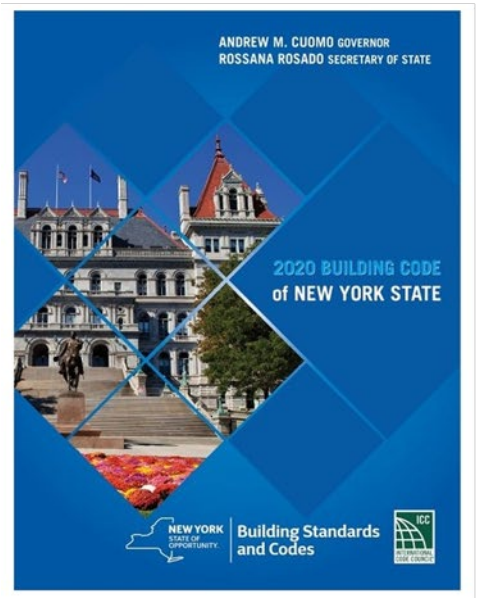
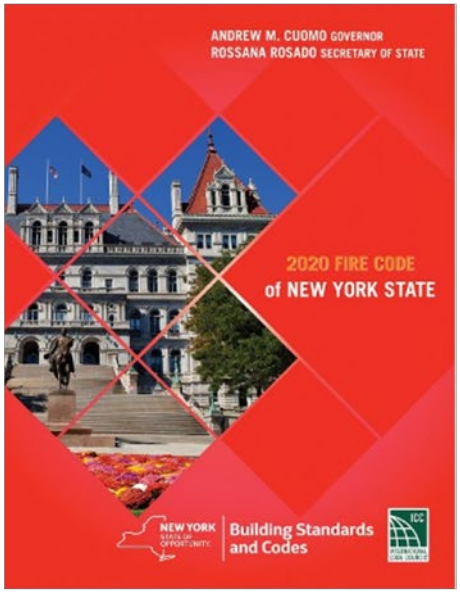
NFSA
NATIONAL FIRE SPRINKLER ASSOCIATION
The Voice of the Fire Sprinkler Industry

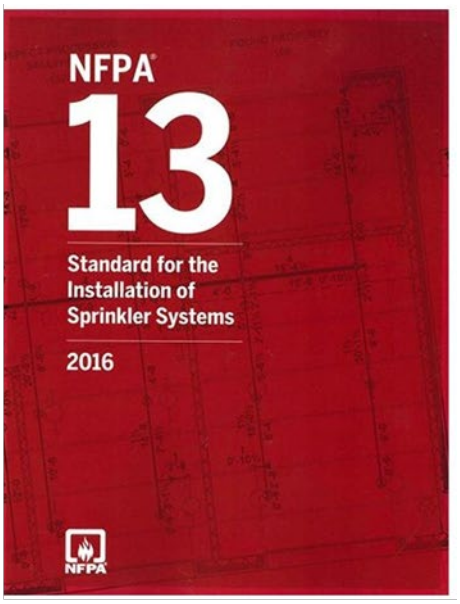
Fire Sprinkler Plan Review Course

Checklists and Participant Guide

2020 New York Codes
2016 NFPA 13







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Review Notes:

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Review Notes:

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Review Notes:

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813		_____ Openings and penetration protec.		913
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Review Notes:

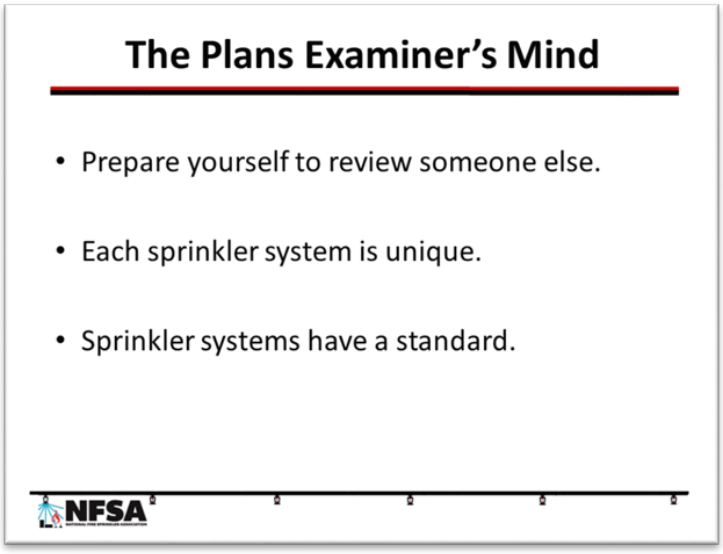
Module 1 – Overview of Fire Sprinkler Plan Review

Introduction

Fire Sprinkler plans examination is a process where the municipality or the authority having jurisdiction is obligated to examine a proposed fire sprinkler system and compare its proposed installation to the laws and ordinances enforced.

The Plans Examiner's Mind

There are many ways to prepare mentally and physically to examine fire sprinkler plans. Each sprinkler system installed is unique. Treat it as unique. It is the only sprinkler system for that building. While there are many codes and standards that divide and sub-divide buildings into use groups and classes, every building is unique as it may be the only building owned by a particular person, ever. It is someone's business, place of employment, residence, or source of food or entertainment.



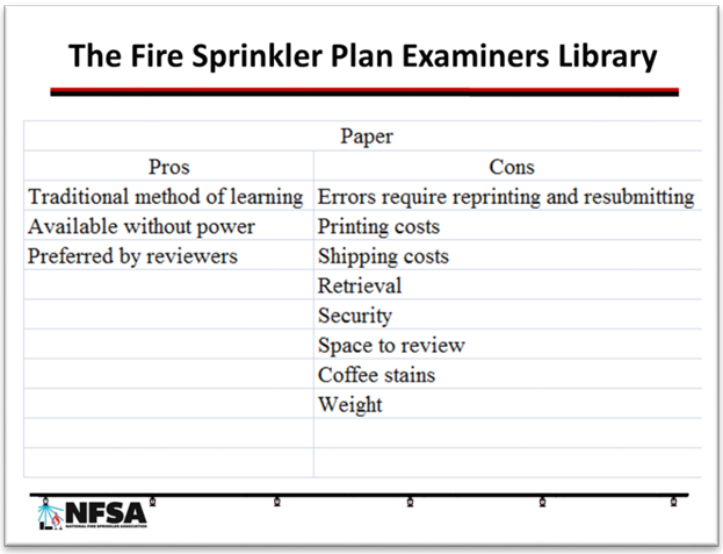
Fire sprinkler systems saves lives and every system installed should be treated as the system to save your life or your family's lives. Prepare yourself to examine each system as a unique system that will never have a devastating fire that makes a sorrowful impact on your community.

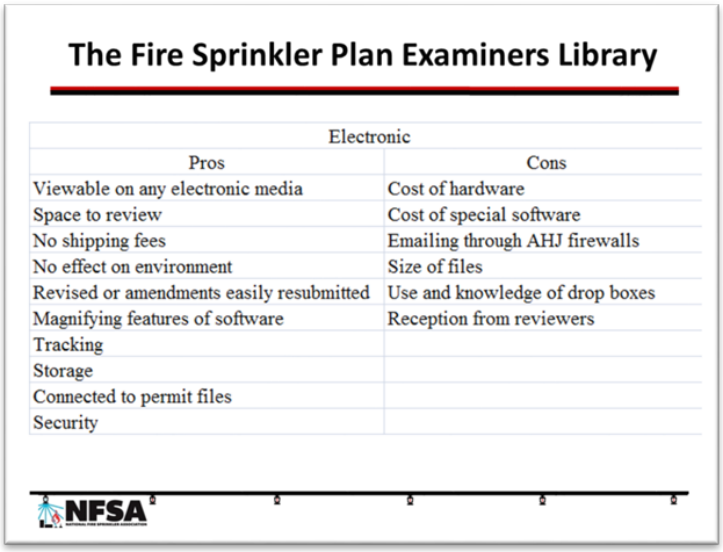
The Fire Sprinkler Plan Examiners Library

The fire sprinkler plan examiner is comparing the fire sprinkler documents submitted for a permit to the laws and ordinances of the community he or she is employed by. Every plan examiner quickly realizes how many documents are needed to complete a review. Whether you are a brand-new plans examiner or an experienced plans examiner, a reference library is something that is budgeted and built upon.

Codes and standards are expensive and while this is recognized by many managers, a portion of every year's budget shall be used for buying current codes and standards. A plans examiner needs to have the latest editions to enforce the latest codes where new technologies have new and updated rules.

Libraries today are not getting smaller, as predicted years ago, by the oncoming internet age. Libraries are changing shape. A room full of books are now able to fit within a computer, tablet, or even a cell phone! It is the authorities having jurisdiction decision on how to store the media on which the codes and standards are printed upon. Electronic or paper? Both have significant advantages and disadvantages. Unfortunately, to many managers, the only thing that matters is cost. Cost for either electronic copy or paper copy is generally the same or comparable when shipping costs are figured in. As mentioned above, this library is a significant investment, one that by law is required to be maintained and updated as new codes are adopted.



