Design No. L550 Continued

9. Steel Framing Members

a. Main Runners installed perpendicular to Structural Steel Members, - Nom 12' long, 15/16" or 1-1/2" wide face, spaced 4' o.c. Main runners hung a min of 2" from bottom chord of Structural Steel Members with 12 SWG galv steel wire. Wires located a max of 48" o.c.

b. Cross tees or channels Nom 4' long, 15/16" or 1-1/2" wide face, or cross channels, nom 4' long, 1-1/2" wide face, installed perpendicular to the main runners, spaced 16" o.c. Additional cross tees or channels used at 8" from each side of butted wallboard end joints. The cross tees or channels may be riveted or screw-attached to the wall angle or channel to facilitate the ceiling installation.

c. Wall angles or channels Used to support steel framing member ends and for screw-attachment of the gypsum wallboard- Painted or galvanized steel angles with 1" legs, or channels with 1" legs and 1-9/16" deep, attached to walls at perimeter of ceiling with fasteners 16" o.c.

CGC INTERIORS, DIVISION OF CGC INC. - TYPE DGL OR RX
USG INTERIORS INC - Type DGL or RX

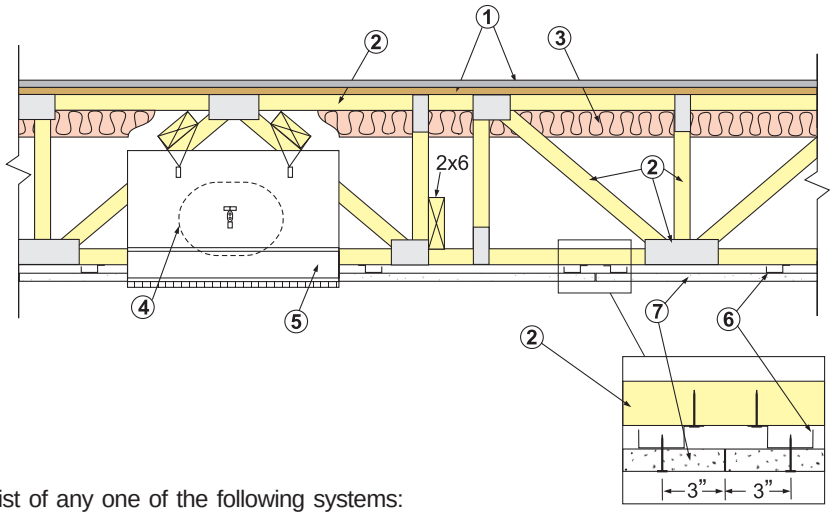
10. Gypsum Board* For use with Steel Framing Members (Item 9) - One layer of nominal 5/8" thick by 48" wide boards, installed with long dimension parallel to the main runners. Wallboard fastened to each cross tee or channel with five wallboard screws, with one screw located at the midspan of the cross tee or channel, one screw located 12" from and on each side of the cross tee or channel mid span and one screw located 1-1/2" from each wallboard side joint. Except at wallboard end joints, wallboard screws shall be located 1/2" from the joint. Wallboard fastened to main runners with wallboard screws 1/2" from side joints, midway between intersections with cross tees or channels (16" o.c.). End joints of adjacent wallboard sheets shall be staggered not less than 32" Wallboard sheets screw attached to leg of wall angle with wallboard screws spaced 12" o.c. Joints treated as described in Item 8.

CANADIAN GYPSUM COMPANY - Type C, IP-X2, IPC-AR
UNITED STATES GYPSUM CO - Type C, IP-X2, IPC-AR
USG MEXICO S A DE C V - Type C, IP-X2, IPC-AR

*Bearing the UL Classification Mark.

Design No. L558
(Source: Underwriters Laboratory, Inc.'s Fire Resistance Directory, April 19 2002)

SPECIFICATIONS
Fire Rating - 60 minutes
Finish Rating - 23 minutes
(See Items 3 and 3A)



End Joint Detail

1. Flooring System The finish flooring may consist of any one of the following systems:

System No. 1
Finish Flooring Nom 1 by 4" T&G; laid perpendicular to trusses; or 15/32" thick wood structural panels, min grade "Underlayment" or "Single-Floor". Long dimensions of panel (strength axis) or face grain of plywood to be perpendicular to trusses with joints staggered. Vapor Barrier (Optional) - Commercial asphalt saturated felt, 0.030" thick. Subflooring 23/32" thick wood structural panels. Installed perpendicular to trusses with end joints staggered 4' Plywood or nonveneer APA rated panels secured to trusses with construction adhesive and No. 6d ringed shank nails. Nails spaced 12" o.c. along each truss. Staples having equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

System No. 2
Finish Flooring - Floor Topping Mixture* 6.8 gal of water to 80 lbs of floor topping mixture to 1.9 cu ft of sand. Compressive strength to be 1100 psi min. Thickness to be 3/4" min.

HACKER INDUSTRIES INC - Firm-Fill, Firm-Fill 2010, Firm-Fill High Strength, Gyp-Span Radiant.

Subflooring 23/32" thick wood structural panels. Installed perpendicular to trusses with end joints staggered 4' Plywood or panels secured to trusses with construction adhesive and No. 6d ringed shank nails. Nails spaced 12" o.c. along each truss. Staples having equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

System No. 3
Finish Floor Mineral and Fiber board*, sizes ranging from 3' by 4' to 8' by 12', by min 1/2" thick. All joints to be staggered a min of 12" o.c. with adjacent sub-floor joints.

HOMASOTE CO - Type 440-32 Mineral and Fiber Board.

Subflooring 1" by 6" T & G fastened diagonally to joists; or 15/32" thick plywood or 7/16" thick oriented strand board (OSB) wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panel to be perpendicular to joists with joints staggered.

System No. 4
Finish Flooring - Floor Topping Mixture* 10 to 13 gal of water to 170 lbs of floor topping mixture to 595 lbs of sand. Compressive strength 900 psi min, thickness to be 3/4" min.

Figure 17.5.20

Design No. L558 Continued

ORTECRETE CORP - Type II.

Subflooring 23/32" thick wood structural panels, min grade "underlayment" or "single floor". Face grain of plywood or strength axis of panels installed perpendicular to trusses with end joints staggered 4'. Panels secured to trusses with construction adhesive and No. 6d ringed shank nails. Nails spaced 12" o.c. along each truss. Staples have equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

2. Trusses Parallel chord trusses, spaced a max of 24" o.c., fabricated from nom 2x4 lumber, with lumber oriented vertically or horizontally. Min truss depth is 18" Truss members secured together with min 0.0356" thick galv steel plates. Plates have 5/16" long teeth projecting perpendicular to the plane of the plate. The teeth are in pairs facing each other (made by the same punch), forming a split tooth type plate. Each tooth has a chisel point on its outside edge. These points are diagonally opposite each other for each pair. The top half of each tooth has a twist for stiffness. The pairs are repeated on approx. 7/8" centers with four rows of teeth per inch of plate width.

3. Batts and Blankets* Glass fiber insulation, max 3-1/2" thick, fitted in the concealed space, draped over the resilient channels and gypsum wallboard ceiling membrane. Any glass fiber insulation bearing the UL Classification Marking as to Surface Burning Characteristics and/or Fire Resistance, having a min density of 0.5 pcf

   3A. Loose Fill Material* As an alternate to Item 3, any loose fill material bearing the UL Classification Marking for Surface Burning Characteristics, having a min density of 0.5 pcf and installed at a max thickness of 3-1/2"

4. Air Duct* Any UL Class 0 or Class 1 flexible air duct installed in accordance with the instructions provided by the damper manufacturer.

5. Ceiling Damper* Maximum nominal area, 324 sq ft Maximum square size, 18" by 18" Rectangular sizes not to exceed 324 sq ft with a maximum width of 18" Maximum damper height is 14" Installed in accordance with the manufacturers installation instructions provided with the damper. Maximum damper openings not to exceed 324 sq ft per 100 sq ft of ceiling area.

   C&S AIR PRODUCTS - Model RD-521.
   POTTORFF CO INC - Model CFD-521.

6. Furring Channels Resilient channels, 3/8" deep by 2-3/8" wide at the base and 1-3/8" wide at the face, formed from 0.020 in. thick galv steel, spaced 12" o.c. Channels secured to each truss with 1-1/4" long Type S steel screws. Channels overlapped 4" at splices. Channels oriented opposite at wallboard butt joints (spaced 6" o.c.) as shown in the above illustration.

7. Gypsum Board* Nom 5/8" thick, 48" wide, installed with long dimension perpendicular to resilient channels with 1-1/8" long Type S screws spaced 12" o.c. and located a min of 1/2" from side joints and 3" from the end joints. At end joints, two resilient channels are used, extending a min of 6" beyond both ends of the joint. When insulation, Item 3 or 3A, is draped over the resilient channel/gypsum wallboard ceiling membrane, screws shall be installed at 8" o.c.

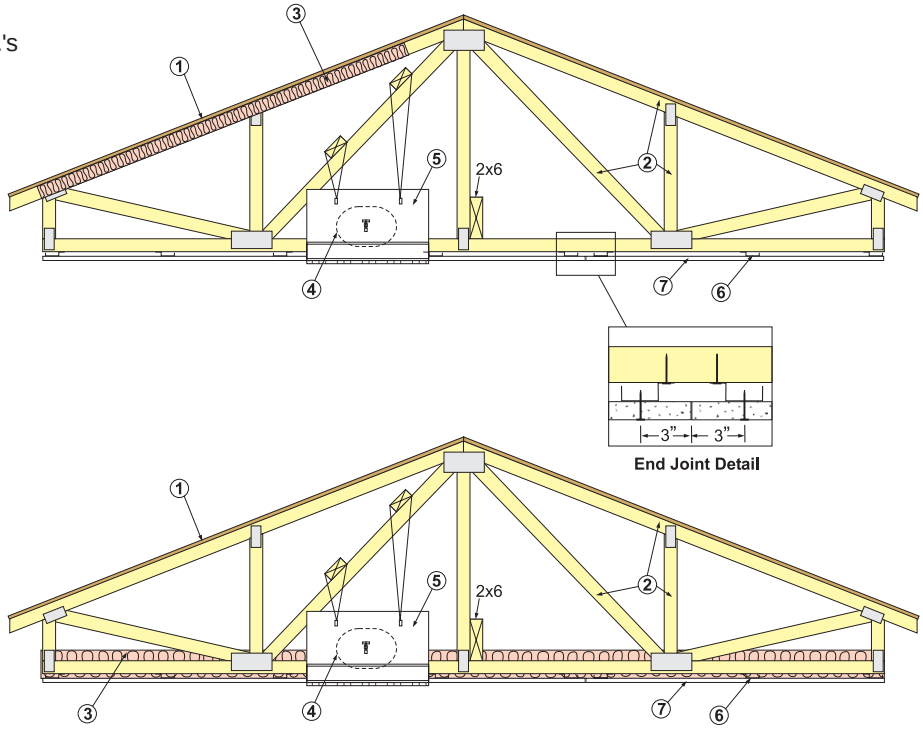
NATIONAL GYPSUM CO - Types FSW-G, FSW-C.

8. Finishing System (Not shown) - Vinyl, dry or premixed joint compound, applied in two coats to joints and screw-heads; paper tape, 2" wide, embedded in first layer of compound over all joints. As an alternate, nom 3/32" thick veneer plaster may be applied to the entire surface of gypsum wallboard.

*Bearing the UL Classification Mark.

Design No. P522
(Source: Underwriters Laboratory, Inc.'s Fire Resistance Directory, 1999)

SPECIFICATIONS
Fire Rating - 60 minutes
Finish Rating - 25 minutes
(See Items 3 or 3A)



1. Roofing System* Any UL Class A, B or C Roofing System (TGFU) or Prepared Roof Covering (TFWZ) acceptable for use over nom 15/32" thick plywood sheathing. Nom 15/32" thick plywood sheathing secured to trusses with construction adhesive and No. 6d ringed shank nails. Nails spaced 12" o.c. along each truss. Staples having equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

2. Trusses Pitched or parallel chord wood trusses, spaced a max of 24" o.c., fabricated from nom 2x4 lumber, with lumber oriented vertically or horizontally. Truss members secured together with 0.040" thick galv steel plates. Plates have 5/16" long teeth projecting perpendicular to the plane of the plate. The teeth are in pairs facing each other (made by the same punch), forming a split tooth type plate. Each tooth has a chisel point on its outside edge. These points are diagonally opposite each other for each pair. The top half of each tooth has a twist for stiffness. The pairs are repeated on approximately 7/8" centers with four rows of teeth per inch of plate width. Where the truss intersects with the interior face of the exterior walls, the min truss depth shall be 5-1/4" with a min roof slope of 3/12 and a min. area in the plane of the truss of 21 sq ft. Where the truss intersects with the interior face of the exterior walls, the min truss depth may be reduced to 3" if the batts and blankets (Item 3) are used as shown in the above illustration (Alternate Insulation Placement) and are firmly packed against the intersection of the bottom chords and the plywood sheathing.

3. Batts and Blankets* (Optional) - Glass fiber insulation, secured to the plywood decking with staples spaced 12" o.c. or to the trusses with 0.090" dia galv steel wires spaced 12" o.c. Any glass fiber insulation bearing the UL Classification Marking as to Surface Burning Characteristics and/or Fire Resistance, having a min density of 0.5 pcf. As an option, the insulation may be fitted in the concealed space, draped over the resilient channel/gypsum wallboard ceiling membrane when resilient channels and gypsum wallboard attachment is modified as specified in Items 6 and 7. The finished rating has only been determined when the insulation is secured to the decking.

   3A. Loose Fill Material* As an alternate to Item 3 - Any thickness of loose fill material bearing the UL Classification Marking for Surface Burning Characteristics, having a min density of 0.5 pcf, fitted in the concealed space, draped over the resilient channel/gypsum wallboard ceiling membrane when resilient channels and gypsum wallboard attachment is modified as specified in Items 6 and 7. The finished rating when loose fill material is used has not been determined.

4. Air Duct* Any UL Class 0 or Class 1 flexible air duct installed in accordance with the instructions provided by the damper manufacturer.

Figure 17.5.21

Design No. P522 Continued

5. Ceiling Damper* Max nom area, 324 sq in. Max square size, 18" by 18" rectangular sizes not to exceed 324 sq in. with a max width of 18" Max damper height is 14" Installed in accordance with manufacturers installation instructions provided with the damper. Max damper openings not to exceed 162 sq in. per 100 sq ft of ceiling area.
   C&S AIR PRODUCTS - Model RD-521.
   POTTORFF CO INC - Model CFD-521.

