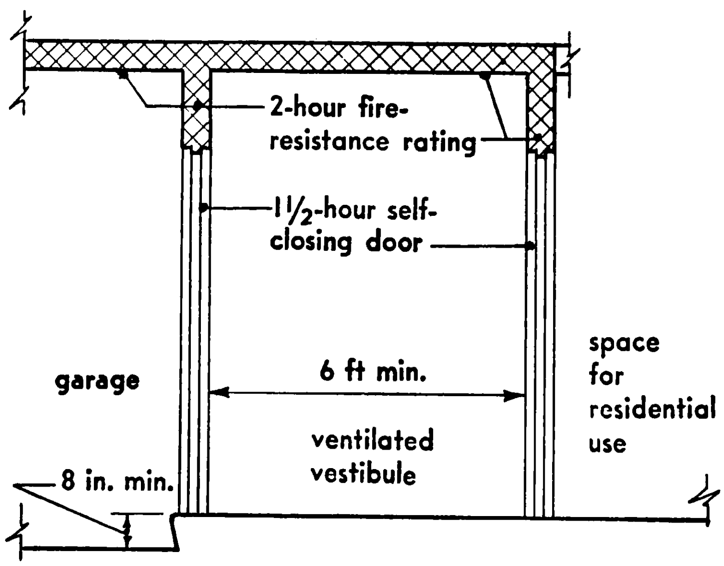
Fire separations between garages having not more than 1000 square feet of area and space for residential use should have a fire-resistance rating of at least ¾ hour. Openings for passage between the garage and space for residential use should be protected by ¾-hour self-closing doors.

Fire separations between garages more than 1000 square feet in area and space for residential use should have a fire-resistance rating of at least 2 hours. Openings for passage between the garage and space for residential use should be protected by a ventilated vestibule with at least 6′-0″ between doors. Such doors should be self-closing and each should have a fire-resistance rating of at least 1½ hours.

Masonry or concrete steps or curb should be provided in all openings for passage between the garage and dwelling. Such curb should be used under all walls, other than of masonry, in common with the garage and dwelling.



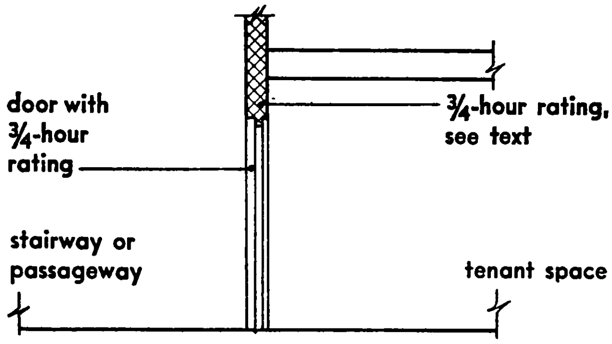
GARAGES OF NOT MORE THAN 1000 SQUARE FEET AREA



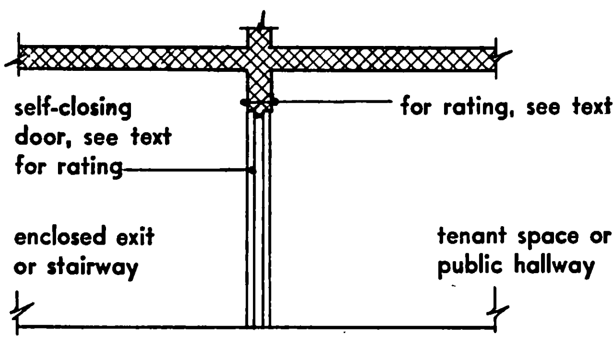
GARAGES OF MORE THAN 1000 SQUARE FEET AREA

SECTIONS

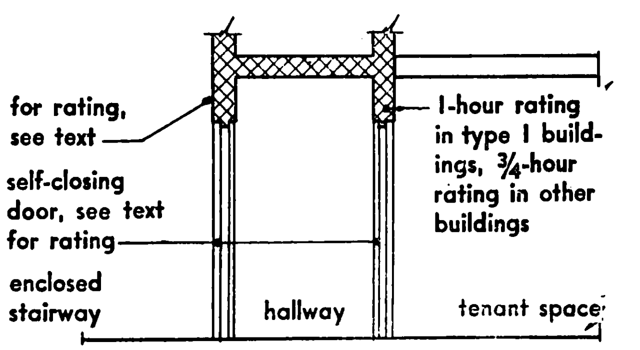
Enclosure of Exits, Stairways, and Public Hallways



BETWEEN TENANT SPACE AND EXIT STAIRWAY OR PASSAGEWAY IN TWO-FAMILY DWELLINGS



BETWEEN TENANT SPACE OR PUBLIC HALLWAY AND ENCLOSED EXIT IN MULTIPLE DWELLINGS



BETWEEN TENANT SPACE AND PUBLIC HALLWAYS OR ENCLOSED STAIRWAY

SECTIONS

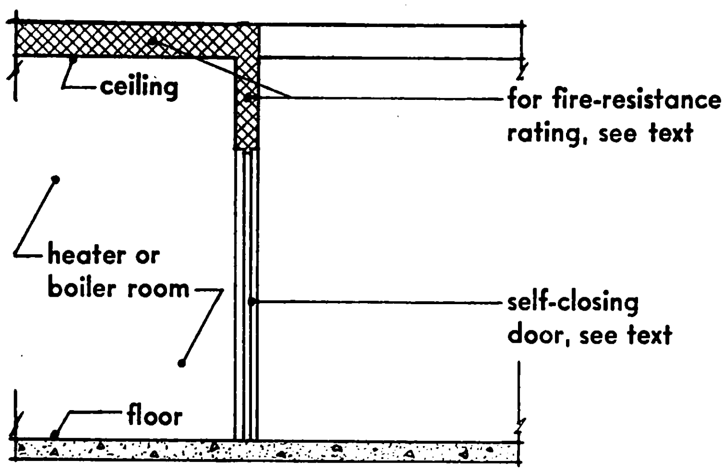
Stairways and passageways, serving both dwelling units or serving one unit and passing through or adjoining the other unit in a two-family dwelling, shall be enclosed with a fire separation having a fire-resistance rating of at least ¾ hour. Openings in such fire separations shall be protected with ¾-hour doors.

Tenant spaces in multiple dwellings shall be separated from public hallways by fire separations having a fire-resistance rating of at least 1 hour in buildings of type 1 construction and at least ¾ hour in buildings of type 2, 3, 4 or 5 construction. Openings in such fire separations shall be equipped with self-closing opening protectives of fire-resistance rating required by table B 402-4.8 of the Code.

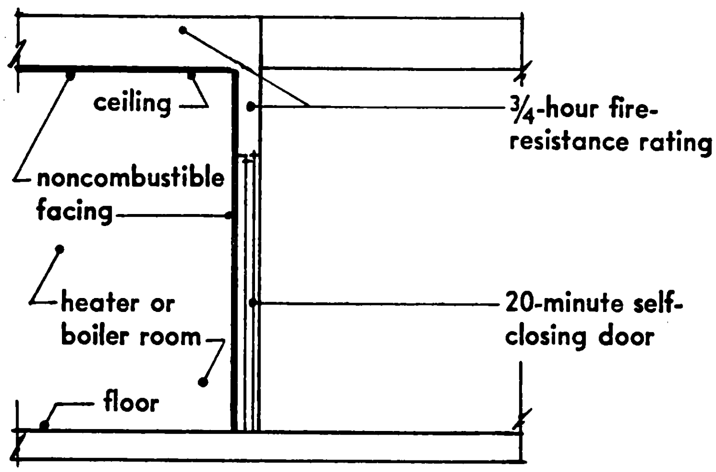
Exits, including stairways and passageways forming a part thereof, shall be enclosed with fire separations having a fire-resistance rating to outside exposure of at least 2 hours; except that in buildings not more than three stories in height, and with not more than eight dwelling units within a fire area, the rating may be 1 hour in type 1 construction and ¾ hour in type 2, 3, 4 or 5 construction. The fire-resistance rating to inside exposure shall be at least 1 hour for all buildings of type 1 construction and ¾ hour for all buildings of type 2, 3, 4 or 5 construction.

In multiple dwellings more than three stories high, the exit stairway shall be separately enclosed. Openings in such fire separations shall be equipped with self-closing opening protectives of fire-resistance rating required by table B 402-4.8 of the Code. In multiple dwellings not more than three stories high, the public hallway may be within the enclosure for the stairway when not more than eight dwelling units are within the fire area.

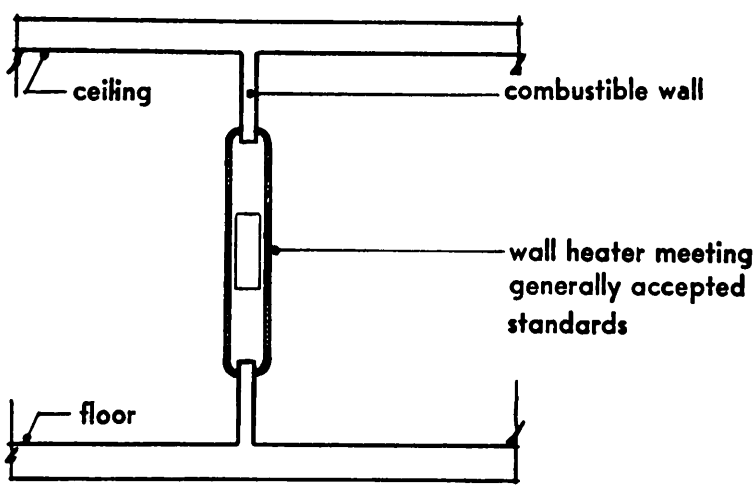
Enclosure of Heat Producing Equipment



CENTRAL HEATING EQUIPMENT IN MULTIPLE DWELLINGS



HEATING EQUIPMENT FOR A SEPARATE DWELLING UNIT



MOUNTING OF RECESSED WALL HEATERS

SECTIONS

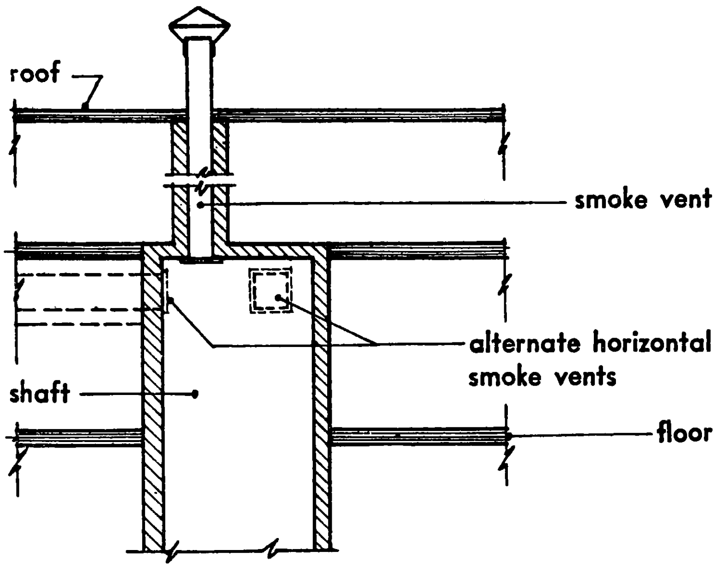
Fuel-burning equipment for central heating of multiple dwellings shall be enclosed by fire separations having a fire-resistance rating of at least 2 hours with 1½-hour self-closing doors when such equipment is capable of operation at pressures in excess of 15 psi or has a gross capacity of 1,000,000 Btu per hour or more.

When the capacity is 250,000 to 1,000,000 Btu per hour, the fire separation shall have a fire-resistance rating of at least 1 hour with ¾-hour self-closing doors.

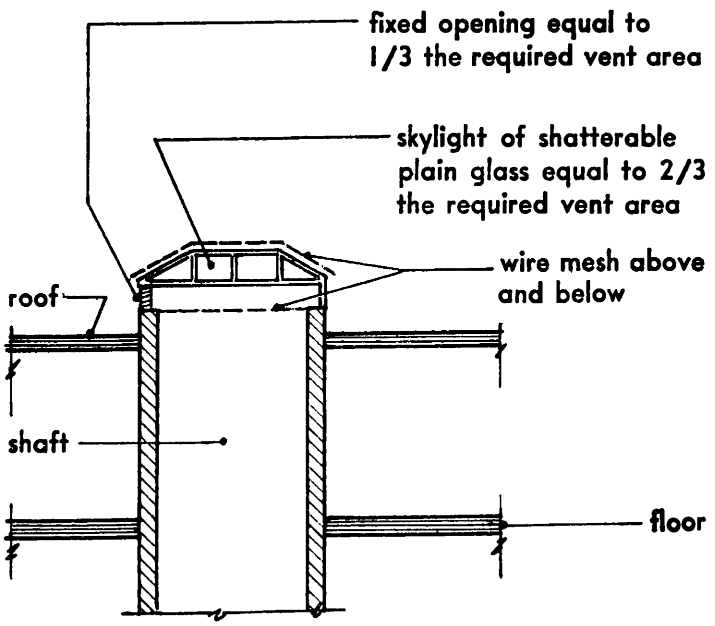
When the gross capacity of such equipment is less than 250,000 Btu per hour, enclosures shall not be required except that heaters and boiler rooms in motels shall be separated from other space by 1-hour fire separations with interior openings equipped with ¾-hour self-closing doors.

Equipment for heating separate dwelling units, located on the first floor or above, and having a gross capacity of less than 250,000 Btu per hour, shall be enclosed by a ¾-hour fire separation unless tests made in conformity with generally accepted standards in an approved laboratory show that such equipment will not create a fire hazard or heat adjacent combustible material above 175° F.

Smoke Vents for Stairways, Shafts, or Hoistways



SHAFT OR HOISTWAY PASSING THROUGH MORE THAN TWO STORIES AND WHICH DOES NOT EXTEND THROUGH THE ROOF



STAIRWAY, SHAFT OR HOISTWAY SERVING TOPMOST STORY OF A MULTIPLE DWELLING, AND EXTENDING THROUGH THE ROOF

Stairways, shafts, and hoistways shall be provided with smoke vents having an area of at least 3½ per cent of that of the stairway, shaft, or hoistway but not less than 3 square feet for each elevator car in an elevator hoistway or less than 72 square inches for other types of shafts. At least one third of the required vent area shall be of the open type. The closed portion of the required vent area may be a window or skylight with metal frames glazed with shatterable plain glass not more than ⅛-inch thick and protected above and below with wire mesh. Windows used for the closed portions of smoke vents in shafts or hoistways extending through the roof shall be at least 3 feet from an interior lot line and at least 2 feet above the roof.

Shafts or hoistways which do not extend through the roof may be provided with a single smoke vent continuing vertically to and through the roof. When a single vertical smoke vent is impracticable, two horizontal vents, each having the same area as required for the single vent, terminating at different sides of the building, may be used.

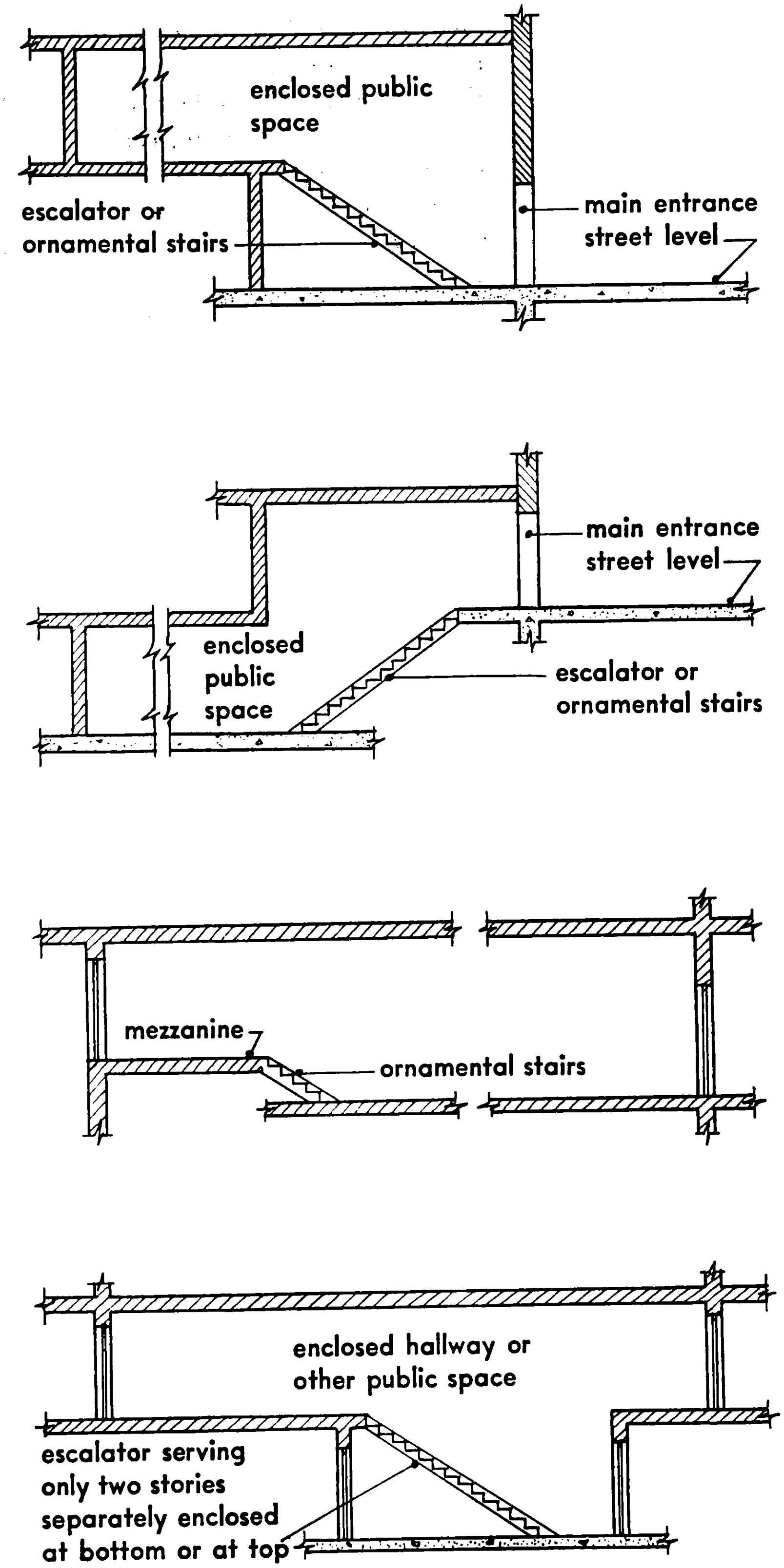
All portions of smoke vents within a building shall be of noncombustible construction having a fire-resistance rating at least equal to that required for the enclosure of the shaft or hoistway.

Enclosure of Escalators and Ornamental Stairs

Escalators and ornamental supplementary stairs in multiple dwellings shall not be required to be enclosed when they connect the main entrance to the story immediately above; or connect the main entrance to the story immediately below; or lead to a mezzanine or different level in the same story; or pass through only one floor construction to or from a fully enclosed space in either of the stories which they connect.

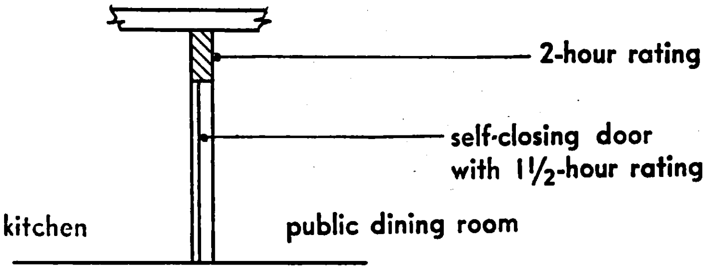
The arrangements and conditions illustrated under which escalators and ornamental stairs may be used without separate enclosures shall be interpreted to mean that the public space either on the top or bottom of the escalator or stair shall be separated from exit stairways and other space with fire separations meeting the requirements indicated in the illustration entitled, "Enclosure of Exits, Stairways, and Public Hallways," part 4, page 25.

When escalators are used in lieu of stairs and pass through more than one floor construction they shall be protected in the same manner as required for separately enclosed exits and stairways.

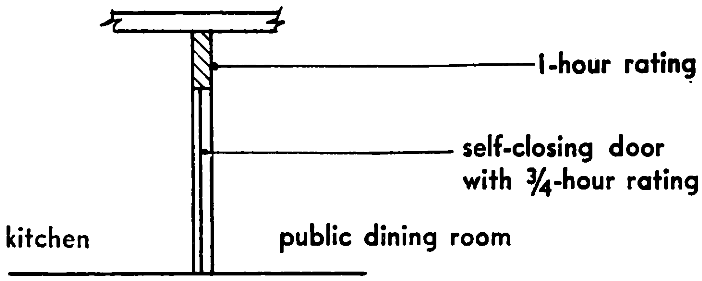


TYPICAL ARRANGEMENT OF ESCALATORS AND ORNAMENTAL STAIRS NOT REQUIRED TO BE SEPARATELY ENCLOSED

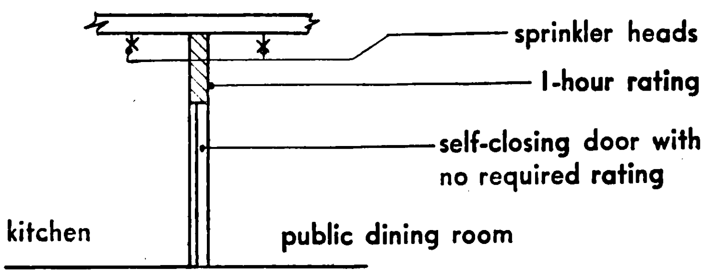
Separation Between Kitchens and Public Dining Rooms



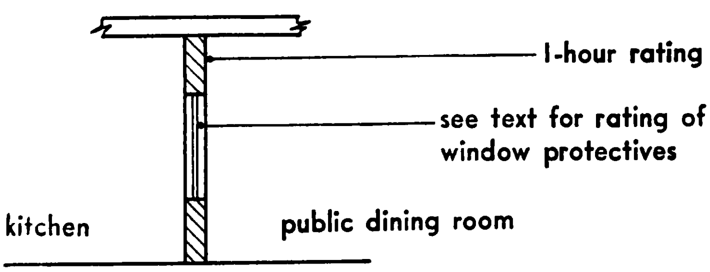
KITCHEN WITHOUT SPRINKLER SYSTEM



KITCHEN EQUIPPED WITH SPRINKLER SYSTEM



KITCHEN EQUIPPED WITH SPRINKLER SYSTEM WITH SPRINKLER HEADS OVER OPENING



WINDOW PERMITTED WHEN KITCHEN IS SPRINKLERED

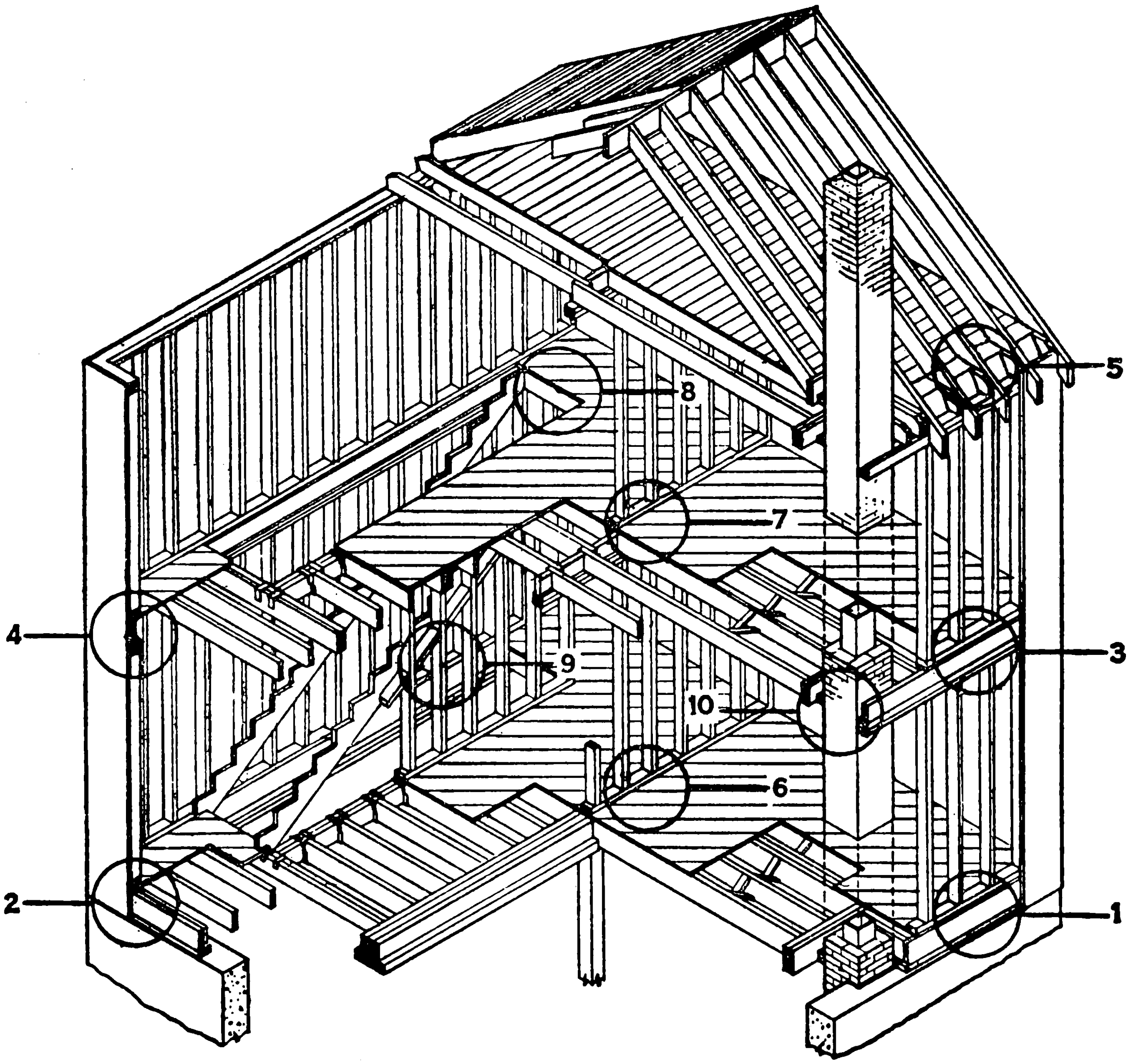
Kitchens and pantries serving public dining rooms, including but not limited to restaurants, cafeterias, coffee shops, and lunch rooms, shall be enclosed by construction having a fire-resistance rating of at least 2 hours; except that when a sprinkler system is installed in the kitchen and pantry the enclosure may have a rating of 1 hour.

Openings between such kitchens and pantries and the public dining rooms which they serve shall be protected with: self-closing 1½-hour opening protectives when the kitchens or pantries are not sprinklered; or self-closing ¾-hour opening protectives when the kitchens and pantries are sprinklered; or self-closing doors having a rating of less than ¾ hour when the kitchens and pantries are sprinklered and sprinkler heads are provided above such openings on each side of the fire separation.

Windows may be placed in the fire separation when the kitchen and pantry are sprinklered. Opening protectives shall not be required for such window openings provided additional sprinkler heads are placed above and not more than 4 feet from each side of the fire separation. Such sprinkler heads shall be not more than 3 feet measured parallel to the fire separation, from the edge of the opening or not more than 4 feet apart when more than one head is required. When sprinkler heads are not provided on each side of the fire separation, the window shall be equipped with opening protectives having a rating of at least ¾ hour.

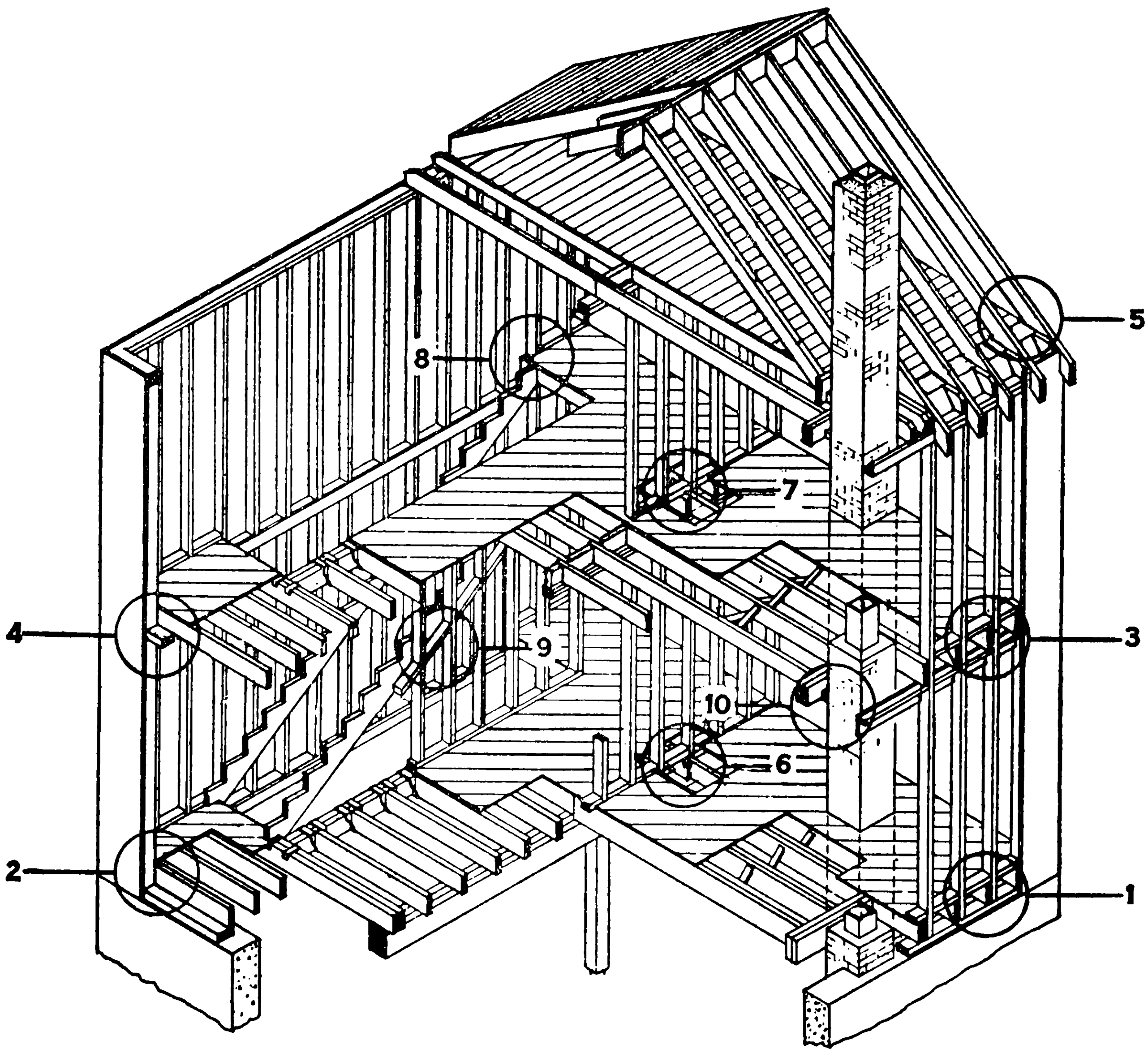
Glass block panels and wired glass in metal frames shall be deemed acceptable as ¾-hour opening protectives.

Locations Requiring Firestopping—1



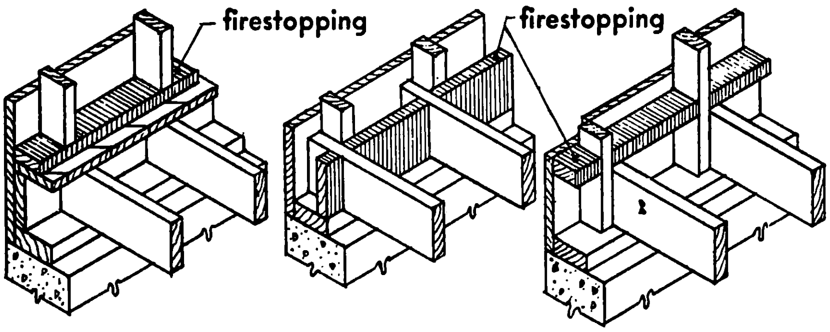
Platform Frame Construction

Locations Requiring Firestopping—2



Balloon Frame Construction

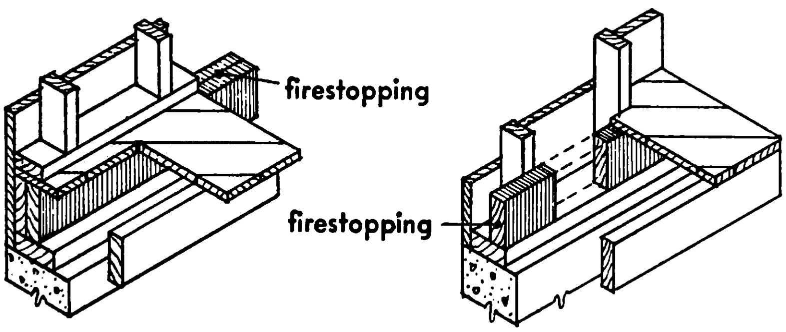
Firestopping Details—1



PLATFORM FRAME   BALLOON FRAME

LOCATION 1

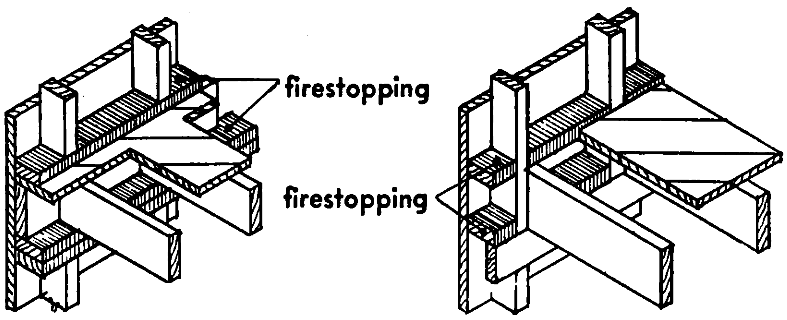
1 For platform frame construction: The sole serves as firestopping. For balloon frame construction: Two-inch wood blocking or the equivalent shall be added between joists or between studs for firestopping.



PLATFORM FRAME   BALLOON FRAME

LOCATION 2

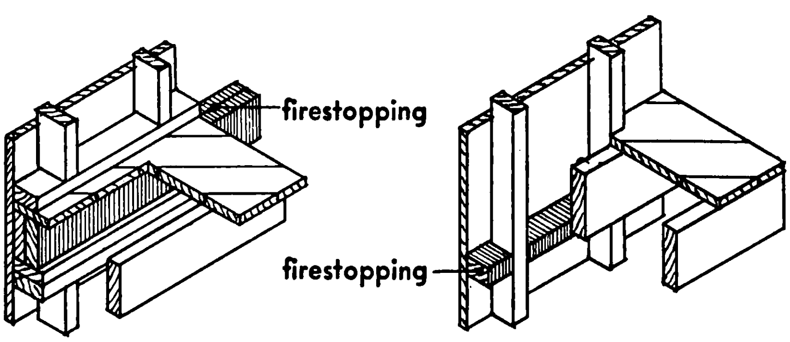
2 For platform frame construction: The double joist serves as firestopping. For balloon frame construction: The joist adjacent to the studs serves as firestopping.



PLATFORM FRAME   BALLOON FRAME

LOCATION 3

3 For platform frame construction: The sole and double plate serve as firestopping. For balloon frame construction: Two-inch wood blocking or the equivalent shall be added between studs for firestopping.

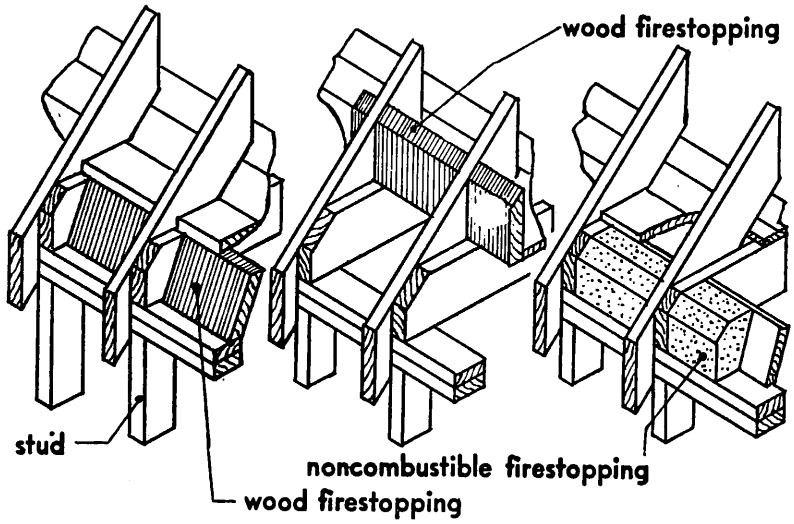


PLATFORM FRAME   BALLOON FRAME

LOCATION 4

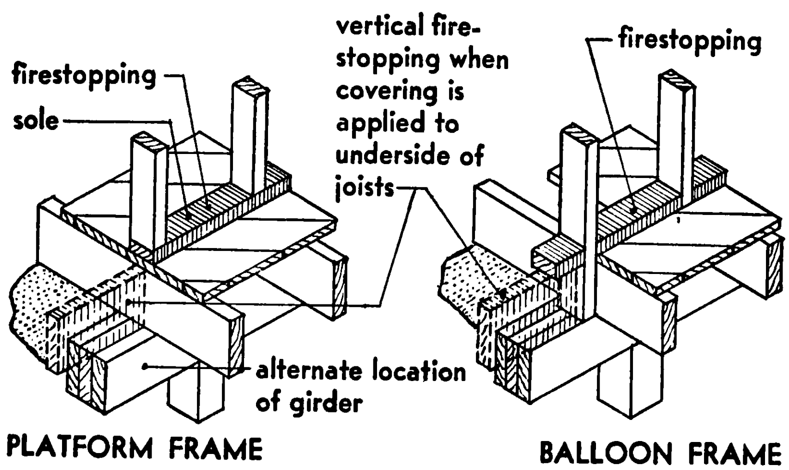
4 For platform frame construction: The double joist serves as firestopping. For balloon frame construction: Two-inch wood blocking or the equivalent shall be added between studs for firestopping.

Firestopping Details—2



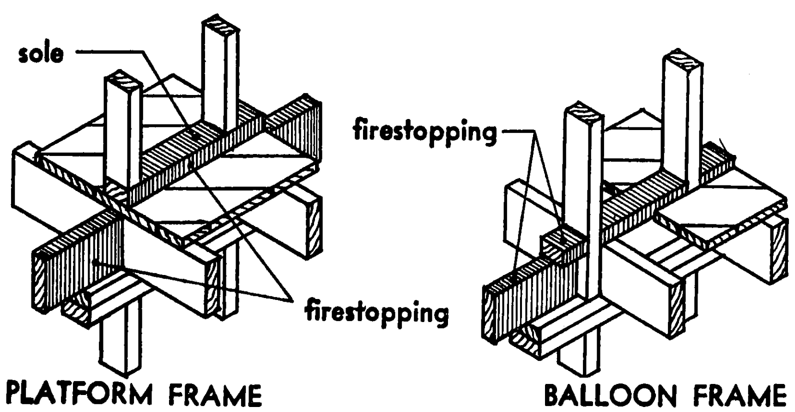
LOCATION 5

5 Firestopping shall be 2 inches of wood blocking or of noncombustible fill.



LOCATION 6

6 For platform frame construction: The sole and 2 inches of wood blocking placed between joists serve as firestopping. For balloon frame construction: Two inches of wood blocking or equivalent shall be added between studs for firestopping. When underside of joists is sealed, 2 inches of wood or equivalent shall be added between joists as illustrated.

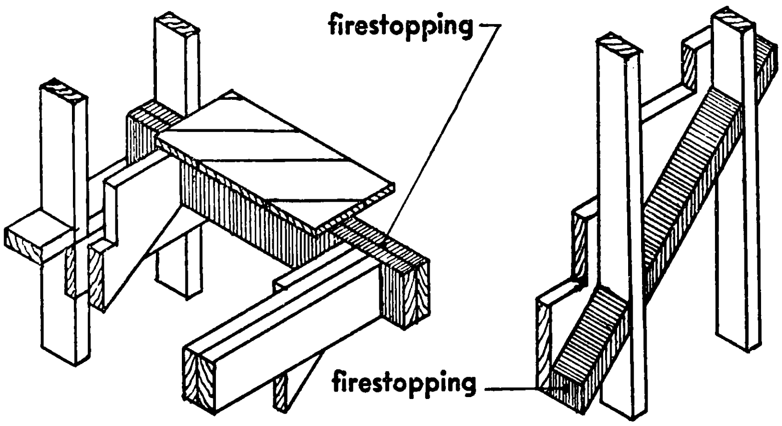


LOCATION 7

7 For platform frame construction: The sole and 2 inches of wood blocking placed between joists serve as firestopping. For balloon frame construction: Two inches of wood blocking or equivalent shall be placed between the joists and between the studs for firestopping.

Note: When pipes, ducts or conduits pass through firestopping, the opening around them shall be sealed with noncombustible material or fitted wood blocking.

Firestopping Details—3

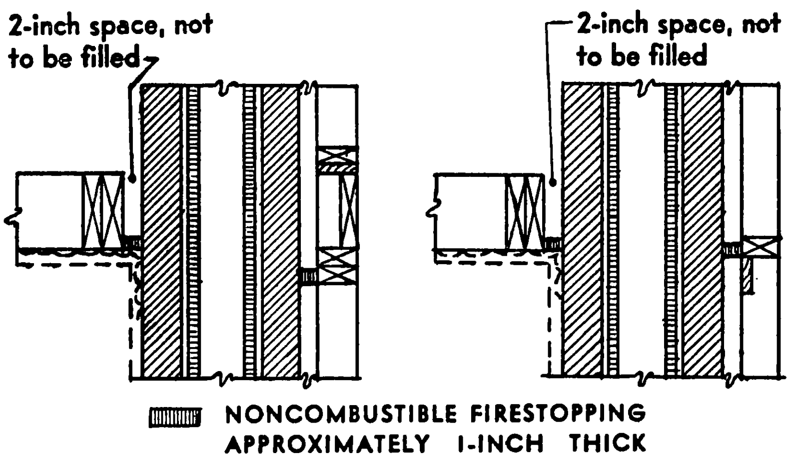


LOCATION 8

LOCATION 9

8 The header serves as firestopping.

9 Two-inch wood blocking or the equivalent shall be added between studs in partition adjacent to stringer to serve as firestopping.



PLATFORM FRAME

BALLOON FRAME

LOCATION 10

10 The space between a chimney and combustible floor framing shall be firestopped at the bottom with approximately 1-inch depth of noncombustible material held in place by metal lath or wire fabric. Such firestopping shall not be required when the bottom of the vertical opening is sealed by plaster on the ceiling and chimney. The space above the firestopping shall be left unfilled so that heat from the chimney can be carried away by air currents moving upward and out through normal shrinkage cracks of the interior finish.

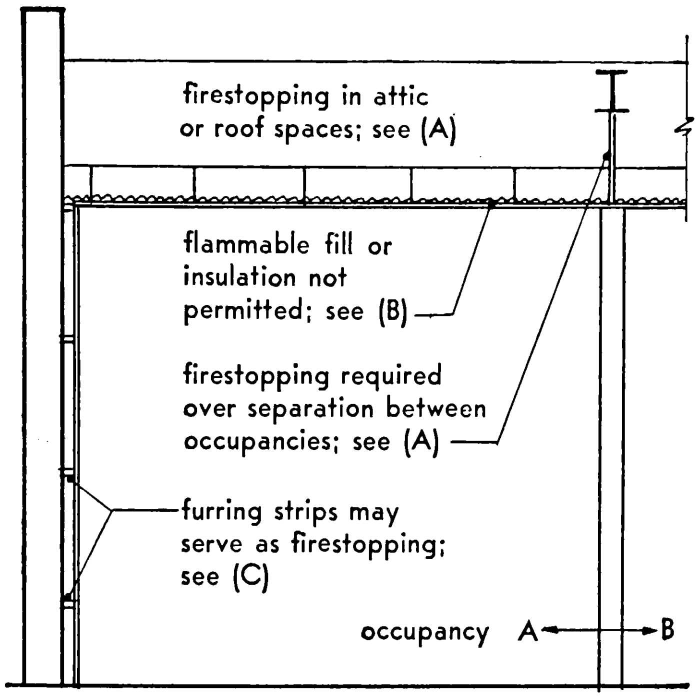
Plaster ceiling on noncombustible lath, extending to chimney faces, will serve as firestopping.

Material

Combustible firestopping may be wood blocking of 2-inch nominal thickness or two layers of 1-inch nominal thickness assembled so that there are no through joints.

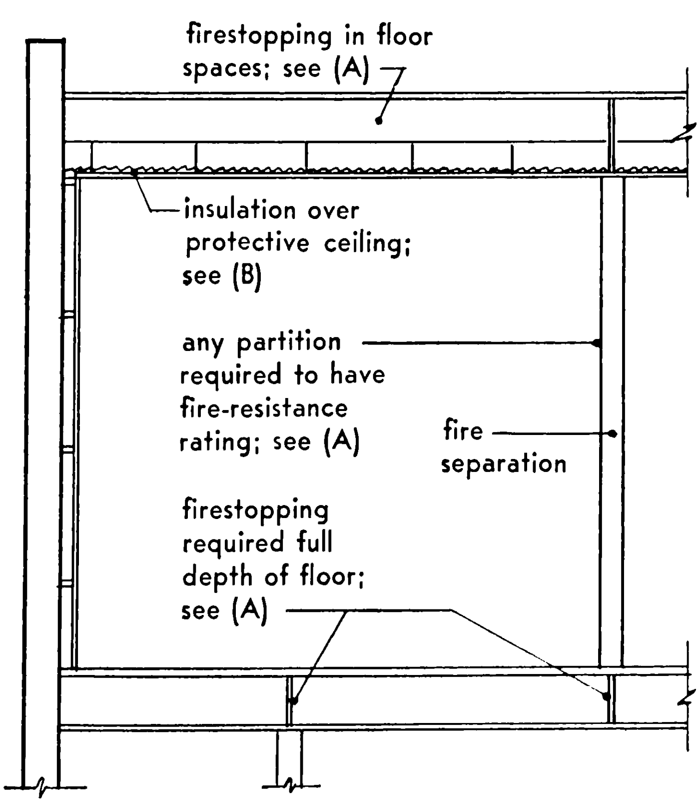
Noncombustible firestopping may be masonry, concrete, plaster, mortar, wallboard or similar material not less than ¼-inch thick, sheet metal of at least 24 U.S. gage, and mineral, slag or rock wool. Metal reinforcement or support such as metal lath should be used when needed to hold firestopping materials in place.

Firestopping Details—4



SECTION

FIRESTOPPING IN ATTICS OR ROOFS



SECTION

FIRESTOPPING IN FLOORS

(A) Concealed space in attics, roofs, or floors, shall be firestopped so that the area between firestopping does not exceed 3000 square feet in combustible construction, or 5000 square feet in noncombustible construction, with no dimension exceeding 100 feet. Firestopping should be placed in the attic or roof space above fire separations between occupancies or tenancies. Firestopping extending the full depth of the joists should also be located above or below any permanent partition required to have a fire-resistance rating. Wood joists, beams, or girders of at least 2 inches (nominal) thickness, or solid web steel joists, beams, or girders may serve as firestopping.

(B) Flammable fill or insulation should not be used in concealed floor or wall spaces, except that asphalt-saturated vapor barriers attached to noncombustible fiber insulation may be used as indicated in "Condensation Control in Buildings," part 3, page 94. Insulation or fill used to increase the rating of fire-protective ceilings should be entirely of noncombustible materials.

(C) Where combustible materials form a part of the concealed space between wall or ceiling finishes and the base to which they are applied, the concealed space should be firestopped so that no dimension of such space exceeds 8 feet vertically or 20 feet horizontally. Wood furring strips are acceptable as firestopping of concealed spaces formed by all classes of insulation.

Interior Finishes

Classification—Interior finishes are divided into four classes designated as A, B, C, and D. Classification is based on the surface flame-spread ratings determined by tests made in conformity with ASTM, *Tentative Method of Fire Hazard Classification of Building Materials (E 84-50T).*

Class A interior finishes include masonry, concrete, glass, stone, metal, ceramic tile, cement-asbestos board, acoustical and insulation board of noncombustible material and other materials having a flame-spread rating not exceeding 20.

Class B interior finishes include materials meeting the requirements for "slow burning" as set forth in FS, *Acoustical Units; Prefabricated (SSA 118b 1954)* and other materials having a flame-spread rating exceeding 20, but not exceeding 75.

Class C interior finishes include materials designated as Class F insulating board by *CS 42-49,* plywood conforming to the requirements of *CS 45-55,* untreated wood of at least 1-inch (nominal) thickness and other materials having a flame-spread rating exceeding 75, but not exceeding 200.

Class D interior finishes include the same type of untreated cellulose board and other materials having a flame-spread rating exceeding 200, but not exceeding 500.

Materials finished with fire-retardant coatings listed in ULI, *Fire Protection Equipment List, January 1956,* as having a flame-spread rating not exceeding 20 and 75, respectively, are deemed to meet the Code requirements for Class A and B interior finishes.

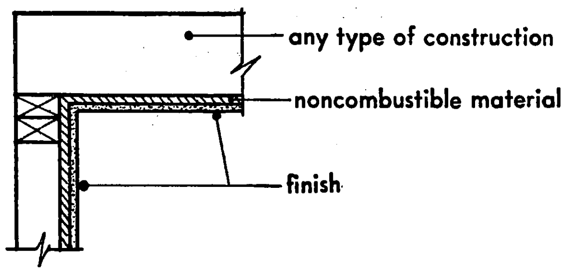
Fire-retardant paints and similar coatings do not have a rating but they do improve the flame-spread rating of interior finishes and the fire-resistance rating of building members. Such improvement is dependent upon the characteristics of the interior finish or building member to which the coating is applied. The extent of such improvement is determined only by comparable tests of interior finishes or structural members, with and without the coating material.

Attachment

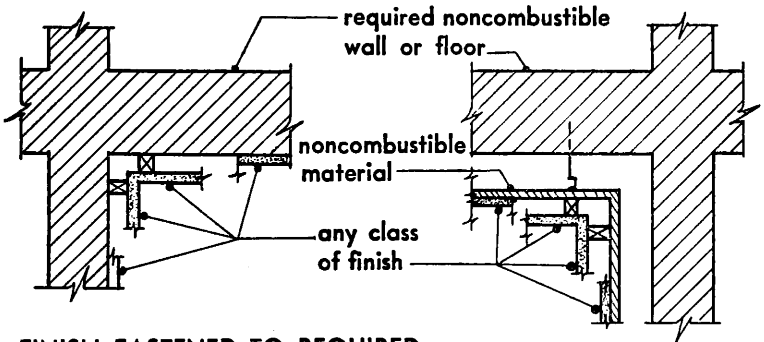
Requirements for the attachment of interior finishes to walls and ceilings are indicated in illustrations entitled, "Interior Finishes: Attachment," part 4, page 37.

Where interior finishes are furred out from a wall or ceiling, the furring strips may be of wood and may serve as firestopping as indicated in illustration entitled, "Firestopping Details—4," part 4, page 35.

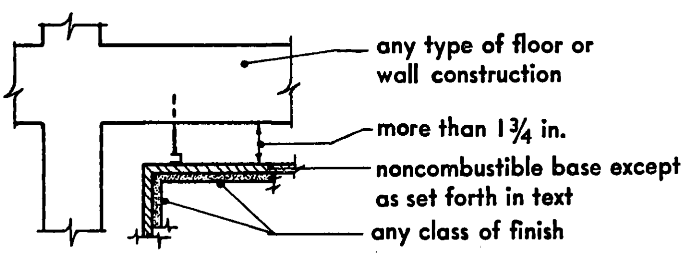
Interior Finishes: Attachment



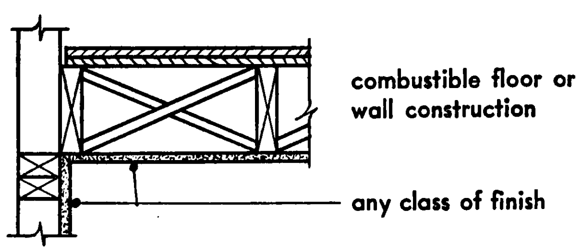
FINISH LESS THAN 1/8 INCH THICK



FINISH FASTENED TO REQUIRED NONCOMBUSTIBLE WALL OR FLOOR



FINISH SET OUT FROM WALL OR SUSPENDED FROM CEILING



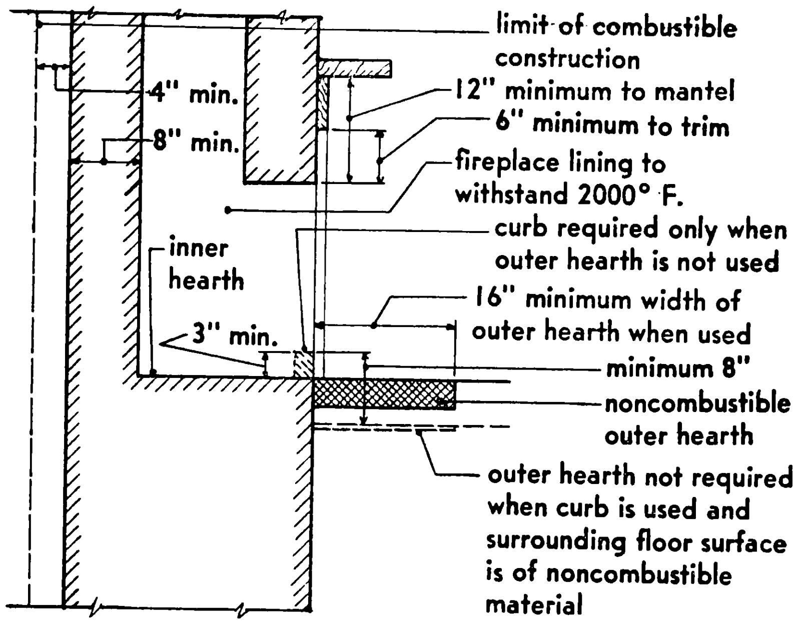
ATTACHMENT OF FINISH IN BUILDINGS NOT MORE THAN 3 STORIES HIGH

When walls and floors are required by the type of building construction or by other Code regulations to be constructed of noncombustible materials, the interior finish shall be attached directly to a noncombustible backing or to furring or nailing strips not exceeding 1¾ inches thick. The noncombustible backing may be the wall or ceiling construction or noncombustible material set out from the wall or ceiling.

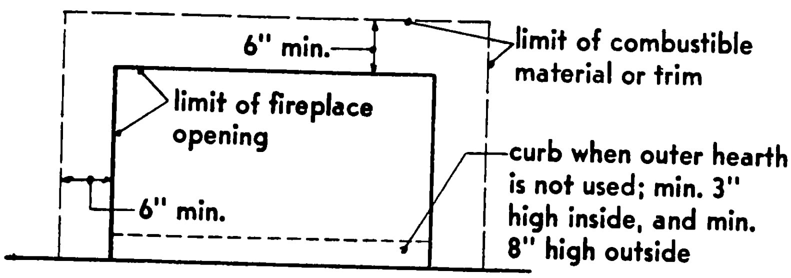
When the walls and floors are not required to be noncombustible, interior finish may be set out from the wall or suspended from the ceiling, provided that it is attached to a noncombustible backing, or the space back of the finish is firestopped so that no dimension of such space exceeds 8 feet vertically or 20 feet horizontally.

In multiple dwellings not more than three stories in height or which contain less than thirty sleeping rooms for transient occupancy, interior finishes may be applied directly to combustible structural members or to a combustible base.

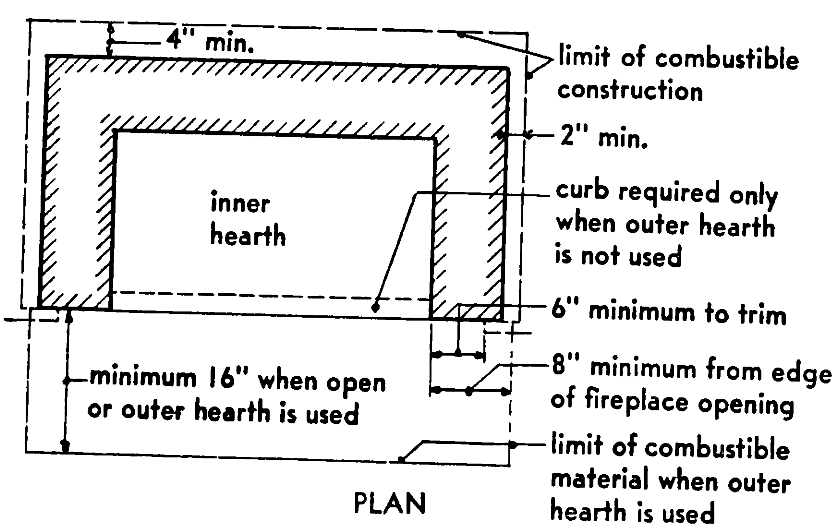
Clearances from Combustible Construction



SECTION



ELEVATION



PLAN

Linings capable of withstanding 2000° F. temperature are clay brick other than shale, fire brick, soapstone, cast iron.

Wood mantels and trim should be attached so that they cannot be heated to temperatures in excess of 175° F., or be ignited by sparks or embers.

Fireplaces should be constructed so that, when they are in use, adjacent or nearby combustible material shall not be heated to temperatures in excess of 175° F. or be exposed to sparks or embers.

When fireplaces have openings on more than one side, the inner hearth should be depressed, or provided with a curb at least 3 inches high. Such fireplaces should also be provided with permanently attached screens to prevent sparks or embers from being scattered into the room.

Fire-Resistance Ratings

The fire-resistance ratings herein are based on fire tests made in conformity with generally accepted standards or have been determined by extension or interpretation of information derived from such tests.

The fire-resistance ratings are given in time periods of ½, ¾, 1, 1½, 2, 3, and 4 hours to conform with the requirements set forth in the State Building Construction Code.

Ratings are for the structural elements and assemblies commonly used in buildings, but do not include proprietary materials or constructions using special features.

The structural elements and assemblies are grouped on a functional basis and illustrated. Each illustrated structural element or assembly has been given a designation, such as "W2-1". Each designation includes: a letter representing the type of structural element; a numeral representing the distinguishing characteristic of the element; and a second numeral representing each structural element that is illustrated.

The structural elements are described on the same page with the applicable illustration and arranged in the order of increasing fire resistance. The descriptions include those specific factors, such as wall thickness, kind of lath, kind and thickness of plaster and kind of framed-in members, which have a direct effect on the fire-resistance rating.

General requirements for all constructions in which they are applicable follow: All materials should conform to generally accepted standards. Wood structural members should have a nominal thickness of at least 2 inches. Double wood flooring should have a paper membrane between the subflooring and finish flooring.

The nature of the aggregate is a factor affecting the fire resistance of concrete. The types of concrete aggregates are:

Type 1: Blast-furnace slag, limestone, calcareous gravel, trap rock, burnt clay or shale, and other dense materials containing not more than 30 per cent of quartz, chert, flint, and similar materials.

Type 1a: Cinders containing not more than 25 per cent of combustible material and not more than 5 per cent of volatile material, expanded burnt clay or shale, expanded slag, and similar materials.

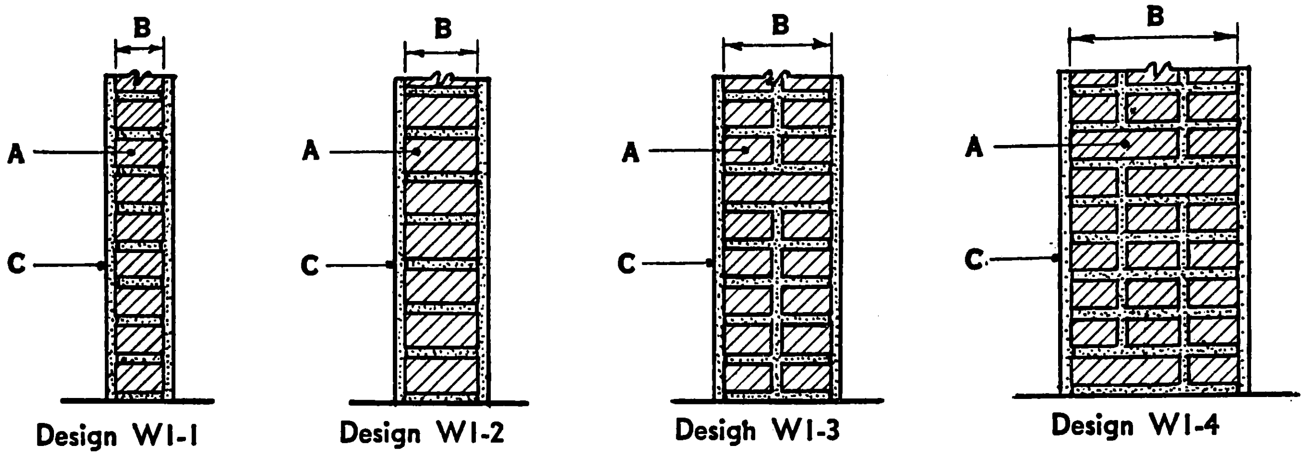
Type 1b: Pumice and similar lightweight materials.

Type 2: Granite, quartzite, siliceous gravel, sandstone, gneiss, and other dense materials containing more than 30 per cent of quartz, chert, flint, and similar materials.

Plaster mixes are given when the ratio of cementing material to aggregate is an important factor. The mix for sanded plasters is weight of cementing material to weight of sand, and for gypsum-perlite and gypsum-vermiculite plasters pounds of gypsum to cubic feet of aggregate. When two mixes are given consecutively the first is for the scratch and the second for the brown coat. When only one mix is given it is the same for the scratch and brown coats.

When plaster is required on masonry walls or partitions, it shall be used on the fire-exposed side.

Walls of Solid Brick: Bearing or Nonbearing



SECTIONS

(A) Brick which is not less than 75 per cent solid, and of the kind given in table.

