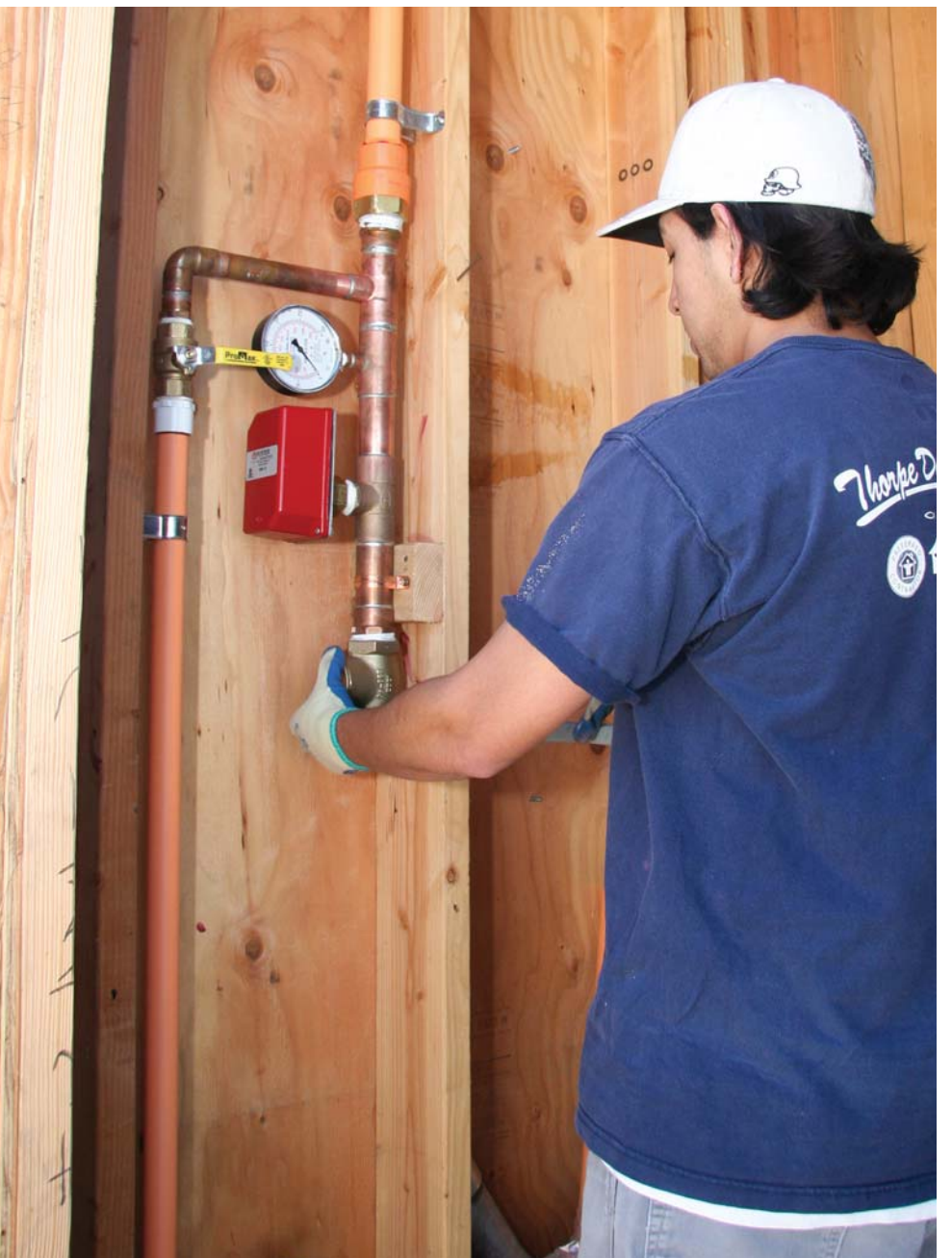
Residential Fire Sprinklers

by Dan Thacker

Your state may be the next to mandate these systems, so it's a good idea to understand how they work



A small but growing number of code jurisdictions now require fire sprinklers in new and substantially remodeled homes. That number is bound to increase as states adopt the 2009 IRC, which requires sprinklers in all new one- and two-family residences and townhouses. Not all states, of course, will choose to implement the new rule — but in ones that do, builders will need to get up to speed on these systems.

