CURRENT & HISTORIC FIRE ASSEMBLIES

DEFINITIONS

- **FIRE PROTECTION RATING.** THE PERIOD OF TIME THAT AN OPENING PROTECTIVE WILL MAINTAIN THE ABILITY TO CONFINE A FIRE AS DETERMINED BY TESTS SPECIFIED IN SECTION 716. RATINGS ARE STATED IN HOURS OR MINUTES.
- **FIRE RESISTANCE.** THAT PROPERTY OF MATERIALS OR THEIR ASSEMBLIES THAT PREVENTS OR RETARDS THE PASSAGE OF EXCESSIVE HEAT, HOT GASES OR FLAMES UNDER CONDITIONS OF USE.
- **FIRE-RESISTANCE RATING.** THE PERIOD OF TIME A BUILDING ELEMENT, COMPONENT OR ASSEMBLY MAINTAINS THE ABILITY TO CONFINE A FIRE, CONTINUES TO PERFORM A GIVEN STRUCTURAL FUNCTION, OR BOTH, AS DETERMINED BY THE TESTS, OR THE METHODS BASED ON TESTS, PRESCRIBED IN SECTION 703.

SYSTEMS

- Fire Walls
- Fire Barrier
- Fire Partition
- Horizontal Assembly
- And others

BUILDING CONSTRUCTION TYPES

BASIS

- The classification of buildings into different construction types is based on how the structure behaves when exposed to fire. This includes material combustibility, and material behavior when exposed to elevated temperatures.
- Lowest common denominator approach is used where even a single element can cause a building to be rated as a lower construction type.

NON-COMBUSTIBLE

- Materials that in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat

INTERNATIONAL CODE COUNCIL, (2018 IBC)

- 5 MAJOR CONSTRUCTION TYPES
- NON-COMBUSTIBLE
  - TYPE I
  - TYPE II
- COMBUSTIBLE
  - TYPE III
  - TYPE IV
  - TYPE V

FIRE-RESISTANCE RATING

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b]	1[b]	0	1[b]	0	HT	1[b]	0
Bearing walls Exterior[e, f] Interior	3 3[a]	2 2[a]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.
a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.
b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed where a 1-hour or less fire-resistance rating is required.
d. Not less than the fire-resistance rating required by other sections of this code.
e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).
f. Not less than the fire-resistance rating as referenced in Section 704.10.

FIRE-RESISTANCE RATING

TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a, d, g]

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H[e]	OCCUPANCY GROUP F-1, M, S-1[f]	OCCUPANCY GROUP A, B, E, F-2, I, R[i], S-2, U[h]
X < 5[b]	All	3	2	1
5 ≤ X < 10	IA Others	3 2	2 1	1 1
10 ≤ X < 30	IA, IB IIB, VB Others	2 1 1	1 0 1	1[c] 0 1[c]
X ≥ 30	All	0	0	0

OCCUPANCY TYPES

- Assembly (A)
- Business (B)
- Educational (E)
- Factory (F)
- High-Hazzard (H)
- Institutional (I)
- Mercantile (M)
- Residential (R)
- Storage (S)
- Utility (U)

SEPARATIONS

TABLE 508.4
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)[f]

OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B[e], F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2[b], U	—	—	—	—	—	—	—	—	N	N	1	2	NP	NP	3	4	2	3	2	NP
B[e], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2	1	NP
H-1	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP
H-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP	1	NP
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1[d]	NP	1	NP
H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP

COMMON BUILDING MATERIALS

- Concrete – Noncombustible, Heat Resistant
  - Constituent Parts (Large Aggregate, Small Aggregate, Portland Cement, Water, Air, Admixtures)
  - Density 110 pcf -145 pcf
  - Reinforcement - steel
- Masonry – Noncombustible, Heat Resistant
- Wrought Iron – Noncombustible
  - Melting Temp - 2800°F

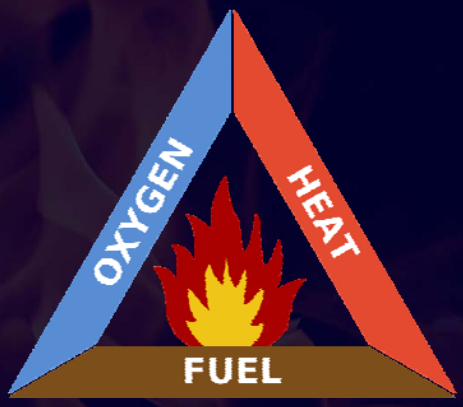
COMMON BUILDING MATERIALS

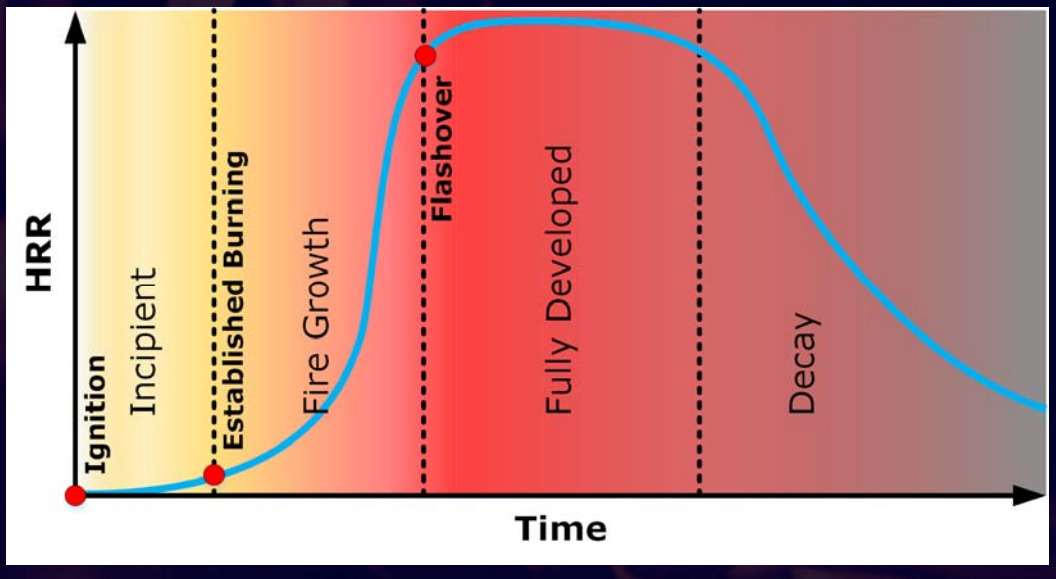
- Cast Iron – Noncombustible
  - Melting Temp – 2800°F
- Steel – Noncombustible
  - Melting Temp – 2500°F
  - At 600°F cold-drawn steel loses 35 percent of its strength
  - 300°F it gets 15 percent stronger
  - 1,000°F it loses 50 percent of its strength
  - 1,200°F – 1,500°F it will not support itself
- Wood – Combustible
  - Known burring characteristics, ½" to 1" in/hr

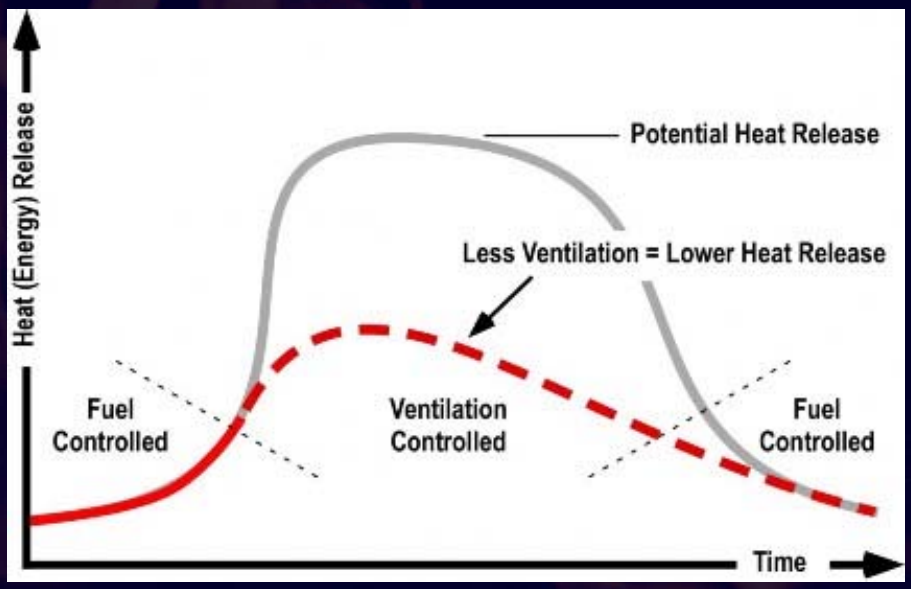
FIRE

- PYROLYSIS: The breakdown of fuels such as, wood and foam plastics, into their basic compound when subjected to heat. Fuels will continue to off-gas (produce pyrolysate) and add to the flammable fuel load within the compartment as long as the material is subjected to elevated temperatures.
- VAPORIZATION: conversion of a substance from the liquid or solid phase into the gaseous (vapour) phase

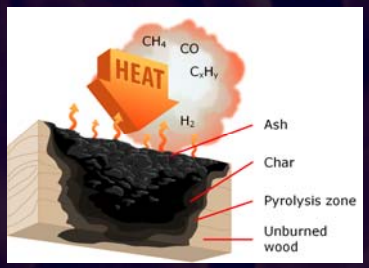
FIRE

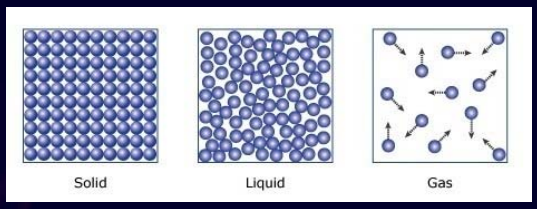

OXYGEN
HEAT
FUEL

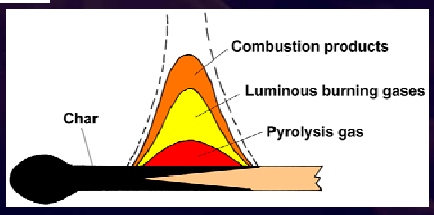

HRR
Ignition
Incipient
Established Burning
Fire Growth
Flashover
Fully Developed
Decay
Time

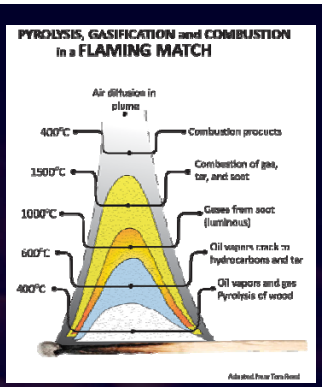


FIRE IS PRESSURE









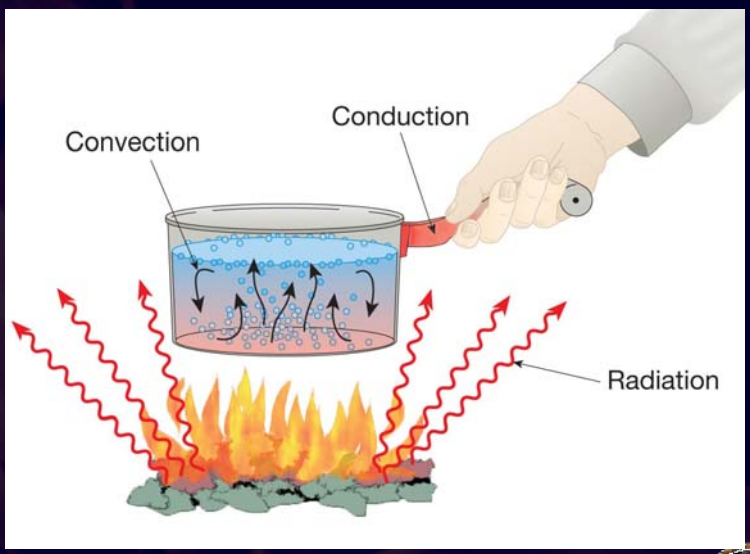
FIRE IS PRESSURE

FIRE IS PRESSURE

HEAT TRANSFER

- CONDUCTION: THE TRANSFER OF HEAT FROM THE DIRECT CONTACT OF A SOLID OF HIGHER TEMPERATURE TO A SOLID OF LOWER TEMPERATURE
- CONVECTION: THE TRANSFER OF HEAT THROUGH THE MOVEMENT OF HOT SMOKE AND GASES TO SOLID SURFACES OF LOWER TEMPERATURE
- RADIATION: THE TRANSMISSION OF HEAT ENERGY BY ELECTROMAGNETIC WAVES THROUGH THE SPACE BETWEEN A BODY AT A HIGHER TEMPERATURE TO A BODY AT A LOWER TEMPERATURE