6. Furring Channels Resilient channels, 3/8'. deep by 2-3/8". wide at the base and 1-3/8". wide at the face, formed from 0.020" thick galv steel, spaced 16". o.c., installed perpendicular to trusses. When batt and blanket material, Item 3, is draped over the resilient channel/gypsum wallboard ceiling membrane, the spacing shall be 12" o.c. Channels secured to each truss with 1-1/4" long Type S steel screws. Channels overlapped 4" at splices. Channels oriented opposite at wallboard butt joints (spaced 6" o.c.) as shown in the above illustration.

7. Gypsum Board* One layer of nom 5/8" thick by 48" wide boards, installed with long dimension parallel to trusses. Attached to the resilient channels using 1" long Type S bugle-head screws. Screws spaced a max of 12" o.c. along butted end-joints and in the field when no insulation (Item 3 or 3A) is fitted in the concealed spaced, or a max of 8" o.c. along butted end-joints and in the field when insulation (Item 3 or 3A) is fitted in the concealed space, draped over the resilient channel/gypsum wallboard ceiling membrane.
   CANADIAN GYPSUM COMPANY - Types C, IP-X2, IPC-AR.
   UNITED STATES GYPSUM CO - Types C, IP-X2, IPC-AR.
   USG MEXICO S A DE C V - Types C, IP-X2, IPC-AR.

8. Finishing System (Not Shown) - Vinyl, dry or premixed joint compound, applied in two coats to joints and screw-heads; paper tape, 2" wide, embedded in first layer of compound over all joints. As an alternate, nom 3/32" thick veneer plaster may be applied to the entire surface of gypsum wallboard. Alternate Ceiling Membrane - Not Shown - Not for use when insulation (Item 6 or 6A) is used.

9. Steel Framing Members

   a. Main runners Installed perpendicular to Structural Steel Members - Nom 12' long, 15/16" or 1-1/2" wide face, spaced 4' o.c. Main runners hung a min of 2" from bottom chord of Structural Steel Members with 12 SWG galv steel wire. Wires located a max of 48" o.c.

   b. Cross tees or channels Nom 4' long, 15/16" or 1-1/2" wide face or cross channels, nom 4' long, 1-1/2" wide face, installed perpendicular to the main runners, spaced 16" o.c. Additional cross tees or channels used at 8" from each side of butted wallboard end joints. The cross tees or channels may be riveted or screw-attached to the wall angle or channel to facilitate the ceiling installation.

   c. Wall angles or channels Used to support steel framing member ends and for screw-attachment of the gypsum wallboard - Painted or galv steel angles with 1" legs or channels with 1" legs and 1-9/16" deep, attached to walls at perimeter of ceiling with fasteners 16" o.c.
      CGC INTERIORS, DIV OF
      CGC INC - Type DGL or RX.
      USG INTERIORS INC - Type DGL or RX.

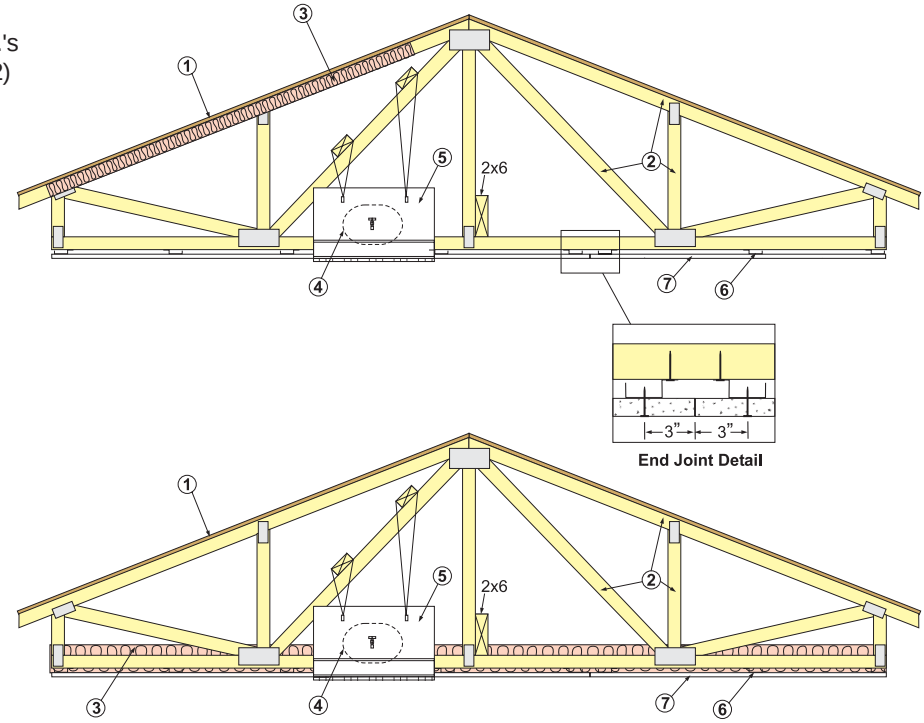
10. Gypsum Board* For use with Steel Framing Members (Item 9) - One layer of nom 5/8" thick by 48" wide boards, installed with long dimension parallel to the main runners. Wallboard fastened to each cross tee or channel with five wallboard screws, with one screw located at the midspan of the cross tee or channel, one screw located 12" from and on each side of the cross tee or channel mid span and one screw located 1-1/2" from each wallboard side joint. Except at wallboard end joints, wallboard screws shall be located on alternating sides of cross tee flange. At wallboard end joints, wallboard screws shall be located 1/2" from the joint. Wallboard fastened to main runners with wallboard screws 1/2" from side joints, midway between intersections with cross tees or channels (16" o.c.). End joints of adjacent wallboard sheets shall be staggered not less than 32" Wallboard sheets screw attached to leg of wall angle with wallboard screws spaced 12" o.c. Joints treated as described in Item 7.

      CANADIAN GYPSUM COMPANY - Type C or IP-X2.
      UNITED STATES GYPSUM CO - Type C or IP-X2.
      USG MEXICO S A DE C V - Type C or IP-X2.

*Bearing the UL Classification Mark.

Design No. P531
(Source: Underwriters Laboratory, Inc.'s Fire Resistance Directory, April 18 2002)

SPECIFICATIONS
Fire Rating-60 minutes
Finish Rating-25 minutes



1. Roofing System* Any UL Class A, B or C Roofing System (TGFU) or Prepared Roof Covering (TFWZ) acceptable for use over nom 15/32" thick plywood sheathing. Nom 15/32" thick plywood sheathing secured to trusses with construction adhesive and No. 6d ringed shank nails. Nails spaced 12" o.c. along each truss. Staples having equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

2. Trusses Pitch or Parallel chord trusses, spaced a max of 24" o.c., fabricated from nom 2x4 lumber, with lumber oriented vertically or horizontally. Truss members secured together with 0.040" thick galv steel plates. Plates have 5/16" long teeth projecting perpendicular to the plane of the plate. The teeth are in pairs facing each other (made by the same punch), forming a split tooth type plate. Each tooth has a chisel point on its outside edge. These points are diagonally opposite each other for each pair. The top half of each tooth has a twist for stiffness. The pairs are repeated on approximately 7/8" centers with four rows of teeth per inch of plate width. Where the truss intersects with the interior face of the exterior walls, the min truss depth shall be 5-1/4" with a min roof slope of 3/12 and a min. area in the plane of the truss of 21 sq/ft. Where the truss intersects with the interior face of the exterior walls, the min truss depth may be reduced to 3" if the batts and blankets (Item 3) are used as shown in the above illustration (Alternate Insulation Placement) and are firmly packed against the intersection of the bottom chords and the plywood sheathing.

3. Batts and Blankets* (Optional) -Glass fiber insulation, secured to the plywood decking with staples spaced 12" o.c. or to the trusses with 0.090" dia galv steel wires spaced 12" o.c.. Any glass fiber insulation bearing the UL Classification Marking as to Surface Burning Characteristics and/or Fire Resistance, having a min density of 0.5 pcf. As an option, the insulation may be fitted in the concealed space, draped over the resilient channel/gypsum wallboard ceiling membrane when resilient channels and gypsum wallboard attachment is modified as specified in Items 6 and 7. The finished rating has only been determined when the insulation is secured to the decking.

4. Air Duct* Any UL Class 0 or Class 1 flexible air duct installed in accordance with the instructions provided by the damper manufacturer.

5. Damper* Nom 20" long by 18" wide by 2-1/8" high, fabricated from galvanized steel. Plenum box maximum size nom. 21" long by 18" wide by 16" high fabricated from either galvanized steel or Classified Air Duct Materials bearing the UL Class 0 or Class 1 rigid air duct material. Installed in accordance with the instructions provided by the manufacturer. Max damper openings not to exceed 360 sq in. per 100 sq ft of ceiling area.

NAILOR INDUSTRIES INC - Type 0755

Figure 17.5.22

Design No. P531 Continued

6. Furring Channels Resilient channels, 3/8" deep by 2-3/8" wide at the base and 1-3/8" wide at the face, formed from 0.020" thick galv steel, spaced 16" o.c., installed perpendicular to trusses. When batt and blanket material, Item 3, is draped over the resilient channel/gypsum wallboard ceiling membrane, the spacing shall be 12" o.c.. Channels secured to each truss with 1-1/4" long Type S steel screws. Channels overlapped 4" at splices. Channels oriented opposite at wallboard butt joints (spaced 6" o.c.) as shown in the above illustration.

7. Wallboard, Gypsum* Nom 5/8" thick, 48" wide, installed with long dimension perpendicular to resilient channels with 1" long Type S screws spaced 12" o.c. and located a min of 1/2" from side joints and 3" from the end joints. At end joints, two resilient channels are used, extending a min of 6" beyond both ends of the joint. When batt and blanket insulation, Item 3, is draped over the resilient channel/gypsum wallboard ceiling membrane, screws shall be installed at 8" o.c..

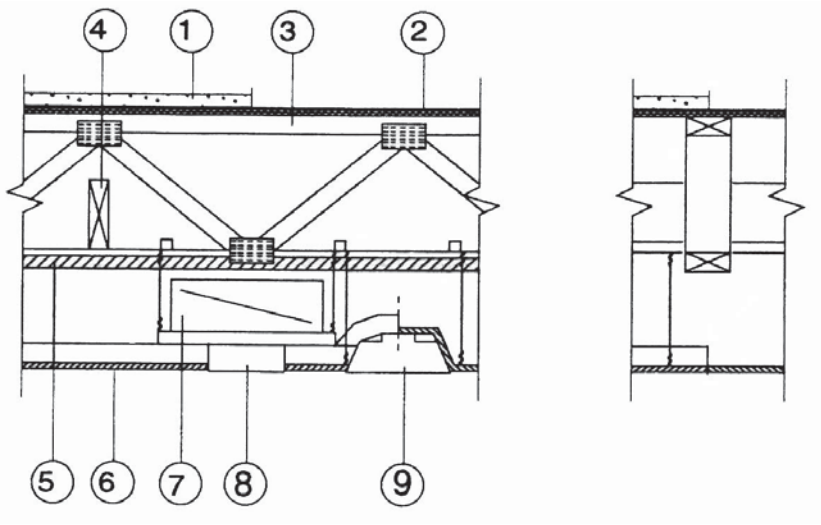
   CANADIAN GYPSUM COMPANY - Types C, IP-X2, IPC-AR
   UNITED STATES GYPSUM CO - Types C, IP-X2, IPC-AR
   USG MEXICO S A DE C V - Types C, IP-X2, IPC-AR

8. Finishing System (Not Shown)- Vinyl, dry or premixed joint compound, applied in two coats to joints and screw-heads; paper tape, 2" wide, embedded in first layer of compound over all joints. As an alternate, nom 3/32" thick veneer plaster may be applied to the entire surface of gypsum wallboard.

*Bearing the UL Classification Mark.

DESIGN NO. TSC/FCA 60-08
(Source: Intertek Testing Services, 2001 Directory of Listed Products)

SPECIFICATIONS
Fire RATING: 60 minutes
Finish Rating - 29 minutes



1. Topping (Optional) - Subject to design and project limitations, these systems may be augmented with a lightweight floor topping mix containing perlite or vermiculite aggregate.

2. Flooring - minimum 3/4" or 19.0 mm plywood or O-2 grade waferboard or strandboard.

3. Structural Member - Truswal metal truss plates with structural graded chords as per NLGA grading rules and having a minimum depth of 10" and spaced up to a maximum of 24" o.c. for floor/ceiling systems. All FlorTruses are to be designed and sealed by a Professional Engineer.

4. Bridging/Strongback - 2x6 SPF #2 to be screwed to the bottom chord with two 3" screws and spaced at 7' o.c.

5. TrusGard Protective Channels - No. 30 gauge steel channel secured to bottom chord of trusses during fabrication.

6. Ceiling System - Suitable fire rated suspended ceiling system. Any suspended ceiling system may be selected which satisfies the following criteria:

   a. It must be a fire rated system, and be installed within the terms of its listing

   b. It must have a finish rating equal to or greater than the finish rating required by the suspended ceiling design.

   c. It must be suspended in accordance with the terms of its listing and a minimum of 7-1/2" below the joist.

d. Penetrations such as ducts, air diffusers, and fixtures must be protected in such a manner as to conform to the terms of the listing of the suspended ceiling system.

7. Duct - see Item 6 above.

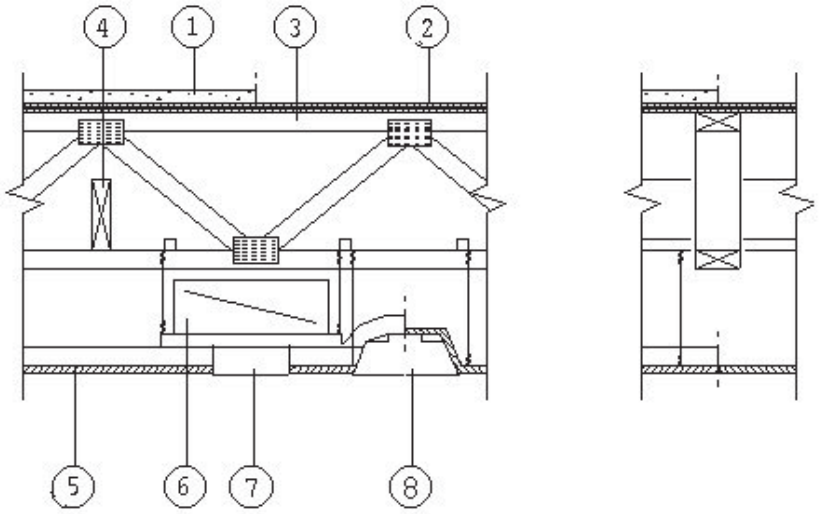
8. Air Diffuser - see Item 6 above.

9. Fixtures - see Item 6 above.

Figure 17.5.23

DESIGN NO. TSC/FCA 60-04
(Source: Intertek Testing Services, 2001 Directory of Listed Products)

SPECIFICATIONS
Fire RATING: 60 minutes
Finish Rating - 27 minutes



1. Topping (Optional) - Subject to design and project limitations, these systems may be augmented with a lightweight floor topping mix containing perlite or vermiculite aggregate.

