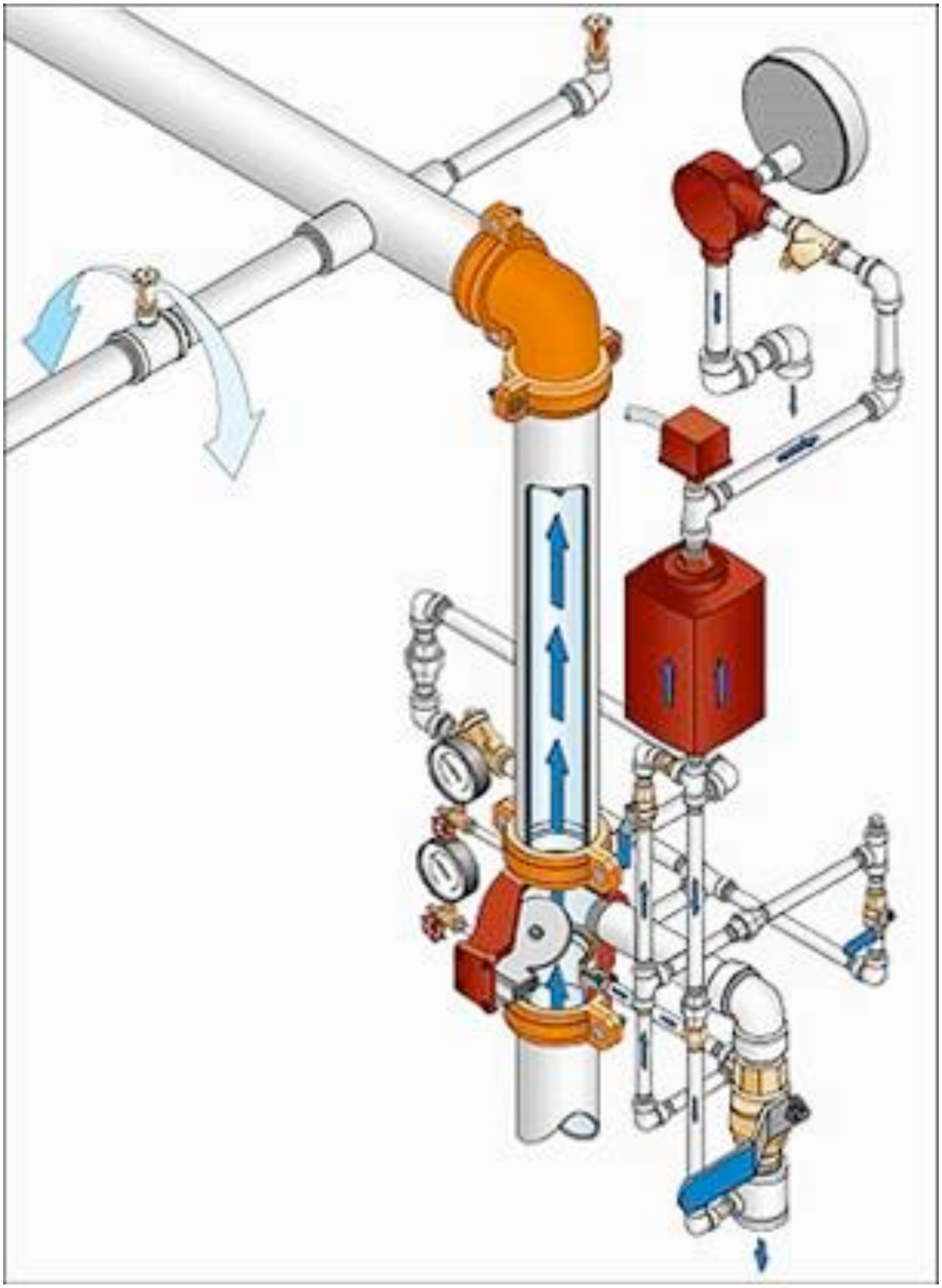
Sprinkler system types

Wet – Wet type systems are the most common type of sprinkler system that is installed. A wet pipe system has water in the pipes in the ambient or normal condition and has heat responsive elements on all sprinklers. Thus, water is instantaneously discharged from a sprinkler when it actuates.



Dry – In areas where low temperatures could cause a wet pipe system to freeze, a dry pipe system is intended for use. Dry pipe systems are pressurized with air in the ambient condition and experience an inherent delay in the discharge of water to allow the pressurized air in the system to escape. When a sprinkler actuates, air is released through the sprinkler, allowing water to flow into the piping system through the dry pipe valve. NFPA 13 mandates that the time for the water to reach the most remote sprinkler be no longer than 60 seconds. This time delay allows the fire to grow larger than it would with a wet pipe system of similar design, and the larger fire size results in more sprinklers in the fire area actuating.

To limit the size of dry pipe systems, a volumetric limitation with a maximum capacity of 750 gallons is placed on dry pipe systems. A quick opening device, such as an accelerator or an exhauster, is installed to rapidly remove air from the system and speed the operation of the dry pipe valve and is required when the system volumetric capacity exceeds 500 gallons.

Preaction and Deluge – Preaction systems and deluge systems required fire detectors (smoke, heat, etc.) for the actuation of the system. A deluge system uses open sprinklers or nozzles, so that all flow water is discharged when the deluge valve actuates. Deluge systems can be used for occupancies where the hazard is considered severe, such as with flammable liquid hazards where the fire could spread over a large floor area.

