



## FIRE RATED ASSEMBLIES OF COLD-FORMED STEEL CONSTRUCTION

**Summary:** Cold-formed steel has been widely used in commercial buildings, especially in non-load bearing (partitions) and curtain wall applications. Cold-formed steel sections are increasingly used as primary structural members, such as beams and columns, or as load-bearing walls or partitions in commercial and residential construction. In most cases, these members are required to be fire resistant where they are part of a compartment wall or floor, or where they support other floors. The purpose of this *Tech Note* is to provide the user with a comprehensive list of resources summarizing available tested fire rated steel assemblies, building code requirements, test methods and applicable references.

### Introduction

Building codes frequently require steel framed assemblies to have a fire-resistance rating that is based on fire tests conducted in accordance with a recognized standard test. Fire rating of an assembly is a measurement which indicates how long the assembly will resist the spread of fire while maintaining structural integrity. Fire resistance ratings are expressed by the number of hours that a wall assembly can maintain its integrity while containing the fire, smoke, and temperature of a working fire. Life safety, and specifically fire protection, has been and will always be a primary concern of the building codes. Current US building codes have significant requirements regulating the use of fire rated assemblies through the installation of firestopping (or fire blocking), draftstopping, and fire suppression systems.

### Methods of Fire Protecting Cold-Formed Steel Sections

The methods of fire protecting load-bearing and non-load bearing cold-formed steel sections can be broadly defined as follows:

1. Planar or flat protection to floors, walls, and ceilings by

single or multi-layer gypsum boards or similar fire protecting boards.

2. Board protection to columns and beams in the form of a box around the section.
3. Sprayed protection to columns and beams around the profile of the section.

The thickness of fire protection needed depends upon the exposure condition and the occupancy classification and hence is intended to limit the heat that enters the section.

### Fire Resistance Requirements

Gypsum wallboard and its derivatives provide the necessary fire protection in floors and walls, such that one or two layers of fire-resistant boards will provide the 1 or 2-hour fire protection. The three major building codes and the CABO outline the minimum fire rating requirements of steel framed assemblies. US building codes have similar, if not the same, requirements for fire rated steel assemblies. Furthermore, some localities in the US, in particular large cities such as New York or Los Angeles, have their own codes which are often more restrictive than the model building codes requirements. Fire rating requirements are described in the chapters/sections of the US building code as shown in Table 1.

### Definitions

**Fire Suppression System:** System, such as water fed sprinklers, that provide early and automatic detection and suppression of developing fires.

**Fire Walls:** A fire resistance rated wall, having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof.

**Occupancy Classification:** The level of hazard associated with the use of the building dictates a level of fire resistance necessary to protect the occupants of the building. Normal or "low hazard" occupancies, such as offices, generally do not require fire resistance ratings, in and of themselves.

**Party Wall:** A fire wall on an interior lot line used or adapted for joint service between two buildings (such as between townhouses)

Table 1

**Applicable Building Code Sections for Fire Rated Steel Assemblies**

Building Code	Fire Resistance Requirements for Building Elements
BOCA's National Building Code (NBC)	Chapters 3, 4, 5, 6, 7, and 9 Table 302.1.1, 313.1.2, 507.2, 602, 705.2 and other tables in Chapter 7, Table 1011.4
ICBO's Uniform Building Code (UBC)	Chapters 3, 4, 5, 6, and 7 Tables 5-A and 5-B, Table 6-A, Table 7-A, 7-B (Walls and Partitions), & 7-C (Floor and Roof systems)
SBCCI's Standard Building Code (SBC)	Chapters 3, 6, and 7 Table 600, 700, & other Tables in Chapter 7.
CABO's One and Two family Dwelling Code	Sections 320, 502.11, 602.7, and Chapter 7.
IBC (Final Draft)	Chapters 6,7, 9
IRC (First Draft)	Sections 320,502.10,602.8 and Chapter 7.