2. Flooring - Minimum 3/4" or 19.0 mm plywood or O-2 grade waferboard or strandboard.

3. Structural Member - Truswal metal truss plates with structural graded chords and webs as per NLGA grading rules and having a minimum depth of 10" and spaced up to a maximum of 24" o.c. for floor/ceiling systems.. All FlorTruses are to be designed and sealed by a Professional Engineer.

4. Bridging/Strongback - 2"x6" SPF #2 to be screwed to the bottom chord with two 3" screws and spaced at 7' on center.

5. Ceiling System - Suitable fire rated suspended ceiling system. Any suspended ceiling system may be selected which satisfies the following criteria:

   a. It must be a fire rated system, and be installed within the terms of its listing

   b. It must have a finish rating equal to or greater than the finish rating required by the suspended ceiling design.

   c. It must be suspended in accordance with the terms of its listing and a minimum of 7-1/2" below the joist.

   d. Penetrations such as ducts, air diffusers, and fixtures must be protected in such a manner as to conform to the terms of the listing of the suspended ceiling system.

6. Duct - See Item 5 above.

7. Air Diffuser - See Item 5 above.

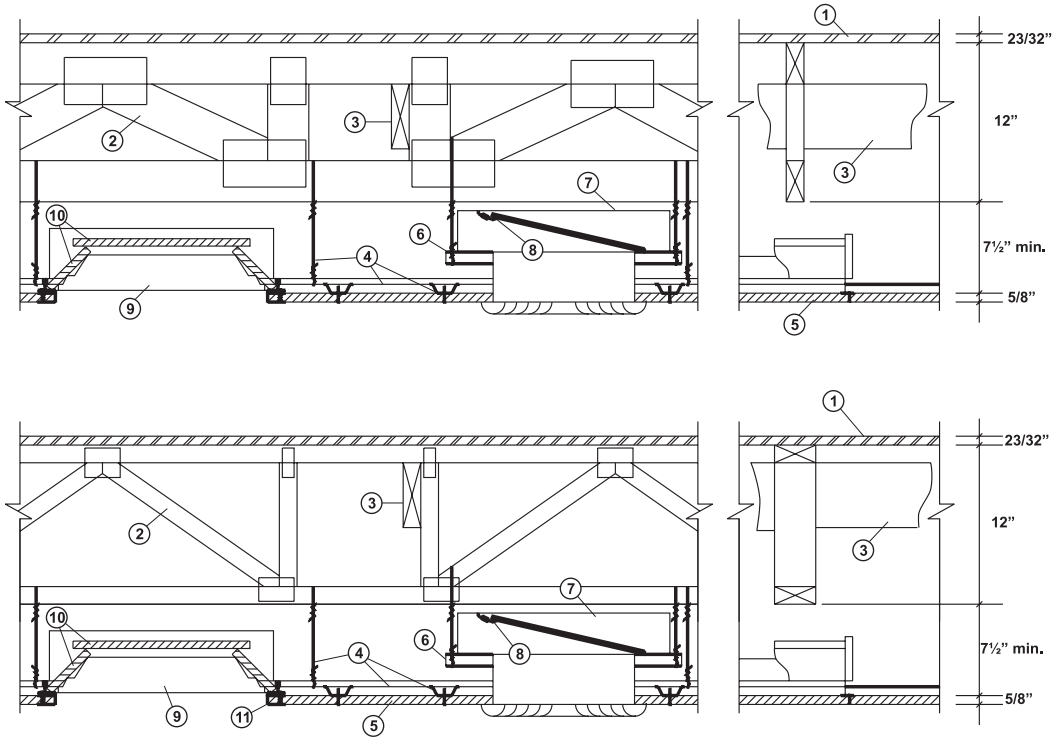
8. Fixtures - See Item 5 above.

Figure 17.5.24

UL-L529

Source: Commentary and Appendices to ANSI/TPI 1-1995, Appendix E; and Underwriters Laboratory, Inc.'s *Fire Resistance Directory*, 1996.

SPECIFICATIONS
Fire Rating: 60 minutes
Finish Rating: 22 minutes



1.Roof-Floor: Sheathing shall be a minimum 23/32" tongue-and-groove long edges. Long edges are installed perpendicular to trusses. Attach sheathing with a minimum 6d ring-shank nails at 12" o.c. A 3/8" bead of adhesive is applied to the top chord of the trusses and in plywood grooves prior to placement. Optional minimum 3/4"-thick lightweight concrete or topping mixture may be installed, over the flooring described above, without affecting the fire-resistive rating.

2.Wood Trusses: Trusses shall be spaced a maximum of 24" o.c. and overall truss depth shall be a minimum 12".

3.Bracing (Strongback): Bracing shall be minimum 2x6 grade marked lumber oriented vertically and installed perpendicular to trusses at a maximum 10' o.c. Secure to each truss with three 16d nails. Locate bracing as close to the bottom chord as possible.

4.Steel Framing Members: Donn Corporation Type RX main runners 12' long spaced 48" o.c. Channels, nominal 48" long installed perpendicular to the main runners, spaced 24" o.c. Additional channels used at 8" from each side of light fixtures and from butted end joints. No. 12 SWG galvanized steel wire tied to lower chord of truss face to face with No. 18 SWG galvanized wire. Hanger wires spaced not over 48" o.c. along main runners and located at ends of main runners at walls and at corners and midspan along 4' sides of light fixtures. Channels clipped into main runner slots. At walls channels secured to wall angle with 1/2" long self-drilling and self-tapping screws having a thread diameter of 0.138" and 5/16" diameter heads. Donn Corporation Type DXL nominal 4' long cross tees, installed perpendicular to main runners to support 4' sides of light fixtures.

Alternate steel framing members (not shown) include main runners nominal 12' long spaced 48" o.c. Cross tees nominal 4' long installed perpendicular to main runners and spaced 24" o.c. Additional cross tees located 8" from and on both sides of each wallboard end joint and each recessed light fixture. Chicago Metallic Corp. - Type 650 (Cat No. 650 main runners and Cat. No. 654 cross tees. As an option, Cat. No. 659 cross tees may be used to support light fixtures.) National Rolling Mills, Inc. - Type CER-8000.

Figure 17.5.25

UL-L529 Continued

5. Gypsum Wallboard: Install single layer of 5/8" US Gypsum Firecode C gypsum wallboard with long dimension perpendicular to cross channels with side joints centered along main runners. Directly secure to cross channels with 1" Type S-12 self drilling and self tapping wallboard screws spaced 12" o.c. and located a minimum 1-3/4" from each side joint and 1/2" from end joints. Wallboard joints are taped, and joints and screw heads are covered with a double layer of compound. As an alternate, nominal 3/32"-thick veneer plaster may be applied to the entire surface of gypsum wallboard.

6. Cold-Rolled Channels: No. 16 MSG cold-rolled steel, 1-1/4" deep No. 12 SWG galvanized steel wire tied to cold-rolled channels face to face with No. 18 SWG galvanized wire.

7. Air Duct: No. 24 MSG galvanized steel. Total area of duct openings not to exceed 57 sq in per 100 sq in of ceiling area. Area of duct opening not to exceed 113 in sq. Maximum dimension of opening 12". Duct supported by cold-rolled channels, spaced approximately 24" o.c.

8. Damper: No. 16 MSG galvanized steel, 16 x 16" protected on both surfaces with a material having similar conductivity at 2000° F as 1/16" thick asbestos paper and held open and held open with a fusible link. (Bearing the UL Listing Mark) Damper to overlap duct outlet 1" minimum.

9. Fixtures, Recessed Light: Fluorescent lamp type, steel housing, 2x4 size. Fixtures spaced so their area does not exceed 24 sq ft per 100 sq ft of ceiling area. Wired in conformance with the National Electrical Code. Fixtures and ballasts must be considered for these ambient temperature conditions before installation.

10. Fixture Protection - Gypsum: 5/8" US Gypsum Firecode C cut into pieces for form a five-sided enclosure, trapezoidal in cross-section, approximately 1/4" longer and wider than the fixture with sufficient depth to provide at least 1/4" clearance between the fixture and enclosure.

11. Metal Trim Molding: No. 22 MSG molding, measuring 5/8" wide with 9/16"- and 1-3/8" long legs. Placed on wallboard edges around light fixtures and secured to the cross tees and main runners with 1" long wallboard screws. Spacing of screws approximately 8" o.c. along 4' side and 10" o.c. along 2' side of light fixture.

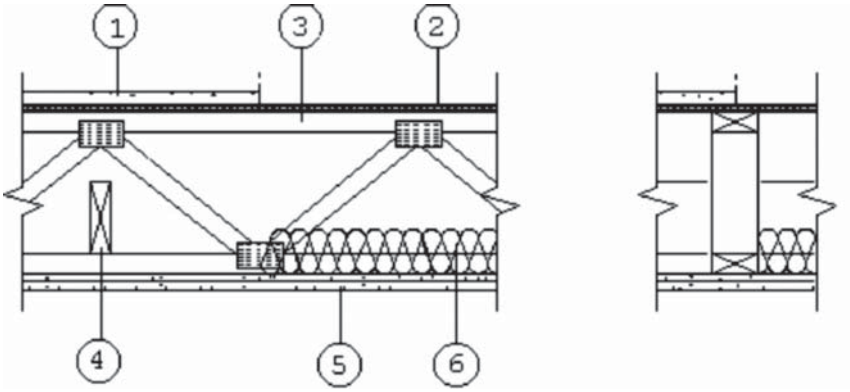
12. Wall Angle (Not Shown): No. 26 MSG angle with 1-1/8" legs, nailed to the walls along perimeter of ceiling to support steel framing member ends and for screw-attachment of the gypsum wallboard.

13. Other Listings: UL Fire Resistance Directory UL Design L529 (Based on UL R9500-1, 2-2-81)

DESIGN NO. TSC/FCA 90-02
(Source: Intertek Testing Services, 2001 Directory of Listed Products)

SPECIFICATIONS
Fire RATING: 90 minutes
Finish Rating - 45 minutes

STC 53 w/ Insulation and Resilient Channel
STC 57 w/ 1-1/2" of Lightweight Concrete



1. Topping (Optional) . Subject to design and project limitations, these systems may be augmented with a lightweight floor topping mix containing perlite or vermiculite aggregate.

2. Flooring - minimum 3/4" or 19.0 mm plywood or O-2 grade waferboard or strandboard.

3. Structural Member - Truswal metal truss plates with structural graded chords and webs as per NLGA grading rules and having a minimum depth of 10" and spaced up to a maximum of 24" o.c. for floor/ceiling systems. All Floor Trusses are to be designed and sealed by a Professional Engineer.

4. Bridging/Strongback - 2x6 SPF #2 to be screwed to the bottom chord with two 3" screws and spaced at 7' o.c.

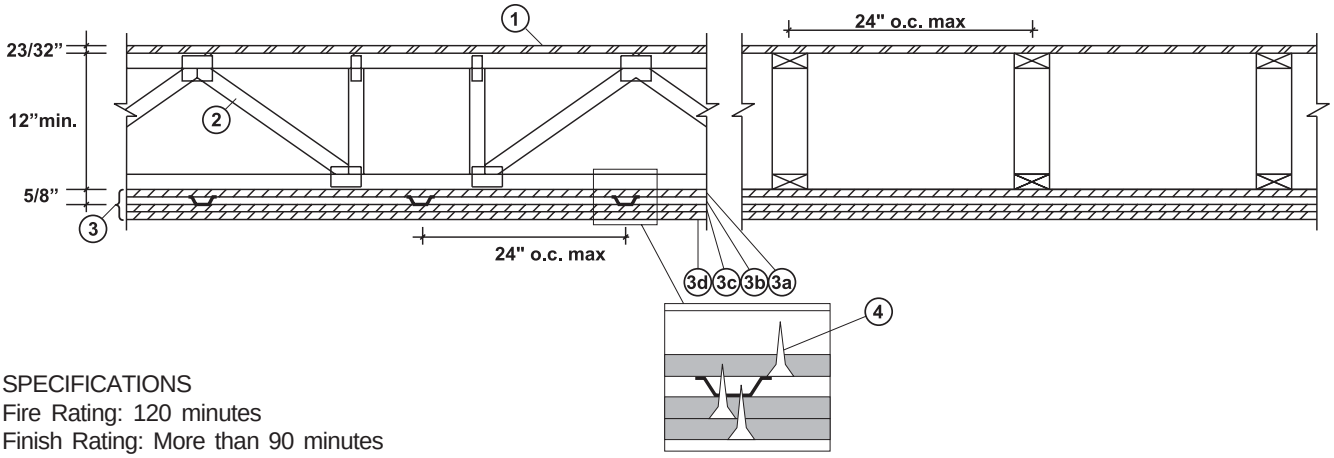
5. Gypsum Board - 2 layers of 5/8" Type X thick gypsum wallboard. Base layer to be installed with long dimensions perpendicular to supports, with end joints butted over supports and staggered 24" minimum. 1-1/4" Type W screws are spaced 12" o.c. on intermediate supports and 6" o.c. on supports at butt joints. Face layer installed with long dimension perpendicular to supports and edges staggered 24" from base layer end joints. 2-1/4" Type W screws are placed minimum 12" o.c. on intermediate supports and 8" o.c. on end supports at butt joints. To fasten face layer to base layer, a row of Type G screws is located 6" away from end joints, spaced 8" o.c.

6. Insulation (Optional) - All batts are to be placed between bottom joist flanges and supported by metal furring channels. In assemblies where metal furring channels are not utilized, support insulation batts on nominal 1" x 3" wood furring strips spaced 16" o.c. along the top side of the bottom flange. Equivalent methods that retain insulation above joist bottom flange are acceptable. All butt joints shall be over furring channels.

Figure 17.5.26

CALCULATION OF A TWO-HOUR FIRE ENDURANCE ASSEMBLY FOR METAL PLATE CONNECTED WOOD TRUSS STRUCTURAL FLOOR AND ROOF FRAMING SYSTEMS

Source: Kirk Grundahl, P.E., Qualtim Technologies International, 1997.



SPECIFICATIONS
Fire Rating: 120 minutes
Finish Rating: More than 90 minutes

1. Finish flooring: 5/8" thick or thicker sheets of interior plywood or oriented strand board (OSB), manufactured with exterior glue having tongue-and-groove edges along the 8' side of 4'x8' sheets, shall be installed perpendicular to the trusses with end joints centered over the top chord of the truss, and placed so the end joints are staggered.

   The application of the plywood or OSB shall comply with the specifications and recommendations provided by the American Plywood Association.

   A lightweight concrete topping may be (but does not have to be) applied over the plywood or OSB. Generally, this topping should be 3/4" thick or thicker, following the architectural specification and topping manufacturer's guidelines.