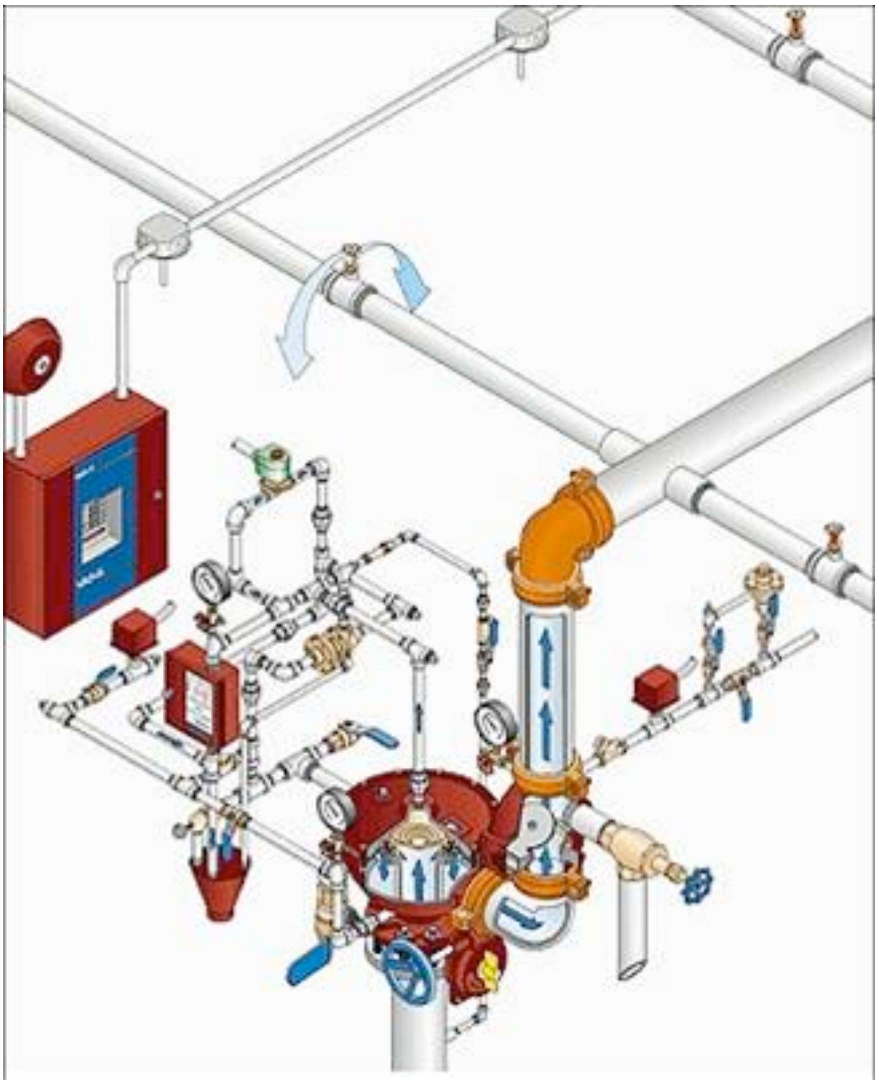
Preaction system have closed heads and pipes filled with pressurized air that supervise a piping system, and can be considered for the protection of valuable assets or irreplaceable property. The detection system for a preaction system can be designed to prevent water discharge in cases of a false alarm from the detection system, or in case of a sprinkler whose element has encountered mechanical damage.

The detection system on a preaction system can be designed with a preaction logic capable of meeting one of the following objectives:

-Actuation of a fire detector trips a deluge valve to admit water into the sprinkler piping to await the actuation of a sprinkler.

-Actuation of a fire detector or actuation of a heat-responsive element on a sprinkler trips a deluge valve to admit water into the sprinkler piping.

-Actuation of a fire detector and actuation of a heat-responsive element on a sprinkler trips a deluge valve to admit water into the sprinkler piping.



Sprinkler Head Types

Spray sprinklers are manufactured in three basic styles. A standard spray upright (SSU) sprinkler is mounted on upright above a branch line pipe, usually in a room with exposed structural elements, and has a deflector, a metal plate whose edge is distinctively bent to deflect water downward from the sprinkler. A standard spray pendant (SSP) sprinkler is mounted below the branch line, usually mounted at or below the surface of a suspended ceiling and is characterized by a flat deflector. SSU and SSP discharge patterns are designed to be the same. Sidewall sprinklers have a specifically designed deflector that allows the sprinkler to discharge water from a wall-mounted position.

Variations on upright, pendant, and sidewall sprinkler are the dry upright, dry pendant, and dry sidewall sprinklers. These special sprinklers are manufactured with a seal at the inlet that prevents water from entering the nipple until the sprinkler actuates. These sprinklers can be extended from a wet pipe system into an unheated area, such as a walk-in freezer, an outside loading dock, or an unheated attic space, or can be used in the pendant position on a dry pipe system to prevent condensation from entering the sprinkler and freezing.

Pendant Head

Upright Head

Sidewall head

Concealed Head

Dry Pendant Head

Sprinkler Head Temperature Ratings

Max Ceiling Temperature (F)	Head Temperature Rating (F)	Temperature Classification	Color Code	Glass Bulb Color
100	135-170	Ordinary	Uncolored or Black	Orange or Red
150	175-225	Intermediate	White	Yellow or Green
225	250-300	High	Blue	Blue
300	325-375	Extra High	Red	Purple
375	400-475	Very Extra High	Green	Black
475	500-575	Ultra High	Orange	Black
625	650	Ultra High	Orange	Black

Sprinkler Coverage

Another development in sprinkler manufacturing is the extended coverage sprinkler. The deflectors on these sprinklers are designed to discharge water over larger areas than standard sprinklers. While this means that each sprinkler must have a higher flow, it results in increased allowable distance between sprinklers, with the possibility that fewer sprinklers may be required in a compartment given size.

Sprinkler Responses

A major development in sprinkler technology was the quick response sprinkler, a sprinkler with a specially designed response element that allows the rapid transfer of heat to the heat-responsive element and provides a more expeditious delivery of water to the fire. At the time of sprinkler actuation, the fire should be smaller with a quick response sprinkler than with a standard response sprinkler, resulting in fewer sprinklers likely to actuate. Sprinkler elements are either glass bulbs or eutectic (soldered) elements.

The response of quick response and standard response sprinklers can be modeled by designers to estimate the time for a sprinkler to actuate, given ceiling height, fire size, and response time index (RTI), using the DETACT computer program, developed by the Building and Fire Research Laboratory at the National Institute of Standards and Technology (NIST). Response time index is a measure of the sensitivity of a sprinkler heat responsive element, with low RTI values being very sensitive to actuation by heat, and high RTI values being less sensitive.

Sprinkler for Storage Applications

ESFR and large Drop sprinklers are for specialized high challenge fire hazards. An ESFR sprinkler has a quick response element and an extra large orifice that allows for greater amounts of water to be applied early in the fire development, usually on a high challenge fire. Large drop sprinklers have large deflectors with widely spaced teeth to facilitate the creation of large water drops intended to penetrate a high velocity fire plume without evaporating, resulting in some water reaching the burning materials. The fire plume is the column of smoke and gas traveling upward from a fire.

