Sprinkler Pipe Installation for APA Performance Rated I-Joists

Number J745
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APA Performance Rated wood I-joists (PRI) are often used in conjunction with both steel and chlorinated polyvinyl chloride (CPVC) sprinkler systems. The purpose of this technical note is to provide some basic guidance on appropriate methods of attachment of steel and CPVC sprinkler systems to PRI joists. All designs should be checked by a design professional to assure the adequacy of not only the hangers and fasteners used but the capacity of the I-joists themselves. **When CPVC sprinkler systems are used, it is the responsibility of the designer to ensure the pipe and fittings are listed by a listing agency for I-joist systems in accordance with NFPA 13.** Design examples in this technical note are based on the assumptions outlined below.

Permitted Fasteners

Chapter 9 of the National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems,* lists the approved fasteners for use in wood and other materials.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height,* requires pipe hanging and bracing methods complying with NFPA 13.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* requires only that pipes supported by structural members be supported by methods comparable to those required by local plumbing codes. Check local code.

Design Load Assumptions

The design information in Tables A-F is provided for the selection and sizing of structural members and connections for the support of the sprinkler system. The capacity information given in the figures, unless otherwise specified, is based on the *2009 Automatic Sprinkler Systems Handbook,* NFPA 13, and is based on an assumed maximum span between pipe supports as shown in Table A for Schedule 40 steel pipe or Table B for Schedule 80 CPVC pipe permanently filled with water. An additional allowance is made for a short-term additional load of 250 pound attachments. See NFPA 13 for spans with other types and diameters of piping. A duration-of-load factor of 0.9 is used for permanent loads, and 1.6 is used for the short-term loads and for seismic loads in the bracing designs. For seismic loads

on bracing, spacing of braces depends on pipe size and length of pipe runs and the seismic design category. I-joist flanges are assumed to be 1-1/2 inches thick. All filler blocking attached to webs is assumed to be nominal 2x No. 2 Spruce-Pine-Fir (SPF) or better.

Design Fastener Capacities

For installations in lumber or into I-joist flanges, lag screw, wood screw and bolt design assumptions are based on the use of AF&PA National Design Specification (NDS-2005) design methods and design capacities for Spruce-Pine-Fir No. 2 with a specific gravity (SG) of 0.42. Sheet metal screws are assumed to have the same bearing strength and withdrawal capacity per threaded inch as wood screws. Oriented strand board (OSB) webs are assumed to be 3/8 inch thick with a design specific gravity of 0.50 per Table 11.3.2B of NDS or A*PA Panel Design Specification,* Form D510, available at www.apawood.org/publications. All filler blocking attached to webs is assumed to be nominal 2x SPF lumber.

Joist Design

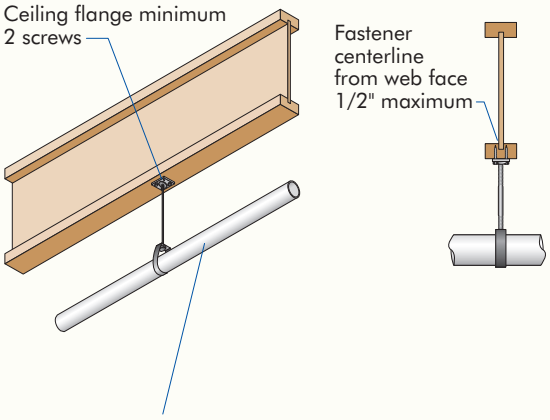
Most wood I-joist design tables are based on an assumed uniform load. Joists and other supporting systems must be designed to carry the added weight of the sprinkler system. This may necessitate the use of deeper I-joists, joists with shorter spans, closer spacing and/or a different I-joist series with higher moment and stiffness capacities or a flange.

Coach Screw Rods and Lag Screws

NFPA 13 limits the use of coach screws. This precludes the direct attachment of coach screw rods to the flanges of most wood I-joists. Lag screws are permitted; however, the designer must remain aware that only the threaded portion is used for design and that the full length of the lag screw is not threaded (see NDS Table L2 for dimensions). While fastener penetration into the edges of the I-joist webs is permissible (through the flange face), it is recommended that web-edge penetration not be added to the withdrawal-from-flange-face value.