The company I work for designs and inspects residential and commercial fire sprinklers. In this article I'll focus primarily on residential sprinkler systems — how they work and what builders need to know about their installation.

Residential vs. Commercial

Fire-sprinkler systems must comply with standards published by the National Fire Protection Agency (NFPA). Sprinklers for one- and two-family dwellings are covered by NFPA 13D, which is the basis for the sprinkler requirements in the 2009 IRC.

Residential systems don't serve quite the same purpose as commercial systems. The sprinklers used in commercial buildings are designed to protect both life and property, and they're sized to supply water to many heads for at least 30 minutes. Residential sprinklers, by contrast, have a single overarching goal: to protect the lives of the home's occupants. Property

Typical Sprinkler Configurations

Stand-Alone

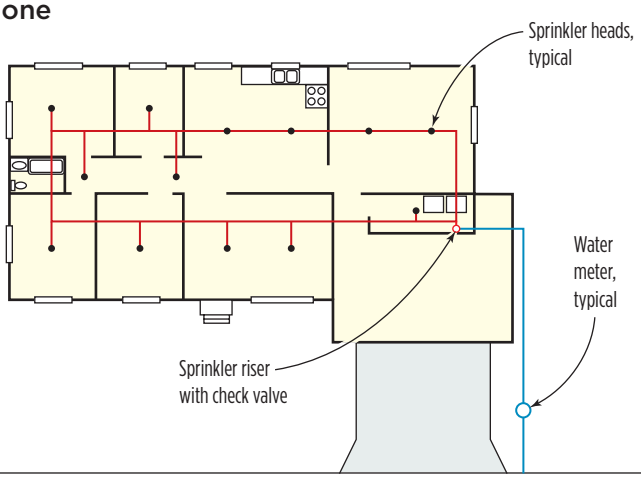
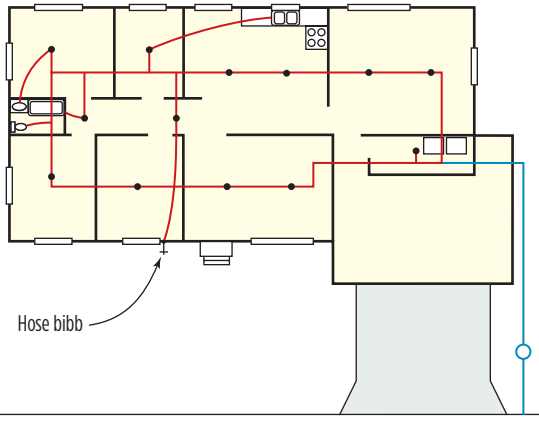


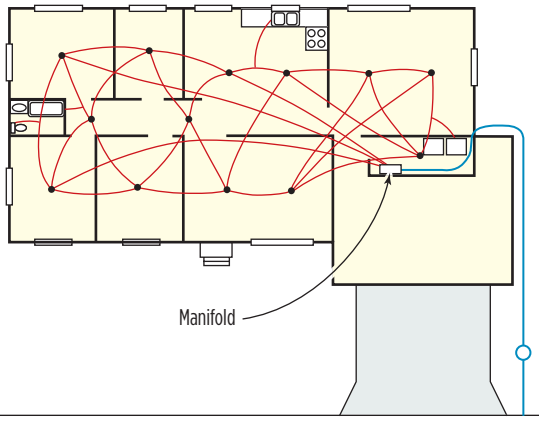
Figure 1. There are two basic types of sprinkler systems: stand-alone and multipurpose. In a stand-alone system, water enters the sprinkler pipes and remains there until a head activates or the system is drained for maintenance. Because this noncirculating water can become stagnant, a check valve is required to prevent it from contaminating the potable water.

Looped Multipurpose



In a looped multipurpose system, the heads are arranged along a continuous circuit. The plumbing fixtures draw their supply water through sprinkler heads, so there are no dead ends where water can stagnate.