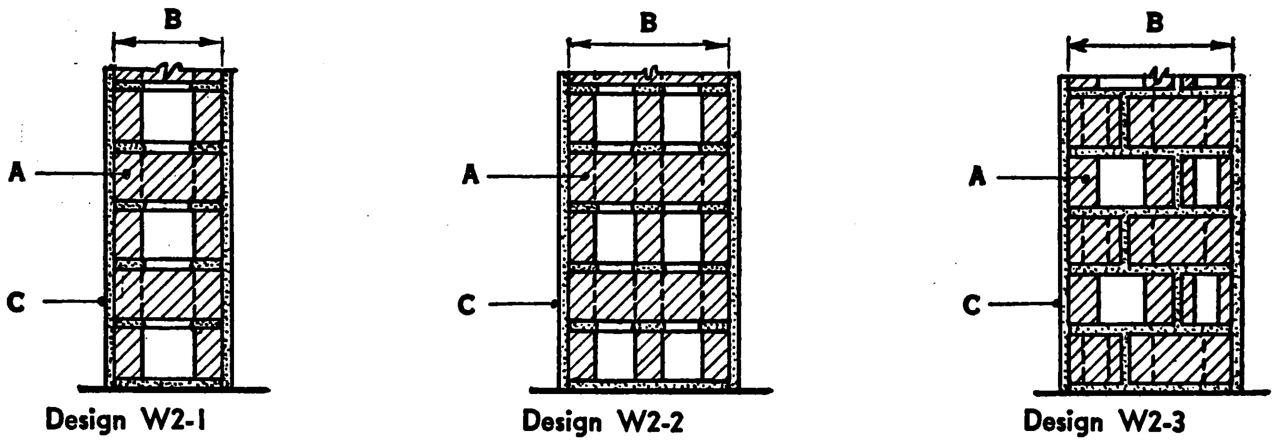
(B) Nominal thickness of wall as given in table.

(C) Finish of gypsum-sand, Portland cement-sand, gypsum-perlite or gypsum-vermiculite plaster at least ½-inch thick, and having not more than three parts of aggregate to one part of cementing material.

Design	Nominal thickness of wall (B) in inches	Kind of brick (A)	Finish (C)	Kind of framed-in members	Rating in hours
W1-1	4	Clay, shale, concrete or sandlime	None	None	1 [1]
W1-1	4	Clay or shale	Plaster	None	2 [1]
W1-2	6	Clay or shale	None	Noncombustible	2
W1-3	8	Clay, shale, concrete or sandlime	None	Combustible	2
W1-3	8	Clay, shale, concrete or sandlime	Plaster	Combustible	2
W1-1	4	Concrete or sandlime	Plaster	None	3 [1]
W1-3	8	Clay, shale, concrete or sandlime	None or plaster	Noncombustible	4
W1-4	12	Clay, shale, concrete or sandlime	None or plaster	Combustible or noncombustible	4

[1] Nonbearing.

Walls of Hollow Brick Units: Bearing or Nonbearing



SECTIONS

(A) Clay units which are less than 75 per cent solid. Such units are generally 4 or 8 inches thick, 12 inches long and from 3 to 5 inches high, and have face shells at least 1½-inches thick and two or more cells extending vertically as laid in the wall.

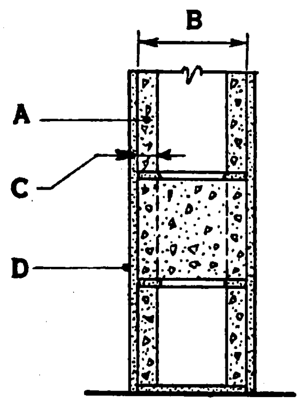
(B) Nominal wall thickness as given in table.

(C) Gypsum-sand, Portland cement-sand, gypsum-perlite, or gypsum-vermiculite plaster at least ½-inch thick and having not more than three parts of aggregate to one part of cementing material.

Design	Nominal wall thickness (B) in inches	Number of units in wall thickness	Number of cells in wall thickness	Finish (C)	Kind of framed-in members	Rating in hours [1]
W2–1	8	1	1	None	Combustible	1
W2–1	8	1	1	Plaster	Combustible	2
W2–1	8	1	1	None	Noncombustible	3
W2–2	12	1	2	None	Combustible	3
W2–1	8	1	1	Plaster	Noncombustible	4
W2–2	12	1	2	None	Noncombustible	4
W2–2	12	1	2	Plaster	Combustible or noncombustible	4
W2–3	12	2	2	None or plaster	Combustible or noncombustible	4

[1] When combustible framed-in members are embedded in solid masonry extending at least 4 inches below and to the sides and ends of such members, the ratings given for walls with noncombustible framed-in members shall apply; except that the rating for 8-inch walls with combustible framed-in members shall not exceed 2 hours.

Walls of Hollow Concrete Masonry Units: Bearing



Design W3-1
SECTION

(A) Concrete masonry units conforming to ASTM, *Standard Specifications for Hollow Load-Bearing Concrete Masonry Units.*

(B) Nominal wall thickness as given in table.

(C) Nominal shell thickness as given in table.

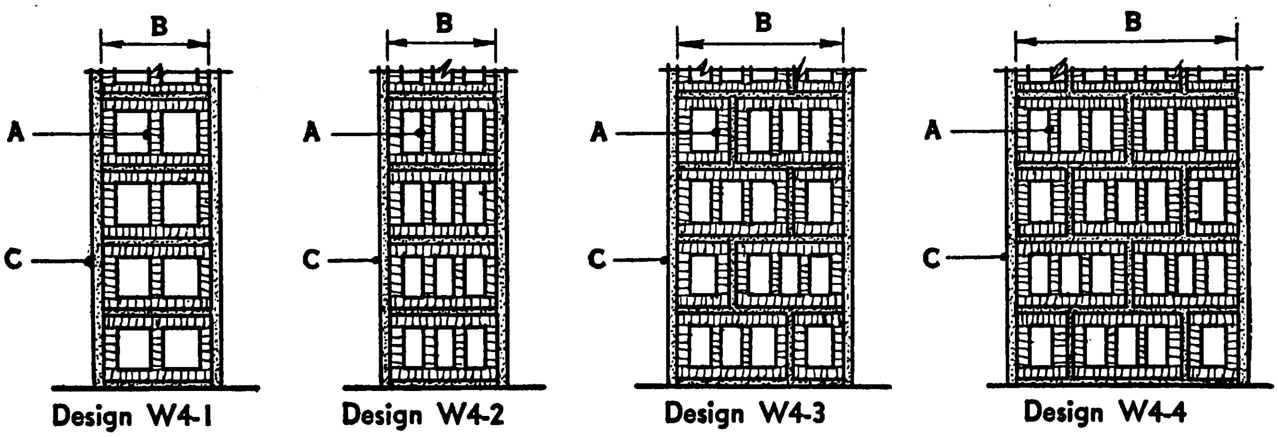
(D) Gypsum plaster at least ½-inch thick, and having not more than three parts of aggregate to one part of cementing material.

Design	Nominal thickness of wall (B) in inches	Minimum thickness of face shells (C) in inches	Type of aggregate [1]	Finish (D)	Kind of framed-in members	Rating in hours [2]
W3–1	8 or 12	1⅛	1a	None	Combustible	¾
W3–1	8 or 12	2⅛	1	None	Combustible	1
W3–1	8 or 12	1⅜	1a	None	Combustible	1
W3–1	8 or 12	1⅛	1a	Plaster	Combustible	1
W3–1	8 or 12	1⅜	1b	None	Combustible	1
W3–1	8 or 12	1⅜	1b	Plaster	Combustible	1
W3–1	8 or 12	1¼	2	Plaster	Combustible	1
W3–1	8 or 12	1¼	1	None	Noncombustible	2
W3–1	8 or 12	1¼	1	Plaster	Combustible	2
W3–1	8 or 12	1¼	1	Plaster	Noncombustible	2
W3–1	8 or 12	1⅛	1a	None	Noncombustible	2
W3–1	8 or 12	1⅝	1b	Plaster	Combustible	2
W3–1	8 or 12	1¼	2	Plaster	Noncombustible	2
W3–1	8 or 12	1½	1	Plaster	Noncombustible	3
W3–1	8 or 12	1⅝	1a	None	Noncombustible	3
W3–1	6	1½	1a	None	Noncombustible	3
W3–1	8 or 12	1⅛	1a	Plaster	Noncombustible	3
W3–1	8 or 12	1⅜	1b	None	Noncombustible	3
W3–1	6	1½	1a	Plaster	Noncombustible	4
W3–1	8 or 12	1⅜	1a	Plaster	Noncombustible	4
W3–1	8 or 12	1⅜	1b	Plaster	Noncombustible	4
W3–1	8 or 12	1⅝	1b	None	Noncombustible	4

[1] See preface to these tables for kinds of aggregate in each type.

[2] The ratings for 8- or 12-inch walls may be increased 1 hour when the units are solid, when the cells are filled with concrete, or when 12-inch walls have two cells through the wall. When combustible framed-in members are embedded in solid masonry extending at least 4 inches below and to the sides and ends of such members, the ratings given for walls with noncombustible framed-in members shall apply; except that the rating for 8-inch walls with combustible framed-in members shall not exceed 2 hours.

Walls of Structural Clay Tile: Bearing



SECTIONS

(A) Structural clay tile laid with cells horizontal or vertical and of any design or arrangement of cells. Units shall conform to ASTM, *Standard Specifications for Structural Clay Load-Bearing Wall Tile.*

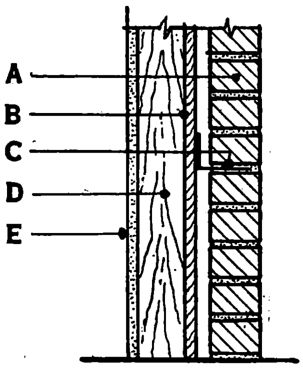
(B) Nominal wall thickness as given in table.

(C) Gypsum-sand, Portland cement-sand, gypsum-perlite or gypsum-vermiculite at least ⅝-inch thick, and having not more than three parts of aggregate to one part of cementing material.

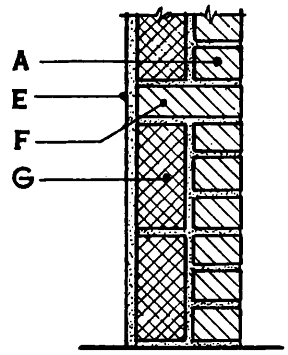
Design	Nominal wall thickness (B) in inches	Minimum number of units in thickness	Minimum number of cells in thickness	Finish (C)	Kind of framed-in members	Rating in hours [1]
W4–1	6	1	2	None	Noncombustible	¾
W4–2	8	1	3	None	Combustible	¾
W4–1	6	1	2	Plaster	Noncombustible	1
W4–1	8	1	2	Plaster	Combustible	1
W4–1	8	1	2	None	Noncombustible	1
W4–2	8	1	3	Plaster	Combustible	1
W4–2	8	1	3	None	Noncombustible	1
W4–2	12	1	3	None	Combustible	2
W4–2	12	1	3	None	Noncombustible	2
W4–1	8	1	2	Plaster	Noncombustible	3
W4–2	8	1	3	Plaster	Noncombustible	3
W4–2	12	1	3	Plaster	Combustible	3
W4–3	12	2	3	None	Combustible	3
W4–2	12	1	3	Plaster	Noncombustible	4
W4–3	12	2	3	Plaster	Combustible	4
W4–3	12	2	3	None	Noncombustible	4
W4–3	12	2	3	Plaster	Noncombustible	4
W4–4	16	2	4	None	Combustible	4
W4–4	16	2	4	Plaster	Combustible	4
W4–4	16	2	4	None	Noncombustible	4
W4–4	16	2	4	Plaster	Noncombustible	4

[1] When combustible framed-in members are embedded in solid masonry extending at least 4 inches below and to the sides and ends, the ratings given for walls with noncombustible framed-in members shall apply; except that the rating for 8-inch walls with combustible framed-in members shall not exceed 2 hours.

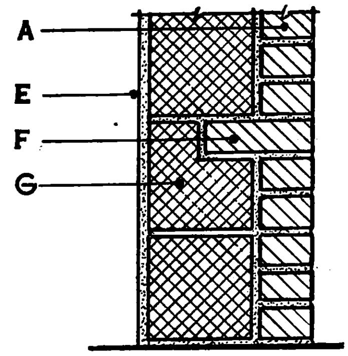
Walls of Faced or Veneered Construction: Bearing



Design W5-1



Design W5-2



Design W5-3

SECTIONS

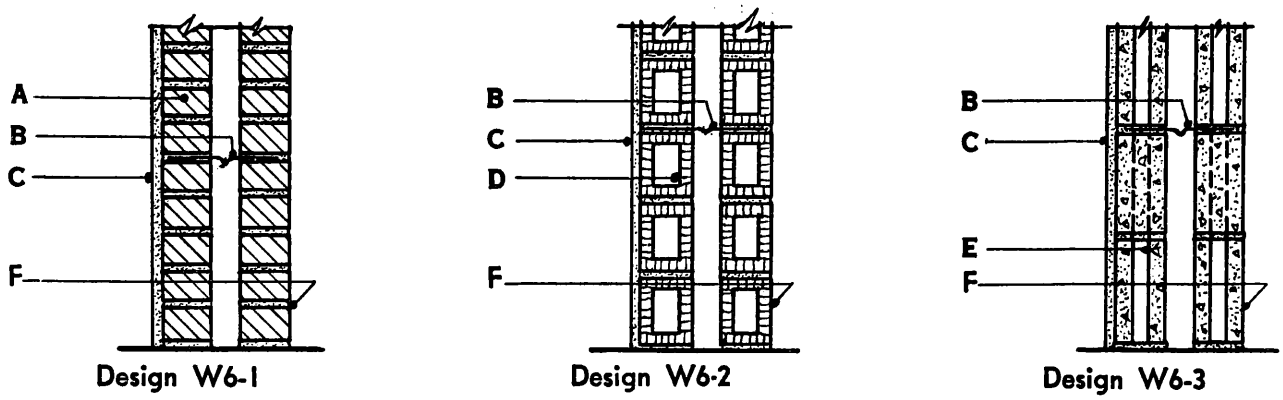
(A) Brick.
(B) Sheathing.
(C) Corrosion-resistant metal ties spaced 24 inches on center, vertically and horizontally.
(D) Wood or steel studs as given in table.
(E) Plaster of any kind and at least ½-inch thick, or gypsum wallboard at least ⅜-inch thick.
(F) Masonry bond.
(G) Masonry backing unit of kind and size given in table.

Design	Nominal thickness in inches	Thickness and kind of material on:		Finish on backing (E)	Kind of framed-in members	Rating in hours
		Exposed side	Unexposed side			
W5–1	8	4-in. brick	4-in. wood stud	Plaster or wallboard	Combustible	1
W5–1	8	4-in. wood stud	4-in. brick	Plaster or wallboard	Combustible	([1])
W5–2	8	4-in. brick	4-in. clay tile or concrete units	None or plaster	Combustible	2
W5–2	8	4-in. clay tile	4-in. brick	None	Combustible or noncombustible	3
W5–2	8	4-in. clay tile	4-in. brick	Plaster	Combustible or noncombustile	4
W5–1	8	4-in. brick	4-in. steel stud	Plaster or wallboard	Noncombustible	4
W5–1	8	4-in. steel stud	4-in. brick	Plaster or wallboard	Combustible or noncombustible	([2])
W5–2	8	4-in. concrete units	4-in. brick	None or plaster	Combustible or noncombustible	4
W5–2	8	4-in. brick	4-in. clay tile or concrete units	None or plaster	Noncombustible	4
W5–3	12	8-in. clay tile or concrete units	4-in. brick	None or plaster	Combustible or noncombustible	4
W5–3	12	4-in. brick	8-in. clay tile or concrete units	None or plaster	Combustible or noncombustible	4

[1] The ratings are dependent upon the type of finish on the backing and are the same as for partitions of wood-stud construction with wallboard or plaster facings.

[2] The ratings are dependent upon the type of finish on the backing and are the same as for partitions of steel-stud construction with wallboard or plaster facings.

Walls of Cavity Type: Bearing



SECTIONS

(A) Clay brick.

(B) Corrosion-resistant metal ties spaced to provide one tie to each 3 square feet of wall surface.

(C) Gypsum plaster at least ½-inch thick and not more than three parts of aggregate to one part of fibered gypsum.

(D) Structural clay load-bearing tile.

(E) Concrete masonry units of load-bearing grade and made with the type of aggregate given in the table.

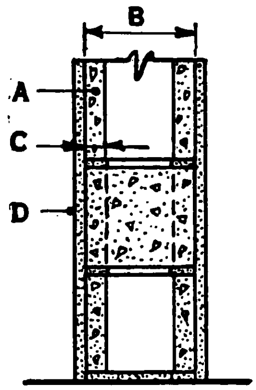
(F) Exterior face of wall.

Design	Nominal thickness of wall in inches	Kind of units (A), (D), or (E)	Finish on exposed side (C)	Kind of framed-in members	Rating in hours [1]
W6–3	10	Concrete, type 1 aggregate [2]	None	Combustible	1
W6–2	10	Structural clay tile	Facing tile	Combustible	1
W6–2	10	Structural clay tile	Facing tile	Noncombustible	1
W6–2	10	Structural clay tile	Plaster	Combustible	1
W6–3	10	Concrete, type 1 aggregate [2]	None	Noncombustible	1
W6–3	10	Concrete, type 1 aggregate [2]	Plaster	Combustible	1
W6–3	10	Concrete, type 1a aggregate [2]	None	Combustible	1
W6–3	10	Concrete, type 1b aggregate [2]	None	Combustible	1
W6–1	10	Clay or shale brick	None	Combustible	2
W6–1	10	Clay or shale brick	Plaster	Combustible	2
W6–3	10	Concrete, type 1a aggregate [2]	Plaster	Combustible	2
W6–3	10	Concrete, type 1b aggregate [2]	Plaster	Combustible	2
W6–3	10	Concrete, type 1a aggregate [2]	None	Noncombustible	3
W6–1	10	Clay or shale brick	None	Noncombustible	4
W6–1	10	Clay or shale brick	Plaster	Noncombustible	4
W6–2	10	Structural clay tile	Plaster	Noncombustible	4
W6–3	10	Concrete, type 1 aggregate [2]	Plaster	Noncombustible	4
W6–3	10	Concrete, type 1a aggregate [2]	Plaster	Noncombustible	4
W6–3	10	Concrete, type 1b aggregate [2]	None	Noncombustible	4
W6–3	10	Concrete, type 1b aggregate [2]	Plaster	Noncombustible	4

[1] When the two withes are of different kinds or types of units or have different finishes, the rating shall be that given in the table for walls with the kind or type of units and finish used on the side which is likely to be exposed to fire.

[2] See preface to these tables for kinds of aggregate in each type.

Partitions of Hollow Concrete Masonry Units: Nonbearing



Design PI-I

SECTION

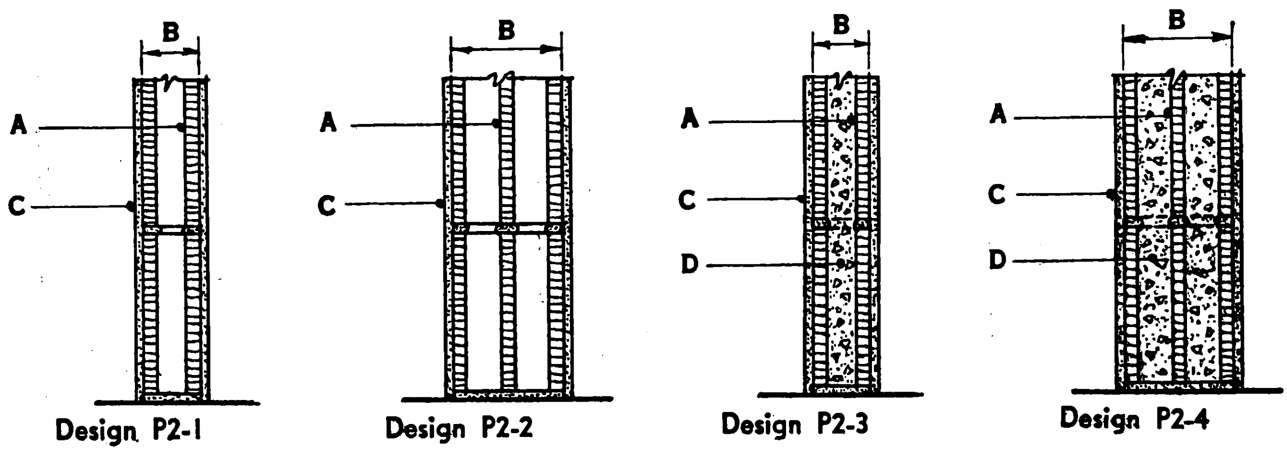
(A) Concrete masonry units conforming to the ASTM, *Standard Specifications for Hollow Non-Load-Bearing Concrete Masonry Units.*
(B) Nominal wall thickness as given in table.

(C) Nominal shell thickness as given in table.
(D) Gypsum plaster at least ½-inch thick and having not more than three parts of aggregate to one part of cementing material.

Design	Nominal thickness of wall (B) in inches	Minimum thickness of face shells (C) in inches	Type of aggregate [1]	Finish (D)		Rating in hours
				Exposed side	Unexposed side	
P1-1	3	1	1a	None	None	¾
P1-1	3	1	1a	Plaster	Plaster	1
P1-1	3	1	1b	None	None	1
P1-1	4	1	1	Plaster	Plaster	1
P1-1	4	1	1a	None	None	1
P1-1	4	1	2	Plaster	Plaster	1
P1-1	6	1	1	Plaster	Plaster	1
P1-1	6	1⅛	1a	None	None	1
P1-1	6	1	2	Plaster	Plaster	1
P1-1	3	1	1b	Plaster	Plaster	2
P1-1	4	1	1a	Plaster	Plaster	2
P1-1	6	1⅜	1a	None	None	2
P1-1	6	1⅛	1a	Plaster	Plaster	2
P1-1	6	1⅛	1b	None	None	2
P1-1	6	1⅜	1b	None	None	3
P1-1	6	1⅛	1b	Plaster	Plaster	3
P1-1	6	1⅜	1b	Plaster	Plaster	4

[1] See preface to these tables for kinds of aggregate in each type.

Partitions of Structural Clay Tile: Nonbearing



SECTIONS

(A) Structural clay tile laid with cells horizontal or vertical. Units may be of any design or arrangement of cells. Units shall conform to ASTM, *Standard Specifications for Structural Clay Non-Load-Bearing Wall Tile.*

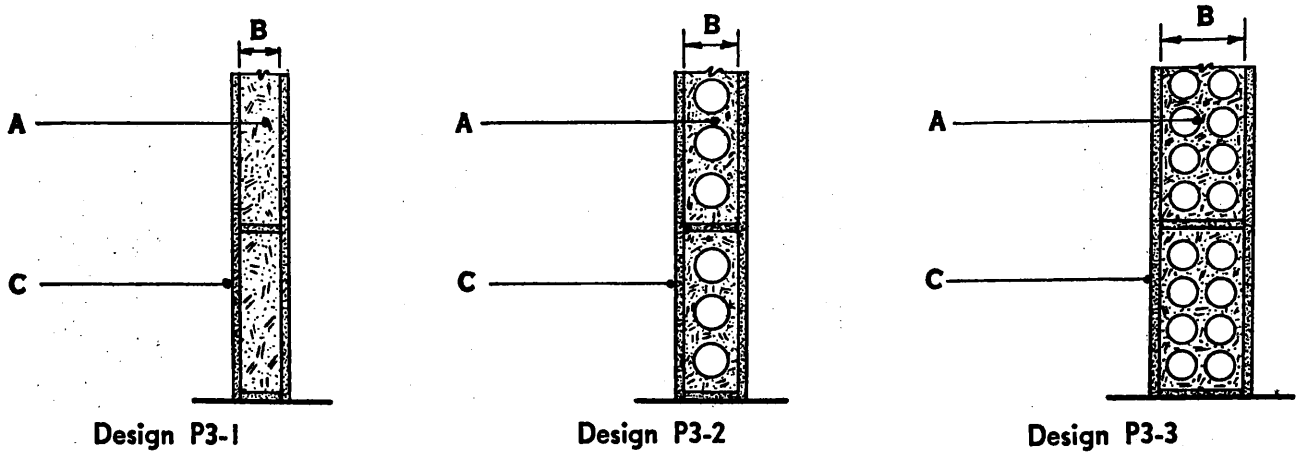
(B) Nominal wall thickness as given in table.

(C) Gypsum-sand, Portland cement-sand, gypsum-perlite or gypsum-vermiculite plaster at least ⅝-inch thick and having not more than three parts of aggregate to one part of cementing material.

(D) Fill of tile scraps or other aggregate mixed with mortar.

Design	Nominal thickness of wall (B) in inches	Number of cells in thickness	Finish (C) Exposed side	Finish (C) Unexposed side	Rating in hours
P2–1	3	1	Plaster	None	½
P2–2	4	2	None	None	½
P2–1	3	1	Plaster	Plaster	¾
P2–1	4	1	Plaster	None	¾
P2–1	6	1	Plaster	None	¾
P2–1	4	1	Plaster	Plaster	1
P2–2	4	2	Plaster	Plaster	1
P2–3	4	(Filled)	None	None	1
P2–1	6	1	Plaster	Plaster	1
P2–2	6	2	None	None	1
P2–2	8	2	None	None	1
P2–3	4	(Filled)	Plaster	Plaster	2
P2–2	6	2	Plaster	Plaster	2
P2–4	6	(Filled)	None	None	2
P2–2	8	2	Plaster	Plaster	2
P2–4	6	(Filled)	Plaster	Plaster	3

Partitions of Gypsum Tile or Block: Nonbearing



SECTIONS

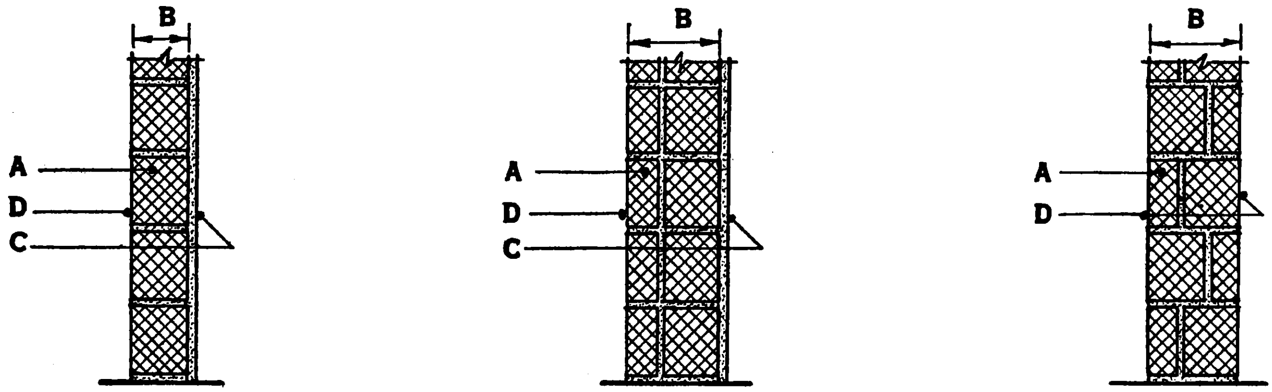
(A) Gypsum block of size and type given in table. Thickness of shells and size of cores shall conform to ASTM, *Standard Specifications for Gypsum Partition Tile or Block.* Block laid in gypsum-sand mortar.

(B) Nominal thickness of wall without plaster as given in table.

(C) Gypsum-sand, gypsum-perlite, or gypsum-vermiculite plaster at least ½-inch thick and having at least three parts of aggregate to one part of fibered gypsum cement.

Design	Nominal thickness of wall (B) in inches	Size and type of block (A)	Finish (C)	Rating in hours
P3–1	2	2-in. solid	None	1
P3–2	3	3-in hollow	None	1
P3–1	2	2-in. solid	Plaster	2
P3–2	4	4-in. hollow	None	2
P3–2	3	3-in. hollow	Plaster	3
P3–1	3	3-in. solid	None	3
P3–3	6	6-in. hollow	None	3
P3–1	3	3-in. solid	Plaster	4
P3–2	4	4-in. hollow	Plaster	4
P3–3	6	6-in. hollow	Plaster	4

Partitions of Structural Clay Facing Tile: Nonbearing



Design P4-1 Design P4-2 Design P4-3

SECTIONS

(A) Clay tile of kind given in table. Cells may be horizontal or vertical.

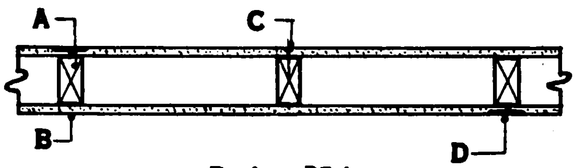
(B) Nominal wall thickness as given in table.

(C) Plaster on unexposed side as given in table.

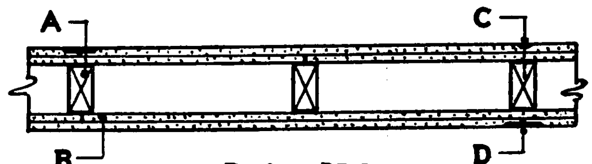
(D) Glazed or smooth-surfaced side of tile.

Design	Nominal thickness of wall (B) in inches	Kind of tile (A)	Finish on unexposed side (C) or (D)	Rating in hours
P4–1	4	Load-bearing wall tile, shells at least ¾-inch thick for horizontally laid units	¾-in. gypsum-sand plaster	1
P4–1	4	Facing tile cored not in excess of 25 per cent	¾-in. gypsum-sand plaster	2
P4–1	4	Facing tile cored not in excess of 30 per cent	¾-in. gypsum-vermiculite plaster	2
P4–2	6	2-in. facing tile cored not in excess of 25 per cent and 4-in. structural clay load-bearing tile cored not in excess of 40 per cent	¾-in. gypsum-sand plaster	3
P4–3	6	Facing tile cored not in excess of 25 per cent and with 2 units in wall thickness	Facing tile	3

Partitions of Wood-Stud Construction with Wallboard Facings: Bearing or Nonbearing



Design P5-1



Design P5-2

PLANS

(A) Wood studs 16 inches on center. Minimum 2 by 4 inches for bearing and 2 by 2 inches for nonbearing partitions.

(B) Facing of kind and thickness given in table. Gypsum wallboard may be applied horizontally or vertically.

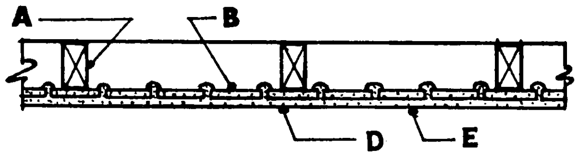
(C) Nails to penetrate framing at least 1⅛ inches; nails spaced 5 to 7 inches for inner layer of boards.

(D) Joints in outer gypsum wallboard filled and taped except for square-edged boards with joints on studs.

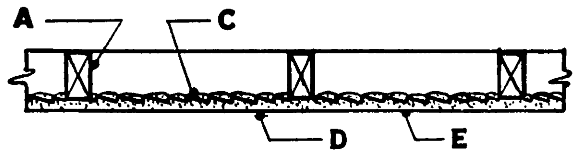
Design	Facing (B)	Rating in hours
P5–1	½-in. gypsum wallboard	½
P5–1	½-in. gypsum wallboard with mineral wool between studs	¾
P5–1	½-in. type X gypsum wallboard [1]	¾
P5–1	¼-in. fir plywood with mineral wool between 2″x4″ studs or ¾-in. fir plywood with mineral wool between 2″x2″ studs	¾
P5–2	Two layers ⅜-in. gypsum wallboard	¾
P5–2	3/16-in. asbestos-cement board over ⅜-in. gypsum wallboard. Mineral wool fill required when studs are less than 2″x4″ nominal	¾
P5–1	⅝-in. type X gypsum wallboard [1]	1
P5–2	Two layers ½-in. gypsum wallboard	1
P5–2	Two layers ½-in. type X gypsum wallboard [1]	1
P5–2	3/16-in. asbestos-cement board over ½-in. gypsum wallboard	1
P5–2	Two layers ⅝-in. type X gypsum wallboard [1]	2

[1] Type X gypsum wallboard has a core which contains special fibers and other materials that give it a greater resistance to fire than regular gypsum wallboard.

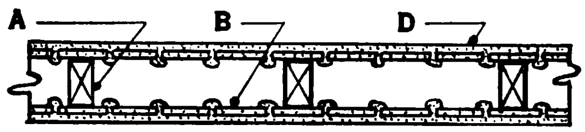
Partitions of Wood-Stud Construction with Plaster Facings: Bearing or Nonbearing



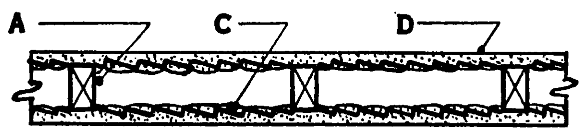
Design P6-1



Design P6-2



Design P6-3



Design P6-4

PLANS

(A) Wood studs 16 inches on center maximum, except that spacing may be 24 inches on center for ribbed metal lath; minimum 2 by 2 inches for nonbearing and 2 by 4 inches for bearing walls.

(B) Perforated gypsum lath attached to studs with No. 13 gage blued nails, 1 1/8 inches long, with 3/8-inch diameter flat heads, spaced not to exceed 4 inches apart.

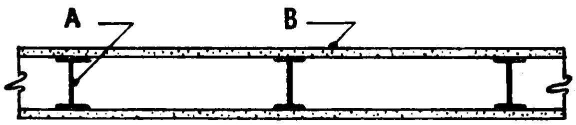
(C) Flat or ribbed expanded metal lath or wire fabric attached with nails or staples with 6-inch maximum spacing to penetrate studs at least 3/4 inch.

(D) Plaster of kind, mix, and thickness given in table.

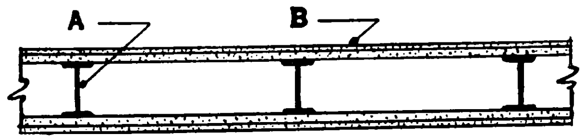
(E) Fire-exposed face of partition.

Design	Plaster base (B) or (C)	Plaster (D)			Rating in hours
		Kind	Mix	Thickness in inches	
P6–1	3/8-in. gypsum lath	Gypsum-perlite	100:2 1/2	1/2	1/2
P6–1	3/8-in. gypsum lath	Gypsum-vermiculite	100:2 1/2	1/2	1/2
P6–2	Metal lath	Gypsum-perlite	100:2, 100:3	3/4	1/2
P6–2	Metal lath	Gypsum-vermiculite	100:2, 100:3	3/4	1/2
P6–2	Metal lath	Portland cement-sand	1:2, 1:3	3/4	1/2
P6–4	Metal lath	Portland cement-sand	1:2, 1:3	7/8	3/4
P6–4	Metal lath	Gypsum-sand	1:2, 1:3	3/4	3/4
P6–3	3/8-in. gypsum lath	Gypsum-sand	1:2	1/2	1
P6–3	3/8-in. gypsum lath	Gypsum-perlite	100:2 1/2	1/2	1
P6–3	3/8-in. gypsum lath	Gypsum-vermiculite	100:2 1/2	1/2	1
P6–4	Metal lath	Gypsum-sand	1:2, 1:3	7/8	1
P6–4	Metal lath	Gypsum-sand	1:2	3/4	1
P6–4	Metal lath	Gypsum (wood fibered)	neat	3/4	1
P6–4	Metal lath	Gypsum-perlite	100:2, 100:3	3/4	1
P6–4	Metal lath	Gypsum-vermiculite	100:2, 100:3	3/4	1
P6–4	Metal lath	Gypsum (wood fibered)	neat	1	2

Partitions of Steel-Stud Construction with Wallboard Facings: Bearing or Nonbearing



Design P7-1



Design P7-2

PLANS

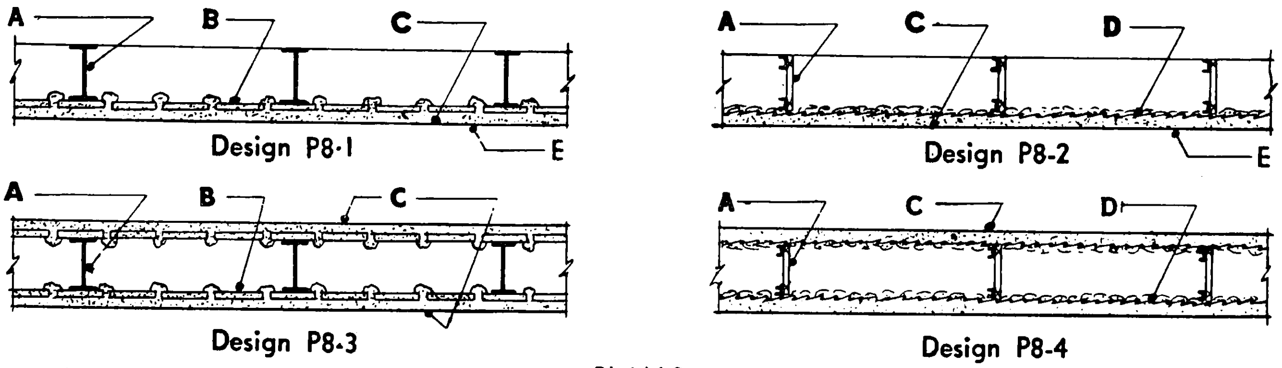
(A) Steel studs 16 inches on center maximum. When partition is load-bearing, studs should be at least 3 inches wide.

(B) Facing of kind and thickness given in table. Facing attached to studs with cement-coated 6d nails spaced not more than 7 inches apart.

Design	Facing (B)	Rating in hours
P7–1	½-in. asbestos-cement board, space between studs filled with mineral wool	1
P7–1	⅝-in. type X gypsum wallboard [1]	1
P7–2	3/16-in. asbestos-cement board over ½-in. gypsum wallboard	1

[1] Type X gypsum wallboard has a core which contains special fibers and other materials that give it a greater resistance to fire than regular gypsum wallboard.

Partitions of Steel-Stud Construction with Plaster Facings: Bearing or Nonbearing



PLANS

(A) Steel studs 16 inches on center maximum, except that spacing may be 24 inches on center for ribbed lath; 3-inch prefabricated studs for load bearing; studs assembled from ¾-inch channels for nonbearing walls.

(B) Perforated gypsum lath attached to studs with cement-coated 6d nails, 7 inches on center maximum; or wired or fastened with metal clips.

(C) Plaster of kind, mix, and thickness given in table.

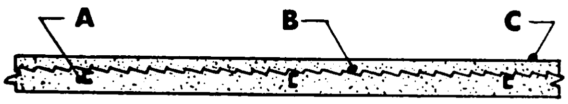
(D) Flat or ribbed expanded metal lath or wire fabric attached to studs with No. 18 gage wire ties on 6-inch maximum spacing.

(E) Fire-exposed side of partition.

Design	Plaster base (B) or (D)	Plaster (C)			Rating in hours
		Kind	Mix	Thickness in inches	
P8–1	⅜-in. gypsum lath	Gypsum-sand	1:2, 1:3	½	½
P8–1	⅜-in. gypsum lath	Gypsum-perlite	100:2½	½	½
P8–1	⅜-in. gypsum lath	Gypsum-vermiculite	100:2½	½	½
P8–2	Metal lath	Gypsum-perlite	100:2, 100:3	¾	½
P8–2	Metal lath	Gypsum-vermiculite	100:2, 100:3	¾	½
P8–2	Metal lath	Gypsum (wood fibered)	neat	¾	½
P8–4	Metal lath	Portland cement-sand	1:2, 1:3	¾	½
P8–4	Metal lath	Gypsum-sand	1:2, 1:3	¾	¾
P8–4	Metal lath	Portland cement-sand	1:2, 1:3	⅞	¾
P8–3	⅜-in. gypsum lath	Gypsum-sand	1:2	½	1
P8–3	⅜-in. gypsum lath	Gypsum-perlite	100:2½	½	1
P8–3	⅜-in. gypsum lath	Gypsum-vermiculite	100:2½	½	1
P8–4	Metal lath	Gypsum-sand	1:2, 1:3	⅞	1
P8–4	Metal lath	Gypsum-sand	1:2	¾	1
P8–4	Metal lath	Gypsum-perlite	100:2, 100:3	¾	1
P8–4	Metal lath	Gypsum-vermiculite	100:2, 100:3	¾	1
P8–4	Metal lath	Gypsum (wood fibered)	neat	⅞ [1]	2
P8–4	Metal lath	Gypsum-sand	1:½	1	2
P8–4	Metal lath	Gypsum-perlite	100:2, 100:3	1	2

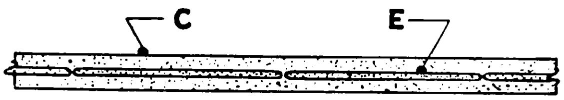
[1] When partition is bearing, plaster shall be at least 1 inch thick.

Partitions of Solid Plaster Construction: Nonbearing



Design P9-1

Design P9-2



Design P9-3

PLANS

(A) ¾-inch channel studs, 16 inches on center securely anchored to floor and ceiling construction.

(B) Expanded metal lath; applied horizontal; tied to studs with No. 18 W & M gage wire ties 6 inches on center with at least one tie between studs at horizontal joint.

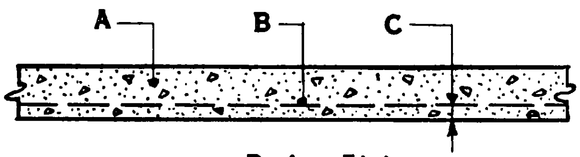
(C) Plaster of kind, mix, and thickness given in table.

(D) Expanded metal lath securely anchored to floor and ceiling construction and to columns or intersecting walls. Wire ties at laps of lath.

(E) Long length gypsum lath of thickness given in table; set in groove of steel or wood at bottom and fastened in steel channel at top.

Design	Framing or Core (A), (D), or (E)	Plaster base (B), (D), or (E)	Plaster (C)			Rating in hours
			Kind	Mix	Thickness in inches	
P9–1	Steel	Metal lath	Portland cement-sand	1:2, 1:3	2	½
P9–1	Steel	Metal lath	Gypsum-sand	1:2, 1:3	2	¾
P9–1	Steel	Metal lath	Gypsum-sand	1:2, 1:3	2½	1
P9–2	Metal lath	Metal lath	Gypsum-sand	1:2	2	1
P9–3	Gypsum lath	⅜-in. gypsum lath	Gypsum-sand	1:1, 1:2	2	1
P9–3	Gypsum lath	½-in. gypsum lath	Gypsum-perlite	100:2, 100:3	2	1
P9–3	Gypsum lath	½-in. gypsum lath	Gypsum-vermiculite	100:2, 100:3	2	1
P9–1	Steel	Metal lath	Gypsum-sand	1:2	2	1
P9–1	Steel	⅜-in. gypsum lath	Gypsum-sand	1:1	2⅛	1
P9–1	Steel	Metal lath	Gypsum-perlite	100:2½	1½	1
P9–1	Steel	Metal lath	Gypsum-vermiculite	100:2½	1½	1
P9–1	Steel	Metal lath	Gypsum (wood fibered)	Neat	2¼	2
P9–1	Steel	Metal lath	Gypsum-sand	1:½	2½	2
P9–1	Steel	Metal lath	Gypsum-perlite	100:2,100:3	2½	2
P9–1	Steel	Metal lath	Gypsum-vermiculite	100:2,100:3	2½	2
P9–1	Steel	Metal lath	Gypsum (wood fibered)	Neat	2	2
P9–3	Gypsum lath	½-in. gypsum lath	Gypsum-vermiculite	100:2,100:3	2½	2

Floors of Reinforced Concrete Construction



Design Fl-1

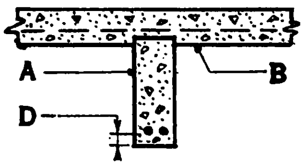
SECTION

(A) Concrete slab of thickness and type of aggregate given in table.
(B) Reinforcing steel.
(C) Thickness of concrete protection under reinforcing steel.

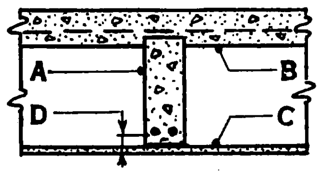
Design	Thickness of floor (A) in inches	Type of Aggregate [1] (A)	Thickness of concrete protection under reinforcing steel (C) in inches	Rating in hours
Fl-1	3	1 or 2	¾	¾
Fl-1	4	1 or 2	¾	1
Fl-1	4¾	1 or 2	¾	2
Fl-1	6	1 or 2	1	3
Fl-1	4½	1a	¾	4

[1] See preface to these tables for kinds of aggregate in each type.

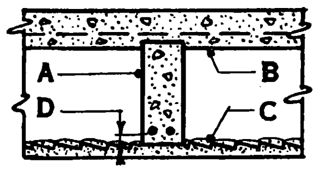
Floors of Reinforced Concrete Slabs on Precast Concrete Joists



Design F2-1



Design F2-2



Design F2-3

SECTIONS

(A) Precast concrete joists at least 8 inches deep and spaced not more than 30 inches on center.

(B) Reinforced concrete slab of the thickness given in the table.

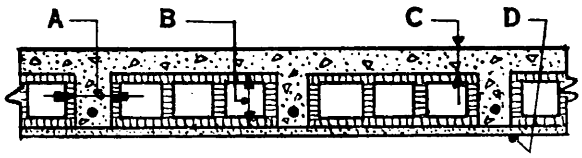
(C) Ceiling, attached or suspended, of the kind and thickness given in table.

(D) Thickness of concrete protection under reinforcing steel in joists.

Design	Thickness of slab (B) inches	Type of aggregate in joists [1]	Protection of steel in joists (D) in inches	Ceiling (C)	Rating in hours
F2–1	2½	1a	¾	None	½
F2–2	2½	1a	¾	½-in. gypsum wallboard	¾
F2–1	3	1a	1	None	¾
F2–2	3	1a	1	½-in. gypsum wallboard	1
F2–3	2¼	1 or 2	¾	¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	2
F2–3	2½	1 or 2	1	¾-in. 100:2, 100:3 gypsum-perlite or gypsum-vermiculite plaster on metal lath	3

[1] See preface to these tables for kinds of aggregate in each type.

Floors of Reinforced Concrete in Combination with Structural Clay Tile



Design F3-1

SECTION

(A) Reinforced concrete beams 2½ inches or more in width.

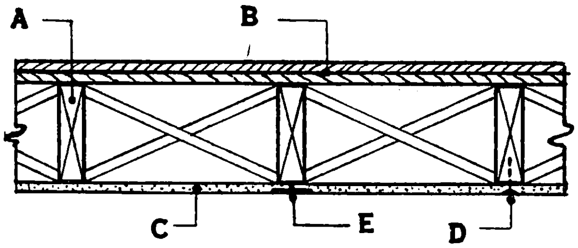
(B) Clay tile fillers of thickness given in table.

(C) Concrete topping of thickness given in table.

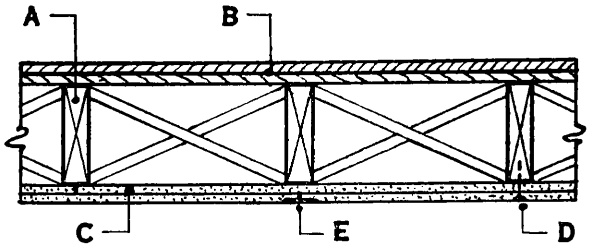
(D) Gypsum plaster at least ⅝-inch thick, and having not more than three parts of aggregate to one part of cementing material.

Design	Thickness of floor in inches	Thickness of clay tile in inches (B)	Thickness of concrete topping in inches (C)	Ceiling finish (D)	Rating in hours
F3-1	5½	4	1½	None	1
F3-1	5½	4	1½	Plaster	1
F3-1	8	6	2	Plaster	2

Floors of Wood-Joist Construction with Wallboard Ceilings



Design F4-1



Design F4-2

SECTIONS

(A) Wood joists with a minimum thickness of 2 inches nominal and a maximum spacing of 16 inches on center.

(B) Double wood floor with paper membrane between subflooring and finishing flooring.

(C) Wallboard ceiling of kind and thickness given in table.

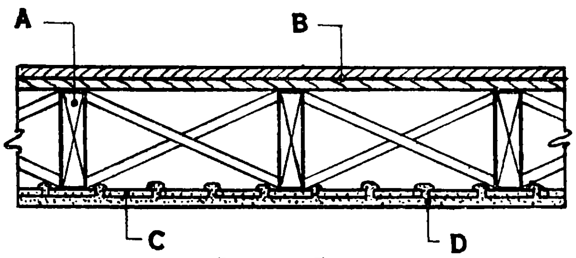
(D) Nails to penetrate joists at least 1⅛ inches and spaced 5 to 7 inches in outer layer and 10 to 14 inches in inner layer.

(E) Joints in outer layer of gypsum wallboard filled and taped.

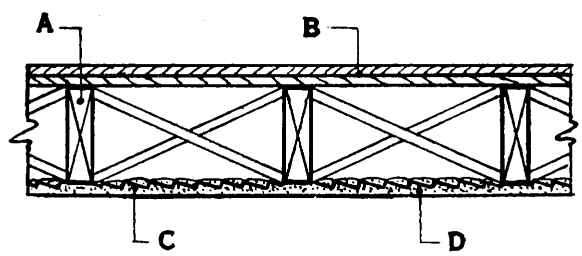
Design	Ceiling (C)	Rating in hours
F4–2	Two layers ⅜-in. gypsum wallboard	½
F4–2	⅜-in. gypsum wallboard with ½-in. gypsum sheathing	½
F4–1	½-in. type X gypsum wallboard [1]	¾
F4–2	Two layers ½-in. gypsum wallboard	¾
F4–1	⅝-in. type X gypsum wallboard [1]	1
F4–2	Two layers ½-in. gypsum wallboard with 1-in. wire mesh between layers	1

[1] Type X gypsum wallboard has a core which contains special fibers and other materials that give it a greater resistance to fire than regular gypsum wallboard.

Floors of Wood-Joist Construction with Plaster Ceilings



Design F5-1



Design F5-2

SECTIONS

(A) Wood joists with a minimum thickness of 2 inches nominal and a maximum spacing of 16 inches on center when gypsum lath is used, and 24 inches on center when metal lath is used.

(B) Double wood floor with paper membrane between subflooring and finish flooring.

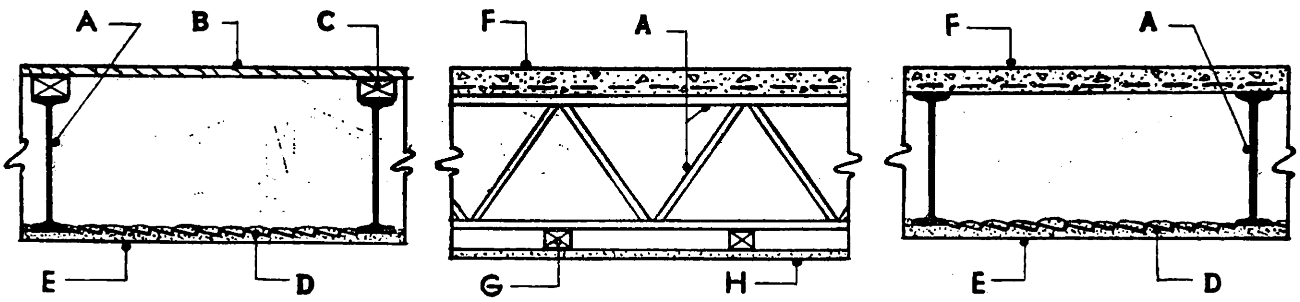
(C) Lath of the kind and thickness given in the table.

(D) Plaster of the kind and thickness given in the table.

Design	Lath (C)	Plaster (D)			Rating in hours
		Kind	Mix	Thickness in inches	
F5–1	⅜-in. gypsum	Gypsum-sand	1:2	½	¾ [1]
F5–1	⅜-in. gypsum	Gypsum-perlite	100:2½	½	1
F5–1	⅜-in. gypsum	Gypsum-vermiculite	100:2½	½	1
F5–2	Expanded metal	Gypsum-sand	1:2, 1:3	¾	1
F5–2	Expanded metal	Portland cement-sand with asbestos fiber	1:2, 1:3	¾	1
F5–2	Expanded metal	Gypsum-perlite	100:2, 100:3	¾	1
F5–2	Expanded metal	Gypsum-vermiculite	100:2, 100:3	¾	1

[1] Rating 1 hour when lath joints are covered with 3 inch wide strips of metal lath.

Floors of Steel-Joist Construction with Protective Ceilings



Design F6-1

Design F6-2

Design F6-3

SECTIONS

(A) Bar joists or light steel beams spaced 16 inches on center for gypsum lath attached directly to the joists or beams, and 24 inches on center when metal lath is used.

(B) T & G wood floor.

(C) Wood nailer blocks.

(D) Gypsum lath, metal lath, or precast concrete or gypsum tile attached directly to or suspended below the joists or beams.

(E) Plaster of kind and thickness given in table.

(F) Floor slab of kind and thickness given in table.

(G) Steel channels or wood furring strips.

(H) Gypsum wallboard of kind and size given in table.

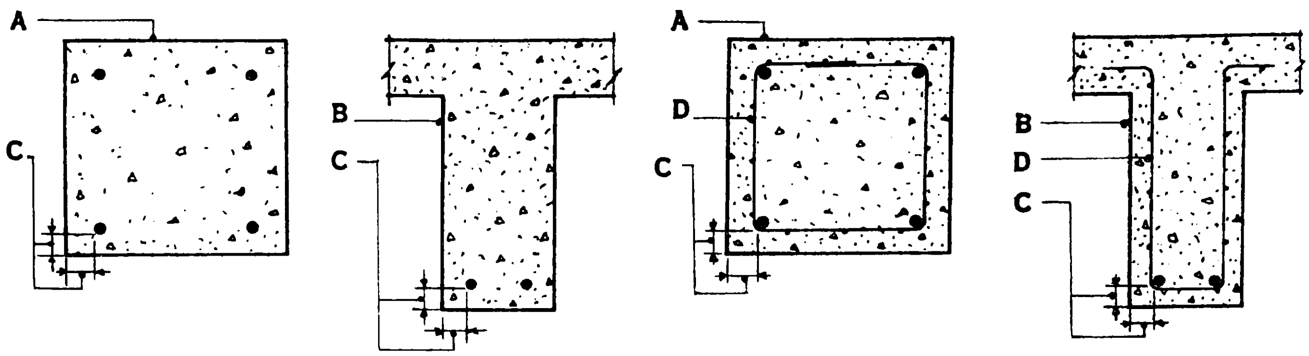
(See table on opposite page).

Floors of Steel-Joist Construction with Protective Ceilings (*Continued*)

Design	Floor (B) or (F)	Ceiling (D), (E), or (H)	Rating in hours
F6–1	T & G wood nailed to wood	¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	¾
F6–1	T & G wood over asbestos paper cemented to steel deck	¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	1
F6–2	2-in. reinforced concrete	⅝-in. type X gypsum wallboard [1] attached with sheet metal screws to ¾-in. furring channels or to wood nailing strips with 1¼-in. nails	1
F6–3	2-in. reinforced concrete	⅝-in. 100:2, 100:3 gypsum-perlite plaster applied to ⅜-in. perforated lath attached to furring channels with interlocking wire clips	1
F6–3	2-in. concrete slab or 2-in. gypsum tile	¾-in. 1:2, 1:3 gypsum-sand or ¾-in. 1:2, 1:3 Portland cement-sand plaster or ⅝-in. sprayed asbestos on metal lath	1½
F6–3	½-in. gypsum concrete over ½-in. gypsum form boards	1¼-in. 100:2, 100:3 gypsum-perlite on ⅜-in. perforated gypsum lath	1½
F6–2	2-in. reinforced concrete	1-in. 100:2, 100:3 gypsum-perlite plaster on ⅜-in. perforated gypsum lath attached to furring channels with interlocking wire clips	1½
F6–3	2¼-in. reinforced concrete or gypsum tile	¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	2
F6–3	2½-in. reinforced concrete	¾-in. sprayed asbestos on metal lath	2
F6–3	2-in. reinforced concrete, or 2-in. gypsum tile with ¼-in. mortar finish	¾-in. 100:2, 100:3 gypsum vermiculite plaster on metal lath	2
F6–3	2½-in. reinforced concrete or 2 in. gypsum tile with ½-in. mortar finish	¾-in. 100:2, 100:3 gypsum-vermiculite plaster on metal lath	3
F6–3	2-in. reinforced concrete	1-in. 100:2½ gypsum-vermiculite plaster on metal lath	3
F6–3	2-in. reinforced concrete	½-in. 100:2, 100:3 gypsum-perlite plaster on ⅜-in. perforated gypsum lath secured to furring channels with interlocking wire clips and with wire mesh reinforcement in plaster	3
F6–3	2-in. reinforced gypsum or cinder concrete or gypsum tile	½-in. 1:2, 1:3 gypsum-sand plaster on 2-in. reinforced gypsum or concrete tile attached to or suspended below joists	4
F6–3	2-in. reinforced concrete	1-in. 100:2, 100:3 gypsum-perlite plaster on ⅜-in. perforated gypsum lath secured to furring channels with interlocking wire clips and with 20 gage wire mesh reinforcement in plaster	4
F6–3	2½-in. reinforced concrete or 2-in. gypsum tile with ½-in. mortar finish	1-in. 100:2, 100:3 gypsum-vermiculite plaster on metal lath	4

[1] Type X gypsum wallboard has a core which contains special fibers and other materials that give it a greater resistance to fire than regular gypsum wallboard.

Columns, Beams, and Girders of Reinforced Concrete



Design Cl-1 Design Bl-1 Design Cl-2 Design Bl-2

SECTIONS

(A) Columns of any size or shape.

(B) Beams or girders of any size or shape which may or may not be cast integrally with the floor slab.

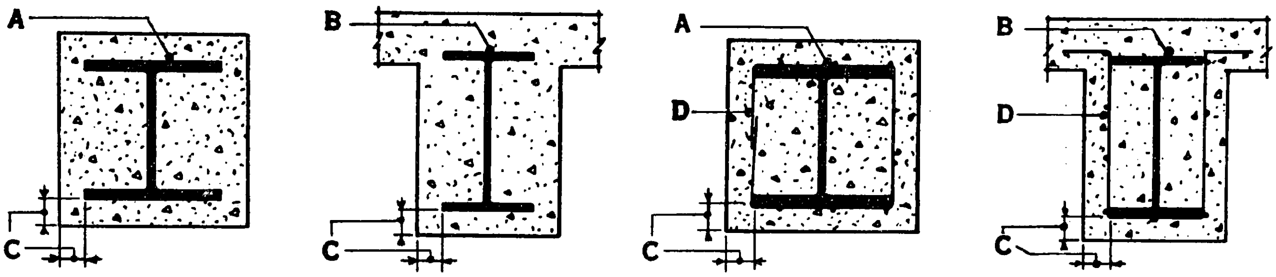
(C) Thickness of concrete protection over reinforcing steel as given in table.

(D) Wire mesh or steel ties.

Design	Concrete aggregate, type [1]	Thickness of protection over reinforcing steel in inches	Rating in hours
C1–1 or B1–1	1	1	1
C1–1 or B1–1	2	1½	1
C1–2 or B1–2	2 (with wire mesh)	1	1
C1–1 or B1–1	1	1½	2
C1–1 or B1–1	2	2	2
C1–2 or B1–2	2 (with wire mesh)	1½	2
C1–1 or B1–1	1	1½	3
C1–1 or B1–1	2	2½	3
C1–2 or B1–2	2 (with wire mesh)	1½	3
C1–1 or B1–1	1	1½	4
C1–1 or B1–1	2	2½	4
B1–2 or B1–2	2 (with wire mesh)	2	4

[1] See preface to these tables for kinds of aggregate in each type.

Steel Columns, Beams, and Girders with Concrete Protection



SECTIONS

(A) Columns of any size or shape.

(B) Beams or girders of any size or shape with concrete protection cast separately or integrally with floor slab.

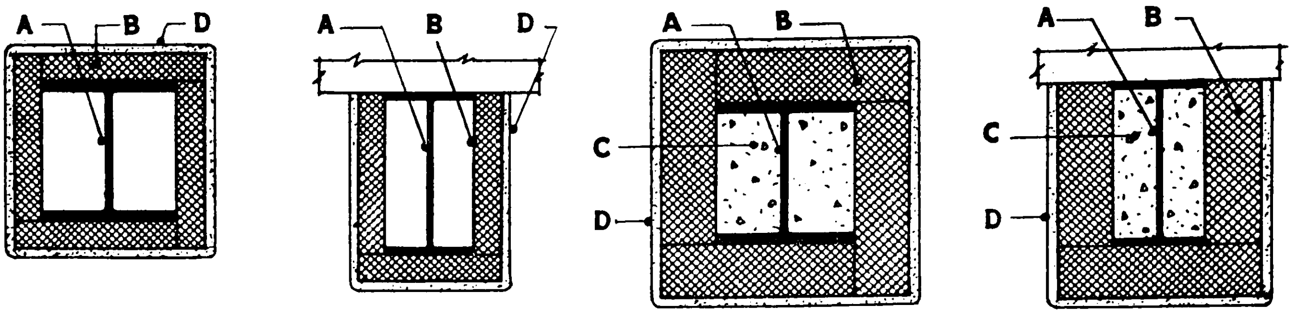
(C) Thickness of concrete protection over flange of structural steel as given in table. Thickness does not include plaster.

(D) Wire mesh or steel ties.

Design	Type of aggregate [1]	Thickness of concrete protection over flanges of steel (C) in inches	Rating in hours
C2–1 or B2–1	1	1	1
C2–1 or B2–1	2	1½	1
C2–2 or B2–2	2 (with wire mesh)	1½	1
C2–1 or B2–1	1	1½	2
C2–1 or B2–1	2	2	2
C2–2 or B2–2	2 (with wire mesh)	2	2
C2–1 or B2–1	1	2	3
C2–1 or B2–1	2	3	3
C2–2 or B2–2	2 (with wire mesh)	2	3
C2–1 or B2–1	1	2	4
C2–1 or B2–1	2	4	4
C2–2 or B2–2	2 (with wire mesh)	3	4

[1] See preface to these tables for kinds of aggregate in each type.

Steel Columns, Beams, and Girders with Masonry Protection



Design C3-1 Design B3-1 Design C3-2 Design B3-2

SECTIONS

(A) Columns, beams or girders of any size or shape.

