Fire-Rated Systems

DESIGN/CONSTRUCTION GUIDE

APA
THE ENGINEERED
WOOD ASSOCIATION

WOOD
The Miracle Material™

Wood is the right choice for a host of construction applications. It is the earth's natural, energy efficient and renewable building material.

Engineered wood is a better use of wood. The miracle in today's wood products is that they make more efficient use of the wood fiber resource to make stronger plywood, oriented strand board, I-joists, glued laminated timbers, and laminated veneer lumber. That's good for the environment, and good for designers seeking strong, efficient, and striking building design.

A few facts about wood.

- ***We're not running out of trees.*** One-third of the United States land base – 731 million acres – is covered by forests. About two-thirds of that 731 million acres is suitable for repeated planting and harvesting of timber. But only about half of the land suitable for growing timber is open to logging. Most of that harvestable acreage also is open to other uses, such as camping, hiking, and hunting. Forests fully cover one-half of Canada's land mass. Of this forestland, nearly half is considered productive, or capable of producing timber on a sustained yield basis. Canada has the highest per capita accumulation of protected natural areas in the world – areas including national and provincial parks.

- ***We're growing more wood every day.*** American landowners plant more than two billion trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 15 percent of forestland ownership, is responsible for 41 percent of replanted forest acreage. That works out to more than one billion trees a year, or about three million trees planted every day. This high rate of replanting accounts for the fact that each year, 27 percent more timber is grown than is harvested. Canada's replanting record shows a fourfold increase in the number of trees planted between 1975 and 1990.

- ***Manufacturing wood is energy efficient.*** Wood products made up 47 percent of all industrial raw materials manufactured in the United States, yet consumed only 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Material	Percent of Production	Percent of Energy Use
Wood	47	4
Steel	23	48
Aluminum	2	8

- ***Good news for a healthy planet.*** For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood, the miracle material for the environment, for design, and for strong, lasting construction.

APA
THE ENGINEERED WOOD ASSOCIATION
RATED SHEATHING
32/16 15/32 INCH
SIZED FOR SPACING
EXPOSURE 1
000
PS 1-95 C-D PRP-108

NOTICE:
The recommendations in this guide apply only to panels that bear the APA trademark. Only panels bearing the APA trademark are subject to the Association's quality auditing program.

Planning and designing buildings that provide good fire protection, don't cost too much to build or insure, meet the codes, make the best use of materials, and strike a balance between form and function is complicated.

The problem arises from the lack of standardized code provisions and insurance rating practices, and partly from the rapid advance of construction technology itself. Many of these advances have changed and improved wood construction's acceptance by building codes and insurance rating agencies.

This brochure from APA – The Engineered Wood Association is designed to bring you up to date on what are considered today among the most cost-effective fire-rated construction systems you can design or build – wood and wood structural panel systems. It provides hard facts about what's available, what's acceptable, and what's best practice. For additional information or assistance with specific design problems, contact the nearest APA regional field office listed on the back cover. A bibliography of other helpful sources is also provided on page 26.

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For updated editions of this publication and additional information on this topic, visit the Association's web site at www.apawood.org

FIREPROOF VS. FIRESAFE

The first step of designing or building for fire protection is to recognize that fireproof buildings simply don't exist. The contents are the critical factor. Almost any building's contents will burn, and the smoke and heat thus generated can cause extensive damage and loss of life long before the building itself begins to burn, regardless of the type of construction.

The Forest Products Laboratory has convincingly documented this fact for residential construction. After studying dwelling-room fires involving combustible contents, FPL concluded that "wall and ceiling materials, whether combustible or noncombustible, had little or no effect on the time or temperature of the critical point" – the point at which human life is untenable. In the FPL studies, the critical point was reached in four to seven minutes. Other tests have shown untenable conditions can occur in as little as two minutes.

Nor are so-called "fireproof" building materials a guarantee of human or property safety. One classic demonstration of this was the 1953 fire in General Motors' huge plant in Livonia, Michigan (photo right). The plant was considered completely noncombustible, yet was a complete loss due to the collapse of unprotected metal construction.

Another was the 1967 disaster at McCormick Place, Chicago's exhibition hall. All of its structural members, including interior nonbearing walls, were noncombustible. Yet a small fire that began in the contents spread with such heat that the entire ceiling fell as steel beams, girders and trusses buckled and collapsed.

The type of construction is, of course, important. But to protect the occupants – always the first concern – as well as to safeguard property, the presence of a prompt detection and alarm system and the accessibility of numerous exits are far more vital. Also of importance are the type of contents and furnishings, interior finishes, degree of sprinkler protection and the availability of adequate fire-fighting equipment.

With proper construction in conformance with code regulations, and with recognition of the above factors, a **firesafe** building can be designed with both combustible and noncombustible materials. This puts wood and wood structural panel systems in perspective, and explains why they are increasingly used for both low-rise and medium-rise (four to six stories) construction today.

General Motors plant in Livonia, Michigan was unprotected metal construction (see text).

THE BASICS OF FIRE PROTECTION

Safety Criteria

In order to evaluate fire safety of a structure, building authorities consider many factors, including flame spread and fire-resistance ratings.

Flame Spread in general means spread of fire within a room – and is measured by the performance of the materials used for interior finish on walls, ceilings, and partitions.

Flame spread is a property of the surface material once fire has started, not the structure.

The best known flame spread test is the tunnel test, American Society for Testing and Materials (ASTM) Test Method E-84. In this test, a sample of the material, 20 inches wide and 25 feet long, is installed as ceiling of a test chamber, and exposed to a gas flame at one end. The rate at which flame spreads across the specimen is compared on a scale of 0 for inorganic reinforced cement board and 100 for red oak.

Another property measured in the ASTM E-84 test is the opacity of the smoke generated by the burning material. This measurement provides an indication of the amount of smoke released, which also is compared on a scale of 0 for inorganic reinforced cement board and 100 for red oak.

TABLE 1

INTERIOR FINISH CLASSIFICATIONS

Interior Finish or Flame Spread Classification	Flame Spread Rating or Index	Smoke Developed Rating or Index
Class A (or I)	0 to 25	
Class B (or II)	26 to 75	450 max.
Class C (or III)	76 to 200	
Examples: Material	**Flame Spread Rating**	**Smoke Developed Rating**
Inorganic reinforced cement board	0	0
Fire-retardant-treated construction plywood	0 to 25	0 to 80
Fire-retardant-coated construction wood structural panels	0 to 45*	0 to 200
Fire-retardant-treated lumber	0 to 25	10 to 360
Red oak lumber	100	100
APA wood structural panels	76 to 200	25 to 270

*See text, page 9.

Model building code interior finish classifications are summarized in Table 1. Materials with the lowest rate of flame spread (0 to 25) are classed by all building codes as Class A (or I), and are permitted for areas where fire hazard is most severe, such as vertical exitways of unsprinklered buildings for public assembly.

Materials with ratings from 26 to 75 are Class B (or II) and are permitted in areas of intermediate severity: for example, corridors providing exitway access in business and industrial buildings.

Materials rated from 76 to 200 are Class C (or III). APA trademarked panels such as plywood, oriented strand board (OSB) and composite panels fall generally in this class and are permitted in rooms of most occupancies. (Exceptions: hospitals, or institutions where occupants are restrained.) For exitways and for most interiors where Class A or Class B flame spread performance is required, fire-retardant-treated plywood (which falls in Class A) is permitted.

Table 1 also shows ratings of some commonly used construction materials. Table 2 (page 6) shows typical flame spread requirements, as called for under the International Building Code.

Table 1 shows that the flame spread rating for construction plywood and APA wood structural panels falls within Class C; but there is considerable variation of ratings, depending on species, thickness, and glue type. Plywood with exterior adhesives performs better than with interior; thick panels better than thin; and low density species better than heavier species. (See Bibliography in Appendix for references to more data on flame spread tests, particularly APA Research Report No. 128.)