2. Structural members: A minimum 12" deep metal plate connected wood truss spaced at a maximum of 24" o.c. can be used in this assembly. The truss application should follow the installation recommendations developed by the Truss Plate Institute.

3. Ceiling Membrane: Three layers of Type C gypsum wallboard are used in this assembly. Each sheet used is assumed to be a minimum of 4' wide. The gypsum wallboard attached directly to the trusses should be placed perpendicular to the trusses. The gypsum wallboard attached to the furring channels is assumed to be installed perpendicular to the furring channels. The ceiling is created as follows:

   a. Wallboard Layer 1: The first 5/8" layer of gypsum wallboard is attached directly to the bottom chord of the truss using 1-1/4" Type S bugle-head screws spaced 6" o.c. along wallboard ends and edges, and 12" o.c. in the field. The application of the Type C gypsum wallboard shall follow the manufacturer's installation instructions. The wallboard end joints should be centered on the bottom chord of the trusses, and should be staggered. The minimum end distance (minimum distance the screws are to be held back from 4' end of wallboard, i.e., butt end) allowed for the base layer is 3/8". The minimum edge distance (minimum distance the screws are to be held back from 8', 10', etc., side of wallboard) is 1-1/2".

   b. Furring Channel: Resilient or inverted hat-type furring channels are placed over the top of the first layer of 5/8" Type C gypsum wallboard. The channels are made of 25 gauge galvanized steel, and installed perpendicular to the structural members. The channels are spaced at a maximum of 24" o.c., and attached to each truss (through the gypsum) with one 1-7/8" Type S screw.

   c. Wallboard Layer 2: This layer of 5/8" Type C gypsum wallboard is attached to the furring or resilient channels. Layer 2 is attached with 1" or 1-1/4" Type S screws spaced at a maximum of 6" o.c. The end joints of each gypsum wallboard sheet shall be centered on the resilient or furring channel. End distance shall be a minimum of 5/8". Edge distance shall be a minimum of 1-1/2".

Figure 17.5.27

CALCULATION OF A TWO-HOUR FIRE ENDURANCE ASSEMBLY FOR METAL PLATE CONNECTED WOOD TRUSS STRUCTURAL FLOOR AND ROOF FRAMING SYSTEMS Continued

d. Wallboard Layer 3: The finish layer of 5/8" Type C gypsum wallboard shall be attached to each resilient or furring channel with a 1-5/8" or 1-7/8" Type S screw that passes through wallboard layer 2. The screws shall be spaced at a maximum of 6" o.c. End distance shall be a minimum of 5/8". Edge distance shall be a minimum of 1-1/2". The end and edge joints of the finish layer of gypsum should be staggered at a minimum of 24" from the joints that exist in layer 2. The end joints of the face layer must be centered on the furring channels. If this is not the case, end joints shall be attached to Wallboard Layer 2 with 1-1/2" Type G screws spaced 6" o.c. with an end and edge distance of 1-1/2".

All screws shall be set so that they are flush with the face of the wallboard and do not damage the core of the wallboard. The following gypsum wallboard may be used in this assembly:

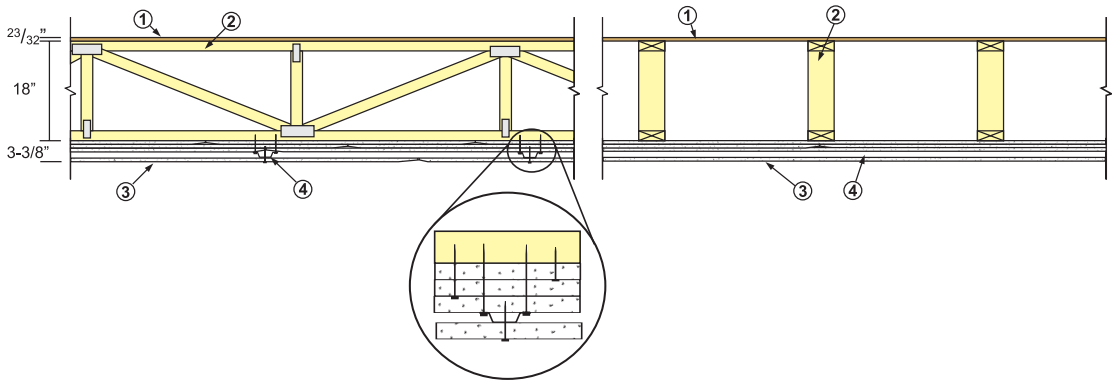
- Canadian Gypsum Co., Ltd.: Type C
- Celotex Corp.: Type 3, B, C, FRP or SF3
- Domtar Gypsum: Type C, S, 5 or 3
- Georgia-Pacific Corp., Gypsum Division: Type GPFS1, GPFS3, GPFS-C
- Gold Bond Building Products: Types FSK-1, FSK-4, FSK-G, FSW-1, or FSW-G
- James Hardi Gypsum: Type III or 3
- Pabco Gypsum Co.: Type C, PG-1, PG-3 or PG-C
- Republic Gypsum Co.: Type RG-1 or RG-3
- Standard Gypsum: Type SGC-1 or SGC-G
- Temple-Inland Forest Products Corp.: Types T, VPB-Type T
- United States Gypsum: Type C, D, or IP-XZ
- Weyerhaeuser Co., Gypsum Division: Type DDG2, DPG2 or DDDG3

4. Wallboard Screws: Type S bugle head screws that are self-drilling and self-tapping shall be used. Where needed, Type G wallboard screws can also be used. Screws shall meet ASTM C102 or ASTM C954 standards.

5. Finishing Systems (Not Shown): The face layer joints shall be covered with tape and coated with joint compound. Screws shall also be covered with joint compound.

Design No. L556
(Source: Underwriters Laboratory, Inc.'s *Fire Resistance Directory*, April 19, 2002)

SPECIFICATIONS
Fire Rating-
120 minutes
Finish Rating-
120 minutes



1. Flooring Nom 23/32" thick wood structural panel, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panel to be perpendicular to joists with joints staggered. T&G edges glued together and panels glued to joists with construction adhesive. In addition, panels nailed to joists with 6d ring-shank nails spaced max 12" o.c.

   1A. Finish Flooring System-(Not Shown, Optional) To be placed over Item 1.

System No. 1
Finish Flooring- Floor Topping Mixture* -8 gal max of water to 80 lbs min of floor topping mixture to 180 lbs max of sand. Compressive strength to be 1000 psi min thickness to be 3/4" min.
UNITED STATES GYPSUM CO - Type F

System No. 2
Finish Flooring-Floor Topping Mixture* -3 to 7 gal of water mixed with 80 lbs of floor topping mixture and 1.0 to 2.1 cu ft of sand. Compressive strength to be 1000 psi min. Thickness of 3/4"

MAXXON CORP - Types D-C, GC, GC2000, L-R or T-F.

Floor Mat Materials* -(Optional) Floor mat material nom 1/4" thick adhered to subfloor with Maxxon Floor Primer. Primer to be applied to the surface of the mat prior to lath placement.

MAXXON CORP - Type Acousti-Mat

Metal Lath -For use with floor mat material, 3/8" expanded galvanized steel diamond mesh, 3.4 lbs sq yd placed over the floor mat material. Floor topping thickness a nom 1" over the floor mat.

Alternate Floor Mat Materials*-(Optional) -Floor mat material nom 1/4" thick loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness a min 1" over the floor mat.

MAXXON CORP - Type Acousti-Mat II.

System No. 3
Finish Flooring-Floor Topping Mixture* -6.8 gal water to 80 lbs bag of floor topping mixture to 1.9 cu ft of sand. Compressive strength to be 1100 psi min. Thickness to be 1" min.

HACKER INDUSTRIES INC - Firm-Fill, Firm-Fill 2010, Firm-Fill High Strength, Gyp-Span Radiant.

Floor Mat Materials* -(Optional)- Floor mat material nom 1/4" thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1-1/2" of floor-topping mixture.

HACKER INDUSTRIES INC - Type Sound-Mat

Figure 17.5.28

Design No. L556 Continued

System No. 4
Finish Flooring-Floor Topping Mixture* -10-13 gal. of water to 170 lbs of floor topping mixture to 595 lbs of sand. Compressive strength 900 psi min. Thickness to be 1" min.
ORTECRETE CORP - Type II.

System No. 5
Finish Flooring-Floor Topping Mixture* -Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mix at rate of 1.4 cu ft of preformed foam to 94 lbs Type 1 Portland cement and 300 lbs of sand with 5-1/2 gal of water. Cast density of floor topping mixture 100 plus or minus 5 pcf. Min compressive strength 1000 psi. Thickness 1-1/2"

ELASTIZELL CORP OF AMERICA - Type FF.

System No. 6
Finish Flooring-Floor Topping Mixture* -Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mix 94 lbs cement, 300 lbs sand, approx 5.4 gal water, 1.2 cu ft preformed foam, 5 oz Type N fiber and 4 oz Component Z. Cast density of floor topping mixture shall be 105 plus or minus 5 pcf with min compressive strength of 1200 psi. Min thickness shall be 3/4"

ELASTIZELL CORP OF AMERICA - Type ZC.

1B. Finish Floor -As an alternate to Item 1A Mineral and Fiber board* (Not Shown, Optional) To be placed over Item 1. Sizes ranging from 3' by 4' to 8' by 12', by min 1/2" thick. All joints to be staggered a min of 12" o.c. with adjacent sub-floor joints.

HOMASOTE CO - Type 440-32 Mineral and Fiber Board

1C. Adhesive (Not Shown)- Construction adhesive per APA specifications AFG-01, applied in nom 1/4" dia bead to top of joists and in grooved edge of flooring panels.

2. Structural Wood Members* Min 8" deep "I" - shaped wood joists spaced a max 24" o.c. Min joist bearing on bearing plates 2" Joists secured to bearing plates with two 8d steel nails at each end. Circular holes may be cut in the web of the joists in accordance with the manufacturer's published design specifications.
WILLAMETTE INDUSTRIES INC - Type WSI or WSI-P

2A. Structural Wood Members As an alternate to item 2, Nominal 2x10 wood joists spaced 16" o.c., firestopped or min. 18" deep parallel chord trusses spaced a max 24" o.c. fabricated from nom 2 by 4" lumber with lumber oriented either vertically (2A) or horizontally (2B). Truss members secured together with No. 20 MSG galv steel truss plates. Plates have 5/16" long teeth projecting perpendicular to the plane of the plate. The teeth are in pairs facing each other (made by the same punch), forming a split-tooth-type plate. Each tooth has a chisel point on its outside edge. These points are diagonally opposite each other for each pair. The top half of each tooth has a twist for stiffness. The pairs are repeated on approx 7/8" centers with four rows of teeth per" of plate width.

3. Gypsum Board* Four layers, 5/8" thick, 4 ft wide Gypsum Board bearing the Classification Marking as to Fire Resistance; first three layers installed with long dimension perpendicular to bottom chord of structural members. Adjacent butt joints staggered approximately 4' o.c. Overlapping layers installed so that edges and butt joints offset min 10" from previous layer. Base layer fastened to bottom chord of structural members with 1-1/4" Type W screws spaced 12" o.c. Second layer secured to bottom chord of structural members with 2" Type S screws spaced 12" o.c. Third layer secured to bottom chord of structural members with 2-1/2" Type S screws spaced 12" o.c. Fourth layer secured to resilient channels with 1-1/8" long Type S steel screws spaced 12" o.c. Screws to be spaced 1/2" from butted end joints and 1" from side joints.

See Gypsum Board (CKNX) Category for names of Classified Companies of 5/8" thick wallboard.

4. Resilient Channels Hat shaped channels formed from No. 25 MSG galv steel spaced 24" o.c. perpendicular to structural wood members. Channels secured to third layer of gypsum board with 2-1/2" Type S steel screws spaced 12" o.c.

5. Finishing System (Not Shown)-Wallboard joints exposed or covered with tape and joint compound. As an option, nom 3/32" thick gypsum veneer plaster may be applied to the entire surface of gypsum board.

*Bearing the UL Classification Mark.

NER 392 - FR-SYSTEM 2™
(Source: National Evaluation Services, Inc. June 1, 2002)

SPECIFICATIONS
Fire Rating: 120 minutes
Finish Rating: 65 minutes

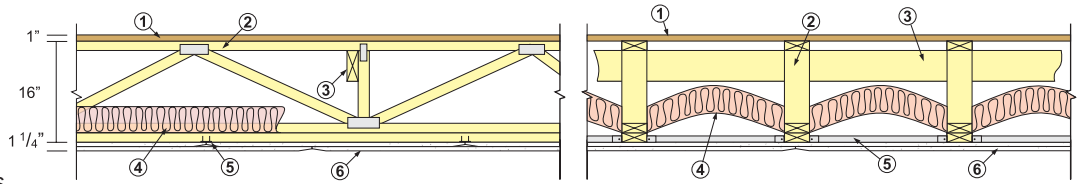


Figure 2a

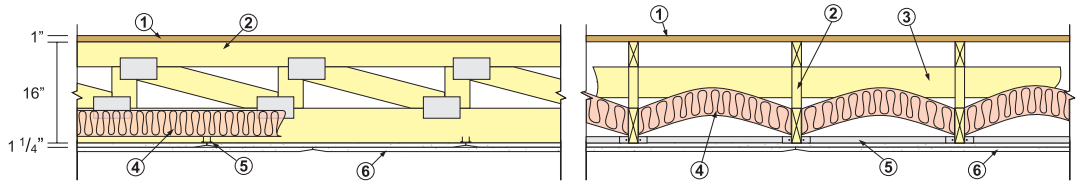


Figure 2b

1. Subfloor and Roof Sheathing: Sheathing shall be minimum 23/32" (18.3 mm) thick with tongue-and-groove long edges. Long edges shall be installed perpendicular to trusses. Construction adhesive, complying with the AFG-01 construction-adhesive standard, shall be applied as a 3/8" diameter (9.5 mm) bead to the top chord of the trusses and the grooved edges of the panels. The sheathing is fastened to the truss chords with 6d deformed shank nails or 8d common nails, spaced 6" (152 mm) o.c. at panel ends and 10" (254 mm) o.c. in the field. Underlayment sheathing shall be a minimum of 1/4" thick (6.4 mm), and shall be installed with edges and ends staggered from the base layer sheathing in accordance with the applicable code.

   In lieu of underlayment, minimum 3/4" thick (19.1 mm) lightweight concrete or topping mixture is permitted to be substituted, in which case the base layer sheathing is permitted to be a minimum of 19/32" (15.1 mm) thick, if this is allowed by the finish floor manufacturer's specifications.