Sprinkler System Inspection Requirements

NFPA requires that certain activities be performed at prescribed frequencies. However, rarely does an inspection and test agreement assign all of these activities and frequencies to a fire prevention company. To comply fully, an implied partnership is formed between the owner or the owner's representative and the contractor. All of the requirements of NFPA 25 are the responsibility of the owner, and the contractor relies on the owner to perform all inspections and tests not specified in the agreement.

A common agreement for a wet sprinkler system will have the fire protection contractor coming to the building on an annual basis to conduct the annual inspections (See Below), while the owner or owner's representative performs the quarterly, monthly, and weekly required inspections.

Unless specifically referenced in the agreement all other less-frequent activities are not included such as testing gauges every 5 years, testing sprinklers every 5, 10, 20, or 50 years; and internally inspecting alarm valve, check valves, strainers, filters, and orifices. These activities are normally performed by the fire protection contractor but are invoiced as additional periodic services.

Sprinkler System Inspection Frequencies

Device	***Activity***	***Frequency***
Sprinkler System		
Gauges (Dry, Pre-Action, Deluge Systems)	Inspection	Weekly/Monthly
Control Valves	Inspection	Weekly/Monthly
Alarm Devices	Inspection	Quarterly
Gauges (Wet Pipe Systems)	Inspection	Monthly
Hydraulic Nameplate	Inspection	Quarterly
Buildings	Inspection	Annually (prior to freezing)
Hanger/Seismic Bracing	Inspection	Annually
Pipe and Fittings	Inspection	Annually
Sprinklers	Inspection	Annually
Spare Sprinklers	Inspection	Annually
Fire Department Connections	Inspection	Quarterly
Alarm Devices	Test	Quarterly/Semi-Annually
Main Drain	Test	Annually
Anti-freeze Solution	Test	Annually

Gauges	Test	5 years
Sprinklers -- Extra High Temperature	Test	5 years
Sprinklers -- Fast Response	Test	At 20 years and every 10 thereafter
Sprinklers	Test	At 50 years and every 10 thereafter
Valves	Maintenance	Annually or as needed
Obstruction	Maintenance	5 years or as needed
Low Point Drains (Dry Pipe Systems)	Maintenance	Annually prior to freezing and as needed
Private Fire Service Main		
Hose Houses	Inspection	Quarterly
Hydrants (Dry Barrel with Wall)	Inspection	Annually and after each operation
Monitor Nozzle	Inspection	Semi-Annually
Hydrants (Wet Barrel)	Inspection	Annually and after each operation
Mainline Strainers	Inspection	Annually and after each significant flow
Piping (Exposed)	Inspection	Annually
Piping (Underground)	Inspection	See NFPA 25
Monitor Nozzle	Test	Flow Annually (Range and Operation)
Hydrants	Test	Flow Annually
Piping (Exposed and Underground)	Flow Test	5 years
Mainline Strainers	Maintenance	Annually and after each operation
Hose Houses	Maintenance	Annually
Hydrants	Maintenance	Annually
Monitor Nozzle	Maintenance	Annually
Standpipe		
Control Valves	Inspection	Weekly/Monthly
Pressure Regulating Devices	Inspection	Quarterly
Piping	Inspection	Quarterly
Hose Connections	Inspection	Quarterly
Cabinet	Inspection	Annually
Hose	Inspection	Annually
Hose Storage Device	Inspection	Annually
Alarm Device	Test	Quarterly
Hose Nozzle	Test	Annually
Hose Storage Device	Test	Annually
Hose	Test	5 years/3 years
Pressure Control Valve	Test	5 years
Pressure Reducing Valve	Test	5 years
Hydrostatic Test	Test	5 years
Flow Test	Test	5 years
Main Drain Test	Test	Annually
Hose Connections	Maintenance	Annually
Valves	Maintenance	Annually or as needed
Water Storage Tanks		

Conditions of Water in Tank	Inspection	Monthly/Quarterly
Water Temperature	Inspection	Daily/Weekly
Heating System	Inspection	Daily/Weekly
Control Valves	Inspection	Weekly/Monthly
Water Level	Inspection	Monthly/Quarterly
Air Pressure	Inspection	Quarterly
Tank Exterior	Inspection	Quarterly
Support Structure	Inspection	Quarterly
Catwalks and Ladders	Inspection	Quarterly
Surrounding Areas	Inspection	Annually
Valves		
Control Valves		
Sealed	Inspection	Weekly
Locked	Inspection	Monthly
Tamper Switches	Inspection	Monthly
Alarm Valves		
Exterior	Inspection	Monthly
Interior	Inspection	5 years
Strainers, filters, orifices	Inspection	5 years
Check Valves		
Interior	Inspection	5 years
Pre-Action/Deluge Valves		
Enclosure (cold)	Inspection	Daily/Weekly
Exterior	Inspection	Monthly
Interior	Inspection	Annually/5 years
Strainers, Filters, Orifices	Inspection	5 years
Dry Pipe Valves/Quick Opening Devices		
Enclosure	Inspection	Daily/Weekly
Exterior	Inspection	Monthly
Interior	Inspection	Annually
Strainers, Filters, Orifices	Inspection	5 years
Pressure Reducing and Relief Valves		
Sprinker System	Inspection	5 years
Hose Connections	Inspection	Quarterly
Hose Racks	Inspection	Quarterly
Fire Pump	Inspection	Weekly
Backflow Prevention Assemblies		
Reduced Pressure	Inspection	Weekly/Monthly
Reduced Pressure Detectors	Inspection	Weekly/Monthly
System Devices		
Fire Department Connections	Inspection	Quarterly