TABLE 2

TYPICAL FLAME SPREAD CLASSIFICATION REQUIREMENTS FOR INTERIOR FINISH BASED ON THE 2003 INTERNATIONAL BUILDING CODE (TABLE 803.5)[l]

	Sprinklered[m]			Nonsprinklered		
Group	Vertical exits and exit passageways[a, b]	Exit access corridors and other exitways	Rooms and enclosed spaces[c]	Vertical exits and exit passageways[a, b]	Exit access corridors and other exitways	Rooms and enclosed spaces[c]
A-1 & A-2	B	B	C	A	A[d]	B[e]
A-3[f], A-4, A-5	B	B	C	A	A[d]	C
B, E, M, R-1, R-4	B	C	C	A	B	C
F	C	C	C	B	C	C
H	B	B	C[g]	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B[h, i]	A	A	B
I-3	A	A[k]	C	A	A	B
I-4	B	B	B[h, i]	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m^2.

a. Class C interior finish materials shall be permitted for wainscotting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.4.1.

b. In vertical exits of buildings less than three stories in height of other than Group I-3, Class B interior finish for nonsprinklered buildings and Class C interior finish for sprinklered buildings shall be permitted.

c. Requirements for rooms and enclosed spaces shall be based upon spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered enclosing spaces and the rooms or spaces on both sides shall be considered one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.

d. Lobby areas in A-1, A-2, and A-3 occupancies shall not be less than Class B materials.

e. Class C interior finish materials shall be permitted in places of assembly with an occupant load of 300 persons or less.

f. For churches and places of worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be permitted.

g. Class B material required where building exceeds two stories.

h. Class C interior finish materials shall be permitted in administrative spaces.

i. Class C interior finish materials shall be permitted in rooms with a capacity of four persons or less.

k. Class B materials shall be permitted as wainscotting extending not more than 48 inches above the finished floor in exit access corridors.

l. Finish materials as provided for in other sections of the code.

m. Applies when the vertical exits, exit passageways, exit access corridors or exitways, or rooms and spaces are protected by a sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

Fire Resistance. Though codes are concerned with how fast fire can spread on a room's surface, they are even more specific about fire resistance: the measure of containment of fire within a room or building. It is defined as protection against fire penetrating a wall, floor or roof, either directly or through a high rate of heat transfer that might cause combustible materials to be ignited on the side of the wall or floor away from the actual fire. Thus, it is a property of an assembly of several materials, including fastenings, and of the workmanship.

A fire-resistive construction gives time to discover a fire, to suppress it before it spreads, and to evacuate the building if need be.

The standard test for measuring fire resistance is ASTM Test Method E-119. Ratings of assemblies are determined by actual fire-test procedures approximating actual fire conditions. Floor-ceilings and roof-ceilings are tested flat, while loaded to their full allowable stress. Walls are tested vertically, either as bearing walls, under axial load, or as nonbearing walls, under no load. The resistance rating is expressed in hours or minutes that the construction withstands the test. So it approximates the time the assembly would be expected to withstand actual structure-fire conditions.

A one-hour rating, for example, is taken to mean that an assembly similar to that tested will not collapse, nor transmit flame or a high temperature, while supporting its full load, for at least one hour after the fire commences.

Protection Methods

In many cases, ordinary wood-frame construction with plywood or other wood structural panel sheathing provides ample fire safety and is completely acceptable. When unusual circumstances require additional protection, the designer's options include protected construction, Heavy Timber construction, and treated construction.

Protected Construction is simply any normal wood-and-panel assembly, such as floor-ceiling or wall, with a fire-resistive material added to give primary protection to the joists. The material may be gypsum wallboard, plaster, or acoustical tile. The panel prevents flame passage and temperature rise, while reinforcing framing against collapse under load. Table 3 (page 8) is an example of typical fire-resistive requirements.

Heavy Timber Construction implies the protection provided by massive wood members. The name comes from early New England textile mills, where it was known as "mill construction," "plank-on-timber," or "slow-burning." In such construction, though the outside may char during exposure to fire, the surface char acts as insulation. And the strength of wood is such that it continues to support its load – so the chance of building collapse is greatly diminished.

Based on comparative fire tests, 1-1/32- or 1-1/8-inch-thick wood structural panels with exterior glue are permitted for heavy timber roof decks. See Figure 1 for typical construction; wood structural panels must have tongue-and-groove edges. (See IBC Section 602.4.5 and ICC Evaluation Service Inc., Report No. ER-1952.)

FIGURE 1

WOOD STRUCTURAL PANEL HEAVY TIMBER ROOF CONSTRUCTION

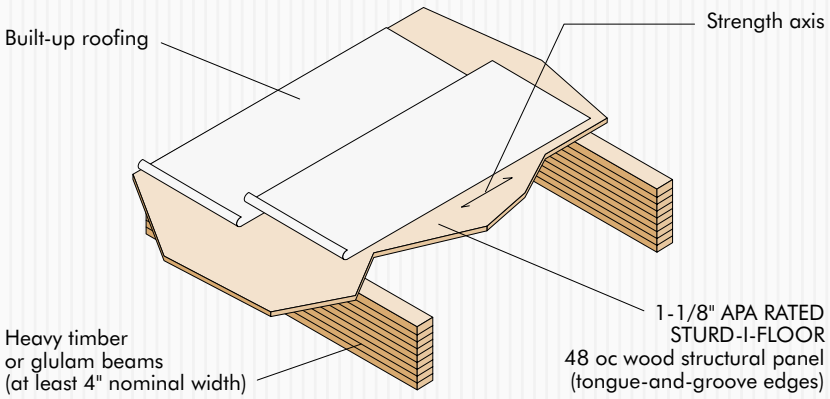


TABLE 3

TYPICAL FIRE-RESISTIVE REQUIREMENTS FOR STRUCTURAL COMPONENTS (IN HOURS, BASED ON 2003 INTERNATIONAL BUILDING CODE)

	Type I		Type II		Type III		Type IV	Type V	
Building Element	**A**	**B**	**A**	**B**	**A**	**B**	**HT**	**A**	**B**
Structural frame									
Including columns, girders, trusses	3	2	1	0	1	0	HT	1	0
Bearing walls									
Exterior	3	2	1	0	2	2	2	1	0
Interior	3	2	1	0	1	0	1/HT	1	0
Floor construction									
Including supporting beams and joists	2	2	1	0	1	0	HT	1	0
Roof construction									
Including supporting beams and joists	1-1/2	1	1	0	1	0	HT	1	0

Note: The above table specifies the fire resistance ratings required based on conditions such as maximum heights and areas. Increases and reductions in these ratings for specified design considerations are covered in the code. Nonbearing walls and partitions are typically not required to have a resistance rating.

A = Protected or one-hour.
B = Unprotected.

TABLE 4

DIMENSIONS OF COMPONENTS FOR HEAVY TIMBER CONSTRUCTION (TYPICAL CODE PROVISIONS)

Heavy timber construction is generally defined in building codes and standards by the following minimum sizes for the various members or portions of a building:

	Inches, nominal
Columns	
Supporting floor loads	8x8
Supporting roof and ceiling loads only	6x8
Floor framing	
Beams and girders	6 wide x 10 deep
Arches and trusses	8 in any dimension
Roof framing – not supporting floor loads	
Arches springing from grade	6x8 lower half 6x6 upper half
Arches, trusses, other framing springing from top of walls, etc.	4x6

	Inches, nominal
Floor (covered with 1-inch nominal flooring, 15/32 or 1/2-inch wood structural panel, or other approved surfacing)	
Splined or tongue-and-groove plank	3
Planks set on edge	4
Roof decks	
Splined or tongue-and-groove plank	2
Plank set on edge	3
Tongue-and-groove wood structural panels	1-3/32

This model code recognition can simplify roof construction practices while providing fire protection. Performance of Heavy Timber construction is markedly superior to most unprotected "noncombustible" (metal) structures, under fire conditions. There are no concealed spaces where fire can spread, making fire fighting simpler and safer.

The IBC and other model codes also recognize 15/32- or 1/2-inch wood structural panels over 3-inch planks for Heavy Timber floors.

See Table 4 (page 8) for code definitions of minimum sizes of members for Heavy Timber construction.

Treated Construction. In any projected use of fire-retardant treatments, thorough investigation should first determine that it is the best overall solution, in view of long-term insurance costs and adequate fire protection at lowest construction cost. It is more expensive than untreated plywood and wood, which in most cases perform satisfactorily in regard to both life safety and protection of property.

FRT (fire-retardant-treated) wood or plywood is pressure-impregnated with chemicals in water solution to permanently inhibit combustion. This qualifies it for lower flame spread (at least as low as gypsum wallboard) and smoke-generation ratings, and reduces its fire-hazard classification. When it is identified as such by a code-recognized testing agency label, it is rated on a parity with noncombustible constructions by many insurance rating bureaus, but not by building codes.

Precisely defined, FRT plywood has been impregnated with fire-retardant chemicals in accordance with American Wood Preservers Association Standard AWPA C27. When tested for thirty minutes under ASTM Standard E-84 (the tunnel test), it has a flame spread not over 25 and shows no evidence of significant progressive combustion.

Span Ratings and load capacities for APA-trademarked plywood are based on untreated panels, and may not apply following fire-retardant treatment. Obtain structural performance characteristics and use recommendations for FRT plywood from the company providing the treatment and redrying service.

Fire Retardant (FR) Paints can be used on plywood for nonstructural interior finish applications such as wall and ceiling paneling, to reduce flame spread ratings to 25 or less (Class A or I), or from 26 to 75 (Class B or II) depending on the paint selected. FR paints are tested per ASTM E-84 for ten minutes, as compared to thirty minutes for FRT plywood. FR paints can be applied as interior finish coats over new or existing plywood surfaces; some FR paints are available with proprietary topcoat finishes for exterior use.

Sprinklers are another option to solve a number of problems. With sprinkler protection, code requirements for flame spread and fire-resistance ratings may be relaxed. It may be possible to add another story or increase building area. Reduced insurance premiums for buildings and contents mean that sprinklers generally will pay for themselves within a few years, depending on the value of the building and its contents. And the difference in insurance rates between sprinklered wood and sprinklered unprotected steel buildings is usually very small.