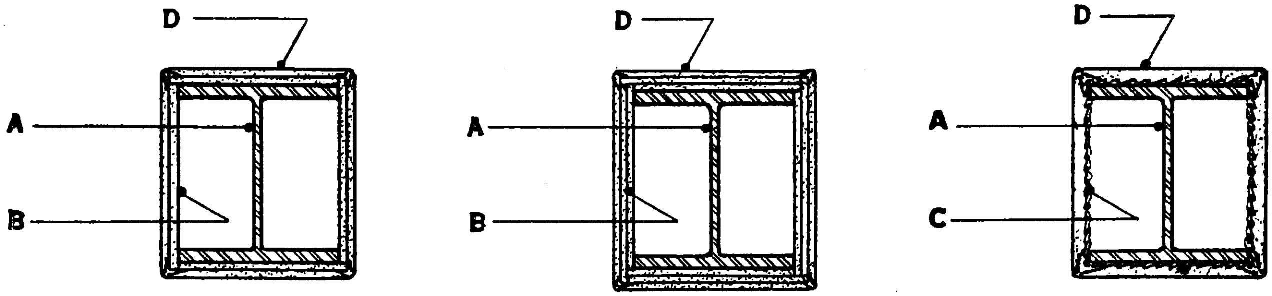
(B) Masonry units of kind and thickness given in table. Masonry for protecting beams and girders shall be tied or otherwise mechanically bonded to the structural member.

(C) Mortar or concrete fill. Such fill shall be required when the rating is 2 hours or more.

(D) Plaster, when used, at least ½-inch thick and of any kind except that gypsum plaster shall be used on gypsum block.

Design	Masonry protection (B)		Finish (D)	Rating in hours
	Kind	Nominal thickness in inches		
C3–1 or B3–1	Brick, clay tile, or gypsum block	2	None	1
C3–2 or B3–2	Brick or clay tile	4	None	2
C3–2 or B3–2	Gypsum hollow block	3	None	2
C3–2 or B3–2	Brick or clay tile	4	Plaster	3
C3–2 or B3–2	Gypsum hollow block	3	Plaster	3
C3–2 or B3–2	Cinder concrete block	3	Plaster	3
C3–2 or B3–2	Brick, clay tile with cells filled, solid concrete block or with cells filled (All masonry tied with wire mesh before plastering)	4	Plaster	4

Steel Columns with Plaster Protection



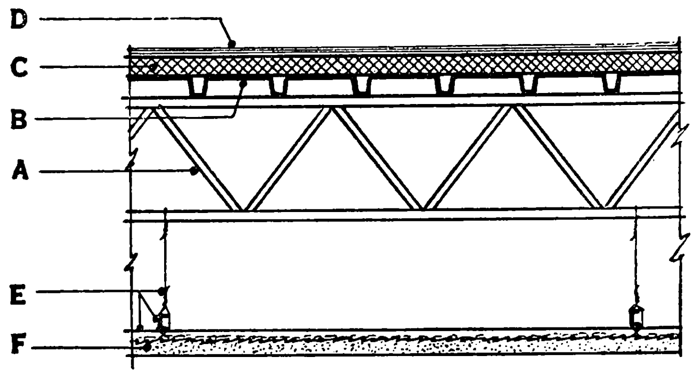
Design C4-1 Design C4-2 Design C4-3

SECTIONS

(A) Steel columns of any size.
(B) Gypsum lath attached to column with wire ties or wire mesh.
(C) Metal lath in contact with, or spaced from, column as indicated in table.
(D) Plaster of kind and thickness given in table.

Design	Column protection (B), (C) and (D)	Rating in hours
C4–1	½-in. 1:2 gypsum-sand plaster on ⅜-in. perforated gypsum lath	1
C4–3	¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	1
C4–3	1-in. 1:2, 1:3 Portland cement-sand plaster on metal lath	1
C4–1	1-in. 100:2½ gypsum-perlite or gypsum-vermiculite plaster on ⅜-in. perforated gypsum lath	2
C4–3	1-in. 100:2, 100:3 gypsum-perlite plaster on self-furring metal lath or metal lath spaced at least 7⁄16 in. from the flanges of the column	2
C4–2	1-in. 100:2½ gypsum-perlite or gypsum-vermiculite plaster reinforced with wire mesh and on two layers of ½-in. gypsum lath	3
C4–2	1⅜-in. 100:2½ gypsum-perlite plaster on two layers of ½-in. gypsum lath	3
C4–2	1¼-in. 100:2½ gypsum-vermiculite plaster on two layers of ⅜-in. perforated gypsum lath	3
C4–1	1½-in. 100:2½ gypsum-perlite plaster reinforced with wire mesh and on one layer of ½-in. gypsum lath	3
C4–1	1¾-in. 100:2, 100:3 gypsum-perlite plaster on ⅜-in. perforated gypsum lath	3
C4–3	1⅜-in. 100:2, 100:3 gypsum-perlite plaster on self-furring metal lath or metal lath spaced at least 7⁄16 in. from flanges of column	3
C4–2	1½-in. 100:2, 100:3 gypsum-perlite or gypsum-vermiculite plaster reinforced with wire mesh and on two layers of ½-in. gypsum lath	4
C4–3	1½-in. 100:2, 100:3 gypsum-perlite plaster on metal lath spaced at least 7⁄16-in. from the flanges of the column	4
C4–3	1¾-in. 100:2, 100:3 gypsum-perlite plaster on self-furring metal lath	4

Roof-Deck Assemblies with Protective Ceilings



Design R1-1

SECTION

(A) Structural steel roof supports including purlins, beams, girders, and trusses.

(B) Roof deck of any type or design.

(C) Roof insulation of kind and thickness given in table.

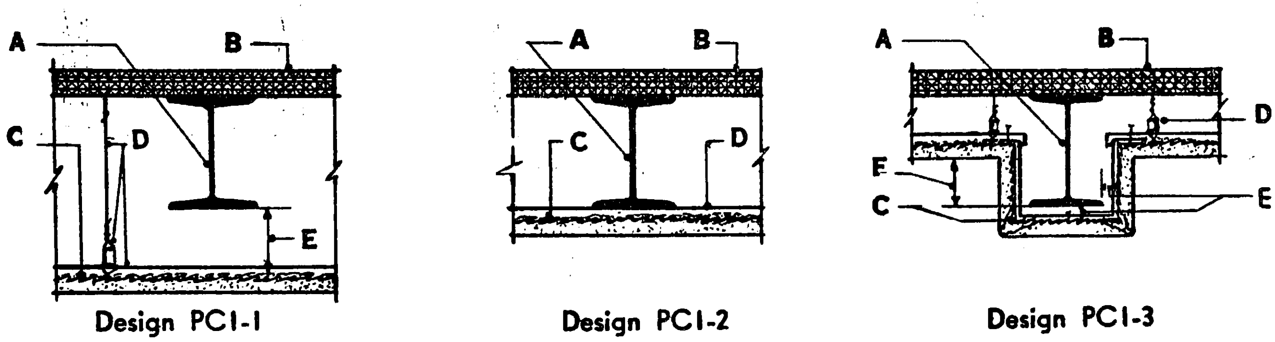
(D) Roof covering of any class.

(E) Ceiling support conforming to ASA, *Standard Specifications for Interior Lathing and Furring*.

(F) Metal lath with plaster of the kind and thickness given in table.

Design	Roof insulation (C)	Plaster (F)	Rating in hours
R1-1	1-in. T & G wood sheathing	¾-in. 1:2, 1:3 gypsum-sand	1
R1-1	1-in. wood fiber board	¾-in. 1:2, 1:3 gypsum-sand	2
R1-1	1½-in. wood fiber with cement binder	⅞-in. 1:2, gypsum-sand	2
R1-1	1½-in. wood fiber board	1-in. 1:2, 1:3 gypsum-sand	2
R1-1	1-in. felted glass-fiber board	1-in. 100:2½ gypsum-vermiculite	2
R1-1	1-in. shredded wood bonded with Portland cement	1-in. 100:2½ gypsum-vermiculite	3
R1-1	2-in. vermiculite concrete	1-in. 100:2½ gypsum-vermiculite	4

Protective Ceilings for Steel Beams, Girders, and Trusses



SECTIONS

(A) Structural steel, including beams, girders, and trusses.

(B) Floor consisting of any combination of noncombustible materials and having a total thickness of at least 2 inches.

(C) Metal lath with plaster of the kind and thickness given in table.

(D) Ceiling support consisting of runner and furring channels with ties conforming to ASA, *Standard Specifications for Interior Lathing and Furring.*

(E) Space between structural steel and lath.

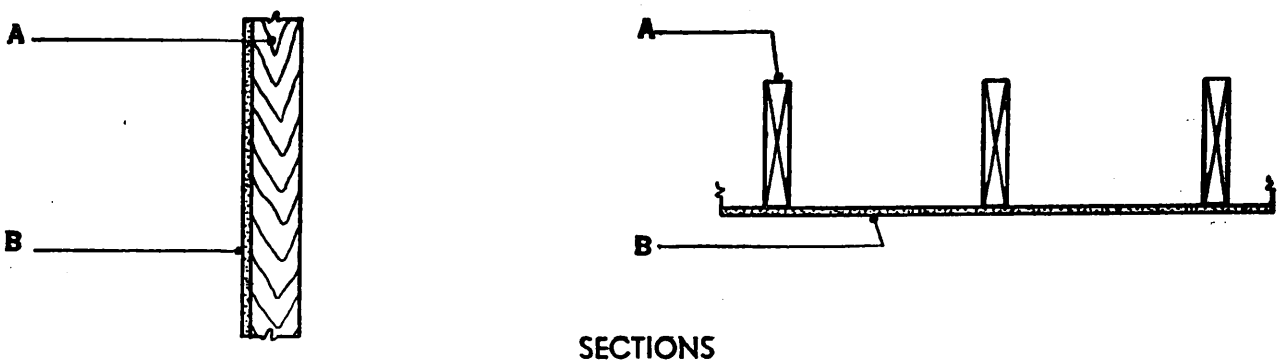
(F) Distance of projection of beam below the ceiling.

Design	Minimum distance between beam and lath (E) in inches	Maximum projection of beam below ceiling (F) in inches	Ceiling (C) and (D)	Rating in hours [1]
PC1–2	0	0	¾-in. 1:2, 1:3 gypsum- or Portland cement-sand plaster	1½
PC1–2	0	0	¾-in. 100:2, 100:3 gypsum-perlite or vermiculite plaster	2
PC1–2	0	0	1-in. 100:2, 100:3 gypsum-vermiculite plaster on metal lath	3
PC1–1	3½	0	⅞-in. 100:2, 100:3 gypsum-vermiculite plaster on metal lath [2]	3
PC1–1	3½	0	⅞-in. 100:2, 100:3 gypsum-perlite plaster on metal lath [2]	4
PC1–3	2½	6	1-in. 100:2, 100:3 gypsum-vermiculite plaster on metal lath	4
PC1–3	2½	6	⅝-in. 100:2, 100:3 gypsum-vermiculite plaster plus ½-in. vermiculite acoustical plaster on metal lath	4

[1] The ratings for floors of steel-joist construction with protective ceilings given in part 4, page 60, may be applied separately to the ceilings described therein when such ceilings are used for protecting steel beams, girders, and trusses.

[2] Gypsum-perlite and gypsum-vermiculite protective ceilings of design PC1-1 may have duct openings not to exceed 1 square foot in each 100 square feet of ceiling area and not more than one electrical outlet to each 90 square feet of ceiling area. Automatic fire damper shall also be provided.

Protective Finishes for Combustible Framing

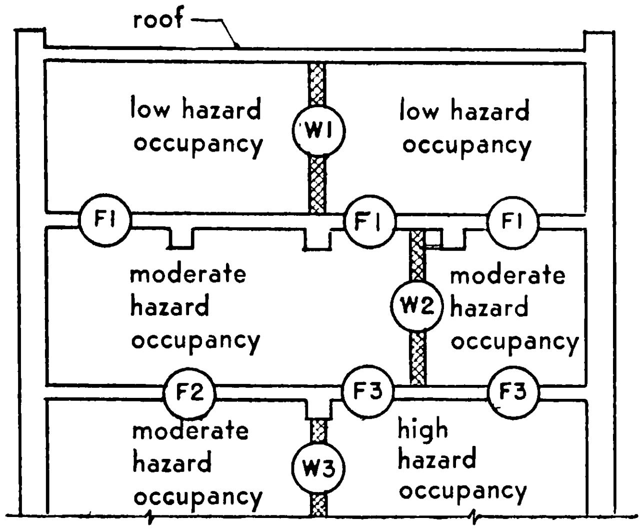


SECTIONS

(A) Combustible framing.
(B) Protective finish of kind and size given in table.

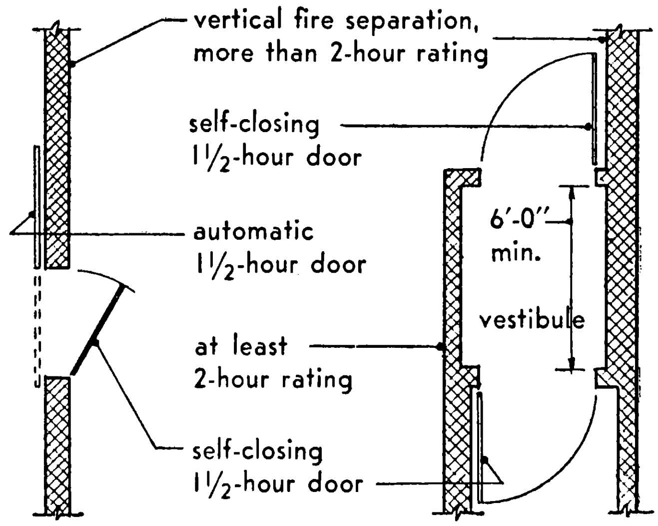
Protective finish (B)	Fire-protection period in minutes
3/16-in. asbestos-cement board	5
¾-in. Portland cement-sand plaster or stucco on metal lath	10
⅜-in. gypsum wallboard	10
½-in. gypsum wallboard	15
⅝-in. gypsum wallboard	20
Two layers ⅜-in. gypsum wallboard	20
¾-in. 1:2, 1:3 gypsum-sand plaster on metal lath	20
Slate, sheet metal or other thin noncombustible material applied over gypsum or other noncombustible sheathing at least ½ inch thick	20
Two layers of ½-in. gypsum wallboard	30
½-in. gypsum-perlite or gypsum-vermiculite plaster on ⅜-in. perforated gypsum lath	30
¾-in. gypsum-perlite or gypsum-vermiculite plaster on metal lath	30
Brick veneer, at least 4 inch nominal thickness	60

Separations Between Occupancies



SECTION

FLOORS AND WALLS
BETWEEN OCCUPANCIES



PLANS

OPENINGS IN
VERTICAL FIRE SEPARATIONS

Walls and floors separating occupancies or tenancies of the same occupancy group, none being accessory to another, should have fire-resistance ratings commensurate with the highest fire hazard classification of the two occupancies separated, as set forth in table C402-4.

Separations are not required within an occupancy or tenancy of the same hazard classification throughout. Where space within an occupancy or tenancy is for accessory use having a higher hazard classification than that of the main occupancy such space should be separated or enclosed in conformity with the requirements of sections C402-4.1 and C402-4.2 of the Code.

Typical examples of fire separations between occupancies are shown in the above illustration where the fire-resistance ratings are as follows:

W1—2 hours; 1 hour where both occupancies are of the same group; 3 hours where one occupancy is group C5.2; 4 hours where one occupancy is group C5.3.

F1—3 hours; 1 hour permitted in buildings of type 2b, 3, 4 and 5 construction; 4 hours where one occupancy is group C5.3.

W2 and F2—3 hours; 1 hour where both occupancies are group C2; 2 hours where both occupancies are group C3.2.

W3 and F3—4 hours.

Where the combined area of adjacent occupancies in any story exceeds the maximum fire area permitted for the occupancy with the higher hazard classification, the fire separation should conform to the requirements for fire walls set forth in section C402-2 of the Code.

Walls separating adjacent occupancies in the same story should extend from floor to floor. Such walls are not required to be continuous through consecutive stories but may be offset to conform to the space used by the different occupancies or tenancies. Where consecutive stories are used by different occupancies or tenancies, the fire separation between them is the floor.

Space in attics or between combustible roof construction and a ceiling should be divided directly over the fire separation between occupancies in the top story of a building. Firestopping as indicated in the illustration entitled, "Firestopping Details," part 4, page 35, may be used in lieu of continuing the fire separation through the attic or roof space.

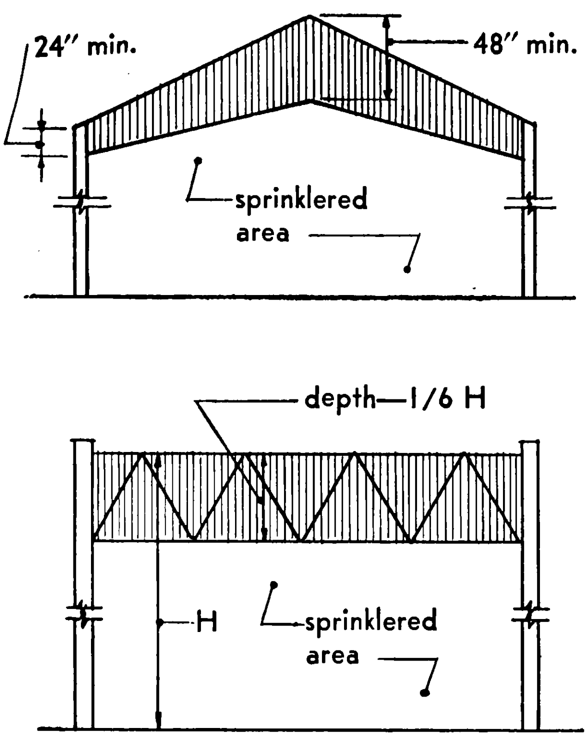
Openings in vertical fire separations should be protected as illustrated, except that a double door is not required when the rating of the separation is 2 hours or less. Openings in horizontal separations between occupancies should not be permitted except when they are part of enclosed exit stairways leading directly to the outside of the building.

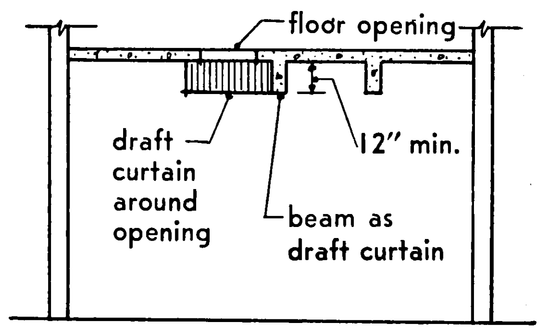
Draft Curtains

In buildings or spaces where the installation of an automatic sprinkler system is required, draft curtains forming heat banking areas are necessary. Their general arrangement and minimum dimensions are illustrated. Solid web beams or girders of approximately the same dimensions may be acceptable as draft curtains.

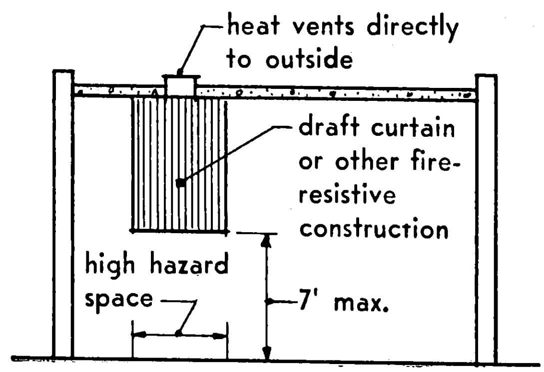
Draft curtains which occur at a truss should preferably extend the full height of such truss. Where openings between floors are permitted in sprinklered buildings, draft curtains of at least 12 inches should be provided.

Space for high hazard use in buildings of group C3.1 and C3.2 occupancy which cannot be completely or separately enclosed can be protected with partial noncombustible enclosures as indicated, vented directly through the roof or through an exterior wall, and provided with fire-extinguishing equipment. Such partial enclosures should begin 7 feet above the floor, or at the least height practicable for operating conditions.





CURTAINS AROUND FLOOR OPENING



SECTIONS

CURTAINS FORMING HEAT-BANKING AREAS

SECTIONS

CURTAINS AROUND HIGH HAZARD SPACE

part 5

Construction illustrated or described herein is acceptable under the State Building Construction Code, but shall not be interpreted as excluding other construction which meets the requirements of the Code.

General Requirements for all Equipment

Underground openings in a foundation wall or slab within 100 feet of an underground gas main or service pipe should be made gastight. Such openings shall include those required for pipes or conduits entering a building, such as those for sewer, water, gas, electricity, and fuel oil.

Plumbing

Plumbing equipment and systems should be designed and installed in conformity with generally accepted standards.

Water Supply

Private Water Supply—No private water supply may be interconnected with any public water supply without the approval of the Department of Health.

Protection Against Backflow—The water distribution system shall be protected against backflow. Every water outlet shall be protected, preferably by having the outlet end, from which water flows, terminate sufficiently above the flood-level rim of the receptacle to provide an effective air gap. Where this is not possible, the water outlet shall be equipped with an accessibly located backflow preventer installed on the discharge side of the manual control valve.

Selection of Materials—When selecting the material and size for water supply pipe, tubing, or fittings, due consideration shall be given to the action of the water on the interior and of the soil, fill, or other material on the exterior of the pipe. No material that would produce toxic conditions in the water-supply system may be used for piping, tubing, or fittings. Piping material that has been used for other purposes than domestic water supply may not be reused in the domestic water supply system.

Water Service Pipe—The water service pipe from the street main to the water distribution system for the building shall be of sufficient size to furnish an adequate flow of water to meet the requirements of the building at peak demand, and in no case shall be less than ¾-inch nominal diameter. If flushometers or other devices requiring a high rate of water flow are used, the water service pipe shall be designed to supply this flow.

MINIMUM SIZE OF A FIXTURE-SUPPLY PIPE

Type of fixture or device	Pipe size (inch)
Bathtub	½
Combination sink and tray	½
Dishwasher (domestic)	½
Drinking fountain	⅜
Hose bibbs	½
Kitchen sink (commercial)	¾
Kitchen sink (residential)	½
Laundry tray, 1, 2, or 3 compartments	½
Lavatory	⅜
Shower (single head)	½
Sinks (flushing rim)	¾
Sinks (service, slop)	½
Urinal (flush tank)	½
Urinal (flush valve)	¾
Wall hydrant	½
Water closet (flush tank)	⅜
Water closet (flush valve)	1

For fixtures not listed, the minimum supply branch may be made the same as for a comparable fixture.

Size of Water Distribution Piping—The size of piping, other than individual fixture supply pipes, should be such that the velocity of water flow, during maximum demand, will not exceed 10 feet per second. In addition, the size of piping should be sufficient to provide, during maximum demand, a minimum available pressure of 8 pounds per square inch at all fixture supply outlets except at flush valves and special equipment where higher pressures, as recommended by the manufacturer, should be available.

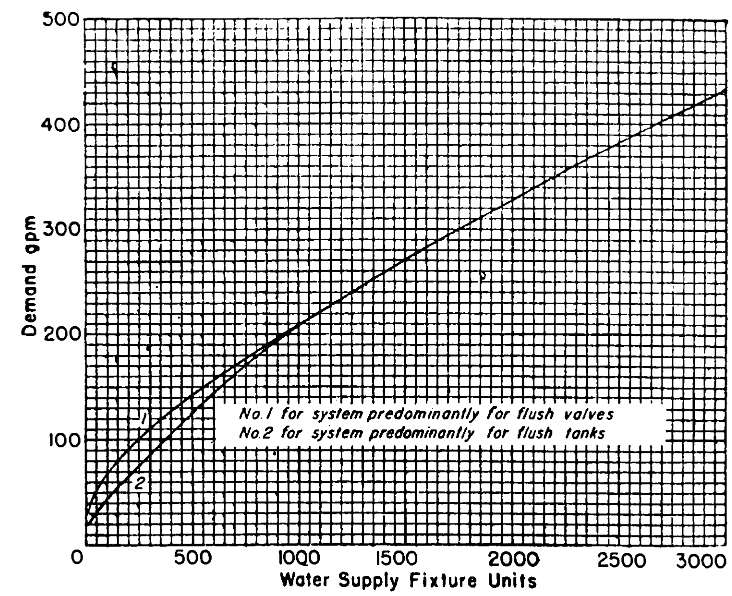
In determining the available pressure, proper allowance should be made for the pressure loss due to friction in the piping system.

Water Supply Demand Load—The demand load, in terms of water supply fixture units, for different plumbing fixtures under several conditions of service, is given in the following table:

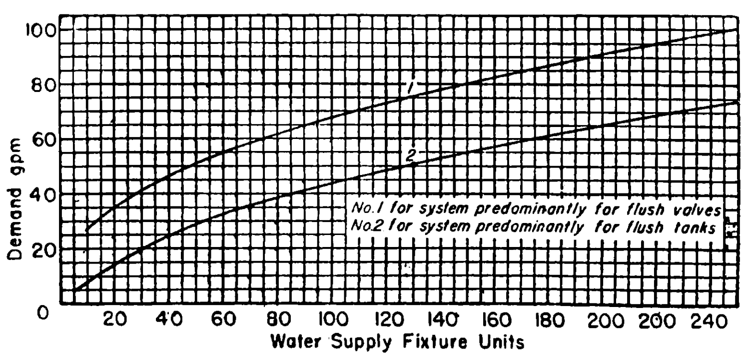
DEMAND LOAD OF FIXTURES

Fixture	Occupancy	Type of supply control	Load, in fixture units
Water closet	Public	Flush valve	10
Water closet	Public	Flush tank	5
Pedestal urinal	Public	Flush valve	10
Stall or wall urinal	Public	Flush valve	5
Stall or wall urinal	Public	Flush tank	3
Lavatory	Public	Faucet	2
Bathtub	Public	Faucet	4
Shower head	Public	Mixing valve	4
Service sink	Office, etc.	Faucet	3
Kitchen sink	Hotel, restaurant	Faucet	4
Water closet	Private	Flush valve	6
Water closet	Private	Flush tank	3
Lavatory	Private	Faucet	1
Bathtub	Private	Faucet	2
Shower head	Private	Mixing valve	2
Bathroom group	Private	Flush valve for closet	8
Bathroom group	Private	Flush tank for closet	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry trays (1 to 3)	Private	Faucet	3
Combination fixture	Private	Faucet	3

Note: For fixtures not listed, loads should be assumed by comparing the fixture to one listed using water in similar quantities and at similar rates. The given loads are for total demand. For fixtures with both hot and cold water supplies, the loads for separate demands may be taken as three fourths of the loads listed.



ESTIMATE CURVES FOR DEMAND LOAD



ENLARGED SCALE DEMAND LOAD

The estimated demand load, for fixtures used intermittently on any supply pipe, in gallons per minute corresponding to any total number of water supply fixture units is given in the charts on the left.

To estimate the total demand in gallons per minute, the demands for outlets, such as hose connections, air conditioning apparatus, etc. which impose continuous demand during times of heavy use, should be calculated separately and added to the demand for fixtures used intermittently.

Water Supply Control—The water-supply system should be controlled by valving as follows:

At curb: A main shutoff valve on the water service pipe near the curb.

At water service pipe entrance: An accessible shutoff valve, with a drip valve, inside the building and near the entrance of the water service pipe.

At water supply tanks: Water supply lines taken from pressure or gravity tanks shall be valved at or near their source.

At risers: An accessible valve at the foot of each water riser, except in one-family dwellings.

In dwelling units: In two-family or multiple dwellings, the water supply to fixtures in each family unit should be controlled by an arrangement of shutoff valves which permit each group of fixtures or the individual fixtures to be shut off without interference with the water supply to any other family unit or other portion of the building. Each such valve should be accessible and located in the same dwelling unit as the fixture or group of fixtures, the water supply of which it controls.

At domestic water heating equipment: A shutoff valve in the cold water branch line to each domestic hot water supply system.

Outside of dwelling units: The water supply to all other fixtures, equipment, or apparatus located outside of dwelling units, should be provided with shutoff valves arranged so that, when water for any such unit is shut off, interruption of water supply should be confined to the individual fixture, equipment, apparatus, or to a separate room in which such units are located.

Drainage of Water Piping—All water pipes should be graded or pitched so that the entire system or parts thereof can be drained. The formation of traps or sags should be avoided where possible. When unavoidable, such traps or sags should have provisions for complete draining.

Hot Water Supply—Hot water supply system should be of the return circulation type in buildings more than four stories high and in buildings where the developed length of hot water piping, from the source of hot water supply to the furthest fixture supplied, exceeds 100 feet.

Sewage Drainage System

Sewage Disposal—Where public sewers are not available, private sewage disposal systems shall conform to local regulations, if any, and shall comply with state and county health regulations. Private sewage disposal systems shall also conform to rules and regulations which are enacted by the local water authorities to prevent pollution of watershed areas. Information regarding such requirements can be obtained from the town, village, city, or county health authorities, or from any of the district offices of the State Department of Health, or from the Bureau of Environmental Sanitation, State Department of Health, Albany, New York.

Where public sewers are not available and private sewage disposal systems are not subject to local regulation, such systems are acceptable if constructed and installed in conformity with generally accepted standards.

Where private sewage disposal systems receive ground garbage or other abnormal waste, such systems should be designed with sufficient capacity to dispose of such abnormal waste.

Materials—Fittings on the drainage system shall conform to the type of piping used. Fittings on screwed pipe shall be of the recessed drainage type.

Grade of Drainage Piping—Piping of 3-inch diameter or less should be installed with a downstream grade of not less than ¼-inch per foot. Piping larger than 3-inch diameter should be installed with a downstream grade of not less than ⅛-inch per foot.

Main Drainage Stack—Every building in which plumbing is installed shall have at least one main drainage stack which shall run undiminished in size and as directly as possible from the building drain through to the open air above the roof.

Drainage Fixture Units—The relative drainage loads, designated for different kinds of fixtures, which should be employed in estimating the total load carried by a soil or waste pipe and which should be used in connection with the table of sizes for soil, waste, drain and vent pipes, are the drainage fixture unit values designated in the table entitled, "Drainage Fixture Units Per Fixture or Group."

For a continuous or semicontinuous flow into a drainage system, such as from a pump, pump ejector, air conditioning equipment, or similar device, two fixture units should be allowed for each gallon-per-minute of flow.

Determination of Sizes for the Drainage System—The maximum fixture unit load that may be connected to a given size of building sewer, building drain, horizontal branch drain, or vertical soil or waste stack shall be as designated in the table of maximum permissible loads for drainage piping, part 5, page 9.

Main drainage stacks may be not less than 3 inches in diameter or the size of the building drain when smaller than 3 inches.

Underground drainage piping shall be at least 2 inches in diameter.

DRAINAGE FIXTURE UNITS PER FIXTURE OR GROUP

Fixture type	Fixture-unit value	Minimum size of trap in inches
1 bathroom group consisting of water closet, lavatory, and bathtub or shower stall	6[1] 8[2]	
Bathtub (with or without overhead shower)	2	1½
Bathtub	3	2
Bidet	3	1½[3]
Combination sink-and-tray	3	1½
Combination sink-and-tray with food-disposal unit	4	1½[4]
Dental unit or cuspidor	1	1¼
Dental lavatory	1	1¼
Drinking fountain	½	1
Dishwasher, domestic	2	1½
Floor drains	1	2
Kitchen sink, domestic	2	1½
Kitchen sink, domestic, with food-disposal unit	3	1½
Lavatory	1	1¼[5]
Lavatory	2	1½[6]
Lavatory, barber, beauty parlor	2	1½
Lavatory, surgeon's	2	1½
Laundry tray (1 or 2 compartments)	2	1½
Shower stall, domestic	2	2
Showers (group) per head	3	
Sinks: Surgeon's	3	1½
Flushing rim (with valve)	8	3
Service (trap standard)	3	3
Service (P trap)	2	2
Pot, scullery, etc.	4	1½
Urinal, pedestal, syphon jet, blowout	8	3[3]
Urinal, wall lip	4	1½
Urinal stall, washout	4	2
Urinal trough (each 2-foot section)	2	1½
Wash sink (circular or multiple), each set of faucets	2	1½[3]
Water closet: Tank-operated	4	3[3]
Valve-operated	8	3

[1] Tank water closet.
[2] Flush-valve water closet.
[3] Nominal.
[4] Separate traps.
[5] Small outlet.
[6] Large outlet.

Fixtures not listed above should be estimated in accordance with the following table:

Fixture drain or trap size	Fixture-unit value
1¼ inches and smaller	1
1½ inches	2
2 inches	3
2½ inches	4
3 inches	5
4 inches	6

Floor Drains—Floor drains subject to backwater shall not be directly connected to the drainage system.

Vents and Venting

Vent Grades and Connections—All vent and branch vent pipes shall be graded and connected so as to drip back to the soil or waste pipe by gravity.

A connection between a vent pipe and a vent stack or stack vent shall be made at least 6 inches above the flood-level rim of the highest fixtures served by the vent pipe. Horizontal vent pipes forming branch vents, relief vents, or loop vents shall be at least 6 inches above the flood-level rim of the highest fixture served.

Fixture Trap Vents—Each fixture trap shall have a protecting vent so located that the developed length in the fixture drain from the trap weir to the vent fitting is in accordance with the following table:

DISTANCE OF FIXTURE TRAP FROM VENT

Size of fixture drain in inches	Distance in feet
1¼	2½
1½	3½
2	5
3	6
4	10

Vent Stacks—A vent stack or a main vent shall be installed with a soil or waste stack whenever back vents, relief vents, or other branch vents are required in two or more branch intervals.

The vent stack should terminate independently above the roof of the building or should be connected with the extension of the soil or waste stack (stack vent) at least 6 inches above the flood-level rim of the highest fixture.

Main Vents to Connect at Base—All main vents or vent stacks shall connect full size at their base to the building drain or to the main soil or waste pipe, at or below the lowest fixture branch. All vent pipes should extend undiminished in size above the roof, or should be reconnected with the main soil or waste vent.

Vent Terminal Location—Extensions of vent pipes through a roof may be terminated not less than 6 inches above the roof.

Such extensions of vent pipes may be terminated not less than 5 feet above the roof, where the roof is to be used for any purpose other than weather protection.

Vent terminals may not be located directly beneath any door, window, or other ventilating opening of the building or of an adjacent building, nor may vent terminals be located within 10 feet horizontally of such openings unless at least 2 feet above the top of such openings.

Extensions of soil, waste, or vent pipes should be extended up inside the building, and should not be run on the outside of an exterior wall of the building.

Vent Terminal Size—The vent extension through a roof shall be at least 3 inches in diameter. When it is found necessary to increase the size of the vent terminal, the change in diameter should be made inside the building. Change in diameter of vent terminals shall be made by use of a long increaser at least 1 foot below the roof.

Stack Venting—Except as required in the paragraph below, a group of fixtures, consisting of one bathroom group and a kitchen sink or combination fixture, may be installed without individual fixture vents, in a one-story building or on the top floor of a building, provided each fixture drain connects independently to the stack and the water closet and bathtub or shower-stall drain enters the stack at the same level and in accordance with the requirements of table entitled, "Distance of Fixture Trap from Vent," part 5, page 6.

When a sink or combination fixture connects to the stack-vented bathroom group, and when the street sewer is sufficiently overloaded to cause frequent submersion of the building sewer, a relief vent or back-vented fixture should be connected to the stack below the stack-vented water closet or bathtub.

Size and Length of Vents—The length of a vent stack or main vent shall be its developed length from the lowest connection of the vent system with the soil stack, waste stack, or building drain to the vent terminal in the open air.

The diameter of an individual vent may be not less than 1¼ inches nor less than one half the diameter of the drain to which it is connected.

The diameter of a relief vent may be not less than one half the diameter of the soil or waste branch to which it is connected.

The diameter of a circuit or loop vent may be not less than one half the diameter of the horizontal soil or waste branch or the diameter of the vent stack, whichever is smaller.

The size of vent piping shall be determined from its length and the total fixture units connected thereto, in accordance with the table entitled, "Size and Length of Vents," part 5, page 8. Twenty per cent of the total length may be installed in a horizontal position.

SIZE AND LENGTH OF VENTS

Size of soil or waste stack in inches	Fixture units connected	Diameter of vent required in inches								
		1¼	1½	2	2½	3	4	5	6	8
		Maximum length of vent in feet								
1¼	2	30	...	...	...	...	...	...	...	...
1½	8	50	150	...	...	...	...	...	...	...
1½	10	30	100	...	...	...	...	...	...	...
2	12	30	75	200	...	...	...	...	...	...
2	20	26	50	150	...	...	...	...	...	...
2½	42	...	30	100	300	...	...	...	...	...
3	10	...	30	100	200	600	...	...	...	...
3	30	...	...	60	200	500	...	...	...	...
3	60	...	...	50	80	400	...	...	...	...
4	100	...	...	35	100	260	1,000	...	...	...
4	200	...	...	30	90	250	900	...	...	...
4	500	...	...	20	70	180	700	...	...	...
5	200	...	...	...	35	80	350	1,000	...	...
5	500	...	...	...	30	70	300	900	...	...
5	1,100	...	...	...	20	50	200	700	...	...
6	350	...	...	...	25	50	200	400	1,300	...
6	620	...	...	...	15	30	125	300	1,100	...
6	960	...	...	...	...	24	100	250	1,000	...
6	1,900	...	...	...	...	20	70	200	700	...
8	600	...	...	...	...	...	50	150	500	1,300
8	1,400	...	...	...	...	...	40	100	400	1,200
8	2,200	...	...	...	...	...	30	80	350	1,100
8	3,600	...	...	...	...	...	25	60	250	800
10	1,000	...	...	...	...	...	...	75	125	1,000
10	2,500	...	...	...	...	...	...	50	100	500
10	3,800	...	...	...	...	...	...	30	80	350
10	5,600	...	...	...	...	...	...	25	60	250

Storm Water Drainage System

Disposal—When a public storm or combined sewer system is not available, disposal of storm water shall be to an adequate and approved system of storm water disposal in conformity with generally accepted standards.

Prohibited Connections—Storm water shall not be drained into sewers intended for sewage only. Leaders shall not be used as soil, waste or vent pipes; nor shall soil, waste or vent pipes be used as leaders.

Materials—Fittings on the drainage system shall conform to the type of piping used. Fittings on screwed pipe shall be of the recessed drainage type.

Traps—Leaders and storm drains, when connected to a combined sewer, shall be trapped. Traps are not required for storm drains which connect to a storm sewer system.

Individual traps shall be installed on the storm drainage branch serving each leader, or a single trap shall be installed on the main storm drain, just before its connection with the combined building sewer, main drain, or public sewer.

Traps, when required, shall be of cast iron. Traps for individual leaders shall be of the same size as the horizontal drain to which they are connected. Leader traps should be located so that an accessible cleanout may be installed on the building side of the trap.

Combined Storm and Sanitary Drainage—The sanitary and storm drainage systems of a building shall be entirely separate except that where a public combined sewer is available, the building storm drain may be connected to the combined building drain or sewer in the same horizontal plane through a single wye fitting and at least 10 feet downstream from any soil stack connection to such drain or sewer.

MAXIMUM PERMISSIBLE LOADS FOR DRAINAGE PIPING [1]

Pipe diameter in inches	Sanitary drainage								Storm drainage							
	Maximum fixture unit load on horizontal fixture branches and stacks				Maximum fixture unit load on building drain, its branches and sewer				Maximum projected drainage area, in square feet, which may be served by—							
	Any horizontal fixture branch	One stack of 3 stories in height or 3 branch intervals	Stacks more than 3 stories in height: Total for stack	Stacks more than 3 stories in height: Total at one story or branch interval	Slope, inches per foot				Horizontal gutters [2] — Slope, inches per foot				Leaders [3]	Horizontal storm drains — Slope, inches per foot		
					1/16	1/8	1/4	1/2	1/16	1/8	1/4	1/2		1/8	1/4	1/2
1¼	1	2	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1½	3	4	8	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	6	10	24	6	.....	.....	21	26	.....	.....	.....	.....	720	.....	.....	.....
2½	12	20	42	9	.....	.....	24	31	.....	.....	.....	.....	1,300	.....	.....	.....
3	20 [4]	30 [5]	60 [5]	16 [4]	.....	20 [4]	27 [4]	36 [4]	170	240	340	480	2,200	822	1,160	1,644
4	160	240	500	90	.....	180	216	250	360	510	720	1,020	4,600	1,880	2,650	3,760
5	360	540	1,100	200	.....	390	480	575	625	880	1,250	1,770	8,650	3,340	4,720	6,680
6	620	960	1,900	350	.....	700	840	1,000	960	1,360	1,920	2,770	13,500	5,350	7,550	10,700
8	1,400	2,200	3,600	600	1,400	1,600	1,920	2,300	1,990	2,800	3,980	5,600	29,000	11,500	16,300	23,000
10	2,500	3,800	5,600	1,000	2,500	2,900	3,500	4,200	3,600	5,100	7,200	10,000	.....	20,700	29,200	41,400
12	3,900	6,000	8,400	1,500	3,900	4,600	5,600	6,700	.....	.....	.....	.....	.....	33,300	47,000	66,600
15	......	......	......	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	59,500	84,000	119,000

[1] Composite arrangement of tables 11.5.2, 11.5.3, 13.6.1, 13.6.2, 13.6.3 of the *Report of the Coordinating Committee for a National Plumbing Code,* dated June, 1951.

[2] Gutters other than semicircular may be used provided they have an equivalent cross-sectional area.

[3] The equivalent diameter of a square or rectangular leader may be taken as the diameter of that circle which may be inscribed within the cross-sectional area of the leader.

[4] Not over two water closets.

[5] Not over six water closets.

Size of Leaders, Storm Drains and Roof Gutters—Leaders, storm drains, and roof gutters shall be in accordance with the table entitled, "Maximum Permissible Loads for Drainage Piping," part 5, page 9.

Size of Combined Drains and Sewers—Drainage fixture-unit loads on combined drains or sewers shall be converted to square feet of equivalent drainage area and added to the actual storm drainage area to determine the total drainage area served by such drains or sewers. The equivalent drainage area shall be 1000 square feet for loads up to 256 fixture units. Each fixture unit in excess of 256 shall be considered the equivalent of an additional 3.9 square feet of drainage area. Combined drains and sewers shall be sized as horizontal storm drains for the total drainage area, and in accordance with the table entitled, "Maximum Permissible Loads for Drainage Piping," part 5, page 9.

Values for Continuous Flow—Where there is a continuous or semicontinuous discharge into the storm drain or sewer, as from a pump, ejector, air conditioning plant, or similar device, each gallon per minute of such discharge shall be computed as being equivalent to 24 square feet of drainage area, based upon a 4-inch rainfall.

Swimming Pools within Multiple Dwellings

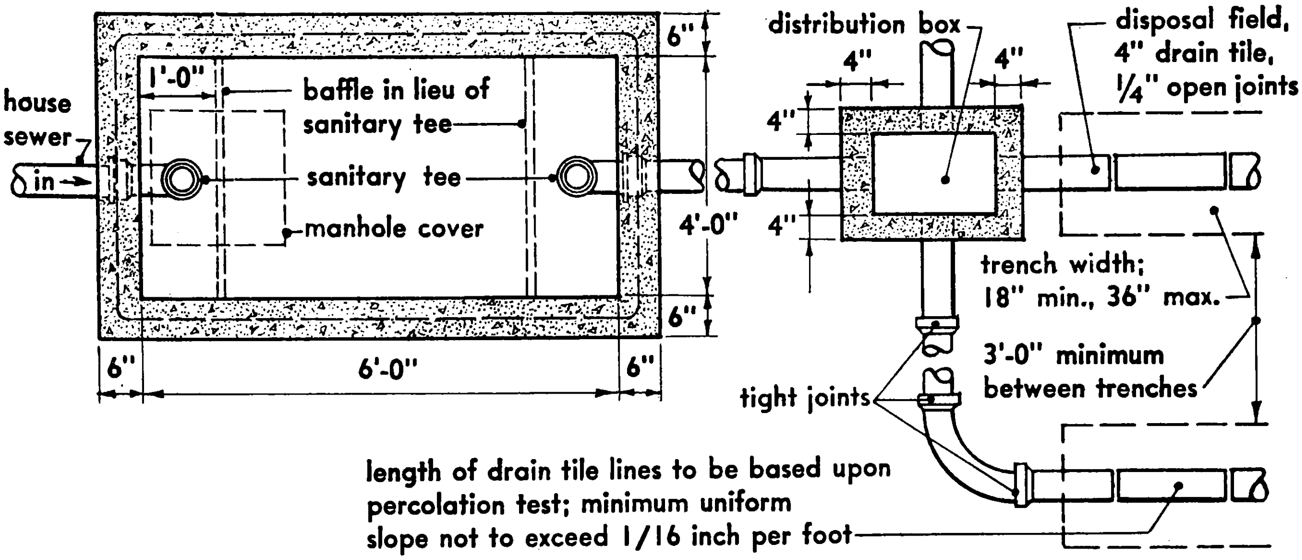
General Requirements—Swimming pools should conform to local regulations and to the requirements of chapter VI of the *New York State Sanitary Code.*

Water Supply Tanks

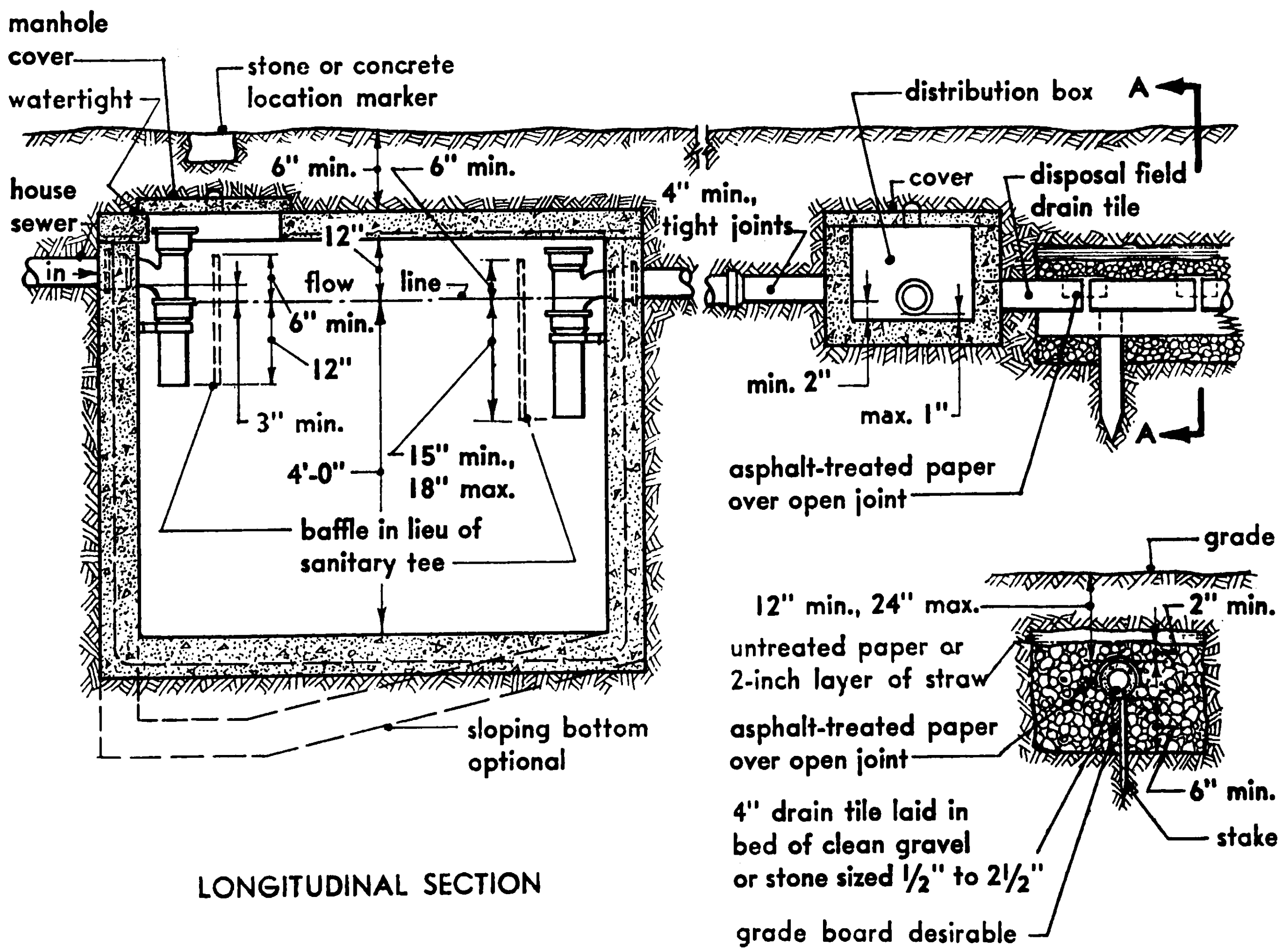
Emergency drain pipe and quick-opening valve shall be accessible from the roof and shall be 2½-inch size for tanks up to 5000 gallon capacity, 3-inch size for tanks having capacity over 5000 and not more than 10,000 gallons, and 4-inch size for tanks over 10,000 gallons.

Drain pipe emptying on roof shall have the terminal horizontal, not more than 18 inches above roof, and directed away from roof openings.

Typical Concrete Septic Tank: Capacity 500 Gallons



PLAN

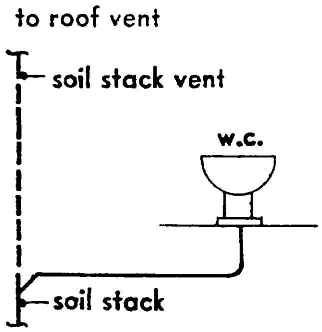


LONGITUDINAL SECTION

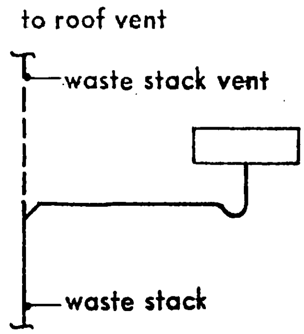
SECTION A-A

Protection of Trap Seals by Vents—1

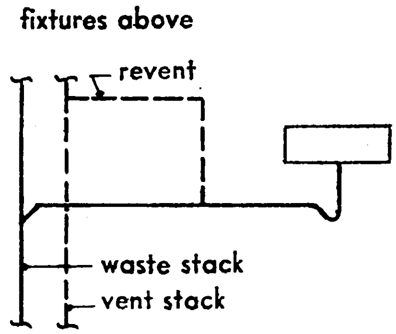
USE OF SOIL STACK



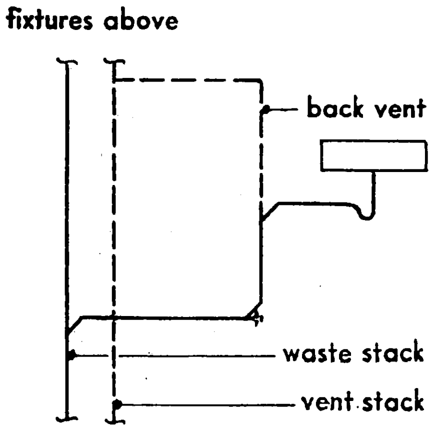
USE OF WASTE STACK



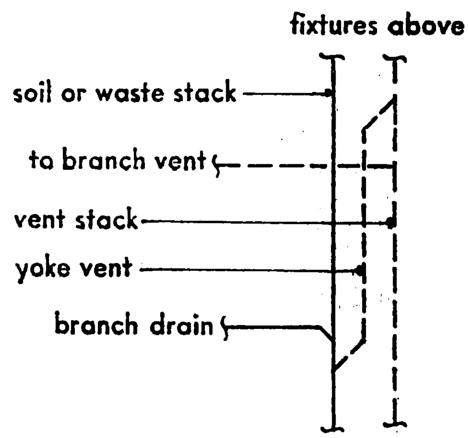
USE OF REVENT (CONTINUOUS VENT)



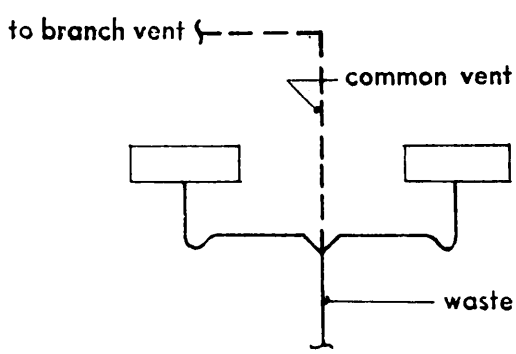
USE OF BACK VENT (CONTINUOUS VENT)



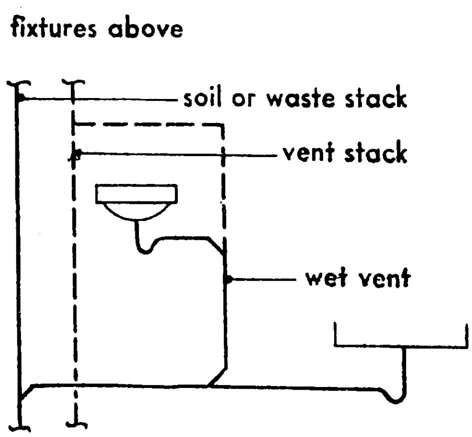
USE OF YOKE VENT



USE OF COMMON VENT

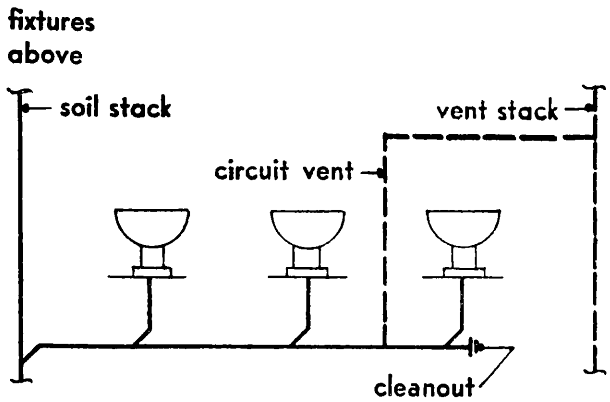


USE OF WET VENT

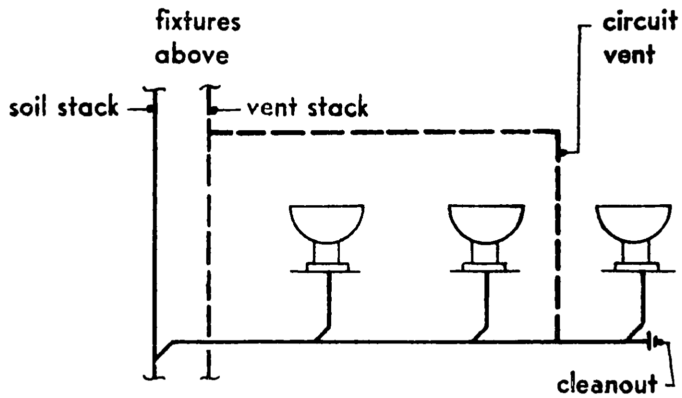


Protection of Trap Seals by Vents—2

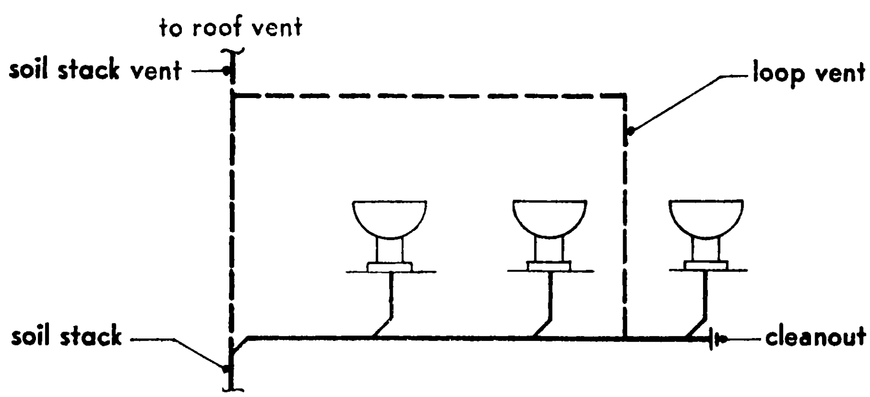
USE OF CIRCUIT VENT



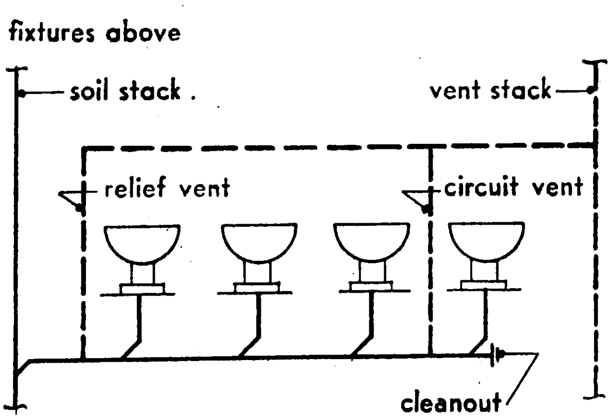
USE OF CIRCUIT VENT



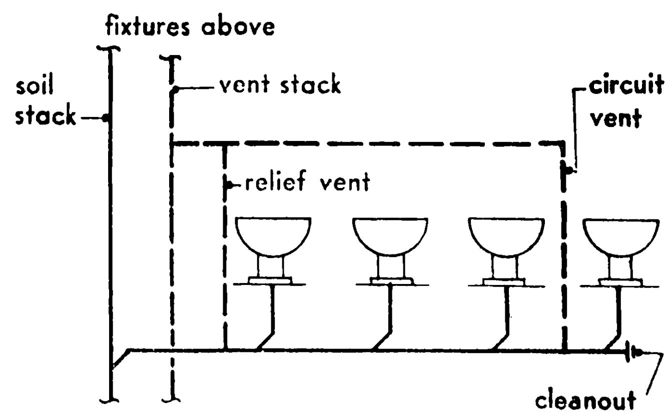
USE OF LOOP VENT



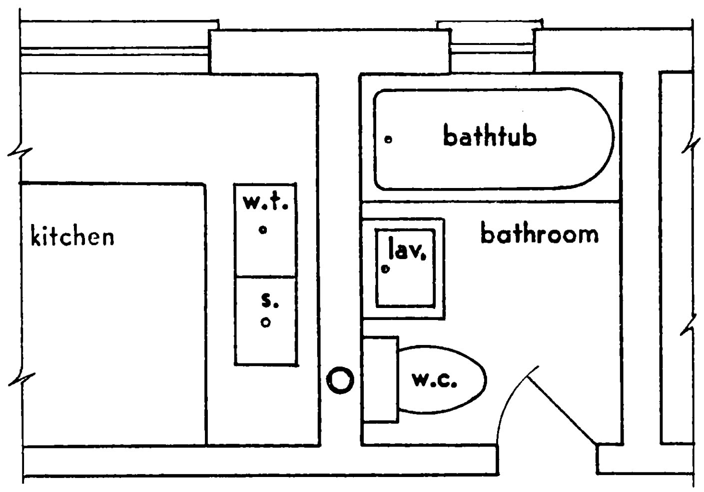
USE OF RELIEF VENT WITH
CIRCUIT VENT



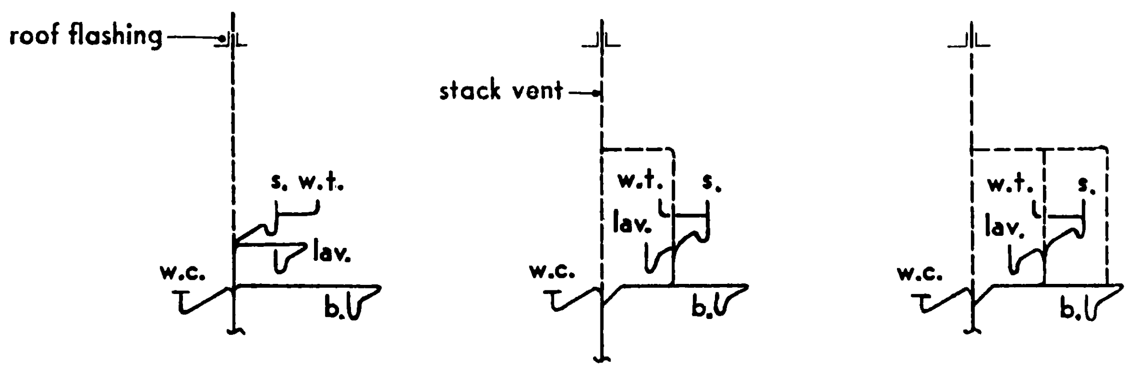
USE OF RELIEF VENT WITH
CIRCUIT VENT



Typical Sewage Drainage System for One-Family Dwelling



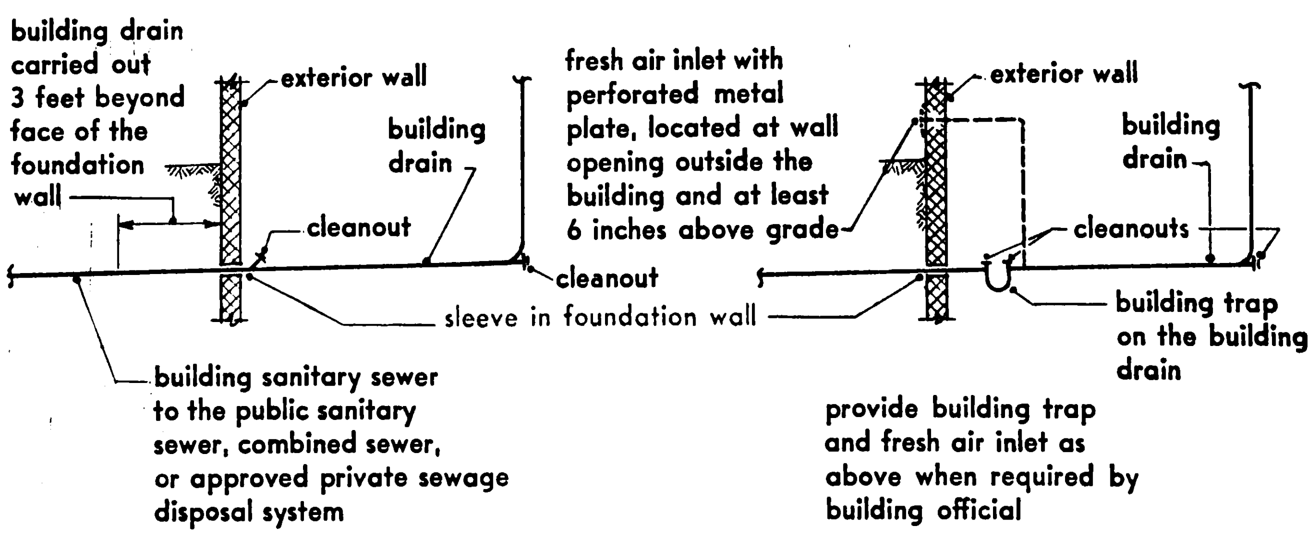
PLAN



STACK VENTED UNIT

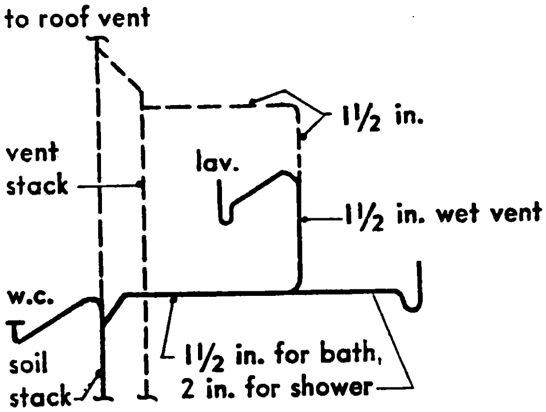
WET VENTED UNIT

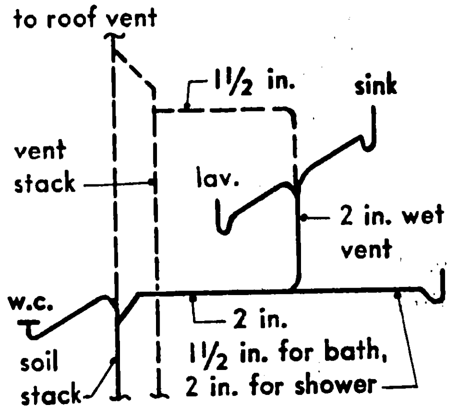
INDIVIDUAL VENTED UNIT

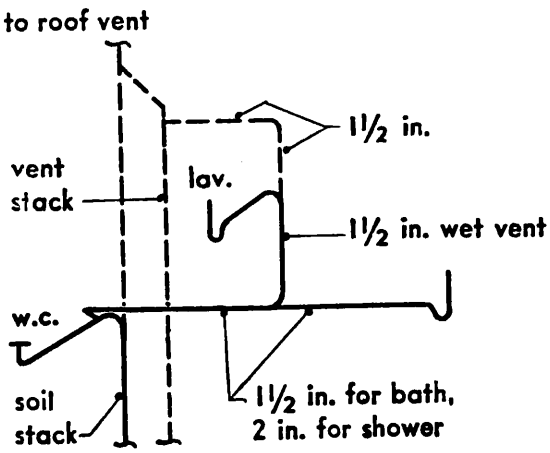


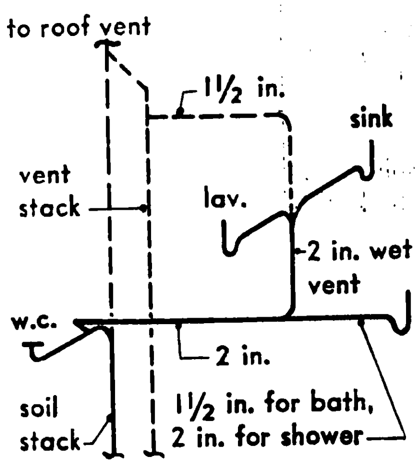
Wet-Vented Single Bathroom and Kitchen Fixture Group

ON A STACK OR AT TOP FLOOR OF A STACK SERVING MULTISTORY BATHROOM GROUPS









Wet Venting

Single Bathroom Groups—A single bathroom group of fixtures may be installed with the drain from a back-vented lavatory, kitchen sink, or combination fixture serving as a wet vent for a bathtub or shower stall and for the water closet, provided that: (1) not more than one fixture unit is drained into a 1½-inch diameter wet vent or not more than four fixture units drain into a 2-inch diameter wet vent, and (2) the horizontal branch connects to the stack at the same level as the water-closet drain or below the water-closet drain when installed on the top floor. It may also connect to the water-closet bend.