HEAT TRANSFER



CARBON MONOXIDE

- FLAMMABLE GAS
- LEL = 12.5% UEL = 74.2%
- AUTO IGNITION TEMPERATURE = 1121°F

ASTM E119/UL 263 - STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS

ASTM E119/UL 263

- CALIBRATED TIME-TEMPERATURE TEST

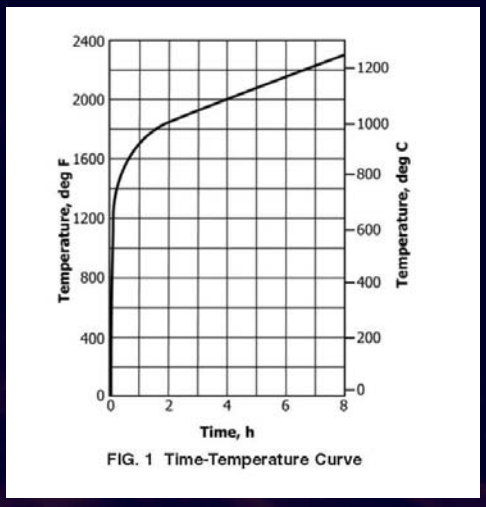


FIG. 1 Time-Temperature Curve

ASTM E119/UL 263

- Hose Stream Test (ASTM E2226)
- Less than 1 hr no test required
- 2nd Specimen burned to ½ rated time but not greater than 1 hr

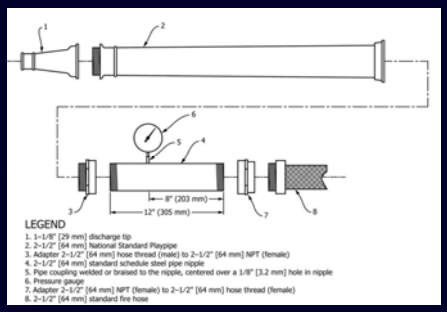


TABLE 1 Water Pressure and Duration for Hose Stream

Resistance Period	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application on Exposed Area, min/100 ft² (9 m²) exposed area
8 h and over	45 (310)	6
4 h and over if less than 8 h	45 (310)	5
2 h and over if less than 4 h	30 (207)	2½
1½ h and over if less than 2 h	30 (207)	1½
1 h and over if less than 1½ h	30 (207)	1
Less than 1 h, if desired	30 (207)	1

ASTM E119/UL 263

- Specimen shall have sustained the applied load during the fire-resistance test without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that for which classification is desired.

ASTM E119/UL 263

- Specimen shall have sustained the applied load during the fire and hose stream test as specified without passage of flame, of gases hot enough to ignite cotton waste, or with the passage of water of from the hose stream. The test specimen shall be considered to have failed the hose stream test if an opening develops that permits a projection of water from the stream beyond the unexposed surface during the time of the hose stream test.

ASTM E119/UL 263

- Transmission of heat through the wall or partition during the fire-resistance test shall not raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

EXPANSION

- Steel 11 x 10^{-6} in/in/°F
- Copper 16 x 10^{-6} in/in/°F
- Concrete 13.5 x 10^{-6} in/in/°F
- Aluminum 22 x 10^{-6} in/in/°F
- Plastics 40-120 x 10^{-6} in/in/°F

30 FT LONG W12X26 STEEL BEAM IN A FIRE

$$\Delta T = 1200°F - 70°F = 1130°F$$

$$30\,ft\left(\frac{12in}{ft}\right) = 360in$$

$$\left(11x10^{-6}\frac{in/in}{°F}\right)(360in)(1130°F) = 4.47in$$

$$\left[1.32in/1000°F/10\,ft\right]$$

$$\Delta = \frac{PL}{AE}$$

$$4.47in = \frac{P(360in)}{(7.65in^2)(29x10^6\,psi)}$$

$$P = 2,755,000lbs$$

$$\left[319,000\,lbs/in^2\right]$$

GYPSUM

ENERGY

- BTU's to heat 1lb of water from 32 degrees Fahrenheit to 212 Degrees Fahrenheit =180 BTU's
- BTU's to Heat 1 lb of water from 212 degrees Fahrenheit to steam = 970 BTU's

CALCINATION

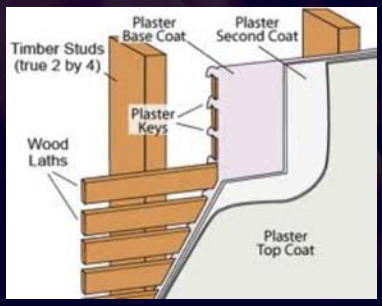
- Calcination is the practice of dehydrating gypsum into plaster or stucco through a batch or continuous process which includes heating the gypsum to evaporate the crystalline water.

DRYWALL MOISTURE

- 5-12 PERCENT IS NORMAL
- LESS THAN 17 PERCENT IS ACCEPTABLE
- 5/8 THICK 4' X 8' SHEET = 70 LBS (8.4 LBS OR 1 GALLON)

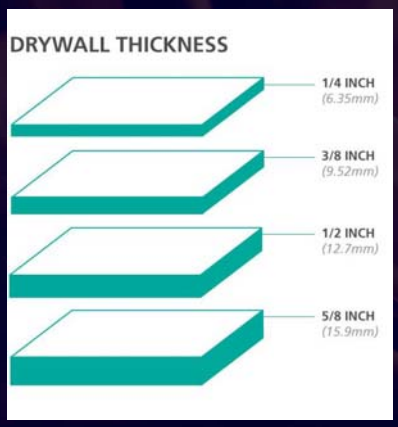
PLASTER

WOOD LATH



EXPANDED METAL LATH

WALL BOARD
DRYWALL



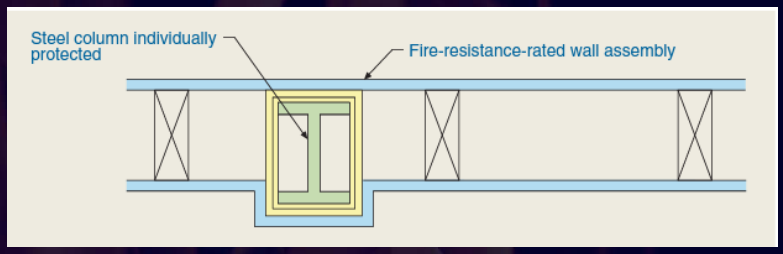
FIRE RESISTANCE

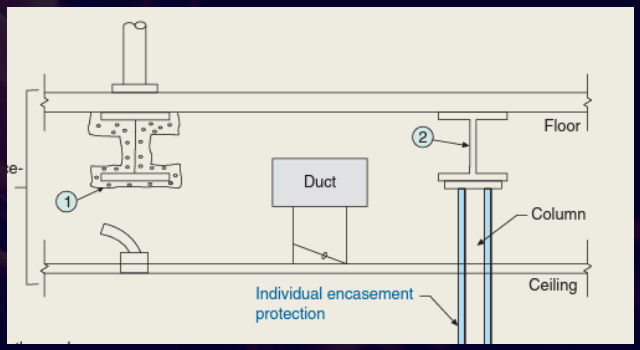
COMPARTMENTALIZATION

- PRACTICE OF DIVIDING LARGE AREAS OF A BUILDING INTO SMALLER ROOMS OR SPACES
- SLOW/CONTROL THE SPREAD OF FIRE

FIRE RESISTANCE

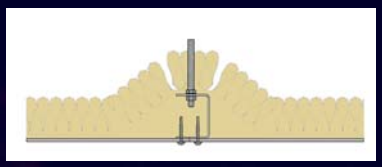
- MEMBRANE
- ENCASEMENT
- INTUMESCENT COATINGS

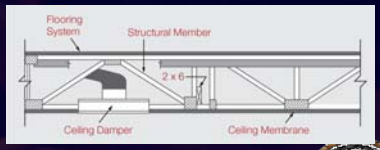




MEMBRANE PROTECTION

- PROTECT MULTIPLE MEMBERS AT THE SAME TIME
- CEILING/FLOOR SYSTEMS
- WALL SYSTEMS
- DETAILS MATTER

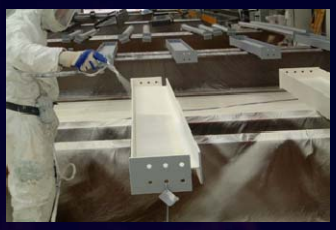




ENCASEMENT

- Concrete
- Masonry
- Drywall/Gypsum Board
- Flexible Blanket
- Sprayed fire-resistive materials
  - Issues
    - Bond Strength
    - Density
    - Thickness
  - Asbestos
  - Mineral-Fiber-Based
  - Cementitious

INTUMESCENT COATINGS



- Epoxy-based paint like mixtures
- Expand when exposed to heat
- Thickness is critical

FIRE RESISTANCE OF BUILDING MATERIALS

FIRE RESISTANCE RATING

- PLASTER
- PRESCRIPTIVE
  - IBC
  - GYPSUM HANDBOOK
  - UL
  - DECK HANDBOOK
- CALCULATED

PLASTER

IBC PLASTER

- **719.1 Thickness of plaster.** The minimum thickness of gypsum plaster or Portland cement plaster used in a fire-resistance- rated system shall be determined by the prescribed fire tests. The plaster thickness shall be measured from the face of the lath where applied to gypsum lath or metal lath.
- **719.2 Plaster equivalents.** For fire-resistance purposes, ½ inch (12.7 mm) of unsanded gypsum plaster shall be deemed equivalent to 3/4 inch (19.1 mm) of one-to-three gypsum sand plaster or 1 inch (25 mm) of Portland cement sand plaster.
- **719.3 Noncombustible furring.** In buildings of Type I and II construction, plaster shall be applied directly on concrete or masonry or on *approved* noncombustible plastering base and furring.

IBC PLASTER

- **719.5 Plaster alternatives for concrete.** In reinforced concrete construction, gypsum plaster or Portland cement plaster is permitted to be substituted for 1/2 inch (12.7 mm) of the required poured concrete protection, except that a minimum thickness of 3/8 inch (9.5 mm) of poured concrete shall be provided in reinforced concrete floors and 1 inch (25 mm) in reinforced concrete columns in addition to the plaster finish. The concrete base shall be prepared in accordance with Section 2510.7.

IEBC

- **1011.5.3 Fire barriers.** Where a change of occupancy classification is made to a higher-hazard category as shown in Table 1011.5, fire barriers in separated mixed use buildings shall comply with the fire-resistance requirements of the International Building Code.
  - **Exception:** Where the fire barriers are required to have a 1-hour fire-resistance rating, existing wood lath and plaster in good condition or existing 1/2-inch-thick (12.7 mm) gypsum wallboard shall be permitted.