Meeting the Building Codes

The primary model building codes are the International Building Code (IBC) and the International Residential Code (IRC). Other codes, currently being superceded by the IBC and IRC, are the Standard Building Code (primarily used in the South); Uniform Building Code (primarily used in the Midwest and West); National Building Code (widely used in the Northeast); and the One and Two Family Dwelling Code. The IBC, IRC, and most of the regional and state codes in the country are similar to or adaptations of these.

All code provisions have the authority of law (unlike insurance requirements, which are optional).

All buildings must meet code specifications as to maximum permissible heights and floor areas. These specifications are based on certain characteristics of the building, including the fire zone; type of occupancy; construction materials and systems; setbacks from property lines; exits; and automatic extinguishing systems.

For further discussion of how to adjust these characteristics in order to achieve area increases, see Appendix, "How Areas Can Be Increased."

Fire Zones. Some cities have established one, two or three geographic fire zones (or fire limits), which restrict type of use or occupancy, percentage of lot coverage, and type of construction permitted. The purpose is to make fire protection easier by concentrating in one area those buildings of similar fire hazard. Usually, frame construction is not permitted in central fire zones, where congestion and closeness of other buildings would make fire spread most likely and fire fighting most difficult.

Occupancy. All codes have use or occupancy classifications; in general, these include: residential, business, educational, institutional, assembly, storage, mercantile, manufacturing, and hazardous. Within occupancy classifications, codes also consider whether the manufacturing is of potentially explosive or dangerous materials; whether the residents are elderly, disabled, or confined; etc. Unprotected wood construction is generally not permitted in such occupancies as high-hazard, theatres with stages, and some institutions.

Setbacks. Codes recognize the advantage of large open areas around buildings, to make fire fighting easier and prevent fire spread. Therefore, buildings that are 20 to 30 or more feet from the property line, or facing a street 20 or more feet wide, are permitted larger areas than those immediately adjacent to other buildings.

Exits. The number and type of exits required depend on occupant load and travel distance to exits. For example, according to the International Residential Code, in a business or residential building of unprotected frame construction, maximum distance to an exit is 200 feet. Other codes may differ somewhat in these provisions. All exit assemblies are classified by fire-resistance ratings, and except for certain high-hazard or institutional occupancies, wood construction is usually permitted.

Types of Construction. Construction-type classifications are based on fire-resistance ratings of structural elements. Of the three types of wood construction, Heavy Timber, or Type IV, is used in multistory buildings (up to five stories) such as educational, religious, manufacturing, warehouse, supermarket; and permits largest areas. The next largest areas are permitted for Type III or ordinary construction – commonly used for commercial or public buildings up to four or five stories high. Finally, light-frame construction or Type V is used in 80 percent of all residential and many commercial, institutional, industrial and assembly buildings.

Codes differ somewhat in the labels they apply to comparable types of construction. Actual codes should be consulted for more detailed differences.

If the building requires a larger area than is permitted for the type of construction selected, the designer has several choices, including: breaking up the area with fire walls, adding sprinklers, increasing property line setbacks, or specifying a more fire-resistant construction. (See Appendix, "How Areas Can Be Increased.")

Calculated Fire Resistance. The IBC and three of the model building codes also permit determination of one-hour fire-rated wood-framed floors, roofs and load-bearing and non-bearing walls by calculation, as an alternate to tested assemblies. These codes provide tables of assigned times for components, which have been developed empirically from extensive studies of assemblies tested in accordance with ASTM

Standard E-119. End-point criteria in the standard also were considered. A one-hour fire-rated assembly can be determined by combining the individual component times of the assembly in accordance with the method and limitations in the codes, thereby providing additional choices for the designer. Methods also provide for determining the required size of glulam beams and columns for a one-hour fire resistance rating. Code references are:

- 2003 International Building Code, Section 721.6
- 1997 Uniform Building Code (UBC), Section 703.3 and UBC Standard 7-7, Parts V and VI
- 1999 Standard Building Code, Section 709.6
- Guidelines for Determining Fire-resistance Ratings of Building Elements (BOCA International, Inc./1994)

Insurance Provisions

Compliance with insurance provisions is purely voluntary. The means of doing so is not specified or even suggested by the rating bureau. This puts a special responsibility on the designer to work out the best combination of economical construction and sufficient protection to qualify for low premiums. And, if possible, to determine during preliminary planning just what kind of rating can be counted on, while there is still time to adjust such factors as setbacks, materials, size, etc.

Most agencies will be glad to cooperate with an architect who wishes to do this kind of research (rating bureaus are constrained to give out rate information only to, or by authority of, the building owner).

Changing ideas about fire safety also obligate the designer to be familiar with the many alternative means of assuring protection. Awareness is increasing that contents, not structure, are most critical (due to many recent tragic fires in high-rise steel and concrete buildings). More emphasis is now being placed on warning and sprinkler systems, less on "fireproof" structural materials.

Furthermore, the greater likelihood of collapse of metal structures is being recognized, compared with sound wood construction. As a result, there is a definite tendency to a lowering of rates for wood, and increasing them for metal.

This tendency is widespread, and has been especially noticeable in the Midwest since 1969, where rates on unprotected metal have increased – possibly under the influence of such incidents as the McCormick Place fire, and other adverse experiences.

Wind resistance of the building's roof system also determines the Extended Coverage Endorsement, or ECE insurance rates. See the APA Design/Construction Guide: *Nonresidential Roof Systems*, Form A310, for wood roof systems that provide maximum fire and wind protection, satisfy code requirements, and qualify for lowest possible insurance rates. The publication is available on the APA web site.

Although insurance rates for wood buildings are higher than for noncombustible buildings, the savings in construction costs are usually enough to result in a substantially reduced annual cost.

Rating Bureaus and Rates. Insurance companies, through assessments against their premium income, have for many years supported state and regional rating bureaus throughout the country. Most of these have been consolidated into the Insurance Services Office (ISO) and are described at www.iso.com.

The intent of the ISO is to develop a nationwide rate schedule, which will straighten out much of the confusion due to the multiplicity of rates throughout the country. However, until a genuinely universal rate schedule comes about, it will still be necessary for architects to be familiar with local situations and to be alert to changes.

There are two kinds of rates: "class" rates (generally for one- and two-family homes, small multifamily, and garages), and "schedule" or specific rates (all other types of buildings). The former, with many shared physical characteristics, may be rated according to their position in established classes based on type of construction, occupancy, and public fire protection. Only major differences in these characteristics would be reason for rate distinction.

In the latter category, however, each building is considered a separate case. It is rated after consideration of five factors: type of construction; effectiveness of public fire protection; private fire protection in the building; occupancy – there are well over a hundred occupancy classes, according to how the building is used, whether people are in it, etc.; and exposure from other properties nearby.

HOW TO BUILD FOR FIRE PROTECTION

Wall Systems

Possible wood wall systems for light-frame construction include ordinary stud-wall, with sheathing or as single wall (Sturd-I-Wall); "protected" construction; and incorporation of fire-retardant treatment or paint.

Unprotected double-wall or Sturd-I-Wall systems, with studs on 16- or 24-inch centers, are fully covered in the APA *Engineered Wood Construction Guide* (see Bibliography in Appendix).

Protected Walls. Protected light-frame construction with gypsum wallboard interior finish is rated by codes between ordinary (Type III) unprotected and Heavy Timber (Type IV) in terms of fire performance. Examples of protected construction are shown in Systems 2A and 2C of Figure 2: 2x4 studs, 16 inches or 24 inches o.c. with wood structural panel siding over 5/8-inch Type X gypsum sheathing on the exterior side and 5/8-inch Type X or proprietary Type X (Type C or G) gypsum wallboard on the interior side. Another option permitted in the Uniform Building Code, using stucco over wood structural panel sheathing, is shown in System 2B of Figure 2.

Protected wall constructions qualify for the same ratings if other materials are added: e.g., siding may be attached to the outside of a rated wall to add shear-wall value, without impairing the rating.

The gypsum sheathing is not required under the International Building Code, National Building Code and Standard Building Code where separation is greater than 5 feet, since they provide that fire-resistive rating need only apply to the interior face of the wall. See Systems 2D through 2F of Figure 2 for one-hour fire-rated wall constructions that are applicable under these code provisions.

Model building code provisions also permit determination of one-hour fire-rated wall systems, using procedures for calculated fire resistance of components (see page 10).

Interior Walls and Partitions. Generally accepted building code regulations place a flame spread limit of 200 (Class C) on materials used for interior surfaces (in areas other than certain exitways and corridors, as noted earlier). Since APA trademarked wood structural panel ratings generally fall within Class C, or 76-200, they are well within the range of acceptable materials.

For interior areas requiring lower flame spread ratings, fire-retardant-treated plywood paneling is acceptable; such panels qualifying for the U.L. label are capable of a Class A rating, and are accepted by codes. Fire retardant paints, properly applied, may also be used to reduce the flame spread rating to Class A or B, and are often recognized by building officials. (See page 10.)