**Resources**

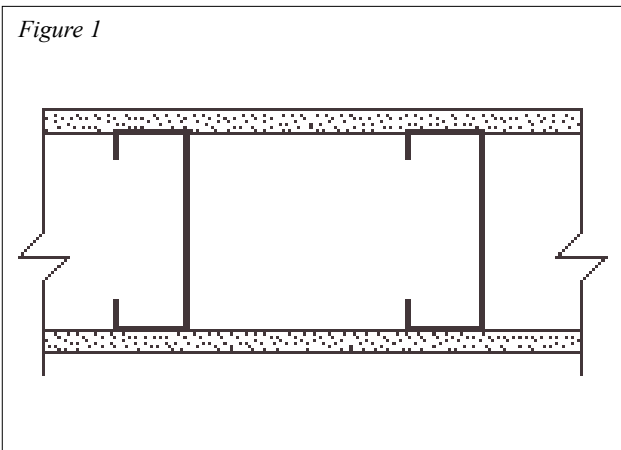
The Gypsum Association, Underwriters Laboratories, Inc. Factory Mutual, and Intertek Testing Services (Warnock Hersey) are the main sources of information on fire resistance and fire ratings of cold-formed steel assemblies. Other organizations, such as the Brick Institute of America, the AISI and CSSBI, have limited information, details and design information. Table 3 is a detailed list of available publications and technical data (primarily in North America).

Table 4 summarizes the contents of the Gypsum

Association's Fire Resistance Design Manual. Table 5 provides a quick summary of the UL's, Gypsum Association's, and Factory Mutual's fire ratings. Table 6 provides a summary of tested fire rated steel assemblies from the Gypsum Design Manual, UL Directory, and Factory Mutual's Product Guide. The information in Table 6 is not inclusive. Table 7 provides a comparison between the three model building codes for the type of construction based on the final draft of the International Building Code (IRC) construction types.

**Sample Assemblies**

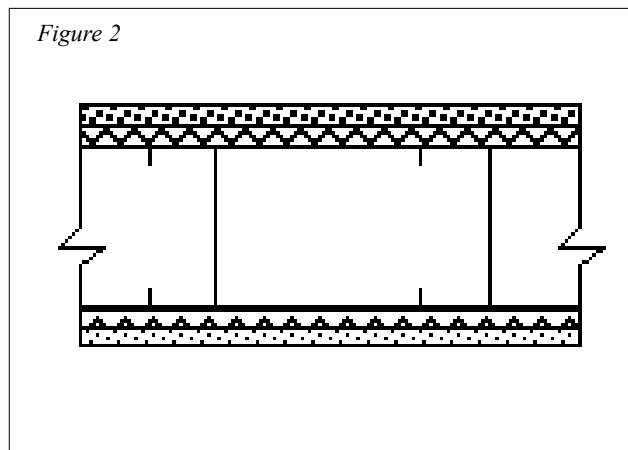
Figure 1



**1 Hour Fire Rated Wall and Interior Partition (Load Bearing)**

- 3 1/2" x 33 mil (20 Ga.) steel studs spaced at 24" o.c.
- One layer 5/8" Type X GWB or veneer applied parallel to each side of steel stud with Type S-12 drywall screws spaced at 12" o.c.
- Lateral bracing provided by 1" x 43 mil (18 Ga.) steel strap spaced not more than 48" o.c. attached to each side of stud.

Figure 2



**1 Hour Fire Rated Floor-Ceiling System**

- 6" x 1-5/8" x 43 mil (18 Ga.) steel channels spaced at 24" o.c.
- One layer 1/2" Type X GWB applied to resilient furring channels 24" o.c. with Type S drywall screws 12" o.c. Resilient channel fastened to 6" joists with 3/8" Type S-12 drywall screws at 24" o.c.
- Top layer of 2" (measured from top flute) light weight concrete of 105 pcf density over 18 mil (25 Ga.) corrugated metal deck.

## Standards and Test Methods

The US model building codes, except the UBC, recognize the ASTM E119 test method as an acceptable method to test fire rated assemblies. The UBC cites its own standard, UBC Standard 7-1. Code bodies usually accept fire

tests conducted by recognized laboratories (such as UL) or organizations (such as Factory Mutual). Table 2 (below) summarizes the most recognized test methods.