FIGURE 1

APA PERFORMANCE RATED I-JOIST – CEILING FLANGE HANGER

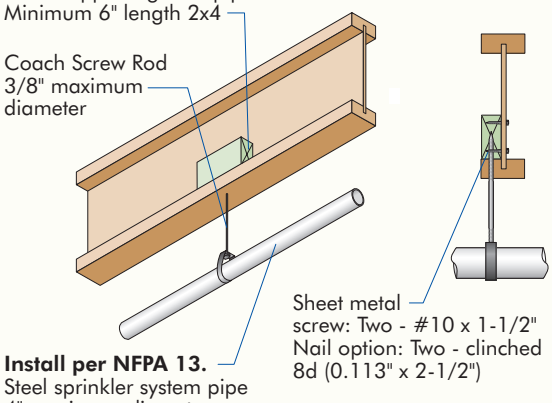


Install per NFPA 13 and manufacturer's instructions.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 2

APA PERFORMANCE RATED I-JOIST – COACH SCREW HANGER

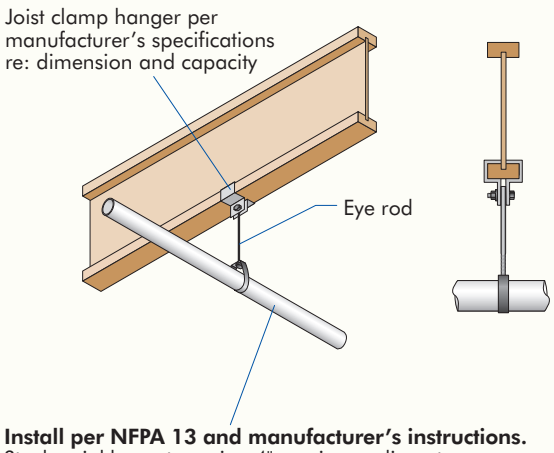
No. 2 SPF or better filler block bearing on flange required when supporting steel pipe. Orient horizontal or vertical. Minimum 6" length 2x4



Install per NFPA 13.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 3

APA PERFORMANCE RATED I-JOIST – JOIST CLAMP HANGER

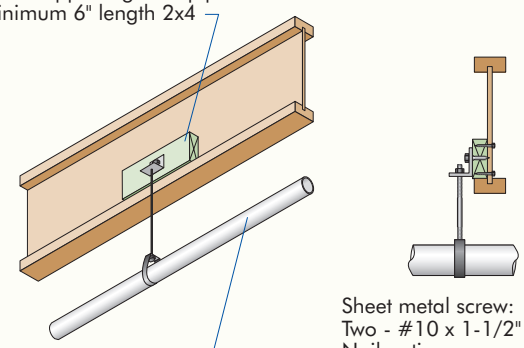


Install per NFPA 13 and manufacturer's instructions.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 4

APA PERFORMANCE RATED I-JOIST – ANGLE BRACKET HANGER

No. 2 SPF or better filler block bearing on flange required when supporting steel pipe. Orient horizontal or vertical. Minimum 6" length 2x4

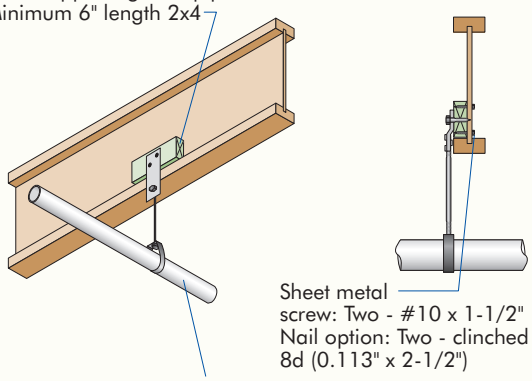


Install per NFPA 13.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 5

APA PERFORMANCE RATED I-JOIST – OFFSET EYE-SOCKET HANGER

No. 2 SPF or better filler block bearing on flange required when supporting steel pipe. Orient horizontal or vertical. Minimum 6" length 2x4

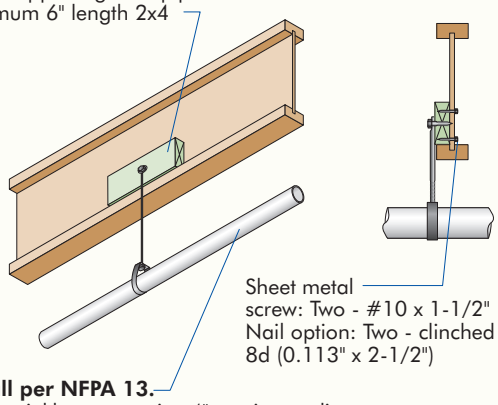


Install per NFPA 13 and manufacturer's instructions.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 6