In single-family residential use, Class C is acceptable. Softwood plywood paneling is well within the acceptable range, and has been used for interior as well as exterior walls where plywood's strength and rigidity help the unit withstand horizontal loads.

As for thermal resistance in fires: because of its superior insulating qualities, wood structural panels may be expected to develop a finish resistance (based on time to develop an average temperature rise of 250° on the back of the panel) of approximately 20 or more minutes per inch of thickness, when exposed to the standard ASTM Time-Temperature curve. Pressure treatment of plywood with fire retardant chemicals does not materially affect the finish resistance, though coating with fire retardant paints may be somewhat more effective.

FIGURE 2

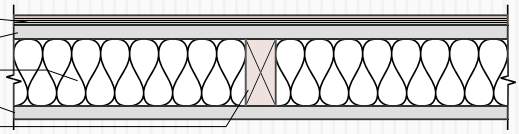
ONE-HOUR COMBUSTIBLE LOAD-BEARING WALL ASSEMBLIES[a]

Some rated assemblies incorporate proprietary products. When designing and specifying, check the appropriate reference for complete details on a particular assembly. A change in details may affect the fire resistance of the assembly.

2A – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on GA File No. WP8105 in *Gypsum Association (G.A.) Fire Resistance Design Manual;* applicable references in *1997 Uniform Building Code* (Table No. 7-B), and *1999 Standard Building Code* (Sec. 701.5.2). (2-Hour)[b]

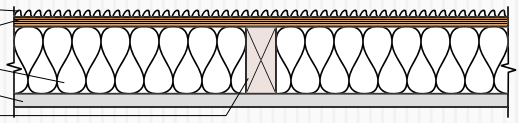
APA Rated Siding Exterior
5/8" Type X gypsum sheathing
Mineral wool or glass fiber insulation (optional)
5/8" Type X gypsum wallboard
Min. 2x4 studs @ 16" or 24" o.c.



2B – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on combining Item No. 15-1.2 and 15-1.3 and Footnote l of Table 720.1(2) in the *2003 International Building Code*. Also see Sec. 2.2.2 of *ICC Evaluation Service, Inc. Report No. ER-1952.*

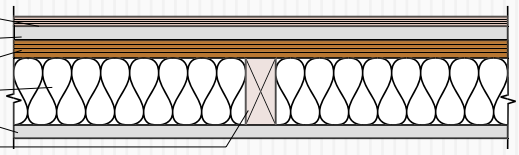
Stucco (over self-furring metal lath)
APA Rated Sheathing Exposure 1 plywood or OSB[c][d]
Mineral wool or glass fiber insulation (optional)
5/8" Type X gypsum wallboard
Min. 2x4 studs @ 16" o.c.



2C – LOAD-BEARING EXTERIOR WALL SYSTEM

Based on U.L. Design No. U344 in *Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.*

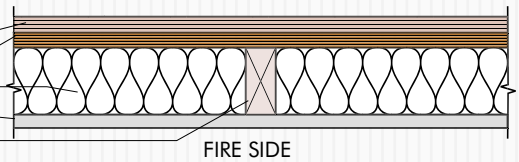
APA Rated Siding Exterior or other
exterior finish (code-approved type)
5/8" Type X gypsum sheathing
Min. 15/32" APA Rated Sheathing Exposure 1 OSB or plywood[d]
Glass fiber insulation (R11)
5/8" proprietary[e] Type X gypsum wallboard
Min. 2x4 studs @ 16" or 24" o.c.



2D – LOAD-BEARING EXTERIOR WALL SYSTEM

Based on U.L. Design No. U356 in *Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.*

APA Rated Siding Exterior or other
exterior finish (code-approved type)
Min. 7/16" APA Rated Sheathing Exposure 1 OSB or plywood
Glass fiber (R13) or mineral wool insulation
5/8" Type X gypsum wallboard
Min. 2x4 studs @ 16" o.c.



(a) Wall systems exposed to fire on both exterior and interior faces, except where indicated by "Fire Side" (tested from interior face only).

(b) For a two-hour load-bearing exterior wall of similar construction, see GA File No. WP 8415 (requires two layers of 5/8" Type X gypsum sheathing on exterior side of wall, and two layers of 5/8" Type X gypsum wallboard on interior side).

(c) See *APA Engineered Wood Construction Guide* (Form E30) for installation recommendations when stucco exterior finish is used. Building paper is required where stucco is applied over structural wood panel sheathing (check local building code and applicator for specific requirements). Uniform Building Code requires two layers of waterproof building paper (per Federal specification UU-B-790, Type 1, Grade D) over wood-based sheathing.

(d) Footnote l of Table No. 720.1(2) in the *2003 International Building Code* permits installation of wood structural panel sheathing directly over studs, beneath fire protective membrane, for added racking resistance or shear wall applications, in certain generic, nonproprietary fire-rated wall assemblies. Also see *ICC Evaluation Service, Inc. Report No. ER-1952* for wood structural panels used for wall sheathing in these assemblies.

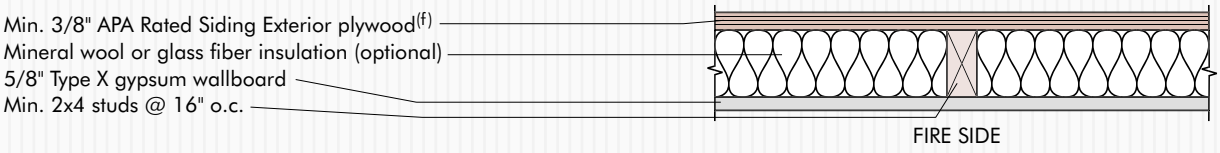
(e) For proprietary names see latest *U.L. Fire Resistance Directory,* www.ul.com.

(figure continued on next page)

FIGURE 2 CONTINUED

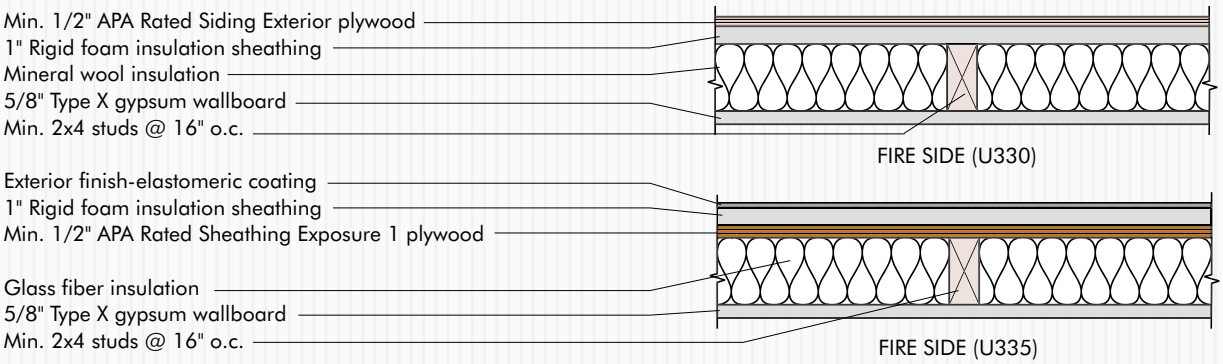
2E – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on provisions for calculated fire resistance rating per Section 721.6 of the International Residential Code, Section 709.6.2.4 of the *1999 Standard Building Code,* and Section 6.2 of *Guidelines for Determining Fireresistance Ratings of Building Elements* (BOCA International, Inc./1994).



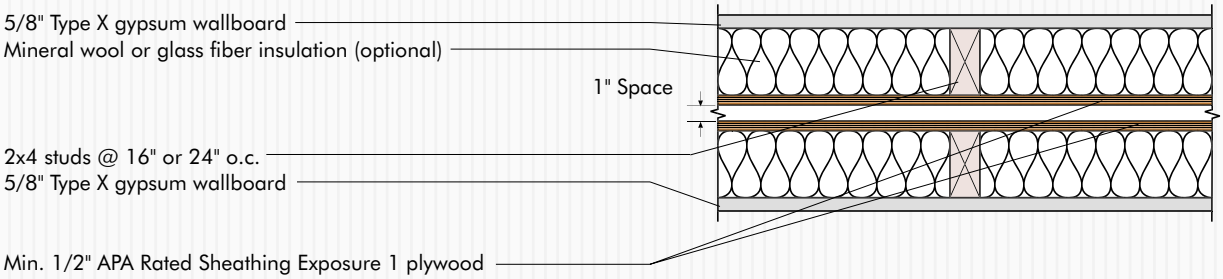
2F – LOAD-BEARING EXTERIOR WALL SYSTEM

Based on U.L. Design Nos. U326, U330 (shown) and U335 (shown) in *Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.*



2G – LOAD-BEARING INTERIOR (CHASE) WALL SYSTEM

Based on U.L. Design Nos. U339 and U341 (shown) in *Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.*

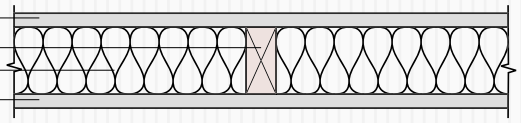


(f) Min. 5/16" APA Rated Sheathing Exposure 1 plywood, with building paper and APA Rated Siding Exterior or other exterior finish, or min. 3/8" APA Rated Siding Exterior directly over studs, may be used in accordance with Table 709.6.2C of the *1999 Standard Building Code.*

FIGURE 2 CONTINUED

2H – ONE-HOUR LOAD-BEARING INTERIOR WALL SYSTEM

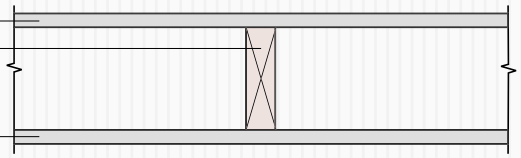
5/8" Type X gypsum wallboard
2x4 studs @ 16" o.c.
3-1/2" mineral wool
5/8" Type X gypsum wallboard



2I – ONE-HOUR LOAD-BEARING WALL SYSTEM

5/8" Type X gypsum wallboard
2x6 studs @ 16" o.c.