Main Drains	Test	Annually/Quarterly
Water-Flow Alarms	Test	Quarterly
Control Valves		
Position	Test	Annually
Operation	Test	Annually
Supervisory	Test	Semi-Annually
Pre-Action/Deluge Valves		
Priming Water	Test	Quarterly
Low Air Pressure Alarm	Test	Quarterly
Full Flow	Test	Annually
Pre-Action/Deluge Valves		
Priming Water	Test	Quarterly
Low Air Pressure Alarm	Test	Quarterly
Full Flow	Test	Annually
Dry Pipe Valves/Quick Opening Devices		
Priming Water	Test	Quarterly
Low Air Pressure Alarm	Test	Quarterly
Quick Opening Devices	Test	Quarterly
Trip Test	Test	Annually
Full Flow Trip Test	Test	3 years
Pressure Reducing and Relief Valves		
Sprinkler System	Test	5 years
Circulation Relief	Test	Annually
Pressure Relief Valves	Test	Annually
Hose Connections	Test	5 years
Hose Racks	Test	Annually
System Devices		
Backflow Prevention Assemblies	Maintenance	Annually
Control Valves	Maintenance	Annually
Pre-Action/Deluge Valves	Maintenance	Annually
Dry Pipe Valves/Quick Opening Devices	Maintenance	Annually

Building Owner’s Responsibility

As you know, testing and inspection of fire protection systems and devices is the responsibility of the building owner. NFPA 25 1998 Edition section 1-4.2 states “the responsibility for properly maintaining a water-based fire protection system shall be that of the owner(s) of the property. By means of periodic inspections, tests, and maintenance, the equipment shall be shown to be in good operating condition, or any defects or impairments shall be revealed. Inspection, testing, and maintenance shall be implemented in accordance with procedures meeting or exceeding those established in this document [NFPA 25] and in accordance with the manufacturer's instructions. These tasks shall be performed by personnel who have developed competence through training and experience.”

Any sprinkler system deficiency or performance related issue shall be repaired by the building owner. NFPA 25 1998 Edition section1-4.4 states that “the owner or occupant promptly shall correct or repair deficiencies, damaged parts, or impairments found while performing the inspection, test, and maintenance requirements of this standard. Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor."

Water Supply and Quality

Water supplies should be tested prior to sprinkler installation to reduce the likelihood of contamination from water source bacteria. Additionally, the quality of the water should be understood to reduce corrosion that is induced from highly alkaline or acidic water supplies. NFPA 13 1999 Edition states in section 9-1.5 that "in areas with water supplies known to have contributed to microbiologically influenced corrosion (MIC) of sprinkler system piping, water supplies shall be tested and appropriately treated prior to filling or testing of metallic piping systems."

NFPA 13 1999 Edition section 10-2.1 states "Fire service mains (from water supply to system riser) and lead-in connections to system risers shall be completely flushed before connection is made to sprinkler piping. Water supplies should be flushed to ensure that pipe scale and debris is not introduced into the sprinkler system at the time of installation. The flushing operation shall be continued for a sufficient time to ensure thorough cleaning."

General Fire Pump Information

Information provided from *Fire Protection System Inspection, Testing, and Maintenance Third Edition Carson and Klinker*

A fire pump is designed to increase the water pressure. The pump intake discharge piping must be capable of flowing the required volume to which the pump will add the needed pressure for fire protection. The pump can be started manually, but is usually arranged to start automatically upon a drop in system pressure or the activation of a fire suppression system. Automatic starting requires a controller. Engines for operating the pump can be electric or diesel. Sizes range from 25 gallons per minute (gpm) to 5000 gpm.

Fire pumps are needed whenever pressure requirements of a fire protection system exceed the capabilities of the available water supply. Two types of pumps are typically used: centrifugal fire pumps, where water is available to supply the pump under pressure, such as a city supply; and vertical turbine pumps, where the available water supply is in a static state, such as a pond or reservoir.

Water enters the centrifugal pump through the suction inlet and passes to the center of an impeller. Rotation of the impeller drives the water by centrifugal force to the rim, where it discharges. One of the unique features of a centrifugal pump is that it takes advantage of the inlet water pressure and adds the pump pressure to it. For example, a centrifugal pump with a rated pressure of 100 psi at a certain flow having a 25 psi inlet pressure will produce that flow at 125 psi.

A vertical turbine pump usually has a right-angle gear drive with impellers connected to the pump head by a vertical shaft. As the pump operates, the water is passed from one impeller to the next impeller, gaining additional pressure at each subsequent impeller until the water passes through the pump outlet. The number of impellers indicates the number of stages for the pump.

Fire pumps are rated by their ability to pump a specific volume of water, usually measured in gallons per minute or liters per minute at a rated pump pressure and pump speed. The pump must be able to deliver 150% of this rated flow at 65% of its rated pressure. In addition, under no-flow conditions, the pressure must reach not more than 140% of the rated pressure (sometimes called the churn pressure). Most centrifugal pumps have a single impeller and are known as single-stage pumps. For high pressure demands, multistage pumps are needed.

Pumps are started and stopped by controllers. They start the pump when they sense the need for additional pressure or upon activation of a fire-extinguishing system. The controller can be arranged to stop the pump after reaching both a preset pressure and preset time. Pumps have timers so they will not continuously start and quickly stop, as would happen for a small leak or small flow. For the same reason, a small low-volume pump, known as a jockey pump, is often installed in the piping parallel to the fire pump to prevent cycling of the fire pump due to leaks.

Pumps are provided with circulation relief valves, to discharge water when the pump is being run with no water discharge. This valve is provided because, without it, the temperature of the water trapped in the pump casing would increase due to the centrifugal force created by the pump. The higher temperature could damage the fire pump.

Pumps taking suction from ponds or wet pits are provided with screens to make sure that the pump is not damaged by the introduction of solid materials into the pump. Foot valves are also provided on suction lines to assure that the pump maintains its "prime." (Centrifugal pumps need the inlet piping and the pump casing full of water in order to start pumping. This water is called the "priming water" or "prime").

Where variable-speed drivers are used (e.g., engine-driven pumps), pressure-relief valves are required. The relief valve will open should pressures exceed the system design pressure due to engine overspeed. Pressure-relief valves are also needed when the pump discharge pressure can exceed the rated pressure of any piping or valves on the discharge side of the pump.