Multistory Bathroom Groups—On the lower floors of a multistory building, the waste pipe from one or two lavatories may be used as a wet vent for one or two bathtubs or showers provided that: the wet vent and its extension to the vent stack is 2 inches in diameter; each water closet below the top floor is individually back vented; and the vent stack is sized in accordance with the following table:

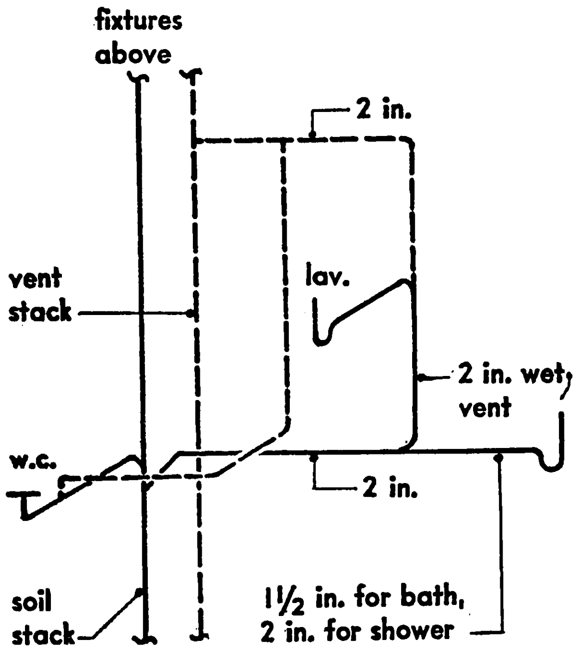
SIZE OF VENT STACKS

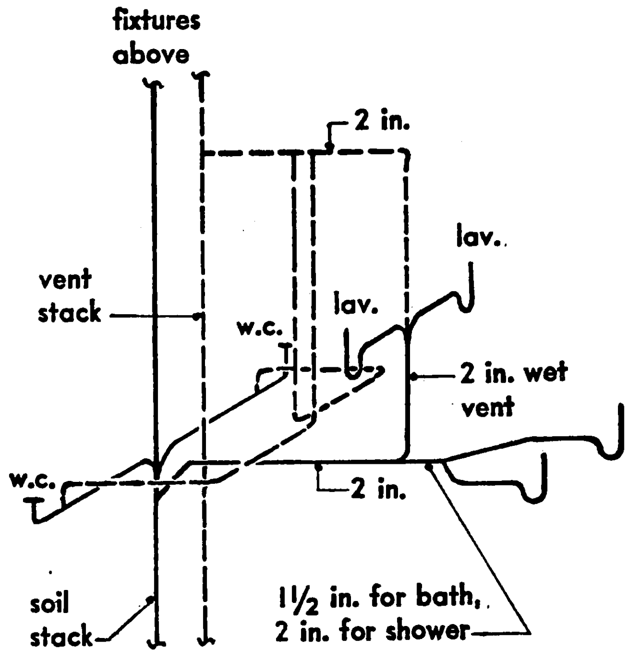
Number of wet-vented fixtures	Diameter of vent stacks in inches
1 or 2 bathtubs or showers	2
3 to 5 bathtubs or showers	2½
6 to 9 bathtubs or showers	3
10 to 16 bathtubs or showers	4

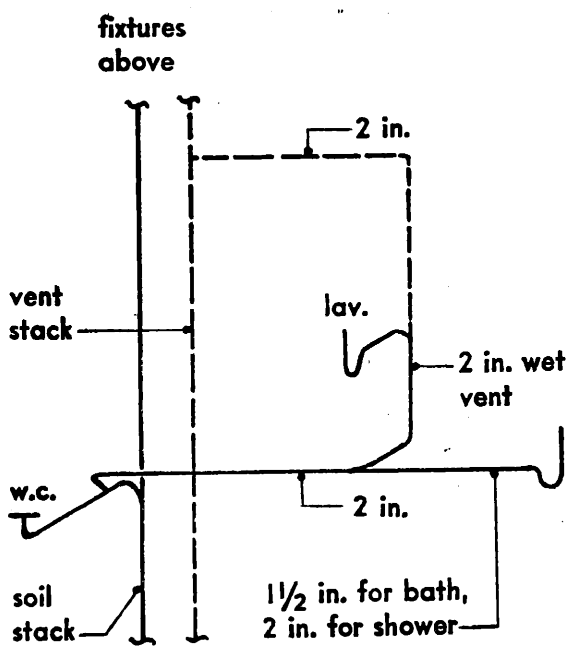
In multistory bathroom groups, wet vented in accordance with the paragraph above, water closets below the top floor group need not be individually vented if the 2-inch waste connects directly into the water-closet bend at a 45-degree angle to the horizontal portion of the bend and in the direction of flow.

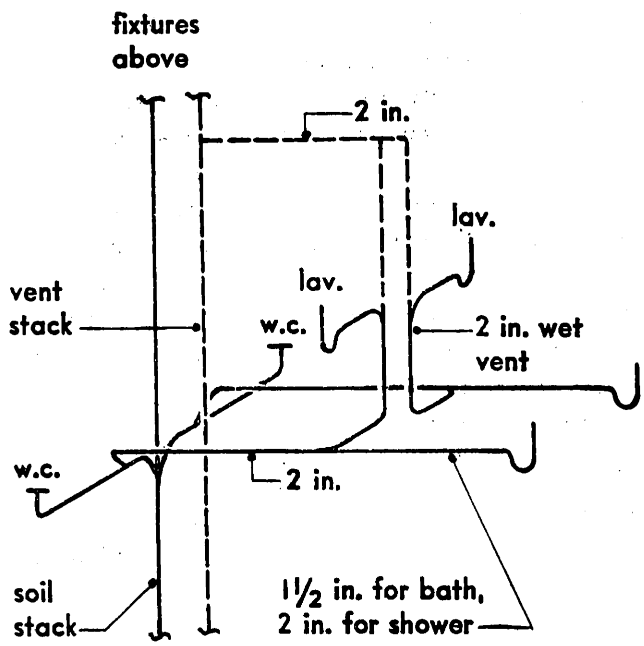
Wet-Vented Multistory Bathroom Fixture Groups

BELOW TOP FLOOR GROUP

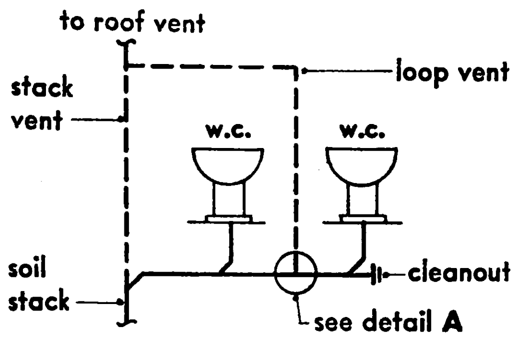


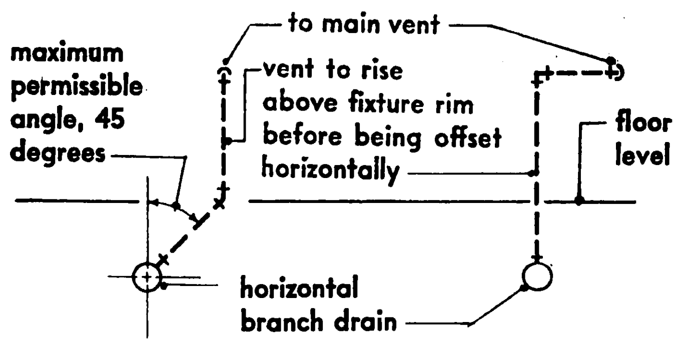




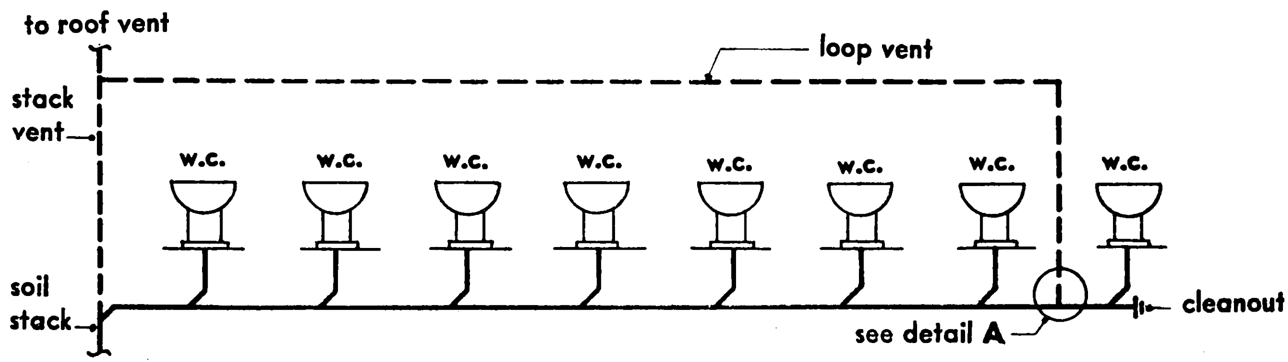


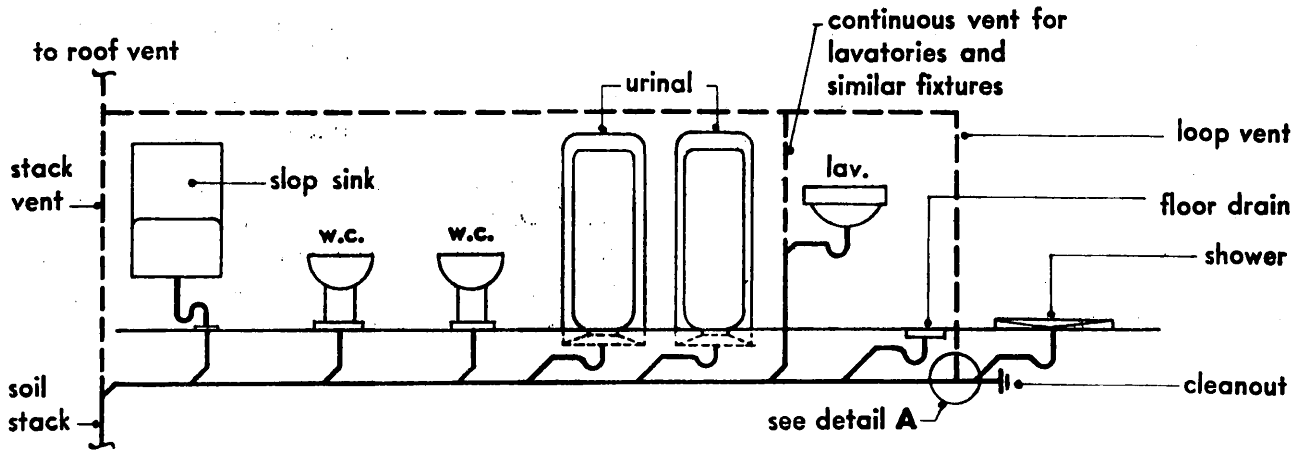
Venting for Batteries of Fixtures: Loop Venting



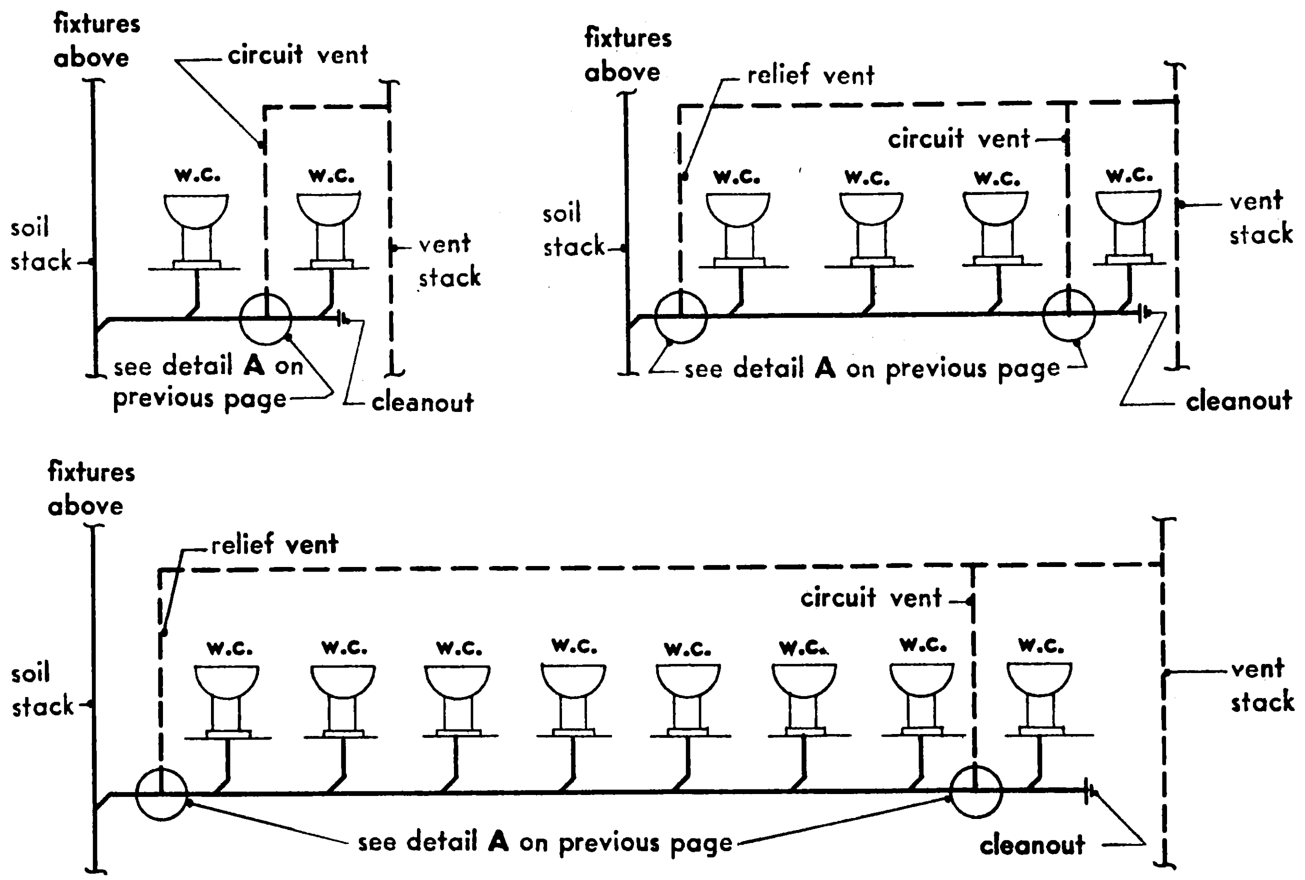


DETAIL A





Venting for Batteries of Fixtures: Circuit Venting



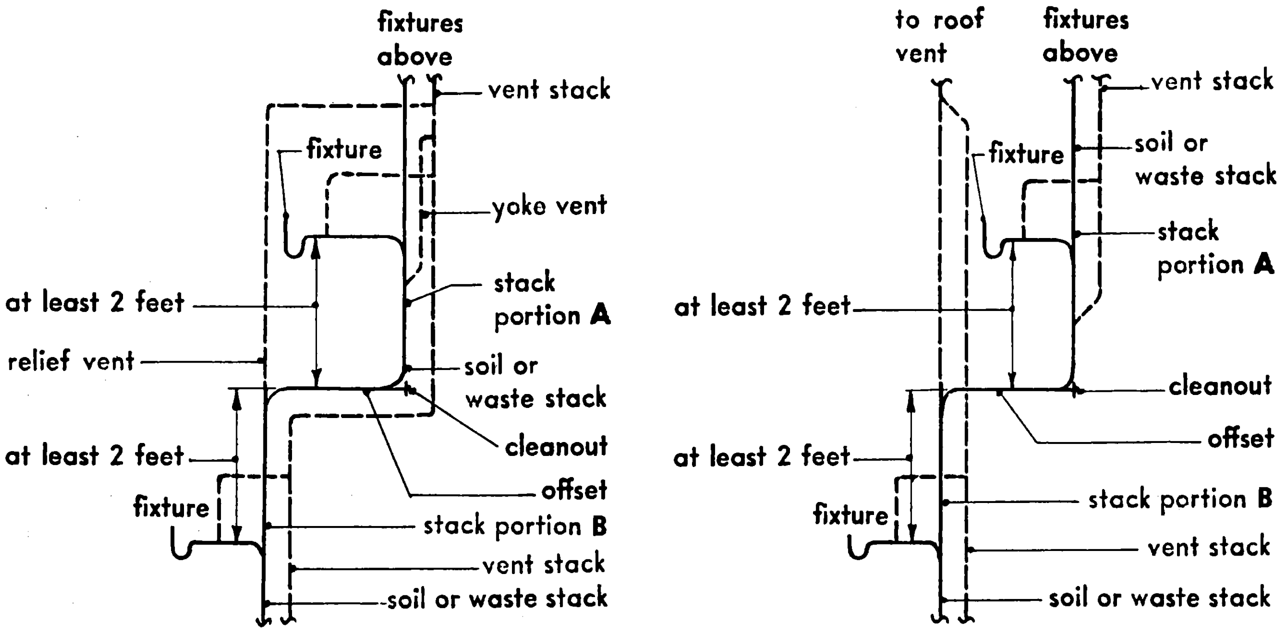
Loop and Circuit Venting

Battery Venting—A branch soil or waste pipe to which two but not more than eight water closets (not blow-out type), pedestal urinals, floor outlet trap-standards, shower stalls, or floor drains are connected in battery, shall be vented by a circuit or loop vent which shall take off in front of the last fixture connection. In addition, lower-floor branches serving more than three water closets shall be provided with a relief vent taken off in front of the first fixture connection. When lavatories or similar fixtures discharge above such branches, each vertical branch shall be provided with a continuous vent.

Vent Connections—When the circuit, loop, or relief vent connections are taken off the horizontal branch, the vent branch connection shall be taken off at a vertical angle or from the top of the horizontal branch.

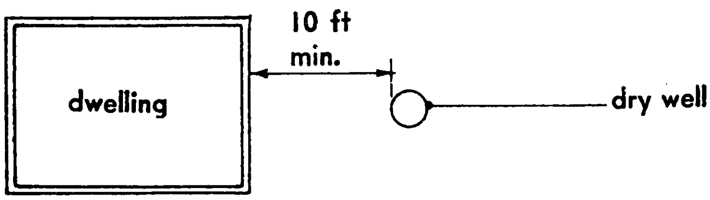
Alternate Methods of Relief Venting for 60- and 90-Degree Offsets in Drainage Stacks

IN BUILDINGS FIVE STORIES OR MORE IN HEIGHT

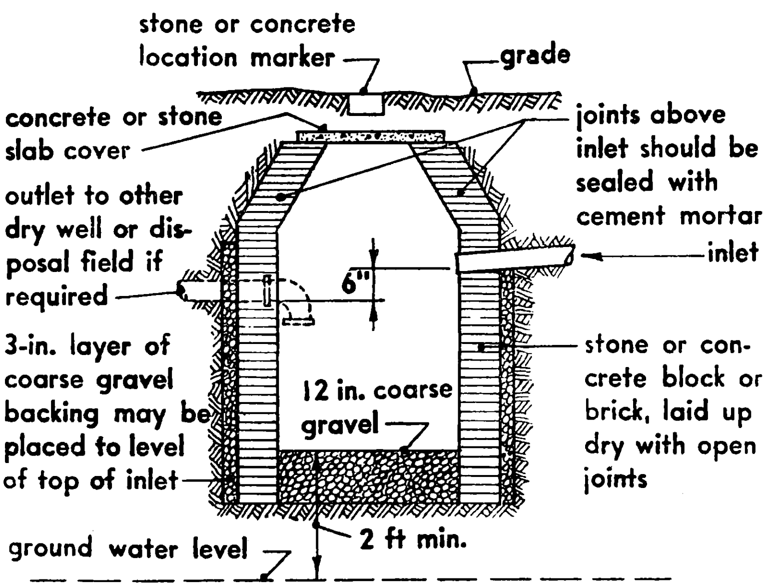


Size offset as for a building drain serving load of stack portion (A). Size stack portion (A) as a separate stack. Size stack portion (B) as a separate stack serving total load of both stack portions (A) plus (B). Size relief and yoke vents not smaller than main vent or soil or waste stacks connected.

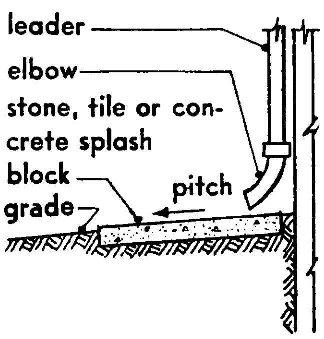
Private Storm Water Disposal



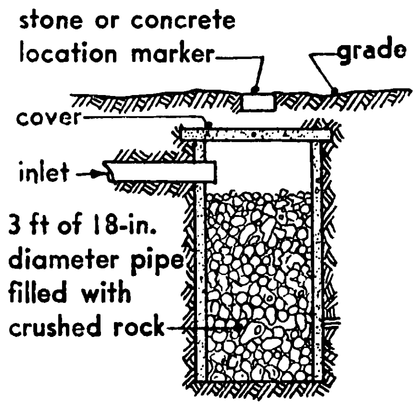
LOCATION OF DRY WELLS



SECTION: LARGE DRY WELL



SPLASH BLOCK



SECTION

SMALL DRY WELL

Where sewers are not available for storm water disposal and where soil and finished surface grade are suitable, the following means of disposal may be used:

1. Dry Well—Size dependent on area to be drained and soil absorption.
2. Dry well with additional subsurface drains—Where soil absorption is such that dry well cannot handle the load.
3. Drainage for roof combined with drainage for surface and subsurface and where dry well is of limited capacity—Dry well for surface and subsurface drainage; roof drains leading to splash block and directed away from dry well.
4. Splash Block—When discharging roof drains at grade, a splash block should be used to minimize soil erosion.

Gas Piping and Equipment

General Requirements—Gas piping and equipment designed and installed in conformity with generally accepted standards are deemed to meet the requirements of the Code.

Curb Valve for Systems Using Other Than Liquefied Petroleum Gas—Curb valves are not required for one- and two-family dwellings where the gas service pressure does not exceed 1 psi gage; where such pressure is exceeded, a curb valve shall be provided.

Curb valve should be installed in a metal box at grade and located 6 feet or more from the exterior wall.

Service Equipment for Systems Using Other Than Liquefied Petroleum Gas—In one- and two-family dwellings where the gas service pressure does not exceed 1 psi gage, the main shutoff valve or cock may also serve as the meter valve. In multiple dwellings, a service valve and a meter valve should be provided.

The type and location of service valve should be in conformity with regulations of the local utility company and should be at least 3 feet from fuel-burning equipment.

Gas service meters, regulators, and valves, located outside of multiple dwellings above grade, should be provided with enclosures.

Where the underground portion of the gas service is longer than one length of pipe, a full length of pipe should be used, terminating within the building. Service entrance pipe shall terminate at least 1 inch within the building.

After the service has been approved by the utility company, the trench should be back-filled with soil that is free of rubbish, rocks, cinder, debris or other deleterious matter. Back-fill should be firmly tamped around pipe to assure adequate support.

Service entrance shall not terminate in coal bins, toilets, bathrooms or sleeping rooms.

Service pipe and equipment within 10 feet from bottom landing of stairs shall be protected from damage.

The Service Pipe Passing Through Building Wall—Service pipe passing through the building wall should be coated, well wrapped with suitable material and protected against corrosion and damage.

Meter Arrangement—Clearances on all sides of meters shall conform with regulations of the local utility company. Maximum height from floor to top of meters should be 7 feet for single meters, or meters in a single tier. The lowest meter should have at least 6-inch clearance above the floor.

High Pressure Gas—Gas service having a pressure exceeding 1 psi gage shall be designated as high pressure gas.

Curb Valve—Curb valves shall be installed in accordance with the regulations of the Public Service Commission of the State of New York, Case 15686, appendix II, *Recommended Rules, Precautions and Improvements Applicable to Gas Corporations Engaged in the Distribution of Gas*, part 11 entitled, "Curb Cocks".

Curb valves shall bear a clear and permanent mark such as "H P Gas," and the cover for such valve shall be located so as to be clearly visible.

Service Valve—A service valve shall be furnished and installed on the high pressure side of the regulator. This valve should be tamperproof and designed so as to prevent the possibility of the core being displaced or blown out by gas pressure.

Location of Drips—Drips, if provided, should be located outside the building.

Service Pipe Passing Through Building Wall—The portion of the service pipe passing through the building wall should be run through a pipe sleeve as shown in illustration entitled, "Gas Service Installation For Pressures Exceeding 1 psi Gage," part 5, page 24.

Pressure Regulator—A pressure regulator shall be provided and should be located close to the service entrance with clearances as required by the local utility company. When two or more regulators are used, each regulator should be provided with a shutoff valve at its inlet and outlet.

Pressure Regulator Vent—The pressure regulator vent should be of standard weight black steel pipe, and where buried, or where less than 6 inches above grade, should be coated and well wrapped or should be of extra heavy black steel. Such coating or extra heavy pipe should be extended to a point at least 1 inch inside of the inner wall surface. Such vent passing through masonry walls 6 inches or more above grade should be coated. Openings in exterior walls providing passage for such vents should be made weathertight. Vents should be as short as possible with a minimum number of bends.

The terminal of the pressure regulator vent pipe shall be at least 18 inches above grade, and at least 18 inches horizontally distant from any building opening, and shall not be located where it may be subject to stoppage or subsequent closure.

Shutoff Valve at Equipment—Valves or cocks on piping near equipment shall be installed on rigid pipe and shall have a lever, handle, or key securely attached thereto.

Gas Refrigerators

Gas refrigerators should be designed and installed in accordance with the following requirements:

A gas cock should be provided at the terminus of the rigid pipe and another should be provided at the refrigerator.

Where the gas pipe to the refrigerator is at the bottom of a vertical run, a dirt pocket should be provided.

Final connection to refrigerator may be made with an approved connector of flexible metal tubing and fittings, protected against mechanical damage, free of kinks, traps and unnecessary bends. The length of such connector should not exceed 6 feet. Flexible tubing shall not be concealed in building construction or installed in spaces other than those containing the connected equipment.

Gas lines should not be installed in spaces subject to low temperatures.

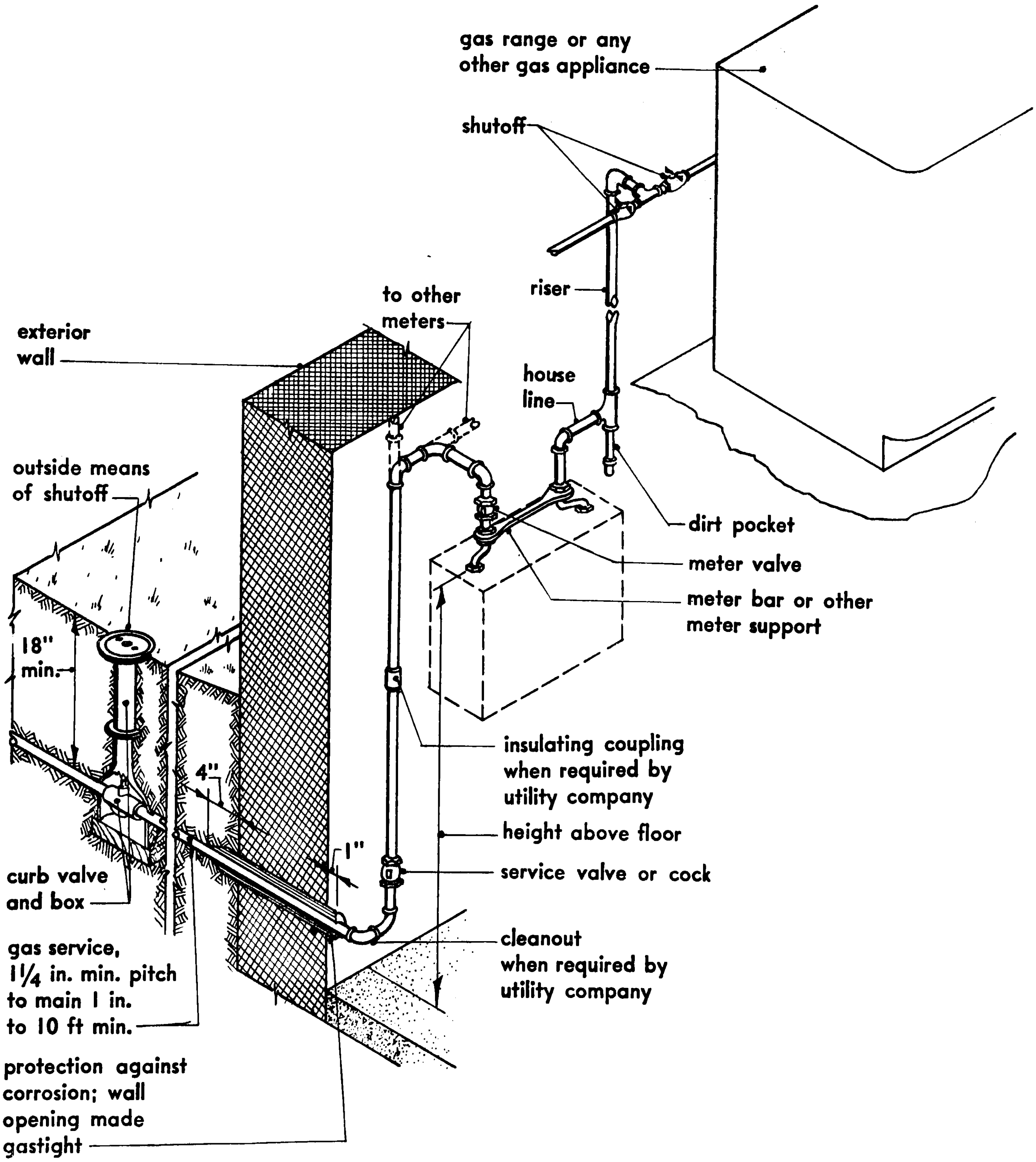
The burner safety device shall be of approved type to shut off the gas completely after the flame is extinguished.

Gas supply to refrigerator shall be adequate at all times. If the connection to the refrigerator is a branch from the pipe serving the gas range, the refrigerator flame should remain undiminished in size with all the range burners on.

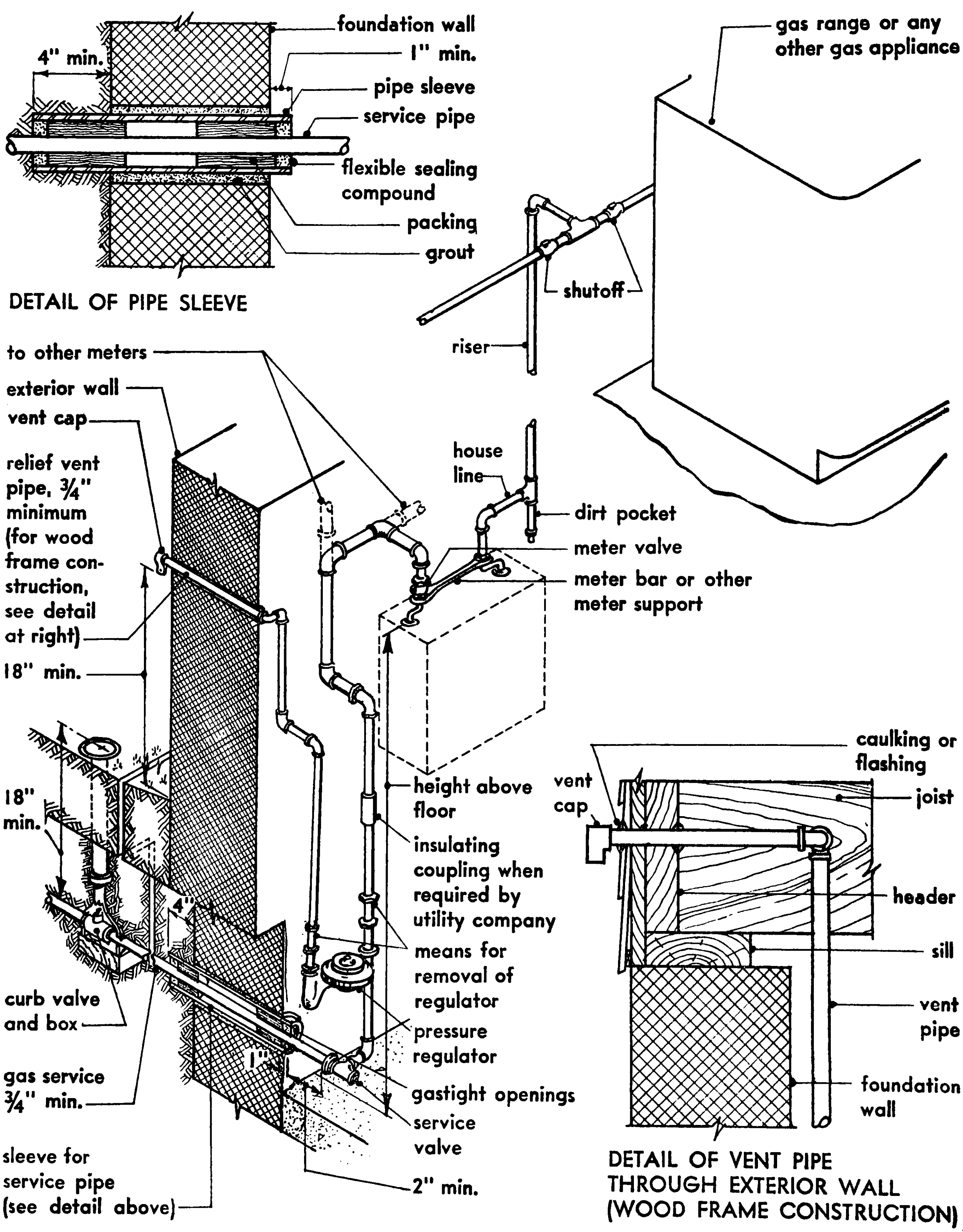
Liquefied Petroleum Gas

General Requirements—Liquefied petroleum gas systems designed and installed in conformity with generally accepted standards are deemed to meet the requirements of the Code.

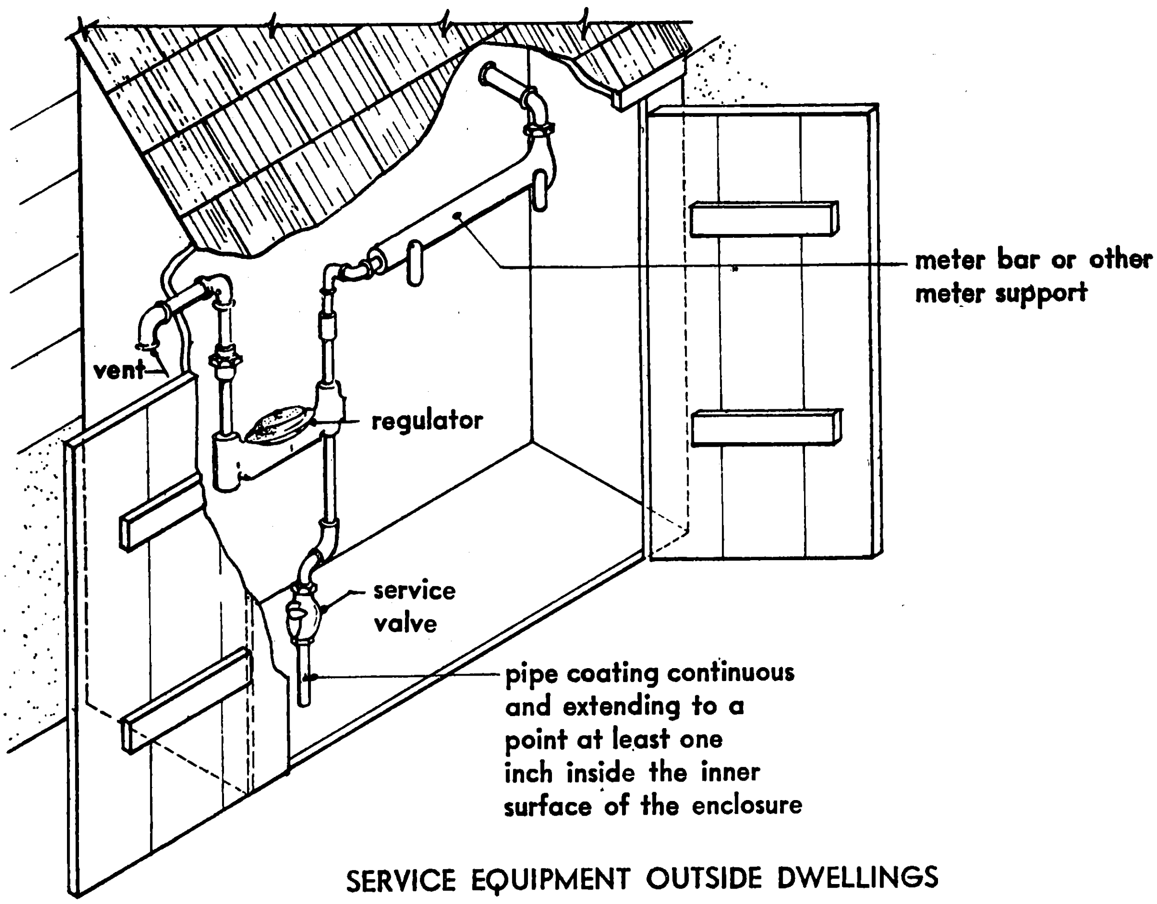
Gas Service Installation for Pressures not Exceeding 1 psi Gage



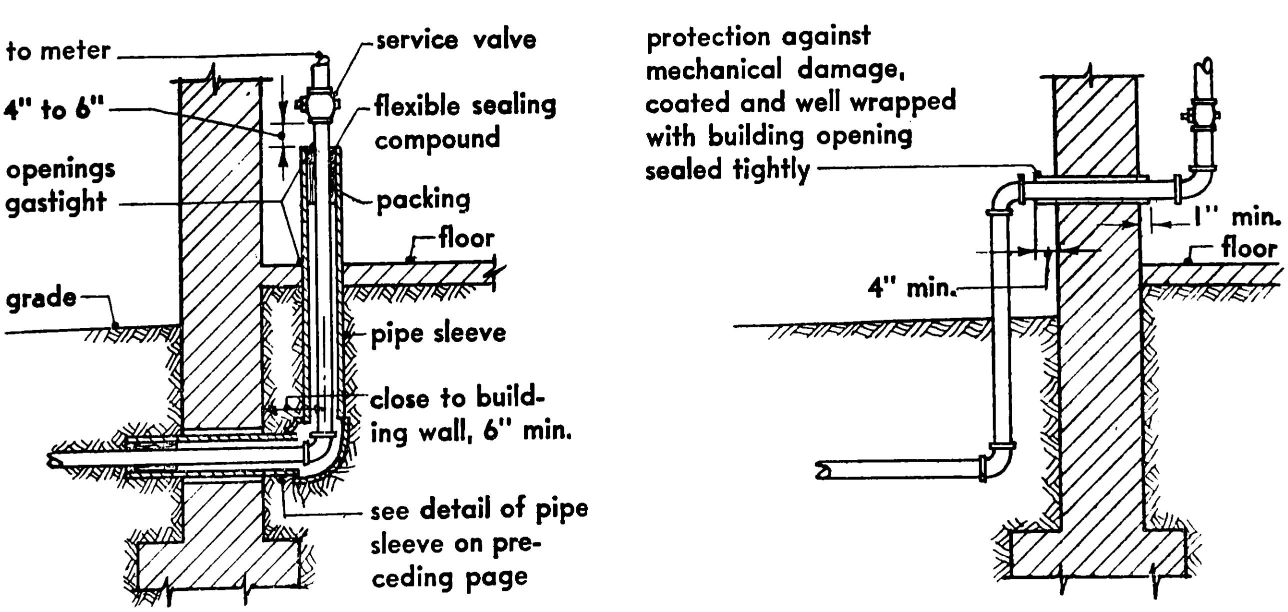
Gas Service Installation for Pressures Exceeding 1 psi Gage



Gas Service Installations Outside Dwellings and for Basementless Dwellings

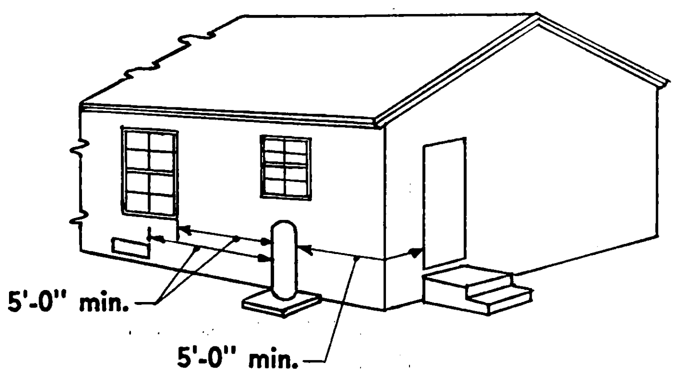


SERVICE EQUIPMENT OUTSIDE DWELLINGS

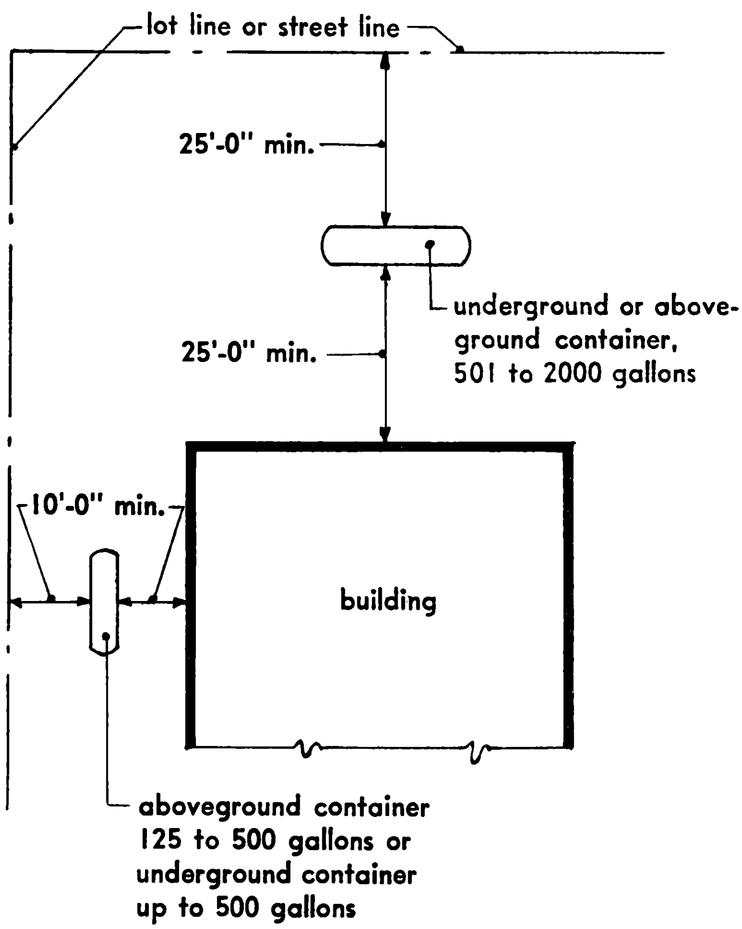


FOR BASEMENTLESS DWELLINGS

Liquefied Petroleum Gas Storage Containers



ABOVEGROUND CONTAINERS OF LESS THAN 125-GALLON CAPACITY



UNDERGROUND CONTAINERS OR ABOVEGROUND CONTAINERS OF MORE THAN 125-GALLON CAPACITY

Aboveground container with a capacity of less than 125 gallons, may be placed directly against exterior wall of building. When two such units are installed, no clearance is required between them.

The space where the aboveground containers are located shall be arranged so that the lowest level of such space, whether enclosed or open, is ventilated horizontally to the outside air, at least 5 feet horizontal distance from any openable window, door, or other ventilating opening which is wholly or in part at a lower level. Such arrangement shall also be maintained from the discharge of cylinder and regulator relief valves.

An aboveground installation shall be at least 5 feet from any driveway.

Underground containers shall be buried at least 2 feet below grade.

Heating

Outside Design Temperature—The design capacity of a heating system to maintain proper indoor temperatures shall be based on the average of the recorded annual minimum outside temperatures for the locality, the type of building served, and the type of heating system.

Listed below are the averages of the recorded annual minimum outside temperatures for various localities, and the design temperatures commonly used.

Heat Producing Equipment

General Requirements—Heat producing equipment designed and installed in conformity with generally accepted standards is deemed to meet the requirements of the Code.

Shutoff—Automatically operated heat producing equipment shall be provided with a means for manual shutoff ahead of all controls.

Rating of Equipment—Unless otherwise specifically stated by manufacturer, ratings indicated on gas-fired heat producing equipment are for localities where elevations are 2000 feet or less; for elevations above 2000 feet, ratings should be reduced 4 per cent for each 1000 feet above sea level.

Where no rating is given for a combination of an oil burner and a boiler or furnace, the burner should be of sufficient capacity, based on 140,000 Btu per gallon of oil and an efficiency of 70 per cent.

Boilers furnishing all the heat requirements for a building shall have a gross output rating capable of supplying the maximum loads required for space heating, hot water to plumbing fixtures, piping losses and pickup.

Hot air furnaces shall have a gross output rating adequate to supply the load required at the registers plus the duct losses.

Identification of Equipment—Direct-fired

RECORDED ANNUAL MINIMUM OUTSIDE TEMPERATURES
Based on Data Obtained from the U. S. Weather Bureau

Locality	County	Annual readings used	Average of the annual readings	Outdoor design temperatures in common use
Albany	Albany	1874–1952	−11	−10
Alfred	Alleghany	1924–1952	−14	−15
Auburn	Cayuga	1933–1952	−11	−10
Binghamton	Broome	1891–1952	−11	−10
Buffalo	Erie	1873–1952	− 4	− 5
Cairo	Greene	1926–1952	−13	−15
Canton	St. Lawrence	1889–1952	−26	−25
Chasm Falls	Franklin	1931–1952	−26	−25
Chazy	Clinton	1924–1952	−23	−25
Cortlandt	Cortlandt	1933–1952	−11	−10
Elmira	Chemung	1929–1952	− 4	− 5
Franklinville	Cattaraugus	1932–1952	−23	−25
Geneva	Ontario	1924–1952	− 7	− 5
Glens Falls	Warren	1924–1952	−19	−20
Ithaca	Tompkins	1879–1952	−10	−10
Jamestown	Chautauqua	1924–1952	− 7	−10
Lake Placid	Essex	1931–1952	−25	−25
Little Falls	Herkimer	1924–1952	−15	−15
Lockport	Niagara	1924–1952	− 5	− 5
New York	New York	1871–1952	+ 4	0
Norwich	Chenango	1924–1952	−16	−15
Ogdensburg	St. Lawrence	1924–1952	−21	−20
Oneonta	Otsego	1924–1952	−12	−15
Oswego	Oswego	1871–1952	− 9	−10
Patchogue	Suffolk	1938–1952	− 1	0
Port Jervis	Orange	1929–1952	− 7	− 5
Poughkeepsie	Dutchess	1929–1952	− 8	−10
Rochester	Monroe	1872–1952	− 4	− 5
Syracuse	Onondaga	1903–1952	−11	−10
Utica Airport	Oneida	1927–1952	−18	−20
Watertown	Jefferson	1924–1952	−22	−20
West Point	Orange	1924–1952	− 2	0

heat producing equipment shall bear a permanent legible marking on a conspicuous part of the equipment that will furnish the following information: manufacturer's name; identification of equipment; compliance with the generally accepted standard under which it is constructed; and maximum rated capacity.

In addition to the above data, markings on boilers shall also furnish the following information: maximum allowable working pressure; whether designed for use with steam and water, or for water only; and the safety valve relief setting.

Markings on oil burners shall indicate, in addition to identification data indicated above, the grade of fuel oil to be used. Where the marking on equipment is concealed, an opening shall be provided for readily viewing such marking.

Instructions—Direct-fired heat producing equipment which is automatically operated shall be provided with legible instructions, conspicuously posted, giving complete instructions for the care and operation of the system. Instructions shall be securely attached near the equipment and shall be on durable material or be enclosed in a glazed frame.

Combustion Space—The net volume of the combustion space after the refractory is in place shall be adequate for the maximum firing capacity.

Combustion space for central heat producing equipment should be in conformity with the requirements of the equipment manufacturer. Except where such equipment is designed for efficient operation at greater combustion rate, the rate of combustion for automatically fired equipment generally should not exceed that shown in the table entitled, "Heat Release Per Cubic Foot of Combustion Space for Automatically Fired Equipment."

Smoke Control—Unless emission of smoke is controlled effectively by other means, fuel-burning equipment should conform to the following:

Hand-fired coal boilers of the vertical type should be limited in size to no more than 250 square feet of boiler heating surface.

Overfire air should be provided where smoke may be produced.

HEAT RELEASE PER CUBIC FOOT OF COMBUSTION SPACE FOR AUTOMATICALLY FIRED EQUIPMENT

Equipment [1]	Combustion rate in Btu per hour per cubic foot
Oil-fired, rated net output up to 2,000,000 Btu per hour	30,000
Oil-fired, rated net output over 2,000,000 Btu per hour	38,000
Gas-fired	38,000
Coal-fired, pulverized	30,000
Coal-fired, overfeed or spreader stokers	35,000
Coal-fired, underfeed coal stokers	50,000

[1] For horizontal return tubular boilers, 25 per cent of the volume back of the bridge wall may be considered as combustion space.

Mechanical chain grate stokers should be provided with an ignition arch.

Spaces within heat producing equipment designed to collect and store ashes should have sufficient capacity for at least 4 hours of operation at rated capacity without causing an increase in the emission of smoke.

Heat producing equipment designed to burn coal in suspension should be provided with means to prevent the emission of fly ash into the atmosphere, and means for the removal of fly ash from stacks and breechings.

Heat producing equipment designed to burn oil requiring preheat should be provided with automatic means to assure that such oil entering the combustion chamber will be adequately preheated at all times.

Scotch Marine boilers equipped for oil-firing should be provided with a Dutch oven.

Mechanical underfeed stokers designed and installed to burn bituminous coal should have the minimum setting height from the stoker dead plate or dump grate to the crown sheet, or to the equivalent of the crown sheet, as set forth in the table entitled, "Setting Height for Mechanical Underfeed Stokers."

Warm Air Heating

Warm air heating systems, designed and installed in conformity with generally accepted standards, are deemed to meet the requirements of the Code. Return air connections shall not be made from bathrooms, garages, laundries, and basement sections not used for living quarters.

SETTING HEIGHT FOR MECHANICAL UNDERFEED STOKERS
Height in inches

Type of boiler	Rated net output, in million Btu per hour					
	Under 1.7	Over 1.7 to 2.7	Over 2.7 to 3.4	Over 3.4 to 4.2	Over 4.2 to 5.0	Over 5.0 to 6.7
Horizontal return tubular, cast iron or steel	42	48	54	60	66	72
Built-in firebox	54	60	66	72	78	84

Steam and Hot Water Heating Systems

The method of connecting the flow and return pipes on boilers should be made so as to facilitate the rapid circulation of steam or water. Connection to water supply and drainage systems shall be in conformity with section B 502 of the Code entitled, "Plumbing."

Accessory Devices for Boilers

Boilers should be provided with the following accessory equipment:

For steam boilers: A water level gage glass equipped with top and bottom shutoff valves; gage cocks located within the visible range of the gage glass, at least two gage cocks provided for low pressure boilers and three for high pressure boilers; high pressure boilers shall be equipped with a water column; steam pressure gage with siphon or other device to keep the gage tube filled with water. For low pressure boilers, gage shall be graduated to 30 psi gage pressure.

For hot water boilers: Pressure or altitude gage connected to the boiler or the flow connection—gage shall be calibrated to 1½ times the maximum allowable working pressure; thermometer, calibrated in degrees Fahrenheit, located at or near the outlet of the boiler and arranged so as to be easily readable when observing the pressure or altitude gage.

Clearances to Combustible Construction

Mounting conditions and minimum clearances to combustible materials should be as set forth herein.

Mounting conditions and lesser clearances may be acceptable for specific heat producing equipment when tests made by a recognized laboratory show that the temperature on the surface of the combustible material will not exceed 175° F.

Example: Assume a low-pressure steam boiler with automatic equipment for burning coal or oil and a rated gross output of 200,000 Btu per hour. Assume the walls and ceiling of combustible material protected with 28-gage sheet metal on ¼-inch asbestos millboard. For clearance to unprotected combustible material for type of appliance, see table 1 on next page; for clearance to protected combustible material, see table 2 on next page. Clearance, therefore, is determined as follows:

Minimum clearance indicated in illustration entitled, "Clearance for Furnaces and Boilers," part 5, page 31	From table 1, minimum clearance in inches	From table 2, minimum clearance in inches
A (Above equipment)........	6	3
B (At sides and rear of equipment)....................	6	2
C (In front of equipment)....	48	48
D (From smoke pipe)........	18	9

Floor Furnaces

General Requirements—Floor furnaces should be installed so that heated air can easily circulate to rooms without passing through more than one doorway, opening or arch. Floor furnaces should be located so that the distance between the furnace and any room to be heated, measured through intervening openings, is as short as possible.

Dampers or registers used to regulate the heat flow shall be arranged so that there can be no complete shutoff of heated air. Connections to auxiliary ducts should be made only when the furnace is specifically designed for such use. Hot air outlets should not be located within closets or confined spaces.

TABLE 1.—CLEARANCE FOR FURNACES AND BOILERS

Type of appliance	Minimum clearance in inches indicated in illustration entitled, "Clearance for Furnaces and Boilers," part 5, page 31			
	A	B	C	D
	Above	Sides and rear	Front (Clearance for maintenance and operation)	From smokepipe or gasvent connection
Warm air furnace with temperature limit control having a minimum setting of 250° F., or boilers with walls integrally lined, insulated or jacketed:				
Solid or liquid fuel	6	6	48	18
Gas fuel, unlisted or when flue gas temperature exceeds 550° F.	6	6	18	9
Gas fuel, listed or where flue gas temperature does not exceed 550° F., with type B gasvent	6	6	18	1 [1]
Warm air furnace or boiler without controls having a maximum setting of 250° F., or boilers without walls integrally lined, insulated or jacketed:				
Solid or liquid fuel	18	18	48	18
Gas fuel, unlisted or where flue gas temperature exceeds 550° F.	18	18	18	9
Gas fuel, listed or where flue gas temperature does not exceed 550° F., with type B gasvent	18	18	18	1 [1]

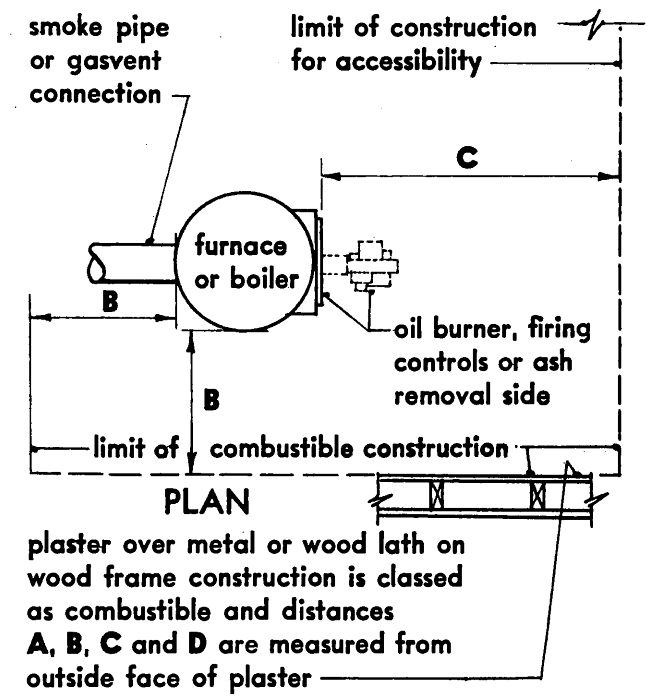
[1] Where other than type B gasvent is used, minimum clearance from smokepipe or gasvent connection shall be 6 inches.