Networked Multipurpose



In a networked multipurpose system, sprinkler heads and fixtures are connected by a web of 1/2-inch PEX lines. Though small in diameter, these lines can provide the necessary flow because there are multiple connections between the heads and the plumbing manifold.

Photos this page, except where noted: Viking Group

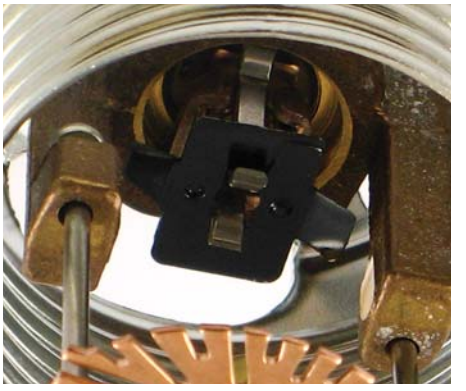


Figure 2. Heads automatically activate when the air surrounding them reaches a predetermined temperature — typically between 155°F and 175°F. The glass bulb in the sprinkler at far left contains a liquid that expands when heated. At the critical temperature, the pressure breaks the bulb and releases the water. The head at left relies on a fusible link of soldered metal that melts at the critical temperature, activating the flow.

protection is a secondary concern. Systems in one- and two-family dwellings are sized to supply at least two heads for a minimum of 10 minutes. This should hold the fire at bay long enough for the occupants to escape and the fire department to arrive on the scene.

Types of Systems

Residential fire sprinklers can be designed as stand-alone or multipurpose systems (**see Figure 1, page 2**).

Stand-alone. In a stand-alone system, the sprinklers are piped separately from the potable water supply and are isolated from it by a check valve. The check valve is necessary because the water in the sprinkler piping does not circulate and may become stagnant.

Multipurpose. In a multipurpose system, the sprinkler piping is part of the cold-water plumbing supply. Stagnation isn't a problem because fresh water enters the sprinkler lines every time a plumbing fixture draws water.

Multipurpose systems are generally piped in either looped or networked configurations. In a looped system, heads are installed along or just off a line that runs in a loop around the house. To prevent stagnation, the designer avoids the long dead-end runs often found in stand-alone systems.

