

Residential Fire Sprinklers - Technical Requirements Concerns of NFPA 13D Systems

Prepared by the National Association of Home Builders Research Center

The following analysis of the NFPA 13D Standard illustrates the many technical installation, inspection, and maintenance concerns that will arise in the design and use of sprinkler systems in homes across the country.

Referenced Standard:

Review based on current language in *NFPA 13D: Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2007

Abbreviations:

RFS ≡ Residential Fire Sprinkler AHJ= Authority Having Jurisdiction
Sprinkler heads are referred to simply as sprinklers

Concerns arising from the Technical Requirements of the 13D Standard:

(These concerns pertain primarily to single family, duplexes and townhouses.)

1. Overall concerns based on the 13D requirements

- a. A RFS system design is complicated and has no prescriptive approach.
- b. Materials such as pipe and fittings are required to be listed for use in sprinkler systems with no difference accounting for the type of occupancy or structure – except if the AHJ is willing to accept a material not listed but able to perform according to the specifications of 130 psi at 120F.
- c. The location of sprinkler heads is still very complicated, especially when obstructions are present.
- d. The temperature rating of the sprinklers and the location near heat sources is complicated and detailed.
- e. Sprinkler heads from different manufacturers have different coverage areas, operating pressures, and flow rates – no optimization is provided in the standard to minimize flow rates (and hence pipe sizes etc.).
- f. Many AHJ's require sprinklers in areas not required in the standard.
- g. The standard does not have any requirements for water meters or the underground except that these items are included in the RFS design but often as a cost not associated with the RFS system.
- h. Ongoing maintenance of the RFS system falls on the consumer. Not many owners/occupants will do the required monthly test and/or yearly maintenance – potentially leading to system failures.

2. Specific Concerns based on technical requirements in the standard

- a. Sprinkler system hydraulic design, material specification, and sprinkler layout must be made available if requested – so is required.
- b. Although all common plumbing pipes for residential construction meet the 130 psi/120F requirement, these products are typically not permitted in sprinkler systems.
- c. Basements that do not have ceilings must still use metal pipe
- d. RFS systems on wells are complicated and may require tanks of between 240 to over 500 gallons depending on sprinkler head type and specification.
- e. Alarms are not required in 13D but are often required by AHJ.
- f. Listed residential sprinklers are required in all spaces but with some exceptions for convenience (such as garages) with the potential for freezing (many AHJ's accept one dry sidewall (not rated for residential)).

- g. Temperature ratings of sprinklers are specified in terms of the maximum normal ceiling temperature – specific locations have higher temperature ratings. Another table lists the minimum distances of sprinkler heads from heat sources such as ducts, pipes, and vents - all of the details are confusing and it is unclear who decides what temperature rating should be used in a particular location.
- h. The water flow rate required for the system varies depending on the sprinkler head rating (based on the coverage area), the pressure available, and the number of heads in any one room (up to 2) – this is very complicated. In addition, the characteristics of the head are required to meet a coverage area minimum and a flow/pressure formula (which is one reason plumbers have resisted involvement).
- i. Multipurpose systems, while originally a hallmark of the 13D standard, have many complications that make its use difficult.
- j. Location of sprinkler heads is so complicated that only a skilled sprinkler designer can locate the heads based on the requirements of the standard. Even so, in more complex situations, there are no guidelines and the decision is left to the AHJ or their designee.
- k. Many AHJ's require sprinklers in locations that are not required in 13D.

3. Potential areas where improvements may be made

- a. Develop a prescriptive approach to RFS design for 13D systems including minimum performance specs for sprinklers and prescribed pipe sizes based on water pressure.
- b. Allow any residential domestic pipe material, even in basements.
- c. Locate sprinklers based on a set of minimum (or maximum) requirements that apply to all sprinklers.
- d. Develop system designs based on life safety (as the original intent) not extinguishing requirements – the fire department will still show up in case the sprinkler or water supply fails.
- e. Consider developing limited sprinkler applications such as the bedrooms and kitchen – locations where the incidence of fire are highest.

4. Some differences in the NFPA 13R Standard

- a. Formal design
- b. Higher flow rate
- c. Alarms and gauges
- d. Fire Department connection
- e. More stringent piping requirements

Specific Technical Issues

Chapter 4 - General

- Installer must provide the owner/occupant with instructions on inspecting, testing, maintaining the RFS system
- Sprinklers painted outside the factory shall be replaced
- RFS using antifreeze must be emptied and refilled each year
- Documentation shall be available upon request to ensure adequate water supply, listed devices, and adequate sprinkler coverage have been addressed

Chapter 5 – System Components

- CPVC and PB accepted in the standard if listed for sprinkler system use
- Other non-metallic pipe must be capable of 130 psi at 120 F (also for non-metallic fittings)