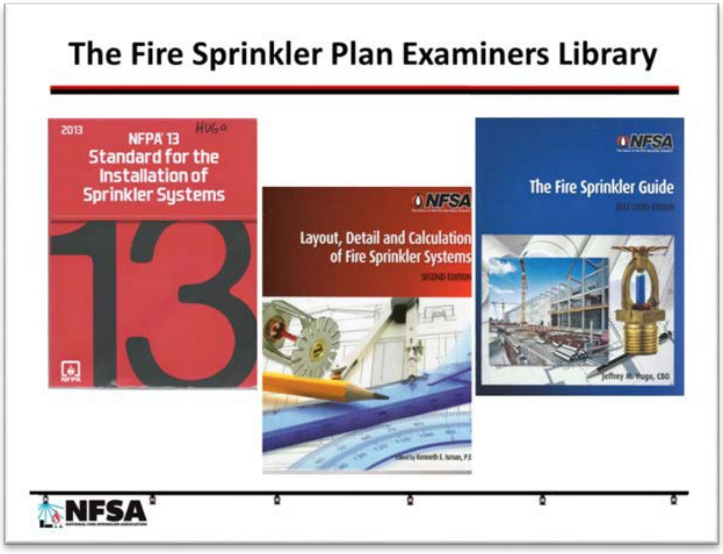


Along with the mandated codes and standards in the library of the plan examiner are handbooks, commentaries, and guides, such as this one. A handbook is typically published by NFPA, such as the *Automatic Sprinkler Systems Handbook* or *The Life Safety Code*

Handbook. A commentary is typically published by the ICC, such as the *2015 IBC Commentary* or the *2015 IFC Commentary*. The NFPA handbooks and ICC code commentaries are helpful to the plan's examiner. In these handbooks and commentaries, the code text along with additional text that describes and explains the code requirement is side by side on the same page. Both documents have many illustrated figures, photos, and examples to help explain. A plans examiner may want to consider budgeting these in every few editions. These are a tremendous help to the fire sprinkler plans examiner.

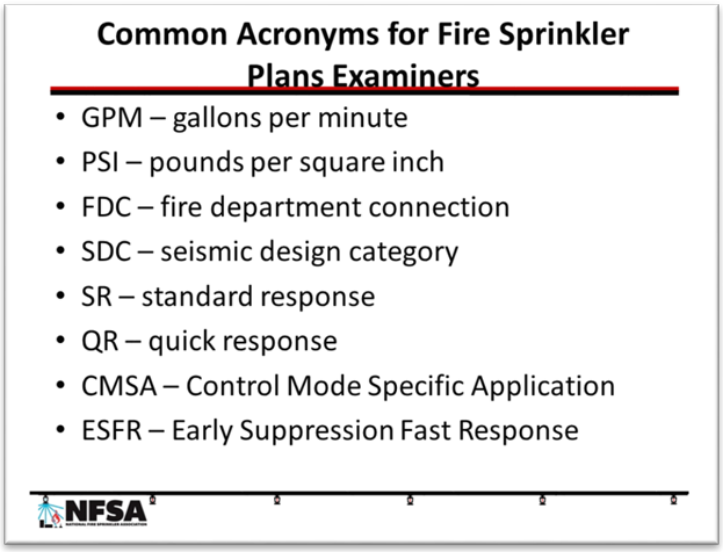
The National Fire Sprinkler Association (NFSA) publishes many guides such as this one, *The Plan Review Guide*, which is available either as a handout in a NFSA seminar or by purchase through our website: www.nfsa.org. Other NFSA resources that a plans examiner may want to obtain are listed below:

- *The 2018 Fire Sprinkler Guide,* by Jeffrey M. Hugo, CBO
- *Layout, Detail, and Calculation of Fire Sprinkler Systems*, Second Edition, by Kenneth E. Isman, P.E.
- *The Hydraulics Handbook*, by Kenneth E. Isman, P.E.



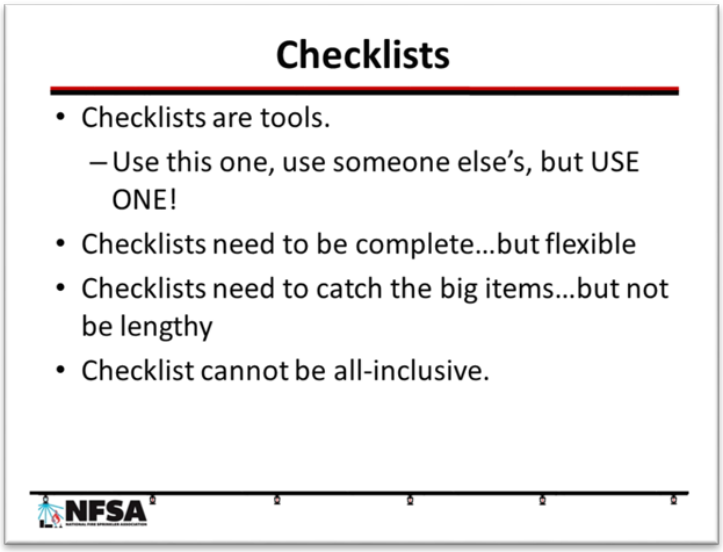
Common Acronyms for Fire Sprinkler Plans Examiners

An acronym is a word formed by the first letters of each word in the name or phrase. The fire sprinkler industry is full of acronyms as there are dozens, if not hundreds, of codes, standards, organizations, units of measure, that are reduced into acronyms. Below, is a list of acronyms that may be helpful during the plan's examination and in the Plan Review Guide.

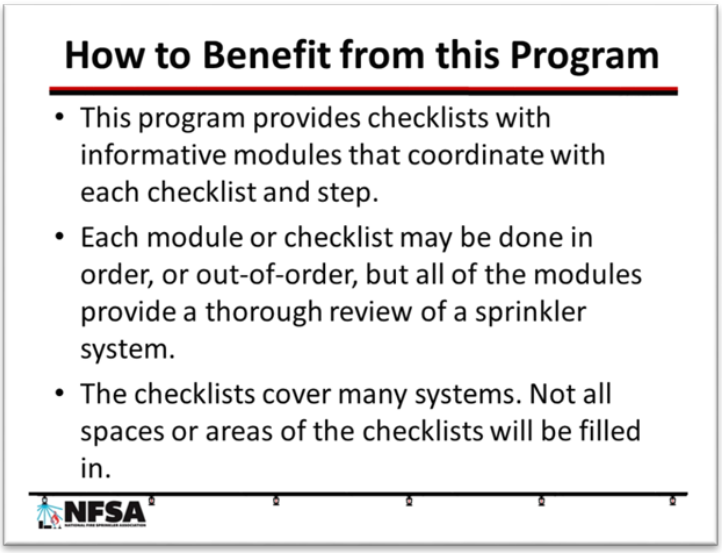


How to Use the Plan Review Guide Checklists

The checklists contained in this guide are yours to use. As a participant of the NFSA seminar that uses this book as a handout, or as a purchaser of this book, it is recognized that doing a thorough plans examination is important to you as a fire sprinkler plans examiner. The first rule about checklists is that to be effective they need to be complete but flexible enough to catch the right amount of "stuff" in each area of the review. Fire sprinkler systems can be complex, and a well-rounded checklist is a valuable tool. The second rule of checklists is that they are not all inclusive and this one is no different. This means that a checklist cannot catch every possible item that needs to be examined. The checklists in this book are lengthy but have enough steps for the plans examiner to do a thorough review.

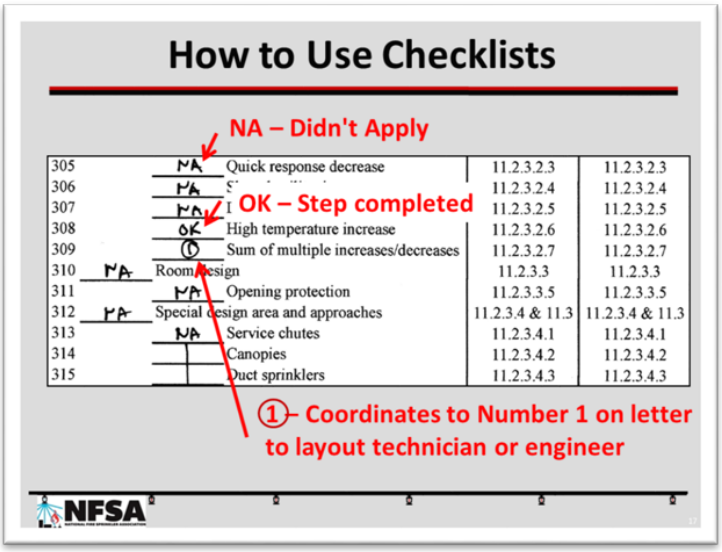


Each module in this program describes each stage of the plan examination in detail. Each step in the checklist has a corresponding explanatory text in this program to explain what each step entails. The text also has large margins to enable you, the fire sprinkler plans examiner, to make notes to optimize your review, add in items that strike you as important, or fill in items where the author missed the boat! It may be common to see text repeated as each section of the codes and standards are explained in each step, it is helpful to repeat text that is similar in another step.



The process of these checklists does not follow the order in which NFPA 13 lists in the plans and calculations chapter, nor does it follow in ascending or descending order in NFPA 13 or the IBC. For example, the checklist may have several steps in one module then a step in another module, then return to the steps in the previous module. The checklists are developed from the experience of several fire sprinkler plans examiners, including those who work at NFSA, to be the most thorough and efficient method. The checklists are divided into several modules. Nothing says that the plans examiner must follow the order that the modules are listed. Every plan examiner has a preference of order.

It is important to note here that each step in the checklist may not be covered depending on the type of fire sprinkler system that is being reviewed. For example, a sprinkler system using residential sprinklers is not going to use the checklist portion for other sprinklers. The portion of the checklist is left blank or better yet, when a step is not used, it is best to leave a mark in that cell or line, such as N/A, which means “Not Applicable”. This shows that the step wasn’t missed on accident or if there is an interruption in the process, it shows the progress of the review. This slide shows the different ways or methods to fill in areas of the unused checklist.



If the answer to the step is yes, then indicate appropriately, with; Yes, OK, or any other notation that is agreed upon in the plan review department. Do not use a notation that is neutral or can be taken either way, such as a checkmark. A checkmark shows that the step was addressed, but it doesn't indicate whether it is affirmative or negative.

The fire sprinkler plans examiner will look at each step as if it is a question. For example, in Step 308, it states: High temperature increase. Frame this step into a question, such as Are high temperature sprinklers used? If the answer is "yes", then make the appropriate mark and move to Step 309. Again, form Step 309 into a question; Is the design area increased by 25% with a minimum of 2,000 square feet? If, after examining the plans, the answer is "no", then make an appropriate notation on the checklist as shown.