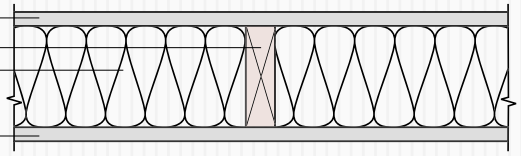
5/8" Type X gypsum wallboard



2J – ONE-HOUR LOAD-BEARING INTERIOR WALL SYSTEM

5/8" Type X gypsum wallboard
2x6 studs @ 16" o.c.
5-1/2" mineral wool

5/8" Type X gypsum wallboard



2K – ONE-HOUR LOAD-BEARING EXTERIOR WALL SYSTEM

FIRE SIDE

5/8" Type X gypsum wallboard
2x6 studs @ 16" o.c.
5-1/2" mineral wool

24/16 APA Exposure 1 sheathing
APA Siding – Panel or lap

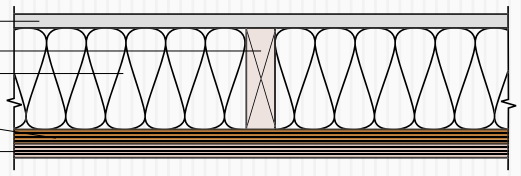
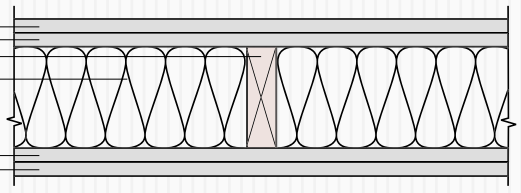


FIGURE 3

TWO-HOUR LOAD-BEARING INTERIOR WALL SYSTEM

5/8" Type X gypsum wallboard
2x6 studs @ 24" o.c.
5-1/2" mineral wool

5/8" Type X gypsum wallboard



Floor and Roof Systems

Roof and floor systems that are accepted by building codes, while providing maximum strength and economy, include numerous constructions involving APA-trademarked wood structural panels over a variety of support systems. Complete information on APA panel sheathing in general, and some two dozen roof and floor systems, may be found in *APA's Engineered Wood Construction Guide*, Form E30, (see Bibliography).

Two systems in particular that achieve good fire protection are protected, and Heavy Timber (see page 7). Examples of protected systems will be found on the following pages.

Protected Roof-Ceiling and Floor-Ceiling Systems.

There are numerous fire rated, specially designed assemblies combining wood structural panels with protective materials, suitable especially for commercial and public buildings. They include one-hour-rated and several two-hour-rated protected wood-frame wall and floor-ceiling systems.

Over 40 wood and plywood floor-ceiling (or roof-ceiling) systems are listed in the U.L. Fire Resistance Directory, and are accepted as rated constructions by building codes. Examples are shown in Figure 4 (pages 17-19). Model building code provisions also permit determination of one-hour fire-rated floor-ceiling or roof-ceiling systems, using procedures for calculating fire resistance of components (see page 10). Other proprietary floor-ceiling or roof-ceiling systems also are recognized by model building code agencies under evaluation reports issued to individual manufacturers or trade associations.

Because they contain wood and may contain other organic materials, they are designated as combustible constructions. At present, codes don't permit them in so-called "noncombustible" types of structures, even though their test performance is identical to that of an assembly classed as noncombustible.

In these assemblies, materials such as gypsum wallboard, plaster, and acoustical tile provide primary fire protection. The panel floor or roof acts to prevent flame passage and temperature rise, as well as to reinforce joists against collapse under load after the effectiveness of the ceiling has been lost.

In many, a double layer of plywood (15/32 inch and 19/32 inch) is used, though several have a single layer of 19/32 inch or thicker. Some model codes accept lightweight or gypsum concrete under certain conditions in lieu of the top layer of plywood for one-hour floor-ceiling assemblies, as indicated in System 4.1 of Figure 4. Any finish floor material may be used. Most codes permit omission of the top layer of plywood in roof assemblies.

One assembly shown in System 4.2 of Figure 4 (L513) permits an economical 24-inch lumber joist spacing with a single-layer 23/32" plywood floor, and several include trusses or I-joists (System 4.3).

Based on comparative tests, APA OSB may be used in plywood floor-ceiling (or roof- ceiling) systems without jeopardizing fire-resistance ratings. In double-layer wood systems, 7/16" OSB APA Rated Sheathing 24/16 may be used in lieu of 15/32" plywood subfloor. Other substitutions are based on equivalent panel thickness.

Roof Coverings.

The fire resistance ratings of finish roofing materials are listed as Class A, B, or C in descending order of fire protection afforded. Their use is prescribed by building codes, and also affects insurance rates. The standard test for measuring the fire characteristics of roof coverings is ASTM E108. Untreated APA Rated Sheathing panels are recognized as a roof deck substrate for rated roof coverings. For individual requirements, see the U.L. *Roofing Materials and Systems Directory*, Category TGFU for built-up or single ply roofing membranes or spray-applied foam insulation and roof coating systems; or Category TFWZ for prepared roof covering materials such as shingles, shakes, cement tile and metal roofing panels.

FIGURE 4

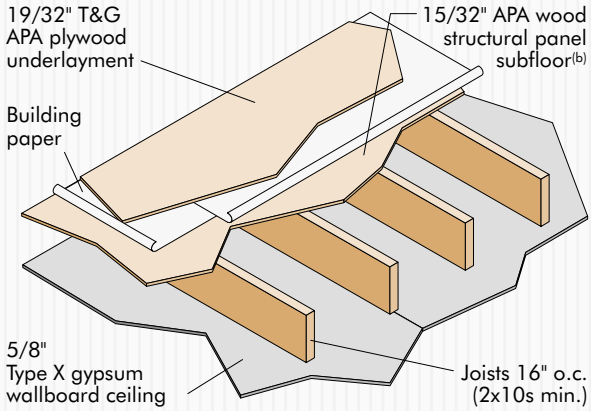
ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES[f][i]

Some rated assemblies incorporate proprietary products. When designing and specifying, check the Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory for complete details on a particular assembly. A change in details may affect the fire resistance of the assembly.

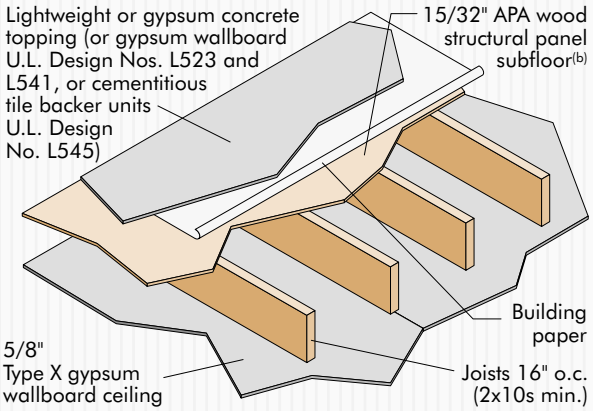
4.1 TWO-LAYER FLOOR SYSTEM WITH JOISTS[a][c]

For details, see U.L. Design Nos. L001, L003, L004, L005, L006, L201, L202, L206, L209, L210, L211 (2 hr), L212, L501, L502, L503, L505 (2 hr), L511 (2 hr), L512, L514, L515, L516, L519, L522, L523, L525, L526, L533, L535, L536 (2 hr), L537, L541 (2 hr) and L545. Also see U.L. Design Nos. L524 with steel joists spaced 24" o.c., L521 with wood trusses spaced 24" o.c. and L549 with steel trusses spaced 48" o.c.