Fire Pump Testing and Maintenance Frequency

Per NFPA 25, 2002

Device	Activity	Frequency
Pump System		
Lubricate pump bearings	Change	Annually
Check pump shaft end play	Check	Annually
Check accuracy of pressure gauges and sensor	Check	Annually
Check pump coupling alignment	Check	Annually
Wet pit suction screens	Check	After each operation
Mechanical Transmission		
Lubricate coupling	Change	Annually
Lubricate right-angle gear drive	Change	Annually
Electrical System		
Exercise isolating switch and circuit breaker	Test	Monthly
Trip circuit breaker (if provided)	Test	Annually
Operate manual starting means (electrical)	Test	Semi-annually
Inspect and operate emergency manual start	Test	Annually
Tighten electrical connections as necessary	Check	Annually
Lubricate mechanical moving parts	Check	Annually
Calibrate pressure switch settings	Check	Annually
Grease motor bearings	Change	Annually
Diesel Engine System		
Fuel		
Tank level	Check	Weekly
Tank float switch	Test	Weekly
Solenoids valve operation	Test	Weekly

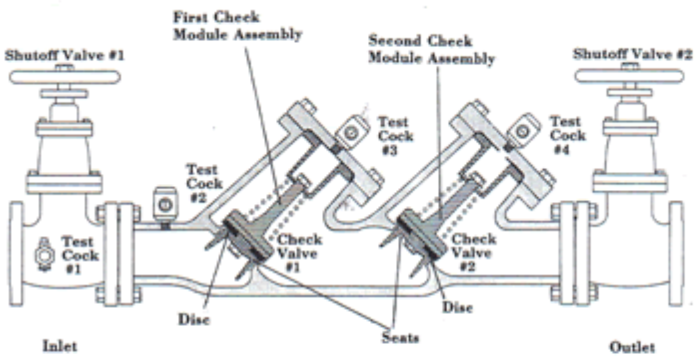
Strainer, filter, or dirt leg, or combination thereof	Clean	Quarterly
Water and foreign material in tank	Clean	Annually
Water in system	Check/Clean	Weekly
Flexible hoses and connectors	Visual Inspection	Weekly
Tank vents and overflow piping unobstructed	Check	Annually
Piping	Visual Inspection	Annually
Lubrication System		
Oil level	Check	Weekly
Oil change	Change	Annually
Oil filter	Change	Annually
Lube oil heater	Check	Weekly
Crankcase breather	Change/Clean	Quarterly
Cooling System		
Level	Check	Weekly
Antifreeze protection level	Test	Semi-annually
Antifreeze	Change	Annually
Adequate cooling water to heat exchanger	Check	Weekly
Rod out heat exchanger	Clean	Annually
Water pump(s)	Visual Inspection	Weekly
Condition of flexible hoses and connections	Check	Weekly
Jacket water heater	Check	Weekly
Inspect duct work, clean louvers (combustion air)	Check/Change	Annually
Water strainer	Clean	Quarterly
Exhaust System		
Leakage	Check	Weekly
Drain condensate trap	Check	Weekly
Insulation and fire hazards	Visual Inspection	Quarterly
Excessive back pressure	Test	Annually
Exhaust system hangers and supports	Visual Inspection	Annually
Flexible exhaust section	Visual Inspection	Semi-annually
Battery System		
Electrolyte level	Check	Weekly
Terminals clean and tight	Check	Quarterly
Remove corrosion, case exterior clean and dry	Change	Monthly
Specific gravity or state of charge	Test	Monthly
Charger and charge rate	Visual Inspection	Monthly
Equalize charge	Check	Monthly
Electrical System		
General inspection	Visual Inspection	Weekly
Tighten control and power wiring connections	Check	Annually
Wire chafing where subject to movement	Check	Quarterly
Operation of safeties and alarms	Check/Test	Semi-annually

Boxes, panels, and cabinets	Clean	Semi-annually
Circuit breakers or fuses	Check	Monthly
Circuit breakers or fuses	Change	Biennially

Backflow Prevention Devices

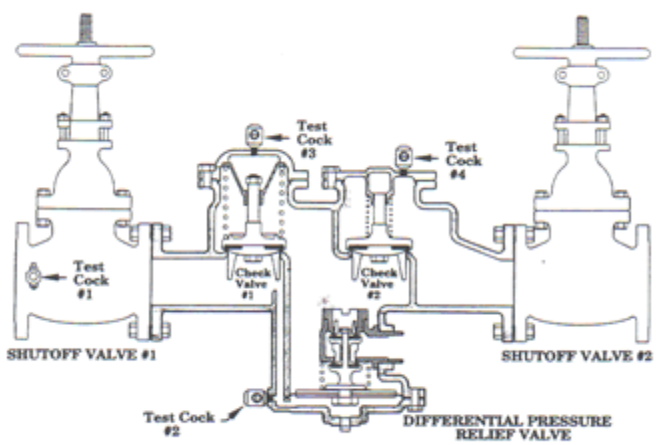
Double Check Valve Assembly (DC)

The double check valve assembly (DC) is composed of two single, independently acting check valves. The unit also has two tightly closing, resilient seated, shutoff valves located at each end of the device and four test cocks for the testing of the check valves.



Reduced Pressure Principal Assembly (RP)

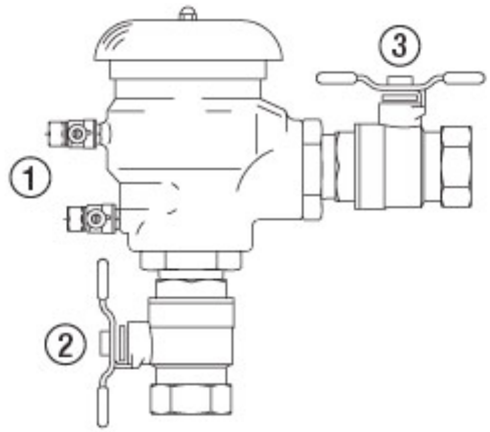
Commonly referred to as an RP or RPP, this device consists of two independently acting check valves, together with an automatically operating pressure differential relief valve located between the two check valves. The first check valve reduces the supply pressure at a predetermined amount so that during normal flow, and at cessation of normal flow the pressure between the two check valves shall be lower than the supply pressure. If either check valve leaks, the relief valve will discharge to atmosphere. This will maintain the pressure in the zone between the two check valves lower than the supply pressure. The unit also has two, resilient seated, shutoff valves (one upstream and one downstream of the checks) and properly located test cocks for field testing.



