## Attaching Fire Sprinkler Components to Trus Joist® TJI® Joists

NFPA 13, *Standard for the Installation of Sprinkler Systems*, may be confusing to those who are not familiar with fire sprinklers and their support systems. This technical bulletin explains options available for designing sprinkler system supports, whether using the prescriptive tables provided in NFPA 13 or an engineered solution and explains the design assumptions for attaching sprinkler components to Trus Joist® TJI® joists. For additional information about connections into the bottom flange of the TJI® joists, refer to *Bottom Flange Trus Joist® TJI® Joist Attachment Connections (*TB-808). For additional information regarding residential and commercial sprinkler system attachment details, refer to *Fire-Rated Assemblies and Sprinkler Systems* (TJ-1500).

NFPA 13 2019 Edition provides two solution paths for fire sprinkler support systems. One way is to use the prescriptive guidelines and tables in Chapter 17; Hanging, Bracing, and Restraint of System Piping, and does not require engineering analysis. The alternative option is to design the support system using engineering principles as allowed by Section 17.1.2, which states:

*17.1.2 Hangers certified by a registered professional engineer to include all the following shall be an acceptable alternative to the requirements of Section 17.1:*

1. *Hangers shall be designed to support five times the weight of the water-filled pipe plus 250 lb (115 kg) at each point of piping support.*
2. *These points of support shall be adequate to support the system.*
3. *The spacing between hangers shall not exceed the value given for the type of pipe as indicated in Table 17.4.2.1(a) or table 17.4.2.1(b).*
4. *Hanger components shall be ferrous.*
5. *Detailed calculations shall be submitted, when require by the reviewing authority, showing stresses developed in hangers, piping, and fittings, and safety factors allowed.*

Weyerhaeuser has chosen to follow the engineered approach permitted by Section 17.1.2 for sprinkler support system details. A discussion of Weyerhaeuser's interpretation of the five components, based on discussions with NFPA's technical staff, is provided below:

1. The metal hanger itself or metal connectors, not the supporting structure (e.g. TJI® joists), must be designed to withstand five times the weight of the water filled pipe plus 250 lb. The additional 250 lb requirement is to represent a sprinkler installer or construction worker possibly losing balance and hanging from a pipe. The extra load on the system is treated as a temporary load, whereas the weight of the water filled pipe is treated as a permanent load. For the permanent load, a duration of load (DOL) factor of 0.9 is applied to the fastener(s) in the system. For the temporary load, a DOL of 1.45 is used. The factor of 1.45 is taken from 2024 NDS® Appendix D Table B1 assuming the loading will be applied for approximately 30 minutes. It is assumed that the adequacy of the metal components is the responsibility of the Engineer of Record and/or the metal hardware supplier.
2. The 2024 NDS® is used for connection design with the appropriate equivalent specific gravity for the Trus Joist® product. In the case of connections to the bottom flange of TJI® joists, the equivalent specific gravity (G) is 0.50 and connections are capped at a maximum of 500 lb at 5′ o.c. along the length of the joist. Do not increase for load duration. If two (2) fasteners are required, the hanger shall be positioned to allow for the fasteners to be offset. Connections into the side of TJI® joist flanges are not recommended.
3. This requirement is based on the span capacity of the piping and this the maximum hanger spacing in NFPA 13 must be followed.
4. Hanger components must be metal. Plastic or other materials are not acceptable.
5. The local building official has the authority to request calculations justifying the support system design. In many cases, supplying the UL listening for the metal fire sprinkler system component and Weyerhaeuser's sprinkler systems guide are adequate to satisfy this request.
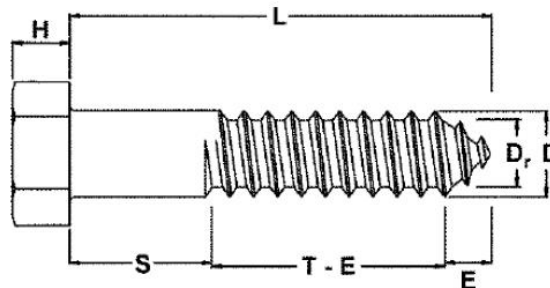
## Design Example: Ceiling Flange Design

**Given:**

2-screw ceiling flange hanger with thickness of ⅛″, spaced 15 feet on-center (rotated to offset fasteners), and fastened with two (2) $5/16$″ x 2″ lag screws.