APA PERFORMANCE RATED I-JOIST – EYE ROD HANGER

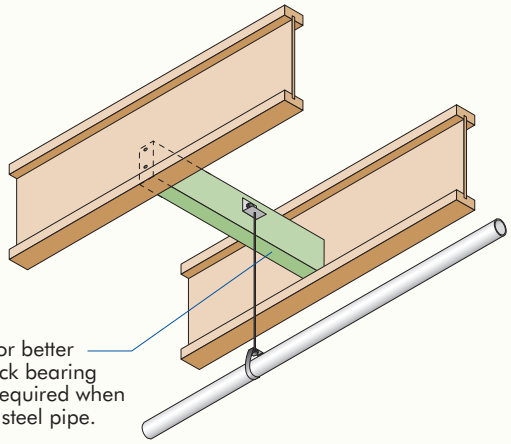
No. 2 SPF or better filler block bearing on flange required when supporting steel pipe. Orient horizontal or vertical. Minimum 6" length 2x4



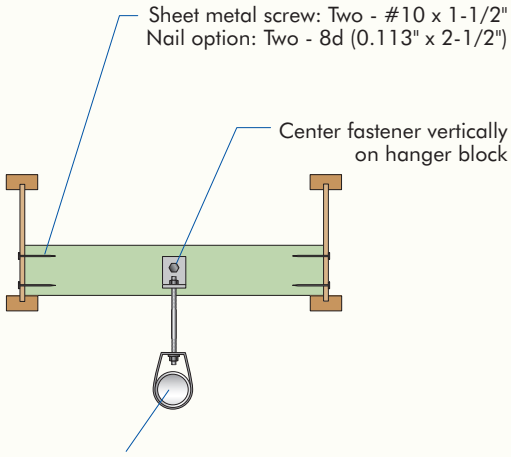
Install per NFPA 13.
Steel sprinkler system pipe 4" maximum diameter or 500 pounds maximum point load

FIGURE 7

APA PERFORMANCE RATED I-JOIST – LOAD CARRIED BY FLANGES



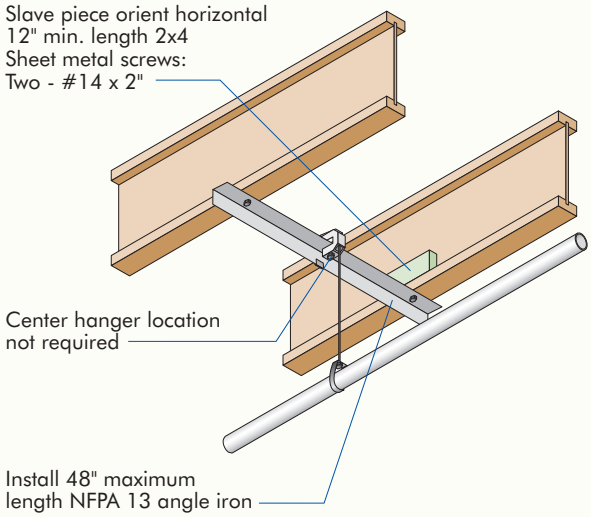
Install - 48" maximum length 2x4 for 3" maximum diameter = 475 pounds maximum point load
Install - 48" maximum length 2x6 for 5" maximum diameter = 600 pounds maximum point load



Install per NFPA 13 and manufacturer's instructions.
Steel sprinkler system pipe. See note to left.

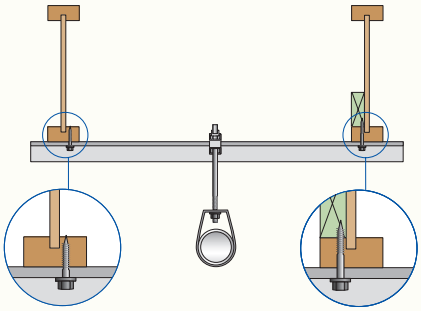
FIGURE 8

APA PERFORMANCE RATED I-JOIST – NFPA 13 STEEL ANGLE TRAPEZE WITH HANGER



Option 1

Install per NFPA 13.
CPVC sprinkler system pipe
2-1/2" maximum diameter =
290 pounds maximum point
load (145 pounds per joist)



Lag Screw: One - 1/4 x 3"
Sheet metal screw
option: One - #14 x 3"
Centerline from web
face 3/4" maximum

Option 2

Install per NFPA 13.
Steel sprinkler system pipe
4" maximum diameter =
500 pounds maximum point
load (250 pounds per joist)

