expectations or from annual to every 18 months when the failure trend indicates an increase in reliability.

References.

Edward K. Budnick, P.E., "Automatic Sprinkler System Reliability," *Fire Protection Engineering*, Society of Fire Protection Engineers, SFPE Winter 2001.

Fire Protection Equipment Surveillance Optimization and Maintenance Guide, Electric Power Research Institute, July 2003.

Kenneth W. Dungan, P.E., "Performance-Based Inspection, Testing, and Maintenance," *Fire Protection Engineering*, SFPE, Quarter 4, 2016.

William E. Koffel, P.E., *Reliability of Automatic Sprinkler Systems, Alliance for Fire Safety*.

NFPA's Future in Performance Based Codes and Standards, July 1995.

NFPA Performance Based Codes and Standards Primer, December 1999.

A.4.9.5 Most places using or storing hazardous materials have stations set up for employees where material safety data sheets (MSDSs) are stored. The inspector should be familiar with the types of materials present and the appropriate actions to take in an emergency.

Δ **A.4.9.6** **WARNING:** NFPA 20 includes electrical requirements that discourage the installation of a disconnect means in the power supply to electric motor-driven fire pumps. This is intended to ensure the availability of power to the fire pumps. Where equipment connected to those circuits is serviced or maintained, the service person could be subject to unusual exposure to electrical and other hazards. It could be necessary to establish special safe work practices and to use safeguards or personal protective clothing, or both. See also NFPA *70E* for additional safety guidance.

N **A.4.9.6.2** NFPA *70E* helps establish an overall electrical safety program. It is not the intent of 4.9.6.2 to restrict the use of other electrical safety programs that are recognized and established by a jurisdiction. For jurisdictions that do not recognize the provisions of NFPA *70E*, other approved electrical safety programs could be acceptable. The acceptance of an equivalent standard or program to NFPA *70E* must be approved by the authority having jurisdiction.

A.5.2 The provisions of the standard are intended to apply to routine inspections. In the event of a fire, a post-fire inspection should be made of all sprinklers within the fire area. In situations where the fire was quickly controlled or extinguished by one or two sprinklers, it might be necessary only to replace the activated sprinklers. Care should be taken that the replacement sprinklers are of the same make and model or that they have compatible performance characteristics (*see 5.4.1.2*). Soot-covered sprinklers should be replaced because deposits can result in corrosion of operating parts. In the event of a substantial fire, special consideration should be given to replacing the first ring of sprinklers surrounding the operated sprinklers because of the potential for excessive thermal exposure, which could weaken the response mechanisms.

N **A.5.2.1.1** The coverplates of concealed sprinklers do not need to be removed for inspection. Where the inspection of coverplates for concealed sprinklers reveals possible signs of leakage, damage, corrosion, or other adverse conditions, those coverplates should be removed to facilitate a closer inspection of the concealed sprinkler.

A.5.2.1.1.1 The conditions described in this section can have a detrimental effect on the performance of sprinklers by adversely impacting water distribution patterns, insulating thermal elements delaying operation, or otherwise rendering the sprinkler inoperable or ineffectual.

Severely corroded or loaded sprinklers should be reported as a deficiency or impairment as part of the visual inspection and designated to be replaced. Such sprinklers could be affected in their distribution or other performance characteristics not addressed by routine sample testing.

Corrosion found on the seat, or built up on the deflector that could affect the spray pattern, or a buildup on the operating elements that could affect the operation can have a detrimental effect on the performance of the sprinkler. Sprinklers having limited corrosion or loading that does not impact the water distribution characteristics can continue to be used if the samples are selected for testing in accordance with 5.3.1 based on worst-case conditions and if the samples successfully pass the tests. Surface discoloration that does not impact the performance of the sprinkler should not warrant replacement or testing.

Multiple sprinkler operations within a facility without a fire might be a sign of exposure to excessive temperatures, sprinkler damage, or excessive corrosion of similar sprinklers installed in that facility. Consideration should be given to replacing sprinklers that are considered representative of the operated sprinklers.

Glass bulbs in sprinklers exposed to sunlight or installed in cold environments such as walk-in coolers and freezers might lose or change their temperature classification color due to the environment. This loss of color should not be confused with loss of fluid in the glass bulb. Tests have shown that this loss or change of color in the bulb does not affect the operation or any other performance characteristics of the sprinkler, and these sprinklers can be allowed to remain in service. The tests also showed that when sprinklers installed in cold environments were subjected to temperatures above 60°F (15.5°C), the fluid color returned.

In lieu of replacing sprinklers that are loaded with a coating of dust, it is permitted to clean sprinklers with compressed air or a vacuum, provided that the equipment does not touch the sprinkler.

A.5.2.1.1.3 Examples include spaces above ceilings, whether the ceilings are lay-in tile or gypsum board, areas under theater stages, pipe chases, and other inaccessible areas, even if access panels or hatches are provided into the areas.

Where temporary listed membrane ceilings are installed, NFPA 13 allows sprinkler protection to be omitted below the "drop out" membrane ceiling. These areas should be inspected during periods when the membrane ceiling is not present.

Where finished ceiling areas around installed pendent sprinklers show signs of water damage, further investigation should be conducted and the building owner or representative should be notified.