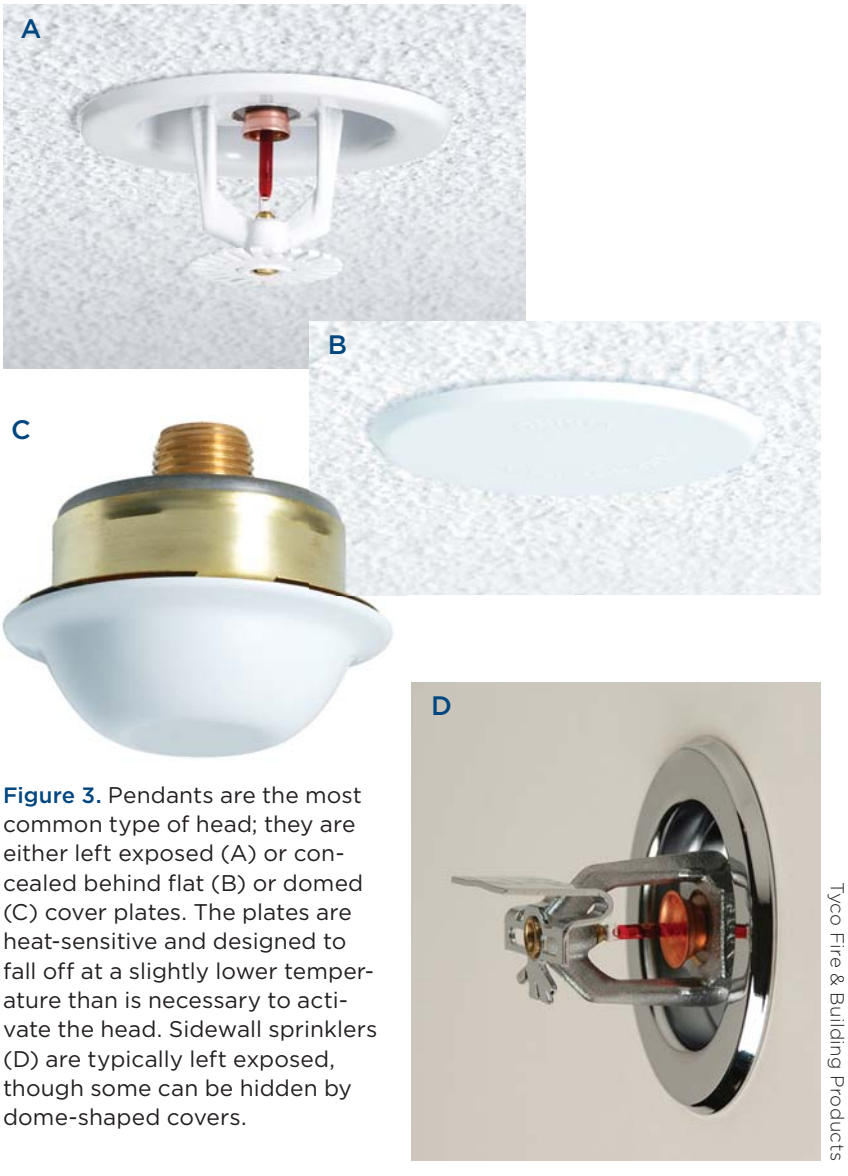


Figure 3. Pendants are the most common type of head; they are either left exposed (A) or concealed behind flat (B) or domed (C) cover plates. The plates are heat-sensitive and designed to fall off at a slightly lower temperature than is necessary to activate the head. Sidewall sprinklers (D) are typically left exposed, though some can be hidden by dome-shaped covers.

Tyco Fire & Building Products

Networked multipurpose systems can only be made with PEX (cross-linked polyethylene) piping. Each head is fed by four connections. A web of 1/2-inch PEX lines connects the heads to each other, to the supply manifold, and to fixtures.

Licensing. In many jurisdictions, plumbers can install multipurpose systems without special licensing. Standalone sprinkler systems, however, typically require a separate license.

Head Activation

Contrary to what you see in the movies, sprinkler heads do not all go off at once. Although such systems exist, they're used only in high-hazard areas like power plants and factories.

The heads in residential (and most commercial) systems are individually activated by heat in the surrounding air. A typical residential sprinkler has a glass bulb containing a fluid that expands when exposed to heat. When the rated temperature is reached — usually between 155°F and 175°F — the glass shatters and water begins to flow (**Figure 2, page 2**). Other residential heads rely on a fusible link — pieces of metal soldered together. When the rated temperature is reached, the solder melts, the link comes apart, and the sprinkler comes on.

Spray pattern. Fires in dwellings usually start at the perimeter of the room — where the furniture and drapes are — so residential sprinklers spray in a pattern that hits high on the walls. Commercial heads spray down, in a conical pattern, because the fuel is assumed to be more evenly distributed throughout the building.

Response time. Residential sprinklers begin to operate 30 to 60 seconds after the critical temperature is reached. The goal is to catch the fire before it has time to activate more than two heads. If more than two are activated, there may not be enough water pressure to achieve the desired spray pattern.

Figure 4. Under NFPA 13D — the basis for the 2009 IRC sprinkler requirements — sprinkler heads are required in the main living areas of a home, though not in small baths and closets. Garages, crawlspaces, and attics are also exempt unless they contain a fuel-burning appliance. Local codes may vary, however.

Sprinkler Heads

There are two main types of residential heads: pendants and sidewall sprinklers. Pendants spray down from the ceiling and sidewall heads spray out from the wall. Pendants are more common; sidewall sprinklers are used when there is no clear path to run pipes to pendants. Sidewall heads can also be used in retrofit situations to avoid cutting and patching the ceiling (**Figure 3, page 2**).

Pendants are frequently concealed behind flat or dome-shaped cover plates, which are soldered to an escutcheon threaded into the sprinkler assembly. At a predetermined temperature the solder melts, a spring ejects the cover, and a deflector pops down. The head activates shortly thereafter, and the water hits the deflector and fans out in the desired spray pattern.