**Find:**

What is the maximum allowed pipe diameter for a TJI® 230.

**Solution:**

- From 2024 NDS® Table L2, the dimensions for a $5/16$″ x 2″ lag screw are as follows:
    - Diameter, D = $5/16$ in.
    - Root diameter, $D_r$ = 0.227 in.
    - Length of tapered tip, E = $3/16$ in.
    - Height of head, H = $7/32$ in.
    - Lag screw length, L = 2 in.
    - Unthreaded body length, S = ½ in.
    - Minimum thread length, T = 1½ in.
    - T – E = $1 5/16$ in.

### TABLE 1: RESIDENTIAL TJI® FLANGE SIZES

| TJI® Series | Minimum Flange Thickness (in.) | Flange Width (in.) |
|---|---|---|
| TJI® 110 | 1.25 | 1.75 |
| TJI® 210 | 1.25 | 2.08 |
| TJI® 230 | 1.25 | 2.30 |
| TJI® 360 | 1.375 | 2.30 |
| TJI® 560 | 1.375 | 3.50 |

- From 2024 NDS® Table 12.2A, the reference withdrawal design values is 266 lb/in. of thread penetration for G = 0.50.
- From **Table 1**, the flange thickness of a TJI® 230 is 1.25 in.
- Determine the length of thread engaged in the main member (flange):
    - Determine whether the unthreaded body length, S, penetrates the flange. In this example, S is greater than the thickness of the ceiling flange hanger, therefore the shank penetrates the flange by ½ in. – ⅛ in. = ⅜ in.
    - Determine the length of thread in the main member. The flange thickness is less than T – E, so the length of thread engaged in the main member is the flange thickness minus the shank penetration length.
    - Length of thread engaged in the flange = 1.25 in. – 0.375 in. = 0.875 in.
- Allowable lag screw withdrawal capacity = 0.875 x 266 lb/in. = (232.7 lb/lag screw) x 2 lag screws = 465.5 lb
- Allowable lag screw capacities with DOL factors applied:
    - Permanent load, 465.5 lb * 0.9 = 419 lb
    - Temporary load, 465.5 lb * 1.45 = 675 lb
- Determine the maximum allowable pipe diameter.
    - Try a 4 in. diameter pipe: From NFPA 13 Table A.18.5.9, a schedule 40, water filled, 4 in. diameter pipe, weighs 16.4 lb/ft at 15 ft o.c. between supports, the total weight is 16.4 lb/ft * 15 ft = 246 lb.
    - Permanent pipe weight = 246 lb
    - Temporary pipe weight = 246 lb + 250 lb = 496 lb
- Check that the pipe weights are less than the flange pull-off and lag screw withdrawal capacities.
    - Permanent load check: 246 lb < 500 lb (flange pull-off) and 419 lb (lag screw withdrawal)
    - Temporary load check: 496 lb < 500 lb (flange pull-off) and 675 lb (lag screw withdrawal)
- Temporary load check controls the design, and the maximum diameter pipe that can be supported by the bottom flange of a TJI® 230 using a ceiling flange hanger with two (2) $5/16$″ x 2″ lag screws is 4 in.

In the above example, the maximum allowable diameter of pipe is greater than the 2″ pipe diameter shown in Detail S21 of the TJ-1500 because the details are limited by NFPA 13's prescriptive rules. It is important to note that some jurisdictions have only adopted NFPA 13's prescriptive solutions and have excluded Section 17.1.2 and the alternative option of engineering a fire sprinkler support system. Therefore, it is important to contact your local building official to confirm that this approach is permitted for your structure.

*If you have any questions, please contact your Weyerhaeuser representative.*