Pressure Vacuum Breaker (PVB)

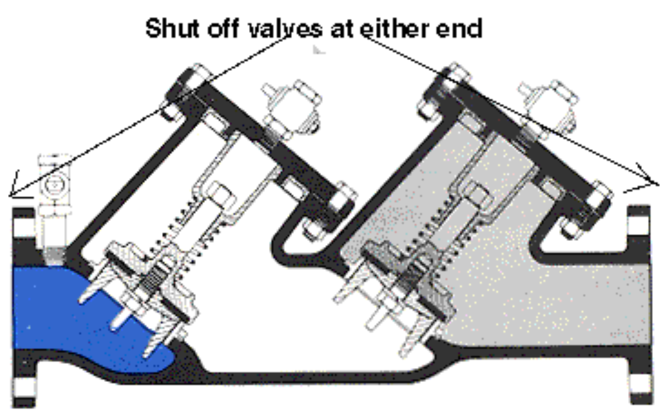
The pressure vacuum breaker (PVB) is a device that contains within a single body, a single loaded check valve and a loaded air opening valve which opens to admit air whenever the pressure within the body of the device approaches atmospheric.

The device has two tight closing, resilient seated, shut-off valves, and it is fitted with test cocks, appropriately placed, for testing the device.



Dual Check Valve (DuC)

The dual check (DuC) is a device which has two single, independent acting check valves in series. It does not have any test-cocks and is generally not field tested.

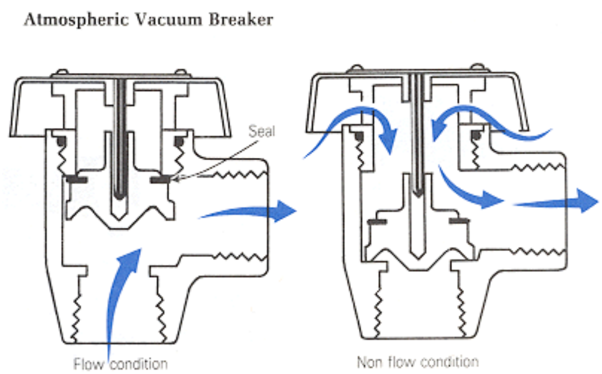


Dual Check with Atmospheric Port (DCAP)

This device has two independent acting check valves with a relief valve located between the checks. The device is not testable and should only be used for lower degrees of hazard.

Atmospheric Vacuum Breaker (AVB)

An atmospheric vacuum breaker (AVB) is a device which has a moving element inside, which during flow prevents water from spilling from the device and during cessation of flow, drops down to provide a vent opening. This device should not remain under pressure for long durations, and it cannot have any shutoff valve downstream of it.



Air Gap

An air gap is a physical separation between the free flowing discharge end of a potable pipe line and an open or non-pressure receiving vessel. To have an acceptable air gap, the end of the discharge pipe has to be at least twice the diameter of the pipe above the topmost rim of the receiving vessel, but in no case can this distance be less than one inch. This may seem to be the simplest, most effective and least expensive type of protection. However, the chance for future cross-connections the cost of additional pumps to pressurize the system often makes this an expensive protection system.

Standard Testing Procedures for Backflow Preventers

Per Enviromental Protection Agency
http://www.epa.gov/OGWDW/crossconnectioncontrol/pdfs/chapter05.pdf

Prior to initiating a test of any backflow device, it is recommended that the following procedures be followed:

1. Permission be obtained from the owner, or his representative, to shut down the water supply. This is necessary to insure that since all testing is accomplished under no-flow conditions, the owner is aware that his water supply will be temporarily shut off while the testing is being performed. Some commercial and industrial operations require constant and uninterrupted water supplies for cooling, boiler feed, seal pump water, etc. and water service interruption cannot be tolerated. The water supply to hospitals and continuous process industries cannot be shut off without planned and coordinated shut downs. The request to shut down the water supply is therefore a necessary prerequisite to protect the customer as well as limit the liability of the tester. Concurrent with the request for permission to shut off the water, it is advisable to point out to the owner, or his representative, that while the water is shut off during the test period, any inadvertent use of water within the building will reduce the water pressure to zero. Backsiphonage could result if unprotected cross-connections existed which would contaminate the building water supply system. In order to address this situation, it is recommended that the owner caution the inhabitants of the building not to use the water until the backflow test is completed and the water pressure restored. Additional options available to the building owner would be the installation of two backflow devices in parallel that would enable a protected bypass flow around the device to be tested. Also, if all water outlets are protected within the building with “fixture outlet protection” backflow devices, cross-connections would not create a problem in the event of potential backsiphonage conditions occurring while devices are tested, or for any other reason.

2. Determine the type of device to be tested i.e., double check valve or reduced pressure principle device.

3. Determine the flow direction. (Reference directional flow arrows or wording provided by the manufacturer on the device.)

4. Number the test cocks, bleed them of potential debris, and assemble appropriate test cock adapters and bushings that may be required.

5. Shut off the downstream (number 2) shut-off valve. (Ref. Item (1) above.)

6. Wait several moments prior to hooking up the test kit hoses when testing a reduced pressure principle device. If water exits the relief valve, in all likelihood, the first check valve is fouled and it is impractical to proceed with the testing until the valve is serviced. This waiting period is not necessary when testing double check valves.

7. Hook up the test kit hoses in the manner appropriate to the device being tested and the specific test being performed. Test personnel are cautioned to be aware and follow local municipal, county, and state testing requirements and guidelines as may be dictated by local authority. The following test procedures are guidelines for standard, generally acceptable test procedures but may be amended, superceded, or modified by local jurisdiction.

Test Equipment

For field testing of reduced pressure principle backflow preventers and double check valve assemblies, a differential pressure test gauge is utilized having a 0 to 15 psi range and a working pressure of 500 psi. Appropriate length of hoses with necessary fittings accompany the test gauge. Several manufactured test kits are commercially available that incorporate the differential gauge, hoses, and fittings and are packaged for ease of portability and come with protective enclosures or straps for hanging. Calibrated water columns are commercially available that are portable and come with carrying cases. It is important that all test equipment be periodically checked for calibration.

Pressure Vacuum Breaker

Field testing of a pressure vacuum breaker involves testing both the internal spring loaded soft seated check valve as well as testing the spring loaded air inlet valve. The testing must be performed with the device pressurized and the air inlet closed. The number 2 shut-off valve must also be closed and the air inlet valve canopy removed.