If the answer to the step is no, then indicate appropriately. In this step, it is not sufficient just to say "no." The final stage of the review is to communicate back to the fire sprinkler layout technician. When a step is not addressed satisfactorily in the fire sprinkler shop drawings, then the missing item in the step needs to be included in a letter or correspondence back to the submitter. There is more to come on writing correction letters later in this chapter, however, when a step is not in compliance, instead of using no, use a number in ascending order. If the high temperature sprinkler example above is the ninth item that has been found lacking or incorrectly on the fire sprinkler shop drawing, then use the number "9" in that step.

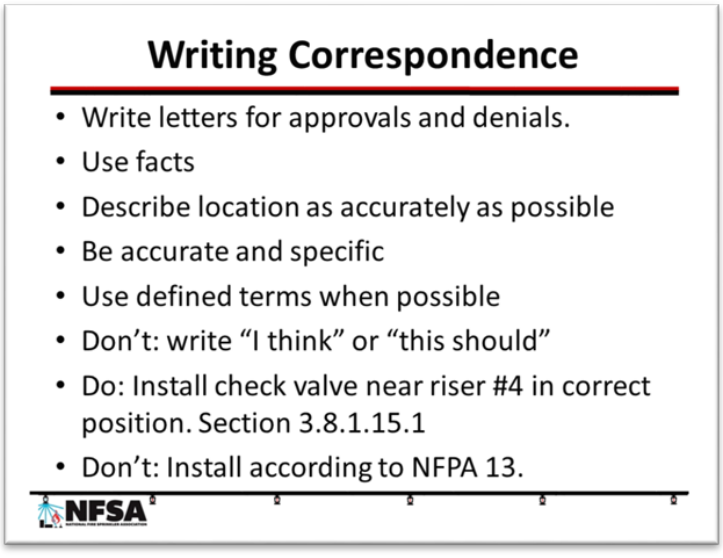
Each page of the checklist has an area near the bottom of the page for notes. While it is optimal to start a fire sprinkler plan review without breaks, it isn't practicable or feasible in some cases. Use the notes area to indicate the time spent on that page, when breaks were made, use the space for calculations, or use the space to address areas that the checklist may have missed.

Writing Correspondence

Effective communication between the plan review department and the public is essential for good relations. This is a two-way street. Architects, designers, and layout technicians need to provide documents that are effective in communicating with the plan's examiner. The plan examiner needs to, in turn, effectively communicate back to, in most cases for fire sprinkler systems, either the fire protection engineer, layout technician, or permit applicant. Corresponding back on the results of the examination of the submitted documents is one of the most important parts of the plan examiners job.

Many departments have a form letter or a commonly used format that is used to reply to the result of the departments' review. In the plan review letter, there are at least four areas thatneed to be addressed:

1. Identify the code or standard, edition and appropriate code section number. Indicate back to the designer what sections of the code or standard was specifically missed or violated. Be as specific as possible. There can be occasions where multiple sections are included.
2. Use facts. State only what is true. Opinions and generalities are not welcome. Phrases that contain phrases such as, "I think" or "this should" show that the plans examiner is not sure.
3. Be accurate and specific. Identify the location of the infraction, such page number, column or grid line, floor, building, etc. Use enough words to describe the situation and avoid lengthy commentary. Use proper grammar and spell-check. Each code and standard have their own definitions. Use the terminology that is used in the codeor standard. Avoid using slang terms
4. Be prompt and professional. Return comments as soon as possible. Follow-up phone calls and emails. Respond and treat the submitter as you would want to be treated.



There are many books, seminars, and courses available on how to write legal correspondence. NFPA and ICC have books on how to communicate as a code official.

Local colleges have grammar and composition classes. The point is, there is no excuse for poor correspondence skills. Some departments have assistants who process and type the correspondence, but it is up to the plans examiner to double check the message that is going out to the applicant.

Furthering Yourself as a Fire Sprinkler Plans Examiner

Nothing says, "I know what I am doing" like a professional certification. A certification shows your employer, perspective employers, contractors, designers, technicians, contemporaries, and the public you work for that you have the knowledge of performing this service. A certification gets you recognized and puts you above others in the same field. a

NFPA and ICC both have professional certifications that are specifically for the fire sprinkler plans examiner. Another certification agency, NICET, certifies fire sprinkler layout technicians. These are the individuals that layout the fire sprinkler system shop drawings and other documents that the fire sprinkler plans examiner reviews.

Module 2 - Submittal Review

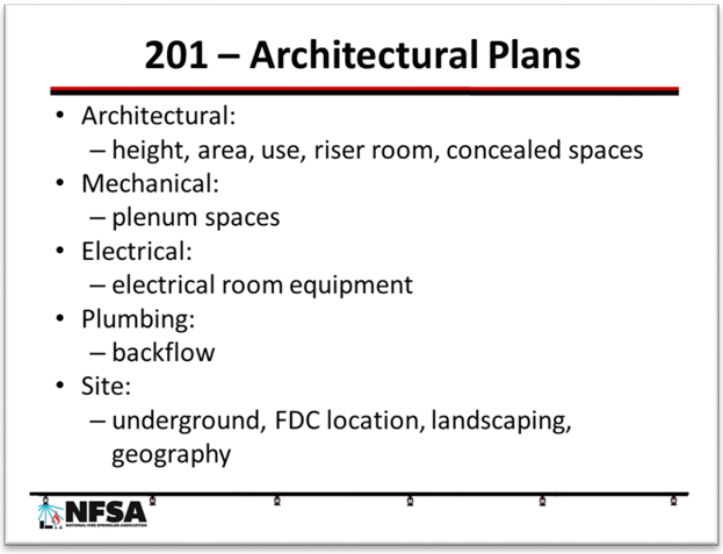
Introduction

The submittal review is the first step in plans examination. The submittal review of the plan review process is to ensure that all the correct documents are available for the plans examiner to commence the review. In this stage, the focus is not so much on the technical aspects of the documents, it is on whether the documents are present. Performing a fire sprinkler plan review is getting into the mind and methods of the fire sprinkler layout technician. To do this, it is necessary for the plans examiner to have what the designer and layout technician had in front of them while laying out the structure and the piping.

After evaluating the actual submittal and comparing to the review checklist, the examiner may or may not reject the submittal package at this point. If the examiner does not have all the necessary documents, it may not be worth the time to start the review. Fire sprinkler system submittals are a package of many items, and it is often a disservice to start a review when part of that system is missing in the submittal review. The plans examiner should write a correction letter, wait for more information, then re-commence when all the pieces are put together. Time is valuable on both sides of the review process, and examiners should be cautioned against rejecting the submittal package at this point if minor items (such as common cut sheets) are missing. The best outcome occurs when both sides worktogether to bring forth a productive review.

201 Architectural Plans

It is imperative for the plans examiner to obtain a sense of the structure and all its nuances to perform the fire sprinkler review. This gives the examiner a sense of the building: areas, heights, concealed spaces, soffits, exempt areas, etc. There is a tremendous amount of coordination needed between the architectural and mechanical, electrical, and plumbing (MEP) teams with the fire sprinkler layout technician.



In some cases, the plans examiner has already performed the review of the structure by the time the sprinkler drawings are submitted for review. However, in some jurisdictions, the

fire sprinkler review and architectural review may be performed by different departments or different examiners. At times, it may be crucial or proactive to obtain the civil, architectural, mechanical, electrical, and plumbing plans from the examiner(s) who performed these reviews, along with the examiner(s)' comments. These plans hold many answers to questions asked during the fire sprinkler review stage. While most fire sprinkler shop drawings show cross sections and room layout, the more the plans examiner understands the structure the better the review is performed.

202 Owner's Certificate

NFPA 13 requires an Owner's Certificate to be submitted to the fire sprinkler layout technician or contractor. This document is produced by the owner of the building and describes what the structure is in order assist the layout technician in designing the fire sprinkler system. The owner's certificate covers the following areas:

(1) Intended use of the building, including the materials within the building and the maximum height of any storage.

(2) A preliminary plan of the building or structure along with the design concepts necessary to perform the layout and detail for the fire sprinkler system.

(3) Any special knowledge of the water supply, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion or commonly referred to as MIC.

203 Water Supply Treatment

When the Owner's Certificate indicates, corrosive properties are found in the owner's investigation, the following is required to be examined:

(1) Type of condition that requires treatment

(2) Type of treatment needed to address the problem

(3) Details of treatment plan

Plan examiners will want to obtain this document for several reasons. First, this certificate should have been completed and forwarded to the fire sprinkler layout technician at the

start of their design and layout. Second, this certificate aids the examiner in understanding the owner's intent for the structure. Third, this certificate is a valuable enforcement tool to keep in the file in the event the owner changes the storage arrangement, commodity, or use.

204 Shop Drawings

Shop drawings show the layout and network of piping that the fire sprinkler layout technician has determined to be the most efficient and effective method of providing fire sprinkler protection throughout the structure.

Shop drawings consist of several pages of paper or in electronic file(s). Pages will be dedicated to the underground piping (correlating to the civil drawings), each floor (or several pages of a single floor), cross sections, elevations, etc. will correlate to the architectural, mechanical, electrical, and plumbing (MEP) drawings.

The International Building Code (IBC) requires shop drawings submitted for review to the authority having jurisdiction (AHJ). *"Shop drawings for the fire protection system(s) shall be submitted to indicate conformance to this code and the construction documents and shall be approved prior to the start of system installation. Shop drawings shall contain all information as required by the referenced installation standards in Chapter 9.*

Some states or jurisdictions require the signature and seal of an engineer, while other states or jurisdictions require the shop drawings prepared by a NICET Level III or Level IV Fire Sprinkler Layout Technician. The examiner should be aware of and enforce the laws regarding who can prepare shop drawings.