Cover plates must not be painted: Paint alters a plate's heat sensitivity and may prevent it from releasing at the proper time.

Coverage. The number of sprinklers needed is based on the size of each room; in residential systems the goal is to spray at least 0.05 gallons of water per minute per square foot of floor area. Coverage per head ranges from a low of 12 feet by 12 feet to a high of 20 feet by 20 feet. Some residential heads will work with as little as 13 gallons per minute (gpm), while others use up to 26 gpm. Commercial sprinklers, not surprisingly, require much more water.

Placement. As a rule, sprinklers must be at least 8 feet apart. If they're closer together than that, the first one to go off may cool the area enough to prevent its neighbor from activating.

Sprinkler heads must be located away from any heat sources that might accidentally set them off — a minimum of 60 inches (measured horizontally) from the front of a fireplace, 18 inches from a

Figure 5. CPVC pipe flexes enough to be pulled into joist bays (top), where it can be glued and then inserted into fittings (center). The system above has been tested for leaks and is ready for drywall to be installed. The head is covered by a protective plastic cap, which will be removed after painting and replaced with a trim piece or cover plate.

kitchen stove, and 6 inches from a water heater or furnace. Beams, lights, and ceiling fans can cause problems, too, by blocking a sprinkler's spray or interfering with its response time. The NFPA standards — as well as manufacturers' installation guidelines — include specific rules for placing heads to avoid obstructions.

Required areas. The vast majority of fatal fires in homes begin in the living room, family room, bedroom, or kitchen. NFPA 13D requires fire sprinklers in all of these rooms, as well as in any other space not specifically exempted by the standard **(Figure 4, page 4)**.

For example, bathrooms smaller than 55 square feet and closets smaller than 24 square feet and less than 3 feet deep do not need sprinklers. Nor do unheated entry areas, garages, or attics and crawlspaces that do not contain fuel-burning appliances. Keep in mind, though, that local jurisdictions may have different requirements; many require garages to have sprinklers, for instance.

Piping

The pipes in residential sprinkler systems can be made of steel, copper, or certain plastics. Most are made from CPVC (chlorinated polyvinyl chloride) or PEX. CPVC piping can be installed in stand-alone and multipurpose piping systems (**Figure 5, page 5**). At present, PEX piping can be used only in multipurpose systems (see "Using PEX for Fire Sprinklers," below). Metal piping can be left exposed, but plastic pipes and fittings generally need to be covered by a

Using PEX for Fire Sprinklers

At present, PEX can be used in multipurpose sprinkler systems but not in stand-alone systems. This restriction exists because, under NFPA regulations, the piping in a stand-alone system must be rated for use at 175 psi. Steel, copper, and CPVC meet this standard, but PEX does not. The pipes in multipurpose systems (which are allowed only in residences) are considered to be plumbing, and plumbing pipes must be rated to 130 psi — a standard PEX does meet.

The distinction between sprinkler pipe and plumbing pipe originated with commercial systems, which typically include a connection for the fire department. Firefighters can hook their truck to this connection and pump additional water to the fire sprinklers, increasing the pressure in the pipes to more than 130 psi. Even though one- and two-family residences do not have to contain these connections, the different pressure requirements for sprinkler and plumbing pipes still apply.

Product benefits. PEX manufacturers make a number of claims for their products. For instance, they argue that because PEX pipes require fewer fittings and are flexible, they are faster and easier to install than pipes made from CPVC. They also claim that PEX piping will expand in diameter if the water inside freezes, making it more resistant to freeze damage than CPVC. Nevertheless, NFPA 13D requires that it be protected from freezing in the same manner as other types of pipe. — *David Frane*

Photos: Uponor

PEX can only be used in multipurpose systems. The small PEX pipe coming off the fitting in this looped system (above) is the supply line for a plumbing fixture. In a networked system (right) four lines feed each head. These lines may run to other heads, to the supply manifold, or to a fixture.

thermal barrier like drywall.