Chapter 6 – Water Supply

- If stored water only, then stored volume equals demand [sprinkler] water flow rate times 10 minutes except if 1 story, less than 2000 ft² - then 2 sprinkler head flow rate times 7 minutes
- A well with a pump that can meet the sprinkler flow demand and pressure can meet the stored water requirement using the water in the well plus the water in the tank (if it supplies the sprinkler system)
- Systems with pumps shall be tested at the design flow and duration (10 or 7 minutes)
- Other pump system requirements depending on the pump/tank system design
- Multipurpose Piping Systems (MPS)
 - For more than 1 unit, 5 gpm added to common piping flow
 - All piping supplying sprinklers in MPS must be listed or conform with standard
 - Piping from the MPS to plumbing fixtures not required to be listed
 - Permitted by local plumbing and health authority
 - Warning sign requirement at main shut-off
 - Special requirements if water treatment equipment installed

Chapter 7 – Installation

- A RFS drain valve is required
- If the sprinkler system has an alarm, an inspector flow test valve for the alarm must be installed
- Listed residential sprinklers are required with exception for some areas as mechanical closets and non-living spaces (such as garages)
- Temperature ratings of the sprinkler varies by location and estimated maximum ceiling temperature, special requirements for sprinklers located:
 - Where ceilings can reach over 100 F,
 - Under skylights exposed to the sun
 - Under an uninsulated roof
 - Near heat sources
 - Table of distances for sprinkler heads located near heat sources including ducts, hot water pipes, light fixtures, etc.
- Sprinklers and covers shall not be painted (unless listed by the manufacturer to be field painted)
- If solvent cement is used in the piping system, sprinklers must not be installed prior to cementing the pipe
- Water flow alarms are required on homes without smoke alarms installed according to NFPA 72
- Non-metallic piping in attic must have insulation over the pipe

Chapter 8 – System Design

- Design discharge (water flow) - up to two heads if 2 or more heads in a room

- Use the flow specification for the sprinkler from the manufacturer or if not listed use 18 gpm for 1 design head or 13 gpm per sprinkler for a 2-sprinkler design
- A minimum discharge density of 0.05 gpm per square foot
- Location of sprinklers – use manufacturer guides and listing for sprinkler
 - Special ceiling configurations outside of the manufacturer listing and installation instructions at the sole discretion of the AHJ
 - Some special requirements in the standard, for example minimum distance between sprinklers on sloped ceilings
- Minimum operating pressure of 7 psi for any sprinkler (pressure and flow must satisfy the relation flow rate = k factor X square root of the pressure)
- Pendant sprinklers within 1” to 4” below ceiling (unless different in listing)
 - Closets can be up to 12” below
- Sidewall sprinklers with deflector within 4” to 6” below ceiling (unless different in listing)
- Basement sprinklers may be installed for future ceiling (metallic piping only if no ceiling)
- Closets less than 400 cubic feet exempt from obstruction requirements
- Pendant sprinklers must be located at least 3 feet from an obstruction; if not possible then a second sprinkler on the other side of the obstruction is required
- Similar requirement for sidewall sprinklers with distance changed to 5 feet
- Special requirements for the location of sprinklers with respect to continuous obstructions and soffits
- Wet pipe systems can be used when temperature year round greater than 40 F, otherwise antifreeze, dry pipe, or dry-sprinkler systems must be used – requirements for each system in the standard
- Pipe sizes based on flow and pressure specifications and the sprinkler demand
- Steel pipe must be a minimum of 1”
- Other pipe minimum diameter of ¾” – ½” pipe diameter permitted in only network system designs where:
 - each sprinkler is supplied with at least three ½” pipes,
 - all pipes are looped (no dead ends),
 - specific hydraulic calculations are performed for the system,
 - plan review documents are available,
 - Hydraulic calculations based on NFPA 13 but with the friction loss of the fitting included in the pipe loss calculations,
 - A maximum of 1 insert fitting in any pipe section feeding a domestic fixture,
 - If an insert fitting is installed, the sprinkler shall have four separate paths of water supply, and
 - All piping to domestic fixtures in accordance with plumbing code
- For sprinkler systems (other than network, grid and looped systems) connected to a water main of at least 4” diameter can use the design procedure in the 13D standard.
- Sprinklers required in all areas except in:
 - Bathrooms less than 55 ft²
 - Closets less than 24 ft², least dimension less than 3 ft, non-combustible walls and ceiling
 - Garages, open attached porches, carports
 - Attics, penthouse equipment rooms, elevator machine rooms, concealed spaces for ventilation equipment, floor/ceiling spaces, elevator shafts, crawl spaces, other spaces not intended for living and do not contain fuel-fired equipment
 - Covered unheated entrance/exit if there is another means of escape
 - Ceiling pockets if less than 100 ft², the floor under the pocket is protected with sprinklers, ceiling pockets are separated by at least 10 horizontal feet, interior finish of the pocket is non – or limited-combustible, and skylights less than 32 ft² can have a plastic cover.