Table 2

**Test Methods for Fire-rated Steel Assemblies**

Standard	Title	Description
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials	Test methods described in this fire-test-response standard are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops	Applicable to through-penetration fire stops of various materials and construction. Fire stops are intended for use in openings in fire-resistive walls and floors that are evaluated in accordance with Test Methods E119.
Factory Mutual	Insulated Wall Construction	Intended for non-load bearing walls (curtain walls) having relatively low fire endurance properties and not intended as hourly rated fire barriers. This test method can be modified to evaluate the performance of partition walls.
Factory Mutual	Insulated Steel Deck Roofs	Intended for the evaluation of commercial type construction such as steel trusses.
International Standard ISO 834	Fire Resistance Tests of Elements in Building Construction	Provides the means to evaluate structural elements of building construction (walls, partitions, columns, beams, and floors) during a predetermined fire test exposure. The assemblies are assigned ratings based upon the duration of the test and the ability of the assembly to exhibit fire-resistance properties
UBC Standard 7-1	Standard for Fire Tests of Building Construction and Materials	This test method is based on ASTM E119.
UL Standard UL 1479	Fire Tests of Through-Penetration Firestops	This test method is based on ASTM E814.
UL Standard UL 263	Standard for Fire Tests of Building Construction and Materials	This test method is based on ASTM E119
UL Standard UL 2079	Tests for Fire Resistance of Building Joint Systems	Used to test joint systems and firestop systems which are intended to prevent the spread of fire through openings between or within fire resistive assemblies.
Intertek Testing Services / Warnock Hersey	Fire Rating & Certification for Products & Systems	Test systems (such as wall assemblies, fire doors and frames, and floor/roof/ceiling) as effective fire barriers and to determine the surface burning characteristics of building material, including flame spread, and smoke developed during exposure to fire.

Additional information and a comprehensive collection of fire-rated assemblies is available through the following organizations:

Underwriters Laboratories, Inc.  
333 Pfingsten Road  
Northbrook, IL 60062-2096  
(847) 272-8800

Gypsum Association  
810 First Street NE, #510  
Washington, DC 20002  
(202) 289-5440

Factory Mutual System  
1151 Boston-Providence Turnpike  
Norwood, MA 02062  
(617) 255-4682

Table 3

### List of Resources for Fire-Rated Steel Assemblies

Source of Information	Title
Gypsum Association	Fire Resistance Design Manual
Underwriters Laboratories Inc. (UL)	Fire Resistance Directory-Volumes I and II
Factory Mutual	Specification Tested Products Guide
Factory Mutual	Loss Prevention Data 1-1 Firesafe Building Construction and Materials, 1-13 Chimneys, 1-28 Insulated Steel Deck, 1-31 Metal Roof Systems
Metal Lath/Steel Framing Association	Technical Bulletin "One-Hour Floor /Ceiling Fire Resistance Test" and "Two-Hour Floor/Ceiling Fire Resistance Test"
Canadian Sheet Steel Building Institute (CSSBI)	"Results of Fire Resistance Tests on Full-Scale, Insulated and Non-Insulated, Gypsum Board Protected Wall Assemblies", NRC Report A-4065.1, "Results of Fire Resistance Tests on Small-Scale, Insulated and Non-Insulated, Gypsum Board Protected Wall Assemblies", NRC Report No. A-4065.2, and "Results of Fire Resistance Tests on Full-Scale Floor Assemblies", NRC Report No. 764.
Brick Institute of America	Technical Notes No. 16B, Calculated Fire Resistance
American Iron and Steel Institute (AISI)	FT-90 - Fire Resistance Ratings of Load Bearing Steel Stud Walls With Gypsum Wallboard Protection With or Without Cavity Insulation.
American Iron and Steel Institute (AISI)	Fire Resistance Steel-Frame Construction, 1973
American Iron and Steel Institute (AISI)	Designing Fire Protection for Steel Trusses
The Steel Construction Institute, SCI P129	Building Design Using Cold-Formed Steel Sections: Fire protection", 1993
Owens Corning	Extruded Polystyrene Insulation Foamular Commercial Steel Stud System
Intertek Testing Services /Warnock Hersey	Directory of Listed Products
US Department of Housing and Urban Development (HUD)	A Guide to Airborne, Impact, and Structure Borne - Noise Control in Multifamily Dwellings