TABLE 2.—CLEARANCE FOR FURNACES AND BOILERS

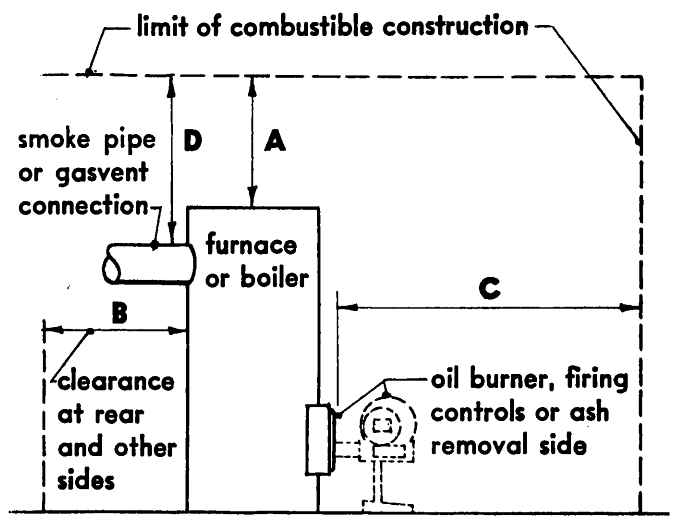
Type of protection	Minimum clearance in inches indicated in illustration entitled, "Clearance for Furnaces and Boilers," part 5, page 31												
	A					B				D			
Unprotected	36	18	12	6	3	36	18	12	6	36	18	9	6
28-gage sheet metal on asbestos paper weighing not less than 12 lbs per 100 sq ft	30	15	9	3	2	24	6	2	2	24	12	3	2
28-gage sheet metal on ¼-inch asbestos cement board or ¼-inch asbestos millboard	24	12	9	3	2	18	4	2	2	18	9	3	2
28-gage sheet metal spaced out from combustible construction with 1-inch noncombustible spacers	18	6	6	2	2	12	3	2	2	18	9	4	2
28-gage sheet metal on 1-inch rock wool batts reinforced with wire mesh or equivalent	18	3	2	2	2	12	2	2	2	12	2	2	2

Clearance for Furnaces and Boilers

WITH A MAXIMUM OPERATING PRESSURE NOT EXCEEDING 15 psi GAGE OR A RATED GROSS OUTPUT NOT EXCEEDING 1,000,000 Btu PER HOUR

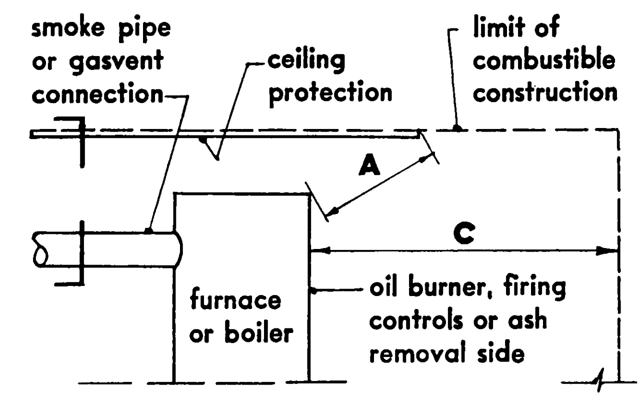


PLAN

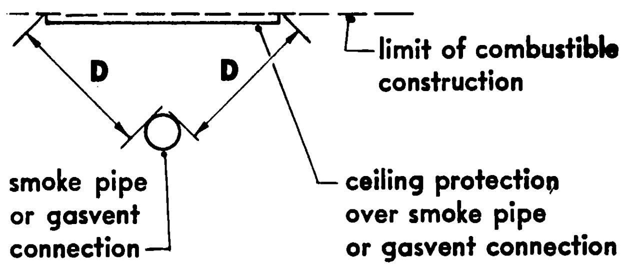


ELEVATION

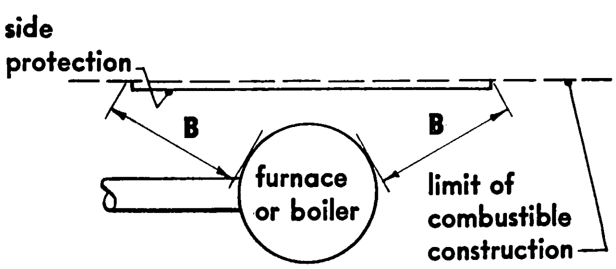
CLEARANCES TO UNPROTECTED COMBUSTIBLE MATERIAL



SIDE ELEVATION (PARTIAL)



SECTION



PLAN (PARTIAL)

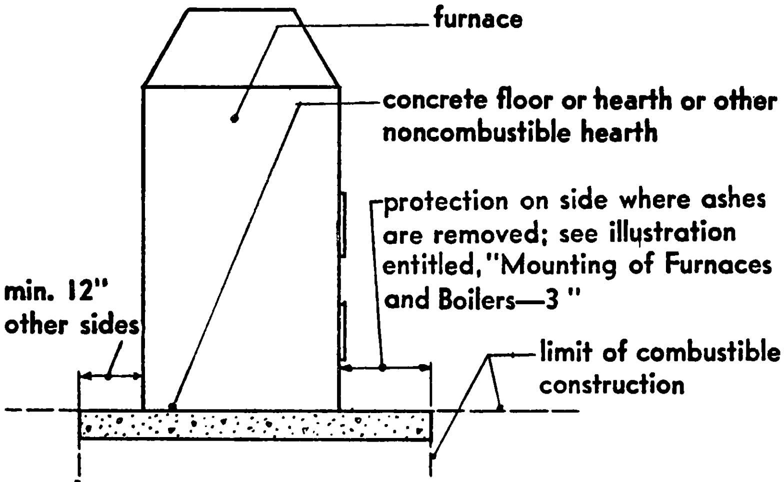
Protection shall extend far enough in each direction so that unprotected combustible material adjoining the protection has a clearance not less than the comparable clearance designated as A, B or D above. For values of A, B, C and D, see table 1, part 5, page 30.

For clearances to protected combustible material, see table 2, part 5, page 30.

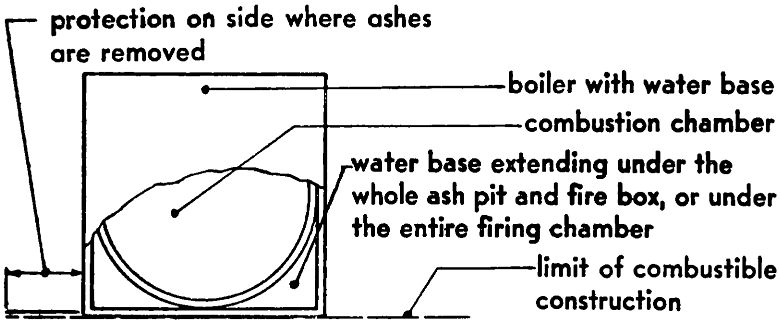
CLEARANCES TO PROTECTED COMBUSTIBLE MATERIAL

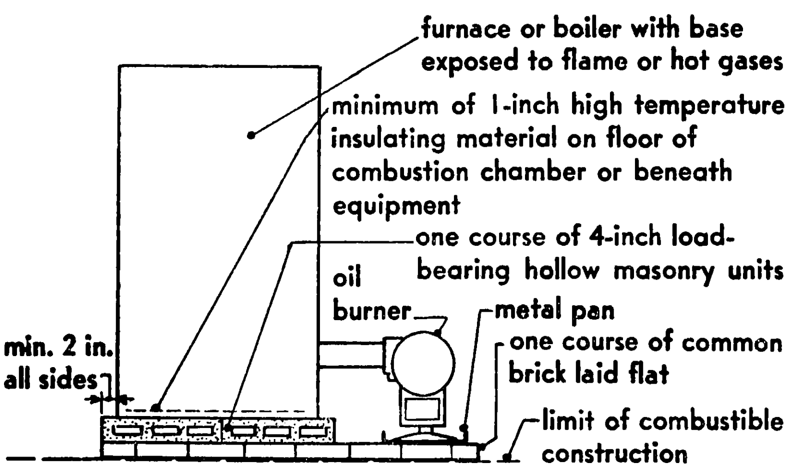
Mounting of Furnaces and Boilers—1

PRESSURE NOT EXCEEDING 15 psi GAGE AND CAPACITY NOT EXCEEDING 1,000,000 Btu PER HOUR



MOUNTING ON NONCOMBUSTIBLE SUPPORT





MOUNTING ON COMBUSTIBLE SUPPORT

ELEVATIONS

Solid-fuel-fired units mounted on combustible floors shall have the floor protected on the side where ashes are removed, as indicated in plan view of illustration entitled, "Mounting of Furnaces and Boilers—3," part 5, page 34.

Oil-fired-units on combustible floors should be mounted as shown in bottom sketch.

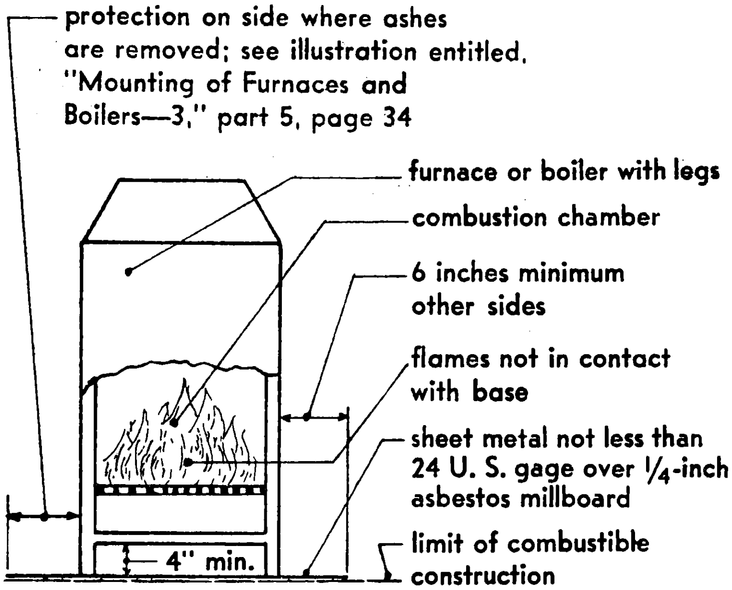
Hollow masonry units should be laid with end joints matched and ends unsealed to provide free circulation of air through cells.

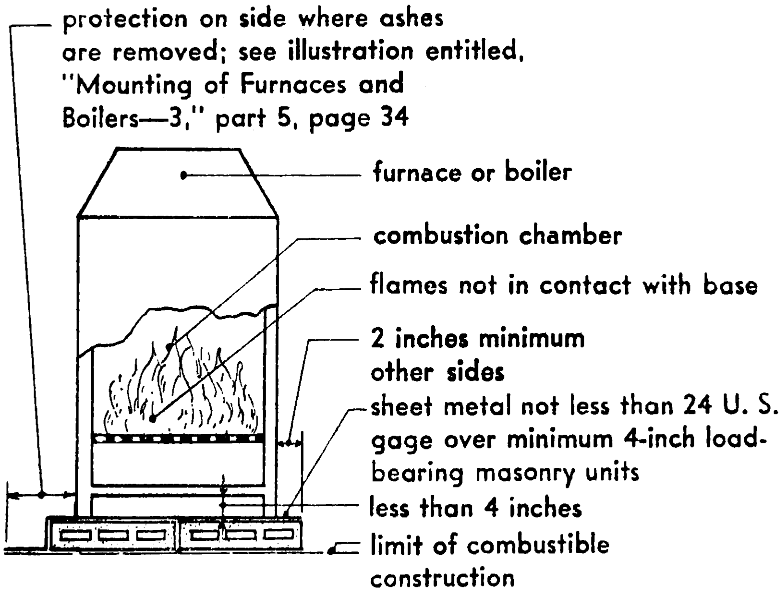
Common brick should be carried out to include the front of the burner with an oil-tight metal pan fastened in place under the burner.

Concentrated loads should be distributed by steel plate of adequate thickness but not less than 16 U.S.S. gage laid over the masonry units.

Mounting of Furnaces and Boilers—2

PRESSURE NOT EXCEEDING 15 psi GAGE AND CAPACITY NOT EXCEEDING 1,000,000 Btu PER HOUR





ELEVATIONS

MOUNTING ON COMBUSTIBLE SUPPORT

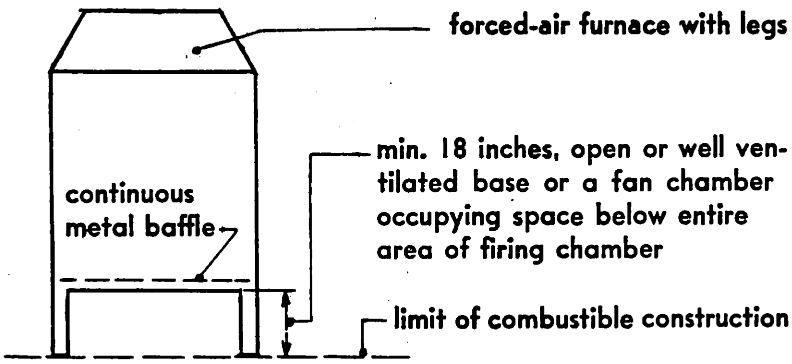
Furnaces and boilers illustrated on this page are constructed so that flame or hot gases are not directly exposed to the base. Included are conventional type furnaces and boilers having an ashpit or space beneath the burning fuel, and similar heat producing equipment where the base is not directly exposed to flame or hot gases.

Hollow masonry units should be laid with end joints matched and ends unsealed to provide free circulation of air through cells.

Concentrated loads should be distributed by steel plate of adequate thickness but not less than 16 U.S.S. gage laid over the masonry units.

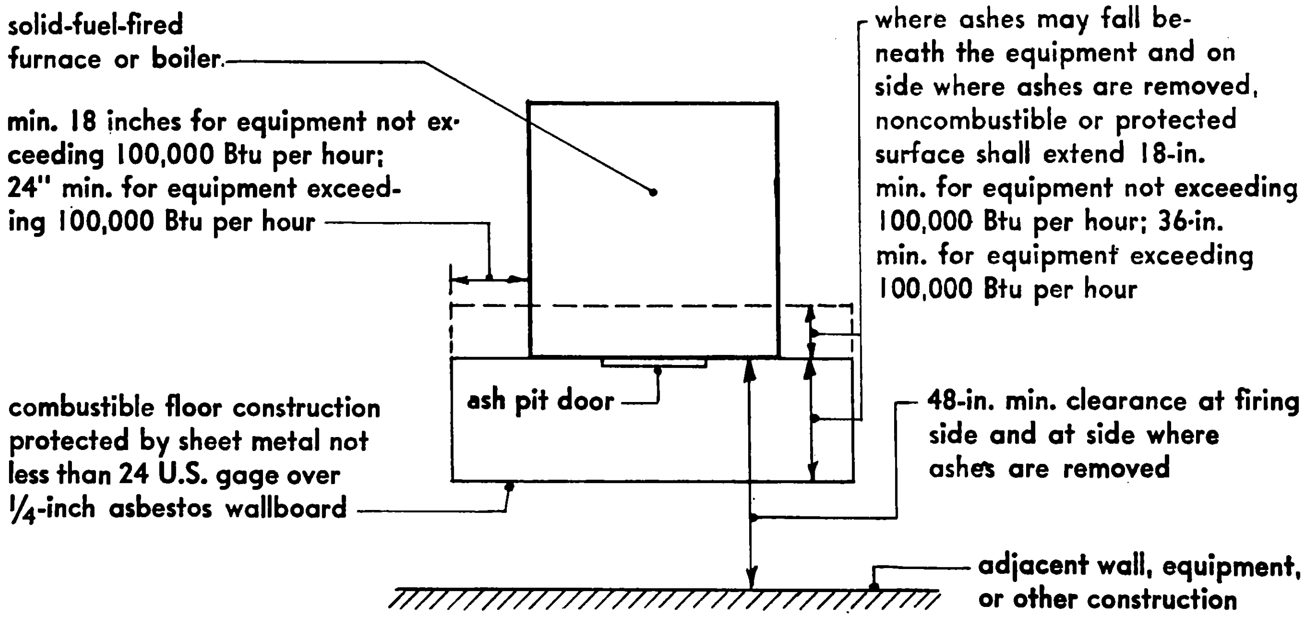
Mounting of Furnaces and Boilers—3

PRESSURE NOT EXCEEDING 15 psi GAGE AND CAPACITY NOT EXCEEDING 1,000,000 Btu PER HOUR



ELEVATION

Where a solid-fuel-fired furnace or boiler is mounted on a combustible floor, a noncombustible or a protected surface shall be provided, as shown in plan.

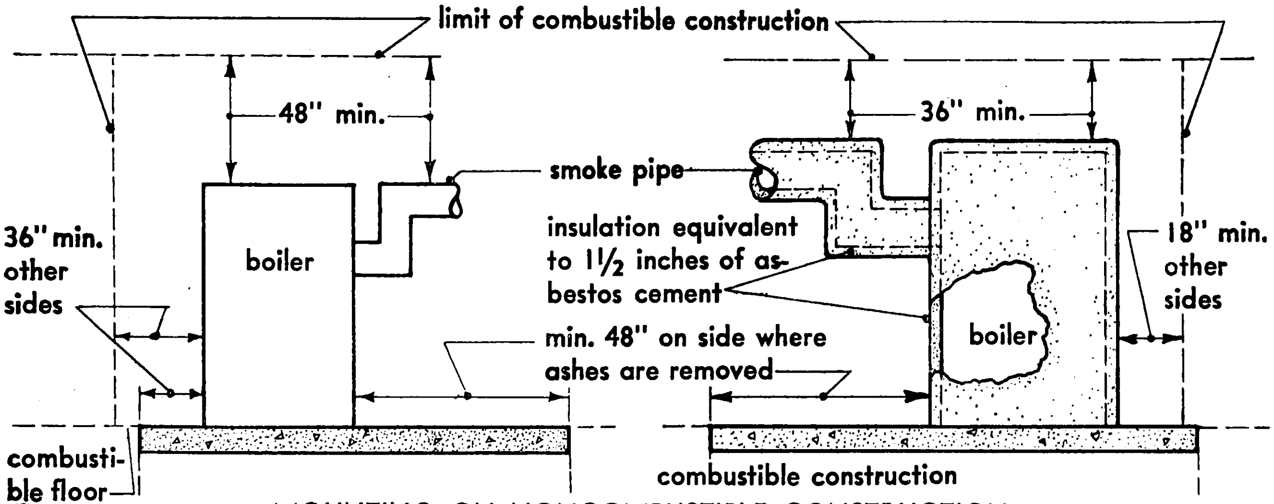


PLAN

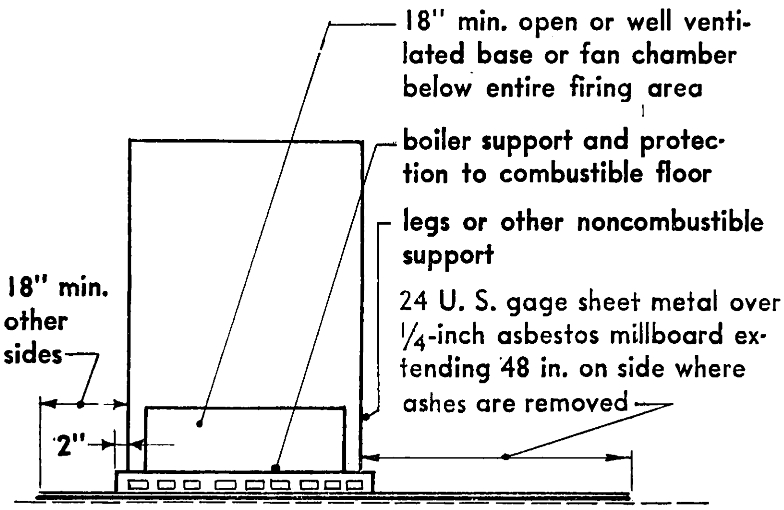
MOUNTING ON COMBUSTIBLE SUPPORT AND CLEARANCE

Mounting and Clearance for Boilers

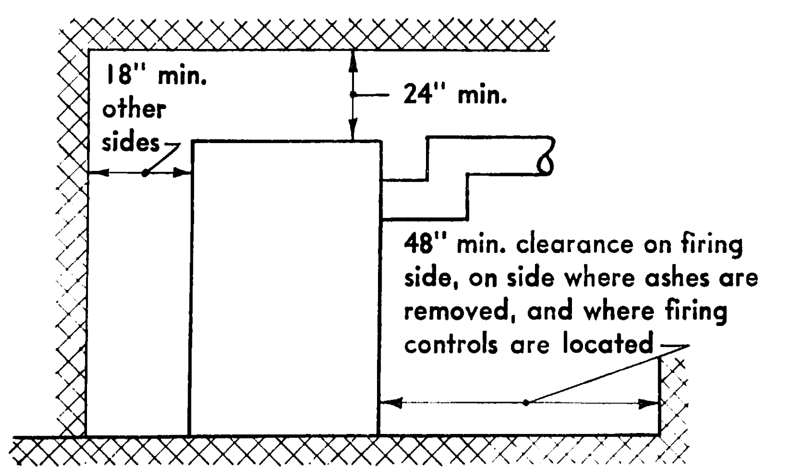
PRESSURE EXCEEDING 15 psi GAGE OR CAPACITY EXCEEDING 1,000,000 Btu PER HOUR



MOUNTING ON NONCOMBUSTIBLE CONSTRUCTION



MOUNTING ON COMBUSTIBLE CONSTRUCTION



CLEARANCES FOR ACCESSIBILITY

Protection to combustible floor and support for equipment to be one course 4-inch hollow masonry units on minimum 24 U.S.S. gage sheet metal over ¼-inch asbestos millboard. Sheet metal and millboard to extend beyond masonry units the minimum distances shown. Hollow masonry should be laid with end joints matched and ends unsealed to provide free circulation of air through cells.

When combustible material is protected, lesser clearances may be obtained. (See table 2 entitled, "Clearance for Furnaces and Boilers," part 5, page 30.)

Distances required for accessibility shall be maintained free from construction and equipment. Minimum distance shall be determined by required distance from combustible material or by clearance for accessibility, whichever is greater.

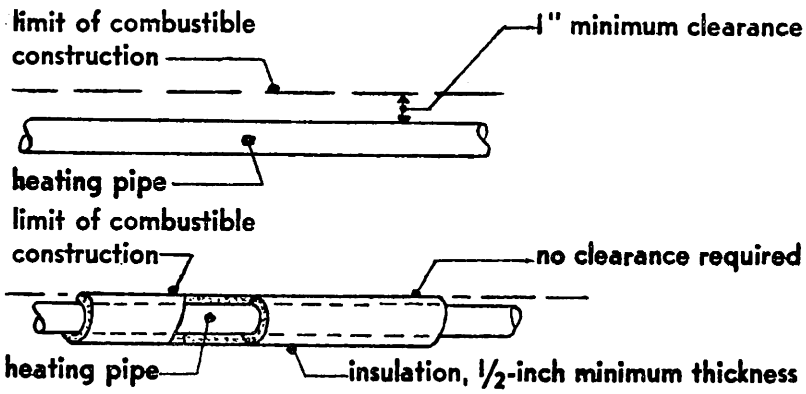
Heating-Pipe Clearance

All insulation used on heating equipment and piping shall be of noncombustible material.

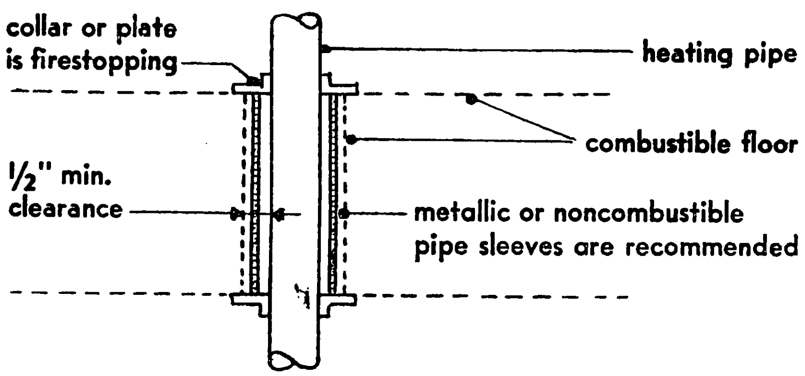
Arrangements similar to those shown on this page may be used for pipes passing through combustible wall constructions.

Pipes passing through noncombustible constructions require no clearance.

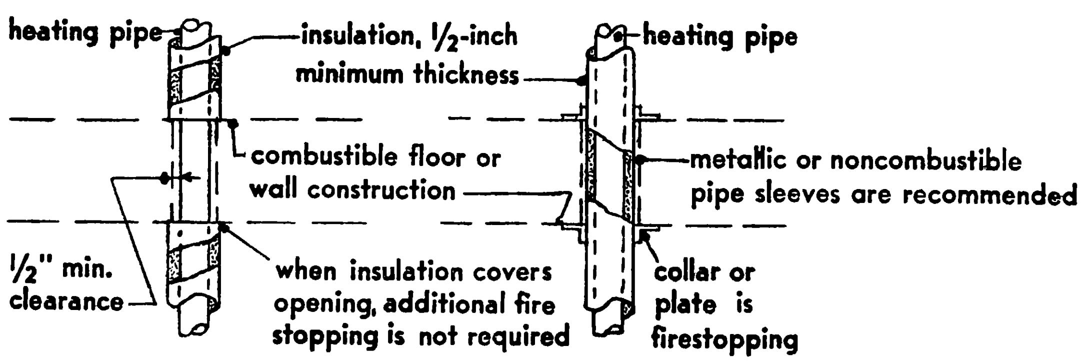
Firestopping may be noncombustible cap, collar, or plate, or noncombustible material packed and secured in place.



HORIZONTAL OR VERTICAL
PIPE RUN ADJOINING
COMBUSTIBLE CONSTRUCTION



UNINSULATED PIPE

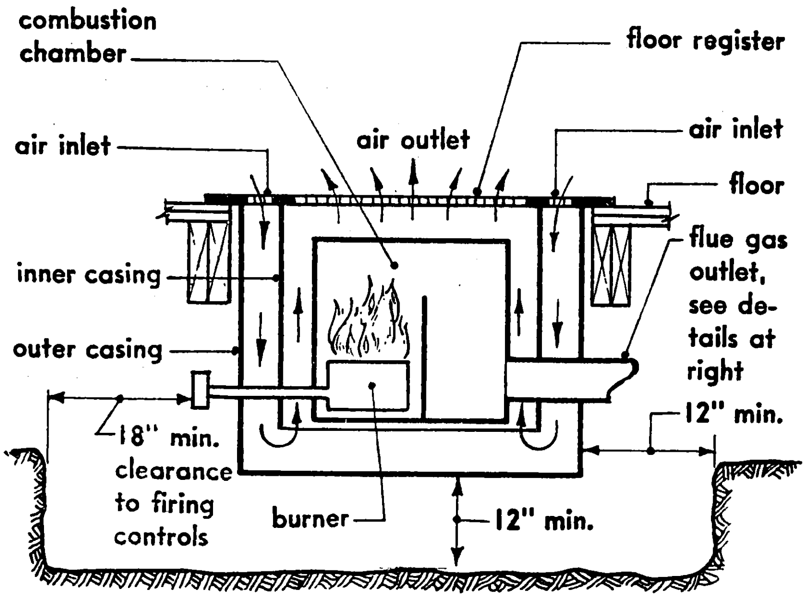


INSULATED PIPE

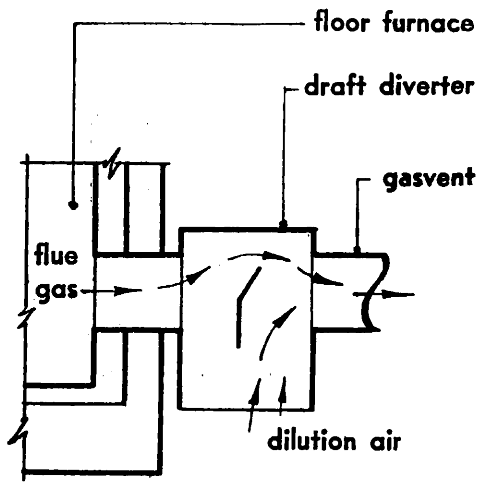
PIPE CONTINUOUSLY INSULATED

IN COMBUSTIBLE CONSTRUCTION

Floor Furnaces

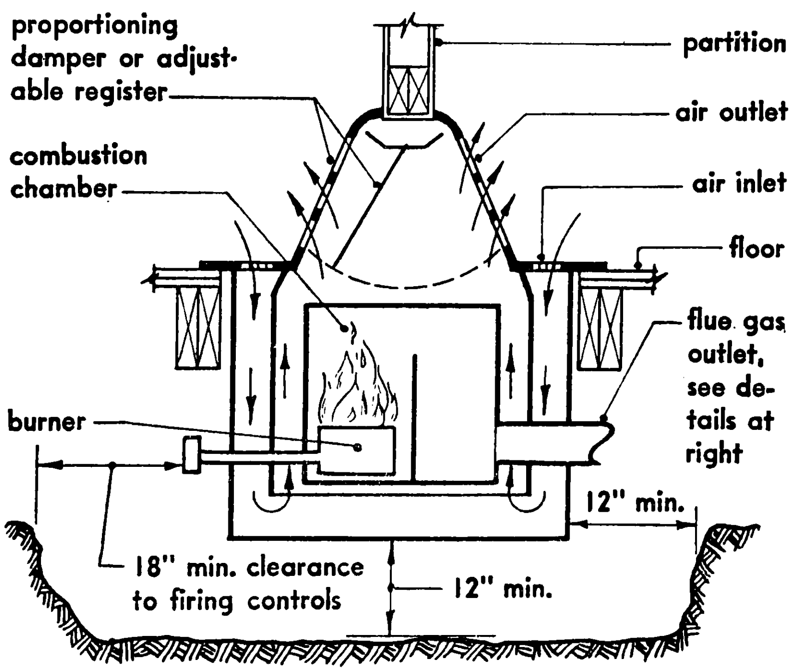


SECTION THROUGH
TYPICAL FLOOR FURNACE

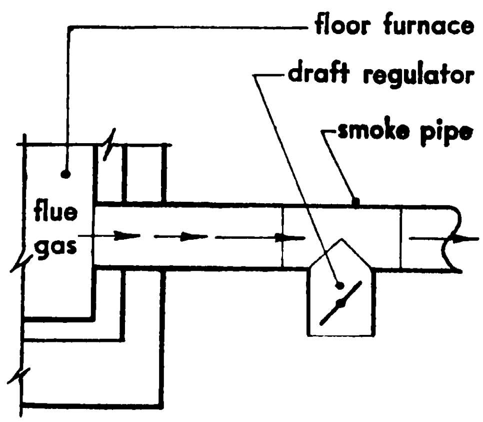


SECTION

FLUE GAS OUTLET
(GAS-FIRED FURNACE)



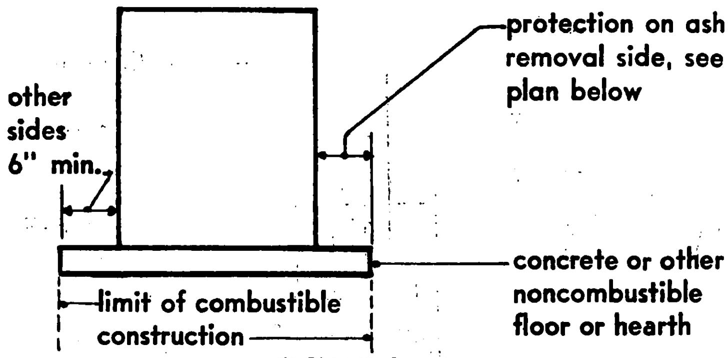
SECTION THROUGH DUAL
REGISTER FLOOR FURNACE



SECTION

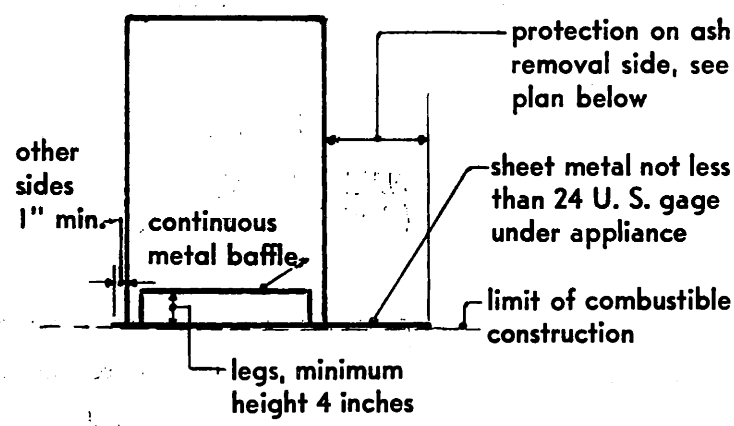
FLUE GAS OUTLET
(OIL-FIRED FURNACE)

Mounting of Small Heating and Cooking Appliances

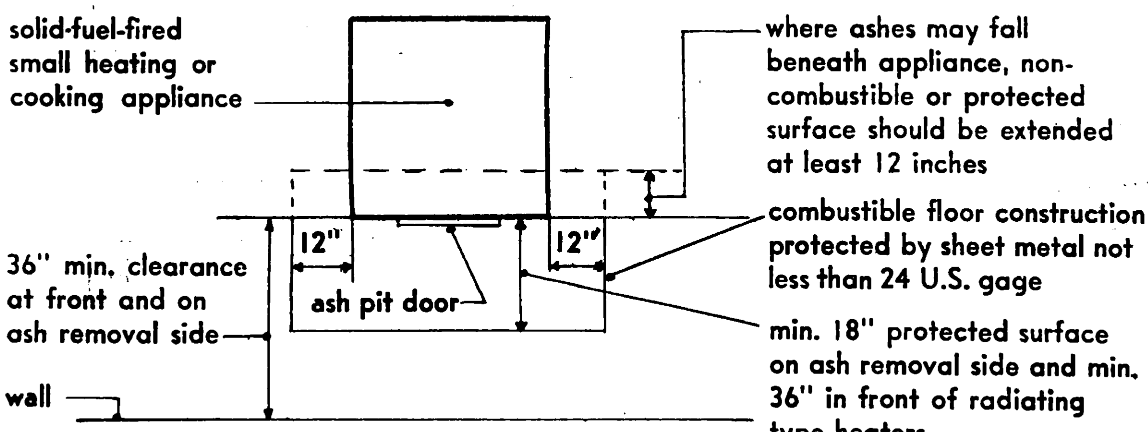


ELEVATION

ON NONCOMBUSTIBLE CONSTRUCTION



ELEVATION



PLAN

ON COMBUSTIBLE CONSTRUCTION

Heating appliances mounted on combustible floors shall not have the flame or hot gas come in contact with the base of the appliance.

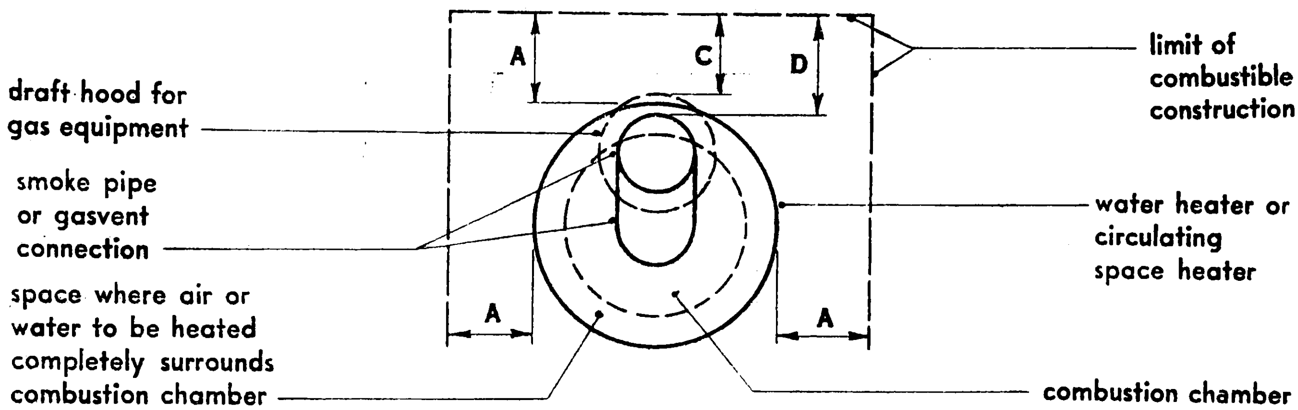
Heating appliances without legs may be mounted on a combustible floor that is covered with sheet metal not less than 24 U.S.S. gage, provided the appliance is permanently raised at the corners with noncombustible pedestals to provide a 4-inch minimum open space beneath.

Heating appliances with legs that provide not less than an 18-inch open space under the base may be mounted directly on a combustible floor provided there is at least one continuous metal plate between the burners and the floor.

Unless otherwise approved, radiating type space heaters mounted on combustible floors and directing the radiation to the front shall have noncombustible or protected surface extended at the front for a distance of not less than 36 inches.

Water Heaters and Circulator-Type Space Heaters

(Applicable to equipment where the casing around the combustion chamber is completely surrounded with an outer jacket enclosing air or water to be heated. Combination stove and water heater and heaters with an outer jacket which does not completely surround the combustion chamber shall be installed with clearances as shown for radiant type heaters.)



PLAN

CLEARANCES [1]

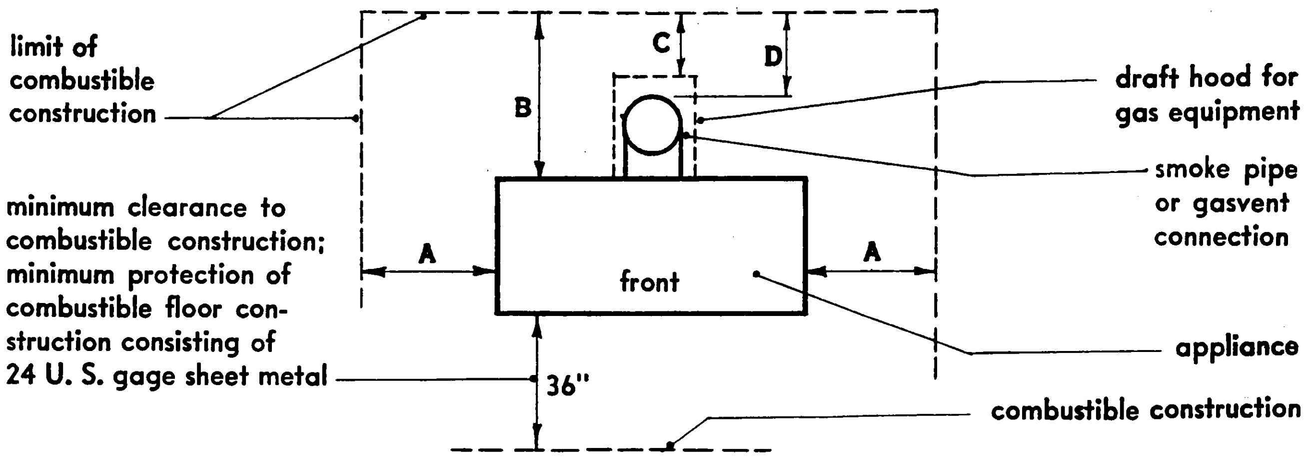
Type of appliance	Minimum clearance, in inches			
	A	C	D [2] Smoke pipe and other than type B gasvent	D [2] Type B gasvent [3]
Burns solid or liquid fuel	12		18	np
Burns gas and of the following type:				
Unlisted	12	2	9	np
Listed and not insulated	6	2	6	1
Listed and insulated	2	2	6	1
Listed for installation flush with combustible construction	0	0	6	1

[1] Minimum clearance to controls shall be 18 inches. Minimum clearance above the top of small heating and cooking appliances to combustible material shall be 36 inches except that lesser clearances may be obtained with protection, provided that protection extends 9 inches beyond the sides of the appliance. Such lesser clearances are indicated in table 2 entitled, "Clearance for Furnaces and Boilers," part 5, page 30.

[2] Distance (D) is also the minimum clearance of smoke pipes and gasvents to ceilings of combustible construction.

[3] Type B gasvents may be installed with lesser clearance to combustible construction when so tested and approved.

Radiating Space Heaters, Heating and Laundry Stoves, and Combination Stove and Water Heaters



PLAN

CLEARANCES [1]

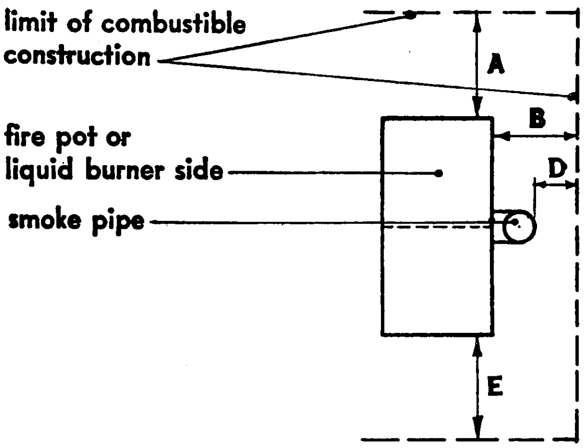
Type of appliance	Minimum clearance, in inches				
	A	B	C	D [2]: Smoke pipe and other than type B gasvent	D [2]: Type B gasvent [3]
Burns solid or liquid fuel	36	36		18	np
Burns gas and of the following type:					
Unlisted	18	18	2	9	np
Unlisted with double wall construction at back	18	12	2	9	np
Listed	6	6	2	6	1
Listed for installation flush with combustible construction	0	0		6	1

[1] Minimum clearance to controls shall be 18 inches. Minimum clearance above the top of small heating and cooking appliances to combustible material shall be 36 inches except that lesser clearances may be obtained with protection, provided that protection extends 9 inches beyond the sides of the appliance. Such lesser clearances are indicated in table 2 entitled, "Clearance for Furnaces and Boilers," part 5, page 30.

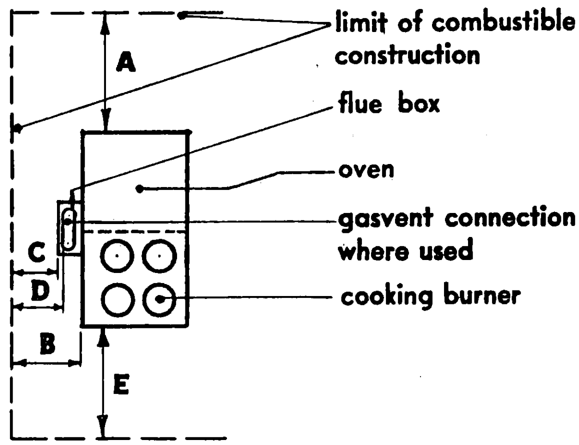
[2] Distance (D) is also the minimum clearance of smoke pipes and gasvents to ceilings of combustible construction.

[3] Type B gasvents may be installed with lesser clearance to combustible construction when so tested and approved.

Domestic Ranges and Cooking Stoves



PLAN OF DOMESTIC RANGE OR COOKING STOVE BURNING SOLID OR LIQUID FUEL



PLAN OF DOMESTIC RANGE OR COOKING STOVE BURNING GAS

CLEARANCES [1]

Type of appliance	Minimum clearance, in inches					
				D [2]		
	A	B	C	Smoke pipe and other than type B gasvent	Type B gasvent [3]	E
Burns solid fuel:						
Fire pot without clay lining	36	36		18	np	18
Fire pot with clay lining	24	24		18	np	18
Burns liquid fuel	24	24		18	np	18
Burns gas:						
Unlisted	6	6	1	6	np	6
Listed and uninsulated	6	6	1	6	1	6
Listed and insulated	3	1	1	6	1	3
Listed and insulated, with adjacent combustible construction more than 5 inches from any top surface cooking burner or where combustible construction does not extend above level of cooking top or top of appliance	½	1	1	6	1	½
Listed and insulated and approved for installation flush with combustible construction	0	0	0	6	1	0

[1] Minimum clearance from the top of small cooking appliances to combustible material should be 36 inches except that lesser clearances may be obtained with protection as indicated in table 2 entitled, "Clearance for Furnaces and Boilers," part 5, page 30, provided that protection extends 9 inches beyond the sides of the appliance.

[2] Distance (D) is also the minimum clearance of smoke pipes and gasvents to ceilings of combustible construction.

[3] Type B gasvents may be installed with lesser clearance to combustible construction when so tested and approved.

Air Supply

Air supply to spaces containing heat producing equipment may be provided through louvers or openings in doors, windows or walls. The clear ventilating area required shall be the net area after deduction for material in screens and louvers. Where the clear ventilating area or the ratio of the clear ventilating area is not given, the clear ventilating area shall be considered as equal to 40 per cent of the gross louver area.

Where fuel-burning equipment consists of two or more units within the same enclosure, the air supply shall be sufficient for the simultaneous operation of all units.

When direct-fired heat producing equipment is installed in a space which is ventilated mechanically or where the operation of fans can deplete the supply available for the equipment, sufficient air shall be supplied to replace the air exhausted and the air required for combustion.

Where the heat producing equipment is within a confined space, the location of the opening for air supply should be below the level of the air inlet on the equipment; and the opening for air outlet should be above the level of the smoke outlet on the equipment.

Where ducts are required to convey the air supply, they shall conform to the requirements for ventilating ducts, and the cross-sectional area shall be not less than free area of the opening to the enclosure. Ducts used to remove heated air should pitch upward in direction of flow.

Heat producing equipment within enclosures shall have permanent openings for obtaining the air supply in conformity with the table entitled, "Permanent Openings for Air Supply to Spaces Containing Heat Producing Equipment."

Removal of Products of Combustion

General Requirements—Heat producing equipment using solid or liquid fuel, or which can be readily converted to the use of solid or liquid fuel, should be connected to flues, excepting liquid-fuel-fired appliances which are specifically approved for installation without flue connections.

The following types of gas-fired equipment should be connected to a flue or gasvent:

1. Equipment having an input rating in excess of 50,000 Btu per hour.

2. Automatically operated equipment with an input rating greater than 5000 Btu per hour.

3. Manually operated equipment not provided with automatic controls to reduce the gas supply to 30 per cent or less of the maximum demand.

4. Automatically controlled equipment with an input rating of less than 5000 Btu per hour, and not provided with an automatic device to shut off the gas supply when flame or pilot is extinguished.

5. Appliances excluding domestic gas ranges,

PERMANENT OPENINGS FOR AIR SUPPLY TO SPACES CONTAINING HEAT PRODUCING EQUIPMENT

Heat producing equipment	Clear area in square inches	
	Air inlet	Air outlet
Gross capacity not exceeding 250,000 Btu per hour:		
Within a small enclosure of unusually tight construction.	1 square inch per 1000 Btu per hour of fuel consumed	1 square inch per 1000 Btu per hour of fuel consumed
Within a large enclosure of unusually tight construction.	½ square inch per 1000 Btu per hour of fuel consumed	½ square inch per 1000 Btu per hour of fuel consumed
Within a large enclosure having adequate air infiltration.	—	—
Gross capacity exceeding 250,000 Btu per hour:		
Within an enclosure of unusually tight construction....	Twice the area of the smoke pipe	—
Within an enclosure having adequate air infiltration...	Equal to the area of the smoke pipe	—

installed in the same room which would make the total input rating of the unvented gas appliances equal to 30 Btu or more per hour per cubic foot of room content.

6. Fuel-burning equipment located in any space that is not adequately ventilated.

7. Steam and hot water boilers, warm air furnaces, duct furnaces, floor furnaces, unit heaters and recessed heaters.

8. Appliances which have draft hood supplied by the appliance manufacturer, except automatic water heaters having a maximum input rating not in excess of 5000 Btu per hour.

9. Appliances having flue collars, unless specifically approved for installation without flue connection.

10. Gas-fired incinerators.

11. Solid- or liquid-fuel-fired equipment converted to gas.

12. Gas-fired equipment arranged with bottom vent or U-shaped vent passages, including but not limited to gas ranges and clothes dryers.

Flues or gasvents are not required for gas ranges, clothes dryers designed for gas fuel, and appliances approved for installation without flues or gasvents.

Smoke Pipes and Gasvent Connections

General Requirements—A gasvent connection is the outlet pipe, primarily horizontal, connecting the gas-fired equipment with the flue.

Smoke pipes and gasvent connections shall be adequately supported, shall have tight joints, and shall be firmly secured to the heat producing equipment and thimble or flue ring.

Smoke pipes and gasvent connections should be supported from structural members by noncombustible supports at intervals not exceeding 5 feet. Sections should be fastened together with not less than three screws, bolts or other approved noncombustible fastening at each joint. Smoke pipes should have provisions for safe relief of explosions in smoke pipes. Smoke pipes should be provided with cleanouts to permit cleaning without disassembly.

Smoke pipes and single wall gasvent connections should be of metal of the following minimum thickness:

SMOKE PIPES AND GASVENT CONNECTIONS

Diameter or greatest dimension	Metal thickness, U.S.S. gage number
To 5 inches	26
6 to 10 inches	24
11 to 14 inches	22
15 inches and more	20

Horizontal runs should pitch upward in the direction of flow not less than ¼ inch to the foot. Where the horizontal run exceeds 5 feet, the height of the flue should be increased. Connections to branches and changes of direction should be made with fittings designed to minimize turbulence and resistance.

Cross-sectional area should be as nearly square or round as possible. Where one dimension exceeds twice the other, the cross-sectional area should be increased to compensate for the greater friction loss.

The minimum cross-sectional area of a smoke pipe from heat producing equipment burning solid or liquid fuel should be as recommended by the manufacturer of the equipment.

Smoke Pipes and Gasvent Connections Serving Two or More Units—Two or more smoke pipes or gasvent connections may be connected into a single flue, smoke pipe or gasvent connection of the proper size and type for the heat producing equipment served. All parts shall be constructed to comply with the most restrictive requirements for any connection thereto and should be in conformity with the following:

a—The junction with the main smoke pipe or gasvent connection should be made at the side, with a fitting in the direction of gas flow and as close as practicable to the flue. Where the junction is not near the flue or chimney, a main smoke pipe or gasvent connection with a pitch of at least 1 inch to 10 inches should extend to each equipment to be connected, and the length of a branch from any smoke outlet to the main smoke pipe or gasvent connection should not exceed 3 feet.

b—Heat producing equipment located in separate enclosures and connecting to a main smoke pipe, gasvent connection, or flue, should have the enclosures containing such equipment provided with adequate openings to assure equal room air pressure.

Smoke pipes and gasvent connections which may be subject to condensation, corrosion, or excessive cooling, should be protected by insulation or should be connected close to chimneys or flues. Smoke pipes and gasvent connections subject to excessive heat loss should pitch upward toward the flue at least 1 inch per foot.

Smoke pipes and gasvent connections exposed to weather or condensed moisture should be corrosion resistant or protected against corrosion.

Draft Regulator—A draft regulator should be provided for all automatically operated heat producing equipment burning liquid fuel within a combustion chamber. No damper shall be installed on any vent connection from gas-fired equipment. Draft regulator for solid- or liquid-fuel-fired heat producing equipment shall have a minimum opening of at least 20 per cent of the internal cross-sectional area of the smoke pipe.

Clearances—No smoke pipe shall pass through a floor or ceiling of combustible material or construction. A smoke pipe may pass through a floor or ceiling of noncombustible construction only where no potential hazard is created.

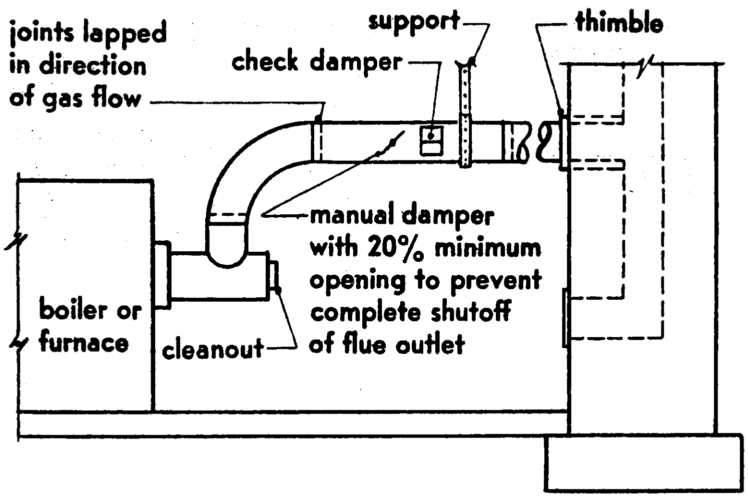
Clearances of smoke pipes and gasvent connections when passing through combustible construction shall be as set forth in the following table and illustration:

CLEARANCES OF SMOKE PIPES AND GASVENT CONNECTIONS

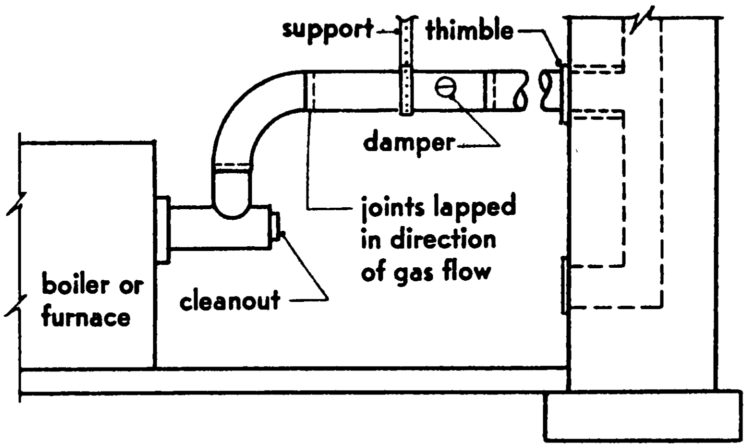
Smoke pipes and gasvent connections serving heat producing equipment	Opening through combustible construction for smoke pipes and gasvent connections, in inches of diameter			
	Without insulation [1]		With insulation [2]	
	Beyond the outlet of draft hood at a distance of—		Beyond the outlet of draft hood at a distance of—	
	Less than 6 feet	More than 6 feet	Less than 6 feet	More than 6 feet
Gas-fired equipment having temperature at outlet of draft hood not exceeding 550° F. or listed gas-fired equipment, except floor furnaces and incinerators:				
Type B gasvent connection........	A + 2	A + 2	B + 1	B + 1
Other than type B gasvent connection............................	A + 4	A + 2	B + 3	B + 2
Gas-fired equipment[3], including floor furnaces provided with draft hoods, which have an individual or combined rated gross capacity not exceeding 250,000 Btu per hour.................	A + 6	A + 4	B + 4	B + 3
Incinerators with capacity not in excess of 5 cubic feet, miniature steam boilers with rated gross capacity not exceeding 250,000 Btu per hour, and low pressure heating equipment having an individual or combined rated gross capacity not exceeding 1,000,000 Btu per hour.......	A + 12	A + 12	B + 8	B + 8
Incinerators with capacity exceeding 5 cubic feet, high pressure boilers with rated gross capacity exceeding 250,000 Btu per hour, and heat producing equipment having an individual or combined rated gross capacity exceeding 1,000,000 Btu per hour........................	np	np	np	np

[1] See figure 1, part 5, page 46.
[2] See figure 2, part 5, page 46.
[3] Does not include incinerators or high pressure boilers.

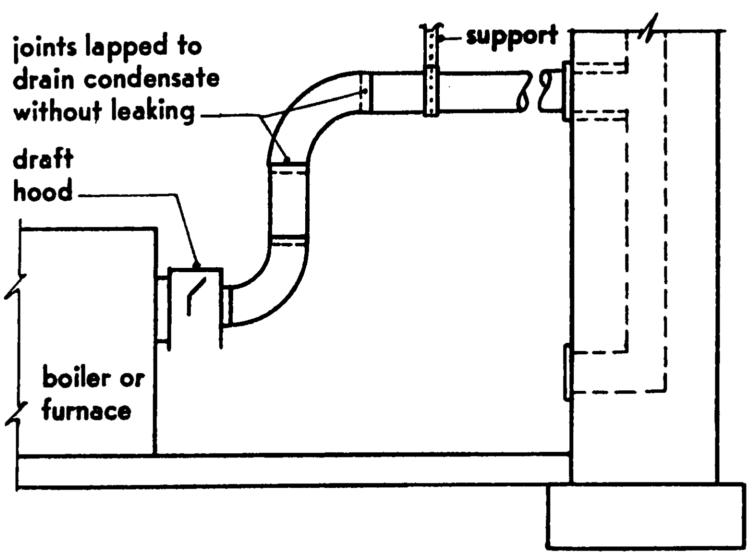
Smoke Pipes and Gasvent Connections



FOR SOLID FUEL



FOR LIQUID FUEL



FOR GAS FUEL

Smoke pipe and gasvent connections should be as short and direct as possible. Bends should be of the long radius type with the inner radius not less than the width of the smoke pipe. All smoke pipes and gasvent connections which exceed 4 feet in length should pitch upward to the flue; for gasvent connections, pitch should be not less than ¼ inch per foot.

Smoke pipes, gasvent connections and thimbles should not project into flues. Entrance into chimneys shall be through thimbles of burned clay or metal, or through flue rings of masonry.

Clearances of Smoke Pipes and Gasvent Connections

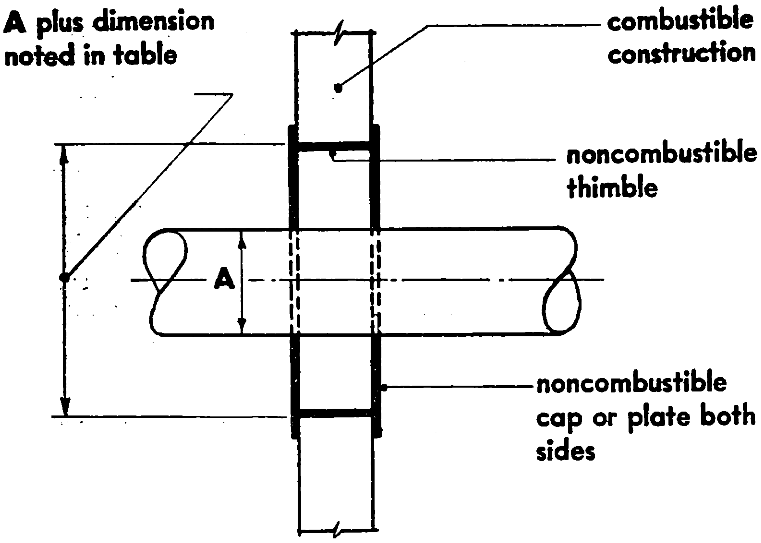


FIGURE I

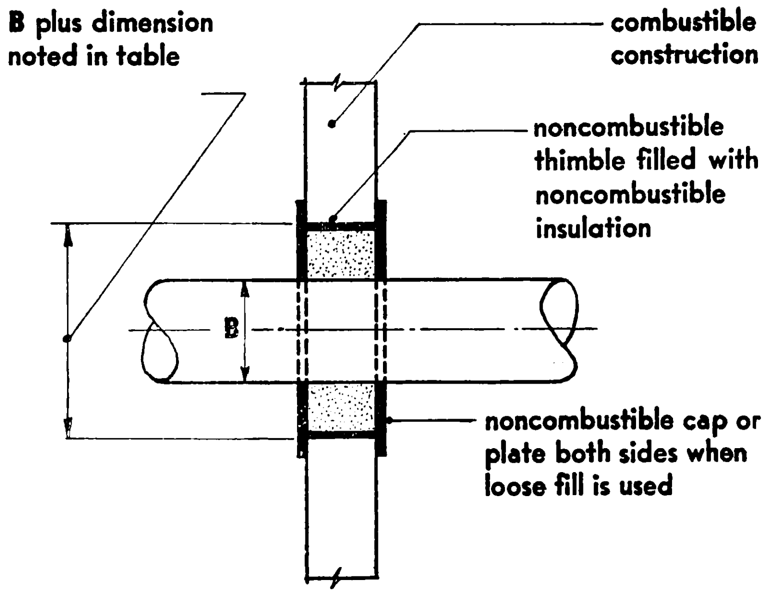


FIGURE 2

THROUGH COMBUSTIBLE CONSTRUCTION

Smoke pipes and gasvent connections passing through combustible construction shall be guarded at the point of passage with minimum clearances as noted in table entitled, "Clearances of Smoke Pipes and Gasvent Connections," part 5, page 44.

Where thimble and cap or plate is not provided, combustible material in wall shall be cut away from the smoke pipe or gasvent to provide clearance to combustible material not less than that shown in figure 1.

Openings shall be firestopped as shown in illustration entitled, "Firestopping Details—3," part 4, page 34.

Clearances are shown for circular construction; such clearances also apply to other shapes.

Safety and Relief Valves

General Requirements—Safety and relief valves designed and installed in conformity with generally accepted standards are deemed to meet the requirements of the Code.

Steam boilers shall have one or more safety valves of the direct spring-loaded pop type. Low-pressure steam boilers shall have the safety valves adjusted and sealed to discharge at pressures not exceeding 15 psi gage.

Hot water boilers shall be provided with relief valves of the spring-loaded type.

Sizes of valves shall be in conformity with the following table:

SIZES OF SAFETY AND RELIEF VALVES

Type	Inlet size, diameter in inches	
	Minimum	Maximum
Safety valve for low-pressure steam boiler	¾	4½
Safety valve for high-pressure steam boiler:		
With other than flanged or welding end inlet connection	¾	3
With flanged or welding end inlet connection	¾	8
Relief valve for hot water boilers	¾	2

Discharge pipe from safety and relief valves should terminate with end unthreaded, in an exposed location and arranged so that there is no danger of persons being scalded.

Safety Controls

Safety controls for automatically operated oil- or gas-fired heat producing equipment shall have a timing device to permit the purging of the furnace before re-ignition is permitted.

Automatically operated heat producing equipment shall be provided with a limit control to stop or to limit the flow of fuel to the combustion space, and such control should be designed for a maximum setting of 250° F. for furnaces, and 15 pounds gage for low-pressure boilers.

Limit controls, where provided, shall be arranged so that when the predetermined temperature or pressure is exceeded, the following operation shall occur even though the action of other controls call for continued operation: hand-fired coal burning equipment—close ash pit damper and open check damper; automatically operated boilers—stop or limit fuel supply, and in hot water systems using circulators, the circulators shall operate whenever the water temperature is in excess of a predetermined setting; automatically operated furnaces—stop or limit fuel supply. In warm air systems, using circulating fans or blowers, such fans or blowers should operate whenever the air temperature is in excess of a predetermined setting.

Oil- or gas-fired heat producing equipment not having fully automatic devices to prevent the flow of fuel during ignition failure shall be installed only when intended for use with a qualified person on constant duty.

Limit controls and low water cutoffs shall be of the type that opens the circuit when operation becomes unsafe, and functions even in the event of failure of electrical power.

Gas-fired heat producing equipment connected to a flue which also serves solid- or liquid-fuel-burning equipment should be equipped with controls which will automatically prevent the escape of unburned gas at the main burners.

Water heaters, automatically operated equipment, and clothes dryers for multiple-family use burning liquefied petroleum gas, shall be provided with controls which will automatically shut off the gas supply to the main burner and pilot in the event of pilot failure. Such controls shall also prevent the flow of gas to the main burner when the pilot light is extinguished.

Remote Control Switch for Oil Burners—Every oil burner shall be provided with a remote control whereby the flow of oil to the oil burner can be stopped, and such control should be located outside the room in which the burner is installed. Where an outside location is impracticable such control may be provided immediately inside the room in which the burner is installed, if accessible at all times. Control should be legibly labeled, "Emergency Control for Oil Burner."

Fuel Oil Storage and Handling

General Requirements—Fuel oil storage and handling equipment designed and installed in conformity with generally accepted standards is deemed to meet the requirements of the Code.

Chimneys, Flues, and Gasvents

General Requirements—The greater dimension of any rectangular or oval-shaped flue should not be more than twice the lesser dimension. Where this ratio is exceeded, the cross-sectional area should be increased.

Smoke pipes or gasvent connections on the same story separately connected into a single flue shall have the openings in the flue at different levels; flue openings for gas-fired equipment shall be located at least 1 foot above openings serving solid- or liquid-fired equipment.

Where chimneys, flues, and gasvents are made of units, the assembly shall form a strong integral structure, securely supported, and adequately braced or tied. Chimneys, flues, and gasvents should run primarily vertically, and shall not support other parts of the structure. Portions exposed to weather or condensed moisture should be acid- or corrosion-resistant, or protected against corrosion. To insure against condensation of flue gas and corrosion, the temperature of the products of combustion leaving the chimney should be at least 250° F. Portions subject to excessive cooling should be insulated or otherwise protected from excessive heat loss.