A.5.2.1.2 NFPA 13 in the storage definitions defines clearance as the distance from the top of storage to the ceiling sprinkler deflectors. Other obstruction rules are impractical to enforce under this standard. However, if obstructions that might cause a concern are present, the owner is advised to have an engineering evaluation performed.

A.5.2.1.2.1 The 18 in. (457 mm) clearance rule generally applies to standard pendent, upright and sidewall spray sprinklers, extended coverage upright and pendent sprinklers, and residential sprinklers.

A.5.2.1.2.3 The special sprinklers that the minimum 36 in. (915 mm) clearance rule generally applies to includes large drop sprinklers, CMSA sprinklers, and early suppression fast-response (ESFR) sprinklers.

A.5.2.1.2.6 The purpose of maintaining a minimum clearance is to ensure water discharge is not obstructed. There are certain installations where this can be achieved by other means. Examples include library stacks, record storage, and where sprinklers are installed in aisles in between storage shelving. Clearance is also not needed for shelving along perimeter walls since this does not cause an obstruction. NFPA 13 allows a clearance less than 18 in. (457 mm) where full-scale fire tests demonstrate an acceptable sprinkler discharge pattern. Also, where sufficient shielding of the sprinkler spray pattern has resulted in an increase in the hazard classification to Extra Hazard Group 2, a clearance less than 18 in. (457 mm) might be acceptable.

A.5.2.1.3 Sprinkler spray patterns should not be obstructed by temporary or nonpermanent obstructions such as signs, banners, or decorations. While it is impractical for an inspector to know all of the various obstruction rules for all the different types of sprinklers, the inspector can observe when temporary or nonpermanent obstructions have been installed that could block or obstruct a sprinkler's spray pattern. Temporary or nonpermanent obstructions that appear to be obstructions to sprinkler spray patterns should be removed or repositioned so they are not an obstruction.

A.5.2.2 The conditions described in 5.2.2 can have a detrimental effect on the performance and life of pipe by affecting corrosion rates or pipe integrity or otherwise rendering the pipe ineffectual.

A.5.2.2.1 Surface corrosion not impacting the integrity of the piping strength or raising concern of potential leakage should not warrant the replacement of piping. A degree of judgment should be exercised in the determination of the extent of corrosion that would necessitate replacement.

A.5.2.2.3 Examples include some floor/ceiling or roof/ceiling assemblies, areas under theater stages, pipe chases, and other inaccessible areas.

A.5.2.3 The conditions described in this section can have a detrimental effect on the performance of hangers and braces by allowing failures if the components become loose.

A.5.2.3.3 Examples of hangers and seismic braces installed in concealed areas include some floor/ceiling or roof/ceiling assemblies, areas under theater stages, pipe chases, and other inaccessible areas.

A.5.2.5 The hydraulic design information sign should be secured to the riser with durable wire, chain, or equivalent. *(See Figure A.5.2.5.)*

This system as shown on ____________ company
print no. ____________ dated ____________
for ________________________
at ____________ contract no. ____________
is designed to discharge at a rate of ____________
gpm per ft^2 (L/min per m^2) of floor area over a maximum
area of ____________ ft^2 (m^2) when supplied
with water at a rate of ____________ gpm (L/min)
at ____________ psi (bar) at the base of the riser.
Hose stream allowance of ____________
gpm (L/min) is included in the above.

FIGURE A.5.2.5 Sample Hydraulic Design Information Sign.

Δ **A.5.2.8** The sign referenced in 5.2.8 should satisfy the requirements of 4.1.9 and 5.2.7. See Figure A.5.2.8.

A.5.3.1 The sprinkler performance testing described in this section is considered routine testing to determine if the installed sprinklers have maintained a level of sensitivity that would allow them to operate as expected during a fire event. Nonroutine testing should be conducted to address unusual conditions not associated with the routine test cycles mandated within this standard. Due to the nature of nonroutine testing, specific tests cannot be identified in this standard. The type of tests to be conducted and the number and location of samples to be submitted should be appropriate to the problem discovered or being investigated and based on consultation with the manufacturer, listing agency, and the authority having jurisdiction.

Examples of documents that can be used to determine the installation date include the Contractor's Material and Test Certificate for Aboveground Piping or the Certificate of Occupancy. Where documentation of the installation date is not available, the start date for the in-service performance testing interval should be based upon the sprinkler's manufacture date.

Δ **A.5.3.1.1** Sprinklers should be first given a visual inspection in accordance with 5.2.1.1.1 to determine if replacement is required. Sprinklers that have passed the visual inspection should then be laboratory tested for sensitivity and functionality. The waterway should clear when sensitivity/functionality tested at 7 psi (0.5 bar) or the minimum listed operating pressure for dry sprinklers.

The thermal sensitivity should be such that the RTI does not exceed 350 (meters-seconds)$^{1/2}$ for standard-response sprinklers, 65 (meters-seconds)$^{1/2}$ for quick-response and residential sprinklers and 50 (meters-seconds)$^{1/2}$ for ESFR sprinklers.