2. Wood Trusses: Trusses shall be spaced a maximum of 24" (610 mm) o.c. and shall have a minimum depth, including shield member, of 16" (406 mm). For horizontal orientation (Figure 2a) or vertical orientation, design depth of trusses shall be 1-1/2" (38 mm) less than overall depth of trusses, including shield member. A nominal 2" thick (51 mm) continuous wood member, the same width as the truss, shall be attached to the truss assembly adjacent to, and under, the bottom chord by extending the truss plates a minimum of 1" (25.4 mm) onto the face of the wood member. The wood member acts as a shield, and is permitted to consist of several pieces.

   Trusses shall be fabricated using nominal 2x3 or larger lumber, oriented either horizontally. Truss members shall be connected with galvanized steel truss plates, minimum No. 20 gage (MSG) [0.036" (0.91 mm)], with 5/16" (7.9 mm) or longer teeth projecting perpendicular to the plane of the plate. Truss bottom chord splices shall be connected with minimum No. 16 MSG [0.058" (1.47 mm)], 5/16" (7.9 mm), or longer, teeth projecting perpendicular to the plane of the plate. Additionally, truss plates shall have a current National Evaluations Services, Inc. (NES) evaluation report. Truss designs for parallel-chord and sloped trusses used in these assemblies shall be approved by the building official. Sloped trusses are trusses with chords that are not parallel, such as triangular trusses. Trusses shall be in compliance with the special inspection requirements for wood trusses indicated in the applicable code.

3. Bracing: Bracing shall be minimum 2x6 nominal lumber oriented vertically and installed perpendicular to trusses on maximum 10' (3048 mm) centers. Bracing shall be attached to each truss with three 16d nails.

4. Insulation: Insulation, when used, shall be batts or rolls installed with stay wires located between the trusses and with the ends of the insulation located a minimum of 1-1/2" (38 mm) above the bottom face of the trusses, and the length of the insulation arched to a minimum 3" (76 mm) above the top of the wallboard.

Figure 17.5.29

NER 392 - FR-SYSTEM 2™ Continued

5. Wallboard Edge Blocking: Adjacent base layer ceiling wallboard edges perpendicular to trusses shall have FR-Quik Channel Sets centered lengthwise over the wallboard joints. Blocking shall be secured to trusses with one 1" long (25.4 mm), Type S drywall screw at each end.

   FR-Quik Channel Sets™ and Bond Washers™ are manufactured by Alpine Engineered Products, Inc., using minimum No. 28 gage MSG [0.016" (0.41 mm) base-metal thickness] galvanized steel with minimum 33,000 psi (227 MPa) yield strength. Channels are 1-1/4" (31.7 mm) by 5/8" (15.9 mm), with sleeve ends permitting channels to move lengthwise. Washers are 1-1/4" (31.7 mm) in diameter, with a center hole formed to match the bugle-head drywall screws, and with smaller holes surrounding the center hole for finish compound adhesion to the wallboard.

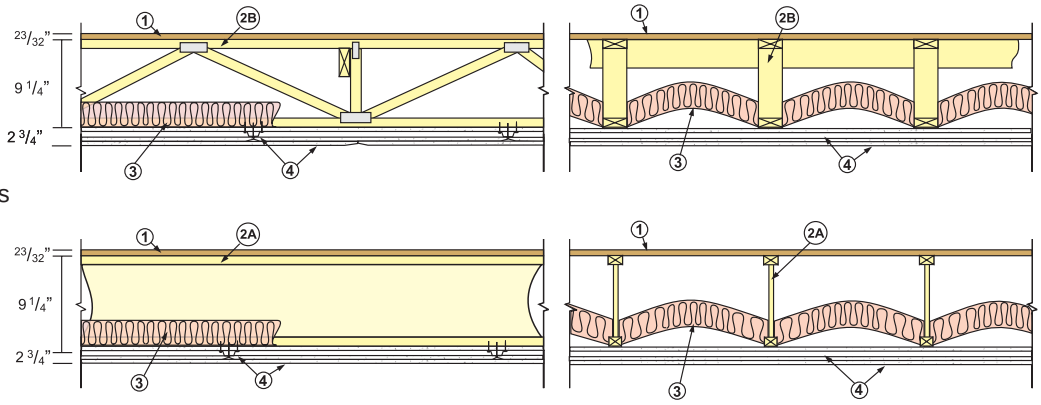
6. Gypsum Wallboard: Two layers of 5/8" thick (15.9 mm) Celotex Fi-Rok Plus, Georgia Pacific Fire Stop C, Gold Bond Fire-Shield G, or U.S. Gypsum Firecode C, Type X gypsum wallboard shall be installed with long dimensions perpendicular to trusses and staggered between base layer and finish layer. End joints shall be on the centerline of truss chords, and all joints shall be staggered between the base layer and finish layer a minimum of 24" (620 mm). The base layer shall be fastened directly to the bottom chord of the truss with minimum 2-5/8" long (67 mm), Type S drywall screws with Bond Washers at 12" (305 mm) o.c.. The base layer is fastened to channel sets with Type S, 1" long (25.4 mm) screws with Bond Washers on 8" (203 mm) centers driven through the crease between adjacent wallboards. The finish layer shall be fastened to trusses with 2-1/4" long (57 mm), Type X drywall screws on 8" (203 mm) centers, and with 11/4" (31.7 mm) Type G screws 1" (305 mm) back from end joints at 1" (305 mm) o.c.

   An alternative installation using resilient channels consists of two layers of 5/8" thick (15.9 mm) Celotex Fi-Rok Plus, Georgia Pacific Fire Stop C, Gold Bond Fire-Shield G, or US Gypsum Firecode C, Type X gypsum wallboard. The base layer shall be installed with the long dimension perpendicular to trusses. End joints shall occur on the centerline of truss chords and shall be staggered. The base layer shall be attached directly to the trusses with minimum 2-5/8" long (67 mm), Type X drywall screws spaced 12" (305 mm) o.c.. The base layer is attached to FR-Quik Channel sets with Bond Washers and Type S, 1" long (25.4 mm) screws on 8" (203 mm) centers, driven through the crease between adjacent wallboard panels. Resilient channels formed from No. 25 [0.021" (0.53 mm)] MSG galvanized steel, spaced 24"(610 mm) o.c., installed perpendicular to trusses and overlapped 1-1/2" (38 mm) at splices, are fastened to each truss with an 8d nail or a Type S, 1-5/8" long (41.3 mm) screw. Minimum clearance of channels to walls shall be 3/4" (19.1 mm). Additional pieces, 60" (1524 mm) long, shall be placed immediately adjacent to end joints of finish layer wallboard and shall extend 6"(152 mm) beyond each edge of the wallboard. Finish layer wallboard long dimensions shall be perpendicular to channels. End joints shall be staggered. The finish layer is fastened directly to the channels with Type S, 1" long (25.4 mm) screws on 8" (203 mm) centers, maximum.

7. Finish System: All joints shall be covered with paper tape embedded in cementitious compound, and exposed screw heads shall be covered with compound. As an alternative, nominal 3/32" thick (2.38 mm) veneer plaster, complying with ASTM C 37, is permitted to be applied to the entire surface of the wallboard.

FR-SYSTEM6™
(Source: NER-392, 1991)

SPECIFICATIONS
Fire Rating: 120 minutes
Finish Rating: 100+ minutes



1. Plywood Sheathing: Sheathing shall be minimum 23/32", 4' by 8' panels, with T & G long edges. Long edges are installed perpendicular to framing members. Apply AFG-01 construction adhesive as 3/8" diameter bead to top chord of trusses and grooved edge of panels. Nail with 6d deformed shank nails or 8d common nails on 6" centers on panel ends and 12" centers in the field.

2A. Wood I-Beams: Shall be spaced a maximum of 24" o.c. and overall depth shall be 9-1/4" or greater. Holes placed in the web shall be in accordance with the manufacturer's recommendations.

2B. Wood Trusses: Trusses shall be spaced a maximum of 24" o.c. and overall depth shall be 9-1/4" or greater. Web members in tension may be steel Tension Webs(tm) manufactured by Alpine Engineered Products, Inc. Bracing shall be a minimum 2x6 nominal lumber oriented vertically and installed perpendicular to trusses on maximum 10' centers. Secure to each truss with three 16d nails.

Truss members shall be secured with Lumbermate Series T, Alpine, Alpine HS, or Woodloc galvanized steel truss plates, minimum No. 20 Manufacturer's Standard Gage (MSG) with minimum 5/16" or longer teeth projecting perpendicular to the plane of the plate. Truss bottom chord splices shall be secured with Lumbermate Series K or Alpine No. 16 galvanized steel truss plates, minimum No. 16 MSG. Truss plates shall have a current National Evaluation Services Report or applicable model code evaluation report. Truss designs for trusses used in these assemblies shall be approved by Alpine Engineered Products, Inc.

3. Insulation (optional): Insulation, if used, shall be batts or rolls of unfaced glass fiber, with a maximum dimension of 8-1/2" between the insulation and the ceiling membrane, installed with stay wires located between the framing members a minimum of 3/4" above the bottom flange of the framing member.

4. Gypsum Wallboard: Install three layers of 5/8" thick Celotex Fi-Rok Plus, Georgia Pacific Fire Stop C, Gold Bond Fire Shield G, or US Gypsum Firecode C, Type X gypsum wallboard. Long dimensions of base layer are perpendicular to framing members. End joints are on centerline of framing members and staggered. Directly secure base layer to framing member with 1-5/8" long drywall screws 12" o.c. Attach minimum 28 MSG resilient channels or drywall furring strips 16" o.c. perpendicular to framing members with 1-5/8" long drywall screws. Install second layer of wallboard perpendicular to channels with 1" long drywall screws 12" o.c. Stagger end joints. Install third (face) layer of wallboard perpendicular to channels with 1-5/8" long drywall screws at 8" o.c. Stagger both long and short edges from second layer.

5. Finish System (not shown): Paper tape embedded in joint compound over wallboard joints with edges of compound feathered out and exposed screw heads covered with compound. As an alternate, nominal 3/32" thick plaster may be applied to the entire surface of the wallboard.

Figure 17.5.30

INSTALLATION OF INSULATION IN WOOD TRUSS FIRE ENDURANCE ASSEMBLIES

Some tested assemblies include insulation in the assembly. The type and placement of insulation in the assembly must be followed carefully. However, insulation can be omitted without the assembly rating being effected.

Thermal and/or acoustical considerations at times may require the installation of insulation in a floor-ceiling or roof-ceiling assembly that has been tested without insulation. To make a rational assessment of this modification, one must look at the impact that its placement inside the assembly will have on the fire endurance performance of the assembly. Insulation retards the transfer of heat and is used to retain heat in warm places, and reduce the flow of heat into colder areas. Since insulation restricts the flow of heat, its addition to a fire endurance assembly can create heat build-up problems. This does not mean that the installation of insulation should not be allowed in assemblies tested without it. The following observations can be made:

- Since insulation retards the transfer of heat, any insulation incorporated into a rated assembly should be kept as far away from the gypsum surface as possible. This will minimize the heat build-up problem.
- Since the plenum cavity helps to dissipate the heat that passes through the gypsum membrane, maintaining a plenum space that is greater than or equal to that of the tested assembly is critical to the field assembly's performance in a fire.

Certain assemblies listed by UL and GA allow addition of any depth of insulation at any location in the assembly as long as another layer of gypsum (of the same type as specified in the tested assembly) is installed at the ceiling. Any other method of adding insulation is prohibited in assemblies tested without insulation.

Including insulation within the free plenum space, especially directly on top of the gypsum membrane is a complex issue. This type of application occurs most often in roof-ceiling assemblies where the insulation is placed directly on top of the gypsum membrane in order to restrict heat flow from the interior of the building to meet energy code requirements. A comparison of assemblies that included insulation in the tested assembly demonstrates a wide range of options - from insulation attached to the underside of the surface further away from the fire source, to insulation laid directly on the gypsum sheathing or over the resilient channel, or held off the gypsum surface with stay wires. The WH assemblies tested with insulation require the insulation be laid on the resilient channel or, if resilient channel is not used, that the insulation is supported above the bottom chord on 1x3 furring strips.

Applications in which insulation is to be added to fire endurance assemblies and placed directly on top of the gypsum membrane should be reviewed by the building designer and code official, preferably with the assistance of a professional engineer, since the final performance of the assembly is dependent upon the entire construction of the assembly.

ALTERNATE PROTECTIVE MEMBRANE SYSTEMS IN WOOD TRUSS FIRE ENDURANCE ASSEMBLIES

Typically in fire endurance assembly testing, a system is tested and then put to use in the field. The field applications must be identical to the tested assembly except for increases in the length, depth, web configuration, splice locations, etc., of the structural members. This is allowed because the structural members have been tested at their maximum allowable design stress under ASTM E119 conditions. The single-most critical element in the fire endurance performance of an assembly is the protective membrane, which is typically fire-rated gypsum wallboard or a suspended ceiling system.

There are three basic types of interior use gypsum board: Regular, Type X, and Type C (or improved Type X):

- Regular - is used as a surface layer for walls and ceilings and is available in tapered and square edges.
- Type X - is available in 1/2" or 5/8" thickness and has improved fire- resistance through the use of fibers mixed within the gypsum core.
- Type C or Improved X - is available in 5/8" thickness and has additional additives that give this product improved fire-resistance over Type X.

Type C is required in some fire-tested assemblies and must be used to achieve the specified rating. Type X cannot be substituted for Type C. Each gypsum board manufacturer has a proprietary brand name for their range of gypsum products. If a tested assembly specifies a proprietary brand name one will have to verify if the brand of gypsum that will actually be used has been approved as a substitute. UL assemblies that require only a UL rating for fire resistance can use any UL certified product that meets the specifications described in the design (see UL-L556, reference 3, pages 17-50, 51).

The performance of the protective membrane is generally defined by a property known as the finish rating. The Finish rating finish rating is defined as the time it takes for one of the following conditions to occur:

- A 250° F average temperature rise of a set of thermocouples above their initial ambient temperature.
- A 325° F temperature rise of any single thermocouple above its initial ambient temperature.

In general, the finish rating of the ceiling membrane is measured by placing thermocouples along the surfaces of the structural members that are closest to the fire, which demonstrates the protection afforded these members by the protective membrane.

The current editions of *Fire Resistance Directory* from UL no longer allow the interchange of individual components between assemblies. However, the IBC does allow alternative methods for determining fire resistance (Section 703.3):

1. Fire-resistance designs documented in approved sources.
2. Prescriptive designs as prescribed in Section 719.
3. Calculations according to Section 720.
4. Engineering analysis based on a comparison of building element designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E 119.
5. Alternative protection methods as allowed by Section 104.11.

IBC Table 719.1(3).21 includes a single prescriptive designed 1-hour rated floor or roof assembly including wood joists, floor trusses and flat or pitched roof trusses spaced a maximum of 24 inches o.c. with 1/2" wood structural panels, and two layers of 5/8" Type X gypsum (a minimum of a 1-1/4" ceiling membrane thickness).