Method 1
Using a differential pressure gauge

Test 1 Test the internal check valve for tightness of 1 psid in the direction of flow.
1. With the valve body under pressure, (number 2 shut-off valve closed and number 1 shut-off valve open) bleed test cocks number 1 and number 2.
2. Hook up the high pressure hose to number 1 test cock and the low pressure hose to number 2 test cock.
3. Bleed the high pressure hose, and low pressure hose, in that order, and close the test kit needle valves slowly.
4. Record the differential pressure on the gauge. A reading of 1 psid is acceptable to insure a tight check valve.

Test 2 Test the air inlet valve for a breakaway of 1 psi.
1. Connect the high pressure hose to test cock number 2, and bleed the high pressure hose.
2. Shut off number 1 shut-off valve.
3. Slowly open the bleed valve of the test kit, and observe and record the psi when the air inlet poppet opens. This should be a minimum of 1 psi. Restore the valve to normal service.

Method 2
Using a water column sight tube and 90 degree elbow fitting with bleed needle

Test 1 Test the internal check valve for tightness of 1 psid in the direction of flow.
1. Assemble sight tube to test cock number 1. Open test cock and fill the tube to a minimum of 36-inches of water height.
2. Close number 1 shut-off valve.
3. Open test cock number 2. The air inlet valve should open and discharge water through number 2 test cock.
4. Open number 1 test cock. The sight tube level of water should drop slowly until it stabilizes. This point should be a minimum of 28-inches of water column which equals 1 psi.

Test 2 Test the air inlet valve for a breakaway of 1 psi.
1. Assemble sight tube to test cock number 2. Open test cock number 2 and fill the tube to a minimum of 36-inches of water height.
2. Close number 1 shut-off valve.
3. Bleed water slowly from the number 2 test cock bleed needle and observe the water column height as it drops.
4. At the point when the air inlet valve pops open, record the height of the water column. This point should be a minimum of 28-inches of water column which equals 1 psi. Restore the valve to normal service.

Reduced Pressure Backflow

Field testing of a reduced pressure principle backflow preventer is accomplished utilizing a differential pressure gauge. The device is tested for three optional characteristics: i.e.,
(1) The first check valve is tight and maintains a minimum of 5 psi differential pressure,
(2) The second check valve is tight against backpressure and
(3) The relief valve opens at a minimum of 2 psi below inlet supply pressure. Testing is performed as follows:

Step 1 Test to insure that the first check valve is tight and maintains a minimum pressure of 5 psi differential pressure.
1. Verify that number 1 shut-off valve is open. Close number 2 shut-off valve. If there is no drainage from the relief valve, it is assumed that the first check is tight.
2. Close all test kit valves.
3. Connect the high pressure hose to test cock number 2.
4. Connect the low pressure hose to test cock number 3.
5. Open test cocks number 2 and number 3.
6. Open high side bleed needle valve on test kit bleeding the air from the high hose. Close the high side bleed needle valve.
7. Open the low side bleed needle valve on test kit bleeding air from the low hose. Close the low side bleed needle valve.
Record the differential gauge pressure. It should be a minimum of 5 psid.

Step 2 Test to insure that the second check is tight against backpressure.
1. Leaving the hoses hooked up as in the conclusion of Step 1 above, connect the bypass hose to test cock number 4.
2. Open test cock number 4, the high control needle valve and the bypass hose control needle valve on the test kit. (This supplies high pressure water downstream of check valve number 2.) If the differential pressure gauge falls off and water comes out of the relief valve, the second check is recorded as leaking. If the differential pressure gauge remains steady, and no water comes out of the relief valve, the second check valve is considered tight
3. To check the tightness of number 2 shut-off valve, leave the hoses hooked up the same as at the conclusion of Step 2 above, and then close test cock number 2. This stops the supply of any high pressure water downstream of check valve number 2. If the differential pressure gauge reading holds steady, the number 2 shut-off valve is recorded as being tight. If the differential pressure gauge drops to zero, the number 2 shut-off valve is recorded as leaking.
With a leaking number 2 shut-off valve, the device is, in most cases, in a flow condition and the previous readings taken are invalid. Unless a non-flow condition can be achieved, either through the operation of an additional shut-off downstream, or the use of a temporary compensating bypass hose, accurate test results will not be achieved.

Step 3 To check that the relief valve opens at a minimum pressure of 2 psi below inlet pressure.
1. With the hoses hooked up the same as at the conclusion of Step #2 (3) above, slowly open up the low control needle valve on the test kit and record the differential pressure gauge reading at the point when the water initially starts to drip from the relief valve opening. This pressure reading should not be below 2 psid.

This completes the standard field test for a reduced pressure principle backflow preventer. Before removal of the test equipment, the tester should insure that he opens number 2 shut-off valve thereby reestablishing flow. Also, the test kit should be thoroughly drained of all water to prevent freezing by opening all control needle valves and bleed needle valves. All test data should be recorded on appropriate forms.

Double Check Valve Assemblies

Some field test procedures for testing double check valve assemblies require that the number 1 shut-off valve be closed to accomplish the test. This procedure may introduce debris such as rust and tuberculin into the valve that will impact against check valve number 1 or number 2 and compromise the sealing quality. This potential problem should be considered prior to the selection of the appropriate test method. Two test methods, one requiring closing of the number 1 shut-off valve, and one without this requirement are presented below:

Method 1
Utilizing the differential pressure gauge and not shutting off number 1 shut-off valve.

Step 1 checking check valve number 1
1. Verify that the number 1 shut-off is open. Shut off number 2 shut-off valve.
2. Connect the high hose to test cock number 2.
3. Connect the low hose to test cock number 3.
4. Open test cocks 2 and 3.
5. Open high side bleed needle valve on test kit bleeding the air from the high hose. Close the high side bleed needle valve.
6. Open low side bleed needle valve on test kit bleeding the air from the low hose. Close the low side bleed needle valve.
7. Record the differential gauge pressure reading. It should be a minimum of 1 psid.
8. Disconnect the hoses.

Step 2 Checking check valve number 2.
1. Connect the high hose to test cock number 3.

2. Connect the low hose to test cock number 4.
3. Open test cocks number 3 and 4.
4. Open high side bleed needle valve on test kit bleeding the air from the high hose. Close the high side bleed needle valve.
5. Open low side bleed needle valve on test kit bleeding the air from the low hose. Close the low side bleed needle valve.
6. Record the differential gauge pressure reading. It should be a minimum of 1 psid.
7. Disconnect the hoses.