A suitable soot pocket and cleanout door should be provided at the base of every chimney or flue except where connected to fireplaces.

Chimneys, flues, and gasvents should be maintained in a safe condition. A flue or gasvent which becomes unsafe or dangerous shall be replaced. Openings no longer required in flues or gasvents shall be sealed with noncombustible material.

The connection of new heat producing equipment to an existing flue or gasvent shall be in conformity with the Code. The lower terminal of chimneys, flues, and gasvents shall be located at the story containing the equipment served.

Flue Linings—Flue linings shall be capable of withstanding the action of flue gases at 2000° F. without softening or cracking. They should be placed in position, and masonry built around each section of lining. Lining should be set with mortar sufficient only to keep the lining in place; voids between lining and chimney walls are desirable.

A flue lining of iron or steel in a masonry chimney should have a thickness as indicated in the following table, except that parts within 8 feet of heat producing equipment shall be of fire clay or of next heavier gage than that indicated:

IRON OR STEEL FLUE LININGS

Cross-sectional area of flue, in square inches	Minimum thickness of metal, U.S.S. gage
To 80	20
81 to 154	18
155 to 201	16
202 to 254	14
More than 254	12

Masonry Chimneys

A prefabricated chimney shall not be considered a masonry chimney. Whenever a masonry chimney contains flues for fireplace and heating equipment, and one of the flues require an offset, the offset should be made in the fireplace flue, and the flue from heating equipment should run straight. Corbeling should start at a lower elevation on that side toward which the offset is desired so as to insure constant internal cross-sectional area without pockets or restrictions to create turbulence in the gas stream. Liners should be properly beveled at changes in direction and at changes in cross-sectional dimensions to insure smooth, tight joints.

Masonry chimneys should be capped with noncombustible weatherproof material, or cement mortar, sloped outward and downward, may be provided.

A flue serving heat producing equipment having a rated gross capacity exceeding 200,000 Btu per hour shall be separated from other flues within the chimney by a masonry withe of at least 4-inch nominal thickness.

Masonry chimneys shall be designed and installed in conformity with the following table:

CONSTRUCTION OF MASONRY CHIMNEYS

Direct-fired heat producing equipment	Chimney walls, minimum construction
Small heating and cooking equipment; or furnaces, low-pressure boilers, and gas-fired high-pressure boilers with approved draft hoods, and rated gross capacity not exceeding 500,000 Btu per hour; or portable or domestic type incinerator[1] with a charging compartment not exceeding 5 cubic feet	For buildings not exceeding two stories in height: Walls 4-inch nominal thickness with ⅝-inch thick clay flue lining; walls of reinforced concrete, solid concrete masonry units or dressed stone, or 8-inch nominal thickness without flue lining, wall of solid masonry units, or 12-inch nominal thickness with ⅝-inch thick clay flue lining, walls of rubble stone masonry, or Approved prefabricated chimneys For buildings exceeding two stories in height: 8-inch nominal thickness with ⅝-inch clay flue lining; walls of reinforced concrete, solid or hollow masonry units, or undressed stone.
Furnaces, low-pressure boilers, and gas-fired high-pressure boilers with approved draft hoods, and rated gross capacity exceeding 500,000 Btu per hour	8-inch nominal thickness with ⅝-inch clay flue lining; walls of reinforced concrete, solid masonry or dressed stone, or 12-inch nominal thickness with ⅝-inch clay flue lining; walls of undressed stone.
High-pressure boilers using solid or liquid fuels or using gas fuel without a draft hood	8-inch nominal thickness plus fire-brick lining 4½ inches thick in fire clay mortar, and extending 25 feet from a point 2 feet below the smoke-pipe entrance; walls of reinforced concrete, solid masonry or dressed stone.

[1] For construction of flues for flue-fed incinerators, see text entitled "Incinerators," beginning in part 5, page 67.

Type B Gasvents

Type B gasvents shall be used only for gas-fired heat producing equipment where the temperature of the flue gases does not exceed 550° F. Each type B gasvent shall bear a permanent label, conspicuously placed, indicating that use is limited to gas-burning appliances only.

A suitable boot and drain for the removal of condensation should be provided at the bottom of the gasvent assembly, except where tests demonstrate that there is no condensation.

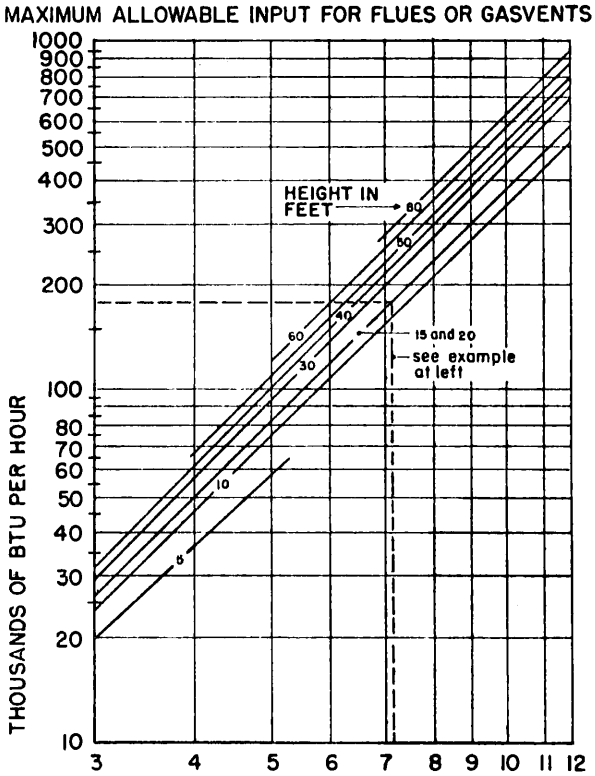
Joint cement shall not deteriorate when subjected to flue gas temperatures up to 700° F.

Type BW Gasvents

Gasvents for recessed wall heaters, type BW, may be installed in a wall or partition of com-

Example: Assume a gas-fired furnace, maximum input 180,000 Btu per hour, draft hood 7 inches inside diameter, height of flu above draft hood 20 feet. From chart, minimum flue size is 7.1 inches, therefore, use 8-inch flue.

MAXIMUM ALLOWABLE INPUT FOR FLUES OR GASVENTS



INSIDE DIAMETER OF FLUE IN INCHES

bustible construction with clearance not less than ⅜ inch when listed for installation with such lesser clearances. Such lesser clearances shall not continue beyond the ceiling plate. Extension beyond that point shall be a type B gasvent or a type A flue.

Type C Gasvents

Type C gasvents should be of sheet copper weighing not less than 16 ounces per square foot, or of galvanized iron not less than 20 U.S.S. gage, or of approved equivalent noncombustible material. Clearances from combustible material and passage through combustible construction shall be as required for smoke pipes.

Metal Smokestacks

Metal smokestacks may serve heat producing equipment using any type of fuel. Smokestacks serving high-pressure boilers, excluding those designed for accessory cleaning and pressing, shall be lined with 4½-inch fire brick laid flat in fire clay mortar, and such lining shall extend not less than 25 feet from a point 2 feet below the smoke-pipe entrance.

Smokestacks shall be installed in conformity with the following table:

METAL SMOKESTACKS

Internal cross-sectional area of smokestack, in square inches	Minimum thickness of metal, U.S.S. gage	Maximum unsupported length extending above the topmost support, in feet
To 80	No. 18	10
81 to 154	No. 16	15
155 to 201	No. 14	15
202 to 254	No. 12	15
Over 254	No. 10	15

Metal shall be resistant to, or protected against, corrosion. Smokestacks on the exterior of a building shall have clearances not less than those indicated in the following table:

CLEARANCE FROM EXTERIOR METAL SMOKESTACKS

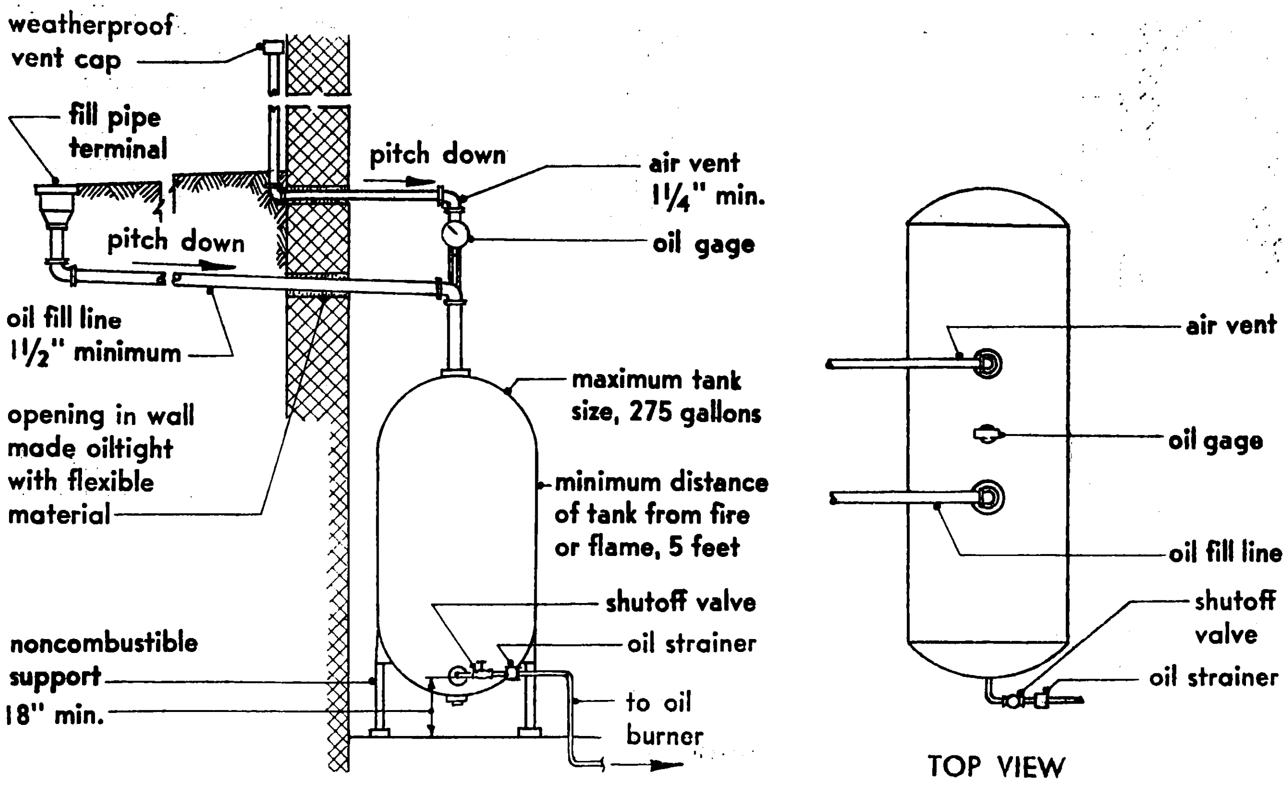
Clearance of exterior smokestacks from—	Distance, in inches	
	Smokestack, not insulated	Smokestack, insulated
Unprotected combustible construction	18	4
Noncombustible construction	4	4
Exterior wall openings	24	18
Any part of fire escapes or exit	12	4

Metal smokestacks within a building shall be enclosed above the story in which the heat producing equipment served thereby is located. Such enclosure shall be of noncombustible construction having a fire-resistance rating of not less than 1 hour, with sufficient clearance on all sides between the smokestack and the enclosing walls to permit examination and repair of the stack.

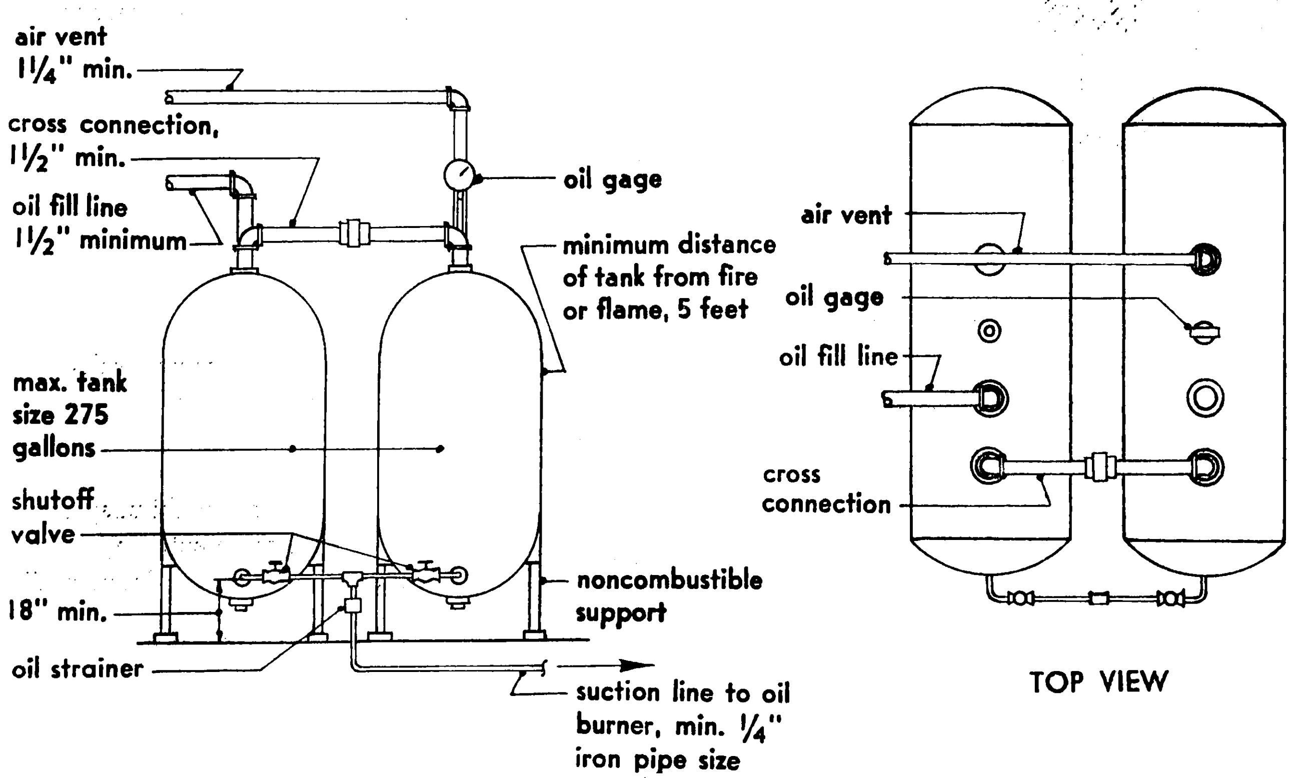
Enclosure for interior smokestacks shall be without openings except those necessary for maintenance of the stack. Such openings shall be equipped with self-closing noncombustible fire doors having a fire-resistance rating of not less than ¾ hour. Enclosure shall be continuous and shall extend through the roof. The space between the smokestack and the enclosing walls shall be ventilated by means of an air inlet at the base, and an air outlet at the roof.

Where an interior smokestack passes through a roof constructed of combustible materials, a metal ventilating thimble shall be provided extending not less than 9 inches above and 9 inches below the roof construction. The outer surface of the thimble shall be separated at least 1 inch from combustible material, and the inner surface of the thimble at least 5 inches from the smokestack.

Interior Exposed Fuel-Oil Storage Tanks



SINGLE 275-GALLON FUEL OIL STORAGE TANK



DUAL 275-GALLON FUEL OIL STORAGE TANKS

Chimney Construction—1

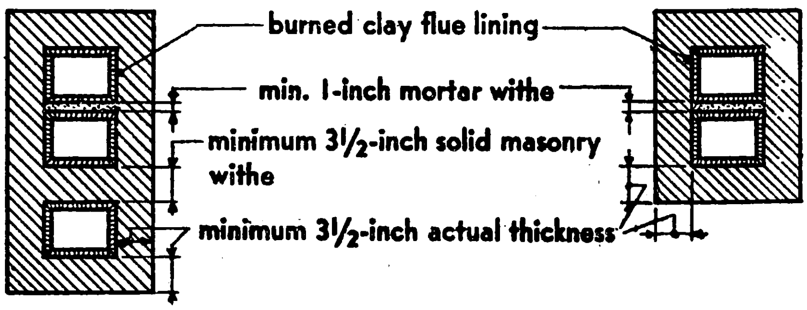


FIGURE 1

Figure 1—Enclosing walls of brick; concrete reinforced vertically and horizontally; solid concrete masonry units; or coursed, sawed, or dressed stone bonded at corners and tied with metal anchors.

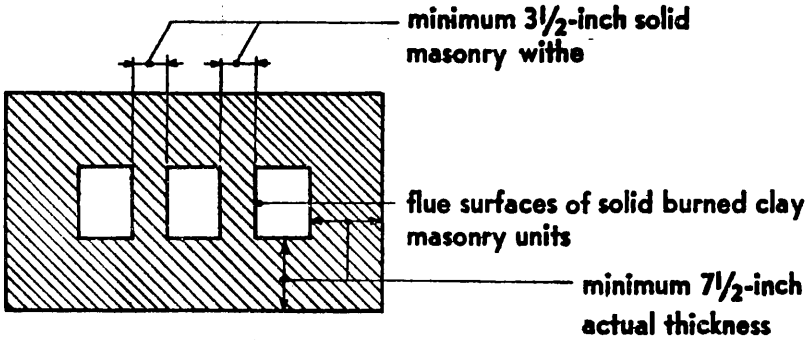


FIGURE 2

Figure 2—Enclosing walls of solid masonry units without flue lining.

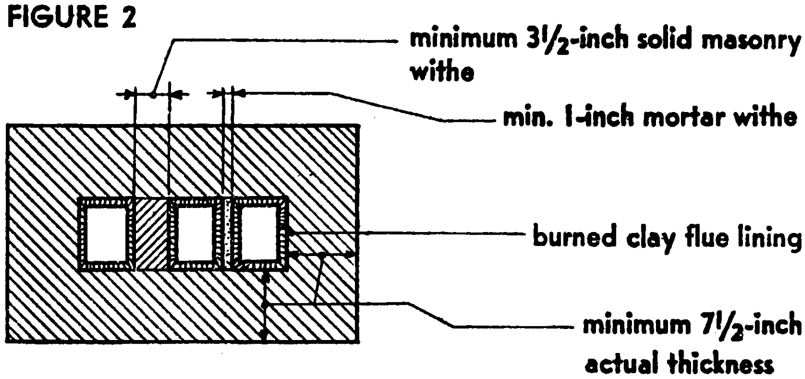


FIGURE 3

Figure 3—Enclosing walls of rubble or rough stone masonry.

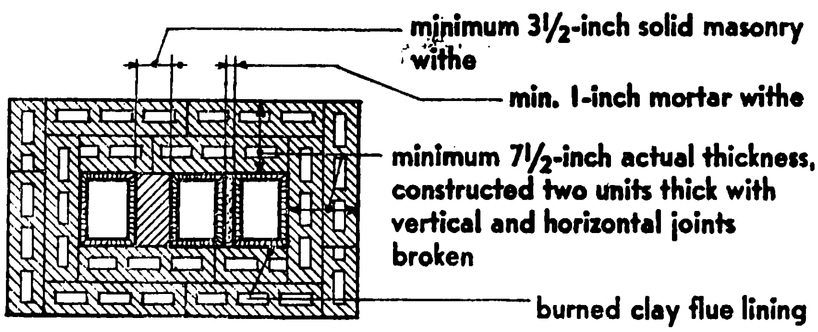
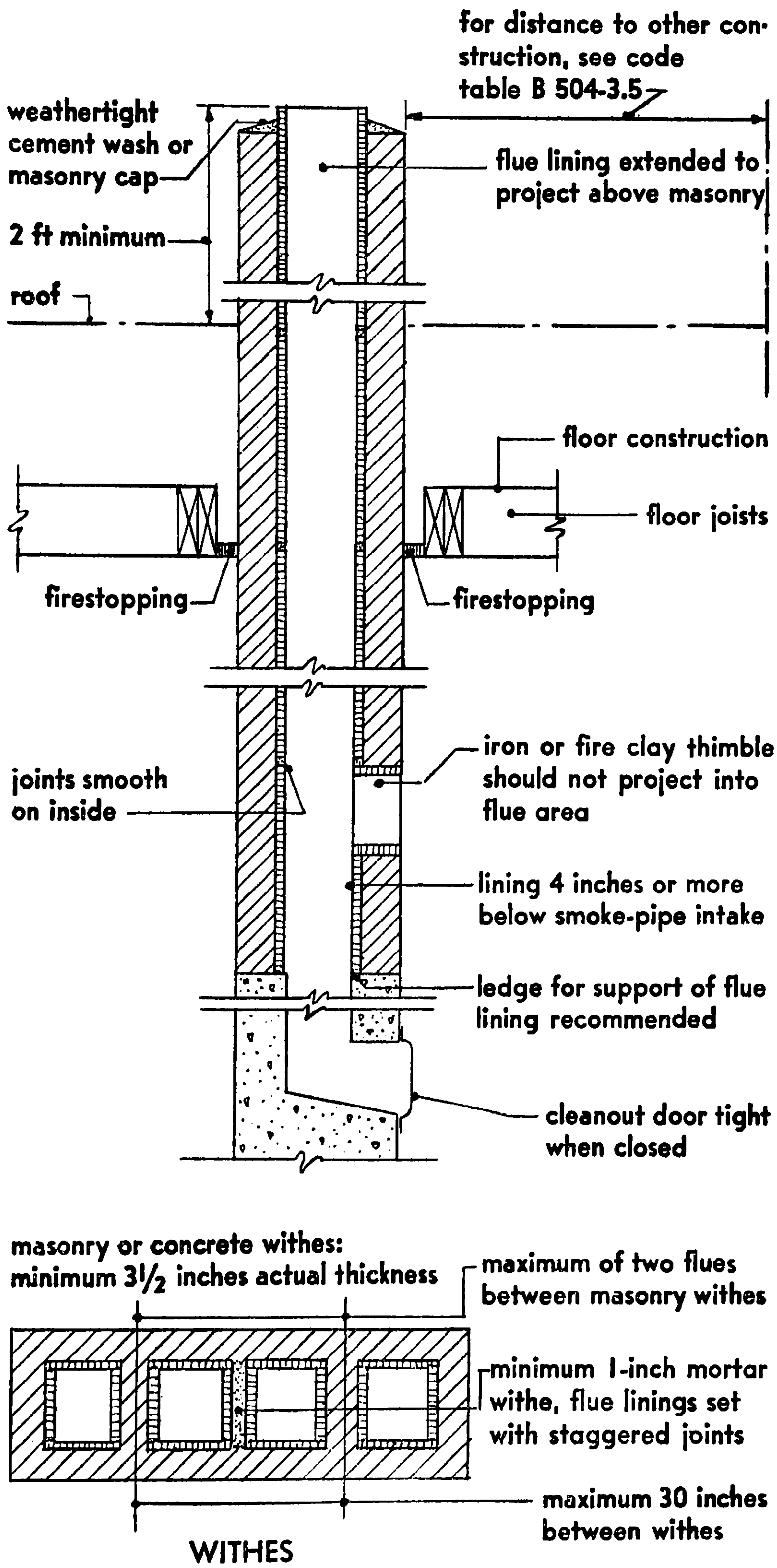


FIGURE 4

Figure 4—Enclosing walls of hollow masonry units.

For limitations on chimney construction, see table entitled, "Construction of Masonry Chimneys," part 5, page 49.

Chimney Construction—2



Flue linings should be of fire clay with dimensions conforming to generally accepted standards. Upon installation, linings shall be free from chips, openings or cracks which may affect the tightness of the flue. They shall be set in full mortar beds with joints struck off smooth on the inside.

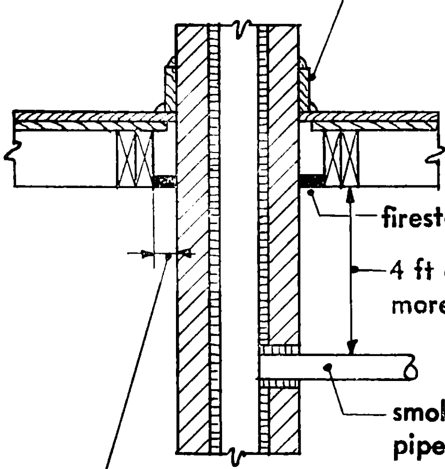
Withes—Where two or more flues are contained in the same chimney, withes of masonry or concrete not less than 3½-inch actual thickness shall be provided at intervals not exceeding 30 inches horizontally. Not more than two flues shall be installed without separation by masonry or concrete withes. Where the flue linings are not separated by masonry or concrete withes, mortar withes not less than 1-inch thick shall be used. Flue linings on either side of mortar withe shall be set so that the vertical distance between joints in adjacent flue linings is not less than 7 inches. There shall be no openings between flues.

Cleanout frame and door at base of flue should be provided.

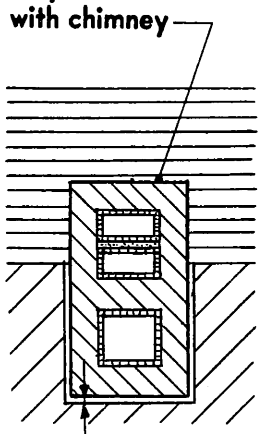
Chimneys: Clearance from Combustible Construction

When more than 4 feet above smoke pipe—Trimmers and headers of combustible material shall be 2 inches or more from chimney; subfloor shall be ⅜ inch or more from chimney; finish floor base and trim may contact chimney.

When 4 feet or less above smoke pipe—Trimmers and headers of combustible material shall be 2 inches or more from chimney; subfloor shall be not closer than 1½ inches from chimney; finish floor shall be not closer than ⅜ inch from chimney except that it may contact chimney for 2 inches at corner; base or trim shall be fastened to soldier grounds placed at corners and opposite masonry cross-withes.

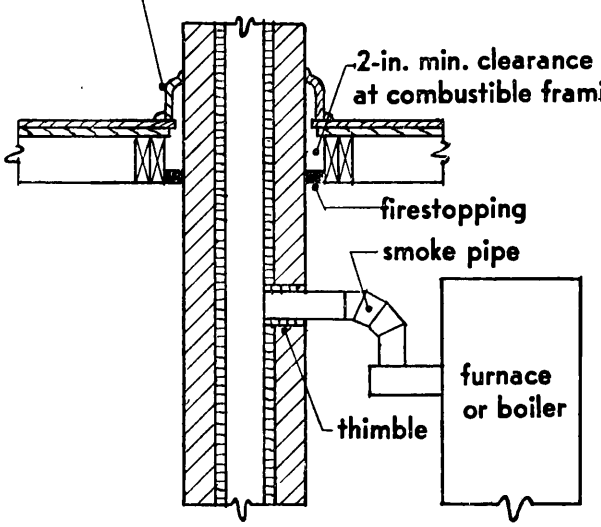


SECTION

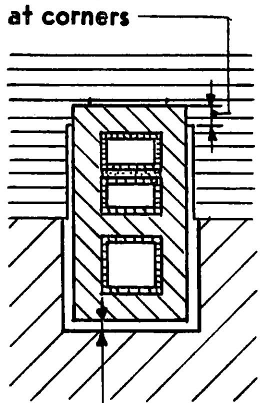


PLAN

FRAMING AND FINISH AT LEVELS MORE THAN 4 FEET ABOVE SMOKE PIPE

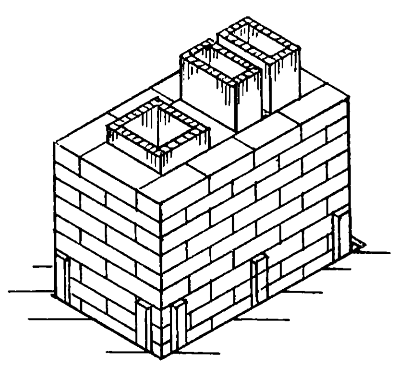


SECTION



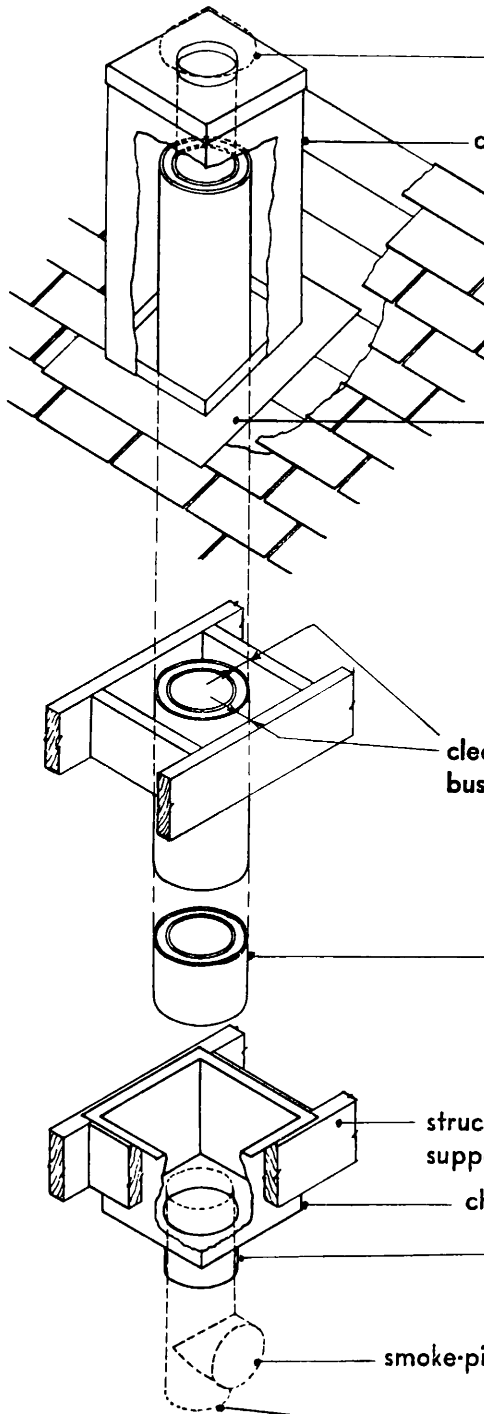
PLAN

FRAMING AND FINISH AT LEVELS 4 FEET OR LESS ABOVE SMOKE PIPE



SOLDIER GROUNDS FOR BASE

Prefabricated Chimneys for All Fuels



Prefabricated chimneys shall be limited to buildings not over two stories in height. The chimney shall be anchored to the building in such a manner that settling of the building or of the chimney, will not cause opening of the joints between chimney sections.

Chimney sections shall be joined to provide an integral flue structure with joints arranged to prevent condensation from penetrating into the interior of the chimney construction. Joint cement compounds, where used, shall be resistant to acid and high temperatures.

Insulation shall be impervious to high temperatures, protected from mechanical damage and shall extend at least 2 feet above the highest point of the opening in the roof through which the chimney passes.

The chimney flue liner should extend up to the underside of the top of the chimney roof housing in a smokeproof and sparkproof joint, or should extend through the top of the housing. When liner is of clay tile, it should be at least ⅝-inch thick.

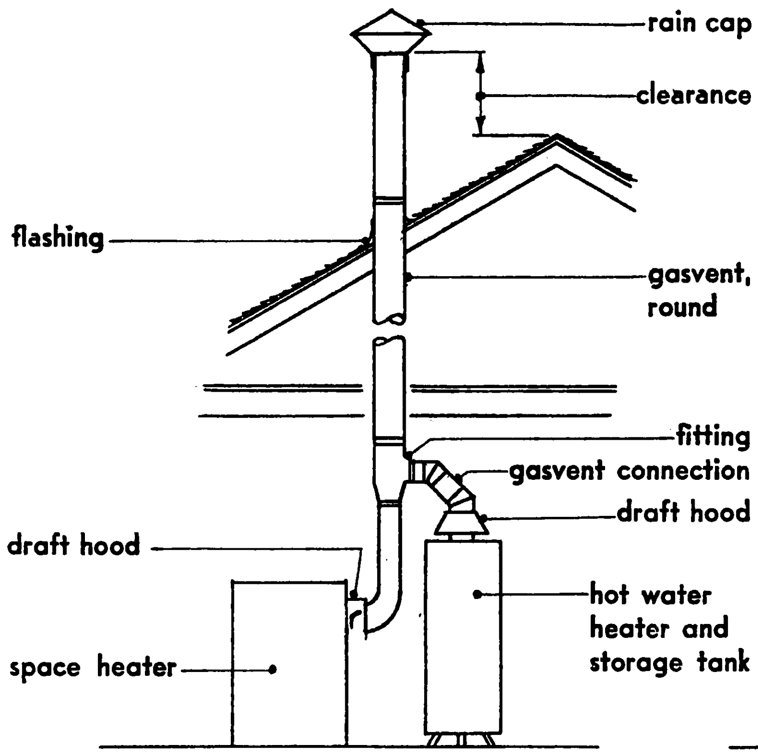
Parts of the chimney located in accessible spaces should be protected from contact and mechanical damage by enclosing with rigid construction equivalent to at least ⅜-inch thick wallboard.

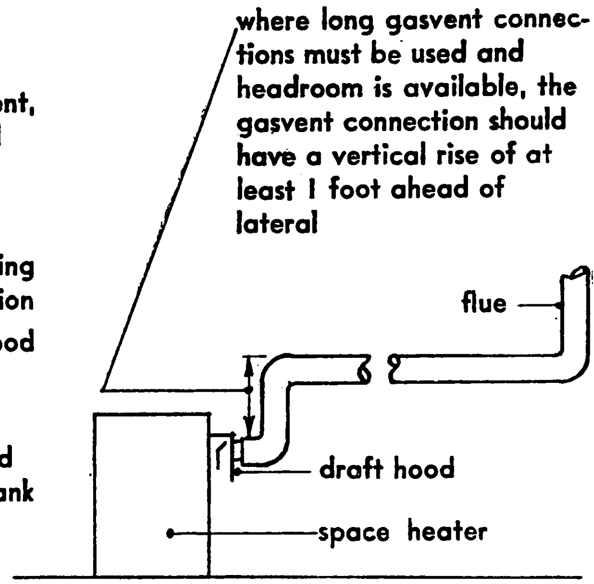
Clearances to combustible material for the particular prefabricated chimney shall be as approved by a recognized testing laboratory.

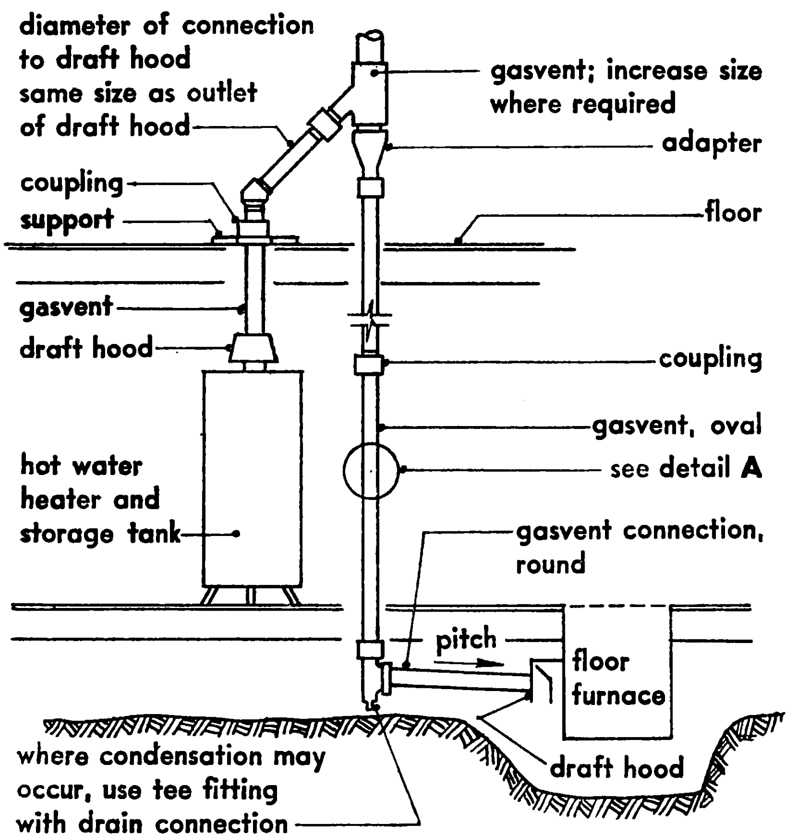
A rain cap is recommended to minimize against down draft and to prevent rain from entering.

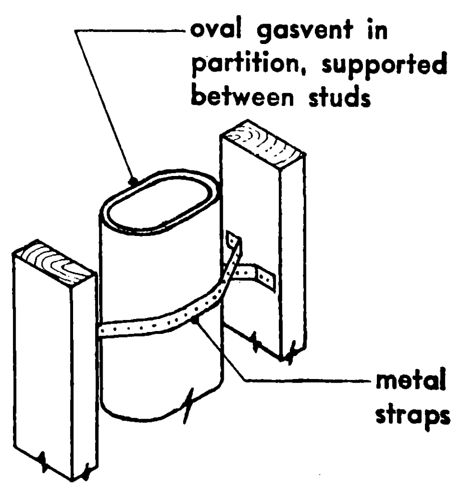
A cleanout below the smoke-pipe connection is recommended.

Type B Gasvents









DETAIL A

Electrical Wiring and Equipment

General Requirements—Electrical wiring and equipment designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

The rated capacity of conductors shall be the allowable current-carrying capacity of insulated conductors in amperes as listed in the *National Electrical Code.*

Service entrance conductors with a rated capacity of 200 amperes or more will usually require a service switch rated at 400 amperes or more, a service circuit breaker rated at 225 amperes or more, or from two to six service switches or circuit breakers of lesser rated capacity.

The required enclosure for service, metering, and distribution equipment should be designed to prevent unauthorized entrance with construction equivalent to at least wire mesh of No. 13 U.S.S. gage having openings which will not permit passage of a ball 1¼ inches in diameter.

It is recommended that in bathrooms a receptacle outlet be provided at least 4 feet above the floor near the mirror.

Laundry appliances, and window-type air conditioning units or ranges, where provided, should be supplied from receptacles having an extra pole for grounding the equipment.

Electrical Service

Service conductors shall have an insulating covering which will normally withstand exposure to atmospheric and other conditions of use and which will prevent any detrimental leakage of current to adjacent conductors, objects or the ground, except that a grounded service conductor without insulating covering may be used where the voltage between any conductor and ground does not exceed 300 volts.

Underground service conductors shall be installed in duct, conduit, or in cable approved for the purpose. Such conductors installed in duct or conduit shall be lead-covered or of other types approved for the purpose.

Service conductors within 8 feet of the ground, extending along the exterior of buildings, shall be installed in rigid conduit, electrical metallic tubing, busways or in cables approved for the purpose. Service conductors should not be run within the hollow spaces of frame buildings.

Overhead service conductors shall be installed at sufficient height to maintain the clearances indicated in the illustration entitled, "Overhead Electrical Service," part 5, page 63.

Service conductors shall be provided with means for disconnecting all conductors from the source of supply. In general, the service disconnecting means shall have a rating of not less than 60 amperes if a switch is used, and not less than 50 amperes if a circuit breaker is used. If the switch or circuit breaker does not interrupt the grounded conductor, other means shall be provided in the service cabinet for disconnecting the grounded conductor from the interior wiring.

Each ungrounded service conductor shall be provided with overcurrent protection in the form of a device which will usually be an integral part of the service disconnecting means.

The service disconnecting means and overcurrent protective devices shall be installed in a readily accessible location near the entrance of the service conductors into the building. Service conductors shall have adequate current-carrying capacity to conduct safely the current for the load supplied, calculated as described in the text entitled, "Electrical Loads," on this page.

Electrical Loads

In dwelling occupancies other than hotels the load for general lighting shall be determined on a basis of 3 watts per square foot of floor area. The floor area shall be computed from the outside dimensions of the building, apartment or area involved, and the number of floors, but not including open porches, garages or unfinished and unused space unless adaptable for future use.

To the calculated general lighting load there shall be added a load of 1500 watts for each dwelling unit in order to provide for portable appliances used in kitchen, dining room, and laundry.

A demand factor of 100 per cent shall be applied to the first 3000 watts or less of general lighting load, 35 per cent to the next 117,000 watts, and 25 per cent to any amount over 120,000 watts.

The load for an electric range shall be determined from the table entitled, "Demand Loads for Household Electric Ranges," part 5, page 58.

DEMAND LOADS FOR HOUSEHOLD ELECTRIC RANGES

Requirements		Examples	
Nameplate rating in watts	Demand load in watts	Nameplate rating in watts	Demand load in watts
Up to 1,750........	Nameplate rating	1,500	1,500
1,751 to 8,750........	80 per cent of nameplate rating	6,500	6,500 x 0.80 = 5,200
8,751 to 12,000.......	8,000	11,600	8,000
12,001 to 21,000.......	8,000 plus 400 for each multiple of 1,000 or major fraction thereof by which the nameplate rating exceeds 12,000	15,750	$8{,}000 + 400\,\dfrac{(15{,}750-12{,}000)}{1{,}000}$ $= 8{,}000 + 400\ (3.75 \text{ use } 4)$ $= 9{,}600$

Note: Electric range ratings are usually given in kw. One kw. equals 1000 watts.

The load for fixed appliances other than the electric range shall be the sum of the nameplate ratings of such appliances. Where more than three fixed appliances in addition to an electric range are to be supplied, a demand factor of 75 per cent may be applied to the fixed appliance load, but not including the electric range load.

The load for a single motor shall be based on 125 per cent of the full-load current rating of the motor. Where two or more motors are supplied, the load shall be based on 125 per cent of the full-load current rating of the highest rated motor in the group plus the sum of the full-load current ratings of the remainder of the motors in the group. Full-load current ratings shall be as listed in the *National Electrical Code* or as given on the motor nameplate.

ELECTRICAL LOAD CALCULATIONS: EXAMPLE NO. 1

Load calculations to determine the minimum size of service conductors required for the building shown in illustration entitled, "Electrical Layout for One-Family Dwelling," part 5, page 64.

Floor area, 1,500 square feet

General lighting load:

1,500 square feet × 3 watts per square foot	4,500 watts		
For portable appliances	1,500 watts		
Computed load	6,000 watts		
3,000 watts × 100 per cent		3,000 watts	
6,000 minus 3,000 = 3,000: 3,000 watts × 35 per cent		1,050 watts	
Demand load		4,050 watts	4,050 watts

Electric range load:

Nameplate rating	15,300 watts		
For first 12,000		8,000 watts	
For excess over 12,000 watts			
$400\left(\dfrac{15{,}300 - 12{,}000}{1{,}000}\right) = 400\ (3.3 \text{ use } 3)$		1,200 watts	
Demand load		9,200 watts	9,200 watts

Other loads:

Appliance heating element load

Water heater	3,000 watts	
Dishwasher	925 watts	
Clothes dryer	1,500 watts	
Ironer	1,375 watts	
Computed load	6,800 watts	6,800 watts

Motor load at 115 volts, AC

½ hp clothes washer, 7.4 amps. at 125 per cent =	9.3 amperes
¼ hp oil burner	4.6 amperes
⅙ hp clothes dryer	3.2 amperes
⅙ hp dishwasher	3.2 amperes
⅙ hp circulating pump	3.2 amperes
⅛ hp ironer	2.2 amperes
Computed motor load	25.7 amperes

115 volts × 25.7 amperes = 2,956 volt-amperes (use same number in watts)	2,956 watts	
Computed load heating elements and motors	9,756 watts	
Demand load 9,756 watts × 75 per cent		7,317 watts
Total demand load		20,567 watts

For 115/230 volt, three-wire service: total demand load current, 20,567 watts ÷ 230 volts = 89 amperes; minimum size of ungrounded service conductors required based on type R wire is No. 2.

Three No. 2 conductors shall be used, except that under certain conditions the neutral conductor may be of smaller size as indicated in the following paragraph:

For a three-wire service, the minimum size of the neutral service conductor may be determined from the demand load of the maximum connected load between the neutral and any one ungrounded conductor, except that a further demand factor of 70 per cent may be applied to a demand load of 8000 watts or more for an electric range. In this example the water heater operates at 230 volts and has no neutral connection.

General lighting demand load	4,050 watts
Electric range demand load..9,200 watts	
9,200 watts × 70 per cent	6,440 watts
Other loads:	
Total..............9,756 watts	
Subtract water heater load:	
9,756 minus 3,000 = 6,756	
6,756 watts × 75 per cent	5,067 watts
Demand load (for neutral conductor determination)	15,557 watts

Demand load current, 15,557 watts ÷ 230 volts = 68 amperes.

Minimum size of neutral service conductor required (based on type R wire) is No. 4.

Branch Circuits

Branch circuits shall be classified in accordance with the maximum permitted rating or setting of the overcurrent device protecting the circuit. The rating or setting of the overcurrent device for a branch circuit supplying not more than one outlet shall not exceed 150 per cent of the current rating of the appliance served, except that such rating or setting need not be less than 15 amperes. Branch circuits supplying two or more outlets shall be in accordance with the following table:

BRANCH CIRCUIT CLASSIFICATION

Rating of branch circuit, amperes	Rating or setting of over-current protective device, amperes	Minimum size, AWG, of circuit conductors in raceway or cable. Types R, RH, RW, RU, RHW, T or TW	Outlet devices supplied	
			Rating of receptacle, amperes	Lamp holders
15	15	14	15	Any type
20	20	12	15 or 20	Any type
30	30	10	20 or 30	np
50	50	6	50	np

The number of branch circuits for the general lighting load shall be not less than that determined from the capacity of the branch circuits to be used and the computed load before demand factors are taken. In addition, at least one 20-ampere branch circuit shall be provided to supply all receptacle outlets for portable appliances, other than outlets for clocks, in kitchen, dining room, and laundry. Such branch circuit shall supply no other outlets.

EXAMPLE NO. 2

Calculations to determine the number of branch circuits required to supply the general lighting load for the building shown in illustration entitled, "Electrical Layout for One-Family Dwelling," part 5, page 64.

Computed load for general lighting....... 4500 watts
4500 watts ÷ 115 volts = 39 amperes

Branch circuits required:

Three 15-ampere or two 20-ampere branch circuits plus one 20-ampere branch circuit for portable appliances in kitchen, dining room and laundry.

EXAMPLE NO. 3

The branch circuit for an electric range shall be determined from the demand load calculated in accordance with the table entitled, "Demand Loads for Household Electric Ranges," part 5, page 58.

Branch circuit calculations for electric range circuit:

Electric range rated at 15,300 watts

Demand load from table:

$$8000 + 400\left(\frac{15{,}300 - 12{,}000}{1000}\right)$$

$$8000 + 400\ (3.3 \text{ use } 3) = 9200 \text{ watts}$$

$$9200 \text{ watts} \div 230 \text{ volts} = 40 \text{ amperes}$$

Branch circuit required: one individual branch circuit with a capacity of 40 amperes

Branch circuits for fixed appliances shall be determined from the computed load of the appliances supplied. Demand factors do not apply to branch circuit calculations for fixed appliances other than electric ranges. The appliances indicated in the illustration entitled, "Electrical Layout for One-Family Dwelling," part 5, page 64, may be supplied by individual branch circuits or may be grouped where possible on branch circuits indicated in table entitled, "Branch Circuit Classification," part 5, page 59. It is recommended that fixed appliances be supplied by individual branch circuits.

The minimum size of conductor for branch circuit wiring shall be No. 14 with the following exceptions: for branch circuit wiring supplying receptacles for small appliances in kitchen, dining room and laundry, No. 12; for branch circuit wiring supplying electric range rated 8¾ KW or more, No. 8 for ungrounded conductors, and No. 10 for the neutral conductor.

Grounding

One conductor of an alternating current service should be grounded when the voltage between the grounded conductor and any other service conductor does not exceed 300 volts. The grounding connection shall be made at each individual service on the supply side of the service disconnecting means.

Metal boxes, cabinets, fittings, raceways and armor should be grounded.

Non-current-carrying metal parts of fixed equipment should be grounded.

Metal lighting fixtures, lamp holders, face plates and other equipment shall be considered as grounded when mechanically connected to grounded metal raceway or cable armor or to a separate equipment grounding conductor not smaller than No. 14.

Raceway, armor, equipment grounding conductor, or the frames of equipment shall not be connected to the grounded circuit conductor except as follows: raceway, armor, or the equipment grounding conductor, may be connected to the grounded circuit conductor on the supply side of the service disconnecting means; frame of electric range or electric clothes dryer may be connected to the grounded circuit conductor when supplied by a three-wire branch circuit with a grounded circuit conductor not smaller than No. 10.

The grounding conductor from the supply side of the service disconnecting means shall be of copper or other corrosion-resistant material and shall be connected to an approved grounding electrode.

The grounding electrode shall be a metallic underground water piping system, where available. Where such system is not available grounding electrodes in the order of preference may be the metal frame of the building if effectively grounded, or a driven pipe, driven rod, buried plate, or other device approved for the purpose.

Soil, waste, vent, drain or heating pipes should not be used for grounding purposes.

Artificial Lighting

General Requirements—Lighting fixtures should be installed in kitchens, bathrooms, laundry rooms, dining rooms, basements, cellars, accessible attics, stairways and hallways, and in multiple dwellings wherever artificial light is required.

A lighting fixture should be installed so as to illuminate the front of the furnace. A lighting fixture should be installed over laundry equipment in a basement or cellar. A lighting fixture should be installed at the mirror in the bathroom.

Lighting fixtures where provided in clothes closets, shall be installed on the ceiling or on the wall above the door. Pendant fixtures shall not be installed in clothes closets.

Switches to control the lighting fixtures should be located at the main entrance to each room. It is recommended, where no lighting fixture is provided in a room, that at least one receptacle outlet be controlled by a switch located at the entrance. Switches in bathrooms should not be located within reach of bathtub or shower.

At least one lighting fixture in an accessible attic should be controlled by a switch located at the foot of the stairs. At least one lighting fixture in a basement or cellar should be controlled by a switch located at the head of the stairs. Lighting fixtures illuminating a stairway between stories in a one- or two-family dwelling should be controlled by switches located at the head and foot of the stairs.

Switches controlling required artificial lighting in multiple dwellings, when accessible to other than authorized persons, should be of the lock type.

Emergency Lighting—Emergency lighting systems should consist of wiring, outlets, fixtures and switches independent of the general lighting system. They should be so designed and installed that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave any space in total darkness.

Where a single source of supply is permitted, the reliability of the service should be such that the possibility of an outage or interruption of supply is remote.

Where two sources of supply are required, the main source shall be the building electric service and the auxiliary source should be a second electric service, or a generator driven by a prime mover always available, or a set of suitable storage batteries continually charged. Lead storage batteries of the sealed, glass-jar type are suitable as an auxiliary source.

An automatically operated transfer switch should be provided to transfer the emergency lighting load from the main source to the auxiliary source whenever the voltage of the main source falls below 75 per cent of rated system voltage. Where the auxiliary source is a generator driven by a prime mover, the operation of the transfer switch should cause the automatic starting of the prime mover.

Transfer of the emergency lighting load from the main source to the auxiliary source should be indicated by an audible signal. Stopping of such signal by manual means should be indicated by a visual signal.

The automatic transfer switch should operate to return the emergency lighting load to the main source of supply upon restoration of rated system voltage to such supply.

Exit and Directional Signs

Exit and directional signs should be constructed of metal or other durable noncombustible material and should be firmly secured to the wall or ceiling.

Externally illuminated signs should have red letters on a white background or white letters on a red background. Letters should be not less than 6 inches in height with principal strokes not less than ¾ inch in width. A light outlet should be installed on the wall or ceiling over the sign.

Internally illuminated signs should have translucent red letters on an opaque background. Letters should be not less than 4½ inches in height with principal strokes not less than ½ inch in width.

Where circuits supplying exit and directional sign outlets originate at an emergency lighting panel, connections should be made so that the sign outlets will remain energized at all times.

Where circuits supplying exit and directional sign outlets originate at a panel containing other than emergency lighting circuits, the handles of the switches or circuit breakers controlling the sign outlet circuits should be colored red and a sign reading SWITCHES WITH RED HANDLES CONTROL EXIT SIGN CIRCUITS AND ARE TO REMAIN IN THE "ON" POSITION AT ALL TIMES should be posted in a glazed metal frame visible when the panel door is open.

Television Antenna Installation

Mast and supporting structure of television antenna should be substantially constructed so as to be capable of withstanding the wind and ice loads to which they are subject. It is recommended that masts extending more than 8 feet above the top of their support be guyed. Guys should be of galvanized steel, copper-covered steel, bronze, or other corrosion-resistant material, not less than No. 14 AWG. Where the stability of mast is dependent on guys, there should be least three, approximately equally spaced about the mast.

Masts may be secured to side walls, to parapet walls, or to chimneys in good structural condition. Attachment to chimneys is not recommended, but where unavoidable, should be made by means of two or more substantial iron straps encircling the chimney. Attachment should not be made to chimneys in poor structural condition or by means of holes drilled into the chimney.

Antenna should not be installed in close proximity to electric service lines. A distance sufficient to prevent contact if the antenna overturns is recommended.

Lead-in conductors attached to buildings should be installed so as to maintain not less than the following clearances from other conductors: 4 inches from conductors of circuits not exceeding 150 volts; 2 feet from conductors of circuits from 151 to 250 volts; 10 feet from conductors of circuits over 250 volts.

Lead-in conductors should be insulated or enclosed in a grounded metallic sheath where they enter the building. Each lead-in conductor should be provided with a lightning arrester, except that where the lead-in conductor is protected by a continuous effectively grounded metal sheath, the lightning arrester may be omitted.

Mast and supporting structure, if of metal, should be effectively grounded. If a system of lightning protection exists, the mast and structure should be bonded to the nearest lightning conductor; where such system does not exist, the mast and structure should be grounded as described in the text entitled, "Lightning Protection for Metal on Buildings," below.

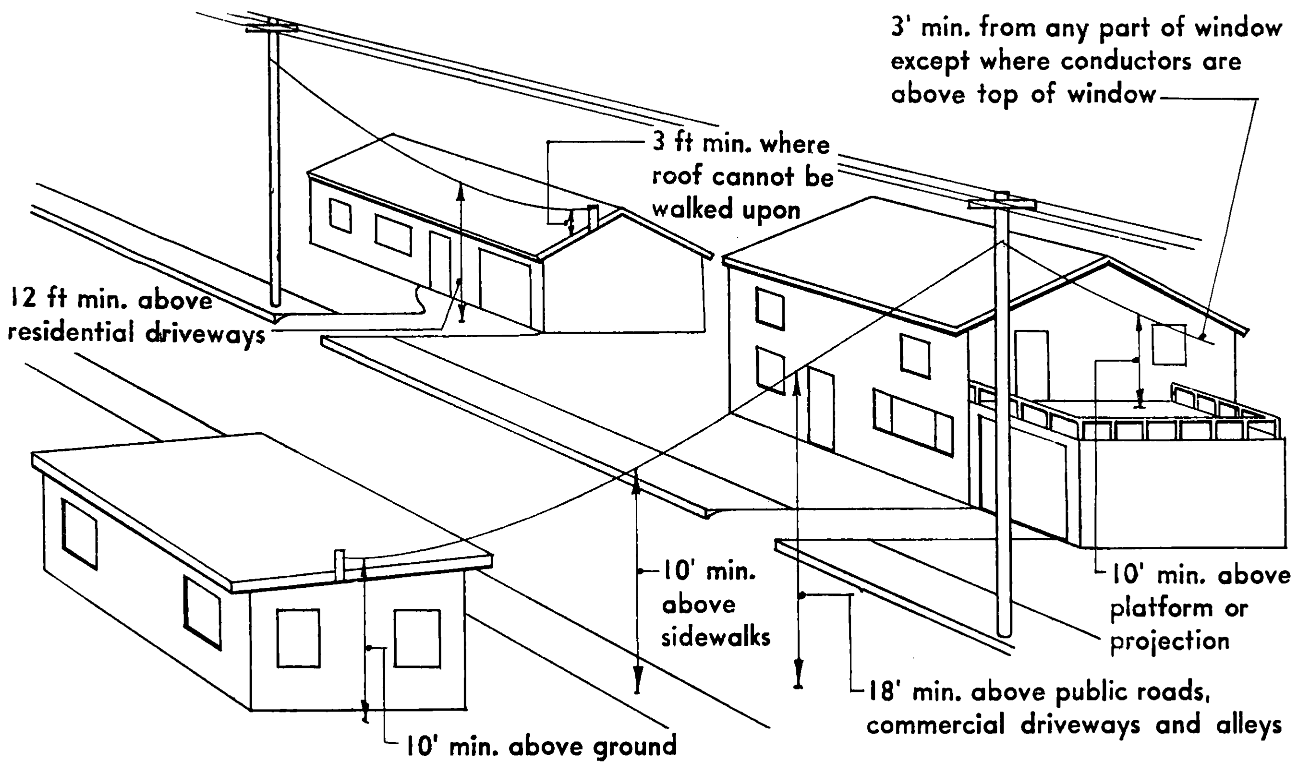
Electrical materials and installation should be in conformity with NFPA, *National Electrical Code.*

Lightning Protection for Metal on Buildings

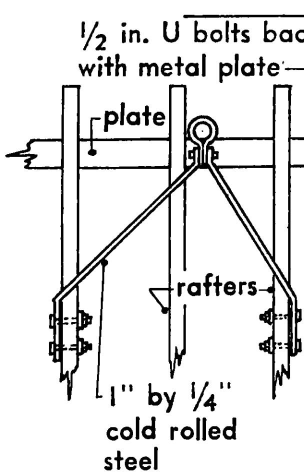
Roofs, veneer and siding of metal on buildings should be made electrically continuous by means of interlocking or bolted contacts or by bonding the sections together with metal conductors. Such roofing, veneer, or siding should be grounded in at least two locations on opposite sides of the building. Grounding connections should be made at the lower part of the veneer or siding, or in the case of metal roofs only, at the edges of the roof.

Masts, towers, tanks and smokestacks, when of metal and located on the roofs of buildings, should be grounded. Ground connections should be made to grounding electrodes as described in the text entitled, "Grounding," part 5, page 60, except that for masts, towers and tanks, connections may be made to a cold water-pipe riser or grounded electrical conduit system at a penthouse or similar location.