PRESCRIPTIVE

TABLE 721.1(1)—continued
MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON TIME PERIODS FOR VARIOUS NONCOMBUSTIBLE INSULATING MATERIALS[a]

STRUCTURAL PARTS TO BE PROTECTED	ITEM NUMBER	INSULATING MATERIAL USED	MINIMUM THICKNESS OF INSULATING MATERIAL FOR THE FOLLOWING FIRE-RESISTANCE PERIODS (inches)			
			4 hours	3 hours	2 hours	1 hour
1. Steel columns and all of primary trusses (continued)	1-6.5	Perlite or vermiculite gypsum plaster over one layer of $\frac{1}{2}$" plain full-length gypsum lath applied tight to column flanges. Lath tied with doubled 0.049" (No. 18 B.W. gage) wire ties spaced 23" on center and scratch coat wrapped with 1" hexagonal mesh 0.035" (No. 20 B.W. gage) wire fabric. For three-coat work, the plaster mix for the second coat shall not exceed 100 pounds of gypsum to $2\frac{1}{2}$ cubic feet of aggregate.	—	2	—	—
	1-7.1	Multiple layers of $\frac{5}{8}$" gypsum wallboard[c] adhesively[e] secured to column flanges and successive layers. Wallboard applied without horizontal joints. Corner edges of each layer staggered. Wallboard layer below outer layer secured to column with doubled 0.049" (No. 18 B.W. gage) steel wire ties spaced 15" on center. Exposed corners taped and treated.	—	—	2	1
	1-7.2	Three layers of $\frac{5}{8}$" Type X gypsum wallboard,[c] First and second layer held in place by $\frac{1}{4}$" diameter by $1\frac{1}{4}$" long ring shank nails with $\frac{7}{16}$" diameter heads spaced 24" on center at corners. Middle layer also secured with metal straps at mid-height and 18" from each end, and by metal corner bead at each corner held by the metal straps. Third layer attached to corner bead with 1" long gypsum wallboard screws spaced 12" on center.	—	—	$1\frac{7}{8}$	—
	1-7.3	Three layers of $\frac{5}{8}$" Type X gypsum wallboard,[c] each layer screw attached to $1\frac{5}{8}$" steel studs 0.018" thick (No. 25 carbon sheet steel gage) at each corner of column. Middle layer also secured with 0.049" (No. 18 B.W. gage) double-strand steel wire ties, 24" on center. Screws are No. 6 by 1" spaced 24" on center for inner layer, No. 6 by $1\frac{5}{8}$" spaced 12" on center for middle layer and No. 8 by $2\frac{1}{4}$" spaced 12" on center for outer layer.	—	$1\frac{7}{8}$	—	—
	1-8.1	Wood-fibered gypsum plaster mixed 1:1 by weight gypsum-to-sand aggregate applied over metal lath. Lath lapped 1" and tied 6" on center at all end, edges and spacers with 0.049" (No. 18 B.W. gage) steel tie wires. Lath applied over $\frac{1}{2}$"-spacers made of $\frac{1}{2}$" furring channel with 2" legs bent around each corner. Spacers located 1" from top and bottom of member and not greater than 40" on center and wire tied with a single strand of 0.049" (No. 18 B.W. gage) steel tie wire. Corner bead tied to the lath at 6" on center along each corner to provide plaster thickness.	—	—	$1\frac{7}{8}$	—
	1-9.1	Minimum W8x31 wide flange steel column (w/d $\geq$ 0.75) with each web cavity filled even with the flange tip with normal weight carbonate or siliceous aggregate concrete (3,000 psi minimum compressive strength with 145 pcf $\pm$ 3 pcf unit weight). Reinforce the concrete in each web cavity with a minimum No. 4 deformed reinforcing bar installed vertically and centered in the cavity, and secured to the column web with a minimum No. 2 horizontal deformed reinforcing bar welded to the web every 18" on center vertically. As an alternative to the No. 4 rebar, $\frac{1}{2}$" diameter by 3" long headed studs, spaced at 12" on center vertically, shall be welded on each side of the web mid-way between the column flanges.	—	—	—	See Note n
2. Webs or flanges of steel beams and girders (continued)	2-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete (not including sandstone, granite and siliceous gravel) with 3" or finer metal mesh placed 1" from the finished surface anchored to the top flange and providing not less than 0.025 square inch of steel area per foot in each direction.	2	$1\frac{1}{2}$	1	1
	2-1.2	Siliceous aggregate concrete and concrete excluded in Item 2-1.1 with 3" or finer metal mesh placed 1" from the finished surface anchored to the top flange and providing not less than 0.025 square inch of steel area per foot in each direction.	$2\frac{1}{2}$	2	$1\frac{1}{2}$	1
	2-2.1	Cement plaster on metal lath attached to $\frac{3}{4}$" cold-rolled channels with 0.04" (No. 18 B.W. gage) wire ties spaced 3" to 6" on center. Plaster mixed 1:2 $\frac{1}{2}$ by volume, cement to sand.	—	—	$2\frac{1}{2}$	$\frac{7}{8}$

(continued)

1. Steel columns and all of primary trusses (continued)		straps. Third layer attached to corner bead with 1" long gypsum wallboard screws spaced 12" on center.				
	1-7.3	Three layers of $\frac{5}{8}$" Type X gypsum wallboard,[c] each layer screw attached to $1\frac{5}{8}$" steel studs 0.018" thick (No. 25 carbon sheet steel gage) at each corner of column. Middle layer also secured with 0.049" (No. 18 B.W. gage) double-strand steel wire ties, 24" on center. Screws are No. 6 by 1" spaced 24" on center for inner layer, No. 6 by $1\frac{5}{8}$" spaced 12" on center for middle layer and No. 8 by $2\frac{1}{4}$" spaced 12" on center for outer layer.	—	$1\frac{7}{8}$	—	—
		Wood-fibered gypsum plaster mixed 1:1 by weight gypsum-to-sand aggregate				

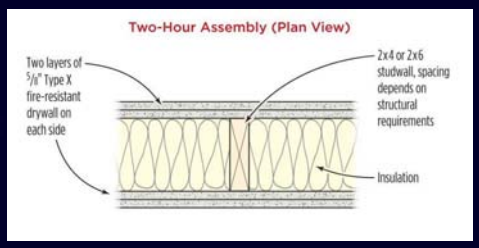
TABLE 721.1(2)—continued
RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS [a,b,c]

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE[f] (inches)			
			4 hours	3 hours	2 hours	1 hour
11. Noncombustible studs—interior partition with plaster each side	11-1.1	$3\frac{1}{2}$" × 0.044" (No. 18 carbon sheet steel gage) steel studs spaced 24" on center. $\frac{5}{8}$" gypsum plaster on metal lath each side mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$4\frac{1}{2}$
	11-1.2	$3\frac{1}{2}$" × 0.055" (No. 16 carbon sheet steel gage) approved nailable[d] studs spaced 24" on center. $\frac{3}{4}$" neat gypsum wood-fibered plaster each side over $\frac{3}{8}$" rib metal lath nailed to studs with 6d common nails, 8" on center. Nails driven $1\frac{1}{2}$" and bent over.	—	—	$5\frac{1}{8}$	—
	11-1.3	4" × 0.044" (No. 18 carbon sheet steel gage) channel-shaped steel studs at 16" on center. On each side approved resilient clips pressed onto stud flange at 16" vertical spacing. $\frac{1}{4}$" pencil rods snapped into or wire tied onto outer loop of clips, metal lath wire-tied to pencil rods at 6" intervals, 1" perlite gypsum plaster, each side.	—	—	$7\frac{1}{4}$	—
	11-1.4	$2\frac{1}{2}$" × 0.044" (No. 18 carbon sheet steel gage) steel studs spaced 16" on center. Wood fibered gypsum plaster mixed 1:1 by weight gypsum to sand aggregate applied on $\frac{1}{2}$-pound metal lath wire tied to studs, each side. $\frac{5}{8}$" plaster applied over each face, including finish coat.	—	—	$4\frac{1}{2}$	—
12. Wood studs—interior partition with plaster each side	12-1.1[e]	2" × 4" wood studs 16" on center with $\frac{3}{4}$" gypsum plaster on metal lath. Lath attached by 4d common nails bent over or No. 14 gage by $1\frac{1}{4}$" by $\frac{1}{2}$" crown width staples spaced 6" on center. Plaster mixed 1:$1\frac{1}{2}$ for scratch coat and 1:3 for brown coat, by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{8}$
	12-1.2[f]	2" × 4" wood studs 16" on center with metal lath and $\frac{3}{4}$" neat wood-fibered gypsum plaster each side. Lath attached by 6d common nails, 7" on center. Nails driven $1\frac{1}{2}$" and bent over.	—	—	$5\frac{1}{2}$	—
	12-1.3[f]	2" × 4" wood studs 16" on center with $\frac{3}{4}$" perforated or plain gypsum lath and $\frac{1}{2}$" gypsum plaster each side. Lath nailed with $1\frac{1}{2}$" by No. 13 gage by $\frac{19}{64}$" head plasterboard blued nails, 4" on center. Plaster mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{4}$
	12-1.4[f]	2" × 4" wood studs 16" on center with $\frac{5}{8}$" Type X gypsum lath and $\frac{1}{2}$" gypsum plaster each side. Lath nailed with $1\frac{1}{4}$" by No. 13 gage by $\frac{19}{64}$" head plasterboard blued nails, 5" on center. Plaster mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{4}$
13. Noncombustible studs—interior partition with gypsum wallboard each side	13-1.1	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 24" on center with one full-length layer of $\frac{5}{8}$" Type X gypsum wallboard[g] applied vertically attached with 1"-long No. 6 dry wall screws to each stud. Screws are 8" on center around the perimeter, and 12" on center on the intermediate stud. Where applied horizontally, the Type X gypsum wallboard shall be attached to $3\frac{5}{8}$" studs and the horizontal joints shall be staggered with those on the opposite side. Screws for the horizontal application shall be 8" on center at vertical edges and 12" on center at intermediate studs.	—	—	—	$2\frac{7}{8}$
	13-1.2	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 25" on center with two full-length layers of $\frac{1}{2}$" Type X gypsum wallboard[g] applied vertically each side. First layer attached with 1"-long, No. 6 drywall screws, 8" on center around the perimeter and 12" on center on the intermediate stud. Second layer applied with vertical joints offset one stud space from first layer using $1\frac{1}{4}$" long, No. 6 drywall screws spaced 9" on center along vertical joints, 12" on center at intermediate studs and 24" on center along top and bottom runners.	—	—	$3\frac{5}{8}$	—
	13-1.3	0.055" (No. 16 carbon sheet steel gage) approved nailable metal studs[d] 24" on center with full-length $\frac{1}{2}$" Type X gypsum wallboard[g] applied vertically and nailed 7" on center with 6d cement-coated common nails. Approved metal fastener grips used with nails at vertical butt joints along studs.	—	—	—	$4\frac{1}{4}$

(continued)

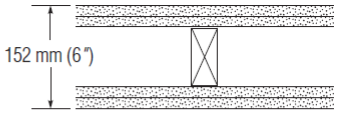
		blued nails, 5" on center. Plaster mixed 1:2 by weight, gypsum to sand aggregate.				
13. Noncombustible studs—interior	13-1.1	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 24" on center with one full-length layer of $\frac{5}{8}$" Type X gypsum wallboard[g] applied vertically attached with 1"-long No. 6 dry wall screws to each stud. Screws are 8" on center around the perimeter and 12" on center on the intermediate stud. Where applied horizontally, the Type X gypsum wallboard shall be attached to $3\frac{5}{8}$" studs and the horizontal joints shall be staggered with those on the opposite side. Screws for the horizontal application shall be 8" on center at vertical edges and 12" on center at intermediate studs.	—	—	—	$2\frac{7}{8}$
		0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 25" on center with				

FIRE RATED ASSEMBLY



GYPSUM HANDBOOK

2-hr. Rating
UL Design U301
ULC Design U301 (similar)
Drywall System

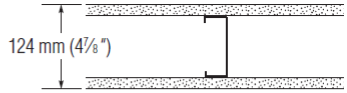


Studs:	Wood 38 x 89 mm (2″x4″) (nom.).
Stud spacing:	400 mm (16″) o.c.
Gypsum panel:	Two layers of 15.9 mm (5/8″) SHEETROCK Brand Gypsum Panel, FIRECODE Core, or 15.9 mm (5/8″) SHEETROCK Brand Gypsum Panel, Water Resistant, FIRECODE Core, each side.
Panel orientation:	Horizontal or vertical—joints of face layer staggered over joints of base layer.
Attachment:	Base layer—48 mm (1-7/8″) cement-coated nails spaced 150 mm (6″) o.c. Face layer—60 mm (2-3/8″) nails 200 mm (8″) o.c.
Joints:	Exposed or taped and treated.
Perimeter:	May be caulked with Acoustical Sealant

GYPSUM HANDBOOK

Steel Frame Partitions

1-hr. Rating
UL Design U419
ULC Design W407 (similar)
Drywall System



Studs:	Steel 92 mm (3-5/8″) x 0.5 mm (25-ga.) (min.).
Stud spacing:	600 mm (24″) o.c.
Gypsum panel:	15.9 mm (5/8″) SHEETROCK Brand Gypsum Panel, FIRECODE Core, or 15.9 mm (5/8″) SHEETROCK Brand Gypsum Panel, Water Resistant, FIRECODE Core, each side.
Panel orientation:	Vertical or horizontal.
Attachment:	TYPE S screws 200 mm (8″) o.c.
Joints:	Taped and treated.
Insulation:	THERMAFIBER SAFB (Optional).
Perimeter:	May be caulked with Acoustical Sealant.