Sheet metal screw
option: One - #14 x 3"
Centerline from web
face 1/2" maximum

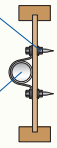
Slave piece orient horizontal.
12" minimum length 2x4.
Sheet metal screws:
Two - #14 x 3"

FIGURE 9

**APA PERFORMANCE RATED I-JOIST –
CPVC HANGER - SURFACE MOUNT**

Option 1

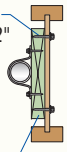
Backing nuts



Install per NFPA 13 and manufacturer's instructions.
CPVC sprinkler system pipe
3" maximum diameter or 310
pounds maximum point load

Option 2

Sheet metal screw:
Four - #10 x 1-1/2"
Nail option:
Four - clinched 8d
(0.113" x 2-1/2")



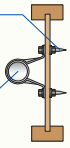
No. 2 SPF or
better filler block
bearing on flange
ok, but not required.
Minimum 6" length 2x4

FIGURE 10

**APA PERFORMANCE RATED I-JOIST –
CPVC HANGER - OFFSET**

Option 1

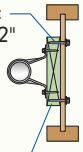
Backing nuts



Install per NFPA 13 and manufacturer's instructions.
CPVC sprinkler system pipe
3" maximum diameter or 310
pounds maximum point load

Option 2

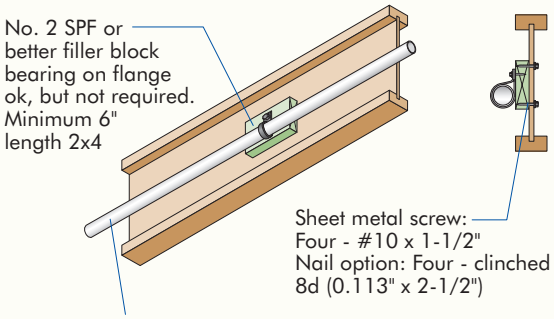
Sheet metal screw:
Four - #10 x 1-1/2"
Nail option:
Four - clinched 8d
(0.113" x 2-1/2")



No. 2 SPF or
better filler block
bearing on flange
ok, but not required.
Minimum 6" length 2x4

FIGURE 11

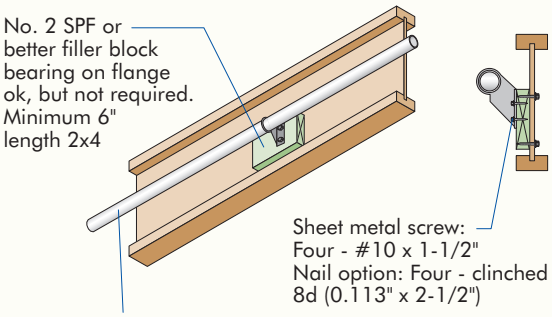
APA PERFORMANCE RATED I-JOIST – CPVC HANGER - SURFACE MOUNT



Install per NFPA 13 and manufacturer's instructions.
CPVC sprinkler system pipe 3" maximum diameter or 310 pounds maximum point load

FIGURE 12

APA PERFORMANCE RATED I-JOIST – CPVC HANGER - DOUBLE OFFSET

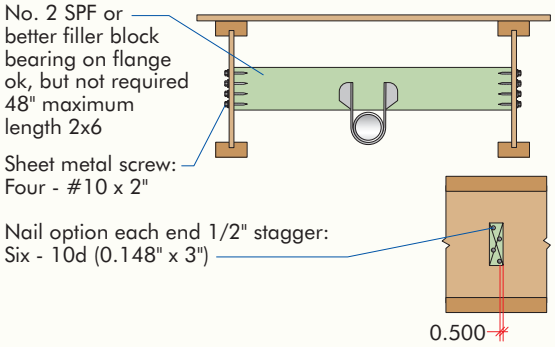


Install per NFPA 13 and manufacturer's instructions.
CPVC sprinkler system pipe 3" maximum diameter or 310 pounds maximum point load