AHJs that arbitrarily require a signature and seal of an engineer in lieu of a full review by a qualified examiner should be cautioned. A seal of an engineer does not necessarily ensure that compliance is achieved and the responsibility of the AHJ is fulfilled. This guide, training programs, and frequent continuing education will give an examiner the tools necessary to ensure compliance.

NFPA 13 has a forty-six-item list of what is to be contained in the fire protection shop drawings. Furthermore, water supply information is also necessary to complete the review and shall be part of the submittals. NFPA 13 also has a nine-item list of requirements for the water supply information. Although these lists appear daunting (and endless), remember at this point in the submittal review the plans examiner is not getting into the detail of each item.

NFPA 13 Requirements for Shop Drawings:

(1) Name of owner and occupant.
(2) Location, including street address.
(3) Point of compass.
(4) Full height cross section, or schematic diagram, including structural member information if required for clarity and including ceiling construction and method of protection for nonmetallic piping.

(5) Location of partitions.
(6) Location of fire walls.
(7) Occupancy class of each area or room.
(8) Location and size of concealed spaces and closets, attics, and bathrooms.
(9) Any small enclosures in which no sprinklers are to be installed.
(10) Size of city main in street, and whether dead-end or circulating; if dead-end, direction and distance to nearest circulating main; and city main test results and system elevation relative to test hydrant.
(11) Other sources of water supply, with pressure or elevation.
(12) Make, type, model, and nominal K-factor of sprinklers including sprinkler identification number.
(13) Temperature rating and location of high temperature sprinklers.
(14) Total area protected by each system on each floor.
(15) Numbers of sprinklers on each riser per floor.
(16) Total number of sprinklers on each dry-pipe system, preaction system, combined dry-pipe/preaction system, or deluge system.
(17) Approximate capacity in gallons of each dry-pipe system.
(18) Pipe type and schedule of wall thickness.
(19) Nominal pipe size and cutting lengths of pipe (or center to center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.
(20) Location and size of riser nipples.
(21) Type of fittings and joints and location of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and the type of fittings or formations to be used.
(22) Type and locations of hangers, sleeves, braces, and methods of securing sprinklerswhen applicable.
(23) All control valves, check valves, drainpipes, and test connections.
(24) Make, type, model, and size of alarm or dry-pipe valve.
(25) Make, type, model, and size of preaction of deluge valve.
(26) Kind and location of alarm.
(27) Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles, and related equipment.
(28) Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters, and valve pits; and the depth that the top of the pipe is laid below grade.
(29) Piping provisions for flushing.
(30) Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.
(31) For hydraulically designed systems, the information on the hydraulic data nameplate.
(32) A graphic representation of the scale used on all plans.
(33) Name and address of contractor.
(34) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.

(35) The minimum rate of water application (density or flow or discharge pressure), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.
(36) The total quantity of water and the pressure required noted at a common reference point for each system.
(37) Relative elevations of sprinklers, junction points, and supply or reference points.
(38) If room design method is used, all unprotected wall openings throughout the floor protected.
(39) Calculation of loads for sizing, and details of sway bracing.
(40) The setting for pressure-reducing valves.
(41) Information about backflow preventers (manufacturer, size, type).
(42) Information about antifreeze solution used (type and amount).
(43) Size and location of hydrants, showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.
(44) Size, location, and piping arrangement of fire department connections.
(45) Ceiling/roof heights and slopes not shown in the full height cross section.
(46) Edition year of NFPA 13 to which the sprinkler system is designed to.

The several lists in NFPA 13 appear daunting; however, remember at this point in the submittal review the examiner is not getting into the detail of each item. This guide will walk you through each item in a systematic and manageable process.

205 Pipe Schedule Systems

NFPA 13 allows the choice of two separate types of sprinkler system design, a pipe schedule system, or a hydraulically designed system. The examiner should immediately note whether the system piping is sized according to a pipe schedule or hydraulic calculations.

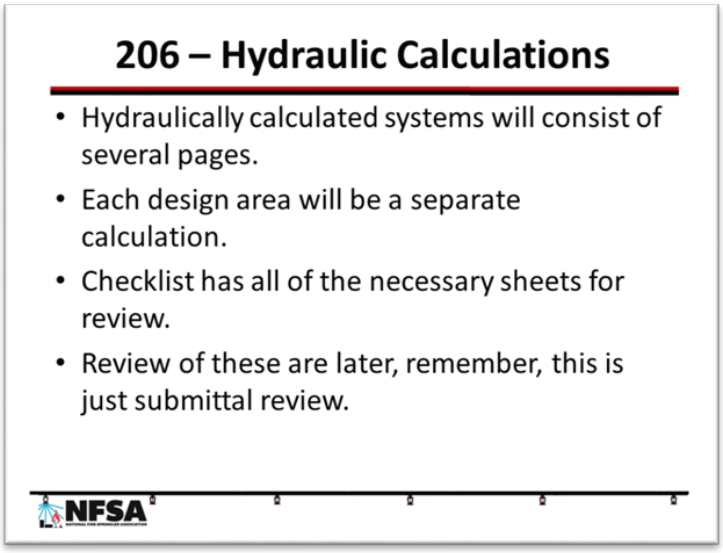
In a pipe schedule system, the piping is sized strictly according to the number of sprinklers which can be fed through each size of pipe. In a hydraulically designed system, the piping is sized per the size and pressure of the available water supply.

The 1996 edition of NFPA 13 was the first to mandate hydraulically calculated systems and limiting the use of pipe schedule systems. Currently, NFPA 13 states that the pipe schedule method is only permitted only for new installations of 5000 square feet or less. Additions or modifications to existing pipe schedule systems are also permitted when the new system is sized per the pipe schedule tables.

206 Hydraulic Calculations

Hydraulic calculations are typically generated by computer software, although some layout technicians may submit manual calculations. Manual calculations are permitted to be submitted, although, any handwritten document must be legible. Since the 2007 edition of NFPA 13 has mandated that computer software be prepared in a uniform format; these calculation software packages are available from various vendors.

An examiner will need to investigate the hydraulic submittals to ensure the information inthe lists below is complete enough to review.



Because computer-generated reports are the most common type submitted for review, NFPA 13 details what shall be prepared on form sheets:

- Summary Sheet
- Graph Sheet
- Water Supply Analysis
- Node Analysis
- Detailed Worksheets

As discussed earlier, at the submittal review stage the examiner is compiling the information needed to determine if the review may be started. If the examiner does not have all the necessary documents, it may not be worth the time to start the review. However, time is valuable on both sides of the review process, and examiners should be cautioned against rejecting the submittal package if minor items are missing.

207 Water Supply

Water supply information is also necessary to complete the review and should be part of the submittals. The following additional list is found in NFPA 13:

(1) Location and elevation of static and residual test gauge with relation to the riser reference point
(2) Flow location
(3) Static pressure in psi
(4) Residual pressure in psi
(5) Flow in gallons per minute
(6) Date
(7) Time
(8) Test conducted by or information supplied by

(9) Other sources of water supply, with pressure or elevation

If the Owner's Certificate indicates corrosive properties are found in the owner's investigation, NFPA 13 addresses a further list that needs to be inspected by the examiner:
(1) Type of condition that requires treatment
(2) Type of treatment needed to address the problem
(3) Details of treatment plan

208 Summary Sheet

The summary sheet (usually the first page) of the hydraulic calculation shall contain the following information, where applicable:
(1) Project name and date
(2) Location (including street address)
(3) Drawing number
(4) Remote area number
(5) Remote area location
(6) Occupancy or commodity classification
(7) System design requirements, as follows:
  (a) Design area of water application per square feet
  (b) Minimum rate of water application (density), shown as gpm/sq.ft.
  c) Area per sprinkler in square feet.
(8) Total water requirements as calculated in gallons per minute (gpm), including allowance for inside hose, outside hydrants, water curtain and exposure sprinklers, and allowance for in-rack sprinklers.
(9) Type of system and, if dry or preaction, the volume of the system in gallons
(10) Water supply information, including:
  (a) Date
  (b) Location
  (c) Source
  (d) Elevation relative to finished floor
(11) Name and address of installing contractor
(12) Name of designer
(13) Authority having jurisdiction
(14) Notes that include items such as peaking information for calculations performed by a computer program, limitations (dimension, flow, and pressure) on extended coverage or other listed special sprinklers.

209 Graph Sheet

A graphic representation of the complete hydraulic calculation shall be plotted on semi exponential graph paper (Q1.85) and shall include:
(1) Water supply curve
(2) Sprinkler system demand
(3) Hose demand (where applicable)
(4) In-rack sprinkler demand (where applicable)
(5) Additional pressures supplied by a fire pump or other source (when applicable)

210 Supply Analysis

The supply analysis sheet shall contain information summarized from the supply graph sheet. This sheet shall include:

(1) Node tag at the source
(2) Static pressure available at the source
(3) Residual pressure available at the source
(4) Total flow available at the source
(5) Available pressure at the source when the total calculated demand is flowing
(6) Total calculated demand (in gallons per minute) at the source
(7) Required pressure when flowing total calculated demand

211 Node Analysis

Organized information regarding the node tags given to each hydraulic reference point on the system as indicated on the shop drawings shall include the following information:

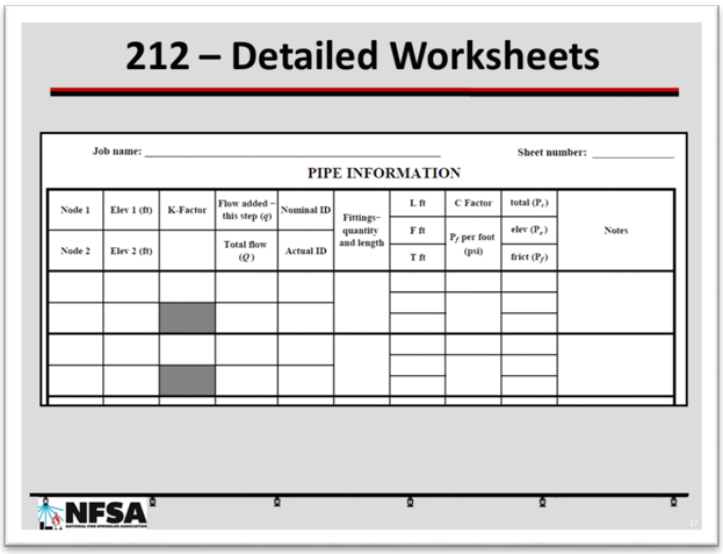
(1) Node tag for each specific point on the system used in the hydraulic calculations
(2) Elevation in feet of each node tag
(3) K-factor of flowing nodes (such as sprinklers)
(4) Hose allowance in gallons per minute requirements for the node tag
(5) Pressure at the node
(6) Discharge of gallons per minute calculated at the node
(7) Notes that indicate any special requirements for the node

212 Detailed Worksheets

Detailed worksheets or computer printout sheets are submitted and shall contain the information listed below. This information is critical to be complete for the plan's examiner.