4.1A

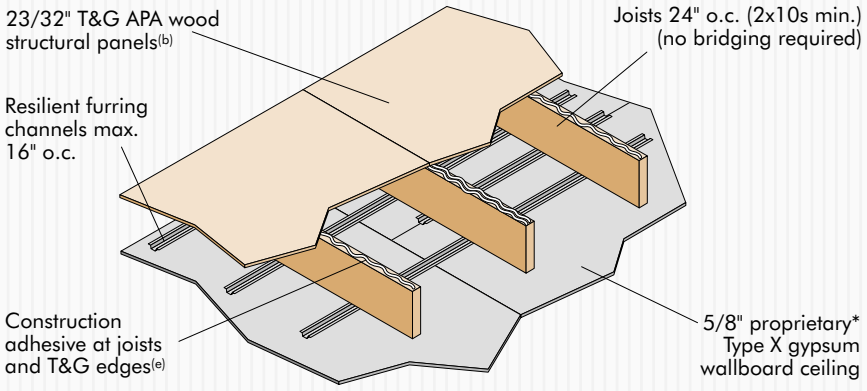


4.1B



4.2 – SINGLE-LAYER FLOOR SYSTEM WITH JOISTS

For details, see U.L. Design No. L513. Also see U.L. Design Nos. L504 for stressed-skin panel (5/8" APA RATED STURD-I-FLOOR or SHEATHING plywood with joists spaced 12" o.c.); L507 for 5/8" APA RATED STURD-I- FLOOR plywood with joists spaced 16" o.c.; L508 for 1-1/8" APA RATED STURD-I-FLOOR plywood with joists spaced 48" o.c.; and L539, L540 with joists spaced 16" or 24" o.c. and separate ceiling assembly (for modular housing units). Also see U.L. Design Nos. L524 and L543 with steel joists spaced 19.2" or 24" o.c. (L543 with separate ceiling assembly).



* For proprietary names see latest U.L. Fire Resistance Directory.

See footnotes, page 20.

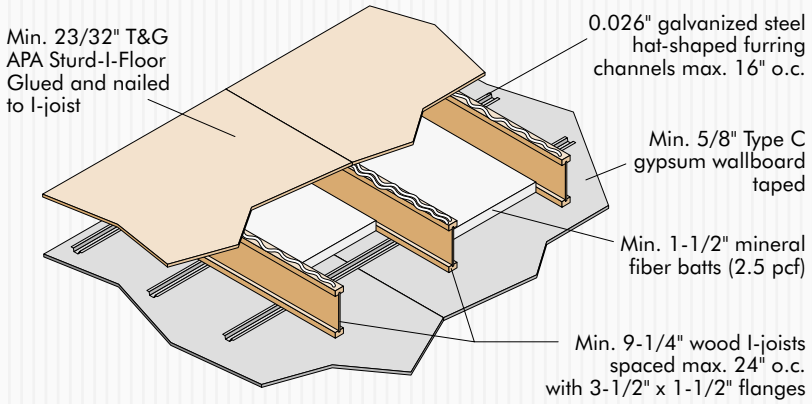
FIGURE 4

ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES[f][i] (CONTINUED)

4.3 – SINGLE-LAYER FLOOR SYSTEMS WITH I-JOISTS OR TRUSSES

For details, see U.L. Design Nos. L528, L529, L534, L542 and L548 with trusses or L544 with I-joists spaced 24" o.c. maximum. Also see GA File No. FC5512 for generic, nonproprietary truss assembly.

4.3A – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



For additional details, see AF&PA DCA 3 Assembly WIJ-1.1 (www.afandpa.org)

STC AND IIC SOUND RATINGS

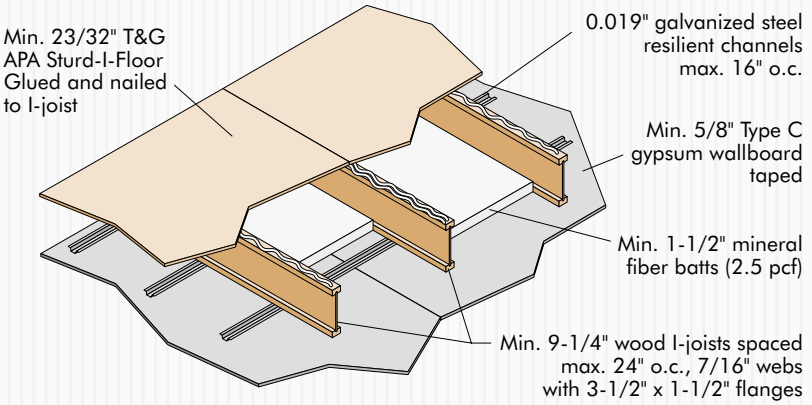
Without Gypsum Concrete

Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
-	-	-	-

With Gypsum Concrete

Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
-	-	49[h]	59[h]

4.3B – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



For additional details, see AF&PA DCA 3, Assembly WIJ-1.2 (www.afandpa.org)

STC AND IIC SOUND RATINGS

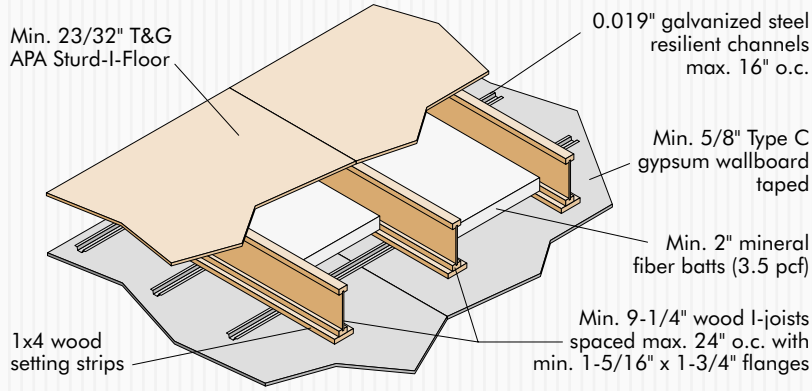
Without Gypsum Concrete

Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
51[h]	46[h]	51[h]	64[h]

With Gypsum Concrete

Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
60[h]	50[h]	60[h]	65[h]

4.3C – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



For additional details, see 2003 IBC Table 720.1(3), Item No. 24-1.1

STC AND IIC SOUND RATINGS

Without Gypsum Concrete

Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
51[h]	46[h]	52	66

With Gypsum Concrete

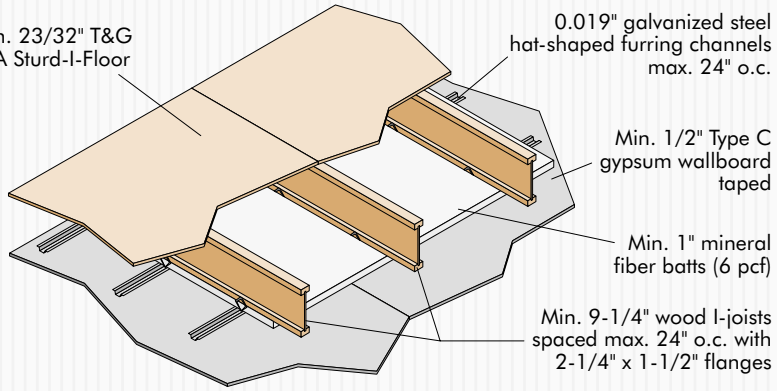
Cushioned Vinyl		Carpet & Pad	
STC	IIC	STC	IIC
60[h]	48[h]	60[h]	60[h]

See footnotes, page 20.

FIGURE 4

ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES[f][i] (CONTINUED)

4.3D – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



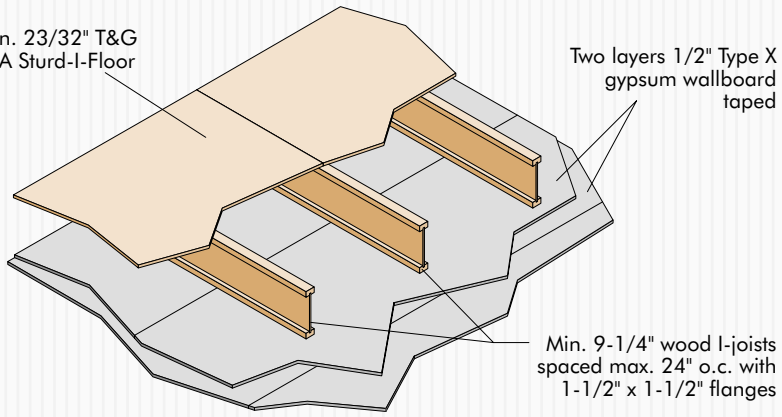
STC AND IIC SOUND RATINGS

Without Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
-	-	46	68

With Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
51	47	50	73

For additional details, see AF&PA DCA 3, Assembly WIJ-1.4 (www.afandpa.org)

4.3E – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



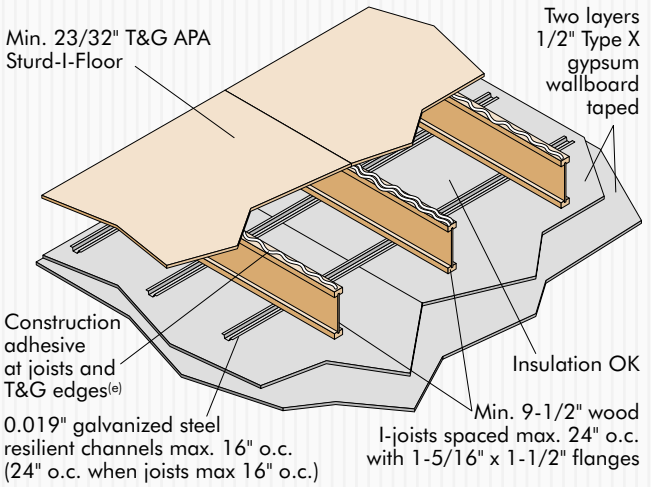
STC AND IIC SOUND RATINGS

Without Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
-	-	-	-

With Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
-	-	49[h]	55[h]