Table 4

### Fire Resistance Design Manual-Gypsum Systems

System description	Fire Rating			
	1 Hour	2 Hours	3 Hours	4 Hours
Interior Partitions	x	x	x	x
Chase Walls	x	x		
Movable Walls & Office Partitions	x			
Shaft Walls	x	x	x	
Exterior Walls	x	x		
Metal Clad Exterior Walls	x	x		
Party Walls		x	x	
Floor-Ceiling Assembly-Steel Frame-Concrete Slab	x	x	x	x
Floor-Ceiling Assembly-Steel Frame-Wood Floor	x			
Steel Columns with Metal studs		x	x	x
Beams and Girders	x	x	x	x

Description
Systems in this manual utilize gypsum products to provide fire resistance to walls, partitions, floors, ceilings, roof-ceilings, columns, beams, girders, and trusses. Fire rated assemblies in this manual are classified in accordance to use and fire resistance rating.
This directory has the most extensive listing of fire-rated assemblies (Vol. I) and firestop penetrations (Vol. II). The ratings are categorized by material and usage. Listed fire resistive assemblies were tested in accordance with ASTM E119
This publication has a limited number of fire rated steel assemblies. This publication is not referenced by building codes, but its fire-rated fire assemblies were tested in accordance with ASTM E119.
Series of data sheets addressing fire rated assemblies. These data sheets are geared towards commercial and industrial applications.
These technical bulletins provide results of specific fire tests.
The National Research Council of Canada conducted 8 full-scale non-loadbearing wall tests, 30 small-scale wall tests, and 5 full-scale floor tests. From these, a whole series of fire-resistance ratings for cold-formed steel assemblies have been including in the National Building Code of Canada. Further Loadbearing wall and floor tests are in progress. Test details are provided in these reports.
This Technical Note provides information on steel-frame, brick veneer wall construction fire ratings.
This publication developed an analytical method to predict the structural behavior of cold-formed steel studs in load bearing walls under elevated temperatures.
This publication provides an overview of fire protection requirements, methods, and materials. Rated assemblies include walls, floors, and roof decks.
This publication discusses methods of protecting three types of truss systems.
This publication presents the principles of fire resistance as applied to light-gauge steel sections and the methods of achieving it by adequate protection. Details in this publication are based on tests conducted by British Steel based on British Standards.
This publication contains information and construction details for a proprietary system consisting of steel framed /brick veneer walls that are routinely specified in commercial and multi-family residential construction. The Foamular Extruded Polystyrene Insulation is a part of fire resistance rated steel framing/masonry veneer, non-load bearing exterior wall assembly. The system was tested in accordance with ASTM E119 and provides a 3-hour fire rating
This directory contains construction details for a wide variety of fire-rated proprietary steel floor/ceiling assemblies.
This guide contains fire rated steel assemblies for residential construction, especially apartments and multifamily dwellings.

*Table 5*

**Ratings of Tested Steel Assemblies <sup>1</sup>**

	Load-Bearing Walls				Nonload-Bearing Walls				Floors/Ceilings				Roof-Ceilings			
	1-HR	2-HR	3-HR	4-HR	1-HR	2-HR	3-HR	4-HR	1-HR	2-HR	3-HR	4-HR	1-HR	2-HR	3-HR	4-HR
UL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
GA	x	x			x	x	x	x	x	x	x	x				
FM	x	x			x	x <sup>2</sup>	x	x	x	x			x	x		x
HUD					x	x			x	x <sup>3</sup>	x					

1. UL denotes Underwriters laboratories; Inc., GA denotes Gypsum Association; and FM denotes Factory Mutual.
2. Fire rating details for 3 HR walls with steel angles perimeter supports and 33 mil (20 ga.) liner panels are provided.
3. Listed fire rating is 1-1/2 HR.

