



## Tuesday e-Tech Alert February 15, 2005

### Branch Line Restraint Options in Earthquake Areas

The December 7, 2004, edition of Tuesday e-Tech Alert dealt with restraint of high-pressure pendent sprinklers below ceilings. A related area in which NFPA 13 uses the term restraint is for sprig-ups and branch lines in areas subject to earthquakes. Compared to earthquake bracing, restraint is considered a lesser degree of holding the piping in place against vertical and lateral forces. Section 9.3.6 of the 2002 edition of NFPA 13 requires it:

- • For the end sprinkler on a branch line
- • At maximum 30 ft intervals where upward or lateral movement of the branch lines could damage sprinklers through impact against the building structure, equipment or finish materials such as rigid ceilings
- • For sprig-ups 4 ft or longer

Full bracing is required for branch lines 2-1/2 inches and larger in diameter.

The standard offers four options on how to provide restraint:

1. 1. Use of listed sway brace assemblies
2. 2. Wraparound U-hooks with legs bent out 30 degrees from vertical and meeting the requirements of Tables 9.3.5.8.9 (a), (b) or (c)
3. 3. Number 12, 440-lb.wire installed at least 45 degrees from vertical and anchored on both sides of the pipe
4. 4. Other approved means

This criteria was first added in the 1991 edition of the sprinkler standard in reaction to damage to sprinkler systems observed as a result of the 1989 Loma Prieta earthquake in the San Francisco area. Some common questions:

Q: Is restraint the same as lateral bracing?

A: No. It is intended as a much less formal approach, and there is officially no need to match the restraint capability to the load as there is with bracing.

Q: Why is the use of listed sway brace assemblies mentioned?

A: It is considered permissible and conservative to use listed sway brace assemblies per Option 1, or to use wrap-around U-hooks under the conditions of Option 2, which are the same conditions under which those devices are permitted to substitute for lateral sway braces.

Q: What kind of wire is intended under option 3?

A: The original wording in the 1991 edition referred to “#12, 440 lb., splayed seismic brace wire” and has led to many questions. Some interpreted the word “splayed” to mean stranded or braided, but the intent was simply that the points of attachment be splayed at 90 degrees from each other in opposite directions (45-degree angles from vertical) from the pipe. This wording came from the one of the California state agencies and was borrowed from the regulations for restraint of ceiling systems, so the requirement relates to the type of wire used to suspend ceilings. Adding to the confusion are the number of different wire gauges in use, and the fact that the American Standard Music Wire Gauge includes a Number 12 that relates to about 440 ft. per lb. But the 440 lb. reference is understood to be a proposed breaking strength of Number 12 steel wire in the American Standard Wire Gauge, a wire 0.0808 inches in diameter.

Q: How does the restraining wire compare to special listed cable bracing?

A: Both rely on tension members anchored on opposite sides of the pipe. However, the special listed cable bracing is investigated and listed for specific maximum loads, and the wire restraint method is not. Attachment methods for the special listed cable bracing are specified in the listing, whereas appendix figures show that restraining wire is typically held in place by “two tight turns around the pipe and fastened with four tight turns within 1-1/2 inches.”

Q: What “other approved means” are contemplated in Option 4?

A: “Approved means” would include any arrangement acceptable to the Authority Having Jurisdiction. The two possibilities specifically cited in the most recent edition of the NFPA *Automatic Sprinkler Systems Handbook*, however, involve hangers arranged for vertical restraint in combination with a substantial ceiling judged capable of providing lateral restraint, or the use of additional hangers brought down at an angle.

Q: Is there any way to quantify the capabilities of these alternates to the Authority Having Jurisdiction?

A: While it is not the intent of the standard to quantify the capability of a restraint system, the capability of any proposed restraint could be compared to branch line loads calculated using the same method as applied to lateral and longitudinal bracing. A length of 30 ft of water-filled 2-inch Schedule 40 branch line, using the NFPA 13 earthquake load default of half the weight and a 1.15 factor to account for fittings, produces a lateral load of 183 lb. However, since a branch line is not expected to move uniformly during an earthquake event, a lone end sprinkler restraint is not expected to address the load of the entire branch line.

Alternatively, the capability of a proposed means could be compared to that of the 440-lb restraint wire. With regard to lateral resistance, the wire used at the minimum 45-degree angle from vertical has a theoretical maximum lateral load capacity of  $440 \text{ lb.} / 1.414 = 311 \text{ lb.}$  The wires are required to connect to a branch line within 2 ft of a hanger, and rely upon the hanger to prevent upward vertical movement.

With regard to an additional hanger used at a 45-degree angle from vertical, the 750-lb minimum hanger test load used by UL assures its capability in tension. The capability of the 3/8-inch hanger rod in compression can be evaluated using Table 9.3.5.8.9(c). At a minimum 45-degree angle from vertical, the rod can be several feet long before buckling becomes a concern, particularly since the accompanying hanger can also be expected to assume some of the compression load. Both hangers should be equipped with restraining clips or have rods brought down to the top of the pipe to prevent upward movement.

Upcoming NFSA Technical Tuesday Online Seminar:

**NFPA 13 Chapter 7 – System Requirements**  
**Instructor: Russell P. Fleming, P.E.**

**Date: March 1, 2005**

This seminar will address the separate requirements of NFPA 13 for wet pipe systems, dry pipe systems, deluge systems and various types of preaction systems. Requirements for antifreeze systems are also addressed, as are multi-purpose piping systems, exposure protection systems, and commercial cooking systems. This is the third in a series of ten seminars dedicated to an in-depth review of the current (2002) edition of NFPA 13. Participants will develop an appreciation for the way in which the material is organized in the 2002 edition while learning more about the background of the rules themselves.

The level of all seminar topics is considered intermediate. These seminars are being offered as a complete program on NFPA 13 - a 20% discount is available if signing up for all eight remaining seminars in the series.

Information and registration for this seminar is available at [www.nfsa.org](http://www.nfsa.org).

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