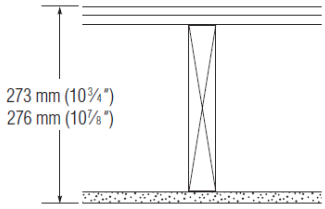
GYPSUM HANDBOOK

Veneer Plaster System	
Studs:	Steel 92 mm (3-5/8″) x 0.5 mm (25-ga.) (min.).
Stud spacing:	600 mm (24″) o.c.
Gypsum panel:	15.9 mm (5/8″) GRAND PRIX Brand Plaster Base FIRECODE Core, each side.
Panel orientation:	Vertical or horizontal.
Attachment:	TYPE S screws 200 mm (8″) o.c.
Joints:	Taped (paper) and treated.
Finish:	2.4 mm (3/32″) DIAMOND Brand or IMPERIAL Brand Plaster finish both sides.
Insulation:	THERMAFIBER SAFB (Optional).
Perimeter:	May be caulked with Acoustical Sealant.

GYPSUM HANDBOOK

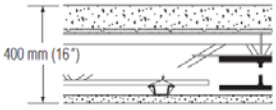
Wood Floor/ Ceilings

1-hr. Rating
UL Design L501 or L512
ULC Design L512 (similar)
Drywall System

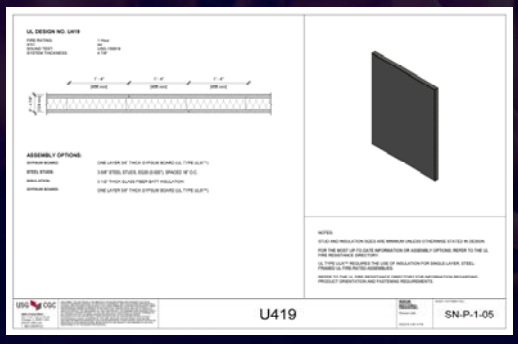


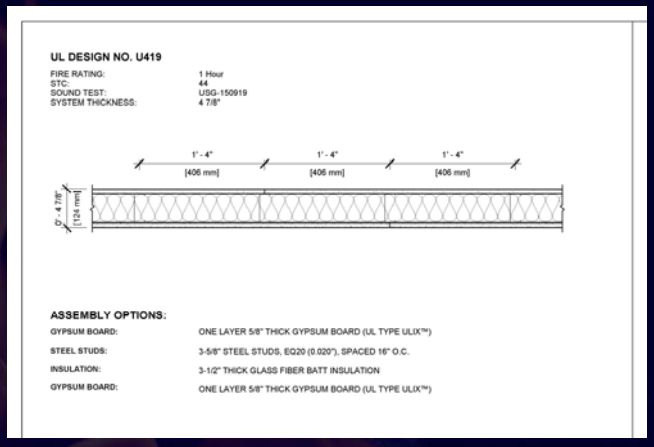
Floor:	25 mm (1″) nom. wood sub and finished floor.
Joists:	Wood 38 x 235 mm (2″x10″) (nom.) cross bridged with 19 x 64 mm (1″x3″) lumber.
Joist spacing:	400 mm (16″) o.c.
Gypsum panel:	15.9 mm (5/8″) SHEETROCK Brand Gypsum Panel, FIRECODE Core (L501), or 12.7 mm (1/2″) SHEETROCK Brand Gypsum Panel, FIRECODE C Core (L512).
Panel orientation:	Perpendicular to joists.
Attachment:	48 mm (1-7/8″) cement-coated nails spaced 150 mm (6″) o.c.
Joints:	Taped and treated.

GYPSUM HANDBOOK

Steel Floor/ Ceilings	3-hr. Rating UL Design G512 Drywall System	
	Floor:	64 mm (2-1/2") concrete on corrugated steel deck or riblath over bar joist—includes 3-hr. unrestrained beam.
	Joists:	Type 12J2 min. size, spaced 600 mm (24") o.c. (riblath); Type 16J2 min. size, spaced 600 mm (24") o.c. (corrugated steel deck).
	Furring channel:	0.5 mm (25-ga.) spaced 600 mm (24") o.c. perpendicular to joists; 76 mm (3") on each side of wallboard end joints—double-strand saddle tied.
	Gypsum panel:	15.9 mm (5/8") SHEETROCK Brand Gypsum Panel, FIRECODE C Core.
	Panel orientation:	Perpendicular to furring.
	Attachment:	25 mm (1") TYPE S screws 300 mm (12") o.c.
	Joints:	End joints backed with wallboard strips and attached to double channels.

UL DIRECTORY





UL DESIGN NO. U419

FIRE RATING: 1 Hour
STC: 44
SOUND TEST: USG-150919
SYSTEM THICKNESS: 4 7/8"

ASSEMBLY OPTIONS:

GYPSUM BOARD:	ONE LAYER 5/8" THICK GYPSUM BOARD (UL TYPE ULIX™)
STEEL STUDS:	3-5/8" STEEL STUDS, EQ20 (0.020"), SPACED 16" O.C.
INSULATION:	3-1/2" THICK GLASS FIBER BATT INSULATION
GYPSUM BOARD:	ONE LAYER 5/8" THICK GYPSUM BOARD (UL TYPE ULIX™)

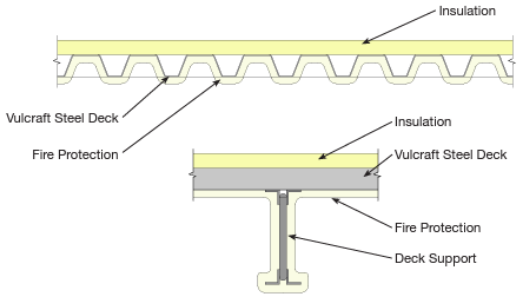
DECK MANUAL

VULCRAFT® ROOF DECK
UL FIRE RATED ASSEMBLIES

UL LISTED

USE UL RECOGNIZED VULCRAFT ROOF DECKS FOR YOUR FIRE RATED ASSEMBLIES

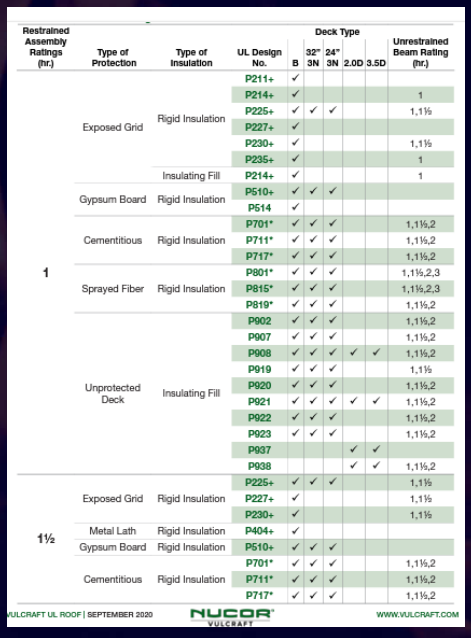
- **Vulcraft steel decks may be used in assemblies which are required to meet hourly fire ratings. Approved hourly fire rated assemblies are a combination of specific proprietary materials as listed in UL fire resistance ratings.**



REPRESENTATIVE FIRE RATED ASSEMBLY

Refer to the table on the following pages for a listing of UL fire-rated assemblies utilizing Vulcraft steel deck profiles. Refer to the particular UL assembly being considered for full details of construction, including specific information about fill or fireproofing thicknesses and span limitations.

DECK MANUAL



Restrained Assembly Ratings (hr.)	Type of Protection	Type of Insulation	UL Design No.	Deck Type B	32" 3N	24" 3N	2.0D	3.5D	Unrestrained Beam Rating (hr.)
1	Exposed Grid	Rigid Insulation	P211+	✓					
			P214+	✓					1
			P225+	✓	✓	✓			1,1½
			P227+	✓					
			P230+	✓					1,1½
			P235+	✓					1
		Insulating Fill	P214+	✓					1
	Gypsum Board	Rigid Insulation	P510+	✓	✓	✓			
			P514	✓					
	Cementitious	Rigid Insulation	P701*	✓	✓	✓			1,1½,2
			P711*	✓	✓	✓			1,1½,2
			P717*	✓	✓	✓			1,1½,2
	Sprayed Fiber	Rigid Insulation	P801*	✓	✓	✓			1,1½,2,3
			P815*	✓	✓	✓			1,1½,2,3
			P819*	✓	✓	✓			1,1½,2
	Unprotected Deck	Insulating Fill	P902	✓	✓	✓			1,1½,2
			P907	✓	✓	✓			1,1½,2
			P908	✓	✓	✓	✓	✓	1,1½,2
			P919	✓	✓	✓			1,1½
			P920	✓	✓	✓			1,1½,2
			P921	✓	✓	✓	✓	✓	1,1½,2
			P922	✓	✓	✓			1,1½,2
			P923	✓	✓	✓			1,1½,2
			P937				✓	✓	
			P938				✓	✓	1,1½,2
1½	Exposed Grid	Rigid Insulation	P225+	✓	✓	✓			1,1½
			P227+	✓					1,1½
			P230+	✓					1,1½
	Metal Lath	Rigid Insulation	P404+	✓					
	Gypsum Board	Rigid Insulation	P510+	✓	✓	✓			
	Cementitious	Rigid Insulation	P701*	✓	✓	✓			1,1½,2
			P711*	✓	✓	✓			1,1½,2
			P717*	✓	✓	✓			1,1½,2

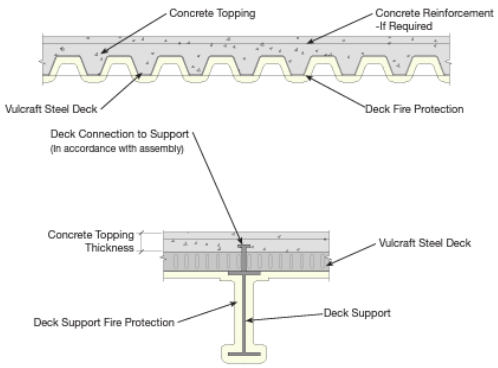
UL Fire Resistance Ratings (continued)

Restrained Assembly Ratings (hr.)	Type of Protection	Type of Insulation	UL Design No.	Deck Type B	32" 3N	24" 3N	2.0D	3.5D	Unrestrained Beam Rating (hr.)
1½	Sprayed Fiber	Rigid Insulation	P801*	✓	✓	✓			1,1½,2
			P815*	✓	✓	✓			1,1½,2,3
			P819*	✓	✓	✓			1,1½,2,3
	Unprotected Deck	Insulating Fill	P902	✓	✓	✓			1,1½,2
			P907	✓	✓	✓			1,1½,2
			P908	✓	✓	✓	✓	✓	1,1½,2
			P919	✓	✓	✓			1,1½
			P920	✓	✓	✓			1,1½,2
			P921	✓	✓	✓	✓	✓	1,1½,2
			P922	✓	✓	✓			1,1½,2
			P923	✓	✓	✓			1,1½,2
			P937				✓	✓	
			P938				✓	✓	1,1½,2
2	Exposed Grid	Rigid Insulation	P237+	✓					2
	Metal Lath	Rigid Insulation	P404+	✓					
	Gypsum Board	Rigid Insulation	P514+	✓					
	Cementitious	Rigid Insulation	P701*	✓	✓	✓			1,1½,2
			P711*	✓	✓	✓			1,1½,2
			P717*	✓	✓	✓			1,1½,2
	Sprayed Fiber	Rigid Insulation	P801*	✓	✓	✓			1,1½,2
			P815*	✓	✓	✓			1,1½,2
			P819*	✓	✓	✓			1,1½,2,3
	Unprotected Deck	Insulating Fill	P902	✓	✓	✓			1,1½,2
			P907	✓	✓	✓			1,1½,2
			P908	✓	✓	✓	✓	✓	1,1½,2
			P920	✓	✓	✓			1,1½,2
			P921	✓	✓	✓	✓	✓	1,1½,2
			P922	✓	✓	✓			1,1½,2
			P923	✓	✓	✓			1,1½,2
			P937				✓	✓	
			P938				✓	✓	1,1½,2

DECK MANUAL

USE UL RECOGNIZED COMPOSITE AND NON-COMPOSITE DECKS FOR YOUR FIRE RATED ASSEMBLIES WITH STRUCTURAL CONCRETE FILL

• **Vulcraft composite and non-composite slabs may be used to meet hourly fire ratings. The type and thickness of concrete specified will generally determine whether fireproofing will be required on the underside of the composite or non-composite deck.**



REPRESENTATIVE FIRE RATED ASSEMBLY

The table on the following pages lists the UL fire rated assemblies that include Vulcraft composite and non-composite decks profiles. This summary table is provided to assist in identification of assemblies to meet specific project requirements. Refer to the particular UL assembly for full details of construction including, specific information about concrete slab, framing, type of fire protection, deck types and span limitations.