The engineering analysis listed at number 4 above does allow for a comparison of "building element designs" that have been tested. Combined with the provisions of IBC Section 104.11 listed at number 5 above, this allows the code interpreter to approve designs that "complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety."

And IBC Section 713.2.3 provides specific mention of truss protection and allows for "approved calculations based on such tests that satisfactorily demonstrate that the assembly has the required fire resistance."

In the past it has been allowable to use the finish rating property to provide for alternate ceiling membranes on a given structural assembly. In general, it could be assumed that if a structural assembly achieved a one-hour rating with a specific finish rating (e.g. 20 minutes), the ceiling membrane would be able to consistently repeat this performance irrespective of the structural assembly to which it is applied.

With these thoughts in mind, the judicious use of the finish rating can provide alternate ceiling membranes for previously tested assemblies.

As an example, let's look at the substitution that UL provided for the Truss Plate Institute's tested assembly L528 (finish rating of 22 minutes) shown on page 17-19. UL judged that 16" o.c. steel resilient channels would be an acceptable replacement for the 24" o.c. steel furring channels used in the tested assembly, based on a comparison with UL assemblies L513 (finish rating of 28 minutes), L514 (finish rating of 26 minutes) and L523 (finish rating of 21 minutes). They did the same type of analysis to develop the suspended ceiling truss assembly UL-L529 shown on page 17-45 & 46. Notice in L529 that the finish rating is identical to L528. Clearly, the finish rating played a key role in determining that the prospective protective membrane was going to function for one hour.

In some cases, the actual field application may require a different ceiling membrane configuration to deal with serviceability issues such as sound transmission. In such situations, the rational use of finish ratings, actual test results, and a "factor of safety" should be allowed, with engineering judgment, to configure fire endurance assemblies for specific end-use requirements.

In the past adding insulation to a tested assembly has been undertaken based on the logic that insulation could be added to an uninsulated assembly by adding it above the minimum depth of the tested structural member. In other words, to incorporate insulation into a tested assembly, an equivalent or greater plenum space of the original assembly needs to be maintained, and the insulation should be placed as far away from the gypsum surface as possible.

Let's illustrate this concept with the following example:

A 12" deep truss assembly was tested and passed the one-hour fire endurance requirement, with 5/8" Type X gypsum directly attached to the bottom chord and 5/8" plywood directly attached to the top chord. The resulting plenum space for this assembly is 12".

The Building Designer is faced with an actual truss application that calls for an 18" deep truss to be used. If insulation is to be added to this hypothetical assembly without diminishing its fire endurance, consideration must be given to the following points:

- Increasing the depth of an assembly does not adversely affect its fire endurance rating. In fact, increasing the depth may actually enhance performance because of better heat dissipation properties, and reduced chord stresses resulting from a larger section modulus for the truss section.

- Insulation added to an assembly should be kept as far away from the surface of the gypsum as possible, so that it does not speed up the hydration process unduly, and so that the additional weight of the insulation does not cause a premature collapse.

Therefore, it is logical that insulation can be added to this truss fire endurance assembly without adversely effecting its rating. Since the depth of the assembly has increased to 18", one can fill the extra 6" of space with batt insulation. The insulation could then be attached 12" above the gypsum membrane, thereby maintaining the original test plenum depth.

OTHER SUBSTITUTIONS OR MODIFICATIONS TO RATED ASSEMBLIES

Lumber Chords

Regarding the use of 3x2 or 2x3 material in assemblies specifying 4x2 or 2x4 material. Specific assemblies list truss material as nominal 2x3. Since this material was not commercially available at the time many of the tests were conducted it was not specified. An argument can be made for use of nominal 2x3 material based on comparisons with tested assemblies utilizing I-Joists, most of which were tested with flange sizes smaller in section (1-3/4" x 1-3/4" or 1-1/2" x 1-1/2") than nominal 2x3 material.

If substituting trusses in assemblies tested with I-Joists, one must be concerned with the I-joist flange size. Since the primary issue is char rate, as long as the truss chord section is larger than the I-joist flange section the substitution should be permitted. This substitution has been allowed in UL-L556 (see page 17-50, 51).

Sheathing

Both the IBC and UL define plywood and OSB as "structural panels" and as long as the products achieve the minimum standard required they should be interchangeable. The minimum thickness indicated in the tested assembly, however, must be observed.

17.6 FIRE SPRINKLER SYSTEMS

INTRODUCTION TO FIRE SPRINKLER SYSTEMS AND TRUSSES

The use of automatic sprinkler systems in commercial, and multifamily construction, and in residential construction is designed to address two concerns: saving lives and saving property. Depending upon the building's usage category one or the other may dominate. As wood truss usage has become more prevalent in construction types requiring sprinkler systems, the sprinkler industry has made a great effort to design sprinkler heads and systems that are designed expressly to address some of the issues that are of greatest concern, namely sprinklers in concealed spaces like floor/ceiling assemblies and roof/ceiling assemblies. They have also developed heads to address specific concerns like sloping areas in hip roofs.

The following was written by Ken Isman, P.E. for the second edition of this handbook and has been updated to reflect modifications based upon the 1999 edition of National Fire Protection Association's NFPA 13, *Standard for the Installation of Sprinkler Systems;* NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes;* and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.* The general discussion refers mainly to the concerns of NFPA 13 but the general guidelines may still apply to NFPA 13R and 13D.

LOCATION AND POSITION OF SPRINKLERS

The basic guidelines for using sprinkler systems with trusses are provided by NFPA 13, which was modified in 1991 to include all types of construction including parallel chord open-web wood trusses.

In order to properly place sprinklers in relation to the wood trusses, a determination needs to be made as to whether the truss represents an obstruction to the sprinkler's water spray pattern or the hot gasses that will operate the sprinkler. For a wood truss to be considered as Unobstructed Construction (construction that will not block the hot gasses or the water spray) the cross sectional area of the truss needs to be at least 70% open. All types of construction (regardless of cross sectional area) with trusses spaced more than 7.5' o.c. are also considered Unobstructed Construction (NFPA 13:A-1-4.6).

Obstructed Construction is any type of construction that cannot meet the definition of Unobstructed Construction. A wood truss can either be obstructed or unobstructed depending on the dimensions of the truss. Consider the following two figures:

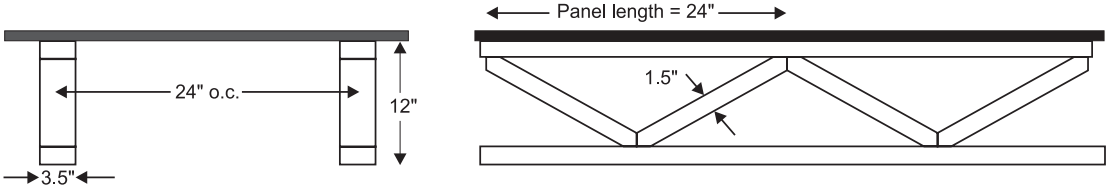


Figure 17.6.1

Figure 17.6.1 A 12" deep parallel chord truss with 2X4 members (1.5"X3.5" net) oriented horizontally.

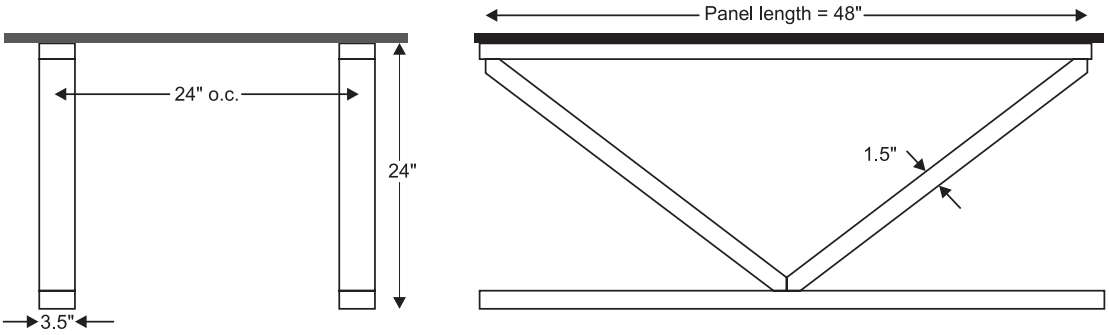


Figure 17.6.2

Figure 17.6.2 A 24" deep parallel chord truss with 2X4 members oriented horizontally.

Figure 17.6.1 is considered Obstructed Construction because the open area of the truss is approximately 60% (less than 70%), while Figure 17.6.2 is considered Unobstructed Construction because the open area is approximately 79% (greater than 70%).

OBSTRUCTED CONSTRUCTION

For Obstructed Construction, NFPA 13:5-5.5.2.1 requires sprinklers to be placed a minimum of 1" and a maximum of 6" below the structural members, as long as the sprinkler is not any more than 22" below the decking (see Figure 17.6.3). An exception to this rule allows sprinklers to be placed above the bottom of the truss, as long as the horizontal distance from the sprinkler to the side of the truss complies with Table 17.6.6 (see Figure 17.6.4). Another exception (13:5-6.4.1) allows sprinklers to be installed in each bay (created by the trusses) with the deflectors 1-12" from the ceiling (see Figure 17.6.5). When installing sprinklers in each bay, Table 17.6.6 can be ignored.

Figure 17.6.3 Sprinkler palcemenr under obstructed construction.

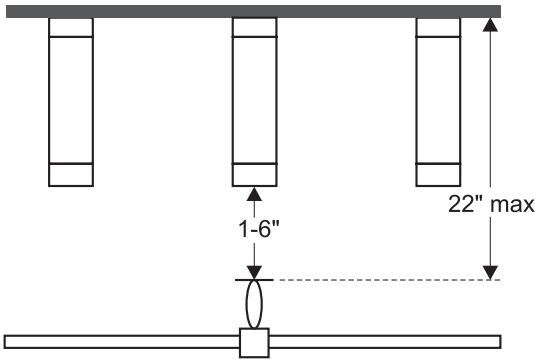


Figure 17.6.3

Figure 17.6.4 Alternative sprinkler placement for obstructed construction.

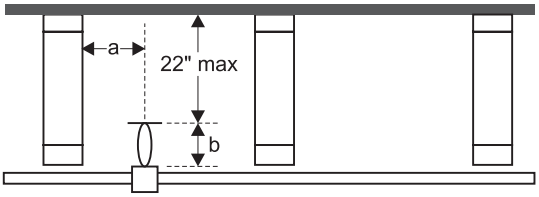


Figure 17.6.4

Figure 17.6.5 Alternative sprinkler placement under obstructed construction.

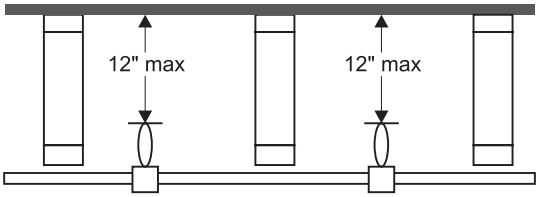


Figure 17.6.5

DEFLECTOR POSITION ABOVE BOTTOM TRUSS CHORD

Distance from Sprinkler to Side of Truss Chord (a)	Maximum Allowable Distance above Bottom of Truss Chord (b)
Less than 12 inches	0.0 inches
12 to less than 18	2.5
18 to less than 24	3.5
24 to less than 30	5.5
30 to less than 36	7.5
36 to less than 42	9.5
42 to less than 48	12.0
48 to less than 54	14.0
54 to less than 60	16.5
60 and greater	18.0

Table 17.6.6

UNOBSTRUCTED CONSTRUCTION

For Unobstructed Construction, NFPA 13:5-6.4.1.1 requires the sprinkler to be installed within 12" of the decking. The sprinkler is not supposed to be any closer than 1" to the decking. For wood truss construction, this usually means that the sprinklers will be somewhere up inside the truss. The truss members then become minor obstructions to the spray pattern and must be accounted for.

Sprinklers are required to be a minimum of three times the maximum dimension of the obstruction away from the obstruction, to a maximum distance of 24" horizontally and 18" vertically (the Three Times Rule). Applying this provision to trusses, a sprinkler must be at least 10.5" away (horizontally and vertically) from the members of a truss constructed of nominal 2x4 lumber, and at least 16.5" away (horizontally and vertically) from the members of a truss constructed with nominal 2x6 lumber. If a truss is constructed with nominal 2x8's, however, the sprinkler must be located at least 21.75" away horizontally and 18" away vertically from each member. For trusses manufactured with members greater than 8" net, the required sprinkler distance is 24" horizontally and 18" vertically.

For Unobstructed Construction with the truss members oriented horizontally (4x2) and spaced exactly 24" o.c., it is impossible to meet these rules since the sprinkler has to be 10.5" away from each of the chords, and there is not 21" of clear space between the members. Since this is a common type of construction, NFPA 13:5-6.5.2.2 has a special Exception No. 3 (Figure 17-6.7-Exhibit 5.17). that allows sprinklers to be installed in wood trusses spaced 24" o.c., as long as the sprinkler is centered between the trusses and the truss members are not more than 4" wide net.

Sprinklers are also permitted by an Exception No. 4 (Figure 17.6.7-Exhibit 5.18) to be installed along the centerline of the bottom chord of an open truss without compliance with the Three Times Rule. The vertical and diagonal members must comply with the Three Times Rule. However, sprinklers are only allowed along the centerline of the truss when the bottom chord is less than 8" wide net and the sprinkler deflector was more than 6" above the obstruction.

Many but not all of the obstruction problems are addressed in 5-6.5.2. When open truss members are closely spaced, it is virtually impossible to locate the sprinkler far enough away from all truss elements that could cause an obstruction. Exception No. 3 addresses this specific problem by permitting the installation of sprinklers in between the members without requiring adherence to the "Three Times Rule" as long as the joists are spaced 24 in. (0.61 m) or more apart. Exhibit 5.17 illustrates such an arrangement.