SPRINKLER SYSTEM — GENERAL INFORMATION
for

____

____

____

Pipe schedule system ❑ Yes ❑ No
High-piled storage ❑ Yes ❑ No
Rack storage: ❑ Yes ❑ No
Commodity class: ________________
Max. storage height __________ ft m
Aisle width (min.) __________ ft m
Encapsulation ❑ Yes ❑ No
Solid shelving: ❑ Yes ❑ No
Flammable/ combustible liquids: ❑ Yes ❑ No
Other storage: ❑ Yes ❑ No

____

Hazardous materials: ❑ Yes ❑ No
Idle pallets: ❑ Yes ❑ No
Antifreeze systems ❑ Yes ❑ No
Location: ____________________
Dry or aux systems ❑ Yes ❑ No
Location: ____________________

Date: ________________________
Flow test data:
Static: __________ psi bar
Resid: __________ psi bar
Flow: __________ gpm lpm
Pitot: __________ psi bar
Date: ________________________
Location: ______________________

____

Location of aux/low point drains:

____

____

____

Dry pipe/double interlock preaction valve test results __________

Original main drain test results:
Static: __________ psi bar
Residual: __________ psi bar
Venting valve location: ________________

Where injection systems are used to treat MIC or corrosion:
Type of chemical: ____________ Concentration: ____________ For proper disposal, see:

____

Name of contractor or designer: ____________________________
Address: ____________________________________
Phone: ____________________________________

N **FIGURE A.5.2.8 Sprinkler System General Information. [13:Figure A.28.6]**

Sprinklers that have been installed for a number of years should not be expected to have all of the performance qualities of a new sprinkler. However, if there is any question about their continued satisfactory performance, the sprinklers should be replaced.

A.5.3.1.1.1.3 Sprinklers defined as fast response have a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less. A quick-response sprinkler, residential sprinkler, and early suppression fast-response (ESFR) sprinklers are examples of fast-response sprinklers.

A.5.3.1.1.1.4 Due to solder migration caused by the high temperatures to which these devices are exposed, it is important to test them every 5 years. Because of this phenomenon, the operating temperature can vary over a wide range.

A.5.3.1.1.1.6 See 3.3.42.4.

Δ **A.5.3.1.1.2** Examples of these environments are paper mills, packing houses, tanneries, alkali plants, organic fertilizer plants, foundries, forge shops, fumigation areas, pickle and vinegar works, stables, storage battery rooms, electroplating rooms, galvanizing rooms, steam rooms of all descriptions including moist vapor dry kilns, salt storage rooms, locomotive sheds or houses, driveways, areas exposed to outside weather, around bleaching equipment in flour mills, and portions of any area where corrosive vapors prevail.

A.5.3.1.2 Within an environment, similar sidewall, upright, and pendent sprinklers produced by the same manufacturer could be considered part of the same sample, but additional sprinklers would be included within the sample if produced by a different manufacturer.

The sample sprinklers sent for testing can represent any group of sprinklers that is practical, keeping in mind that if one sprinkler in the sample set fails, then all sprinklers that the sample represents should be replaced. The following is an example of sample sprinklers chosen for testing:

Example:

A warehouse has five overhead systems with 300 sprinklers per system, and an office area with 200 sprinklers. The warehouse sprinklers are all subject to the same ambient environment and all of the office area sprinklers are subjected to the same ambient environment.

Sample Option #1: All warehouse sprinklers as one sample set (1% of 1500 = 15 sprinklers).

All office sprinklers as one sample set (1% of 200 = 2, but a minimum of 4 sprinklers must be tested).

Total of 19 sprinklers tested.

Sample Option #2: Each warehouse system sample set (1% of 300 = 3, but a minimum of 4 sprinklers must be tested, 4 × 5 = 20 sprinklers).

All office sprinklers as one sample set (1% of 200 = 2, but a minimum of 4 sprinklers must be tested).

Total of 24 sprinklers tested.

As shown, the number of sprinklers to be tested would be different depending on the sample chosen.

A.5.3.3.2 Data concerning reliability of electrical waterflow switches indicate no appreciable change in failure rates for those tested quarterly and those tested semiannually. Mechanical motor gongs, however, have additional mechanical and environmental failure modes and need to be tested more often.

Δ **A.5.3.4** Sampling from the top and bottom of the system helps to determine if the solution has settled. Antifreeze solutions are heavier than water. If the antifreeze compound is separating from the water due to poor mixing, it will exhibit a higher concentration in the lower portion of the system than in the upper portion of the system. If the concentration is acceptable near the top, but too low near the water connection, it might mean that the system is becoming diluted near the water supply. If the concentration is either too high or too low in both the samples, it might mean that the wrong concentration was added to the system.

Two or three times during the freezing season, test samples can be drawn from test valve B as shown in Figure 8.6.3.1 of NFPA 13, especially if the water portion of the system has been drained for maintenance or repairs. A small hydrometer can be used so that a small sample is sufficient. Where water appears at valve B, or where the sample indicates that the solution has become weakened, the entire system should be emptied and refilled with acceptable solution as previously described.

See Figure A.5.3.4 for expected minimum air temperatures in 48 of the United States and parts of Canada where the lowest one-day mean temperature can be used as one method of determining the minimum reasonable air temperature. In situations where the piping containing the antifreeze solution is protected in some way from exposure to the outside air, higher minimum temperatures can be anticipated.

Where systems are drained in order to be refilled, it is not typically necessary to drain drops. Most systems with drops have insufficient volume to cause a problem, even if slightly higher concentration solutions collect in the drops. For drops in excess of 36 in. (915 mm), consideration should be given to draining drops if there is evidence that unacceptably high concentrations of antifreeze have collected in these long drops.