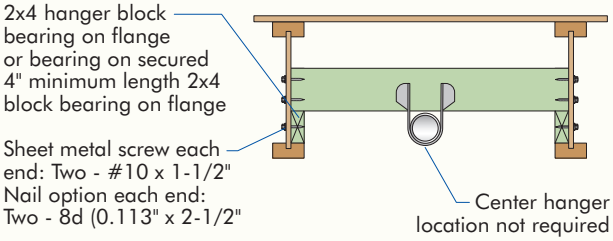
FIGURE 13

APA PERFORMANCE RATED I-JOIST – CPVC HANGER - FACE MOUNT

Option 1



Option 2

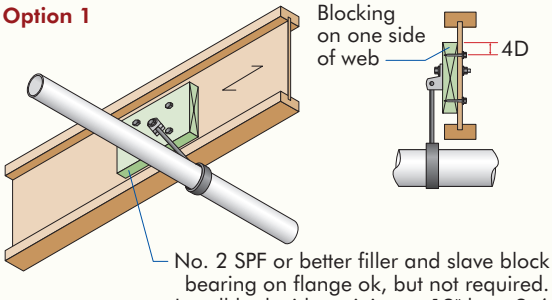


Install per NFPA 13 and manufacturer's instructions.
CPVC sprinkler system pipe 3" maximum diameter or 310 pounds maximum point load (155 pounds per joist)

FIGURE 14

APA PERFORMANCE RATED I-JOIST – SWAY BRACE BLOCKING FOR SEISMIC LOADS PARALLEL TO THE JOIST

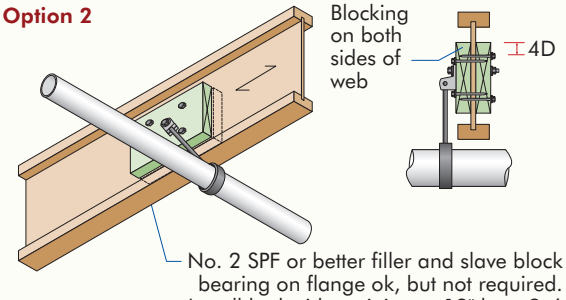
Option 1



Sheet metal screw through web into block: Eight - #10 x 1-1/2"
Lag option though web into block: Eight - 1/4" x 1-1/2"
Nail option through web into block: Ten - clinched 10d (0.128" x 3")

Install per NFPA 13 and manufacturer's instructions.
Maximum horizontal load = 650 pounds includes a 1.33 duration of load adjustment

Option 2



Sheet metal screw each side: Eight - #14 x 3"
Lag option each side: Eight - 1/4" x 3"
Nail option each side: Ten - clinched 12d (0.128" x 3-1/4")

Install per NFPA 13 and manufacturer's instructions.
Maximum horizontal load = 1000 pounds includes a 1.33 duration of load adjustment