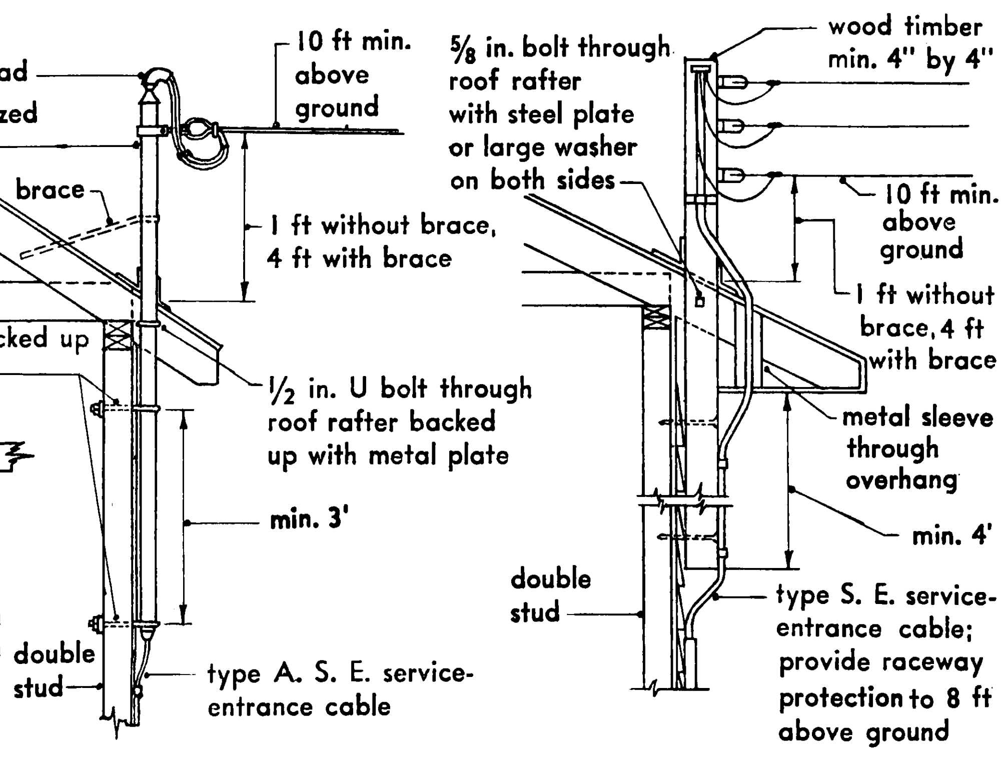
Overhead Electrical Service



MINIMUM CLEARANCES OF OVERHEAD SERVICE CONDUCTORS

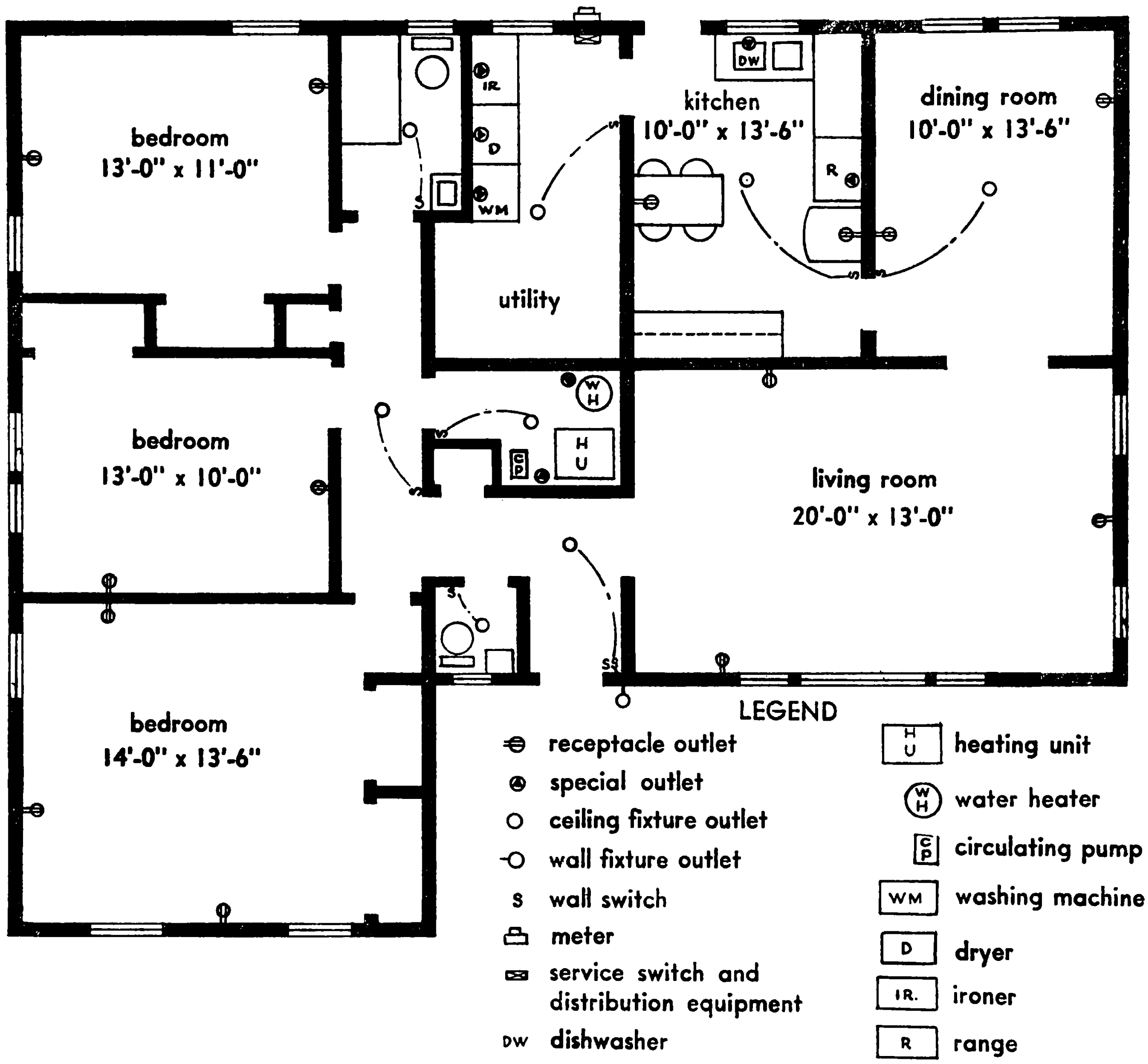


DETAIL OF BRACE



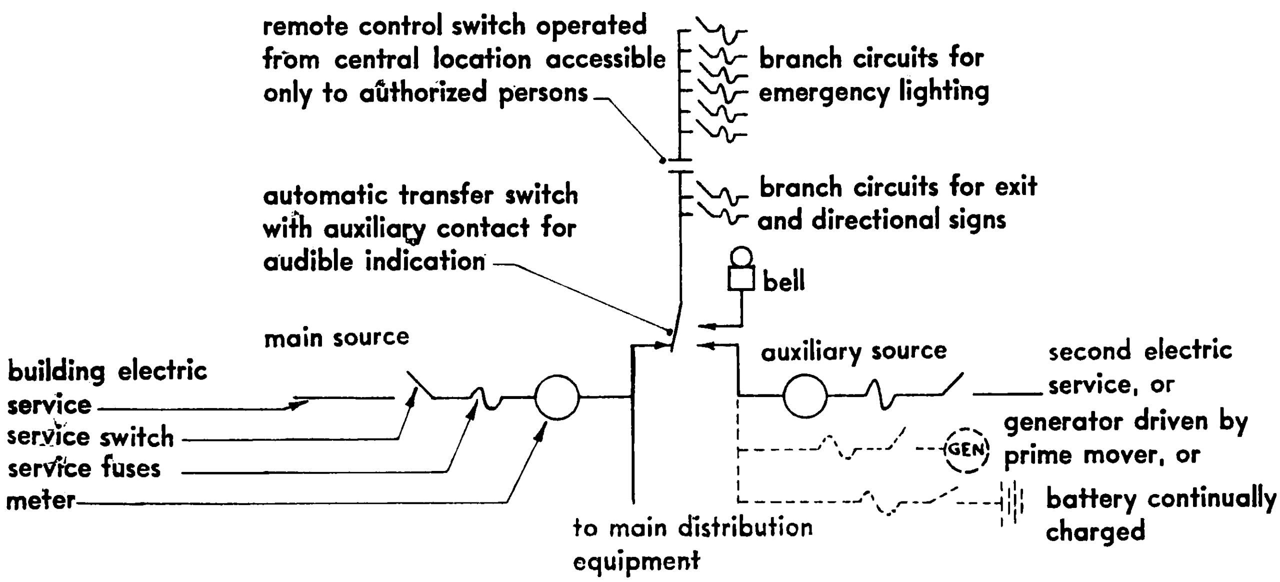
ARRANGEMENT OF SERVICE ENTRANCE CONDUCTORS TO OBTAIN REQUIRED CLEARANCE ABOVE GROUND

Electrical Layout for One-Family Dwelling

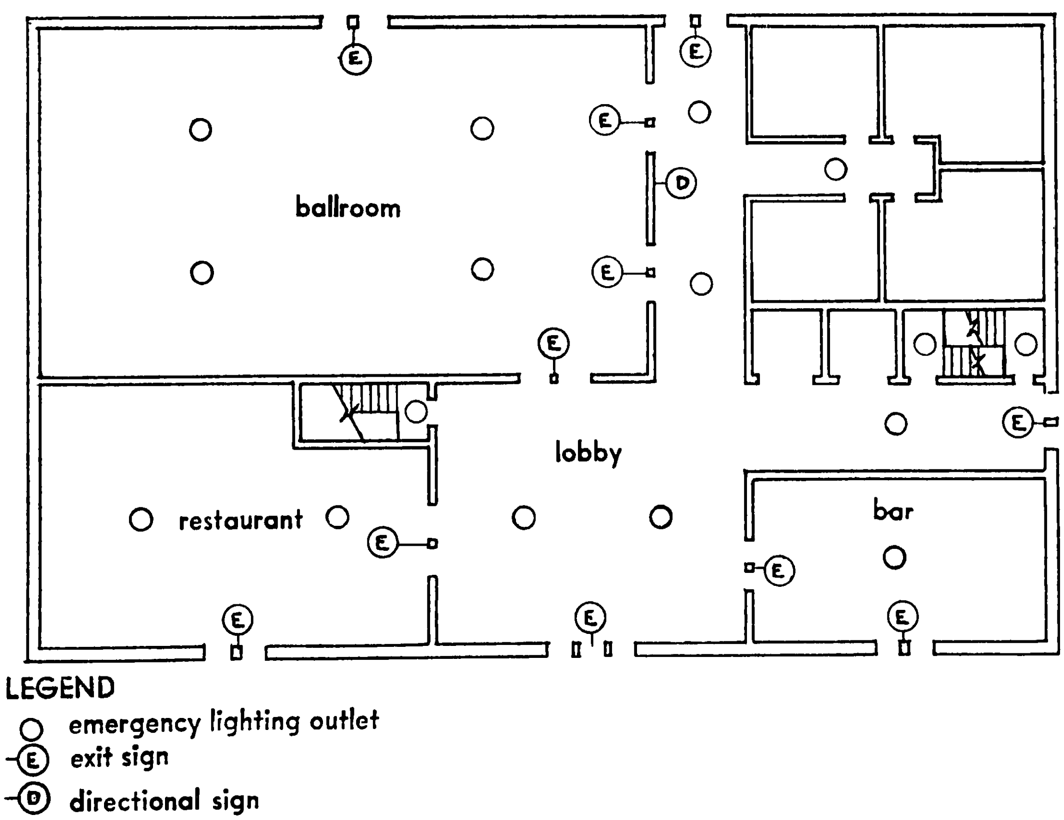


Receptacle outlets shall be provided in every kitchen, dining room, living room, parlor, library, den, sun room, recreation room, and bedroom. At least one receptacle outlet shall be provided for every multiple of 20 feet or major fraction thereof of the total distance around the room as measured horizontally along the wall at the floor line. At least one three-pole receptacle outlet designed for grounding shall be provided for the connection of laundry appliances. The fixed appliances and lighting arrangements shown are optional.

Emergency Lighting, Exit Signs, and Directional Signs

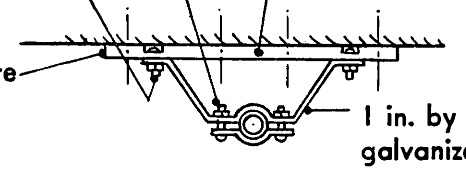


SUPPLY FROM MAIN AND AUXILIARY SOURCE

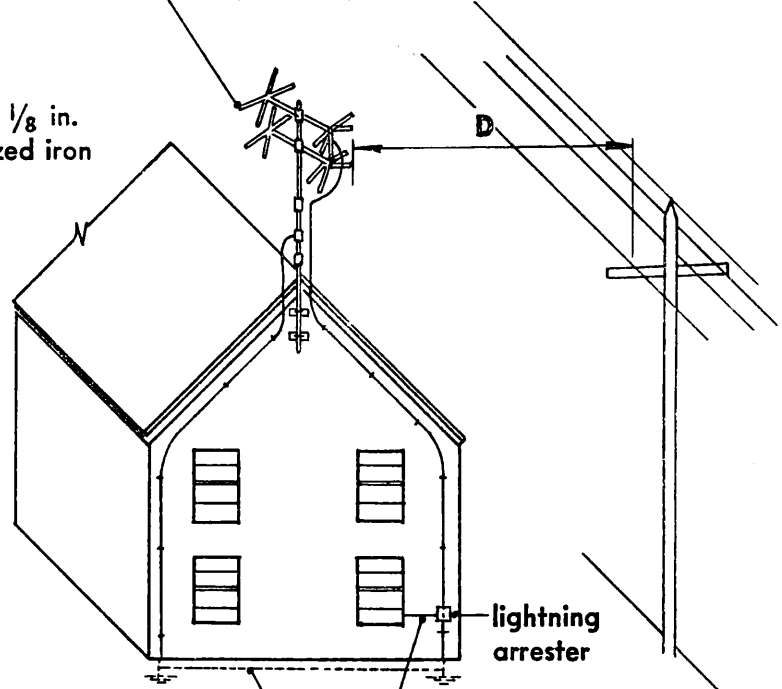


TYPICAL ARRANGEMENT OF EMERGENCY LIGHTING, EXIT SIGNS, AND DIRECTIONAL SIGNS

Television Antenna Installation

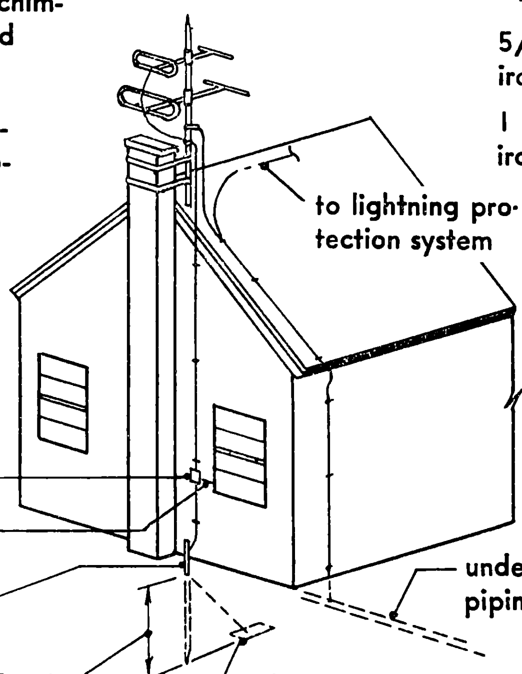


BRACKET SUPPORTING MAST ON SIDE WALL

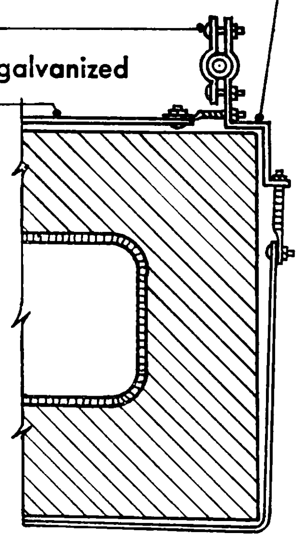


distance **D** shall be such that in the event of antenna overturning, contact cannot be made with electric service lines

Note: attachment to side wall as shown above is preferred; attachment to chimney is not recommended



ACCEPTABLE GROUNDING METHODS



BRACKET AND STRAP SUPPORTING MAST ON MASONRY CHIMNEY

Incinerators

General Requirements—Incinerators designed and installed in conformity with generally accepted standards are deemed to meet the requirements of the Code.

Incinerators shall be installed within fire-resistive enclosures, except that domestic or portable type, or direct-fed type having a charging compartment not exceeding 5 cubic feet, need not be so enclosed. Domestic or portable type incinerators that are direct-fed and have a charging compartment not exceeding 5 cubic feet shall be insulated, jacketed, or have a refractory lined combustion chamber capable of withstanding internal temperatures of 1800° F. without cracking, warping, or other failure of structural parts.

Mounting and Clearance—Mounting of incinerators shall be as shown in part 5, in the following illustrations: for domestic or portable type that are direct fed and have a changing compartment not exceeding 5 cubic feet, see illustrations entitled, "Mounting of Furnaces and Boilers—1, 2 and 3," part 5, pages 32 to 34; for other incinerators, see illustration entitled, "Mounting and Clearance for Boilers," part 5, page 35.

Incinerators having smoke pipes passing through combustible construction shall be as shown in the illustration entitled, "Clearances of Smoke Pipes and Gasvent Connections," part 5, page 46.

Construction of Flue-Fed Incinerators—Flue-fed incinerators shall have the combustion chamber, flue and expansion chamber of construction at least equivalent to that shown in the accompanying table entitled, "Construction of Flue-Fed Incinerators."

Arrangement of incinerators shall be as indicated in illustration entitled, "Clearance for Furnaces and Boilers," part 5, page 31. Clearance to unprotected combustible construction should be as shown in the accompanying table entitled, "Clearance of Incinerators to Unprotected Combustible Construction;" except that where combustible construction is protected, clearance may be as shown in table 2 entitled, "Clearance for Furnaces and Boilers," part 5, page 30.

CLEARANCE OF INCINERATORS TO UNPROTECTED COMBUSTIBLE CONSTRUCTION

Type of incinerator	Minimum clearance in inches, indicated in illustration as:			
	A	B	C	D
	Above	Sides and rear	Front	From smokepipe or gasvent connection
Portable or domestic type, direct fed and having charging compartment not exceeding 5 cubic feet:				
Listed [1]	48	12	48	18
Not listed	48	18	48	18
Incinerators, other than above, with brick walls at least of thickness indicated in following table entitled, "Construction of Flue-fed Incinerators"	36	18	96	36
Incinerators, other than immediately above without brick wall enclosure of thickness indicated in following table entitled, "Construction of Flue-fed Incinerators"	48	36	96	36

[1] When listed for installation with lesser clearances, installation may be in accordance with such listing.

CONSTRUCTION OF FLUE-FED INCINERATORS

Grate area of combustion chamber, square feet	Combustion chamber, inches of thickness		Flue		
	Interior lining, first-grade fire brick	Outside brick of clay or shale	Vertical interval above roof of combustion chamber	Interior lining; inches of thickness	Outside brick of clay or shale; inches of thickness
7 or less [1]	4½	4	First 10 feet	4½ fire brick in fire clay mortar	4
			Beyond first 10 feet	Standard thickness fire clay flue lining	4
Over 7	4½ [2]	8 [2]	First 40 feet	4½ fire brick in fire clay mortar	4
			Beyond first 40 feet	Standard thickness fire clay flue lining	8

[1] For flues of incinerators of portable or domestic type and not exceeding 5 cubic feet, see table entitled, "Construction of Masonry Chimneys," part 5, page 49.

[2] Air space between interior lining and outside brick to provide room for expansion and contraction.

Where an expansion chamber is used for secondary combustion, construction shall be the same as for combustion chamber; where used for settling, construction may be the same as for the upper part of the flue.

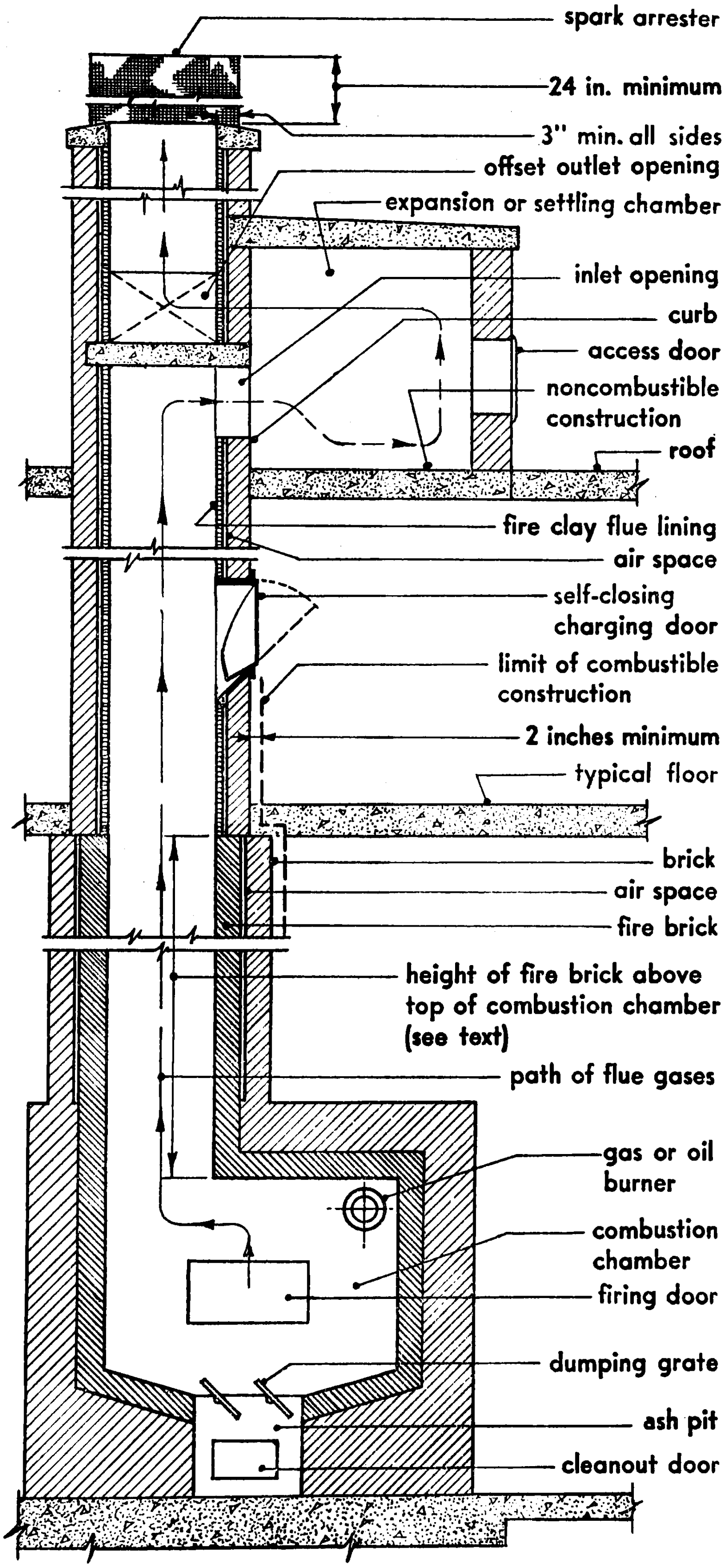
Flue-fed incinerators should have the size of flues and service openings as shown in the accompanying table entitled, "Size of Flues and Service Openings for Flue-Fed Incinerators."

SIZE OF FLUES AND SERVICE OPENINGS FOR FLUE-FED INCINERATORS

Type of dwelling	Service openings		Minimum size of flue, in inches	Maximum ratio of clear area of service opening to clear area of flue
	Number	Maximum clear area of each opening in square inches		
1- and 2-family	1 or 2	72 [1]	12 x 12	½
Multiple dwelling	1	98 [1]	14 x 14	⅓
Multiple dwelling	2 to 6	108 [1]	18 x 18	⅓
Multiple dwelling	7 or over	160	22 x 22	⅓
Multiple dwelling	7 or over	160	More than 22 x 22	—

[1] The maximum area of each opening when flue of minimum size is used; when flue is larger, the maximum area of service opening should be determined by the maximum ratios, but in no case exceeding 160 square inches.

Flue-Fed Incinerator



Flue shall be straight, plumb and smooth on the inside.

Fire brick and flue lining shall be laid in high-temperature cement or fire-clay mortar. Flue shall serve incinerator only.

Inlet and outlet openings of expansion or settling chamber shall each have a cross-sectional area at least equal to that of flue.

When flue passes through wood-joisted floor construction, the framing shall have at least 2-inch clearance from flue, and be firestopped as shown in illustration entitled, "Firestopping Details—3," part 4, page 34. Clearance of wood floor from flue shall be as shown in illustration entitled, "Chimneys: Clearance from Combustible Construction," part 5, page 54.

The self-closing charging door shall have a ¾-hour rating and be arranged so that there is no opening into the flue when the hopper is being charged.

Spark arrester shall be of metal, easily replaceable, galvanized or otherwise protected against corrosion and have a mesh opening of ½ inch by ½ inch.

Refrigeration and Air Conditioning

General Requirements—Refrigeration, air conditioning and mechanical ventilating systems designed and installed in conformity with generally accepted standards are deemed to meet the requirements of the Code.

Self-contained refrigerating and air conditioning equipment listed in ULI, *Electrical Equipment List,* covers all refrigerant-containing parts, safety devices, electrical components and wiring.

Refrigeration components and accessories intended for remote installation with refrigerant piping connections in the field and listed in ULI, *Electrical Equipment List,* need not be tested as to design and construction. Such systems and their piping shall be tested for refrigerant leakage after installation and shall be gastight.

This section does not apply to systems using water or air as a refrigerant.

Pressure Limiting Device—A limit control shall be connected to the high-pressure side of a system to stop the action of the compressor whenever a predetermined pressure is exceeded. No intervening valve shall be installed between the compressor and such control. The action of this control shall take precedence over the action of any other control. Such control shall be provided for air-cooled systems containing more than 20 pounds of refrigerant and water-cooled systems containing more than 3 pounds of refrigerant. The control shall be set at a pressure not exceeding 90 per cent of the setting of the safety relief device, or 90 per cent of the pressure for which the system has been satisfactorily tested for refrigerant leakage, or 90 per cent of the design working pressure.

Pressure Relief—Every system shall be provided with a pressure relief device or other means so that in the event of fire excessive refrigerant pressure will be prevented and the refrigerant will be relieved safely. Such devices shall be arranged so that they cannot be shut off from the parts of the system they protect. At least one of the following means shall be provided: spring loaded pressure relief valve; disk designed to rupture; fusible plug designed to melt at a predetermined temperature; soldered joint or lead gasket designed to melt at a predetermined temperature. This type is usually found on small self-contained systems listed in ULI, *Electrical Equipment List.*

Systems not located in machinery rooms shall have pressure relief valves vented to the outer air when they contain more than 6 pounds of refrigerant that is moderately flammable or moderately toxic or more than 100 pounds of refrigerant that is nonflammable or nontoxic.

A pressure relief device shall bear a clear and permanent stamping indicating its relieving capacity. Pressure vessels that can be isolated from the rest of the system shall be protected with adequate relief devices.

Signs—Refrigerating systems shall be provided with attached signs of durable material and accessible for inspection. Such signs shall state the name of the manufacturer, the kind of refrigerant used, the total number of pounds of refrigerant required for normal operation, and the test pressure. In the case of field-erected systems, the name of the installer shall be indicated.

Systems containing more than 100 pounds of refrigerant shall have signs of metal with letters at least ½-inch high located at, and identifying the following controls: the main shutoff valve to each vessel, the main controls, the remote controls, and the pressure limiting devices. Such systems shall have refrigerant piping outside the machinery room identified with the name of the refrigerant and letters HP or LP.

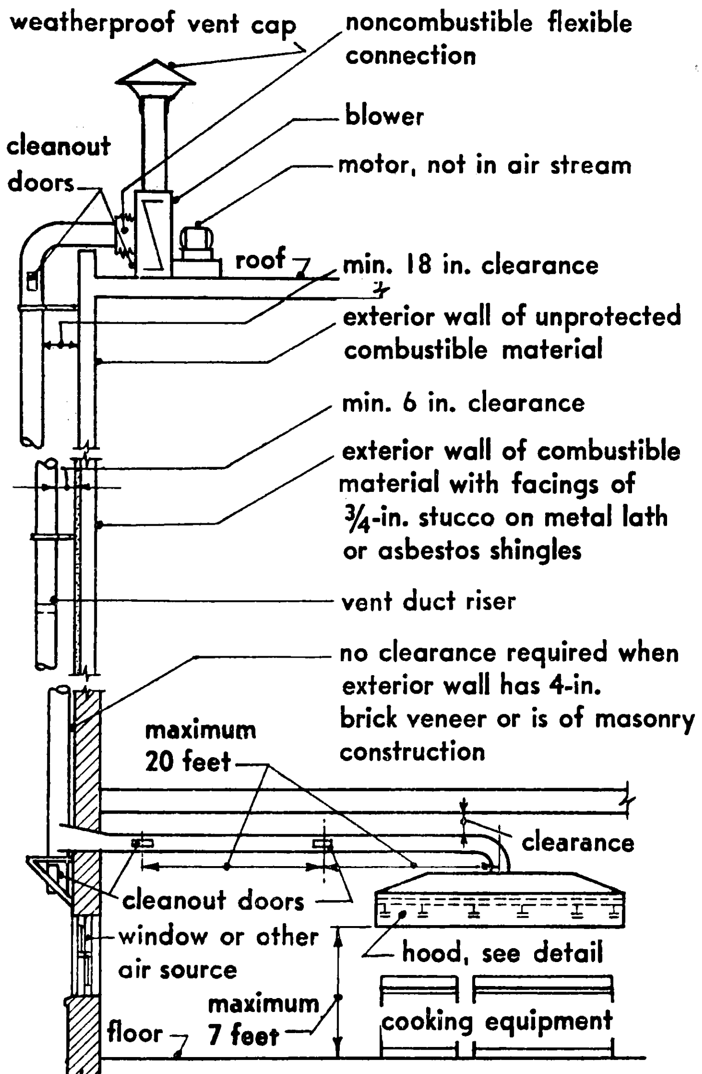
Mechanical Ventilation

General Requirements—Ventilating systems designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

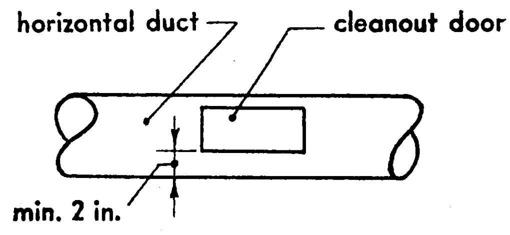
When exhaust ducts are installed without fire dampers or automatic fire protection equipment, the outlets of such ducts shall be located so that they will not be a potential fire hazard to combustible material or unprotected structural supports.

Wind-Operated Devices—Roof ventilators may be of the stationary or revolving type. Such ventilators of other than the power-driven type should be designed and installed to provide re-

Ventilating Equipment for Kitchens Serving Public Dining Rooms

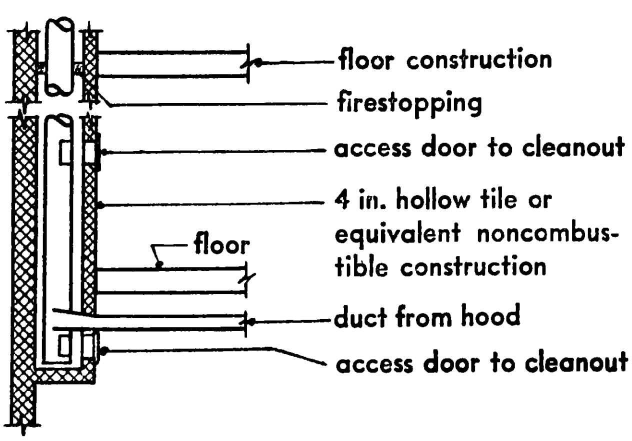


EXTERIOR EXHAUST DUCT

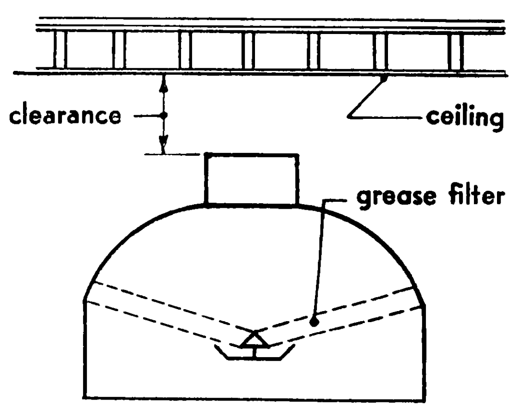


DETAIL
CLEANOUT DOOR

Ducts—Minimum 18 U.S.S. gage steel or 20 U.S.S. gage stainless steel. Ducts shall be adequately supported at base and braced to wall at distances not exceeding 10 feet on centers. Joints shall be lapped against direction of flow to prevent leakage of hot grease. Cleanout doors shall be accessible for maintenance.



INTERIOR EXHAUST DUCT



DETAIL
SECTION THROUGH HOOD

quired ventilation when the temperature difference between inner and outer air is 10° F. and there is no wind, and when the temperature difference between inner and outer air is 0° F. and the wind is at a velocity of 4 miles per hour.

Kitchens Serving Restaurants and Public Dining Rooms—Kitchens serving restaurants or public dining rooms shall be provided with ventilating and fire extinguishing equipment for ranges, broilers, frying units, and other equipment producing grease-laden vapors. Such equipment designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Fire extinguishing equipment shall be provided as follows:

a—A water spray nozzle and first-aid hose connected either to a wet standpipe, or a 2½-inch or larger fixed wet sprinkler pipe; or portable or fixed-pipe equipment providing at least 10 pounds of carbon dioxide or dry chemical or 5 gallons of foam.

b—Kitchens not within the same enclosure as the dining area shall be provided with fixed-pipe fire extinguishing systems having approved controls which will effect the release of the extinguishing agent, the closure of the dampers, and the shutdown of the exhaust fan. The discharge outlets for the extinguishing agent shall be located to cover the entire hood area with an outlet at each deep fat frying unit.

The extinguishing agent shall be water, steam, or a chemical which is inert, nontoxic, nonirritant, continuously available, and under sufficient pressure to extinguish fires effectively in the equipment.

Fire Alarm Systems

General Requirements—Fire alarm equipment designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Fire alarm systems shall be actuated manually and shall be used to give indication of fire, air raid, or other emergency endangering life.

Circuit trouble should be indicated by an audible signal from a bell or other device actuated by the interruption of a supervisory current caused by failure of the main source of electrical energy, an open circuit, or a grounded circuit. The supervisory current should be supplied from the main source. Current to operate the trouble signal should be supplied from the auxiliary source, except that where a single source of power is permitted, the trouble signal shall be operated from a side or phase of the power supply separate from that operating the signaling system. If a silencing switch is used in the trouble signal circuit, such switch shall automatically transfer the trouble signal to a lamp at the control unit.

Where a building is divided into fire areas by a fire wall each such area shall be provided with manual fire alarm boxes and sounding devices and the system may be arranged to operate independently on each side of fire wall.

Presignal systems should be arranged so that the manual operation of any fire alarm box will actuate the sounding devices in the telephone switchboard room, engine room, fire brigade stations and at other central locations on the premises where there is an authorized person or trained fire brigade on duty at all times to receive the alarm and take proper action. The manual operation of any box in a special manner by a key or plug, available to the authorized person, shall actuate all the sounding devices throughout the building.

Fire alarm equipment should be located and mounted so as not to be subject to excessive vibration or jarring which might cause uncalled for operation.

At each coded fire alarm box there should be posted a card on which the code legend for the entire premises is clearly printed.

Manual Fire Alarm Boxes—Box enclosures should be of metal, and when exposed to moisture, should be made weatherproof. Boxes should be designed so that once started, the proper transmission of the signal cannot be interfered with by manipulation of the starting device. Not more than twenty boxes should be connected on any single circuit.

Pull-lever type boxes should be provided with a door to protect the pull lever. The door should be constructed so as to open readily and the wording, IN CASE OF FIRE OPEN DOOR AND PULL DOWN LEVER or equivalent instructions should appear on the door in raised letters at least ⅜ inch in height.

Break-glass type boxes should be provided with a hinged lever or other suitable means to break the glass and the wording, IN CASE OF FIRE BREAK GLASS or equivalent instructions should appear on the front in raised letters at least ⅜ inch in height. The breaking of the glass should set the system into automatic operation. The replacement of the glass should reset the mechanism for the next alarm.

Each coded box should be arranged to send signals distinguishable from the signals of other boxes to indicate the floor or portion of the floor from which the signal is sent. The action of coded boxes should be so timed that the sounding devices will give the code signal clearly. The code signal should be repeated at least four times whenever the lever is pulled down to its stop position.

Sounding Devices—Sounding devices may consist of bells, gongs, whistles, or horns but should be of only one type within a building. If located where they are subject to mechanical damage, they should be installed in a protecting enclosure of wire mesh or perforated metal. Not more than fourteen sounding devices should be connected on any single direct current circuit and not more than ten sounding devices should be connected on any single alternating current circuit.

Electrical Requirements—One source of electrical energy is permitted for the fire alarm system where electrical distribution is underground through a network system and the service record for the locality is satisfactory. The following types of electric service are acceptable: three-wire DC; three-wire single-phase AC; two- or three-phase AC. The neutral conductor shall be continuous, grounded, and unfused. The connection for the fire alarm system should be made on the street side of the main service switch.

Where two sources of supply are required the main source should be the building electric service. Connection should be made as close as practicable to the main service entrance.

The auxiliary source should be available for immediate use at all times and may be an electric generator driven by some form of prime mover, a set of storage battery units continually charged, or a sufficient number of heavy duty primary batteries of suitable types and of adequate capacity.

Where a system of emergency lighting is provided, the emergency lighting supply may be used to supply the fire alarm system, except that when storage batteries are used as the auxiliary source a separate auxiliary source should be provided for the fire alarm system.

An automatically operated transfer switch should be provided to transfer the fire alarm load from the main source to the auxiliary source whenever the voltage of the main source falls below 75 per cent of rated system voltage.

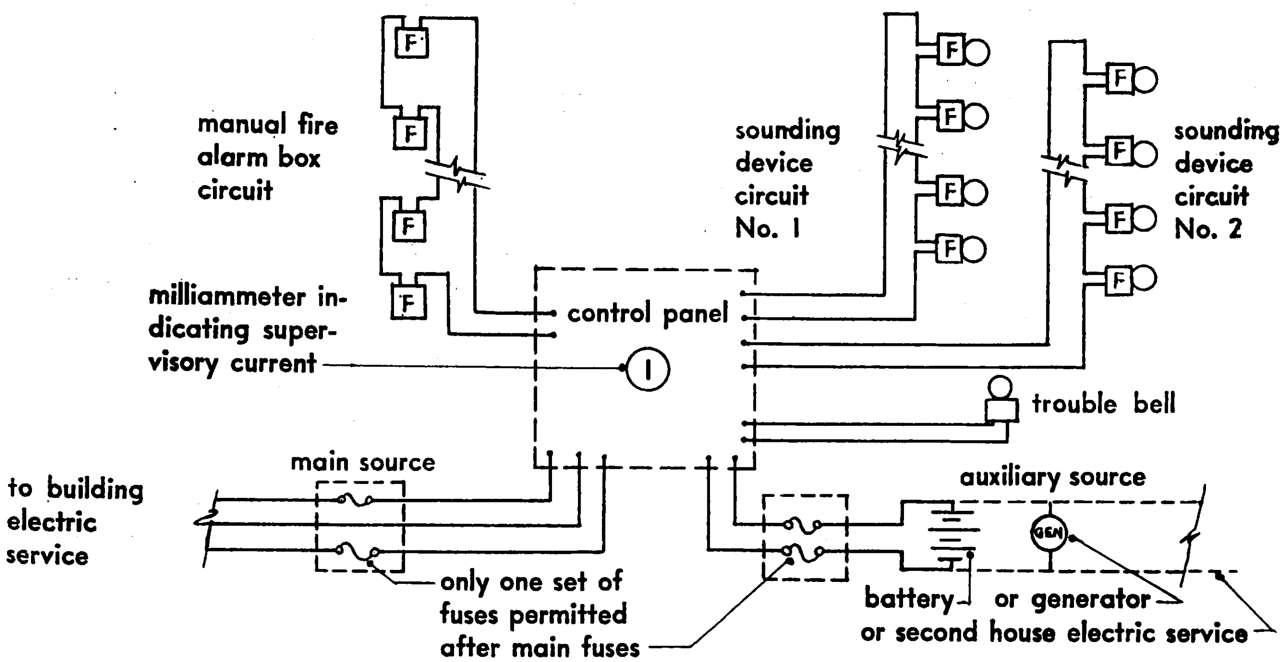
After the main fuses or circuit breaker, only one set of protective devices should be permitted in the fire alarm supply circuit.

Circuit wiring for fire alarm systems should have a rating of not less than 300 volts, except that on systems designed for operation at 50 volts or less, wiring having a rating of not less than 150 volts may be used for circuits where the input is limited to 100 volt-amperes with current not exceeding 5 amperes.

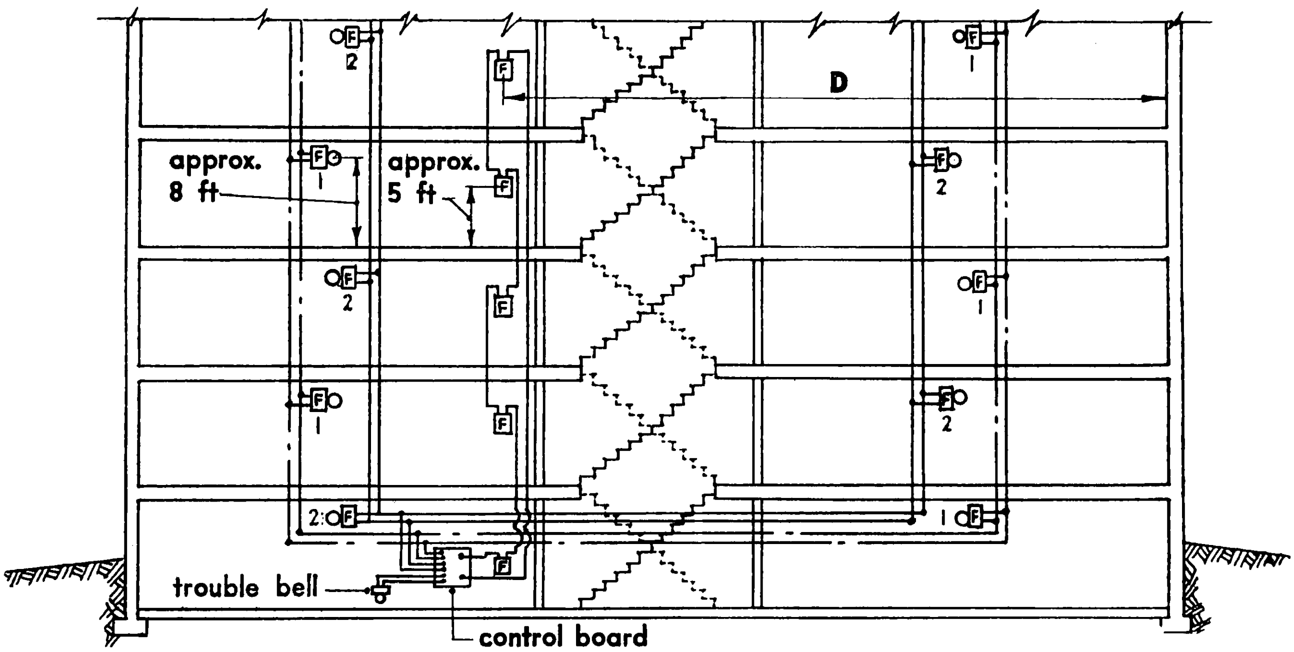
Raceway or armor used for protection of wiring should be rigid or flexible conduit, electrical metallic tubing, surface metal or underfloor raceway, or armored cable, and should be properly grounded. The fire alarm system raceway or armor shall be considered to be properly grounded if connected with approved fittings to the grounded raceway or armor of the building lighting system.

Fire alarm conductors should not be installed in the same raceway, box, or fitting with conductors for light, power or other signaling systems. Fire alarm circuits may be used to transmit alarm and supervisory signals to a central station provided such signals do not prevent an alarm from being sounded on the premises whenever a fire alarm box is operated for such purpose.

Fire Alarm Systems



CLOSED CIRCUIT, ELECTRICALLY SUPERVISED FIRE ALARM SYSTEM SUPPLIED FROM MAIN AND AUXILIARY SOURCE



LEGEND

F○ vibrating-type bell, number denotes circuit

F fire alarm box

D see B 508-2.2d

NONSUPERVISED VIBRATING-TYPE BELL CIRCUITS

Fire-Detecting Systems

General Requirements—Fire-detecting equipment designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Fire-detecting systems should be actuated automatically to give early indication of fire or rapid or excessive rise of temperature. Fire-detecting systems, including the signaling apparatus, should be connected and operated on closed electrically supervised circuits. Individual thermostats and pneumatic tubing need not be so supervised, but circuits controlled by such devices should be so supervised.

Where a coded system is required, the system should be arranged to indicate the floor or section of a floor from which the signal is transmitted. Such indication may be by means of coded signal transmitted to the sounding devices, or an annunciator in a central location where an authorized person is on duty at all times to receive the alarm and take proper action.

Fire-Detecting Devices

Fire-detecting devices may consist of thermostats, pneumatic tubing, or fire-detecting wire with thermo-responsive insulation. They should be provided throughout the building to be protected, including but not limited to rooms, exits, cellars, basements, elevator and dumbwaiter hoistways, chutes under stairs, and inside closets and alcoves.

Fire-detecting devices should be arranged to transmit an alarm signal to the sounding devices when one of the following conditions prevails: when a predetermined temperature is exceeded; or when a predetermined rate of temperature rise is exceeded.

Fire-detecting devices of fixed-temperature type shall be classified in accordance with the following table:

CLASSIFICATION OF FIRE-DETECTING DEVICES OF FIXED-TEMPERATURE TYPE

Maximum ceiling temperature in degrees F.	Operating temperature in degrees F.	Rating
To 100	165	Ordinary
101 to 150	212	Intermediate
151 to 225	286	Hard
226 to 300	360	Extra hard

Fire-detecting devices of the rate-of-rise type should operate whenever the rate of rise of temperature exceeds 20 degrees F. per minute. Not more than 65 thermostats should be connected on any single circuit.

Fire-detecting wire should be arranged so that in no case shall any point on the ceiling be more than 7½ feet from the nearest portion of the wire.

Pneumatic tubing should be arranged so that in no case shall any point on the ceiling be more than 15 feet from the nearest portion of the tubing; nor should any enclosed space or separate room contain less than 25 feet of exposed tubing or less than 5 per cent of the length of the circuit.

A single circuit of fire-detecting wire or pneumatic tubing should not exceed 1000 feet in length.

Miscellaneous Requirements—The construction and installation of sounding devices, circuit trouble signal device, and electrical equipment and wiring shall be in conformity with the applicable provisions indicated in the subjects entitled, "General Requirements," and "Sounding Devices," under the title, "Fire Alarm Systems," beginning in part 5, page 73.

Sprinkler Systems

General Requirements—Sprinkler systems designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Sprinkler systems in multiple dwellings should be in conformity with the rules for installation of sprinkler systems in light-hazard occupancies, except that in attics, basements, kitchens, laundry rooms, storage areas, and workrooms the spacing of sprinklers should be in conformity with ordinary hazard occupancies.

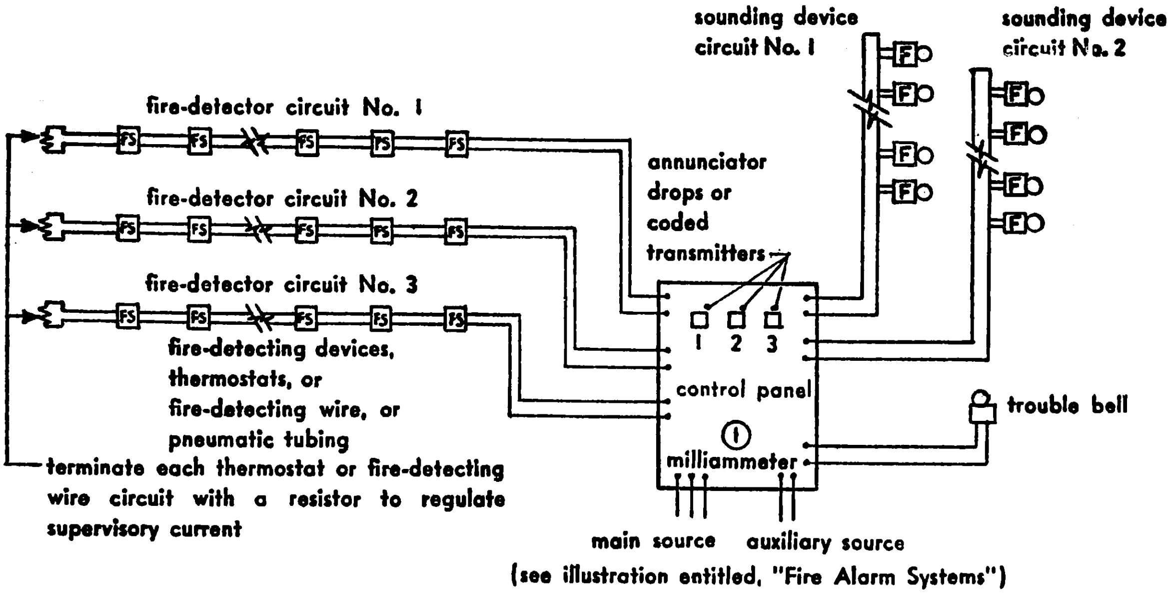
Standpipe Systems

Standpipe systems designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

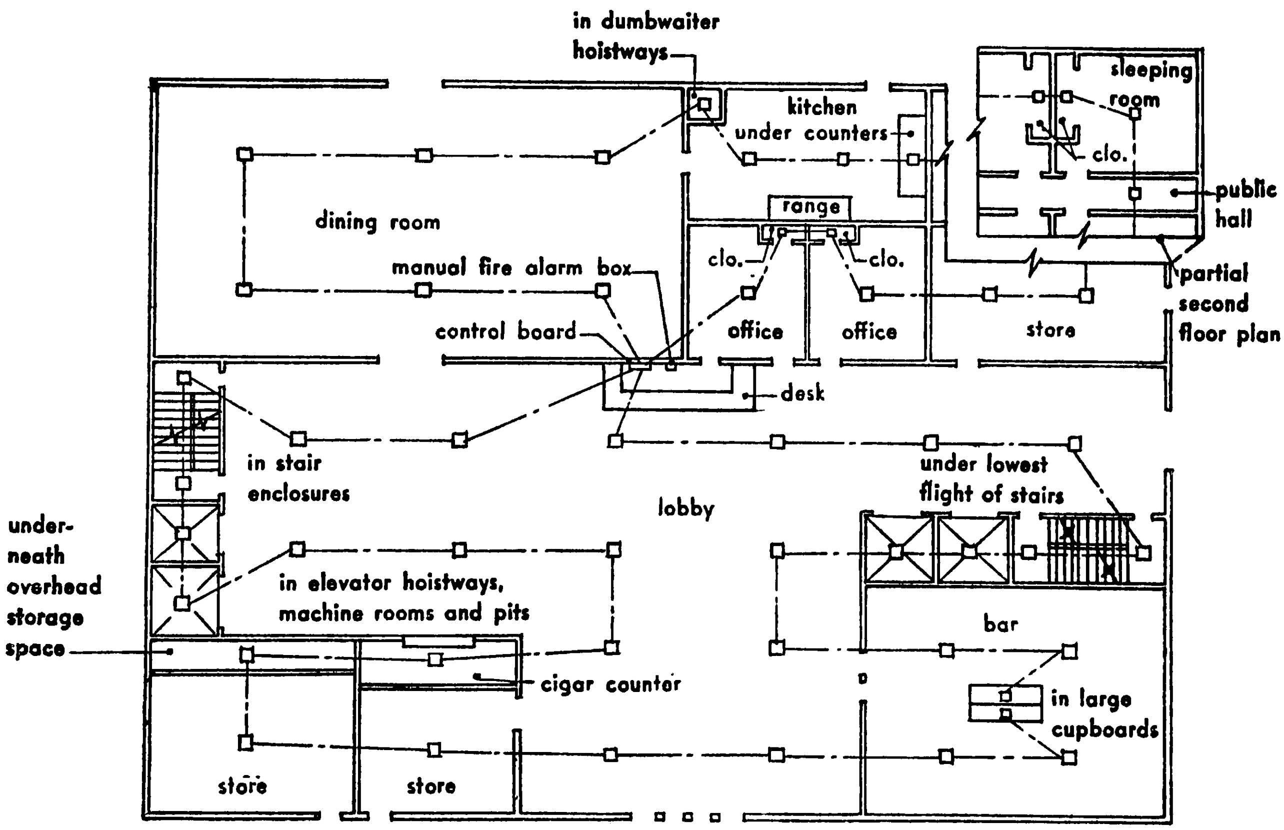
Watchman's Systems

Watchman's systems designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Fire-Detecting Systems



CODE, CLOSED CIRCUIT, ELECTRICALLY SUPERVISED FIRE-DETECTING SYSTEM



ARRANGEMENT OF FIRE-DETECTING DEVICES

Elevators, Dumbwaiters and Escalators

General Requirements—Elevators, dumbwaiters and escalators designed and installed in conformity with generally accepted standards shall be deemed to meet the requirements of the Code.

Elevators and Dumbwaiters—Elevator hoistways extending to the ground should have noncombustible pit floors designed so as to prevent the entrance of ground water. Hoistways not extending to the ground should have noncombustible pit floors having a fire-resistance rating at least equal to that required for the hoistway enclosure.

The pit floor should be approximately level and should not contain a drain connected directly to a sewer. An indirect connection or a sump may be installed in the pit.

Access to pits may be by means of the lowest hoistway door or a separate self-closing access door equipped with a spring lock arranged to be opened from the inside.

Permanent electric lighting equipment, light disconnect switch, and at least one receptacle outlet, should be provided in elevator pits and in machine rooms. The light disconnect switch should be located so as to be accessible from the access door. The receptacle outlet should be provided with means for grounding portable equipment.

Electrical wiring in hoistways should be installed in rigid conduit, electrical metallic tubing or metal wireways, except that flexible conduit or armored cable may be used for connections between risers and limit switches, interlocks, signal or stop buttons, and similar devices.

Pipes, ducts or wiring not used in connection with the operation of the elevator or dumbwaiter should not be installed in the hoistway, except that branch pipes conveying low pressure steam or hot water to radiators used only to heat the hoistway, and branch sprinkler pipes each supplying sprinkler heads at not more than one floor level, are permitted in the hoistway. Heating risers, sprinkler supply risers, and electric feeders supplying power to the elevator machine should be located outside the hoistway. Shutoff valves for hoistway heating and for sprinkler equipment should be in a readily accessible location outside the hoistway.

Counterweights should be located only in the hoistway of the elevator which they serve.

Elevator machine rooms located at the top of the hoistway may contain machinery and equipment such as air conditioning or ventilation equipment essential to the operation of the building. The elevator machinery and equipment should be separated from the other machinery and equipment by a substantial wire-mesh enclosure at least 6 feet high provided with a self-closing and self-locking door. Where the machine room is located elsewhere than at the top of the hoistway only machinery and equipment necessary for the operation of the elevator should be permitted therein.

The following equipment in the machine room should be provided with guards conforming to the requirements of ASA, *Safety Code for Mechanical Power Transmission Apparatus*: exposed gears, sprockets, tape or rope sheaves or drums of selectors, floor controllers or signal machines, and the ropes, chains, or tapes for driving same. Hoist ropes extending beyond the line of the machine bed should be guarded above the level of the machine room floor.

Escalators—The angle of inclination should not exceed 30 degrees from the horizontal. Step treads should be horizontal. The depth of the step tread in the direction of travel should be not less than 15¾ inches and the rise between treads should not exceed 8½ inches. The width of a step tread perpendicular to the direction of travel should be not less than 16 inches. The surface of the step tread should be slotted in the direction of travel.

At the top and bottom landings of each escalator there should be a combplate to mesh with and set into the slots in the step tread surface. The combplate should be designed so that the points of the teeth are always below the upper surface of the step treads in mesh.

At a point 27 inches above the nose line of the step treads the width between balustrades should not be less than 22 inches nor more than 48 inches and should not exceed the width of the steps by more than 13 inches.

Glass panels may be used in balustrades provided the glass is of the tempered type not less than ¼ inch in thickness.

A guard shall be provided in the intersection formed by the top of the balustrade and the ceiling when the horizontal distance between such intersection and the center line of the handrail is 24 inches or less. The guard shall extend not less than 14 inches horizontally from the apex of the angle and the exposed edge shall be rounded with a radius of at least ¼ inch.

The speed of the escalator measured along the angle of inclination should be not more than 125 feet per minute, except that if the line of entrance and exit is not in the vertical plane of travel, the speed should be not more than 100 feet per minute.

Controls for Elevators and Dumbwaiters— Hoistway doors should be provided with hoistway-door interlocks to prevent the operation of the elevator machine by the operating device unless the door at the landing at which the car is at rest is locked in the closed position or unless all hoistway doors are locked in the closed position.

Car doors or gates of elevators should be provided with car-door or gate electric contacts to prevent the operation of the elevator machine by the operating device unless the car door or gate is in the closed position.

Elevator cars suspended by cables, except sidewalk elevators whose travel does not exceed 15 feet, should be provided with a car safety which will stop and hold the car and its contract load in case of overspeed, or in case the hoisting cables break.

Elevators and power dumbwaiters should be provided with upper and lower terminal stopping devices arranged to stop the car at the terminals independent of the operating device.

Elevators should be provided with an emergency stop switch located in the car. For self-service elevators the operation of the emergency stop switch should also cause an alarm bell to ring. Alarm bell should be located outside the hoistway.

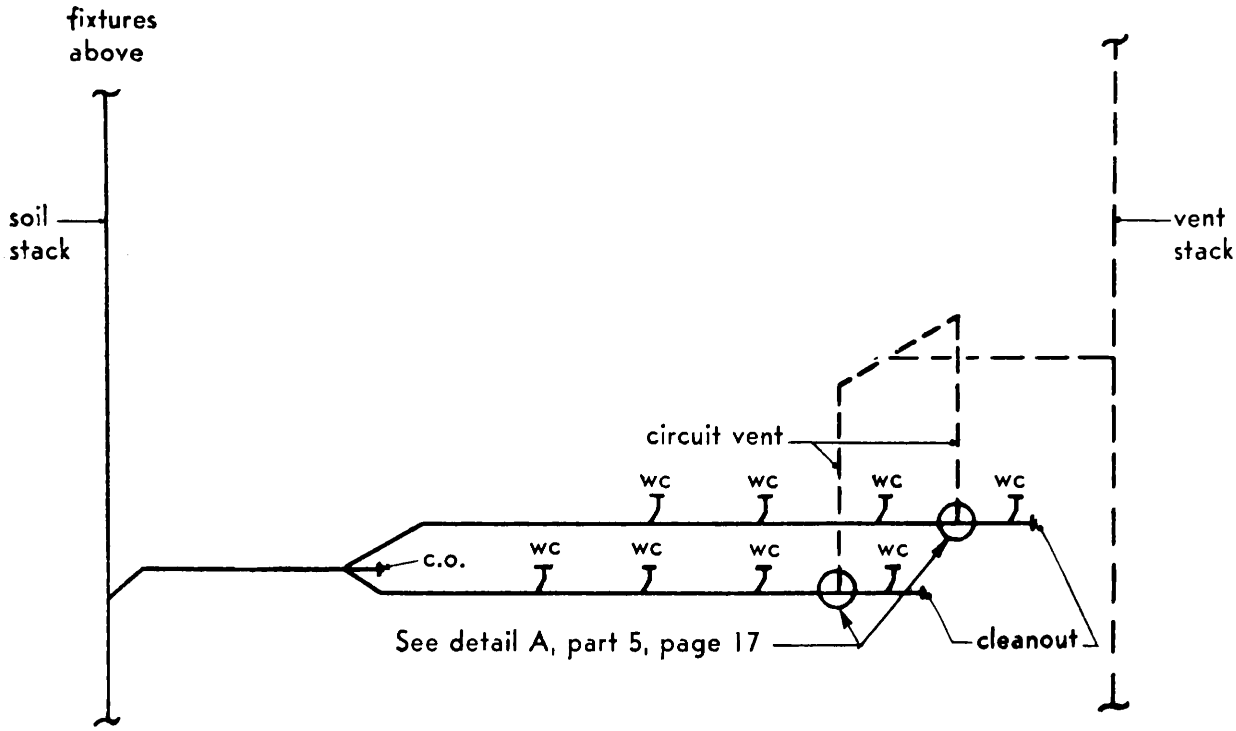
Controls for Escalators—Starting switches for escalators should be located within sight of the escalator steps and should be of the key type to prevent operation by unauthorized persons.

Escalators should be provided with emergency stop switches conspicuously and accessibly located near the top and bottom landings. The operation of either of these switches should interrupt the power to the driving machine and cause the application of the brake. The switch should be marked for identification with the wording, ESCALATOR STOP SWITCH.

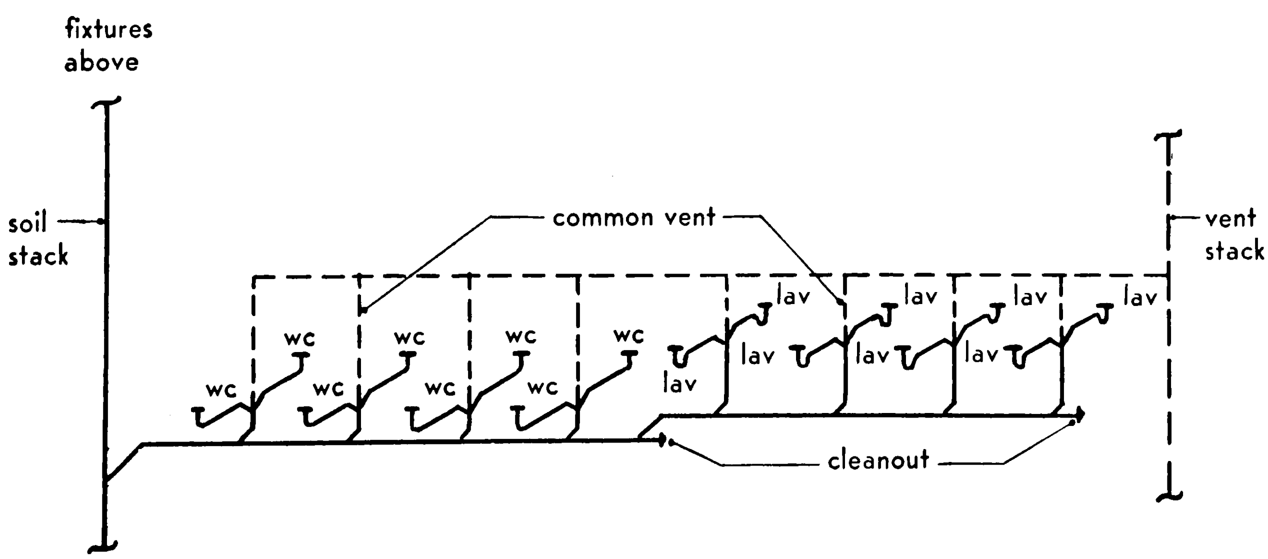
Escalators should be provided with a device to interrupt the power to the driving machine whenever a step chain breaks or develops excessive sag. Where the driving machine is connected to the main drive shaft by a chain, a device should be provided which will cause the application of the brake on the main drive shaft if the drive chain breaks.

Escalators should be provided with a speed governor to interrupt the power to the driving machine and cause the application of the brake whenever the speed exceeds a predetermined value which should not be more than 140 per cent of the rated speed of the escalator.