When emptying and refilling antifreeze solutions, every attempt should be made to recycle the old solution with the antifreeze manufacturer rather than discard it.

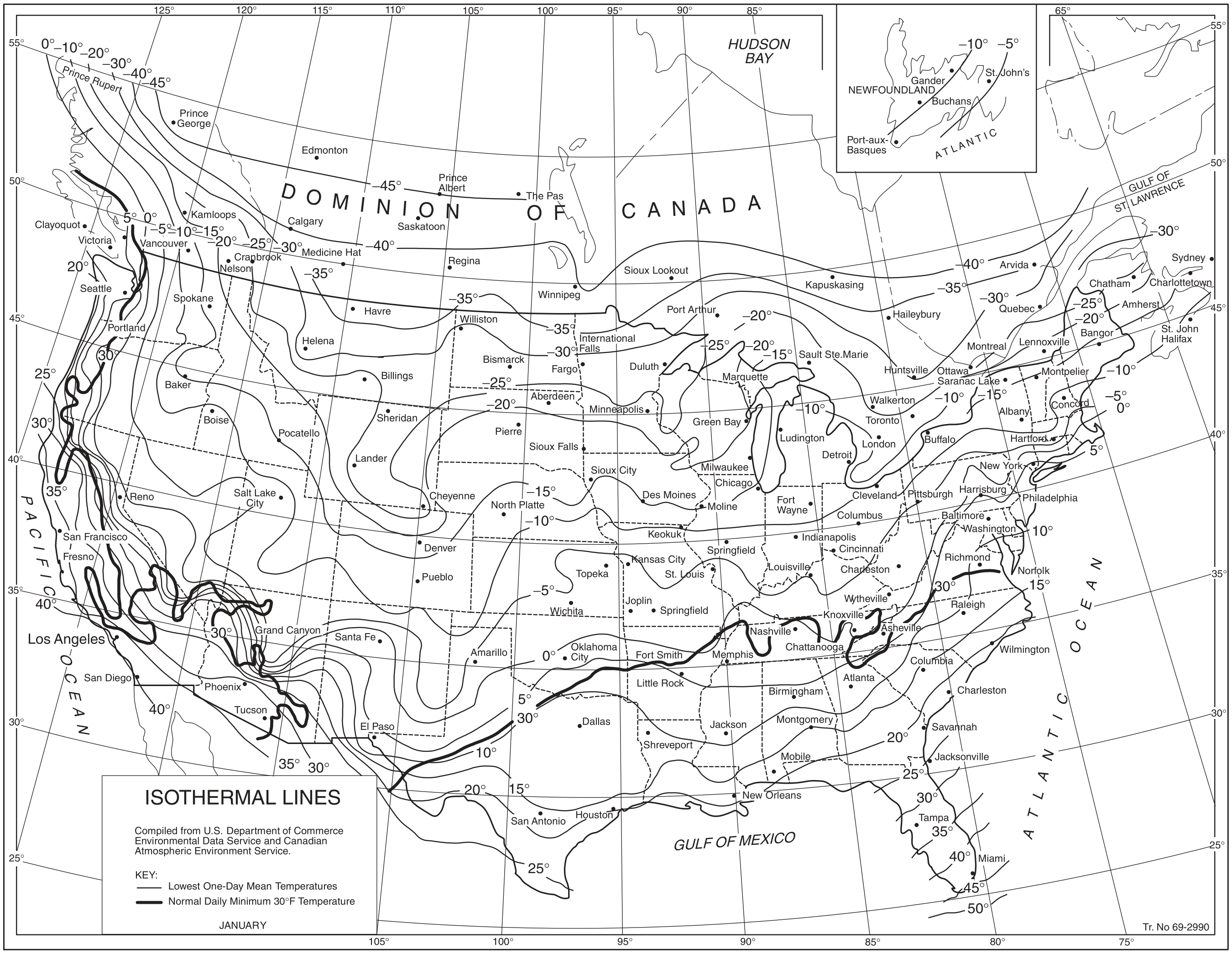
A.5.3.4.3.1 Where inspecting antifreeze systems employing listed CPVC piping, the solution should be verified to be glycerine based.

A.5.3.4.4.1 All antifreeze systems installed after September 30, 2012, are assumed to meet the minimum requirements of NFPA 13, 2013 edition. For systems installed after September 30, 2012, that do not meet the requirements of the 2013 edition of NFPA 13, consideration should be given to applying 5.3.4.4.1.

A.5.3.4.4.1(1) The use of factory premixed solutions is required because solutions that are not mixed properly have a possibility of separating from the water, allowing the pure concentrate (which is heavier than water) to drop out of solution and collect in drops or low points of the system. Such concentrations are combustible and could present problems during fires. The properties of glycerine are shown in Table A.5.3.4.4.1(1).

A.5.3.4.4.1(2) Antifreeze solutions with a maximum concentration of 38 percent glycerine or 30 percent propylene glycol

 Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. *N* = New material.



Source: Compiled from United States Weather Bureau records.
For SI units, °C = 5/9 (°F −32); 1 mi = 1.609 km.