FIGURE 15

APA PERFORMANCE RATED I-JOIST – SWAY BRACE BLOCKING FOR SEISMIC LOADS PERPENDICULAR TO THE JOIST

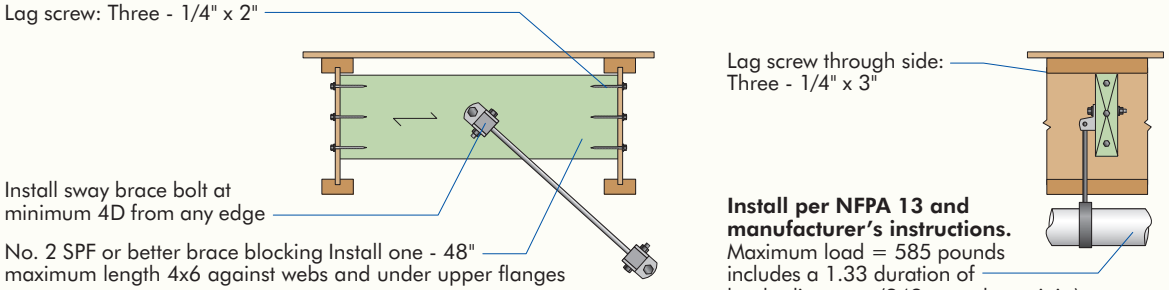


FIGURE 16

APA PERFORMANCE RATED I-JOIST – SWAY BRACE BLOCKING FOR SEISMIC LOADS PERPENDICULAR TO THE JOIST

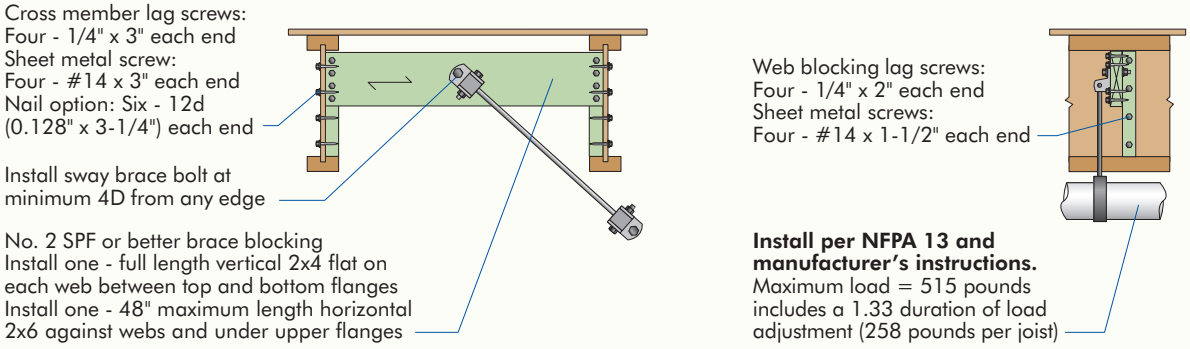


FIGURE 17

APA PERFORMANCE RATED I-JOIST – SWAY BRACE BLOCKING FOR SEISMIC LOADS PERPENDICULAR TO THE JOIST

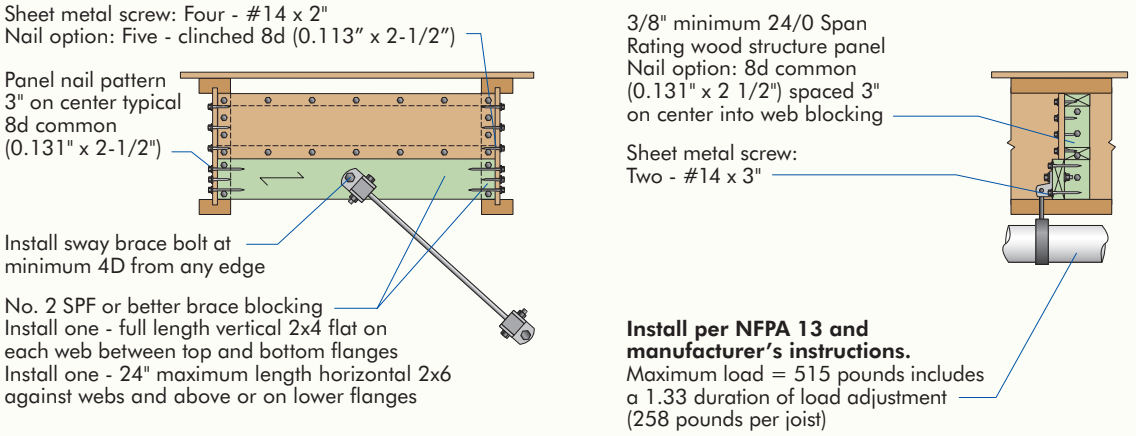
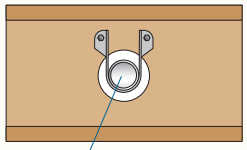


FIGURE 18

APA PERFORMANCE RATED I-JOIST – CPVC HANGER IN WEB BORE



Install per NFPA 13 and manufacturer's instructions.
CPVC Sprinkler system pipe
3" maximum diameter or
310 pounds maximum point load

FIGURE 19

END AND EDGE DISTANCES, LOADED AND UNLOADED

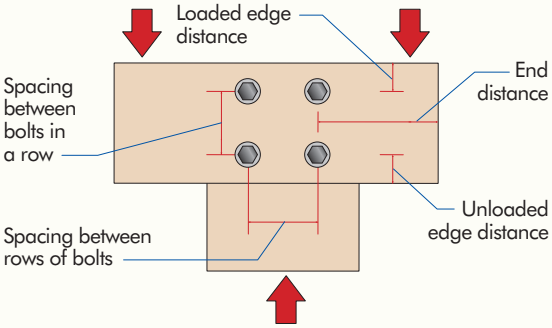


FIGURE 20

MAIN AND SIDE MEMBERS

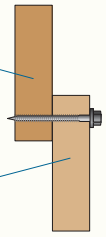


TABLE A

STEEL SCHEDULE 40 PIPE SIZES, SPANS AND WEIGHTS FOR STRUCTURAL DESIGN

Nominal Size (in.)	Max. Dist. Between Hangers[a] (ft)	Hanger Load at Max. Spacing: 1x (Pipe[b] Plus Water) x 1.15 (lb/hanger)	Conc. Load Requirement per Hanger for Design[c] (lb)	Short-term Design Load[c] (lb per hanger)
1	12	27	250	277
1-1/4	12	49	250	299
1-1/2	15	60	250	310
2	15	85	250	335
2-1/2	15	132	250	382
3	15	180	250	430
3-1/2	15	231	250	481
4	15	281	250	531
5	15	402	250	652
6	15	544	250	794
8[d]	15	866	250	1116

(a) Maximum distance between hangers: NFPA 13.