Storage. CPVC and PEX pipes should always be tarped when stored outdoors, because direct sunlight weakens them and makes them less flexible. If a building inspector sees fading in CPVC sprinkler pipe — indicating that it's been exposed to sunlight — he'll fail the system.

Size. How big the piping needs to be depends on the hydraulic demand — the pressure and flow required to operate that particular system. Low water pressure can be offset by using larger pipe, reducing the number of fittings, or spacing heads so that no one sprinkler uses more than 13 gpm.

If 60-psi water is available at the street, a stand-alone system in a one-story 2,500-square-foot home can usually be made with one-inch pipe.

Risers. In a stand-alone system, the sprinklers and overhead piping are supplied through a riser **(Figure 6)**. The riser contains a check valve and a drain valve, which is used to empty the system for repairs and to verify that there's water inside. Many risers also have a pressure gauge, though it's not required.

Most stand-alone systems are equipped with a flow detector, an electric device that sets off an audible alarm when water flows into the sprinkler pipes. Flow detectors aren't required if the house has smoke detectors, but they're typically included as part of the sprinkler system anyway.

A stand-alone system's main control valve must be upstream from the connection to the domestic water so that the sprinklers can't be shut off without the domestic water being shut off as well. (Exceptions are when the control valve can be locked open or when it's monitored by a central alarm station.) This safeguard makes it less likely that anyone will leave the sprinklers off.