FIGURE A.5.3.4 Isothermal Lines — Lowest One-Day Mean Temperature (°F). [24:Figure A.10.5.1]

do not require a deterministic hazard analysis. The risk assessment should be prepared by individual(s) who can demonstrate an ability to prepare a risk assessment by education and experience and who can demonstrate an understanding of the issues associated with antifreeze sprinkler systems, including the available related fire tests. For additional information regarding the risk assessment process, documentation to be submitted, and the AHJ's role, refer to NFPA 551 and the SFPE *Engineering Guide: Fire Risk Assessment*.

Propylene glycol and glycerine antifreeze solutions discharged from sprinklers have the potential to ignite under certain conditions. Research testing has indicated that several variables might influence the potential for large-scale ignition of the antifreeze solution discharged from a sprinkler. These variables include, but are not limited to, the concentration of antifreeze solution, sprinkler discharge characteristics, inlet pressure at the sprinkler, ceiling height, and size of fire at the time of sprinkler discharge. All relevant data and information should be carefully reviewed and considered in the deterministic risk assessment. As appropriate, the risk assessment should consider factors such as the following:

(1) Occupancy use group per NFPA 13
(2) Ceiling height
(3) Antifreeze solution concentration and type
(4) Maximum system pressure (normal static pressures)
(5) Sprinkler type, including K-factor
(6) Potential and actual fuel load (Christmas trees)
(7) Type of structure (construction types)
(8) Size of structure
(9) Ability of the sprinkler system to control the fire
(10) Occupied spaces versus unoccupied spaces such as trash enclosures and dust collectors as follows:
    (a) Adjacent occupancies (spaces adjacent to the area protected by antifreeze systems)
    (b) Separation between areas protected with an antifreeze system and other areas
    (c) Ventilation of areas protected with an antifreeze system to prevent damage to adjacent areas
    (d) Duration of antifreeze discharge

Table A.5.3.4.4.1(1) Properties of Glycerine and Propylene Glycol

Material	Solution (% by Volume)	Specific Gravity at 77°F (25°C)	Freezing Point °F	Freezing Point °C
Glycerine (C.P. or U.S.P. grade)	0	1.000	32	0
	5	1.014	31	–0.5
	10	1.029	28	–2.2
	15	1.043	25	–3.9
	20	1.059	20	–6.7
	25	1.071	16	–8.9
	30	1.087	10	–12
	35	1.100	4	–15.5
	40	1.114	–2	–19
	45	1.130	–11	–24
	50	1.141	–19	–28
Propylene glycol	0	1.000	32	0
	5	1.004	26	–3
	10	1.008	25	–4
	15	1.012	22	–6
	20	1.016	19	–7
	25	1.020	15	–10
	30	1.024	11	–12
	35	1.028	2	–17
	40	1.032	–6	–21

Tests summarized in Table A.5.3.4.4.1(2) show that large-scale ignition of the sprinkler spray did not occur in tests with 50 percent glycerine and 40 percent propylene glycol antifreeze solutions discharging onto a fire having a nominal heat release rate (HRR) of 1.4 MW. A deterministic risk assessment that demonstrates that the heat release rate for reasonably credible fire scenarios will be less than 1.4 MW at the time of sprinkler activation should be acceptable. The risk assessment should also address issues associated with management of change, such as change in occupancy and temporary fuel loads. A natural Christmas tree can result in an HRR well above 1.4 MW at the time of sprinkler activation. In addition to the variables identified previously, the deterministic risk assessment should include occupancy, quantity of solution, impact on life safety, and potential increase in heat release rate.

The following is a list of research reports that have been issued by the Fire Protection Research Foundation (FPRF) related to the use of antifreeze in sprinkler systems that should be considered in the development of the deterministic risk assessment:

(1) *Antifreeze Systems in Home Fire Sprinkler Systems — Literature Review and Research Plan*, Fire Protection Research Foundation, June 2010.
(2) *Antifreeze Systems in Home Fire Sprinkler Systems — Phase II Final Report*, Fire Protection Research Foundation, December 2010.
(3) *Antifreeze Solutions Supplied through Spray Sprinklers — Interim Report*, Fire Protection Research Foundation, February 2012.

Table A.5.3.4.4.1(2) provides an overview of the testing conducted by the FPRF.

A.5.4.1.2 To help in the replacement of like sprinklers, unique sprinkler identification numbers (SINs) are provided on all sprinklers manufactured after January 1, 2001. The SIN accounts for differences in orifice size, deflector characteristics, pressure rating, and thermal sensitivity.

A.5.4.1.2.1 Old-style sprinklers are permitted to replace existing old-style sprinklers. Old-style sprinklers should not be used to replace standard sprinklers without a complete engineering review of the system. The old-style sprinkler is the type manufactured before 1953. It discharges approximately 40 percent of the water upward to the ceiling, and it can be installed in either the upright or pendent position.

A.5.4.1.2.2 It is recognized that the flow and pressure available to the replacement sprinkler might be less than its current flow and pressure requirement.

A.5.4.1.4 It is imperative that any replacement sprinkler have the same characteristics as the sprinkler being replaced. If the same temperature range, response characteristics, spacing requirements, flow rates, and K-factors cannot be obtained, a sprinkler with similar characteristics should be used, and the system should be evaluated to verify the sprinkler is appropriate for the intended use. With regard to response characteristics, matching identical response time index (RTI) and conductivity factors are not necessary unless special design considerations are given for those specific values.

A.5.4.1.5 A minimum of two sprinklers of each type and temperature rating installed should be provided.