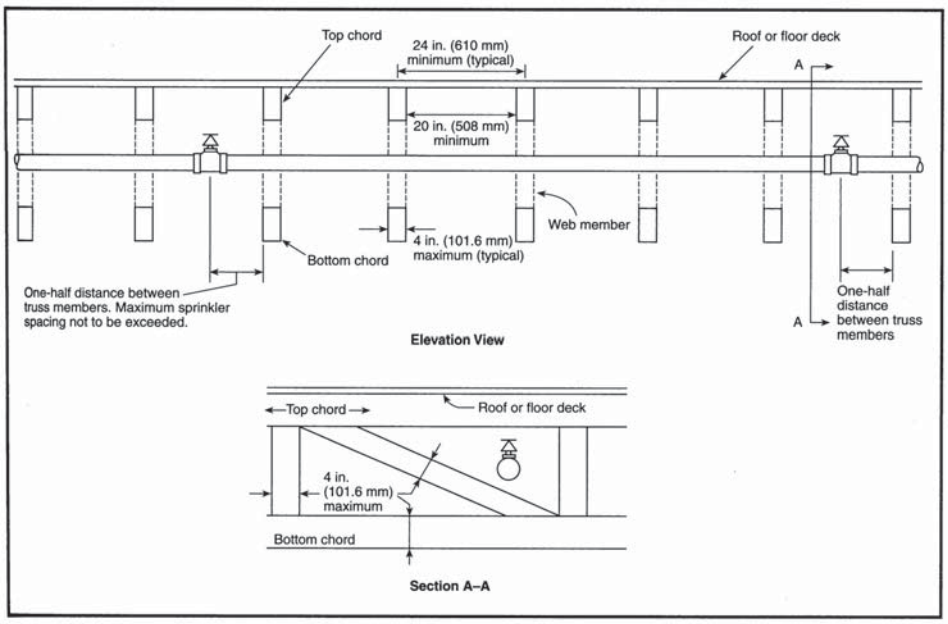


Exhibit 5.17 *Location of sprinklers in open truss construction.*

Exception No. 4 identifies the conditions under which standard spray upright and pendant sprinklers can be located directly over the centerline of the bottom chord of an open truss, bar joist, or beam without compliance to the "Three Times Rule." Under the conditions specified by Exception No. 4 and illustrated in Exhibit 5.18, the bottom chord and beams do no present a significant obstruction to sprinkler discharge. However, the vertical and diagonal truss and web members must comply with the "Three Times Rule."

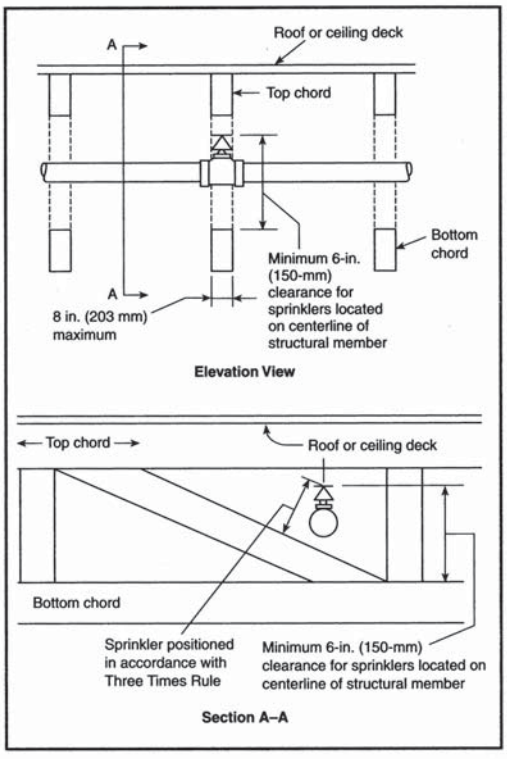


Exhibit 5.18 *Sprinkler placed over the centerline of the bottom chord of a wood truss in accordance with Exception No. 4 to 5-6.5.2.2.*

Figure 17.6.7 Courtesy of National Fire Protection Association

These rules have been generalized from NFPA 13's requirements for standard spray sprinklers (upright and pendent) in Chapter 5-6. Rules for other sprinklers such as sidewall, extended coverage, large drop and Early Suppression Fast Response (ESFR) are similar in nature, but have different obstruction criteria. Chapter 5 of NFPA 13 contains special information on location and position for these sprinklers and should be consulted prior to system design.

FIRE SPRINKLER SYSTEMS - DESIGN CONSIDERATIONS FOR WOOD TRUSSES

This section provides information to aid in the design and installation of wood floor and roof trusses that are required to support fire sprinkler systems. Guidelines are provided for locating and connecting the pipes to trusses, avoiding excessive load on the trusses, and making provisions in the truss design for the structural effects of the sprinkler system.

The open webbing of the truss construction makes it compatible with other building trades. Heating, electrical wiring, sprinklers, and other mechanicals can be run through the open webbing, making maximum use of the available space and eliminating costly through-drilling or loss of headroom. In many cases, sprinkler savings are realized because of efficient water transfer made possible by the openness of the truss configuration.

Occasionally, the building use or its contents demand a fire protection (sprinkler) system requiring special layouts and heavy mains that cannot be compromised. Truss construction can easily be manipulated with adjustments to panel lengths and web configurations to accommodate most special requirements.

Early communication between the building designer, sprinkler contractor, and the truss manufacturer will allow total systems integration from the beginning of the project through building completion. This will provide optimum efficiency in design, construction, and overall building costs.

This section is applicable to both floor and roof systems. Only vertical loads are discussed here. Lateral load-resisting elements, where required, should be evaluated separately by a professional engineer, and are generally attached directly to the lateral load-resisting diaphragm.

The methods and details illustrated in this section are considered standard in the industry, and are presented as a guide. Specific designs should be confirmed by local building authorities, who may have unique regulations not addressed in this section. This section is not intended to exclude alternative solutions for specific projects that have been designed by a qualified design professional.

CONFORMANCE WITH NFPA 13

The hangers and installation methods shown herein are in conformance with the 1999 edition of NFPA 13, Standard for the Installation of Sprinkler Systems, by the National Fire Protection Association (NFPA), provided that the hanger is manufactured in accordance with the following requirements:

a) It is designed to support the weight of the water-filled pipe plus 250 lb at each point of support.

b) Points of support are sufficient to support the sprinkler system.

c) Ferrous metals are used for the hanger components.

INSTALLATION LOADS

The truss must be capable of supporting the added load of the water-filled pipe plus the minimum 250 lb load applied at the point of attachment.

The 250 lb load provision is intended to accommodate the weight of sprinkler installation personnel for a very short time, likely 10 minutes or less. In keeping with this intention, the 250 lb load is to be applied to any single fire sprinkler support point, but not simultaneously to all support points. Also, the 250 lb load need not be checked simultaneously with other short duration loads such as live, snow, or wind loads. If multiple sprinkler lines are attached to the same truss, the 250 lb load should be applied at only one location, representing only one worker on an individual truss.

If conditions prevail other than those intended, such as extended repairs during a period of snow, additional temporary support is advised.

In residential sprinkler system installations NFPA 13D assumes that the system will use the domestic water delivery system and one may not need to account for additional loading. However, the truss designs and the sprinkler system design need to be coordinated to eliminate conflicts for sprinkler head location or pipe runs.

TRUSS DESIGN LOADS

In addition to load requirements imposed under codes, the building designer must include adequate additional dead load allowance in the truss design loads to provide for the weight of the sprinkler system. Such loads are generally expressed in pounds per square foot (lb sq ft). It is generally best to support the sprinkler system from the top chord of the truss, so this load must be applied to the top chord.

When conditions require that attachments be made to truss bottom chords, the building designer must notify the truss manufacturer, who will make special provisions for attachments and loads. Alternatively, concentrated loads for the sprinkler system may be given when attachment locations are known.

LIMITATIONS AND PROVISIONS

Resistance of truss chords and other structural elements to lateral loads shall be considered by the building designer.

Large diameter sprinkler lines (4" or greater), significant risers, and lines running parallel to trusses may require special design provisions and/or additional members.

Pilot holes are required for all screws. Locating supports within truss panels containing chord splices should be avoided.

Screw and bolt sizes, and other mechanical connections or parts thereof, shall be sized in accordance with NFPA 13 and the National Design Specification® for Wood Construction (NDS®), by the American Forest & Paper Association (AF&PA). Alternative sizes may be used to meet specific project conditions, provided that the intent of all applicable codes is met and the design is accomplished by a registered professional engineer.

There should be no more than one sprinkler support attached to each truss panel. If more than one sprinkler support is needed in a panel, special engineering is required and a design professional should be contracted.

With the approval of the truss designer or other design professional, the accommodation of the sprinklers in the truss system may vary from that presented in this document.

STRUCTURAL CONSIDERATIONS

Trusses are capable of supporting significantly higher loads at panel points (i.e., where the chords and webs come together) than in the spaces between panel points. The location of the pipe support in relation to the panel points of the truss is very important, and should be included in the analysis.

The building designer or owner should provide the truss manufacturer with as much information as possible about the sprinkler system prior to the truss design process. This will give the truss manufacturer a more accurate estimate of the overall load, so that prior to truss manufacture and installation, the truss designer can identify the locations of special support points to accommodate attachment of the sprinkler system.

Table 17.6.8 Weights of water-filled pipe. Thinwall steel pipe (i.e., below Schedule 10), plastic pipe and copper tube are also allowed by NFPA 13. These pipes will have different weights should be determined for each specific application.

SPRINKLER SUPPORT SPACING

The maximum spacing of support points for a length of pipe is calculated using the following procedure:

Spacing of Supports (ft) = MPL (lb)/Unit Weight of Pipe (lb ft)

Where MPL is the maximum point load, calculated as:

MPL (lb) = {Truss spacing (in)/12 (in/ft)} x Sprinkler Load (lb sq ft) x Panel Length (ft) xLocation Factor

The Sprinkler Load is the dead load specified by the building designer for the weight of the sprinkler system. Unit Weights of Water-Filled Pipe are given in Table 17.6.8 from NFPA 13 Table A-6-4.5.6 for thinwall steel pipe. Plastic pipe and copper tube are also allowed in some circumstances but will have different weights. The Location Factor is obtained from Figure 17.6.9.

A more economical design that uses fewer hangers can be achieved by using a load-carrying member or trapeze to spread the sprinkler pipe load to two trusses. (See Figures 17.6.19 & 20.) NFPA 13 includes calculations to size the trapeze. This design, however, is a function of the sprinkler system designer.

Nominal Pipe Size (in.)	lb/ft of Water-Filled Pipe Sched. 40 Steel	Sched. 10 Steel
1	2.05	1.81
1 1/4	2.93	2.52
1 1/2	3.61	3.04
2	5.13	4.22
2 1/2	7.89	5.89
3	10.82	7.94
3 1/2	13.48	9.78
4	16.40	11.78
5	23.47	17.30
6	31.69	23.03
8	47.70*	40.08

* Schedule 30

Table 17.6.8 Source: NFPA 13, Table A-4-6.4.3.5.2

Figure 17.6.9 Method for determining the location factors used to calculate the maximum support spacing for the sprinkler systerm.

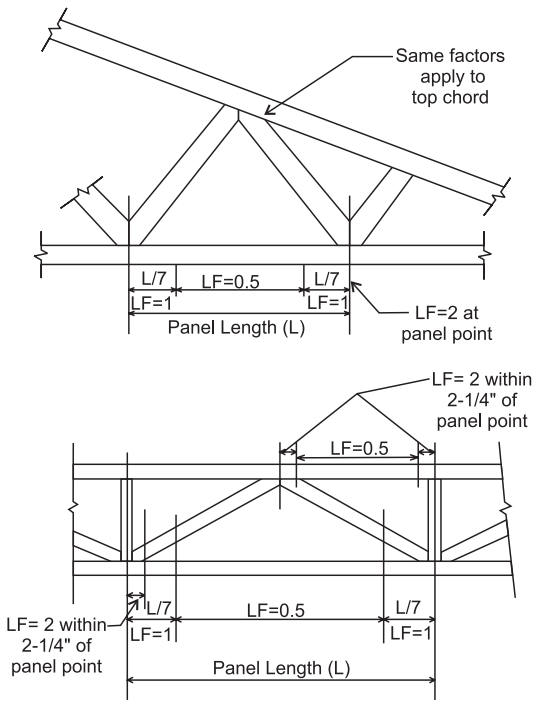


Figure 17.6.9

EXAMPLE PROBLEM

Given: A 2-1/2" diameter line is to be suspended within a run of roof trusses installed at 24" o.c.; the line is located 1' from a top chord panel point, within a 9' panel. The truss designer has determined that a 9' panel in a specific size and grade of chord lumber will safely support the weight of one installation personnel at the point of hanger attachment (see INSTALLATION LOADS pages 17-62,63). The Building Designer has included a 3.5 lb sq ft allowance for sprinkler loading on the top chord.

Find: The hanger spacing required to avoid overstressing the trusses, assuming Schedule 40 steel pipe will be used?

Solution: The support is less than 1/7 of the panel length away from the panel point, therefore, the location factor = 1. (See Figure 17.6.9). Unit weight of the water-filled pipe is 7.9 lb/ft (See Table 17.6.8). Entering the values into the equations given above:

MPL = (24/12) x 3.5 x 9 x 1 = 63 lb

Spacing of Supports = 63/7.9 = 7.97' (say 8')

If a trapeze is used to spread the load between two trusses, one might assume that the spacing of the supports could be increased to as much as 16'. However, NFPA requirements limit the maximum spacing to 15' for the size and type of pipe used in this example. The installer's options are to support the pipe from every fourth truss, or to use a trapeze between a pair of trusses to support the pipe every 15'.

Refer to Chapter 6 of NFPA 13 for additional requirements for support spacing involving different sizes and types of pipe.

Examples of standard sprinkler attachment details are included as guidelines only. Connections for specific applications must be sized in accordance with NFPA 13 and NDS requirements.

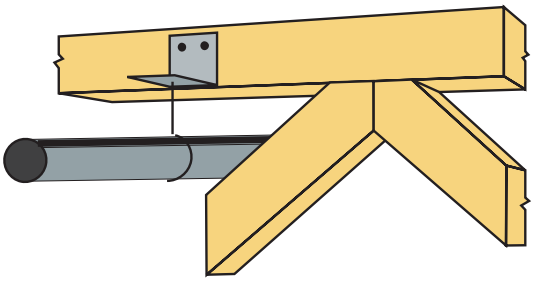


Figure 17.6.10 A pipe being attached to a top chord with an angle bracket support. Install fasteners in the top half of the chord. This is not recommended for attachment into narrow face of a single 2x_ member.

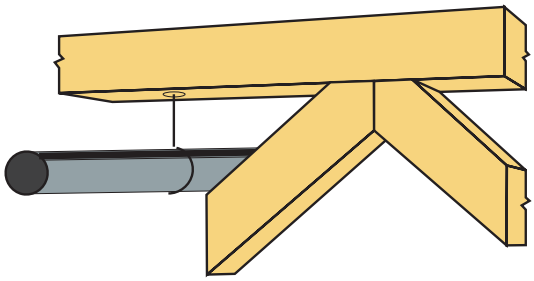


Figure 17.6.11 A pipe being attached using a ceiling flange with wood screws. This is limited to a 2" or smaller pipe.