DECK MANUAL

UL Fire Resistance Ratings

Restrained Assembly Ratings (hr.)	Type of Protection	Concrete Thickness & Type	UL Design No.	Deck Type 1.5VL	2VL	3VL	1.5VLP	2VLP	3VLP	Unrestrained Beam Rating (hr.)
¾	Unprotected Deck	2½" LW	D914 #	✓	✓	✓	✓	✓	✓	1
			D916 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
1	Exposed Grid	2½" NW	D216 +	✓	✓	✓		✓	✓	2,3
	Cementitious	2" NW & LW	D743 *		✓	✓		✓	✓	1,1½,2,3
		2½" NW & LW	D703 *	✓	✓	✓	✓	✓	✓	1½
			D712 *		✓	✓			✓	2
			D722 *		✓	✓		✓	✓	1,1½,2
			D739 *	✓	✓	✓	✓	✓	✓	1,1½,2,3,4
			D759 *	✓	✓	✓	✓	✓	✓	1,1½,2,3
	Sprayed Fiber	2" NW & LW	D859 *		✓	✓		✓	✓	1,1.5,2,3
		2½" NW & LW	D832 *	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D847 *		✓	✓		✓	✓	1,1⅛,3
			D858 *		✓	✓		✓	✓	1,1½,2,3,4
			D871 *		✓	✓		✓	✓	1,1½,2,3
	Unprotected Deck	2½" LW	D902 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D914 #	✓	✓	✓	✓	✓	✓	1
			D916 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D919 #	✓	✓	✓	✓	✓	✓	1,1½
		3½" NW	D902 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D916 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D919 #	✓	✓	✓	✓	✓	✓	1,1½
1½	Gypsum Board	2½" NW	D502 *	✓	✓	✓		✓	✓	1½,2
	Cementitious	2" NW & LW	D743 *		✓	✓		✓	✓	1,1½,2,3
		2½" NW & LW	D703 *	✓	✓	✓	✓	✓	✓	1½
			D712 *		✓	✓			✓	2
			D722 *		✓	✓		✓	✓	1,1½,2
			D739 *	✓	✓	✓	✓	✓	✓	1,1½,2,3,4
			D759*	✓	✓	✓	✓	✓	✓	1,1½,2,3

✓+ 1.5VLI Only

(continued on next page)

DECK MANUAL

UL Fire Resistance Ratings (continued)

Restrained Assembly Ratings (hr.)	Type of Protection	Concrete Thickness & Type	UL Design No.	Deck Type 1.5VL	2VL	3VL	1.5VLP	2VLP	3VLP	Unrestrained Beam Rating (hr.)
1½	Sprayed Fiber	2" NW & LW	D859 *		✓	✓		✓	✓	1,1½,2,3
		2½" NW & LW	D832 *	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D847 *		✓	✓		✓	✓	1,1½,3
			D858 *		✓	✓		✓	✓	1,1½,2,3,4
			D871 *		✓	✓		✓	✓	1,1½,2,3
	Unprotected Deck	3" LW	D902 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D916 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D919 #	✓	✓	✓	✓	✓	✓	1,1½
		4" NW	D902 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D916 #	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D919 #	✓	✓	✓	✓	✓	✓	1,1½
2	Exposed Grid	2½" NW	D216 +	✓	✓	✓		✓	✓	2,3
	Gypsum Board	2½" NW	D502 +	✓	✓	✓		✓	✓	1½,2
	Cementitious	2" NW & LW	D743 *		✓	✓		✓	✓	1,1½,2,3
		2½" LW	D746 *	✓						1,1½,2,3
			D752 *	✓	✓	✓	✓	✓	✓	1,1½,2,
		2½" NW & LW	D703 *	✓	✓	✓	✓	✓	✓	1½
			D712 *		✓	✓			✓	2
			D716 *	✓	✓	✓		✓	✓	1½,2
			D722 *		✓	✓		✓	✓	1,1½,2
			D739 *		✓	✓	✓	✓	✓	1,1½,2,3,4
			D745 *		✓	✓				1,1½,2
			D750 *	✓	✓	✓				1½,2
			D755*	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D759*	✓	✓	✓	✓	✓	✓	1,1½,2,3
			D760 *	✓+	✓	✓				1,1½,2,3,4
		2½" NW	D730 *		✓	✓		✓	✓	
			D742 *	✓	✓	✓				1,1½

✓+ 1.5VLI Only

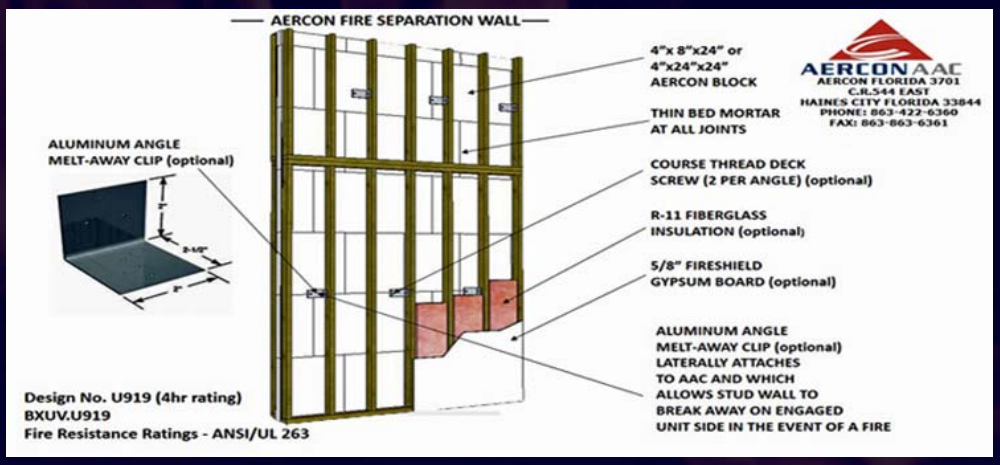
(continued on next page)

DECK MANUAL

UL Fire Resistance Ratings

Restrained Assembly Ratings (hr.)	Type of Protection	Concrete Thickness & Type	UL Design No.	Deck Type 0.6C	1.0C	1.3C	1.5C	Unrestrained Beam Rating (hr.)
1	Exposed Grid	2½" NW	G256 +	✓	✓	✓	✓	1,2,3
	Cementitious	2½" NW & LW	G701	✓	✓	✓	✓	1,1½,2,3
			G705	✓	✓	✓	✓	1,1½,2,3
	Sprayed Fiber	2¾" NW & LW	G801	✓	✓	✓	✓	1,1½,2
1½	Exposed Grid	2" NW	G229 +	✓	✓	✓	✓	1½,2,3
		2½" NW	G228 +	✓	✓	✓	✓	1½,2
			G243 +	✓	✓	✓	✓	1½,2
			G213 +	✓	✓	✓	✓	1½,2,3
	Gypsum Board	2" NW & LW	G502 +	✓	✓	✓	✓	
	Cementitious	2½" NW & LW	G701	✓	✓	✓	✓	1,1½,2,3
			G705	✓	✓	✓	✓	1,1½,2,3
	Sprayed Fiber	2¾" NW & LW	G801	✓	✓	✓	✓	1,1½,2
2	Exposed Grid	2½" NW	G227 +	✓	✓	✓	✓	2,3
			G228 +	✓	✓	✓	✓	1½,2
			G229 +	✓	✓	✓	✓	1½,2,3
			G243 +	✓	✓	✓	✓	1½,2
			G256 +	✓	✓	✓	✓	1,2,3
			G213 +	✓	✓	✓	✓	1½,2,3
	Gypsum Board	2" NW	G505 +	✓	✓	✓	✓	
		2½" NW & LW	G529 +	✓	✓	✓	✓	2,3
		2½" NW	G514 +	✓	✓	✓	✓	3
			G523 +	✓	✓	✓	✓	2,3
	Cementitious	2½" NW & LW	G701	✓	✓	✓	✓	1,1½,2,3
			G705	✓	✓	✓	✓	1,1½,2,3
	Sprayed Fiber	2¾" NW & LW	G801	✓	✓	✓	✓	1,1½,2
3	Exposed Grid	3¼" NW	G229 +	✓	✓	✓	✓	1½,2,3
		3½" NW	G213 +	✓	✓	✓	✓	1½,2,3
			G256 +	✓	✓	✓	✓	1½,2,3
	Gypsum Board	3¼" NW & LW	G529 +	✓	✓	✓	✓	2,3
	Cementitious	2¾" NW & LW	G701	✓	✓	✓	✓	1,1½,2,3
			G705	✓	✓	✓	✓	1,1½,2,3
	Sprayed Fiber	2¾" NW & LW	G801	✓	✓	✓	✓	1,1½,2

FIREWALL SYSTEM



CALCULATED

OTHER STANDARDS

- ACI 216.1/TMS 0216
- ASCE 29
- AWC NDS CHAPTER 16

CONCRETE

TABLE 722.2.1.1
MINIMUM EQUIVALENT THICKNESS OF CAST-IN-PLACE OR PRECAST CONCRETE WALLS, LOAD-BEARING OR NONLOAD-BEARING

CONCRETE TYPE	MINIMUM SLAB THICKNESS (Inches) FOR FIRE-RESISTANCE RATING OF				
	1 hour	1 1/2 hours	2 hours	3 hours	4 hours
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

PRECAST CONCRETE

- **722.2.1.1.1 Hollow-core precast wall panels.** For hollow-core precast concrete wall panels in which the cores are of constant cross section throughout the length, calculation of the equivalent thickness by dividing the net cross-sectional area (the gross cross section minus the area of the cores) of the panel by its width shall be permitted
- **722.2.1.1.2 Core spaces filled.** Where all of the core spaces of hollow-core wall panels are filled with loose-fill material, such as expanded shale, clay or slag, or vermiculite or perlite, the fire-resistance rating of the wall is the same as that of a solid wall of the same concrete type and of the same overall thickness.
- **722.2.1.1.3 Tapered cross sections.** The thickness of panels with tapered cross sections shall be that determined at a distance 2t or 6 inches (152 mm), whichever is less, from the point of minimum thickness, where t is the minimum thickness.

PRECAST CONCRETE

722.2.1.1.4 Ribbed or undulating surfaces. The equivalent thickness of panels with ribbed or undulating surfaces shall be determined by one of the following expressions:

For $s \geq 4t$, the thickness to be used shall be t

For $s \leq 2t$, the thickness to be used shall be t_e

For $4t > s > 2t$, the thickness to be used shall be

$$t + \left(\frac{4t}{s} - 1\right)(t_e - t) \qquad \textbf{(Equation 7-3)}$$

where:

s = Spacing of ribs or undulations.

t = Minimum thickness.

t_e = Equivalent thickness of the panel calculated as the net cross-sectional area of the panel divided by the width, in which the maximum thickness used in the calculation shall not exceed $2t$.