(b) Pipe weights: NFPA 13 per Automatic Sprinkler System Handbook,

(c) For design-capacity requirements: NFPA 13, (1 x weight of water-filled pipe PLUS 250 lb).

(d) Schedule 30 pipe.

TABLE B

CPVC SCHEDULE 80 PIPE SIZES, SPANS AND WEIGHTS FOR STRUCTURAL DESIGN

Nominal Size (in.)	Max. Dist. Between Hangers[a] (ft)	Hanger Load at Max. Spacing: 1x (Pipe Plus Water) (lb/hanger)	Conc. Load Requirement per hanger for Design[b] (lb)	Short-term Design Load[(b),] (lb per hanger)
3/4	5-1/2	15	250	265
1	6	26	250	276
1-1/4	6-1/2	44	250	294
1-1/2	7		250	311
2	8	106	250	356
2-1/2	9	176	250	426
3	10	285	250	535

(a) Maximum distance between hangers: NFPA 13.

(b) For design-capacity requirements: NFPA 13 (1 x weight of water-filled pipe PLUS 250 lb).

TABLE C

MINIMUM EDGE DISTANCE: LAG SCREWS AND BOLTS IN 1-1/2" LUMBER[a]

Lag Screw and Bolt Diameter[a] (in.)	Minimum End Distance Parallel to Grain Unloaded Edge (in.) 4D	Minimum End Distance Parallel to Grain: Loaded Edge (in.) 7D	Minimum Edge Distance Perpendicular to Grain: Loaded Edge (in.) 4D	Minimum Edge Distance Perpendicular to Grain: Unloaded Edge (in.) 1.5D
3/8	1-1/2	2-5/8	1-1/2	5/8
1/2	2	3-1/2	2	3/4

(a) NDS, Section 11.5.

(b) Reducing distance to ends and edges is permissable provided that the geometry factor, C_{Δ}, is applied to calculated design capacity (NDS 11.5).

TABLE D

LOAD CAPACITY: FASTENERS WITH 3/8" OSB SIDE MEMBERS[a]

Lag Screw Diameter[a],[c] (in.)	Penetration into Side Grain of Main Member: Lateral Load Capacity[b] (lb) Main 1-1/2", Side 3/8"	Withdrawal Capacity[d] (lb)
1/4 x 2	75	211
5/16 x 2	91	243
3/8 x 2	77	271

Bolt Diameter[a] (in.)	Main Member Thickness: Single Shear 1-1/2"	Double Shear[e] Main 3/8", Side 1-1/2"
1/4	86	109
5/16	109	136
3/8	127	163
1/2	149	218

Screw[c] Size No.	Lateral Load Capacity (lb) Main 1-1/2", Side 7/8"	Wood Screw Withdrawal Capacity[d] (lb)	Sheet Metal Screw Withdrawal Capacity
8 x 2"	63	60	124
10 x 2"	78	69	143
12 x 2"	97	79	98
14 x 2"	106	88	109

(a) NDS Section 11.3.1. See Figure 20.

(b) Side Member 3/8" OSB (SG = 0.50); Main Member 1-1/2" SPF lumber (SG = 0.42); DOL = 1.0; Load Perpendicular to Grain; Single Shear.

(c) Multiply tabulated capacity by C_{eg} = 0.67, when fastener is in end grain.

(d) Full length of lag screws and wood screws is not threaded.

(e) OSB main member in double shear.

TABLE E

LOAD CAPACITY: FASTENERS WITH 1/8" STEEL SIDE MEMBER[a]

Lag Screw Diameter[c] (in.)	Main Member Thickness: Lateral Load Capacity[b] (lb) 1-1/2" (2" Lag)
1/4	112
3/8	97

Bolt Diameter[a] (in.)	1-1/2"
1/4	124
5/16	140
3/8	155
1/2	183
5/8	207

Wood Screw[c] Size No.	1-1/2"
8 x 2	96 (1")
10 x 2	118 (1")
12 x 2	142
14 x 2	154

(a) NDS Section 11.3.1.