A.5.4.1.5.5 One sprinkler wrench design can be appropriate for many types of sprinklers, and multiple wrenches of the same design should not be required.

A.5.4.1.5.6.1 The minimum information in the list contained in the spare sprinkler cabinet should be marked with the following:

(1) General description of the sprinkler, including upright, pendent, residential, ESFR, and so forth
(2) Quantity of sprinklers to be maintained in the spare sprinkler cabinet

An example of the list is shown in Figure A.5.4.1.5.6.1.

A.5.4.1.6 Corrosion-resistant or specially coated sprinklers should be installed in locations where chemicals, moisture, or other corrosive vapors exist.

A.5.4.1.9.1 Typical sandwich bags purchased in a grocery store are generally plastic, not cellophane. Plastic bags have a tendency to shrink and adhere to the sprinkler prior to sprinkler activation, creating the potential for disruption of sprinkler spray patterns. Bags placed over sprinklers need to be true cellophane or paper.

A.5.4.2 Conversion of dry pipe systems to wet pipe systems on a seasonal basis causes corrosion and accumulation of foreign matter in the pipe system and loss of alarm service.

Table A.5.3.4.4.1(2) FPRF Testing Summary

Topic	Information
Scope of sprinklers tested	The following sprinklers were used during the residential sprinkler research program described in the report dated December 2010: (1) Residential pendent style having nominal K-factors of 3.1, 4.9, and 7.4 gpm/psi$^{1/2}$ (2) Residential concealed pendent style having a nominal K-factor of 4.9 gpm/psi$^{1/2}$ (3) Residential sidewall style having nominal K-factors of 4.2 and 5.5 gpm/psi$^{1/2}$ The following sprinklers were used during the spray sprinkler research program described in the report dated February 2012: (1) Residential pendent style having a nominal K-factor of 3.1 gpm/psi$^{1/2}$ (2) Standard spray pendent style having nominal K-factors of 2.8, 4.2, 5.6, and 8.0 gpm/psi$^{1/2}$ (3) Standard spray concealed pendent style having a nominal K-factor of 5.6 gpm/psi$^{1/2}$ (4) Standard spray upright style having a nominal K-factor of 5.6 gpm/psi$^{1/2}$ (5) Standard spray extended coverage pendent style having a nominal K-factor of 5.6 gpm/psi$^{1/2}$
Antifreeze solution concentration	<50% glycerine and <40% propylene glycol antifreeze solutions — solutions were not tested. 50% glycerine and 40% propylene glycol antifreeze solutions — large-scale ignition of the sprinkler spray did not occur in tests with sprinkler discharge onto a fire having a nominal heat release rate (HRR) of 1.4 MW. Large-scale ignition of the sprinkler spray occurred in multiple tests with sprinkler discharge onto a fire having a nominal HRR of 3.0 MW. 55% glycerine and 45% propylene glycol antifreeze solutions — large-scale ignition of the sprinkler spray occurred in tests with sprinkler discharge onto a fire having a nominal HRR of 1.4 MW. >55% glycerine and >45% propylene glycol antifreeze solutions — large-scale ignition of the sprinkler spray occurred in tests with sprinkler discharge onto a fire having an HRR of less than 500 kW. 70% glycerine and 60% propylene glycol antifreeze solutions — maximum antifreeze solution concentrations tested.
Sprinkler inlet pressure	Large-scale ignition of the sprinkler discharge spray was not observed when the sprinkler inlet pressure was 50 psi or less for tests using 50% glycerine or 40% propylene glycol.
Ceiling height	When discharging 50% glycerine and 40% propylene glycol antifreeze solutions onto fires having an HRR of 1.4 MW, no large-scale ignition of the sprinkler spray was observed with ceiling heights up to 20 ft. When discharging 50% glycerine and 40% propylene glycol antifreeze solutions onto fires having an HRR of 3.0 MW, large-scale ignition of the sprinkler spray was observed at a ceiling height of 20 ft.
Fire control	The test results described in the test reports of December 2010 and February 2012 indicated that discharging glycerine and propylene glycol antifreeze solutions onto a fire can temporarily increase the fire size until water is discharged. As a part of the residential sprinkler research described in report dated December 2010, tests were conducted to evaluate the effectiveness of residential sprinklers to control fires involving furniture and simulated furniture. The results of these tests indicated that 50% glycerine and 40% propylene glycol antifreeze solutions demonstrated the ability to control the furniture-type fires in a manner similar to water. For standard spray–type sprinklers, no tests were conducted to investigate the ability of these sprinklers to control the types and sizes of fires that these sprinklers are intended to protect.

A.5.4.3 Certain sprinkler systems, such as those installed aboard ships, are maintained under pressure by a small fresh-water supply but are supplied by a raw water source following system activation. In these systems, the effects of raw water are minimized by draining and refilling with freshwater. For systems on ships, flushing within 45 days or the vessel's next port of call, whichever is longer, is considered acceptable.

A.6.2.2 The design information sign should be secured with durable wire, chain, or equivalent to the water supply control valve for automatic or semiautomatic standpipe systems and at an approved location for manual systems. See Figure A.6.2.2 for sample hydraulic information sign.

•

A.6.3.1.1 The hydraulically most remote hose connections in a building are generally at a roof manifold, if provided, or at the top of a stair leading to the roof. In a multizone system, the testing means is generally at a test header at grade or at a suction tank on higher floors.