(1) Sheet number
(2) Hydraulic reference points used in each step
(3) Elevation in feet at each hydraulic reference point
(4) Sprinkler description and discharge constant (K-factor) for the flowing reference point
(5) Flow in gallons per minute for the flowing reference point (when applicable)
(6) Total flow in gallons per minute through each step
(7) Nominal pipe size in inches
(8) Actual internal diameter of pipe in inches
(9) Quantity and length in feet of each type of fitting and device
(10) Pipe lengths in feet, center-to-center of fittings
(11) Equivalent pipe lengths in feet of fittings and devices for the step
(12) Total equivalent length in feet of pipes and fitting for the step
(13) C-factor used in each step
(14) Friction loss in pressure per foot of pipe
(15) Sum of the pressures from the previous step (starting pressure at beginning)
(16) Elevation head between reference points
(17) Total friction loss between reference points
(18) Required pressure at each reference point
(19) Notes and other information shall include the following:
    (a) Velocity pressure and normal pressure if included in calculations

(b) In-rack sprinkler demand balanced to ceiling demand
(c) Notes to indicate starting points or reference to other sheets or to clarify data shown
(d) Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area
(e) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where calculations do not begin at the sprinkler
(f) The pressure loss assigned the backflow device when included on a system



213 Cut Sheets

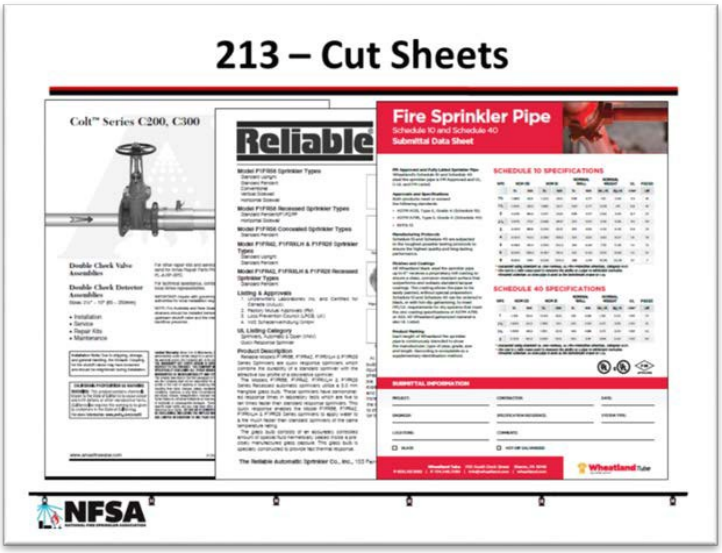
A "cut sheet" is trade lingo for product specifications provided by the manufacturer for the installed equipment on the job. Other names for cut sheets are manufactures installation guide, data sheets, and product specifications. The fire sprinkler layout technician will need to provide this information to the plan's examiner for review. Cut sheets or product specifications should be neatly packaged and organized. A plans examiner needs this information not only at plan review, but also in the field to ensure that what was submitted and reviewed is installed on site.

Cut sheets are needed for the following:

- Fire sprinklers
- Backflow prevention devices
- Valves - control valves, system valves: dry, preaction, deluge, etc.
- Trim, pressure gauges, drains
- Piping
- Hangers
- Seismic - bracing, restraints, assemblies, etc.

The plan examiner uses cut sheets during the review to compare to the hydraulic calculations, for example, the plans examiner will compare the extended coverage sprinkler flow rates from the cut sheet to the actual hydraulic calculation or compare the friction loss

at a certain flow for a backflow preventer to the hydraulic calculations. This technique will be discussed much later in Modules 3 and 4.



It is extremely important to verify that what the plans propose to use is used on-site. For example, a double check backflow assembly reduces the flow pressure, and this reduction is reflected in the hydraulic calculations. If an on-site inspection reveals that an RPZ is installed instead, it must be noted that the RPZ has significant pressure loss over the double check backflow assembly. This may change the dynamics of the flow and pressure through the system and may not provide the minimum flow and pressure to the remote design area. In this case, the fire sprinkler layout technician will need to be notified and the hydraulic calculations redone.

214 Codes and Standards

The architectural plans and the fire sprinkler shop drawings, the fire sprinkler standard should be noted and identified at the submittal review. The building code, for the purposes of this book, is the International Building Code (IBC). In the IBC is Chapter 35 which is the Referenced Standards chapter. This chapter identifies the standards and the edition of the standards that are referenced by the IBC. For example, the 2015 IBC references the 2013 edition of NFPA 13, 13R and 13D. The adopted code, the IBC, will determine which standards the examiner will use to review the documents. It is a common practice to use the current edition of the referenced standards, however, if this is done, then the practice should be consistent through the jurisdiction and through the standard. For example, if the 2007 edition of NFPA 13 is referenced by the IBC, but the examiner wants to use the 2013 edition of NFPA 13, then they should apply that edition throughout the jurisdiction and throughout the review. A plans examiner cannot pick and choose, at random, bits and pieces of standards to enforce.

As stated in Module 1, the library of the examiner is extensive, but necessary to properly review fire sprinkler construction documents. Following is a list of standards that are

commonly used in designing fire sprinkler systems and, likewise, are commonly used to review:

- NFPA 13 – The Standard for the Installation of Sprinkler Systems
- NFPA 13R – The Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
- NFPA 13D – The Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes
- NFPA 14 - The Standard for the Installation of Standpipes and Hose Systems
- NFPA 20 - The Standard for the Installation of Stationary Pumps for Fire Protection
  NFPA 22 - The Standard for Water Tanks for Private Fire Protection
- NFPA 24 - The Standard for the Installation of Private Fire Service Mains and Their Appurtenances

215 Use Group - Occupancies

Identify the use group as determined by Chapter 3 of the IBC. This assists the examiner to frame the project by typical occupancy fuel loads, hazards, etc. While the occupancies of the IBC do not have any correlation with NFPA 13, Chapter 3 of the IBC categorizes every conceivable building use into a specific occupancy.

Determining the use group or occupancy will help the examiner in justifying the classification of hazard and/or commodity.

216 Classification of Hazard Occupancies

After viewing the fire sprinkler shop drawings and hydraulic calculations, the examiner will be able to compare the shop drawings to the classification of hazard as determined by NFPA 13. During the submittal review, this is one of the times in which the examiner will dig deeper in the submitted plans to see of the determination of the hazard is correct with that of the fire sprinkler layout technician.

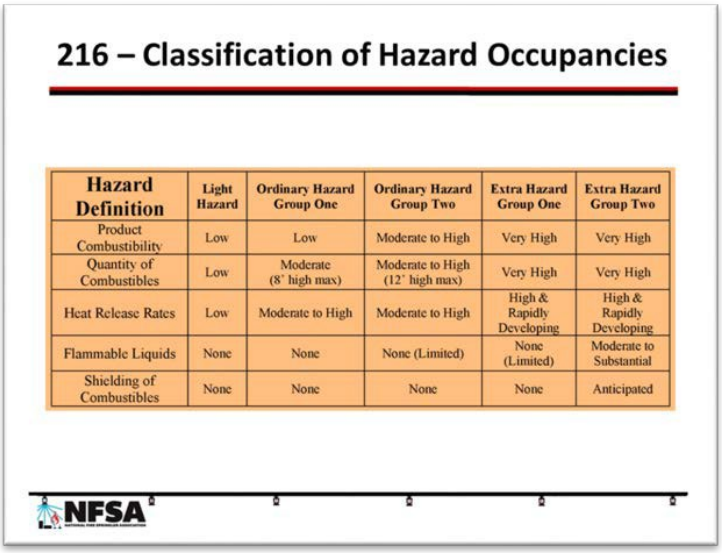
This investigation will involve all the documents already identified and discussed in Module 2. This should also include the Owner's Certificate as required by NFPA 13. This document from the owner helps the fire sprinkler layout technician as well as the plans examiner. The Owner's Certificate is also good document to keep in the permit file for the fire code inspector or the property maintenance inspector to compare the contents to the original intent.

A frequently misunderstood concept regarding sprinkler protection is the relationship between fire sprinkler design and "fire hazard." The design of a fire sprinkler system and water supply is based more on the difficulty of suppression or control after a fire starts than with the probable frequency with which the fire will occur. A printing shop, for example, with frequent use of volatile inks and cleaning fluids in combination with motors and machinery, is more likely to have a fire than is a warehouse used for storage of rolled paper. However, should a fire occur, the rolled paper warehouse fire would require much more water for control and extinguishment. The rolled paper warehouse poses the greater demand regarding the design of an automatic sprinkler system. The severity of fire and

difficulty of control due to the rate of heat release is thus more important in system design than the potential frequency of a fire starting.