For additional details, see AF&PA DCA 3, Assembly WIJ-1.5 (www.afandpa.org)

4.3F – ONE-HOUR FIRE-RESISTIVE FLOOR[g]/CEILING ASSEMBLY



STC AND IIC SOUND RATINGS

	Without Gypsum Concrete			
	Cushioned Vinyl		**Carpet & Pad**	
	STC	IIC	STC	IIC
With Isulation	59	50	55[h]	68[h]
Without Isulation	-	-	54	68

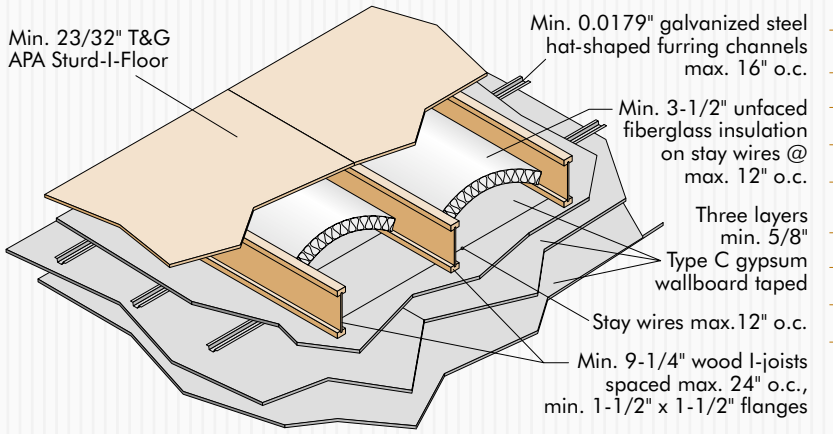
	With Gypsum Concrete			
	Cushioned Vinyl		**Carpet & Pad**	
	STC	IIC	STC	IIC
With Isulation	65	51	63[h]	65[h]
Without Isulation	-	-	58[h]	55[h]

For additional details, see AF&PA DCA 3, Assembly WIJ-1.6 (www.afandpa.org)

See footnotes, page 20.

FIGURE 5

TWO-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES[f][i]



For additional details, see AF&PA DCA 3 Assembly WIJ-2.1 (www.afandpa.org)

STC AND IIC SOUND RATINGS

Without Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
-	-	49[h]	54[h]

With Gypsum Concrete			
Cushioned Vinyl		**Carpet & Pad**	
STC	IIC	STC	IIC
52[h]	46[h]	52[h]	60[h]

FOOTNOTES FOR FIGURES 4 AND 5

(a) Substitution of 1-1/8" APA RATED STURD-I-FLOOR 48 oc for the combination of subfloor, paper and underlayment is often allowed. Check with local building official.

(b) Tests have shown that substitution of OSB or composite APA RATED SHEATHING subfloor and APA RATED STURD-I-FLOOR underlayment for the plywood panels in rated assemblies will not jeopardize fire-resistance ratings. Substitution is based on equivalent panel thickness, except that in two-layer wood assemblies 7/16" OSB subfloor panels may be used in place of 15/32" plywood subfloor panels. OSB panels are listed as alternates to plywood for subflooring or finish flooring in U.L. Design Nos. L501, L503, L505 (2hr), L508, L511 (2 hr), L513, L514, L516, L521, L526, L528, L529, L539, L540, L543 and L544.

(c) Most building codes do not require the top layer of two-layer rated assemblies when used for roofs.

(d) For improved acoustical performance, the gypsum wallboard is fastened to resilient metal channels in some assemblies. Other assemblies use mineral acoustical panels suspended under the floor framing on a T-bar grid system.

(e) Construction adhesive to conform to APA Specification AFG-01 (ASTM D3498).

(f) For other plywood floor-ceiling assemblies, see U.L. Design Nos. L208 (1-1/2hr), L506 (3/4 hr), L509 (1/2 hr), L520 (3/4 hr), L527 (1-1/2 hr) and L532 (1-1/2 hr).

(g) This assembly may also be used in a fire-rated roof/ceiling application, but only when constructed exactly as described.

(h) STC and IIC values estimated by David L. Adams Associates, Inc.

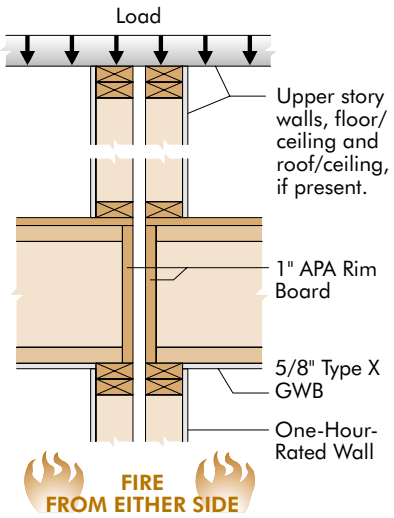
(i) The following fire-rated floor-ceiling or roof-ceiling assemblies include thermal or acoustical insulation in the joist cavity:

U.L. Design No.	Insulation	Insulation Thickness (in.)
L211 (2 hr)	Glass fiber batts	6
L212	Glass fiber batts	6
L507	Mineral wool (blown in)	9-1/4
L516	Glass fiber batts	3
L520 (3/4 hr)	Glass fiber batts	3
L521	Glass fiber batts	3-1/2
L532 (1-1/2 hr)	Glass fiber batts	3-1/2
L533	Glass fiber batts	3
L539	Glass fiber batts	3-5/8
L540	Glass fiber batts	3-5/8
L541 (2 hr)	Mineral wool batts	3
L543	Mineral wool (blown in)	3-1/2
L545	Glass fiber batts	3

APA Rim Board Assemblies (One- and Two-Hour)

See APA Data File No. D350, APA Rim Board in Fire Rated Assemblies, available at www.apawood.org, for typical assemblies, as shown below.

Assembly No. 1



Structural Glued Laminated Timber (Glulam)

The requirements for Heavy Timber construction in model building codes do not constitute one-hour fire resistance. Procedures are available in the model building codes, however, to estimate the size of glulam beams required for projects in which one-hour fire resistance is required (see page 10).

A structural member's fire resistance is measured by the time it can support its design load during a fire. An exposed beam or column sized for a minimum one-hour fire resistance will support its full design load for at least one hour during standard fire test conditions which simulate an actual fire. As with all other structural framing, final specifications of members designed to have one-hour fire resistance should be carefully checked by a professional engineer or architect to assure compliance with all local building codes.

For further information, see *APA EWS Technical Note EWS Y245, Calculating Fire Resistance of Glulam Beams and Columns.*

Beams. Charring of glulam surfaces during a fire places a premium on cross-sectional area. Charring weakens a glulam cross section slowly because of the self-insulating character of the char. Glulam beams with a minimum width of 5-1/8 inches (nominal 6 inches) can be adapted to a one-hour fire rating in accordance with procedures recognized by the model building codes.

For 6-3/4-inch and 8-3/4-inch widths, there is a minimum depth at and above which all members with these widths can be adapted at 100 percent of the allowable design load for a one-hour fire rating. The minimum depth increases when the design calls for the beam to be exposed on four rather than three sides. See Table 5.

TABLE 5

MINIMUM DEPTH AT WHICH GLULAM BEAMS CAN BE ADAPTED FOR ONE-HOUR FIRE RATINGS

Beam Width (in.)	Depth 3 Sides Exposed (in.)	Depth 4 Sides Exposed (in.)
5-1/8[a]	12	22-1/2
6-3/4	13-1/2	27
8-3/4	7-1/2	13-1/2

(a) When 5-1/8-inch wide glulam is used for one-hour fire-rated beams, load capacity is reduced to about 50% of the allowable design load for depths shown in Table 5. Contact APA for details.

To adapt beams whose dimensions qualify for one-hour fire rating, the basic layup must be modified as shown in Figure 6. One core lamination must be removed from the center and the tension face augmented with the addition of a tension lamination.

Columns. Columns are often produced with a single grade of laminations throughout and therefore need no special layup to qualify for a one-hour fire rating. For glulam beams having 8-3/4-inch and 10-3/4-inch widths, columns meeting the minimum size standard satisfy the one-hour fire rating requirement at 100 percent of the allowable design load.

However, column length plays a significant role in determining minimum size for one-hour ratings. The column size needed for a one-hour fire rating is determined by calculating the ℓ/d and then using the appropriate minimum dimensions in Table 6.

ℓ = column length in inches

d = column least dimension in inches

If ℓ/d is less than or equal to 11, the minimum required size is smaller than when ℓ/d is greater than 11.