A.6.3.1.2 When the standpipe system was accepted, NFPA 14 required that each additional standpipe be flowed to simulate the hydraulic calculations. Typically, the lowest hose valve was used to create this simultaneous flow so hoses wouldn't have to be run all the way down each standpipe.

Sprinklers Contained in this Cabinet			
Sprinkler Identification, SIN	General Description	Temperature Rating, °F	Sprinkler Quantity Maintained
TY9128	Extended Coverage, K-25, upright	165	6
VK494	Residential concealed pendent	155	6
Issued: 8/31/19	Revised:		

Δ **FIGURE A.5.4.1.5.6.1 Sample List. [13:Figure A.16.2.7.7.1]**

Location of the two hydraulically most remote hose connections: ________________
Design flow rate for the connections identified above: ____________
Design residual inlet and outlet pressures for the connections identified above: ______________
Design static pressure and design system demand (i.e., flow and residual pressure) at the system control valve, or at the pump discharge flange where a pump is installed, and at each fire department connection: ____________

FIGURE A.6.2.2 Sample Hydraulic Sign. [14:Figure A.6.8]

A.6.3.1.2.1 Since the pressures at each standpipe aren't required to be balanced by NFPA 14 or this standard, any hose valve on the standpipe can be flowed to achieve the additional 250 gpm (950 L/min) needed. It might be more convenient to use a hose valve on an upper level rather than the lowest one on the standpipe.

A.6.3.1.2.2 In some instances it isn't reasonable to attach a hose to a standpipe to provide this additional flow point. The authority having jurisdiction can allow the additional flow be made at other outlets on the standpipe system, such as from another standpipe, or from the fire pump test header. Although the results of having the flow points somewhere else in the standpipe system won't match the hydraulic calculations, the test will still prove that the most remote standpipe can provide the necessary flow and pressure required for fire department use while simultaneously flowing the full system demand.

A.6.3.2.1 The intent of 6.3.2.1 is to ascertain whether the system retains its integrity under fire conditions. Minimum leakage existing only under test pressure is not cause for repair.

A.7.2.2 The requirements in 7.2.2 outline inspection intervals, conditions to be inspected, and corrective actions necessary for private fire service mains and associated equipment.

A.7.2.2.2 Generally, underground piping cannot be inspected on a routine basis. However, flow testing can reveal the condition of underground piping and should be conducted in accordance with Section 7.3.

A.7.2.2.3 Any flow in excess of the flow through the main drain connection should be considered significant.

N **A.7.2.2.6** There could be a need for more frequent inspections due to freezing and droughts. Particular attention should be given to streams and ponds where frequent removal of debris, dredging or excavation of silt, and protection from erosion might be required.

The pond should be maintained as free of aquatic growth as possible. At times it might be necessary to drain the pond to control this growth. Helpful information is available from such sources as the county agricultural extension agent or the U.S. Department of Agriculture. [**1142**, 2017]

N **A.7.2.2.6.5** Dry hydrants can be checked and tested by actual drafting as part of the fire department training program. If the tests do not produce the design flow, the fire department should determine what the problem is. It could be necessary to back flush the system to clear leaves and other debris. When a dry hydrant is back flushed, pump pressures should not exceed 20 psi. [**1142**, 2017]

Δ **A.7.3.1** Full flow tests of underground piping can be accomplished by methods including, but not limited to, flow through yard hydrants, fire department connections once the check valve has been removed, main drain connections, and hose connections. The flow test should be conducted in accordance with NFPA 291.

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A.7.4.2.2 The intent of 7.4.2.2 is to maintain adequate space for use of hydrants during a fire emergency. The amount of space needed depends on the configuration as well as the type and size of accessory equipment, such as hose, wrenches, and other devices that could be used.

A.7.5.3 Private fire service mains might not include a main drain connection; therefore, other equivalent means of flow such as an installed fire hydrant can be used.

A.8.1 A fire pump assembly provides waterflow and pressure for private fire protection. The assembly includes the water supply suction and discharge piping and valving; pump; electric, diesel, or steam turbine driver and control; and the auxiliary equipment appurtenant thereto.

A.8.1.1.2 Alternative Inspection, Testing, and Maintenance Procedures. In the absence of manufacturer's recommendations for preventive maintenance, Table A.8.1.1.2 can be used for alternative requirements.

A.8.1.1.2.1 Shaft movement should be less than ⅛ in. (3 mm).

N **A.8.1.1.2.2.1** Where available, a disconnect switch upstream of the fire pump controller can be opened and the isolated electrical connections inside the electric-motor-driven controller inspected. In some cases the fire pump controller cannot be isolated without shutting off power to the building, and shutting off power to the building could be impractical.

N **A.8.1.1.2.2.2** Some manufacturers are including an isolation switch upstream of all controller components in an isolated sub-cabinet as part of the controller. This permits de-energizing the circuit boards and other controller components and allows the controller to be opened for ITM activities.

 Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. *N* = New material.