There are several factors which influence sprinkler system design such as: the number of combustible contents, the type and arrangement of high heat release materials, structural members that may shield fires from water spray and the potential for a rapid fire that could open a large number of sprinklers. These factors, and other considerations, are all considered in the classification of hazard, the first and foremost parameter in sprinkler system design.

Hazard classifications, as used in this program are referenced strictly to NFPA 13 designations and do not relate to occupancy designations in any other standard or code. The occupancy classifications used in building codes, as mentioned in the previous section are not the same as those used in NFPA sprinkler standards.



Hazard Definition	Light Hazard	Ordinary Hazard Group One	Ordinary Hazard Group Two	Extra Hazard Group One	Extra Hazard Group Two
Product Combustibility	Low	Low	Moderate to High	Very High	Very High
Quantity of Combustibles	Low	Moderate (8' high max)	Moderate to High (12' high max)	Very High	Very High
Heat Release Rates	Low	Moderate to High	Moderate to High	High & Rapidly Developing	High & Rapidly Developing
Flammable Liquids	None	None	None (Limited)	None (Limited)	Moderate to Substantial
Shielding of Combustibles	None	None	None	None	Anticipated

Light Hazard is commonly abbreviated by the acronym LH in shop drawings and hydraulic calculations. NFPA 13 describes Light Hazard occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

Ordinary Hazard Group 1 is commonly abbreviated by the acronym OH1 in shop drawings and hydraulic calculations. NFPA 13 describes Ordinary Group 1 occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 feet in height, and fires with moderate rates of heat release are expected.

Ordinary Hazard Group 2 is commonly abbreviated by the acronym OH2 in shop drawings and hydraulic calculations. NFPA 13 describes occupancies or portions of other occupancies where quantity and combustibility of contents is moderate to high, stockpiles

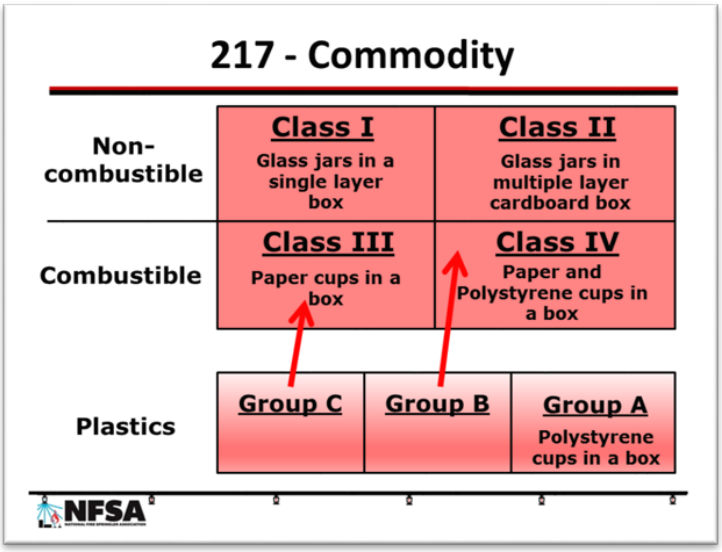
do not exceed 12 feet in height and fires with moderate to high rates of heat release are expected.

Extra Hazard Group 1 is commonly abbreviated by the acronym EH1 in shop drawings and hydraulic calculations. NFPA 13 describes occupancies or portions of other occupancies where quantity and combustibility of contents is very high and flammable and combustible liquids, dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release. Extra Hazard Group 1 occupancies or portions of other occupancies described above have little or no flammable or combustible liquids.

Extra Hazard Group 2 is commonly abbreviated by the acronym EH2 in shop drawings and hydraulic calculations. NFPA 13 describes occupancies or portions of other occupancies where quantity and combustibility of contents is very high, and flammable and combustible liquids, dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release. Extra Hazard Group 2 occupancies or portions of other occupancies as described above but with moderate to substantial amounts of flammable or combustible liquids or where shielding of combustibles is extensive.

217 Commodity

When the submitted plans contain storage, the fire sprinkler layout technician and plans examiner will further classify the fire sprinkler system. Protecting occupancies that have storage is very different from using the hazard occupancies described prior. The first thing you need to know is that the things we store in a building are called "commodities" in the NFPA documents. Commodities are addressed in NFPA 13 and in the Annex, are long lists of commodities that are helpful to the plan's examiner.



There are seven types of commodities in general storage occupancies; Class I, Class II, Class III, Class IV, Group A Plastics, Group B Plastics and Group C Plastics. As we will

see in the definitions, two of these classifications will drop out and there will only be five different levels of sprinkler protection.

Class I commodities are noncombustible products stored in ordinary single layer cardboard cartons. This includes metal and glass products as well as noncombustible foods. Noncombustible products placed directly on wooden pallets and noncombustible products with shrink wrap or paper wrap as a unit load with the unit load resting on or off pallets.

An example of a Class I commodity familiar to most of the people in this industry is sprinklers in cartons. Factory Mutual considers glass jars in compartmented cardboard cartons to be a benchmark Class I commodity

Class II commodities are the same as Class I, but in more substantial packaging such as wooden crates, solid wooden boxes, or multiple thickness cartons. Factory Mutual considers metal lined double triwall cartons to be a benchmark Class II commodity
Class III commodities are products fashioned from ordinary combustibles such as wood, paper, cloth, and leather. Group C Plastics are also defined as Class III commodities. Class III commodities can have a "limited amount" of Group A or B Plastics. A limited amount is defined as a maximum of 5% by weight or volume. Factory Mutual considers paper cupsin compartmented cartons to be a benchmark Class III commodity.

Class IV commodities are those Class I, II or III commodities with an "appreciable amount" of plastic or with plastic packaging. An appreciable amount of plastic is defined as between 5 and 15 percent by weight or between 5 and 25 percent by volume. Group B Plastics are also considered as Class IV commodities. Factory Mutual considers polystyrene and paper cups in compartmented cardboard cartons to be a benchmark Class IV commodity.

Plastics and rubbers are divided into three categories (Group A, B and C) depending on their burning characteristics. NFPA 13 contains a list of common plastics, and which group they belong. It is possible for the manufacturer to add fire retardant chemicals into the plastic which will alter its burning characteristics and lower its category. Factory Mutual considers polystyrene cups in compartmented cardboard cartons to be a benchmark GroupA plastic commodity.

There are two conditions in which Group A plastics can be treated as Class IV commodities. These conditions will make a difference in how the commodity is treated and how the sprinkler system is designed.

The first condition is when the plastic is considered "free flowing." To be free flowing, the commodity must be small objects that fall out of the box, fill the flue space, and smother the fire. Examples of free-flowing plastics are:

- Powder
- Pellets
- Flakes,
- Random packed small objects

The second condition under which Group A plastics can be considered as Class IV commodities is when there are multiple layers of cardboard or equivalent outer material which would significantly delay the involvement of plastics in the fire by acting as an insulation. Another consideration is the storage arrangement and the amount of material within the carton. If the additional packaging, arrangement, or material is where it would not significantly increase the fire hazard then the Group A plastic can be reduced to a Class IV commodity.

218 System Protection Area Limitation

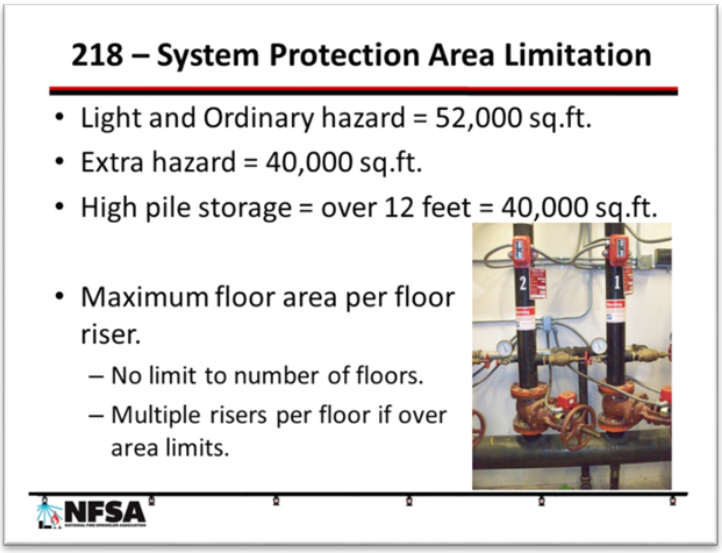
Fire sprinkler systems are hydraulically efficient, yet NFPA 13 limits the size of fire sprinkler systems to floor area. The AHJ will need to check the limits below and compare with what is noted on the shop drawings. A single riser or an individual riser stemming from a manifold may only extend over a floor area up to the following limits:

- Light hazard: 52,000 square feet
- Ordinary hazard: 52,000 square feet
- Extra hazard, hydraulically calculated: 40,000 square feet
- High pile storage: Solid-piled, palletized, rack storage, bin box, and shelf storage over 12 feet in height: 40,000 square feet

Where there are single risers protecting light or ordinary hazard areas with high piled storage or extra hazard, the maximum floor area cannot exceed a52,000 square feet, of which 40,000 square feet may be high-piled storage or extra hazard.

Where the floor area is protected by a single riser and a mezzanine is within that sprinklered floor area, the mezzanine floor area is not counted or included.

The single riser may cover separate or individual buildings where connected by common canopies, covered breezeways, common roofs and common walks and are to be included in the calculation of the floor area of a single riser.



Module 3 - Design Review

Introduction

During the submittal review, the fire sprinkler plans examiner is assuring the documents are present to start the review. In this stage, the design review, the fire sprinkler plans examiner goes deeper into the construction documents and further examines and compares them to the adopted codes and referenced standards. The design review is the part of the plans examination that entails the how the system is hydraulically designed and where sprinklers are placed.

In the design review checklist, below, do not expect to fill in all the blank areas. Each design method stands alone from each other and are not usually intertwined with other design methods. For example, where the fire sprinkler layout technician chooses the room design method, the examiner would review only to that section. The plans examiner would not examine according to the density/area method.