Table 6

Selected Fire-Rated Steel Assemblies<sup>1</sup>

Fire Rating(Hrs)	Source / Assembly ID	System Description	
		Stud Size & Spacing	
1	UL Vol. I - Design No. U404	3-1/2"x 33 mil (20 Ga.), 16" o.c. max. spacing	
1	UL Vol. I -Design No. U410	2-1/2"x1-3/8" x1/4" lip, 18 mil (25 Ga.), 24" o.c. max. spacing	
1	GA WP 1015	2-1/2"x 18 mil (25 Ga.), 24" o.c. max. spacing	
1	GA WP 1053	2-1/2"x 18 mil (25 Ga.), 24" o.c. max. spacing	
1	GA WP 1204	3-1/2" x 33 mil (20 Ga.), 24" o.c. max.	
1	GA WP 1206	3-1/2" x 33 mil (20 Ga.), 24" o.c. max. spacing	
2 (plaster side exposed) 4 (brick side exposed)	BIA 16B	43 mil (18 Ga.), minimum	
2	UL Vol. I - Design No. U411	2-1/2"x1-1/4"x 3/8" lip, 18 mil (25 Ga.), 24" o.c. max. spacing	
2	GA WP 1470	3-1/2" x 33 mil (20 Ga.), 24" o.c. max. spacing	
2	UL Vol. I - Design No. U418	3-1/2" or 5-1/2" x 1-1/2" x 1/2" lip, 43 mil (18 Ga.), 24" o.c. max.	
2	UL Vol. I - Design No. U420	(2) 1-5/8" x 1-3/8" x 1/4" x 18 mil (25 Ga.), at 24" o.c. max. spacing. Channel studs separated by 9 -1/2" steel runner or GWB	
2	UL Vol. I - Design No. U425	3-1/2" x 33 mil (20 Ga.) 24" o.c. max. spacing	
2	GA WP 1635	3-1/2" x 33 mil (20 Ga.), 24" o.c. max. spacing	
3	UL Vol. I - Design No. U419	1-5/8"x1-1/4"x 1/4" lip, 18 mil (25 Ga.), 24" o.c. max.	
3	GA WP 2800	1-5/8" stud, 24" o.c. max.	
3	UL Vol. I - Design No. U426	3-1/2", 33 mil (20 Ga.), 24" o.c. max. spacing	
4	GA WP 2945	1-5/8 stud, 24" o.c. max.	
1	GA WP 8001	3-5/8"x 33 mil (20 Ga.), 16" o.c. max. spacing	
2	GA WP 8202	3-5/8"x 43 mil (18 Ga.), 16" o.c. max. spacing	
2	FM	3-5/8"x 33 mil (20 Ga.), 24" o.c. max. spacing	
1	GA FC 4502	7" x 43 mil (18 Ga.), 24" o.c. max. spacing	

