Considerations When Retrofitting Fire Sprinkler Systems with Enhanced Backflow Prevention

Sprinkler system design begins with water. Everything else depends on having enough of it ready to control a fire. NFPA 13 requires an automatic water supply for sprinkler systems (5.1.2), meaning that the water will flow through sprinkler heads without any human intervention. Many possible sources can be used, including city water, ponds, rivers, reservoirs, water tanks, pressure tanks, and gravity tanks or water towers. But in most cases, a municipal waterwork is the go-to supply.

Whatever the source, it must have sufficient capacity for fire control (5.1.3). The factors that determine capacity include flow rate (in gallons per minute, GPM), pressure (in pounds per square inch, PSI), and duration (how long it can maintain the required pressure and flow). For a municipal water supply, capacity is determined with a flow test performed at nearby fire hydrants.

A flow test requires at least two hydrants, A and B. First, a static pressure reading is taken at hydrant A while neither hydrant is flowing water. Then, hydrant B is opened wide and another pressure reading is taken at hydrant A. This residual pressure reading is the amount of pressure that can push water through sprinkler heads (minus some losses). A pitot tool is used to measure the pressure of the water flowing from hydrant B do determine the flow.

The water supply capacity is the foundation of sprinkler system design. Many of the steps following this one are all about ensuring hydraulic demands won't exceed this capacity. Designers choose pipes and sprinklers to make the hydraulic calculations work out. If they can't do it with the available flow and pressure, they have to resort to using a fire pump (which may cost tens of thousands of dollars) to boost the water supply. In any case, designers strive to provide a system that functions efficiently at the lowest cost.

A designer can use one of two methodologies to engineer a fire sprinkler system: Pipe Schedule method, and Hydraulic Calculation method. The pipe schedule system uses a simple chart of the allowable sprinklers that can be supplied by pipes of various sizes. A hydraulic design takes many facts into account include the diameter and length of pipes, elevation losses, losses experienced through pipe and other fittings and devices. Using the hydraulic design method generally results in a more efficient system using smaller diameter pipes. As a result, virtually all fire sprinkler systems installed today utilize the hydraulic design method.

A properly designed and installed fire sprinkler system will include a documented hydraulic design that works with the public water supply that is available on site. The system riser will be provided with a hydraulic data placard that lists the design density, design area, and number of sprinklers in the design area. It will also indicate the minimum flow (in gallons per minute) and pressure (pounds per square inch) required at the base of the riser. This is the minimum water supply that will allow the fire sprinkler system to function correctly and suppress a fire adequately based on the hazard classification.

All pipe fittings and components introduce resistance to the flow of water in a fire sprinkler system. All of these losses must be considered when designing the fire sprinkler system. This includes the backflow device installed on the system. The pressure loss of backflow devices varies based on the type of device and the manufacturer's specific model. Generally, the more complex the backflow device is, the more pressure is lost. The amount of pressure loss is proportional to the amount of flow through the device.

4" devices flowing 500 gpm		
Type	Loss	Example
SC	2psi	Watts 1000SS
DC	4psi	Watts 2000SS
DCDA	4psi	Watts 3000SS
RPZ	11psi	Watts 4000SS
RPDA	12psi	Watts 5000SS

The Uniform Plumbing Code, in Section 603.5.14.3 Hydraulic Design, states:

Where a backflow device is installed in the potable water supply to a fire protection system, the hydraulic design of the system shall account for the pressure drop through the backflow device. Where such devices are retrofitted for an existing fire protection system, the hydraulics of the design shall be checked to verify that there will be sufficient water pressure available for satisfactory operation of the fire sprinklers.

When retrofitting a Fire Sprinkler System to include a more robust backflow preventer, the plan reviewer needs to evaluate whether the additional loss introduced by the new backflow device will be detrimental to the operation of the Fire Sprinkler System.

The best practice process is for a fire protection engineer or equivalently qualified person to review the as-built hydraulic calculations to determine the required flow and pressure at the base of the riser. If the as-built hydraulic calculations are not available, the engineer will need to gather data on the pipe sizes and lengths and fittings used. This is a very involved and time-consuming task. The engineer should then evaluate the available water by performing a hydrant flow test and compare the result to those used when the system was designed. The engineer can then determine if the additional loss introduced by the new backflow device will negatively affect the system operation. The engineer should document the proposed installation and become the engineer of record.

Possible outcomes ranging in degree of difficulty:

Plenty of pressure to support the new backflow device	Documentation only	
Not enough pressure to support the new backflow device	Consider enhancements	
	$	Larger dackflow device
	$$	Larger piping somewhere in system
	$$$	Larger water service
	$$$$	Reduced sprinkler spacing
	$$$$$	Fire pump installation

Water purveyors should not assume that upgrading backflow devices on existing fire sprinkler systems is without risk. It is a complex and potentially very expensive endeavor.