(b) Side Member 1/8" ASTM 436 Steel; SG Main Member = 0.42; DOL = 1.0; Load Perpendicular to Grain; Single Shear.

(c) Multiply tabulated capacity by C_{eg} = 0.67, when fastener is in end grain. Minimum penetration required for lag screws is 4 times bolt diameter.

For additional information on installing and designing with I-joists, including information on span ratings, installation details, cantilever designs, architectural specifications and engineering design properties for APA Performance Rated I-Joists, refer to the following APA publications available for download from the APA web site:

- *APA Performance Rated I-Joists,* Form Z725
- *I-Joist Construction Details – Performance Rated I-Joists in Floor and Roof Framing,* Form D710

TABLE F

LATERAL CAPACITY OF 2-INCH NOMINAL LUMBER FILLER BLOCK (SG = 0.42) ON 3/8" I-JOIST WEB[a] (lb)

Size: Bolt with Nut and Washer	Number of Bolts (maintain specified edge and end distances)			
	1	**2**	**4**	**5**
1/4"	86	172	344	430
5/16"	109	218	436	545
3/8"	127	254	508	635
Nail Size	**Number of Nails**			
	1	**2**	**4**	**5**
6d box (0.099")	40	80	160	200
8d box (0.113")	50	100	200	250
10d box (0.128")	63	126	252	315
16d box (0.135")	69	138	276	345
6d common (0.113")	50	100	200	250
8d common (0.131")	65	130	260	325
10d common (0.148")	78	156	312	390
16d common (0.162")	93	186	372	465
Screw Size	**Number of Screws**			
	1	**2**	**4**	**5**
No. 8 (0.164")	63	126	252	315
No. 10 (0.190")	78	156	312	390
No. 12 (0.216")	97	194	388	485
No. 14 (0.242")	106	212	424	530

(a) Lateral capacity of 2" nominal lumber filler block (SG = 0.42) on 3/8" I-joist web (lb).

DEFINITIONS

Backer block – Also known as a *slave piece* by the sprinkler industry, a backer block is a supplemental piece of framing or wood structural panel required to augment the thickness of the material anchoring the end of the screw or nail. The composite of the original piece and the backer block is required to provide sufficient embedment of the fastener in order to develop its required capacity.

Beam Clamp – An NFPA-13-approved mechanical device that wraps around the flange of the I-joist and permits support of pipe hangers via eye-rods or other similar devices.

Coach screw – An NFPA-13-approved rod-type hanger used to support sprinkler piping through machine threaded portion at the lower end of the hanger via attachment to a pipe hanger. At the upper end of the hanger is threaded to permit it to be attached directly to the framing above without the use of straps or clamps.

Eye rod – An NFPA-13-approved rod-type hanger used to support sprinkler piping through a loop at the lower end of the hanger to which the pipe hanger is attached. At the upper end of the hanger is machine-screw threaded to facilitate attachment to the I-joist via number of approved straps or clamps using nuts and washers. The threaded end may be bent at a 90 degree bend to facilitate numerous strap or clamp geometries.

Filler block – Lumber blocking required to reinforce the web of the I-joist to permit the use of bolts or screws to facilitate the attachment of hardware to the web of the I-joist.

Flange – The outermost components of an engineered I-joist, constructed of sawn or structural composite lumber.

I-Joist – An "I"-shaped engineered wood structural member designed for use as rafters or joists in floors and roof construction. This product is prefabricated using sawn or structural composite lumber flanges and wood structural panel webs, bonded together with exterior-type adhesive.

NFPA-13 – The National Fire Protection Association, Inc., *Standard for the Installation of Sprinkler Systems.*

NFPA-13D – The National Fire Protection Association, Inc., *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes.*

NFPA-13R – The National Fire Protection Association, Inc., *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.*

SPF – The abbreviation for Spruce-Pine-Fir, a lumber grouping of similar species with a Specific Gravity of 0.42. This grouping of species is considered to have the lowest strength properties of framing materials normally used in construction today.

Trapeze – A sprinkler pipe support system that is attached to two framing members. From this support member – normally a short piece of pipe or angle iron – the sprinkler pipe is attached. Conventional support systems are used to support the sprinkler piping from the trapeze and can also be used to support the ends of the trapeze.

Web – The wood structural panel component of an engineered wood I-joist, which connects the two flanges together. Normally the web is made of oriented strand board with a minimum thickness of 3/8".

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Sprinkler Pipe Installation for APA Performance Rated I-Joists

We have field representatives in many major U.S. cities and in Canada
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