MULTIWYTHE CONCRETE

722.2.1.2.2 Foam plastic insulation. The *fire-resistance ratings* of precast concrete wall panels consisting of a layer of foam plastic insulation sandwiched between two wythes of concrete shall be permitted to be determined by use of Equation 7-4. Foam plastic insulation with a total thickness of less than 1 inch (25 mm) shall be disregarded. The R_n value for thickness of foam plastic insulation of 1 inch (25 mm) or greater, for use in the calculation, is 5 minutes; therefore $R_n^{0.59} = 2.5$.

722.2.1.2.1 Two or more wythes. The *fire-resistance rating* for wall panels consisting of two or more wythes shall be permitted to be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59})^{1.7} \qquad \textbf{(Equation 7-4)}$$

MULTIWYTHE CONCRETE

TABLE 722.2.1.2(1)
VALUES OF $R_n^{0.59}$ FOR USE IN EQUATION 7-4

TYPE OF MATERIAL	THICKNESS OF MATERIAL (Inches)											
	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7
Siliceous aggregate concrete	5.3	6.5	8.1	9.5	11.3	13.0	14.9	16.9	18.8	20.7	22.8	25.1
Carbonate aggregate concrete	5.5	7.1	8.9	10.4	12.0	14.0	16.2	18.1	20.3	21.9	24.7	27.2[c]
Sand-lightweight concrete	6.5	8.2	10.5	12.8	15.5	18.1	20.7	23.3	26.0[c]	Note c	Note c	Note c
Lightweight concrete	6.6	8.8	11.2	13.7	16.5	19.1	21.9	24.7	27.8[c]	Note c	Note c	Note c
Insulating concrete[a]	9.3	13.3	16.6	18.3	23.1	26.5[c]	Note c	Note c	Note c	Note c	Note c	Note c
Airspace[b]	—	—	—	—	—	—	—	—	—	—	—	—

MULTIWYTHE CONCRETE

TABLE 722.2.1.2(2)
FIRE-RESISTANCE RATINGS BASED ON $R^{0.59}$

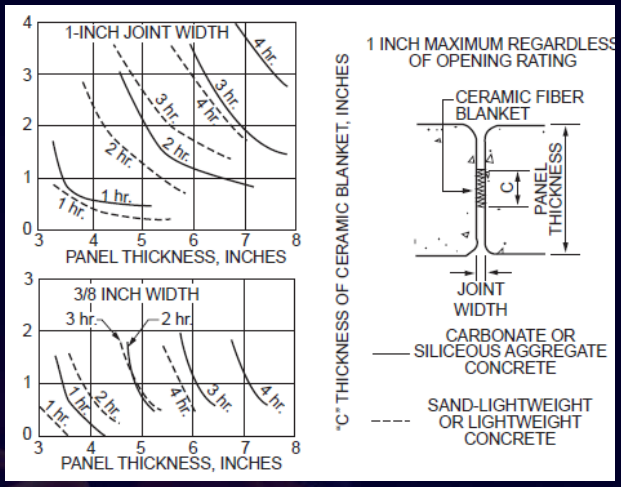
R^a, MINUTES	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

MULTIWYTHE CONCRETE

- CONCRETE SANDWICH PANEL – 4" CONCRETE, 2" RIGID FOAM, 2.5" CONCRETE
- $R^{0.59}$ = 13.0 + 2.5 + 8.1 = 23.6 > 21.41 (3 HOUR) < 25.37 (4 HOUR)
- R 216 MIN OR 3.6 HRS

PRECAST JOINTS

722.2.1.3 Joints between precast wall panels. Joints between precast concrete wall panels that are not insulated as required by this section shall be considered as openings in walls. Uninsulated joints shall be included in determining the percentage of openings permitted by Table 705.8. Where openings are not permitted or are required by this code to be protected, the provisions of this section shall be used to determine the amount of joint insulation required. Insulated joints shall not be considered openings for purposes of determining compliance with the allowable percentage of openings in Table 705.8.



CONCRETE & GYP BOARD

TABLE 722.2.1.4(2)
TIME ASSIGNED TO FINISH MATERIALS ON FIRE-EXPOSED SIDE OF WALL

FINISH DESCRIPTION	TIME (minutes)
Gypsum wallboard	
3/8 inch	10
1/2 inch	15
5/8 inch	20
2 layers of 3/8 inch	25
1 layer of 3/8 inch, 1 layer of 1/2 inch	35
2 layers of 1/2 inch	40
Type X gypsum wallboard	
1/2 inch	25
5/8 inch	40
Portland cement-sand plaster applied directly to concrete masonry	See Note a
Portland cement-sand plaster on metal lath	
3/4 inch	20
7/8 inch	25
1 inch	30
Gypsum sand plaster on 3/8-inch gypsum lath	
1/2 inch	35
5/8 inch	40
3/4 inch	50
Gypsum sand plaster on metal lath	
3/4 inch	50
7/8 inch	60
1 inch	80

CONCRETE & GYP BOARD

- **722.2.1.4.1 NONFIRE-EXPOSED SIDE.** WHERE THE FINISH OF GYPSUM WALLBOARD OR PLASTER IS APPLIED TO THE SIDE OF THE WALL NOT EXPOSED TO FIRE, THE CONTRIBUTION OF THE FINISH TO THE TOTAL *FIRE-RESISTANCE RATING* SHALL BE DETERMINED AS FOLLOWS: THE THICKNESS OF THE FINISH SHALL FIRST BE CORRECTED BY MULTIPLYING THE ACTUAL THICKNESS OF THE FINISH BY THE APPLICABLE FACTOR DETERMINED FROM TABLE 722.2.1.4(1) BASED ON THE TYPE OF AGGREGATE IN THE CONCRETE. THE CORRECTED THICKNESS OF FINISH SHALL THEN BE ADDED TO THE ACTUAL OR EQUIVALENT THICKNESS OF CONCRETE AND *FIRE-RESISTANCE RATING* OF THE CONCRETE AND FINISH DETERMINED FROM TABLES 722.2.1.1 AND 722.2.1.2(1) AND FIGURE 722.2.1.2.

CONCRETE & GYP BOARD

TABLE 722.2.1.4(1)
MULTIPLYING FACTOR FOR FINISHES ON NONFIRE-EXPOSED SIDE OF WALL

TYPE OF FINISH APPLIED TO CONCRETE OR CONCRETE MASONRY WALL	TYPE OF AGGREGATE USED IN CONCRETE OR CONCRETE MASONRY			
	Concrete: siliceous or carbonate Concrete Masonry: siliceous or carbonate; solid clay brick	Concrete: sand-lightweight Concrete Masonry: clay tile; hollow clay brick; concrete masonry units of expanded shale and < 20% sand	Concrete: lightweight Concrete Masonry: concrete masonry units of expanded shale, expanded clay, expanded slag, or pumice < 20% sand	Concrete Masonry: concrete masonry units of expanded slag, expanded clay, or pumice
Portland cement-sand plaster	1.00	0.75[a]	0.75[a]	0.50[a]
Gypsum-sand plaster	1.25	1.00	1.00	1.00
Gypsum-vermiculite or perlite plaster	1.75	1.50	1.25	1.25
Gypsum wallboard	3.00	2.25	2.25	2.25

CONCRETE & GYP BOARD

- **722.2.1.4.2 Fire-exposed side.** Where gypsum wallboard or plaster is applied to the fire-exposed side of the wall, the contribution of the finish to the total fireresistance rating shall be determined as follows: The time assigned to the finish as established by Table 722.2.1.4(2) shall be added to the fire-resistance rating determined from Tables 722.2.1.1 and 722.2.1.2(1) and Figure 722.2.1.2 for the concrete alone, or to the rating determined in Section 722.2.1.4.1 for the concrete and finish on the nonfireexposed side.

CONCRETE & GYP BOARD

- **722.2.1.4.3 Nonsymmetrical assemblies.** For a wall without finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of Sections 722.2.1.4.1 and 722.2.1.4.2 shall be performed twice, assuming either side of the wall to be the fire-exposed side. The *fire-resistance rating* of the wall shall not exceed the lower of the two values.
- **Exception:** For an *exterior wall* with a *fire separation distance* greater than 5 feet (1524 mm) the fire shall be assumed to occur on the interior side only.

CONCRETE & FINISHES

- **722.2.1.4.4 Minimum concrete fire-resistance rating.** Where finishes applied to one or both sides of a concrete wall contribute to the *fire-resistance rating*, the concrete alone shall provide not less than one half of the total required *fire-resistance rating*. Additionally, the contribution to the *fire resistance* of the finish on the nonfire-exposed side of a *loadbearing wall* shall not exceed one-half the contribution of the concrete alone.

MULTIWYTHE CONCRETE W/ FINISH

- Concrete sandwich panel – 4" concrete, 2" rigid foam, 2.5" concrete, 5/8" Typ X Gyp Bd fire side
- $R^{0.59}$ = 13.0 + 2.5 + 8.1 = 23.6 > 21.41 (3 hour) < 25.37 (4 hour)
- R 216 min +40 min = 256 min or 4.3 hrs

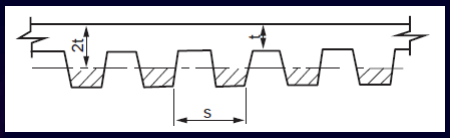
CONCRETE FLOORS

TABLE 722.2.2.1
MINIMUM SLAB THICKNESS (inches)

CONCRETE TYPE	FIRE-RESISTANCE RATING (hours)				
	1	1 1/2	2	3	4
Siliceous	3.5	4.3	5	6.2	7
Carbonate	3.2	4	4.6	5.7	6.6
Sand-lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

722.2.2.1.1 Hollow-core prestressed slabs. For hollow-core prestressed concrete slabs in which the cores are of constant cross section throughout the length, the equivalent thickness shall be permitted to be obtained by dividing the net cross-sectional area of the slab including grout in the joints, by its width.

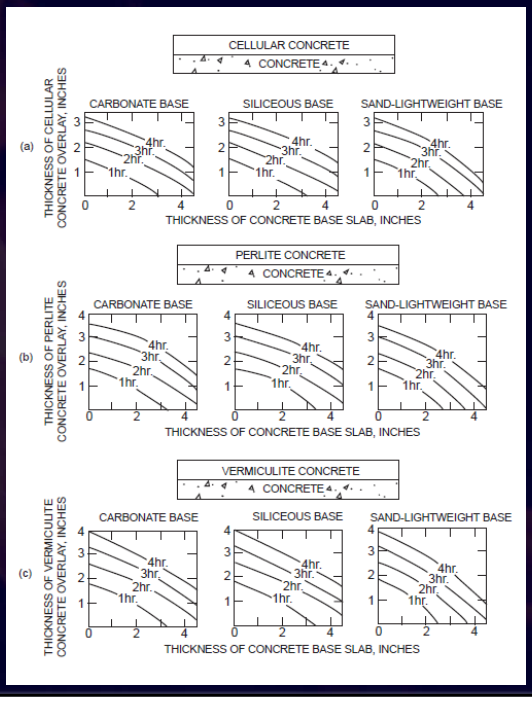
RIBBED CONCRETE

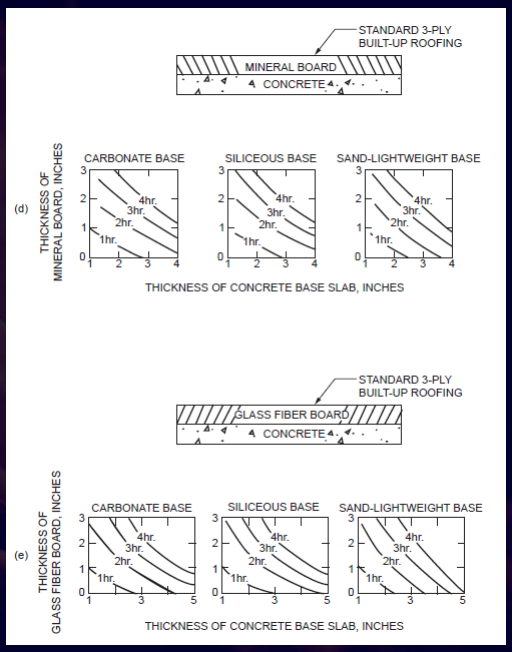


- For $s > 4t$, the thickness to be used shall be t
- For $s \leq 2t$, the thickness to be used shall be T_E
- For $4t > s > 2t$, the thickness to be used shall be: $t + \left(\frac{4t}{s} - 1\right)(t_e - t)$

CONCRETE ROOF SYSTEMS

722.2.2.2.3.1 Heat transfer. For the transfer of heat, three-ply built-up roofing contributes 10 minutes to the *fire-resistance rating*. The *fire-resistance rating* for concrete assemblies such as those shown in Figure 722.2.2.3(1) shall be increased by 10 minutes. This increase is not applicable to those shown in Figure 722.2.2.3(2).