To check tightness of number 2 shut-off valve, both the check valves must be tight and holding a minimum of 1 psid. Also, little or no fluctuation of inlet supply pressure can be tolerated. The testing is performed as follows:
1. Connect the high hose to number 2 test cock.
2. Connect the low hose to number 3 test cock.
3. Connect the bypass hose to number 4 test cock.
4. Open test cocks numbers 2, 3, and 4.
5. Open high side bleed needle valve on test kit bleeding the air from the high hose. Close the high side bleed needle valve.
6. Open low side bleed needle valve on test kit bleeding the air from the low hose. Close the low side bleed needle valve.
7. The differential gauge pressure should read a minimum of 1 psid.
8. Open the high side control needle valve and the bypass hose control needle valve on the test kit. (This supplies high pressure water downstream of check valve number 2).
9. Close test cock number 2. (This stops the supply of any high pressure water downstream of number 2 check valve), If the differential pressure gauge holds steady, the number 2 shut-off valve is recorded as being tight. If the differential pressure gauge drops to zero, the number 2 shut-off valve is recorded as leaking.

With a leaking number 2 shut-off valve, the device is, in most cases, in a flow condition, and the previous test readings taken are invalid. Unless a non-flow condition can be achieved, either through the operation of an additional shut-off downstream, or the use of a temporary compensating bypass hose, accurate test results will not be achieved.
This completes the standard field test for a double check valve assembly. Prior to removal of the test equipment, the tester should insure that he opens number 2 shut-off valve thereby reestablishing flow. All test data should be recorded on appropriate forms and the test kit drained of water.

Method 2
Utilizing "Duplex Gauge" or individual bourdon gauges, requires closing number 1 shut-off.

Step 1 checking check valve number 1
1. Connect the high hose to test cock number 2.
2. Connect the low hose to test cock number 3.
3. Open test cocks number 2 and number 3.
4. Close number 2 shut-off valve; then close number 1 shut-off valve.
5. By means of the high side needle valve, lower the pressure at test cock number 2 about 2 psi below the pressure at test cock number 3. If this small difference can be maintained, then check valve number 1 is reported as "tight". Proceed to Step number 2. If the small difference cannot be maintained, proceed to Step number 3.

Step 2 checking check valve number 2.
Proceed exactly the same test procedure as in Step number 1, except that the high hose is connected to test cock number 3 and the low hose connected to test cock number 4.

Step 3
1. Open shut-off valve number 1 to re-pressurize the assembly.
2. Loosely attach the bypass hose to test cock number 1, and bleed from the gauge through the bypass hose by opening the low side needle valve to eliminate trapped air. Close low side needle valve. Tighten bypass hose. Open test cock number 1.
3. Close number 1 shut-off valve.
4. By loosening the low side hose at test cock number 3, lower the pressure in the assembly about 10 psi below normal line conditions.
5. Simultaneously open both needle valves. If the check valve is holding tight the high pressure gauge will begin to drop while the low pressure gauge will increase. Close needle valves. If the gauge shows that a small (no more than 5 psi) backpressure is created and held, then the check valve is reported as tight. If the check valve leaks, a pressure differential is not maintained as both gauges tend to equalize or move back towards each other, then the check valve is reported as leaking. With both needle valves open enough to keep the needles on the gauge stationary, the amount of leakage is visible as the discharge from the upstream needle valve.

Lighting Inspection Requirements

NFPA 101, 2003

7.9.2 Performance of System.

7.9.2.1 Emergency illumination shall be provided for not less than 1.5 hours in the event of failure of normal lighting. Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 10.8 lux (1 ft-candela) and at any point, not less than 1.1 lux (0.1 ft-candela), measured along the path of egress at floor level. Illumination levels shall be permitted to decline to not less than an average of 6.5 lux (0.6 ft-candela) and, at any point, not less than 6.5 lux (0.06 ft-candela) at the end of the 1.5 hours. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded.

7.9.2.2 The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting due to any of the following: (1) Failure of a public utility of other outside electrical power supply. (2) Opening of a circuit breaker or fuse. (3) Manual act(s), including accidental opening of a switch controlling normal lighting facilities.

7.9.2.3 Emergency generators providing power to emergency lighting system shall be installed, tested, and maintained in accordance with NFPA 110, Standard for Emergency and Standby Power Systems, Stored electrical energy systems, where required in this Code, shall be installed and tested in accordance with NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems.

7.9.2.4 Battery-operated emergency lights shall use only reliable types of rechargeable batteries provided with suitable facilities for maintaining them in properly charged condition. Batteries used in such lights or units shall be approved for their intended use and shall comply with NFPA 70, National Electrical Code.

7.9.2.5 The emergency lighting system shall be either continuosly in operation or shall be capable of repeated automatic operation without manual intervention.

7.9.3 Periodic Testing of Emergency Lighting Equipment.

7.9.3.1 Required emergency lighting systems shall be tested in accordance with one of the three options offered by 7.9.3.1.1, 7.9.3.1.2, or 7.9.3.1.3.

7.9.3.1.1 Testing of required emergency lighting systems shall be permitted to be conducted as follows:(1) Functional testing shall be conducted at 30-day intervals for not less than 30 seconds.(2) Functional testing shall be conducted annually for not less than 1.5 hours if the emergency lighting system is battery powered.(3) The emergency lighting equipment shall be fully operational for the duration of the tests required by 7.9.3.1.1 (1) and 7.9.3.1.1 (2).(4) Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.2 Testing of required emergency lighting systems shall be permitted to be conducted as follows:(1) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.(2) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall automatically perform not less than once every 30 days a test for not less than 30 seconds and a diagnostic routine.(3) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall indicate failures by a status indicator.(4) A visual inspection shall be performed at intervals not exceeding 30 days.(5) Functional testing shall be conducted annually for not less than 1.5 hours.(6) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be fully operational for the duration of the 1.5 hour test.(7) Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.3 Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Computer-based, self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.

(2) The emergency lighting equipment shall automatically perform not less than once every 30 days a test for not less than 30 seconds and a diagnostic routine.

(3) The emergency lighting equipment shall automatically perform annually a test for not less than 1.5 hours.

(4) The emergency lighting equipment shall be fully operational for the duration of the tests required by 7.9.3.1.3 (2) and 7.9.3.1.3 (3).

(5) the comper-based system shall be capable of providing a report of the history of tests and failures at all times.