301 Water Demand

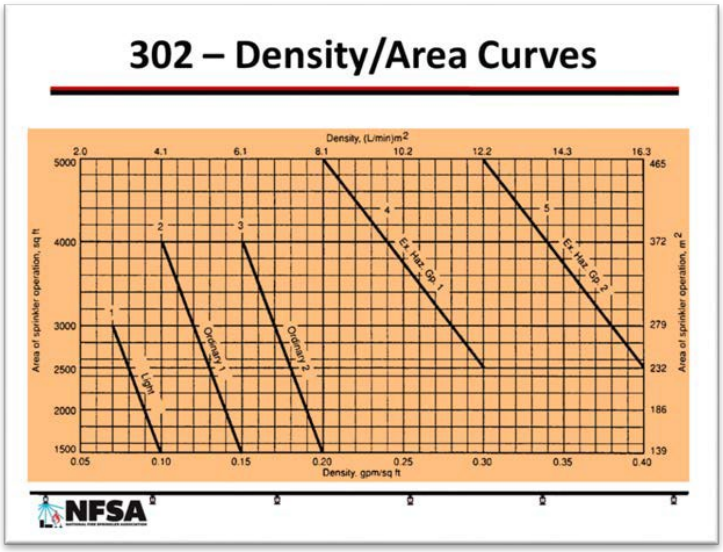
There are three hydraulic calculation methods for sprinkler systems that the fire sprinkler layout technician can choose:

1. Density/area curves of Figure 11.2.3.1.1 in accordance with the method of 11.2.3.2
2. The room design method in accordance with 11.2.3.3
3. Special design areas in accordance with 11.2.3.4.

It should be clearly noted on the hydraulic calculations and shop drawings which hydraulic calculation method is used. The design review checklist has three distinct areas that correspond with the three methods. Follow the appropriate method on the checklist.

302 Density/Area Curves

The density/area method of determining the flow needed out of the sprinklers has been the most popular for several decades. Although specially listed sprinklers and other types of sprinklers that do not use this method are gaining in popularity, the density/area method is commonly utilized for most fire sprinkler system calculations.



In the density/area calculation method, the density is the variable that answers the question, "How much water needs to discharge from the sprinkler to control or suppress the fire?" The density is the measurement of the flow of water that discharges from a sprinkler and lands in a single square foot under that sprinkler. Density is measured in flow divided by unit area. In the inch-pound system of units, the density is most often measured in gallons per minute per square foot. This is also commonly abbreviated as gpm/sq feet.

To have a better understanding of density, consider it an average of the flow of water coming out of a sprinkler. The water is spread around to cover the floor area under the sprinkler. For example, assume that a sprinkler is discharging water at a flow rate of 45 gpm and that water is spreading out over a floor space of 225 square feet under that sprinkler. The amount of water falling in any single square foot of space under that sprinkler will average 0.2 gallons per minute per square feet (45/225 = 0.2 gpm/feet). The 0.2 gpm/feet is the density.

Fire sprinklers have been used for over 100 years. In that time, a lot has been learned from the experience in real fires that have occurred and from fire tests that have been performed. By studying all this data, the density needed to control or suppress a fire in different occupancies has been determined. For light, ordinary, and extra hazard occupancies, the densities necessary to control or suppress a fire are found in Step 302. For other hazards, such as for storage occupancies, NFPA 13 contains density criteria in several storage chapters.

The density/area method of design is the most commonly used method of answering the question, "How many sprinklers are going to open?" While the density portion of the curves is used to answer the question about the flow from each sprinkler, the area portion is used to answer the question of how many sprinklers to calculate. The exact number of

sprinklers that are assumed to open in the event of a fire will vary depending on the spacing of sprinklers and the placement of sprinklers with respect to walls. In a building where the sprinkler spacing is consistently the same, the number of sprinklers that will be assumed to open during a fire can be calculated using the following formula:

N = the total number of sprinklers to calculate
A_c= the area from the density/area curves
A_s = the area of coverage for the typical sprinklers in the system

Note that this formula only works when most of the sprinklers in the system are installed on the same spacing. When sprinklers are not installed on relatively uniform spacing, other methods must be used to answer the question regarding the number of sprinklers in the design area.

Consider the following example. Sprinklers are installed throughout an ordinary hazard group 2 occupancy at 10 feet x 12 feet spacing. The point of 0.2 gpm per square feet over 1,500 square feet is selected from the density/area curves. How many sprinklers need to be in the design area?

To answer the question, the design area selected from the curves needs to be divided by the area of coverage for each sprinkler. In this case, the area of coverage for each sprinkler is 120 square feet (10 x 12 = 120). The total number of sprinklers in the design area then needs to be 13 (1,500/120 = 12.5 rounded up to 13). Note that when this calculation is made, any fraction, no matter how small needs to be rounded up to the next whole number. This is because a fraction of a sprinkler doesn't exist and rounding up provides a safety factor.

The design area needs to be the hydraulically most demanding in the sprinkler system. In most situations, this will include the single sprinkler that is the farthest from the water supply. However, in sprinkler systems with special sprinklers, multiple hazards, or in systems with non-uniform spacing, the single most demanding sprinkler may not be the farthest from the water supply. It may be necessary to perform multiple sets of hydraulic calculations to prove that the most demanding situation is determined.

For sprinkler systems where the piping is in the configuration of a grid, (for an example of a gridded system see Step 405) it is not easy to determine just by looking at the system which is the most demanding sprinkler (or set of sprinklers). Because of this, NFPA 13 requires three sets of hydraulic calculations to be performed; the most demanding and the two design areas to either side.

Once the number of sprinklers in the design area has been determined, the next step is to determine the shape of the design area. NFPA 13 requires the design area to be a rectangle and gives the dimension for the length of the rectangle in the direction parallel to the branch lines. To get the design area into a rectangle, NFPA 13 uses 1.2 times the square root of the design area. Other authorities having jurisdiction, such as Factory Mutual, may use 1.4 the square root of the design area. When using 1.2 the square root of the design area, this forces more sprinklers to be calculated on the branch line, which

then forces the branch line pipes to be slightly larger than they would have been if a perfectly square (1.0 times the square root of the design area) area were used.

To find the number of sprinklers that need to be in the design area on the branch line, the following formula can be used on systems where the distance between sprinklers on the branch line is similar:

NBL = number of sprinklers to calculate on a branch line
Area = the value selected from the density/area curves
S = distance between sprinklers on the branch line

For example, earlier in this module, a sprinkler system was discussed for an ordinary hazard group 2 occupancy with sprinklers installed on 10 feet x 12 feet spacing. The point of 0.2 gpm per square feet over 1,500 square feet was selected from the density/area curves. A total of 13 sprinklers was calculated to be needed in the design area (1,500/120 = 12.5 rounded up to 13). If the distance between branch lines is 12 feet and the distance between sprinklers on the branch line is 10 feet, the following formula can be used to calculate the number of sprinklers that are necessary for the design area along the branch lines:

This means that the number of sprinklers in the design area will be 5 sprinklers on the most remote branch line, 5 sprinklers on the second most remote branch line and 3 sprinklers on the third most remote branch line to make a total of 13 sprinklers in the design area.

In summary, the sprinklers in the design area must be the most demanding for the sprinkler system. Once the most demanding individual sprinkler in the system (usually the most remote) is included in the design area, every sprinkler closer to the riser operates at a higher pressure and is therefore more demanding. The design area consists of the correct number of sprinklers per branch line as determined by 1.2 times the square root of the area from the density/area curves. After that, additional branch lines with the same number of sprinklers (in the same location) are added until the design area is reached, or the addition of another full branch line will take the total area above that needed. If the addition of another full branch line will take the area over that needed to meet the desired area, then individual sprinklers (starting with the sprinkler closer to the water supply) are added until the total design area is reached

304 Sprinklers

After a lengthy explanation and review of the area/design method, at this point verify if the sprinklers in the design areas are calculated correctly.

The density/area method is only permitted to be used with spray sprinklers. Sprinklers used for storage applications, such as CMSA and ESFR sprinklers will use the criteria specifically addressed in storage chapters. Furthermore, NFPA 13 does not have criteria for nozzles, such as nozzles used for protecting columns. These are addressed in other NFPA standards such as NFPA 15, *The Standard Water Spray Fixed Systems for Fire Protection.*

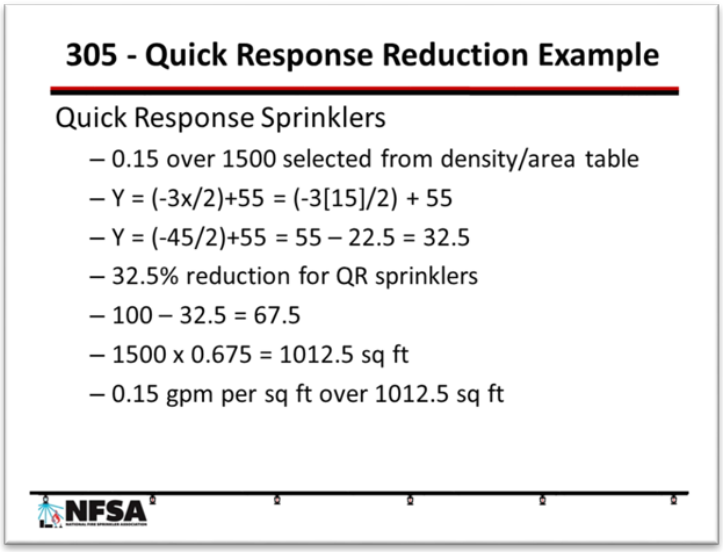
Quick response sprinklers are not permitted in extra hazard occupancies or in occupancies where there is substantial amounts of combustible dusts or flammable liquids. This will be up to the fire sprinkler plans examiner to determine. Will this operation produce combustible dusts that may cause more sprinklers than designed? A flash fire may overcome what the fire sprinkler system design. Having too many sprinklers open may not provide enough flow and pressure to the sprinklers to control the fire

Extended coverage sprinklers have coverage up to 400 square feet. While four extended coverage sprinklers may be able to cover the typical design area of 1,500 square feet, NFPA 13 wants at least five sprinklers in the design area. Five is the minimum number of sprinklers in the design area in several locations throughout NFPA 13. Extended coverage sprinkler design area shall be either five sprinklers or 1,500 sq. feet, whichever is greater. The extended coverage sprinkler shall be listed and provide the minimum flow and pressure for the coverage area.