Venting for Batteries of Fixtures

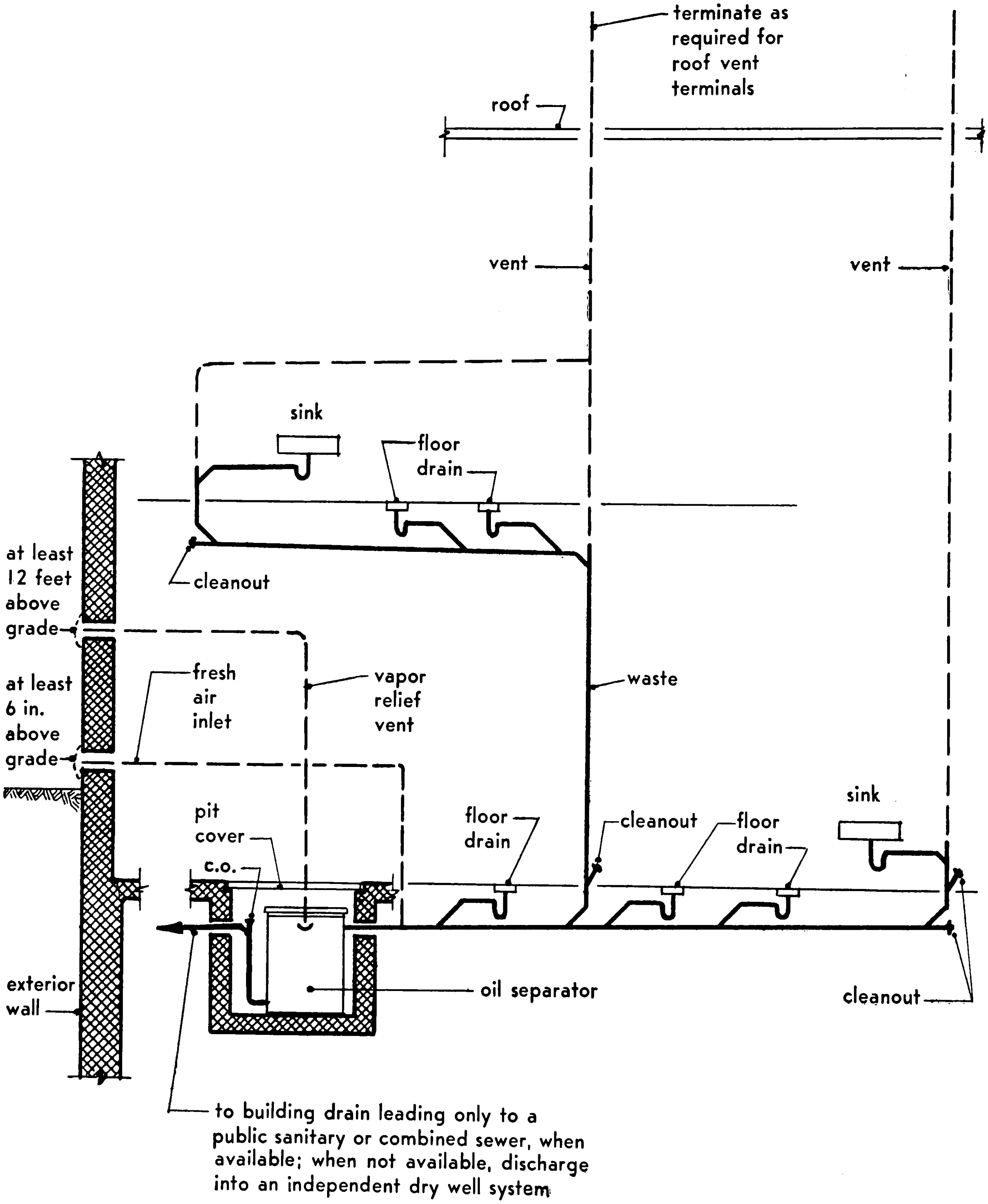


CIRCUIT VENTING OF PARALLEL BRANCH DRAINS



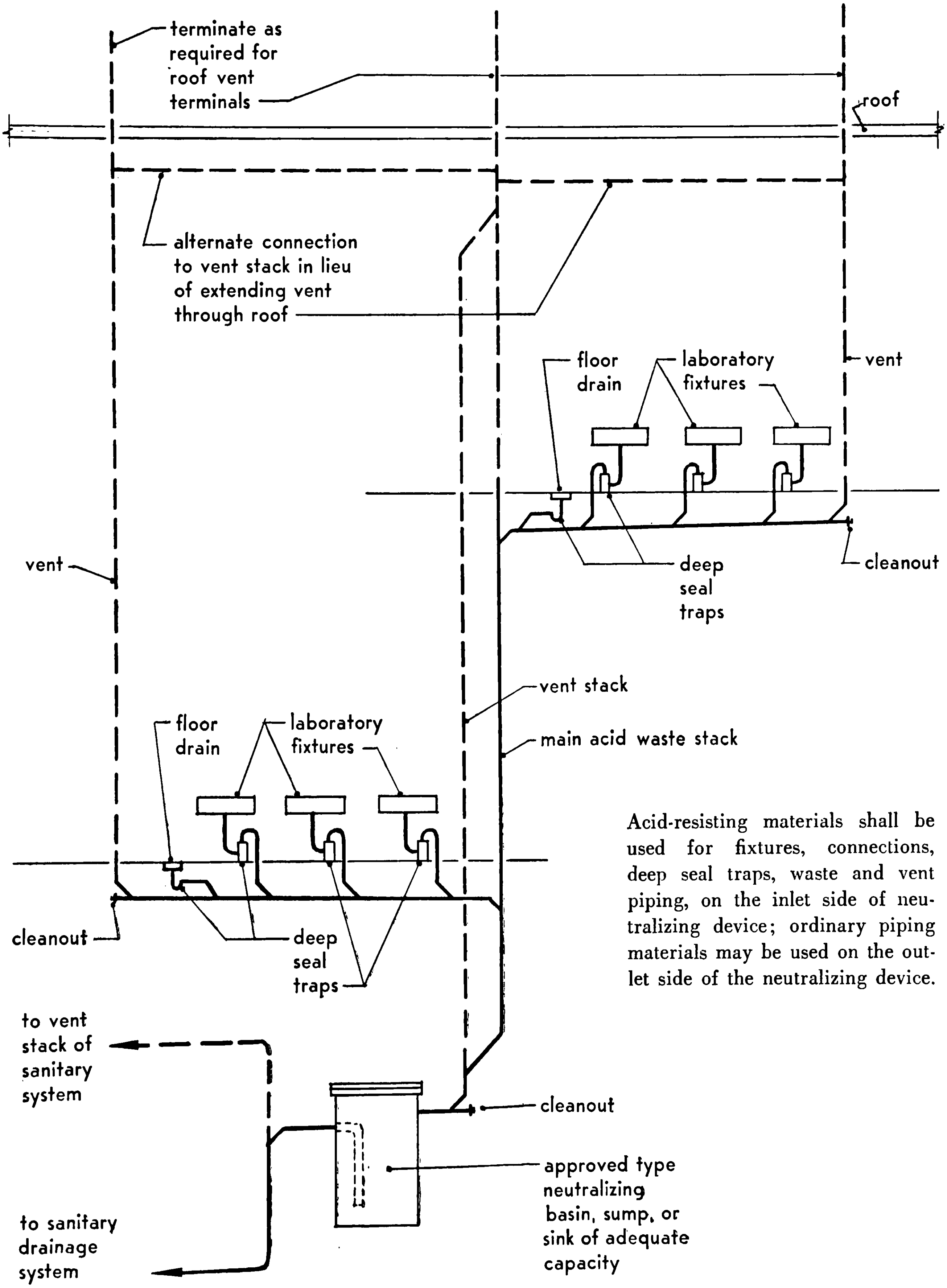
COMMON VENTING FOR BACK-TO-BACK ARRANGEMENT

Combination Waste and Vent Arrangement for Volatile, Flammable Oil Waste Drainage



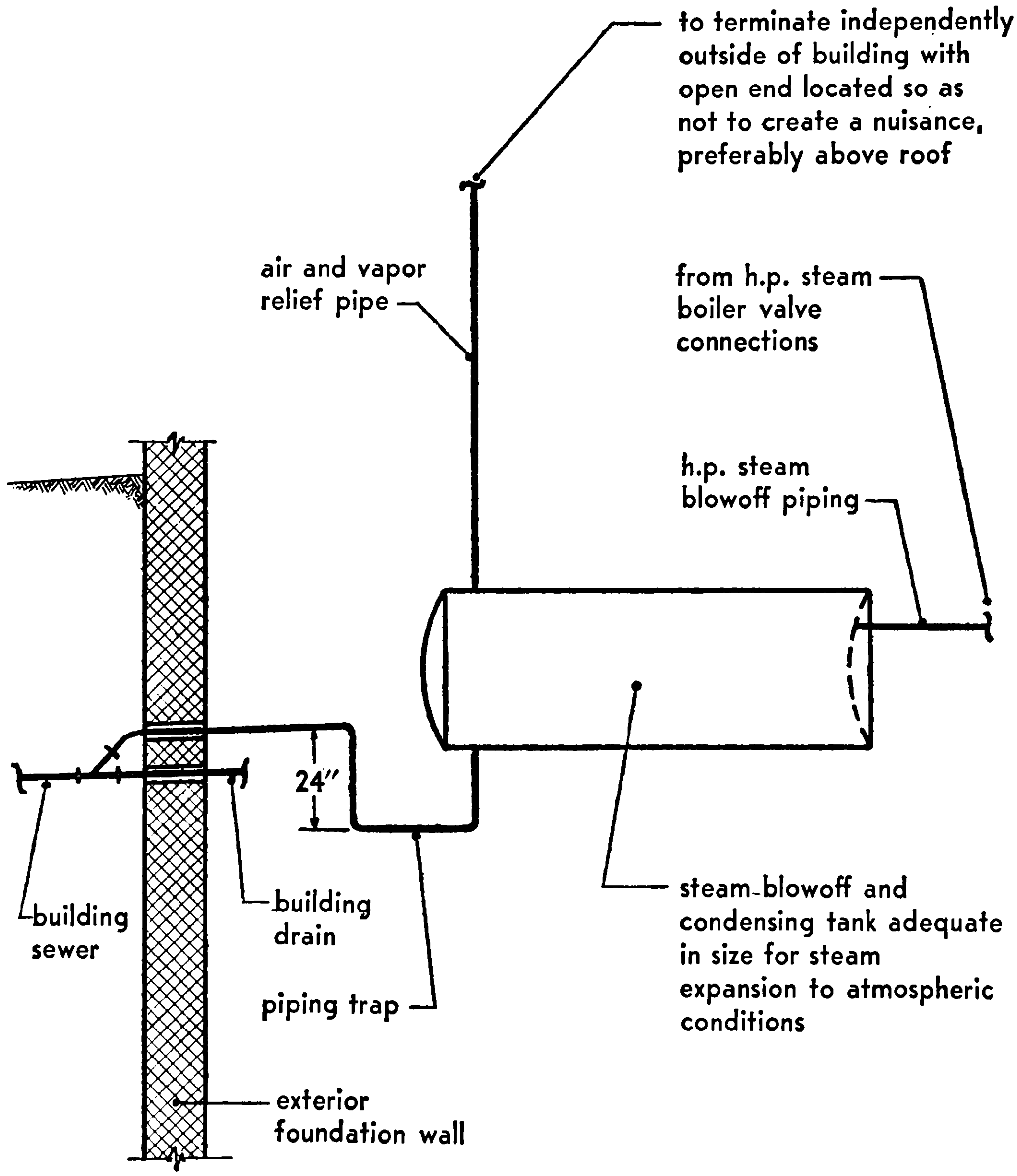
Acid Waste System With Neutralizing Unit

(May be used only where adequate maintenance is assured)



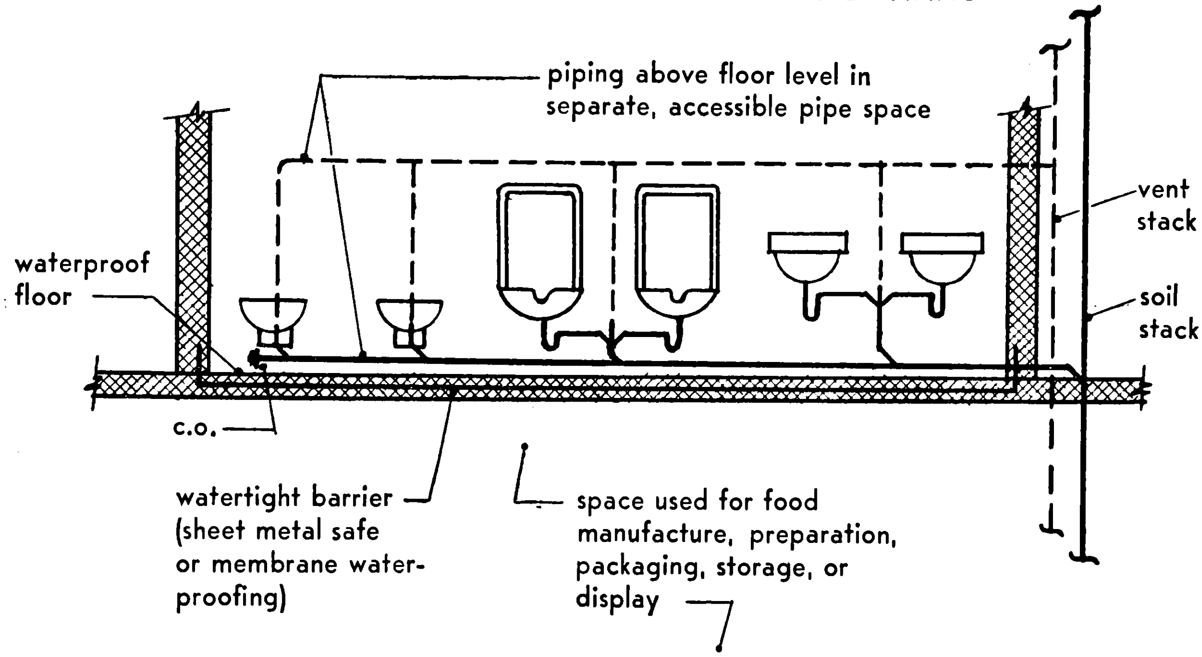
Acid-resisting materials shall be used for fixtures, connections, deep seal traps, waste and vent piping, on the inlet side of neutralizing device; ordinary piping materials may be used on the outlet side of the neutralizing device.

High Pressure Steam Blowoff Tank Connection to Drainage System

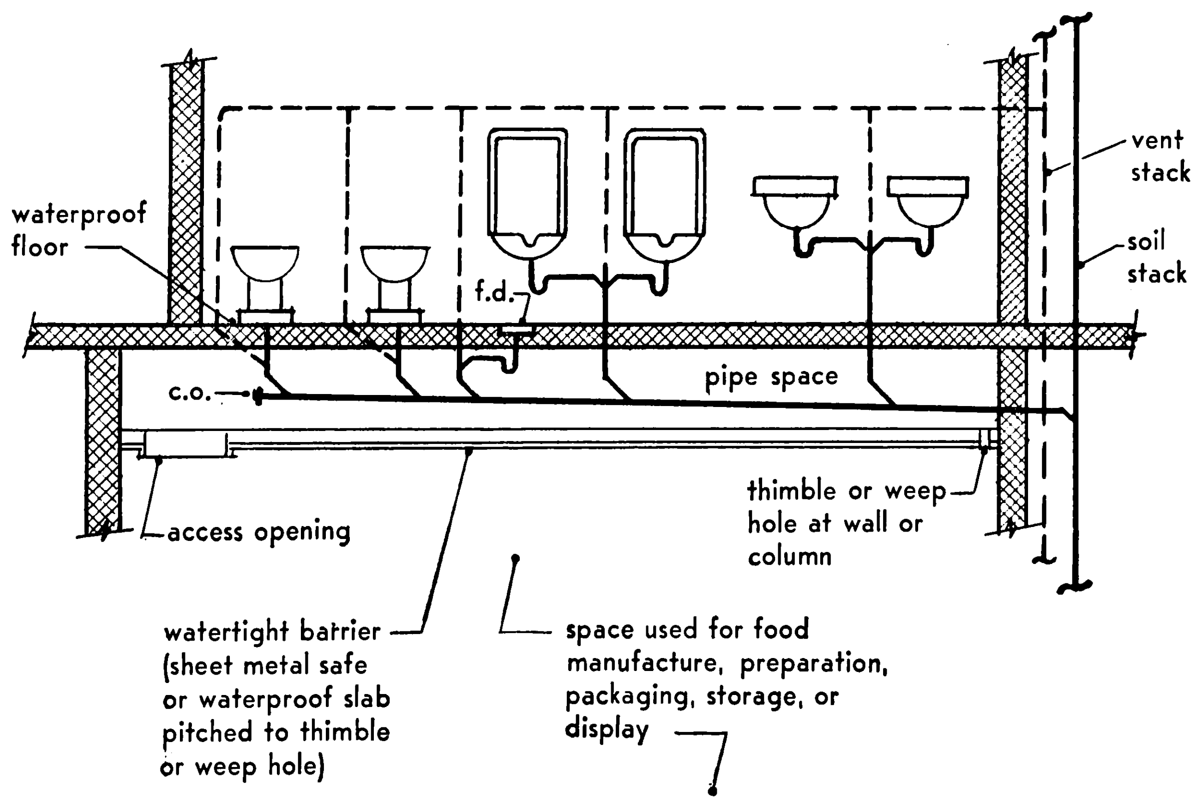


Watertight Floor or Intervening Watertight Barrier

WHERE WATERPROOF FLOORS OF TOILET ROOMS OR BATHROOMS ARE UNPIERCED BY FIXTURE CONNECTIONS OR PIPING

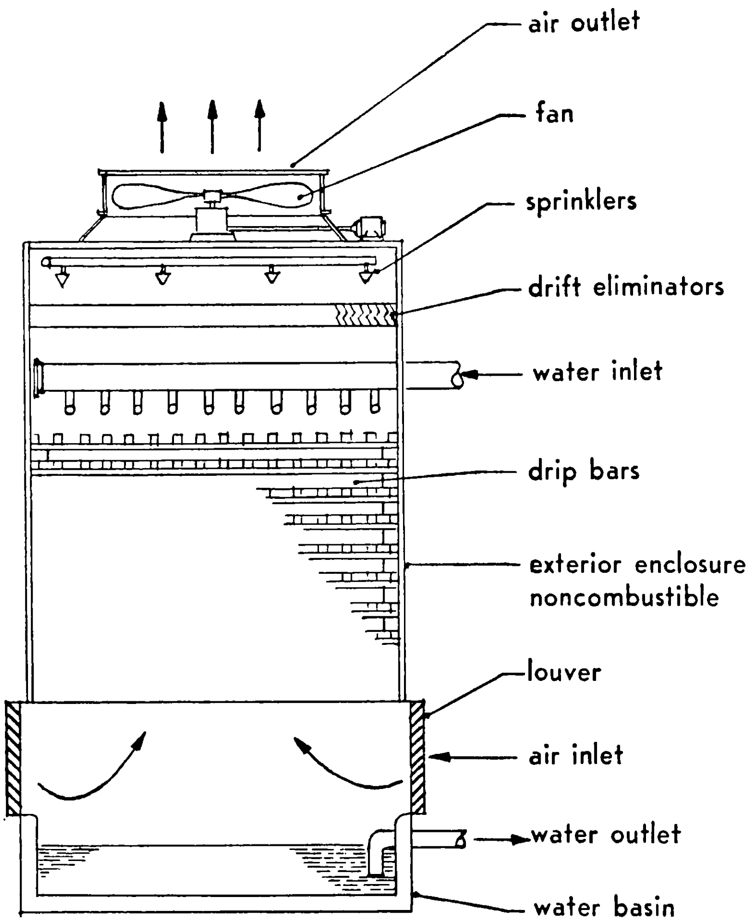


WHERE WATERPROOF FLOORS OF TOILET ROOMS OR BATHROOMS ARE PIERCED BY FIXTURE CONNECTIONS OR PIPING



Wood Cooling Towers

(For Buildings of Group C 1, C 2, C 3 and C 4 Occupancies)



WOOD COOLING TOWER,
INDUCED DRAFT TYPE

Sprinklers should be located at the highest level and should provide sufficient water to protect combustible material when cooling tower is not operating.

Cooling towers that operate intermittently should have means to start the flow of cooling water quickly to provide additional fire protection. A manually operated switch and an interlock should be provided to stop the fan motor in the event of sprinkler operation.

Where cooling towers are located near high hazard occupancies, sprinklers should be provided to protect the tower exterior.

Cooling towers should be separated: (a) by 100 feet from outlets of chimneys serving incinerators and similar fuel-burning equipment that may emit sparks; (b) by 50 feet from large buildings other than those supporting the cooling towers, chimneys serving other fuel-burning equipment, other wood cooling towers, and other combustible construction.

Access should be provided to the base and top of the tower. Fixed openings in the tower enclosure should be protected with corrosion-resistive screening.

Hydrants should be located within 40 feet of the base. Cooling towers exceeding 50 feet in height should have standpipe systems extending to the top. Cooling towers used for processes other than refrigeration or air conditioning should also conform to the foregoing requirements.

Ventilating Ducts Passing through Fire Separation

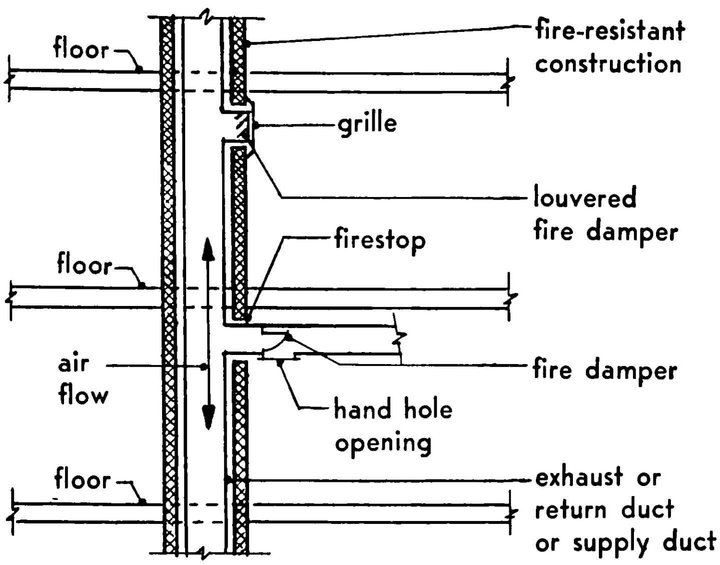


FIGURE A

Shaft should have smoke vent at top in accordance with section C 402-4.6k. Smoke vents are not required, however, for shafts containing a single duct and having a gross area not exceeding 4 square feet.

Ducts passing through floor should be enclosed with fire-resistive construction as required in section C 202-2, for partitions enclosing shafts, except that enclosure may be omitted where ducts extend through not more than one floor and fire dampers are provided to prevent the spread of fire between stories (see Figure C).

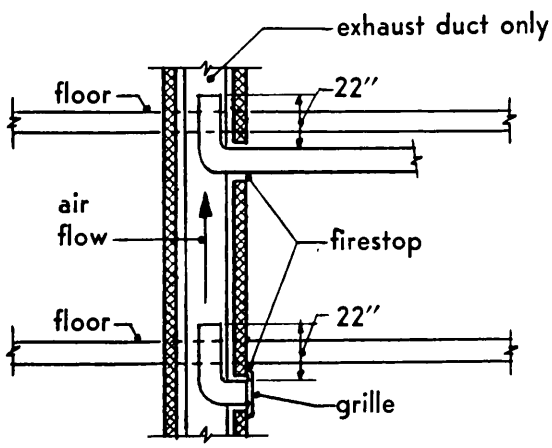


FIGURE B

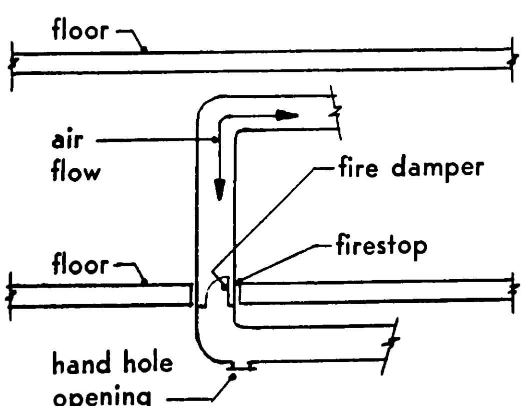
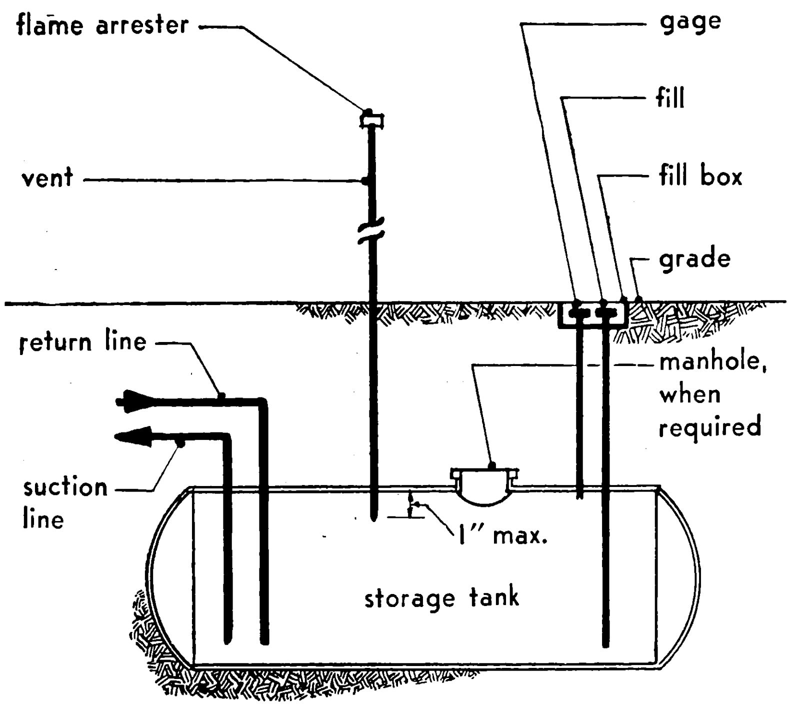


FIGURE C

Storage Tanks for Flammable Liquids—1



Tanks should be coated with corrosion-resistive material. Backfill should be clean earth, free from deleterious matter.

Vent terminals should not be enclosed or restricted by construction and should be arranged to prevent closure due to freezing.

Vent terminals should be at a distance of not less than 5 feet from building openings or below eaves, except that the distance may be reduced to not less than 2 feet where the flammable liquid has a flash point of more than 70° F. and cannot be heated to the flash point.

Vent terminals should be located so that they are not subject to physical damage. Vent pipes from tanks storing the same class of flammable liquid may be connected into one outlet pipe of a size based on the aggregate capacity of the tanks. The connection between vent lines should be at an elevation above the level of the fill pipe openings.

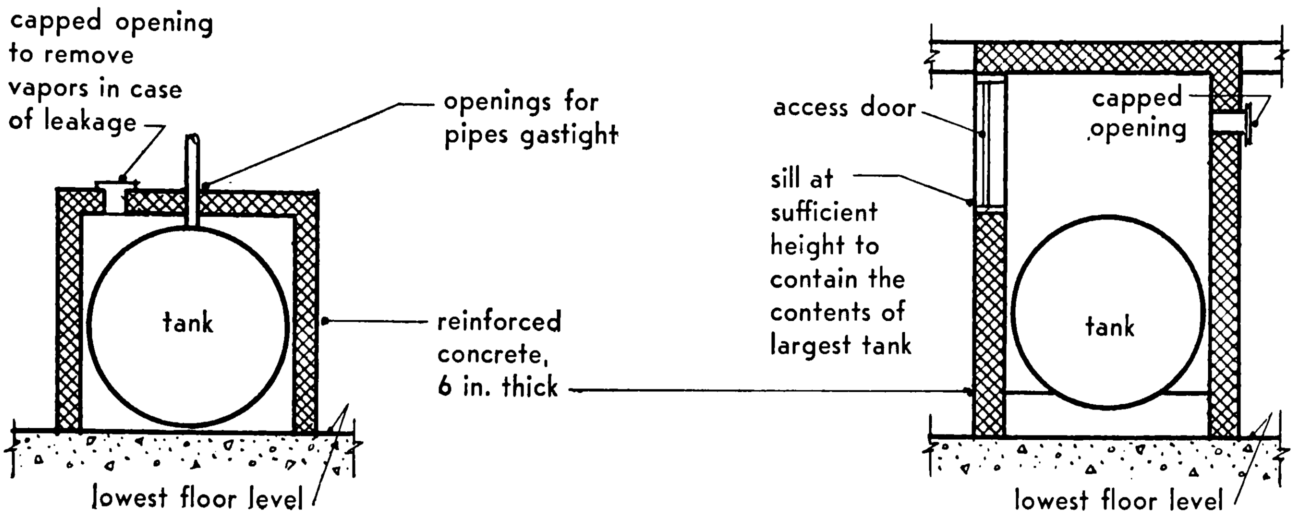
A flame arrester or a pressure and vacuum vent valve should be provided where the flammable liquid has a flash point of 70° F. or less. A flame arrester, when used, should be located in the vent line at the terminal or within a distance of 15 feet of the terminal.

A separate gage line may be omitted if the fill line is located directly above the tank.

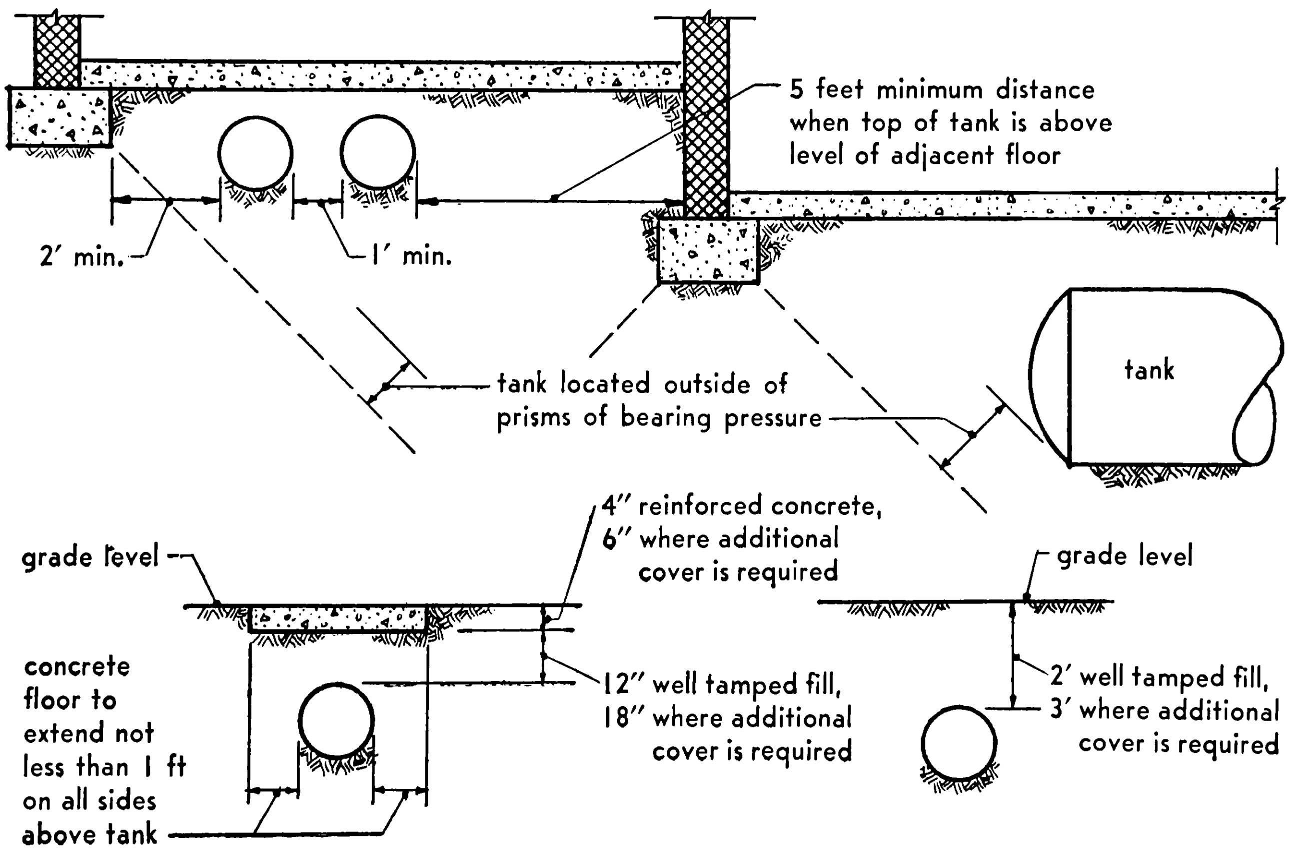
VENT PIPE SIZES

Tank capacity in gallons	Vent pipe size in inches	
	Buried tanks	Above-ground tanks
Up to 500	1¼	1¼
501-1,000	1¼	1½
1,001-3,000	1½	2
3,001-6,000	1½	2½
6,001-12,000	2	3
12,001-30,000	3	4

Storage Tanks for Flammable Liquids—2



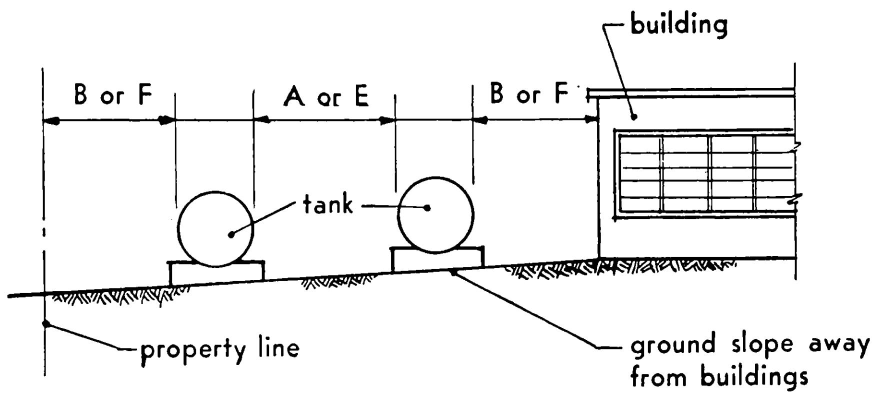
TANKS ABOVE GROUND



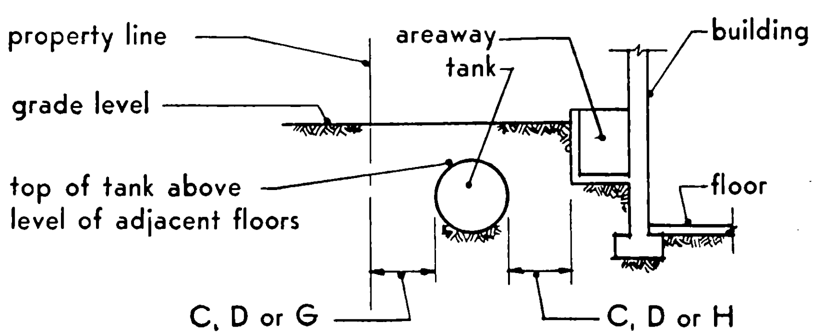
TANKS BELOW GROUND

Additional Cover for Underground Tanks—This should be provided where any of these conditions prevail: where tank is subject to vehicular traffic; where flammable liquid has a flash point of 70° F. or less; where bulk of flammable liquid can be heated to the flash point; where tank is located close to combustible material or to other tanks containing flammable liquid having a flash point of 70° F. or less.

Storage Tanks for Flammable Liquids Located Outside of Buildings



TANKS ABOVE GROUND



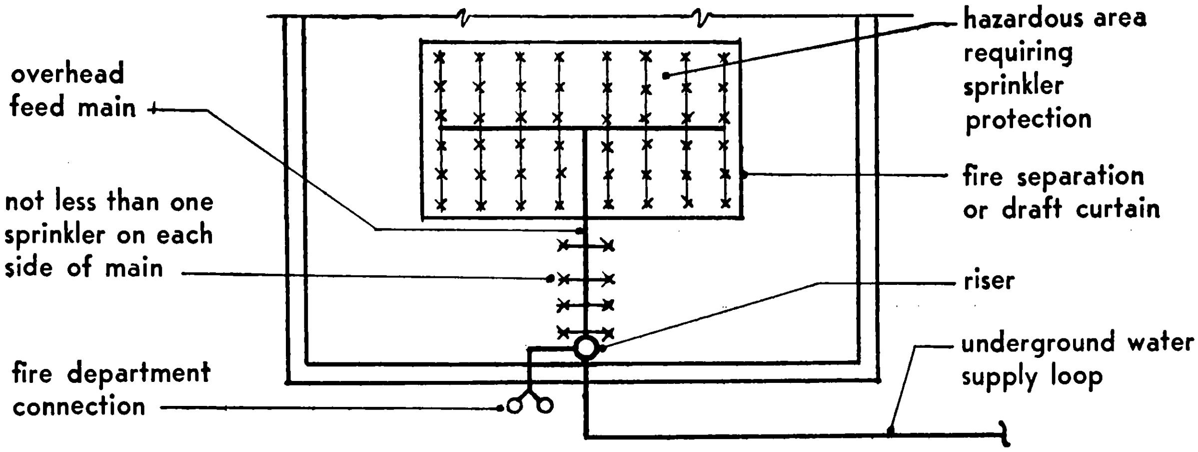
TANKS BELOW GROUND

Individual tank capacity, in gallons	Above-ground and below-ground tanks, distances in feet							
	Liquid flash point of 70° F. or less				Liquid flash point over 70° F.			
	Above ground		Below ground		Above ground		Below ground	
	Between tanks	From property line and from buildings on same premises	From property line and from buildings on same premises: No tank enclosure	From property line and from buildings on same premises: Tank with concrete enclosure 12″ thick	Between tanks	From property line and from buildings on same premises	From property line	From building on same premises
	A	B	C	D	E	F	G	H
0-275	3	10	5	3	3	0	3	3[2]
276-550	3	10	5	3	3	5	3	3[2]
551-1,100	5[1]	10[1]	10[1]	5[1]	3	5	3	3[2]
1,101-5,000	5[1]	15[1]	10[1]	5[1]	3	10	3	3[2]
5,001-15,000	5[1]	15[1]	15[1]	10[1]	5	10	5	3
15,001-25,000	10[1]	20[1]	15[1]	10[1]	5	15	5	3

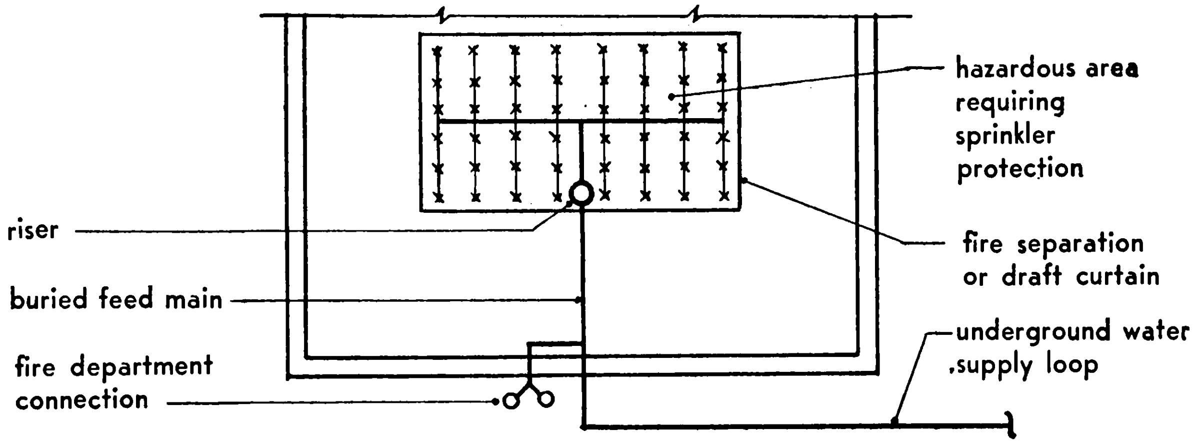
[1] Permitted only outside of fire limits when used exclusively for manufacture or storage of flammable liquid and installed in conformity with generally accepted standards.

[2] No separation required to nonbearing walls.

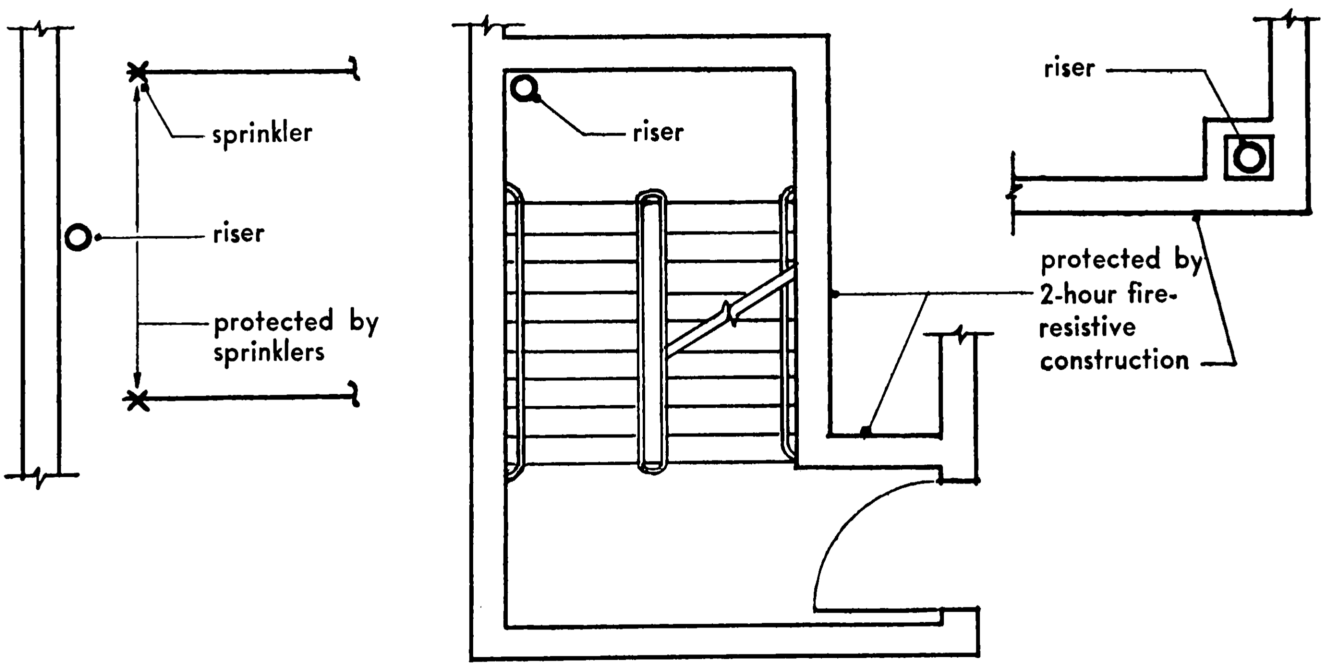
Protection of Sprinkler Piping



OVERHEAD FEED MAIN AND RISER IN
UNSPRINKLERED AREAS PROTECTED BY SPRINKLERS



FEED MAIN BURIED UNDER UNSPRINKLERED AREAS



PROTECTION OF SPRINKLER RISERS SUPPLYING UPPER STORIES

Sprinkler Systems—Screens or other means should be provided to prevent foreign matter from entering sprinkler piping. Required sprinkler systems should be provided with equipment in accordance with the following table:

Occupancy group	Piping and sprinkler spacing[1]	Supervisory equipment for:			
		Pressure tanks and fire pumps	Water level of gravity tanks	Temperature, where subject to freezing	Valves controlling water flow
C1, C3.1, C4.1 and C6.1	(2)	Alarm	Alarm or indicating device	Alarm	Valve seal or alarm
C2	Ordinary hazard, and extra hazard for escalator openings	Alarm	Alarm or indicating device[3]	Alarm	Valve seal or alarm[3]
C3.2 and C4.2	Ordinary hazard	Alarm	Alarm or indicating device	Alarm	Valve seal or alarm
C3.3 and C4.3	Extra hazard	Alarm	Alarm or indicating device[3]	Alarm	Valve seal or alarm[3]
C5	Light hazard, and ordinary hazard for stage, dressing and storage rooms	Alarm	Alarm or indicating device	Alarm	Valve seal or alarm
C6.2 and C6.3	(2)	Alarm	Alarm or indicating device	Alarm	Valve seal or alarm

[1] In conformity with the schedule of pipe sizes and sprinkler spacing in generally accepted standards, where classification is light, ordinary, and extra hazard.

[2] Light hazard except that ordinary hazard spacing should be used in attics, basements, laundries, storage, workrooms, refuse rooms, kitchens, kitchenettes, pantries and exits.

[3] Alarm is recommended where the system contains extra hazard sprinkler spacing.

Water Supplies for Sprinkler Systems

Capacity of water supply for a sprinkler system is determined by the maximum number of sprinklers in a fire area that are expected to open. This number depends upon the fire hazard classification of the occupancy and the size of the fire area.

Where first-aid fire hose is connected to a sprinkler system, the water supply should be sufficient to permit simultaneous operation of sprinklers and hose streams.

The percentage of sprinklers in a fire area that are expected to open are given in the table below.

Example: Assume a building of moderate hazard occupancy, without hose connections, the largest fire area containing 33,000 sq. ft. and 390 sprinklers, and a water pressure at the highest sprinkler of 20 psi, providing a discharge capacity of 25 gpm per sprinkler.

Values obtained from the table under "Ordinary Hazard" are: for 35,000 sq. ft., 13 per cent of sprinklers are expected to open; for 30,000 sq. ft., 15 per cent of sprinklers are expected to open. By interpolation, for 33,000 sq. ft., 13.8 per cent of sprinklers are expected to open.

Capacity of water supply should be as follows: 390 sprinklers x 13.8 per cent x 25 gpm per sprinkler x 20 minutes = 26,900 gallons.

Fire Department Connection

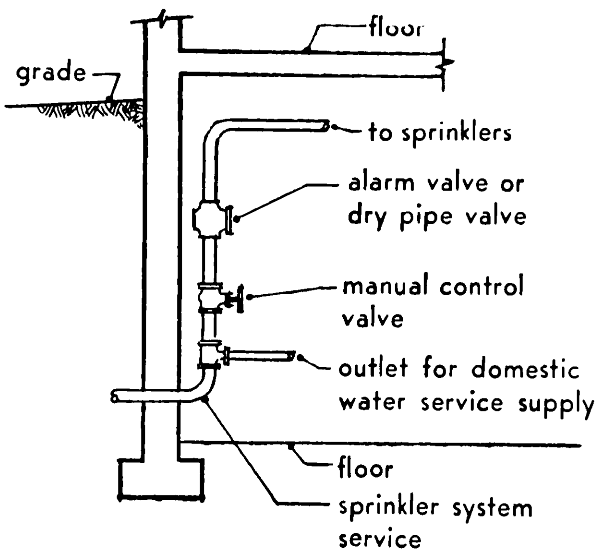
Where a building has two or more sprinkler systems which are not interconnected, having a combined total of 36 or more sprinkler heads, there should be provided a fire department connection for each system. A durable sign, conspicuously located, should be provided to identify the system and designate the area it protects.

Domestic Water Service Supply From Sprinkler System Service—A domestic water service supply obtained from a sprinkler system service, should connect to the supply side of the sprinkler control valve as illustrated below.

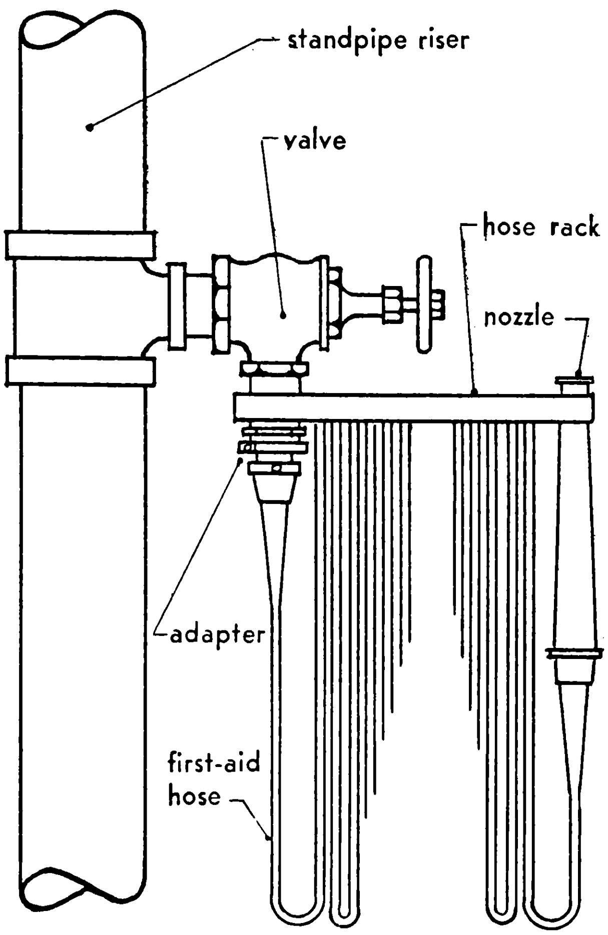
SPRINKLERS OPENING DURING A FIRE
(In percentage of sprinklers in a fire area)

Fire area protected by sprinklers (in sq. ft.)	Spacing of sprinklers[1]		
	Light hazard	Ordinary hazard	Extra hazard
3,000 and under	100	100	100
4,000	54	100	100
5,000	37	100	100
6,000	37	100	100
7,000	34	62	80
8,000	30	48	62
9,000	28	40	51
10,000	25	35	46
12,500	22	29	38
20,000	16	20	26
25,000	13	17	22
30,000	11	15	20
35,000	10	13	18
40,000	9	12	17
50,000	8	10	14
60,000	7	9	12
70,000	6	8	11
80,000	6	8	10
90,000 and over	5	7	9

[1] In conformity with the schedule of sprinkler spacing in generally accepted standards, where classification is light, ordinary, and extra hazard.



Standpipe Systems



Standpipe systems should be designed and installed so that the discharge from nozzles will reach all parts of rooms, closets, and important enclosures. The minimum effective range of a good hose stream is 30 feet for 2½-inch hose and 20 feet for first-aid hose.

Standpipe risers should be protected in the same manner as sprinkler risers. (See "Protection of Sprinkler Piping," part 5, page 91.)

Water supply for 2½-inch hose should be sufficient to provide at least 250 gpm for 1 standpipe and 500 gpm for 2 or more standpipes for a period of 30 minutes, but in no case should the supply be less than 250 gpm for a fire pump, 5000 gallons for a gravity tank and 4500 gallons for a pressure tank. Pressure at the highest outlet, while required water is being discharged from the system, should be 40 to 50 psi, with a minimum of 20 psi.

Water supply for first-aid hose only should be sufficient to provide at least 70 gpm for 2 first-aid streams while pressure at the highest outlet is 25 psi, but in no case should the pressure be less than 12 psi.

Hose for heavy streams should be 2½-inch size with a maximum length of 100 feet. The hose rack should be of nonautomatic type. Hose stations should be provided with durable signs, conspicuously located, reading "For Fire Department Use Only—Dangerous."

Hose for first-aid streams should be attached and ready for use. Hose should be unlined, 1½- or 1¼-inch maximum size, with length not exceeding 75 feet. Hose rack should be semi-automatic. Nozzle should be ½-inch maximum.

Adapter should be 2½" x 1½" or 2½" x 1¼", easily removable, to permit connection of 2½-inch hose.

First-Aid Fire Hose Connected to Sprinkler Systems

First-aid fire hose connected to sprinkler systems should be in accordance with the following table:

Sprinkler risers in a fire area	First-aid fire hose connections in a fire area, maximum number per floor
1 or 2	1
3, 4 or 5	2
6 or more	One-third of the total number of sprinkler risers

Safety Controls

Large Direct-Fired Heat-Producing Equipment—Direct-fired automatically and semiautomatically operated fuel-burning equipment having an input rating exceeding 400,000 Btu per hour should be provided with controls to function as follows:

1. Combination gas-oil burners or oil-gas burners, when gas is fired—

a. Air should completely purge the combustion chamber, flue passages, breeching and chimney.

b. Gas torch or pilot light should be in operation to light the main burner; failure of such torch or pilot should prevent flow of fuel to main burner.

c. Upon failure of main burner to start within 15 seconds after main fuel valve is open, or upon interruption of the main flame for a period of 2 to 4 seconds, flow of fuel to main burner should stop and require manual reset.

d. After a period of main burner operation, air should be supplied to purge completely the combustion chamber, flue passages, breeching, and chimney.

2. Light oil and combination gas-oil burners, when light oil is fired—

a. Same as 1a above.

b. Upon failure of main burner to start within 5 seconds, or upon interruption of the main flame for a period of 2 to 4 seconds, flow of fuel to main burner should stop and require manual reset.

3. Heavy oil burners and combination gas-oil burners, when heavy oil is fired—

a. Same as 1a above.

b. Same as 1b above.

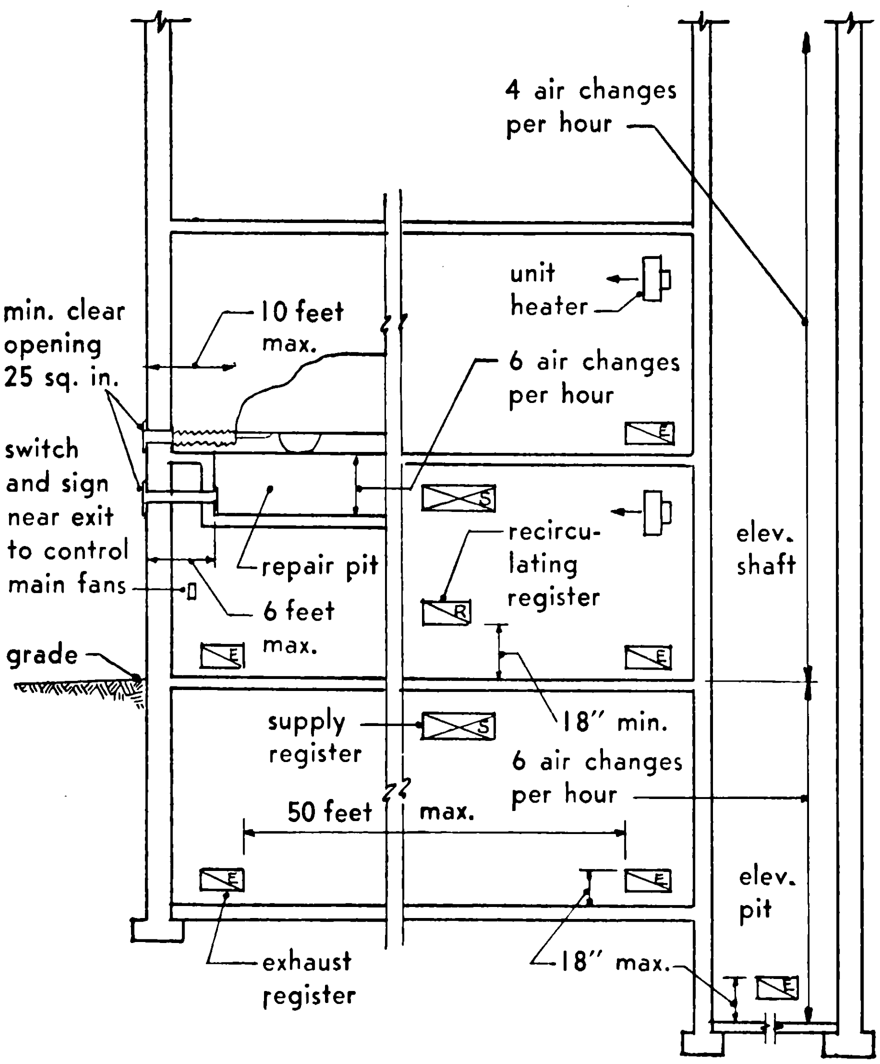
c. Upon failure of main burner to start within 60 seconds, or upon interruption of the main flame for a period of 2 to 4 seconds, flow of fuel to main burner should stop and require manual reset.

d. Same as 1d above.

4. Gas burners—See ASA, *Requirements for Installation of Gas-Burning Equipment in Power Boilers (Z21.33-1950).*

In addition to the above requirements, the input rate of fuel supply to a burner for automatic ignition from a gas torch or pilot light should not exceed a heat content of 5,000,000 Btu per hour. Such burners having a capacity exceeding 5,000,000 Btu per hour should operate at approximately 5,000,000 Btu per hour for a period of at least one minute before increase.

Garage Ventilation and Warm Air Heating



SECTION

Gravity warm-air heating systems should not be used. Warm-air heating systems should shut down automatically upon the operation of sprinklers or fire alarm. Air for recirculation should not be taken from spaces below grade level, and openings for recirculated air should be at least 18 inches above floor level.

Exhaust registers should extend not more than 18 inches above floor level. They should be located on the walls enclosing the storage area, with peripheral distance between registers not exceeding 50 feet. Supply air should be introduced so that even distribution of flow can be maintained over the tops of vehicles.

Pits should have exhaust outlets located on the wall near the bottom. Where pits are ventilated by ducts without fans, the maximum length of duct should be 6 feet. Mechanical ventilation of pits should provide at least 12 air changes per hour. Where engine exhaust is discharged to the exterior by means of ducts without fans, the maximum length of duct should be 10 feet.

Mechanical ventilation for engine exhaust should provide at least 400 cfm per inlet for engine connection.

Hazardous Locations

Classification of Equipment

Explosion-proof equipment approved for use in locations where a flammable gas, such as acetylene, is used or stored, is not necessarily approved for use where flour dust is present. In addition to considerations of ignition of flammable materials, equipment for use where flammable dust is present must be able to operate without exceeding its allowable temperature rise when coated with a thick film of dust. Electrical equipment approved for installation in hazardous locations is designated in ULI, *Hazardous Location Equipment List, May 1955,* by class number and group letter.

The class number and group letter for equipment approved for use in a particular hazardous location may be determined from the following two tables. The class number depends on the type of hazardous material present and is determined from Table 1.

Table 1

CLASSIFICATION BY CLASS NUMBER

Class	Type of hazardous material present
I	Flammable gases or vapors
II	Flammable dust
III	Flammable fibers

The group letter depends on the specific hazardous material present and is determined from Table 2.

Table 2

CLASSIFICATION BY GROUP LETTER

Group	Specific hazardous material present
A	Acetylene
B	Hydrogen, manufactured gas, carbon monoxide, ethylene oxide, or formaldehyde
C	Ethyl ether, ethylene, cyclopropane, or carbon disulphide
D	Gasoline, hexane, naphtha, benzine, butane, propane, alcohols, acetone, benzol, paint solvent, or natural gas
E	Metal dust of aluminum, magnesium, or alloys of such metals
F	Dust of carbon black, coal, or coke
G	Dust of flour, starch, or grain

Switches, pilot lights, wall receptacles, and motors installed within five feet of the floor in a hospital operating room are approved for installation in a Class I, Group C location. To check such equipment for approval, proceed as follows: first, from the nameplate or carton, obtain manufacturer's name and catalog number; second, refer to ULI, *Hazardous Location Equipment List, May 1955,* and under the name of the equipment, such as "switches," look for manufacturer's name, catalog number, class number, and group letter.

The following examples indicate how the above tables may be used to obtain the class number and group letter for electrical equipment installed in various hazardous locations:

EXAMPLES OF CLASS NUMBER AND GROUP LETTER DESIGNATION

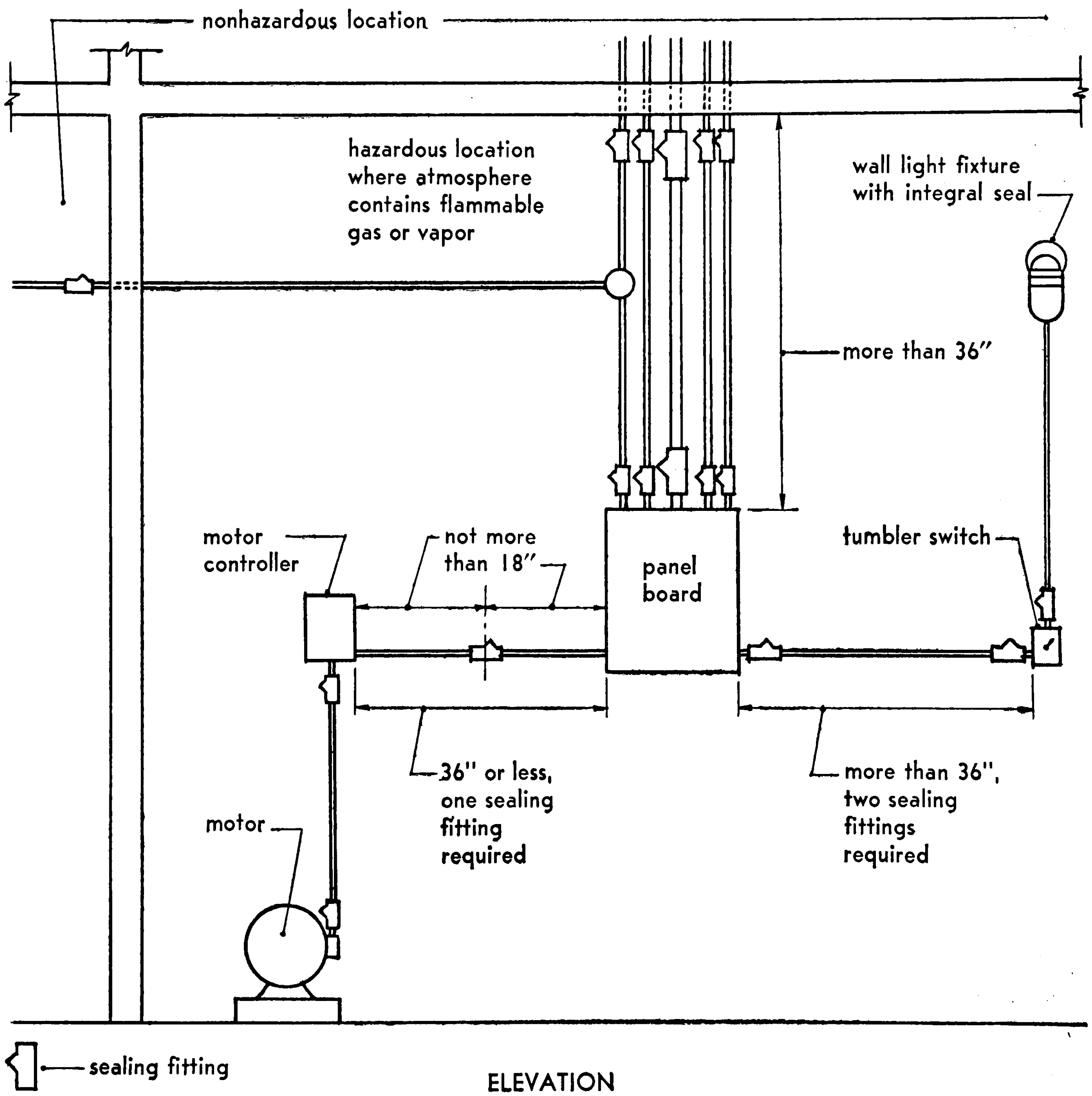
Location	Type of hazardous material present	Specific hazardous material present	Class number and group letter
Foundry	Flammable gas	Acetylene	I-A
Gas plant	Flammable gas	Manufactured gas	I-B
Hospital operating room	Flammable gas	Ethyl ether	I-C
Dry cleaning plant	Flammable gas	Benzine	I-D
Aluminum bronze plant	Flammable dust	Aluminum bronze dust	II-E
Coal pulverizing plant	Flammable dust	Coal dust	II-F
Flour mill	Flammable dust	Flour dust	II-G
Textile mill	Flammable fibers	Cotton lint	III[1]

[1] Equipment listed for Class II, Group G hazardous locations (except fan-cooled type motors), shall be used in Class III locations.

Hazardous Locations

In hazardous locations designated as Class I, Groups A, B, C, or D (see preceding page), a sealing fitting should be provided in each conduit entering an enclosure for equipment which may produce arcs, sparks, or high temperatures.

A sealing fitting should also be provided in each conduit leaving such location. Such fitting may be located in the conduit on either side of the boundary between the hazardous and non-hazardous locations.



ELEVATION

INDEX

INDEX

[Number Preceding Decimal Point Indicates Part; Numbers Following Indicate Pages]