CONCRETE COVER OVER REINFORCEMENT.

TABLE 722.2.3(1)
COVER THICKNESS FOR REINFORCED CONCRETE FLOOR OR ROOF SLABS (inches)

CONCRETE AGGREGATE TYPE	FIRE-RESISTANCE RATING (hours)									
	Restrained					Unrestrained				
	1	1 1/2	2	3	4	1	1 1/2	2	3	4
Siliceous	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1	1 1/4	1 5/8
Carbonate	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1 1/4	1 1/4
Sand-lightweight or lightweight	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1 1/4	1 1/4

CONCRETE COVER OVER REINFORCEMENT.

TABLE 722.2.3(2)
COVER THICKNESS FOR PRESTRESSED CONCRETE FLOOR OR ROOF SLABS (inches)

CONCRETE AGGREGATE TYPE	FIRE-RESISTANCE RATING (hours)									
	Restrained					Unrestrained				
	1	1 1/2	2	3	4	1	1 1/2	2	3	4
Siliceous	3/4	3/4	3/4	3/4	3/4	1 1/8	1 1/2	1 3/4	2 3/8	2 3/4
Carbonate	3/4	3/4	3/4	3/4	3/4	1	1 3/8	1 5/8	2 1/8	2 1/4
Sand-lightweight or lightweight	3/4	3/4	3/4	3/4	3/4	1	1 3/8	1 1/2	2	2 1/4

CONCRETE COVER OVER REINFORCEMENT.

TABLE 722.2.3(3)
MINIMUM COVER FOR MAIN REINFORCING BARS OF REINFORCED CONCRETE BEAMS[c]
(APPLICABLE TO ALL TYPES OF STRUCTURAL CONCRETE)

RESTRAINED OR UNRESTRAINED[a]	BEAM WIDTH[b] (inches)	FIRE-RESISTANCE RATING (hours)				
		1	1 1/2	2	3	4
Restrained	5	3/4	3/4	3/4	1[a]	1 1/4[a]
	7	3/4	3/4	3/4	3/4	3/4
	≥ 10	3/4	3/4	3/4	3/4	3/4
Unrestrained	5	3/4	1	1 1/4	—	—
	7	3/4	3/4	3/4	1 3/4	3
	≥ 10	3/4	3/4	3/4	1	1 3/4

CONCRETE COVER OVER REINFORCEMENT.

TABLE 722.2.3(4)
MINIMUM COVER FOR PRESTRESSED CONCRETE BEAMS 8 INCHES OR GREATER IN WIDTH[b]

RESTRAINED OR UNRESTRAINED[a]	CONCRETE AGGREGATE TYPE	BEAM WIDTH (inches)	FIRE-RESISTANCE RATING (hours)				
			1	1 1/2	2	3	4
Restrained	Carbonate or siliceous	8	1 1/2	1 1/2	1 1/2	1 3/4[a]	2 1/2[a]
	Carbonate or siliceous	≥ 12	1 1/2	1 1/2	1 1/2	1 1/2	1 7/8[a]
	Sand lightweight	8	1 1/2	1 1/2	1 1/2	1 1/2	2[a]
	Sand lightweight	≥ 12	1 1/2	1 1/2	1 1/2	1 1/2	1 5/8[a]
Unrestrained	Carbonate or siliceous	8	1 1/2	1 3/4	2 1/2	5[c]	—
	Carbonate or siliceous	≥ 12	1 1/2	1 1/2	1 7/8[a]	2 1/2	3
	Sand lightweight	8	1 1/2	1 1/2	2	3 1/4	—
	Sand lightweight	≥ 12	1 1/2	1 1/2	1 5/8	2	2 1/2

CONCRETE COLUMNS

TABLE 722.2.4
MINIMUM DIMENSION OF CONCRETE COLUMNS (inches)

TYPES OF CONCRETE	FIRE-RESISTANCE RATING (hours)				
	1	1½	2[a]	3[a]	4[b]
Siliceous	8	9	10	12	14
Carbonate	8	9	10	11	12
Sand-lightweight	8	8½	9	10½	12

722.2.4.2 Minimum cover for R/C columns. The minimum thickness of concrete cover to the main longitudinal reinforcement in columns, regardless of the type of aggregate used in the concrete and the specified compressive strength of concrete, f'_c, shall be not less than 1 inch (25 mm) times the number of hours of required *fire resistance* or 2 inches (51 mm), whichever is less.

CONCRETE MASONRY EQUIVALENT THICKNESS

- T_E = 1728A/LH
- A = NET VOLUME IN CU FT
- L = LENGTH IN INCHES
- H = HEIGHT IN INCHES
- A = C/D
- C = DRY UNIT WEIGHT IN LBS
- D = DENSITY IN POUNDS PER CUBIC FEET

EXAMPLE

- Dry unit weight 44 lbs, density 135 pcf
- A = 44lbs/135pcf = 0.326 cu ft
- T_E = (1728in^3/ft^3)(0.326 ft^3)/(15.625")(7.625")=4.73"

CONCRETE MASONRY

Nominal dimensions (inches)	Specified thickness (inches)	Equivalent thickness (inches)		Net concrete volume (cubic feet)	
		Minimum	Typical	Minimum	Typical
4x8x16	3.63	1.91	2.36	0.132	0.161
6x8x16	5.63	2.66	2.76	0.183	0.190
8x8x16	7.63	3.41	3.97	0.235	0.274
10x8x16	9.63	4.16	5.00	0.287	0.345
12x8x16	11.63	4.91	5.7	0.339	0.393

CONCRETE MASONRY UNITS

TABLE 722.3.2
MINIMUM EQUIVALENT THICKNESS (inches) OF BEARING OR NONBEARING CONCRETE MASONRY WALLS[a, b, c, d]

TYPE OF AGGREGATE	FIRE-RESISTANCE RATING (hours)														
	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4
Pumice or expanded slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded shale, clay or slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, cinders or unexpanded slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous or siliceous gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2

CONCRETE MASONRY

- **722.3.1.2 Ungrouted or partially grouted construction.** Te shall be the value obtained for the concrete masonry unit determined in accordance with ASTM C140.
- **722.3.1.3 Solid grouted construction.** The equivalent thickness, Te, of solid grouted concrete masonry units is the actual thickness of the unit.
- **722.3.1.4 Airspaces and cells filled with loose-fill material.** The equivalent thickness of completely filled hollow concrete masonry is the actual thickness of the unit where loose-fill materials are: sand, pea gravel, crushed stone, or slag that meet ASTM C33 requirements; pumice, scoria, expanded shale, expanded clay, expanded slate, expanded slag, expanded fly ash, or cinders that comply with ASTM C331; or perlite or vermiculite meeting the requirements of ASTM C549 and ASTM C516, respectively.

CONCRETE MASONRY MULTIWYTHE

$$R_A = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59} + A_1 + A_2 + \ldots + A_n)^{1.7}$$

(Equation 7-7)

where:

R_A = *Fire-resistance rating* of the assembly (hours).

$R_1, R_2, \ldots, R_n$ = *Fire-resistance rating* of wythes for 1, 2, *n* (hours), respectively.

$A_1, A_2, \ldots, A_n$ = 0.30, factor for each continuous airspace for 1, 2, ...*n*, respectively, having a depth of $^1/_2$ inch (12.7 mm) or more between wythes.

CONCRETE MASONRY MULTIWYTHE

- 4" SOLID SPLITFACE CMU, 2" AIRSPACE, 2" RIGID FOAM, 8" CMU, 5/8" TYPE X GYP BD
- ALL BLOCK LIMESTONE AGGREGATE
- $R = (2.0^{0.59} + 0.30 + 2.5^{0.59})^{1.7} = 8.5$ HRS
- R=8.5 HRS +.67 HRS = 9.2 HRS

CONCRETE MASONRY COLUMNS

TABLE 722.3.5
MINIMUM DIMENSION OF CONCRETE MASONRY COLUMNS (Inches)

FIRE-RESISTANCE RATING (hours)			
1	2	3	4
8 inches	10 inches	12 inches	14 inches

MASONRY

TABLE 722.4.1(1)
FIRE-RESISTANCE PERIODS OF CLAY MASONRY WALLS

MATERIAL TYPE	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE RESISTANCE[a, b, c] (inches)			
	1 hour	2 hours	3 hours	4 hours
Solid brick of clay or shale[d]	2.7	3.8	4.9	6.0
Hollow brick or tile of clay or shale, unfilled	2.3	3.4	4.3	5.0
Hollow brick or tile of clay or shale, grouted or filled with materials specified in Section 722.4.1.1.3	3.0	4.4	5.5	6.6

CLAY MASONRY

$T_e = V_n/LH$ **(Equation 7-8)**

where:

T_e = The equivalent thickness of the clay masonry unit (inches).

V_n = The net volume of the clay masonry unit (inch^3).

L = The specified length of the clay masonry unit (inches).

H = The specified height of the clay masonry unit (inches).

CLAY MASONRY

- **722.4.1.1.1 Hollow clay units.** The equivalent thickness, Te, shall be the value obtained for hollow clay units as determined in accordance with Equation 7-8. The net volume, Vn, of the units shall be determined using the gross volume and percentage of void area determined in accordance with ASTM C67.
- **722.4.1.1.2 Solid grouted clay units.** The equivalent thickness of solid grouted clay masonry units shall be taken as the actual thickness of the units.
- **722.4.1.1.3 Units with filled cores.** The equivalent thickness of the hollow clay masonry units is the actual thickness of the unit where completely filled with loose-fill materials of: sand, pea gravel, crushed stone, or slag that meet ASTM C33 requirements; pumice, scoria, expanded shale, expanded clay, expanded slate, expanded slag, expanded fly ash, or cinders in compliance with ASTM C331; or perlite or vermiculite meeting the requirements of ASTM C549 and ASTM C516, respectively.

CLAY MASONRY

722.4.1.2 Plaster finishes. Where plaster is applied to the wall, the total *fire-resistance rating* shall be determined by the formula:

$$R = (R_n^{0.59} + pl)^{1.7} \quad \textbf{(Equation 7-9)}$$

where:

R = The *fire-resistance rating* of the assembly (hours).

R_n = The *fire-resistance rating* of the individual wall (hours).

pl = Coefficient for thickness of plaster.