Metal Connectors for Glulam. In structures using one-hour fire-rated glulam, all supporting metal connectors and fasteners must be protected to achieve a one-hour fire rating. A 1-1/2 inch covering of wood, 5/8" Type X gypsum wallboard or any coating approved for a one-hour rating provides the needed protection.

FIGURE 6

SIMPLE SPAN LAYUP

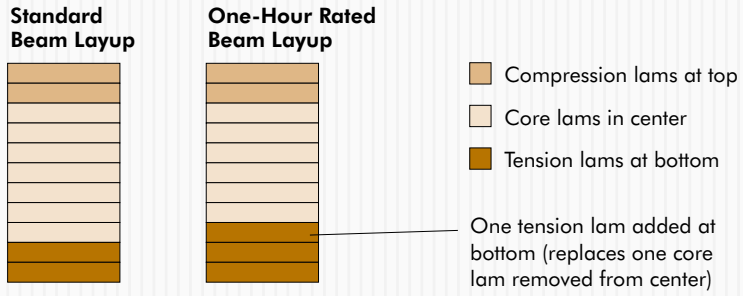


TABLE 6

MINIMUM DEPTH AT WHICH GLULAM COLUMNS QUALIFY FOR ONE-HOUR RATING FOR GIVEN ℓ/D

ℓ/d Criteria	Column Width (in.)	Depth 3 Sides Exposed (in.)	Depth 4 Sides Exposed (in.)
ℓ/d>11	10-3/4	10-1/2	13-1/2
ℓ/d≤ 11	6-3/4[a]	10-1/2	10-1/2
	8-3/4	7-1/2	12
	10-3/4	7-1/2	10-1/2

(a) Glulam with a nominal width of 6-3/4 inches can be used for one-hour fire-rated columns, but load capacity is reduced to about 50% of the allowable design load for depths shown in Table 6. Contact APA for details.

APPENDIX

How Areas Can Be Increased

Building codes place limitations on the height and area of a building according to its compliance with certain established criteria which are based on code concern with health and safety of the occupants.

These criteria include occupancies, types of construction, and location within fire zones.

Because light-frame construction is usually the best choice from the standpoint of cost and simplicity, yet is accorded the lowest basic allowable areas, it is to the designer's advantage to find ways to secure area increases, in order to take advantage of the economy and versatility of wood and plywood construction.

The following suggestions, and the data in Table 7 (page 24), should help. For further assistance on specific questions, designers should contact APA or its field specialists in order to find ways to achieve area increases.

1. One-hour fire resistance: Codes allow the area of a wood-frame building to be increased when one-hour fire resistance is provided for all structural elements in the building, including beams and columns, floors, walls, and roofs.

2. Automatic sprinkler protection: All codes have provisions which allow building areas to be increased when an automatic sprinkler system is installed throughout the building. For example, under the International Building Code, a 300 percent increase is permitted for one-story buildings, and 200 percent for multi-story buildings. An additional benefit is the likelihood of substantially lower insurance rates with sprinklers. Sprinkler systems can be connected to a central alarm system for additional protection.

3. Building separation: Basic area increases are allowed if there are large open areas on two or more sides of a building. Under the International Building Code, a 175 percent increase is allowed if all sides face toward public streets.

4. Unlimited areas: In some codes, provisions are made for the construction of unlimited area buildings for industrial, storage or business uses. Generally, there must be large areas of open space surrounding the building, and the building must be completely sprinklered.

The IBC permits unlimited areas in certain factory and storage buildings. The IBC also permits unlimited areas for all business, factory, mercantile and storage occupancies when the building is one story and equipped with an automatic sprinkler system.

5. Fire walls: The equivalent effect of area increases can be achieved by introduction of properly constructed fire walls. In effect, two contiguous buildings are erected, but are separated by a rated wall or partition, with all openings protected.

TABLE 7

ALLOWABLE HEIGHT AND BUILDING AREAS
Height limitations shown as stories and feet above grade plane.
Area limitations as determined by the definition of "Area, building," per floor.

		Type of Construction								
		Type I		Type II		Type III		Type IV	Type V	
	Hgt (feet)	A	B	A	B	A	B	HT	A	B
Group	Hgt(S)	UL	160	65	55	65	55	65	50	40
A-1	S	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-3	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-4	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-5	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
	A	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	S	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
E	S	UL	5	3	2	3	2	3	1	1
	A	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
F-1	S	UL	11	4	2	3	2	4	2	1
	A	UL	UL	25,000	15,500	19,00	12,000	33,500	14,000	8,500
F-2	S	UL	11	5	3	4	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	18,000	50,5000	21,000	13,000
H-1	S	1	1	1	1	1	1	1	1	NP
	A	21,000	16,500	11,000	7,000	9,500	7,000	10,500	7,500	NP
H-2	S	UL	3	2	1	2	1	2	1	1
	A	21,000	16,500	11,000	7,000	9,500	7,000	10,500	7,500	3,000
H-3	S	UL	6	4	2	4	2	4	2	1
	A	UL	60,000	26,500	14,000	17,500	13,000	25,500	10,000	5,000
H-4	S	UL	7	5	3	5	3	5	3	2
	A	UL	UL	37,500	17,500	28,500	17,500	36,000	18,000	6,500
H-5	S	3	3	3	3	3	3	3	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
I-1	S	UL	9	4	3	4	3	4	3	2
	A	UL	55,000	19,000	10,000	16,500	10,000	18,000	10,500	4,500
I-2	S	UL	4	2	1	1	NP	1	1	NP
	A	UL	UL	15,000	11,000	12,000	NP	12,000	9,500	NP
I-3	S	UL	4	2	1	2	1	2	2	1
	A	UL	UL	15,000	11,000	10,500	7,500	12,000	7,500	5,000
I-4	S	UL	5	3	2	3	2	3	1	1
	A	UL	60,500	26,500	13,000	23,500	13,000	25,500	18,500	9,000
M	S	UL	11	4	4	4	4	4	3	1
	A	UL	UL	21,500	12,500	18,500	12,500	20,500	14,000	9,000

CONTINUED ON NEXT PAGE

TABLE 7 CONTINUED

ALLOWABLE HEIGHT AND BUILDING AREAS
Height limitations shown as stories and feet above grade plane.
Area limitations as determined by the definition of "Area, building," per floor.

		Type of Construction								
		Type I		Type II		Type III		Type IV	Type V	
	Hgt (feet)	A	B	A	B	A	B	HT	A	B
Group	Hgt(S)	UL	160	65	55	65	55	65	50	40
R-1	S	UL	11	4	4	4	4	4	3	2
	A	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000
R-2[a]	S	UL	11	4	4	4	4	4	3	2
	A	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000
R-3[a]	S	UL	11	4	4	4	4	4	3	3
	A	UL	UL	UL	UL	UL	UL	UL	UL	UL
R-4	S	UL	11	4	4	4	4	4	3	2
	A	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000
S-1	S	UL	11	4	3	3	3	4	3	1
	A	UL	48,000	26,000	17,500	26,000	17,500	25,500	14,000	9,000
S-2[b, c]	S	UL	11	5	4	4	4	5	4	2
	A	UL	79,000	39,000	26,000	39,000	26,000	38,500	21,000	13,500
U	S	UL	5	4	2	3	2	4	2	1
	A	UL	35,500	19,000	8,500	14,000	8,500	18,000	9,000	5,500

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

A = protected (fire resistive) or one-hour. **B** = no special requirements for fire resistance.

S = story, A = area.

UL = unlimited, NP = not permitted.

a. As applicable in Section 101.2.

b. Fore open parking structures, see Section 406.3.

c. For private garages, see Section 406.1.

BIBLIOGRAPHY

The following APA publications contain additional details on subjects covered in this booklet. Copies are available upon request from APA – The Engineered Wood Association, 7011 So. 19th St., Tacoma, Washington 98466-5399. Or at www.apawood.org.

APA Engineered Wood Construction Guide. E30, $8

APA Design/Construction Guide: Non-residential Roof Systems. A310. Online only.

Research Report 128: Fire Hazard Classification of PS-1 Plywood. Y380, $4

EWS Product Guide: Glulam. EWS X440, $3

In addition, the following are good sources of technical or background information on wood construction systems in relation to code provisions and insurance regulations:

Building Materials Directory (issued annually). Underwriters Laboratories Inc., Northbrook, Illinois. www.ul.com

Fire Resistance Directory (issued annually). Underwriters Laboratories Inc., Northbrook, Illinois. www.ul.com

Roofing Materials and Systems Directory (issued annually). Underwriters Laboratories Inc., Northbrook, Illinois. www.ul.com

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Other publications and information are available from:

American Forest and Paper Association, Washington, D.C.

American Institute of Timber Construction, Englewood, Colorado.

American Society for Testing and Materials, West Conshohocken, Pennsylvania.

U.S. Forest Products Laboratory, Madison, Wisconsin.

National Fire Protection Association, Quincy, Massachusetts.

Canadian Wood Council, Ottawa, Ontario, Canada.

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