1. For UL, GA, FM, and BIA refer to references 23, 14, 13, and 7 respectively.

**(System Description)**

<b>Exterior Cover</b>	<b>Interior Cover</b>	<b>Application</b>
5/8" cementitious board screws	5/8" GWB screwed @ 8" o.c. (V, H)	Bearing Wall
2 layers, 1/2" & 1/4" GWB screwed @ 12" o.c. (V,H)	2 layers, 1/2" & 1/4" GWB screwed @ 12" o.c. (V,H)	Nonbearing wall
2 layers 1/2"& 5/8" GWB screwed @ 12" o.c. (V)	2 layers 1/2"& 5/8" GWB screwed @ 12" o.c. (V)	Nonbearing wall
2 layers 3/8" GWB & 5/8" Type X GWB screwed @ 8" o.c. (V)	2 layers 1/2"& 5/8" GWB screwed @ 8" o.c. (V)	Nonbearing wall
2 layers 1/2" GWB Type X screwed @12" o.c. (V). Lateral bracing 1" x 43 mil (18 Ga.), steel strap w/channel bracing	2 layers 1/2" GWB Type screwed @ 12" o.c. (V). Lateral bracing 1"x 43 mil (18 Ga.), steel strap w/channel bracing	Bearing wall
5/8" layers GWB Type X screwed @ 12" o.c. (V). Lateral bracing 1"x 43 mil (18 Ga.), steel strap w/channel bracing	5/8" layers GWB Type X screwed @ 12" o.c. (V). Lateral bracing 1"x 43 mil (18 Ga.), steel strap w/channel bracing	Bearing wall
1/2" GWB attached to stud with 3-3/4" brick veneer attached to steel frame with metal ties every 5th course.	1/2" sanded gypsum plaster applied to 1/2" perforated gypsum lath attached to studs with strips of metal lath 3" wide applied to all horizontal joints of gypsum lath.	Bearing wall
5/8" GWB applied vertically in 2 layers, screwed @ 8"/12".	5/8" GWB applied vertically in 2 layers, screwed @ 8"/12".	Nonbearing wall
2 layers 1/2" GWB Type X screwed @ 12" o.c. (V)	2 layers 1/2" GWB Type screwed @ 12" o.c. (V)	Nonbearing wall
Stucco, 3/4" min. or any type 4" wide brick, or aluminum siding	3 layers 1/2" wallboard applied vertically, 12" o.c.	Bearing wall
2 layers GWB, 5/8" each., with Type S screws fastened at 8/12. (V)	2 layers GWB, 5/8" each., with Type S screws fastened at 8/12. (V)	Nonbearing wall
1/2" or 5/8" GWB installed vertically, attached to studs w/1" Type S-12 screws attached to studs w/1" Type S-12 screws at 12" o.c. Siding, brick, stucco, mineral and fiber boards, or cementitious backer units applied on the exterior face.	3 layers GWB, 1/2" each, or 2 layers 3/4" thick each. Batts and blankets installed in stud cavities.	Exterior load bearing wall
2 layers 1/2" GWB Type screwed @ 12" o.c. (V). Lateral bracing 1"x18" steel strap w/channel bracing	2 layers 1/2" GWB Type screwed @ 12" o.c. (V). Lateral bracing 1"x 43 mil (18 Ga.), steel strap w/channel bracing	Bearing wall
3 layers 1/2" wallboard @ 12" o.c. (V,H)	3 layers 1/2" wallboard @12" o.c. (H,V)	Nonbearing wall
3 layers 1/2" Type X GWB @ 12" o.c. (V)	3 layers 1/2" Type X GWB @ 12" o.c. (V)	Nonbearing wall
4 layers 1/2" wallboard applied vertically, 12" o.c.	4 layers 1/2" wallboard applied vertically, 12" o.c.	Bearing wall
4 layers 1/2" Type X GWB @ 12" o.c. (V)	4 layers 1/2" Type X GWB @ 12" o.c. (V)	Nonbearing wall
1/2" cementitious backer unit with screws @ 8" o.c.	5/8" layers Type X GWB @ 8"/12" (V)	Nonbearing exterior wall
Two 5/8" Type X GWB layers @ 8" and 12" o.c. EIFS exterior, 4" max. foam thickness	Two 5/8" Type X GWB layers, 5/8" layers Type @ 8"/12" (V)	Nonbearing exterior wall
1/2" GWB covered w/7/8" Portland cement plaster on 3.4# self-furred, expanded metal lath.	5/8" GWB with glass fiber insulation in stud space	Nonbearing exterior wall
5/8" T&G plywood screws @ 6"/10"	Two 1/2" Type X GWB layers screwed @ 8" o.c.	Load Bearing floor

Table 7

## Types of Construction Comparison for US Building Codes

Building Code <sup>1</sup>	Construction Type <sup>2</sup> (Based on IBC Types of Construction) <sup>3</sup>										
	Type I		Type II		Type III		Type IV	Type V			
	A	B	A	B	A	B	HT	A	B		
UBC	I-F.R.		II-F.R.		II-1 Hr.	II-N	III-1 Hr.	III-N	IV-H.T.	V-1 Hr.	V-N
NBC	1A	1B	2A	2B	2C	3A	3B	4	5A	5B	
SBC	I		II		IV-1 Hr. protected	IV unprot.	V-1 Hr. protected	V unprot.	III	V1-1 Hr.	V1

1. UBC: Uniform Building Code; NBC: BOCA National Building Code; SBC: Standard Building Code
2. Refer to Sections 602-607 of UBC, 603.0-606.0 of NBC and 603-608 of SBC for definition of Construction types
3. Construction types are defined in Sections 602.2 through 602.6 of the IBC (Final Draft).