Δ Table A.8.1.1.2 Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Frequency
Pump System						
Pump bearings		X				Annually
Lubricate pump bearings			X			As needed
Inspect pump shaft end play		X				Annually
Inspect accuracy of pressure gauges and sensors		X	X			Annually (replace or recalibrate when 5% out of calibration)
Inspect pump coupling alignment		X				Annually
Wet pit suction screens		X		X		After each pump operation
Mechanical Transmission						
Lubricate coupling/flexible connecting shaft (driveshaft)		X				Annually
Lubricate right-angle gear drive		X				Annually
Electrical System						
Exercise isolating switch and circuit breaker					X	Monthly
Trip circuit breaker (if mechanism provided)					X	Annually
Operate manual starting means (electrical)					X	Semiannually
Inspect and operate emergency manual starting means (without power)	X				X	Annually
Lubricate mechanical moving parts (excluding starters and relays)		X				Annually
Calibrate pressure switch settings*		X				Annually
Grease motor bearings		X				Annually
			X			Annually or as needed
Any corrosion on printed circuit boards (PCBs)*	X					Annually
Any cracked cable/wire insulation*	X					Annually
Any leaks in plumbing parts*	X					Annually
Any signs of water on electrical parts*	X					Annually
Diesel Engine System						
Fuel						
Tank level	X	X				Weekly
Tank float switch	X				X	Weekly
Solenoid valve operation	X				X	Weekly
Strainer, filter, or dirt leg, or combination thereof				X		Quarterly
Water and foreign material in tank				X		Annually
Water in system		X		X		Weekly
Flexible hoses and connectors	X					Weekly
Tank vents and overflow piping unobstructed		X			X	Annually
Piping	X					Annually
Lubrication system						
Oil level	X	X				Weekly
Oil change			X			50 hours or annually
Oil filter(s)			X			50 hours or annually
Lube oil heater		X				Weekly
Crankcase breather	X		X	X		Quarterly
Cooling system						
Level	X	X				Weekly
Antifreeze protection level					X	Semiannually
Antifreeze		X				Annually
Adequate cooling water to heat exchanger		X				Weekly
Rod out heat exchanger				X		Annually
Water pump(s)	X					Weekly
Condition of flexible hoses and connections	X	X				Weekly

(continues)

Δ Table A.8.1.1.2 ***Continued***

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Frequency
Jacket water heater		X				Weekly
Inspect duct work, clean louvers (combustion air)	X	X	X			Annually
Water strainer				X		Quarterly
Exhaust system						
Leakage	X	X				Weekly
Drain condensate trap		X				Weekly
Insulation and fire hazards	X					Quarterly
Excessive back pressure					X	Annually
Exhaust system hangers and supports	X					Annually
Flexible exhaust section	X					Semiannually
Battery system						
Electrolyte level		X				Weekly
Terminals clean and tight	X	X				Quarterly
Case exterior clean and dry	X	X				Monthly
Specific gravity or state of charge					X	Monthly
Charger and charge rate	X					Monthly
Equalize charge		X				Monthly
Clean terminals				X		Annually
Cranking voltage exceeds 9 volts on a 12 volt system or 18 volts on a 24 volt system		X				Weekly
Electrical system						
General inspection	X					Weekly
Tighten control and power wiring connections		X				Annually
Wire chafing where subject to movement	X	X				Quarterly
Operation of safeties and alarms		X			X	Semiannually
Boxes, panels, and cabinets				X		Semiannually
Circuit breakers or fuses	X	X				Monthly
Circuit breakers or fuses			X			Biennially
Voltmeter and ammeter for accuracy (5%)		X				Annually
Any corrosion on printed circuit boards (PCBs)	X					Annually
Any cracked cable/wire insulation	X					Annually
Any leaks in plumbing parts	X					Annually
Any signs of water on electrical parts	X					Annually

*Required only where the extent of such work can be completed without the opening of energized electric motor-driven fire pump controller.

A.8.1.4 Types of centrifugal fire pumps include single and multistage units of horizontal or vertical shaft design. Listed fire pumps have rated capacities of 25 gpm to 5000 gpm (95 L/min to 18,925 L/min), with a net pressure range from approximately 40 psi to 400 psi (2.75 bar to 27.6 bar).

(1) *Horizontal Split Case.* This pump has a double suction impeller with an inboard and outboard bearing and is used with a positive suction supply. A variation of this design can be mounted with the shaft in a vertical plane. *[See Figure A.8.1.4(a).]*
(2) *End Suction and Vertical In-Line.* This pump can have either a horizontal or vertical shaft with a single suction impeller and a single bearing at the drive end. *[See Figure A.8.1.4(b).]*
(3) *Vertical Shaft, Turbine Type.* This pump has multiple impellers and is suspended from the pump head by a column pipe that also serves as a support for the shaft and bearings. This pump is necessary where a suction lift is needed, such as from an underground reservoir, well, river, or lake. *[See Figure A.8.1.4(c).]*

A.8.1.8 Controllers include air-, hydraulic-, or electric-operated units. These units can take power from the energy source for their operation, or the power can be obtained elsewhere. Controllers used with electric power sources can apply the source to the driver in one (across-the-line) or two (reduced voltage or current) steps. Controllers can be used with automatic and manual transfer switches to select the available electric power source where more than one is provided.

A.8.2.2 See Table A.8.2.2 and Figure A.8.2.2.

A.8.2.2(5) Visual indicators other than pilot lights can be used for the same purpose.

A.8.3 The purpose of testing the pump assembly is to ensure automatic or manual operation upon demand and continuous delivery of the required system output. An additional purpose is to detect deficiencies of the pump assembly not evident by inspection.