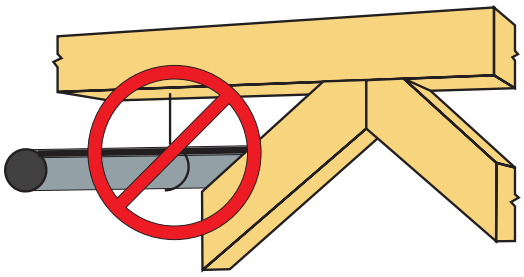


Figure 17.6.12 **WARNING: The application of a coach screw on the narrow face of a 2x_ is NOT recommended.**

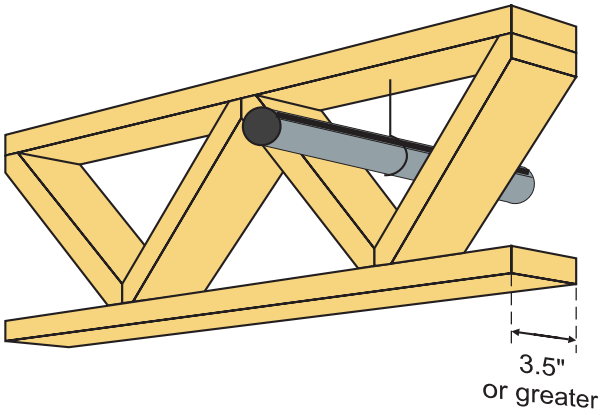


Figure 17.6.13 A coach screw support applied to the wide face of the truss chord.

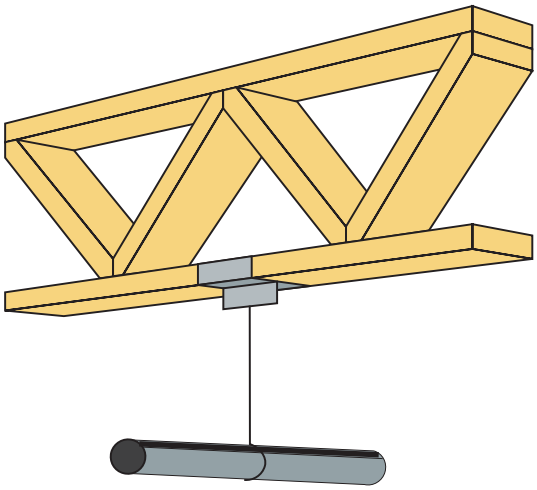


Figure 17.6.14 A sprinkler pipe attached to the bottom chord of a truss with a beam clamp support. Special provisions for attachments and loads may be required if the sprinkler pipe is to be supported from the bottom chord.

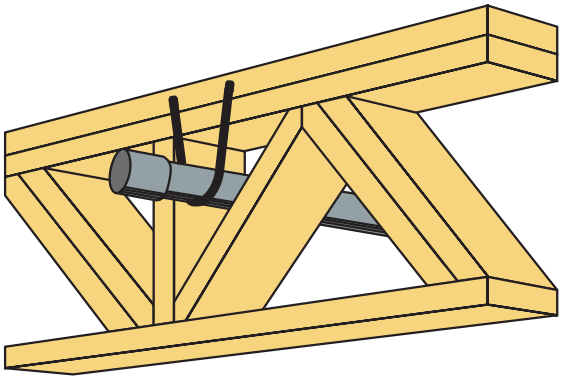


Figure 17.6.15 A U-hook support.

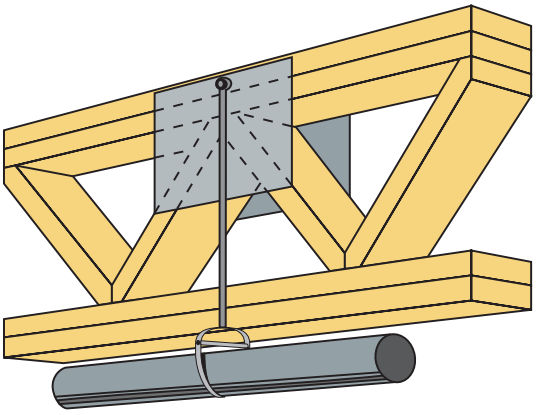


Figure 17.6.16 Eye rod support into top chord at panel point.

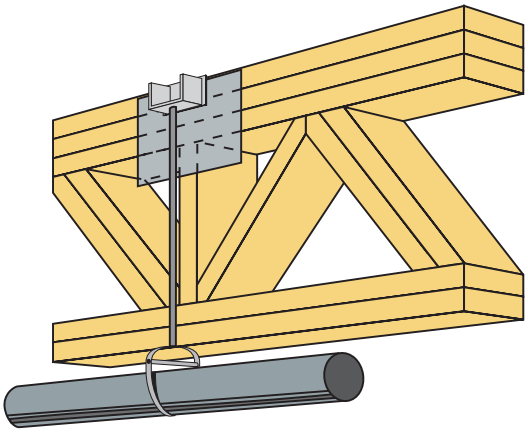


Figure 17.6.17 Top flange support bracket at the panel point.

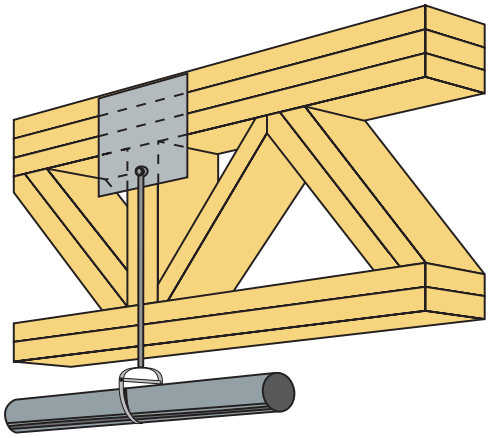


Figure 17.6.18 Eye rod support into vertical web.

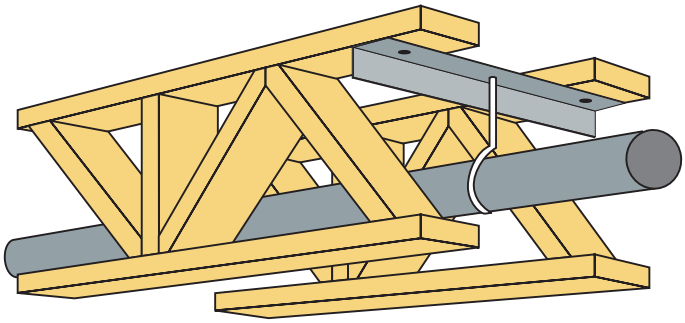


Figure 17.6.19 Metal angle trapeze attached to top chords of adjacent trusses.

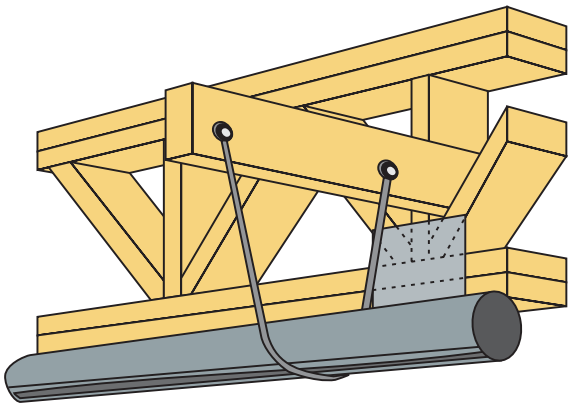


Figure 17.6.20 2x_ wood trapeze attached to vertical web of a truss. The trapeze must not interfere with metal connector plates.

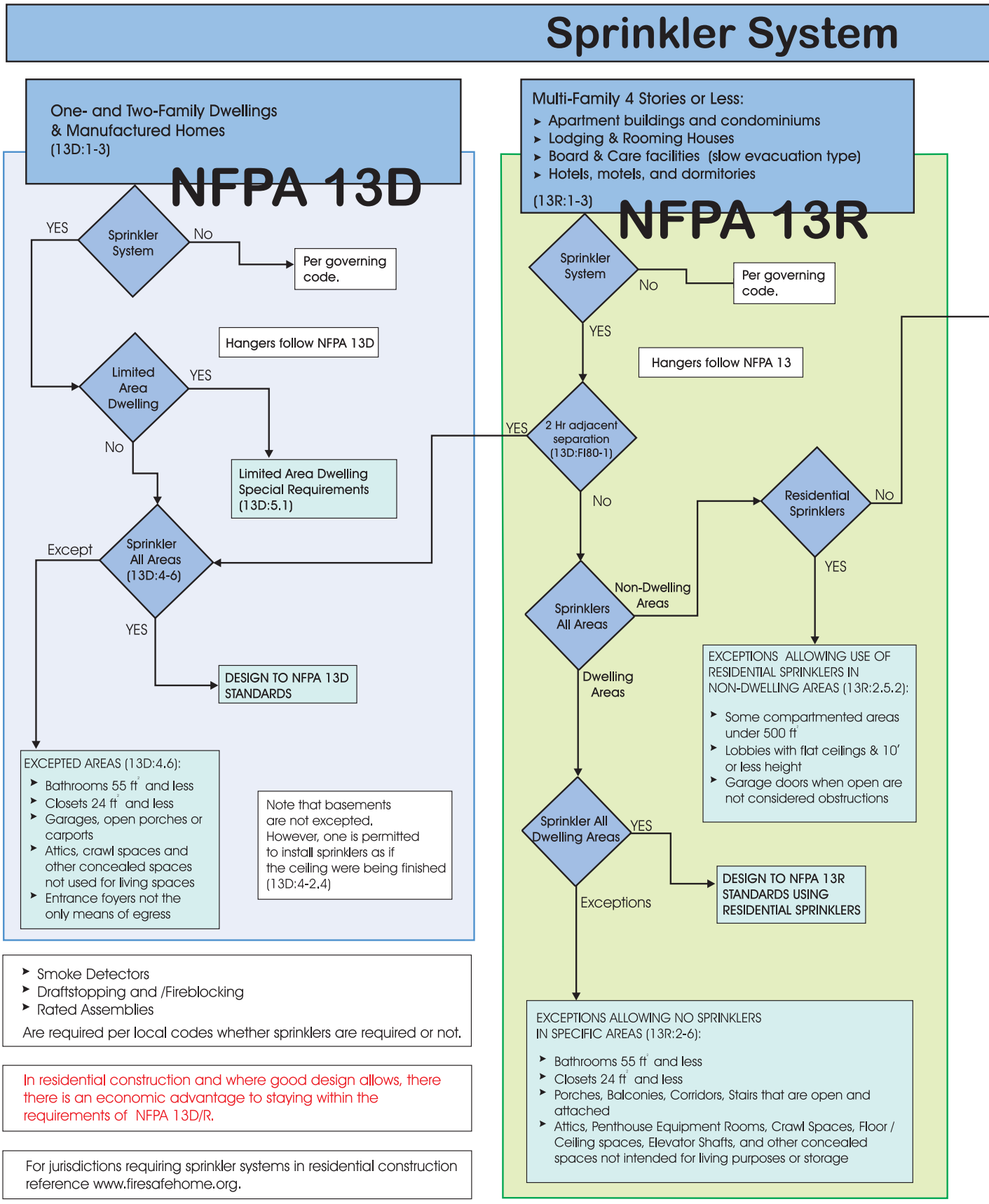


Figure 17.6.21 This decision tree diagram is intended to provide general guidance and does not represent the full complexity of the NF

Decision Tree

Everything else

NFPA 13

Special sprinklers have been developed for specific applications in concealed roof/ceiling or floor/ceiling cases where trusses are used. They address protection for flat concealed spaces as will as pitched roof attic spaces, including hipped roofs.

Sprinkler System

No → Per governing code.

YES

Roof/Ceiling or Floor/Ceiling

Construction Type

Obstructed

EXAMPLES OF OBSTRUCTED CONSTUCTION (13:1-4.6 & 13:a-1-4.6) INCLUDE:

- Beam and Girder - spaced 3-7.5′ on center and 4″ or greater in depth
- Composite Wood Joist (I-Joist) requiring fire-stopping so channels do not exceed 300 ft²
- Panel - where spacing of structural members creates panels of less than 300 ft²
- Semi-mill - modified standard mill, with greater column spacing & beams resting on girders.
- Wood Joist (2x or 4x wide max. and 14″ deep max.) regardless of spacing

For installing sprinklers in trusses when considered obstructed see Figures 17.6.3 - 5.

A Roof/Ceiling or Floor/Ceiling can be constructed either in an open space environment or can create concealed spaces within the roof or floor assemblies. The two categories (Obstructed and Unobstructed Construction) determine the spacing and positioning rules for sprinklers.

Unobstructed

EXAMPLES OF UNOBSTRUCTED CONSTRUCTION (13:1-4.6 & 13:A-1-4.6) INCLUDE:

- Any construction where supporting members are spaced 7.5′ on center
- Where spacing is less than 7.5′ on center, any structural member that is not solid and where openings are at least 70% of the cross section area and the depth does not exceed the least dimension of the openings.
- Bar joists - including some types of wood trusses
- Open Grid Ceilings
- Smooth Ceilings
- Standard Mill - heavy timber construction
- Wood Truss- parallel or pitched chord

Wood Trusses can be considered obstructed under some circumstances:

- If trusses are spaced less than 7.5′ o.c., one must calculate the area of the cross-section to determine what type of construction it qualifies as.
- Use 70% rule to determine. See Figures 17.6.1 & 2.
- Requires evaluating designed truss. Cannot be based on generic designs.

For sprinkler installations in trusses when considered unobstructed see Figures 17.6.7.

Material Type

Non-combustible → DESIGN TO - NFPA 13 STANDARD

Combustible

If the assembly is partially or wholly enclosed by combustible construction, the concealed space may require to be protected by sprinklers.

EXCEPTIONS FOR CONCEALED COMBUSTIBLE SPACES (13:5-13.1) are allowed where the space is:

- #1 formed by studs or joists with less than 6″ between edges.
- #2 formed by bar joists with less than 6″ between roof/floor and ceiling.
- #3 formed by ceilings attached to or within 6″ of wood joists.
- #4 formed by ceilings directly attached to composite wood joist, provided joist channel is firestopped into volumes not exceeding 160 ft³ with material equal to that of the webs.
- #5 entirely filled with noncombustible insulation. *
- #6 within wood or composite joist construction with insulation filling space from ceiling to bottom of joist and in composite wood construction firestopped into volumes not exceeding 160 ft³ with material equal to that of the webs.
- #7 over isolated small rooms not exceeding 55 ft² in area.
- #8 created with rigid material with any exposed surface having a flame spread rating of 25 or less.
- #9 constructed entirely of fire-retardant treated wood as defined by NFPA 703. *
- #10 noncombustible having exposed combustible insulation where the heat content of the facing and substrate does not exceed 1000 Btu/ft².*
- #11 created by insulation that is laid directly on top of or within the ceiling joists in an otherwise sprinklered attic.
- #12 are pipe chase under 10 ft² formed by studs or wood joists, provided they are firestopped at each floor and contain no sources of ignition.

* Items that Metal Plate Connected Wood Trusses can use.

Although exceptions are allowed, they may not offer protection equal to sprinklered concealed spaces.

FPA Standards.

NOTES