Problems with freezing. In cold climates it's important to make sure that

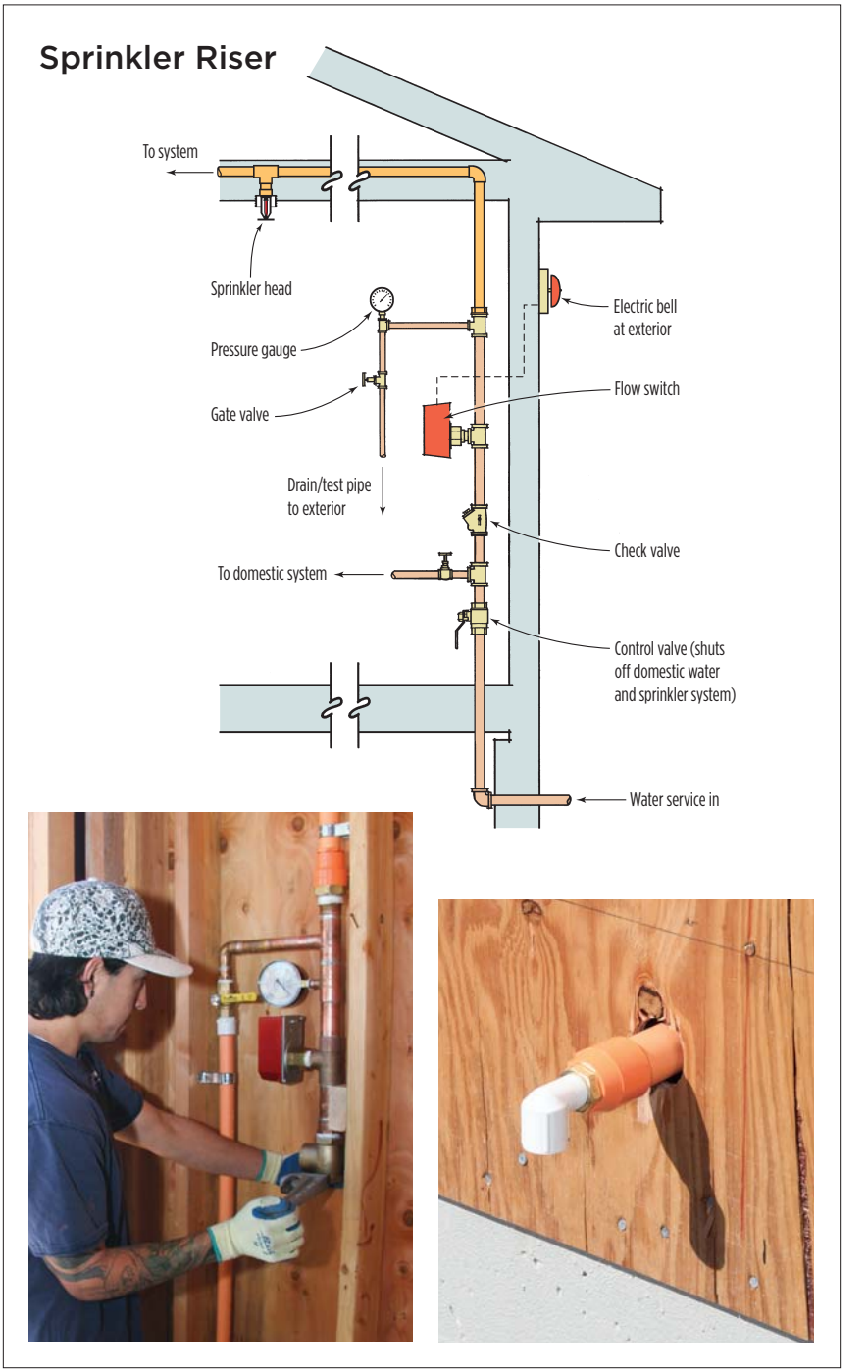


Figure 6. The pipes in a stand-alone system are supplied through a riser, which contains a check valve to prevent sprinkler water from entering the potable water supply (illustration, top). By code, sprinklers may not have a separate shutoff valve. Here, an installer tightens the check valve on a riser (above left); a plumber will later connect the main water supply to this valve. The CPVC pipe on the left is a drain line that terminates outside the house (above right).

the sprinkler pipes in upper-floor ceilings won't freeze and break. This can be done either by keeping pipes inside the home's thermal boundary or, in stand-alone systems, by filling them with a mixture of glycerin and water — an anti-freeze solution approved for use in CPVC. A reduced-pressure backflow-prevention valve (a type of double check valve) may be required to ensure that the mixture does not get into the potable water.

Planning Ahead

Altogether, it takes several weeks to design the system, get through plan review, and obtain a permit, so it's best to bring the sprinkler designer or installing contractor on board at the beginning of the project. Waiting until well into construction is a common and costly mistake.

Water service. Many contractors fail to consider the water supply. The underground piping and the water meter must be large enough to provide the necessary flow. A residential system typically requires a 1-inch meter — a 5/8- or 3/4-inch meter probably isn't adequate. The only way to know for sure what size meter is needed is to design the system and then calculate its hydraulic demand.

A well works fine with fire sprinklers as long as it can produce the required flow for 10 minutes straight — usually about 300 gallons. If the flow is insufficient, a standby water source will be needed, such as a pressurized or elevated storage tank.

Completing the Job

Once the piping is in place, the heads are installed and the system is tested for leaks. All piping must remain visible until the system has been inspected by the building official. The heads come with temporary plastic covers to protect them while the drywall is hung and painted. When the painting is complete, the sprinkler installer removes the temporary caps and replaces them with the finish trim.

Dan Thacker *is the design manager for Engineered Fire Systems in Grass Valley, Calif.*

Sources of Supply

Residential Sprinkler Systems

Blazemaster Fire Sprinkler Systems
The Lubrizol Corp.
216/447-5000, blazemaster.com

Freedom Residential Series
Viking Group
800/968-9501, vikinggroupinc.com

Globe Fire Sprinkler Corp.
989/846-4583,
globesprinkler.com

Rapid Response Home Fire Sprinkler System
Tyco Fire and Building Products
877/438-8926, tyco-rapidresponse.com

The Reliable Automatic Sprinkler Co.
800/431-1588, reliablesprinkler.com

PEX Systems

FirePEX Residential Fire Sprinkler System
Rehau
703/777-5255, rehau.com

Greenflow Kwench Systems
Kwench Systems of New England
603/563-9911, kwenchgroup.com

***PEX Fire Sprinkler**
Viega
800/976-9818, viega.net

Uponor Fire Safety Systems
Uponor
800/321-4739, uponor-usa.com

***Zurn PEX Fire Protection Systems**
Zurn PEX
800/872-7277, zurnpex.com

*These products will be available in the next few months.