TABLE 722.4.1(3)
VALUES OF $R_n^{0.59}$

R_n 0.59	R (hours)
1	1.0
2	1.50
3	1.91
4	2.27

TABLE 722.4.1(4)
COEFFICIENTS FOR PLASTER, pl [a]

THICKNESS OF PLASTER (inch)	ONE SIDE	TWO SIDES
1/2	0.3	0.6
5/8	0.37	0.75
3/4	0.45	0.90

HYBRID MASONRY WALLS

TABLE 722.4.1(2)
FIRE-RESISTANCE RATINGS FOR BEARING STEEL FRAME BRICK VENEER WALLS OR PARTITIONS

WALL OR PARTITION ASSEMBLY	PLASTER SIDE EXPOSED (hours)	BRICK FACED SIDE EXPOSED (hours)
Outside facing of steel studs: 1/2" wood fiberboard sheathing next to studs, 3/4" airspace formed with 3/4" × 1 5/8" wood strips placed over the fiberboard and secured to the studs; metal or wire lath nailed to such strips, 3 3/4" brick veneer held in place by filling 3/4" airspace between the brick and lath with mortar. Inside facing of studs: 3/4" unsanded gypsum plaster on metal or wire lath attached to 5/16" wood strips secured to edges of the studs.	1.5	4
Outside facing of steel studs: 1" insulation board sheathing attached to studs, 1" airspace, and 3 3/4" brick veneer attached to steel frame with metal ties every 5th course. Inside facing of studs: 7/8" sanded gypsum plaster (1:2 mix) applied on metal or wire lath attached directly to the studs.	1.5	4
Same as previous assembly except use 7/8" vermiculite-gypsum plaster or 1" sanded gypsum plaster (1:2 mix) applied to metal or wire.	2	4
Outside facing of steel studs: 1/2" gypsum sheathing board, attached to studs, and 3 3/4" brick veneer attached to steel frame with metal ties every 5th course. Inside facing of studs: 1/2" sanded gypsum plaster (1:2 mix) applied to 1/2" perforated gypsum lath securely attached to studs and having strips of metal lath 3 inches wide applied to all horizontal joints of gypsum lath.	2	4

For SI: 1 inch = 25.4 mm.

STEEL

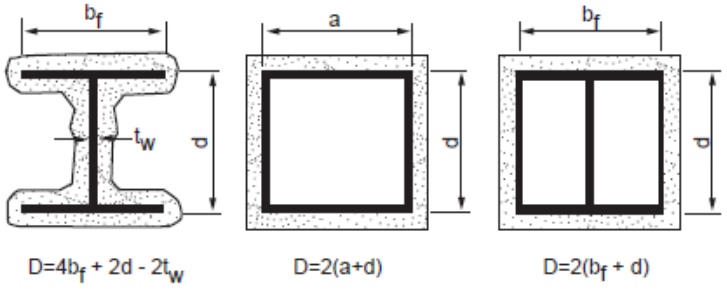


FIGURE 722.5.1(1)
DETERMINATION OF THE HEATED PERIMETER OF STRUCTURAL STEEL COLUMNS

STEEL WITH GYP BD

$$R = 130\left[\frac{h(W'/D)}{2}\right]^{0.75} \quad \textbf{(Equation 7-12)}$$

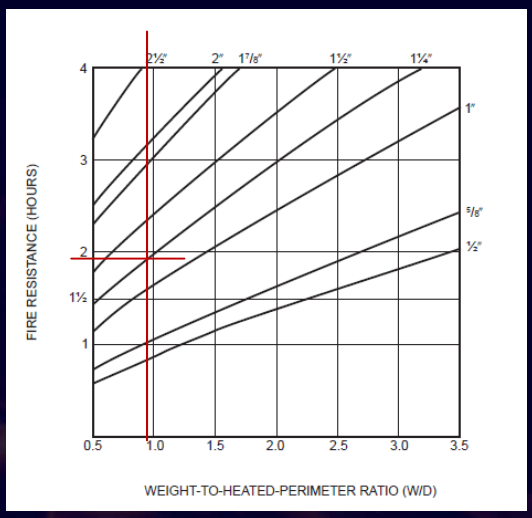
where:

R = Fire resistance (minutes).
h = Total thickness of gypsum wallboard (inches).
D = Heated perimeter of the structural steel column (inches).
W' = Total weight of the structural steel column and gypsum wallboard protection (pounds per linear foot).
$W' = W + 50hD/144$.

- **722.5.1.2 Gypsum wallboard protection.** The fire resistance of structural steel columns with weight-to-heated- perimeter ratios (W/D) less than or equal to 3.65 and that are protected with Type X gypsum wallboard shall be permitted to be determined from the following expression:
- **7.22.5.1.2.2 …** For structural steel columns with weight-to-heated-perimeter ratios (W/D) greater than 3.65, the thickness of gypsum wallboard required for specified fire-resistance ratings shall be the same as the thickness determined for a W14 × 233 wide flange shape.

W14X61
2 LAYERS 5/8" TYPE X

- D = 4(9.99")+2(13.9")-2(0.375") = 67"
- W/D = 61/67 = 0.91
- W' = 61+ 50(1.25")(67")/144 = 90
- R = 130(1.25"(90/67)/2)$^{0.75}$ =114 MIN



STEEL WITH SFRM

$R = [C_1(W/D) + C_2]h$ **(Equation 7-13)**

where:

R = Fire resistance (minutes).

h = Thickness of sprayed fire-resistant material (inches).

D = Heated perimeter of the structural steel column (inches).

C_1 and C_2 = Material-dependent constants.

W = Weight of structural steel columns (pounds per linear foot).

STEEL BEAMS

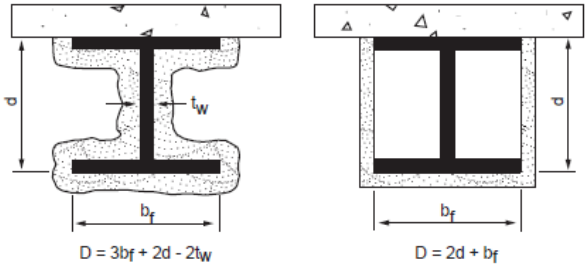


FIGURE 722.5.2
DETERMINATION OF THE HEATED PERIMETER OF STRUCTURAL STEEL BEAMS AND GIRDERS

STEEL BEAMS

- **722.5.2.1.2 BEAM AND GIRDER SUBSTITUTIONS.** EXCEPT AS PROVIDED FOR IN SECTION 722.5.2.2, STRUCTURAL STEEL BEAMS IN APPROVED FIRE-RESISTANCE-RATED ASSEMBLIES SHALL BE CONSIDERED TO BE THE MINIMUM PERMISSIBLE SIZE. OTHER BEAM OR GIRDER SHAPES SHALL BE PERMITTED TO BE SUBSTITUTED PROVIDED THAT THE WEIGHT-TO-HEATED-PERIMETER RATIO (W/D) OF THE SUBSTITUTE BEAM IS EQUAL TO OR GREATER THAN THAT OF THE BEAM SPECIFIED IN THE APPROVED ASSEMBLY.

STEEL BEAMS

- **722.5.2.2 Sprayed fire-resistant materials.** The provisions in this section apply to structural steel beams and girders protected with sprayed fire-resistant materials. Larger or smaller beam and girder shapes shall be permitted to be substituted for beams specified in *approved* unrestrained or restrained fire-resistance-rated assemblies, provided that the thickness of the fire-resistant material is adjusted in accordance with the following expression:

$$h_2 = h_1 \, [(W_1 / D_1) + 0.60] / [(W_2 / D_2) + 0.60] \quad \textbf{(Equation 7-17)}$$

where:

h = Thickness of sprayed fire-resistant material in inches.

W = Weight of the structural steel beam or girder in pounds per linear foot.

D = Heated perimeter of the structural steel beam in inches.

WOOD

- **722.6.1.1 Maximum fire-resistance rating.** Fire-resistance ratings calculated for assemblies using the methods in Section 722.6 shall be limited to not more than 1 hour.
- **722.6.1.2 Dissimilar membranes.** Where dissimilar membranes are used on a wall assembly that requires consideration of fire exposure from both sides, the calculation shall be made from the least fire-resistant (weaker) side.

WOOD

- **722.6.2.1 Fire-resistance rating of wood frame assemblies.** The fire-resistance rating of a wood frame assembly is equal to the sum of the time assigned to the membrane on the fire-exposed side, the time assigned to the framing members and the time assigned for additional contribution by other protective measures such as insulation. The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly.

TABLE 722.6.2(1)
TIME ASSIGNED TO WALLBOARD MEMBRANES[a, b, c, d]

DESCRIPTION OF FINISH	TIME[c](minutes)
$^{3}/_{8}$-inch wood structural panel bonded with exterior glue	5
$^{15}/_{32}$-inch wood structural panel bonded with exterior glue	10
$^{19}/_{32}$-inch wood structural panel bonded with exterior glue	15
$^{3}/_{8}$-inch gypsum wallboard	10
$^{1}/_{2}$-inch gypsum wallboard	15
$^{5}/_{8}$-inch gypsum wallboard	30
$^{1}/_{2}$-inch Type X gypsum wallboard	25
$^{5}/_{8}$-inch Type X gypsum wallboard	40
Double $^{3}/_{8}$-inch gypsum wallboard	25
$^{1}/_{2}$-inch + $^{3}/_{8}$-inch gypsum wallboard	35
Double $^{1}/_{2}$-inch gypsum wallboard	40

TABLE 722.6.2(2)
TIME ASSIGNED FOR CONTRIBUTION OF WOOD FRAME [a, b, c]

DESCRIPTION	TIME ASSIGNED TO FRAME (minutes)
Wood studs 16 inches o.c.	20
Wood floor and roof joists 16 inches o.c.	10

TABLE 722.6.2(3)
MEMBRANE[a] ON EXTERIOR FACE OF WOOD STUD WALLS

SHEATHING	PAPER	EXTERIOR FINISH
$^5/_8$-inch T & G lumber $^5/_{16}$-inch exterior glue wood structural panel $^1/_2$-inch gypsum wallboard $^5/_8$-inch gypsum wallboard $^1/_2$-inch fiberboard	Sheathing paper	Lumber siding Wood shingles and shakes $^1/_4$-inch fiber-cement lap, panel or shingle siding $^1/_4$-inch wood structural panels-exterior type $^1/_4$-inch hardboard Metal siding Stucco on metal lath Masonry veneer Vinyl siding
None	—	$^3/_8$-inch exterior-grade wood structural panels

TABLE 722.6.2(4)
FLOORING OR ROOFING OVER WOOD FRAMING[a]

ASSEMBLY	STRUCTURAL MEMBERS	SUBFLOOR OR ROOF DECK	FINISHED FLOORING OR ROOFING
Floor	Wood	$^{15}/_{32}$-inch wood structural panels or $^{11}/_{16}$-inch T & G softwood	Hardwood or softwood flooring on building paper resilient flooring, parquet floor felted-synthetic fiber floor coverings, carpeting, or ceramic tile on $^1/_4$-inch-thick fiber-cement underlayment or $^3/_8$-inch-thick panel-type underlay Ceramic tile on $1^1/_4$-inch mortar bed
Roof	Wood	$^{15}/_{32}$-inch wood structural panels or $^{11}/_{16}$-inch T & G softwood	Finished roofing material with or without insulation

TABLE 722.6.2(5)
TIME ASSIGNED FOR ADDITIONAL PROTECTION

DESCRIPTION OF ADDITIONAL PROTECTION	FIRE RESISTANCE (minutes)
Add to the *fire-resistance rating* of wood stud walls if the spaces between the studs are completely filled with glass fiber mineral wool batts weighing not less than 2 pounds per cubic foot (0.6 pound per square foot of wall surface) or rockwool or slag material wool batts weighing not less than 3.3 pounds per cubic foot (1 pound per square foot of wall surface), or cellulose insulation having a nominal density not less than 2.6 pounds per cubic foot.	15

WOOD

- **722.6.2.3 Exterior walls.** For an exterior wall with a fire separation distance greater than 10 feet (3048 mm), the wall is assigned a rating dependent on the interior membrane and the framing as described in Tables 722.6.2(1) and 722.6.2(2). The membrane on the outside of the nonfire-exposed side of exterior walls with a fire separation distance greater than 10 feet (3048 mm) shall consist of sheathing, sheathing paper and siding as described in Table 722.6.2(3).
- **722.6.2.4 Floors and roofs.** In the case of a floor or roof, the standard test provides only for testing for fire exposure from below. Except as noted in Section 703.3, Item 5, floor or roof assemblies of wood framing shall have an upper membrane consisting of a subfloor and finished floor conforming to Table 722.6.2(4) or any other membrane that has a contribution to fire resistance of not less than 15 minutes in Table 722.6.2(1).

WOOD

- 2x6 No 2 SPF @16 in oc with 2 layers 5/8" Typ X Gyp Bd each side, mineral wool batt 2.5 pcf fill the cavity
- R = (2)40 min + 15 min + 20 min = 115 min


QUESTIONS