### References

1. AISI FT-901 (1981). "Fire Resistance Ratings of Load Bearing Steel Stud Walls With Gypsum Wallboard Protection With or Without Cavity Insulation." American Iron and Steel Institute, Washington, DC.
2. AISI (1973). "Fire Resistance Steel-Frame Construction". American Iron and Steel Institute, Washington, DC.
3. AISI FT 227-1281-20M-NB (1981). "Designing Fire Protection for Steel Trusses", second edition. American Iron and Steel Institute (AISI), Washington, DC.
4. ASTM E119-98. "Standard Test Methods for Fire Tests of Building Construction and Materials", American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1998.
5. ASTM E814-97. "Standard Test Method for Fire Tests of Through-Penetration Fire Stops", American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1998.
6. BOCA (1993). "The BOCA National Building Code". Building Officials & Code Administrators International, Inc., Country Club Hills, Illinois.
7. BIA (1991). "Calculated Fire Resistance", Technical Notes on Brick Construction, 16B, Brick Institute of America, Reston, VA. June, 1991.
8. CABO (1995). "One and Two Family Dwelling Code", 1995 Edition, Council of American Building Officials.
9. CSSBI. "Results of Fire Resistance Test on Small-Scale, Insulated and Non-Insulated, Gypsum Board Protected Wall assemblies", National Research Council of Canada, Ottawa, Canada.
10. CSSBI. "Results of Fire Resistance Test on Full-Scale, Insulated and Non-Insulated, Gypsum Board Protected Wall assemblies", National Research Council of Canada, Ottawa, Canada.
11. Factory Mutual (1974). "Factory Mutual System, Insulated Wall Constructions, Approved Class Number 4411", Norwood, MA.
12. Factory Mutual (1989). "Factory Mutual System, Class I Insulated Deck Roofs, Approved Class Number 4450", Norwood, MA.
13. Factory Mutual (1993). "Factory Mutual System, Specification Tested Products Guide", Norwood, MA.
14. Gypsum Association (1994). "Fire Resistance Design Manual", 14th Edition. Washington DC.
15. HUD (1968). "A Guide to Airborne, Impact, and Structure Borne - Noise Control in Multifamily Dwellings". U.S. Department of Housing and Urban Development, Washington DC.
16. ICBO (1997). "Uniform Building Code". International Conference of Building Officials, Whittier, California.
17. ITS (1997). "ITS Directory of Listed Products, Vol. I and II", Intertek Testing Services, Cortland, NY.
18. ISO 834 (1975). "Fire Resistance Tests of Elements in Building Construction", International Organization for Standardization, Geneva, Switzerland.
19. MLSFA. Technical Bulletins "One-Hour Floor/Ceiling Fire Resistance Test" and "Two-Hour Floor/Ceiling Fire Resistance Test", Chicago, Illinois.
20. SBCCI (1994). Standard Building Code. Southern Building Code Congress International, Inc., Birmingham, Alabama.
21. SCI (1993). "Building Design Using Cold-Formed Steel Sections: Fire Protection", Publication P129, The Steel Construction Institute, Berkshire, England.
22. UCI (1996). "Extruded Polystyrene Insulation Foamular Commercial Steel Stud System", UC Industries, Inc., an Owens Corning Company, Parsippany, New Jersey.
23. UL (1997). "Fire Resistance Directory, Volumes 1 and 2." Underwriters Laboratories Inc., Northbrook, Illinois.
24. "Results of Fire Resistance Tests on Full-Scale Floor Assemblies", NRC Report No. 764, National Research Council of Canada, Ottawa,

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