305 Quick Response Decrease

In light and ordinary hazard occupancies where quick response sprinklers have been used throughout the compartment, the design area can be reduced by 25% to 40% depending on ceiling height. For ceiling heights of 10 feet or less, the reduction to the design area is 40%. For ceiling heights of 20 feet, the reduction in design area is 25%. For ceiling heights over 20 feet, no reduction in design area is allowed.

When the ceiling height is between 10 feet and 20 feet, interpolation is permitted and a calculation for the reduction percentage is necessary. To obtain the area reduction percentage, use the following equation: $yy = \frac{-3xx}{2} + 55$ The "x" is the actual ceiling height.



To take advantage of this quick response sprinkler reduction in area, all the following conditions must be met:

- Quick response sprinklers only
- Wet pipe system only
- Light or ordinary hazard only
- 20 feet maximum ceiling height
- No unprotected ceiling pockets

The reduction in design area depends on the ceiling height. For a room with multiple or sloped ceiling heights, the highest point of the ceiling is what counts for this reduction.

Although the design area can be less than 1,500 square feet, there cannot be less than 5 quick response sprinklers in the design area.

306 Sloped Ceiling Increase

For hazards where the roof or ceiling above the sprinklers is sloped more than 2 units in 12 units, the design area is increased by 30%. The pitch of the roof or ceiling should be indicated in an elevation view and/or in This increase is in addition to any other increase that might be required by any other condition.

The purpose of the 30% increase for sloped roofs and ceilings is to account for the additional sprinklers that open remote from the fire as heat runs up the slope and along the ridge. These sprinklers take water from the water supply but are not usually close enough to the fire to have an effect. It takes more time for the heat to bank down and open sprinklers directly over the fire. During that delay, the fire will grow larger and require more sprinklers to open to control it. The delay in getting sprinklers directly over the fire to open is like the delay that occurs in dry-pipe systems, so the increase is the same.

The sloped ceiling increase applies to light, ordinary and extra hazards, but not to storage. Roof or ceiling slopes over 2 units in 12 units for storage occupancies are not permitted. For storage occupancies, the number of sprinklers that might open during a fire under a sloped ceiling is unknown.

307 Dry Pipe and Double Interlock Preaction System Increase

For dry pipe and double interlock preaction sprinkler systems, the design area selected from the density/area curves is required to be increased by 30%. The adjustment to the design area is made without changing to the density. For example: If a value of 0.2 gpm per square feet over 1,500 square feet is selected for an ordinary hazard group 2 occupancy with a dry pipe system, the area increases of 30% would bring the discharge criteria to 0.2 gpm per square feet over 1,950 square feet. A 30% increase is the same as multiplying the area by 1.3(1.3 x 1,500 = 1,950)

The purpose of the 30% increase is to account for the time delay in getting water into a dry pipe sprinkler system. When a fire occurs in a building protected by a dry pipe sprinkler system, the first sprinkler opens and drops the pressure enough to trip the dry pipe valve. Once the valve trips, it takes time for the water to travel from the dry pipe

valve through the piping system to the open sprinkler(s). During that delay in getting water to the fire, it is possible for the fire to grow and open additional sprinklers.

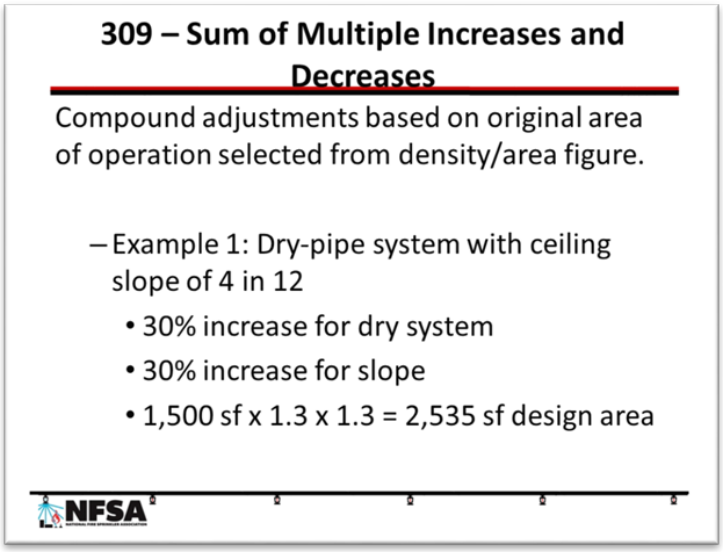
It is important to note that this increase only applies one preaction system, the double interlock. There are two other kinds of preaction sprinkler systems: single-interlock and non-interlocking. For these two types of systems, no area increase is required (in light, ordinary and extra hazard occupancies) because water starts to flow in the piping system before a sprinkler opens due to the heat of a fire.

308 High Temperature Increase

The density/area curves for extra hazard are based on the use of ordinary temperature sprinklers. When high temperature sprinklers are used, the design area is decreased by 25%, but never below the minimum threshold of 2,000 square feet. For example, for an extra hazard group 1 occupancy, the point in the density/area curves of 0.3 gpm per square feet over 2,500 square feet can be selected. If high temperature sprinklers are used, then the area may be decreased. A 25% decrease is the same as multiplying the area by 75% (0.75). Taking 75% of 2500 square feet would yield a design area of 1875 square feet (0.75 x 2,500 = 1,875). However, the design area is not allowed to go below 2,000 square feet, so the minimum density/area criteria for high temperature sprinklers is 0.3 gpm per square feet over 2,000 square feet.

309 Sum of Multiple Increases/Decreases

In any sprinkler system that has two or more adjustments that are made in the design area, the adjustments are required to be compounded based on the original area of operation selected from the density/area curves. This method of applying the adjustments makes it irrelevant which adjustment comes first.



310 Room Design Method

An alternative to the Density/Area Method for determining the number of sprinklers that will open during a fire is called the Room Design Method. The room design method is a

separate method of determining how many sprinklers will open during a fire; therefore, the rules from the density/area method do not apply. This method is the fire sprinkler layout technician's choice. This method assumes that all the sprinklers in the room will open during the fire and confine the fire to that room. For the design of the sprinkler system, all the sprinklers in the most demanding room (usually the largest room farthest from the water supply) will need to be calculated. The person performing or reviewing the calculations must be careful to make sure that they look at all the possibilities. A room farther from the water supply may be more demanding because of the arrangement of sprinklers or a room close to the water supply may be more demanding because of its size.

To qualify for this design method, the room must be a compartment surrounded by walls and a ceiling. The walls are required to have a fire resistance rating equal to the water supply duration applicable to the hazard classification. Compartments can have openings to other compartments if there is a lintel over the opening at least 8 inches deep. The lintel helps the hot gasses from a fire stay in the room and build up to activate the sprinkler.

Corridors are rooms and need to be considered when determining what the most demanding room is. It is entirely possible that a corridor might be the most demanding room in a building. However, most corridors are long and narrow and protected with a single row of sprinklers. A fire starting in a corridor is not likely to set off all the sprinklers in the corridor since the sprinklers will cool the gases from the fire and prevent other sprinklers farther down the hall from opening. Therefore, a special set of rules exist for the room design method where the room in question is a corridor protected by a single row of sprinklers. For light hazard occupancies, a maximum of five sprinklers are calculated regardless of the number of sprinklers in the corridor or whether or not the openings onto the corridor have the correct fire-resistant doors with closers or not. For ordinary and extra hazard occupancies, the doors are required to have the correct fire resistance and closers, so the design will also be five sprinklers for the corridor.

There is no requirement under the room design method to increase the number of sprinklers for a dry-pipe system nor is there any allowance for decreasing the number of sprinklers if quick response sprinklers are used. Quite simply, the room design method states that all the sprinklers in the room will open, unless that room is long and narrow like a corridor.

Frequently, when using the room design method, there will be many different rooms, each with unique flow and pressure demands. If one single room has the highest pressure and flow demand, then that will be the single most demanding room to use for the hydraulic calculations. If there is one room that has the highest flow demand, and a different room that has the highest-pressure demand, then both rooms are considered the most demanding and two sets of hydraulic calculations need to be performed. The water supply will need to be capable of supplying both rooms (individually, not added together).

311 Opening Protection

Room design method requires openings in walls will need some sort of protection (like a door) in them to help keep the heat in during a fire. For light hazard occupancies, the doors must have some sort of closing capability (automatic or self-closer), or the calculations must include two sprinklers in the adjoining space. For ordinary and extra hazard occupancies, the doors must have automatic or self-closers with appropriate fire resistance ratings for the walls they are set in.

The room design method can conflict with the building code in regard to how the room is fire rated. The fire resistance rating requirement is only for the walls of the room. NFPA 13 is not requiring a rating on the floor or ceiling. The only opening protection required is for the door opening (closers) and not for pipe or HVAC penetrations. The room design method does not trigger the penetration protection requirements in the IBC.

As the plan's examiner, be aware of the trade-offs that eliminate the corridor ratings in the building code. If the corridor or other room ratings were eliminated by trade-offs, then they need to be "put back on" to comply with the room design method.

312 Special Design Areas and Approaches

The water supply for sprinklers shall be determined only from one of the following methods:

1. Density/area curves
2. The room design method
3. Special design areas

It is important to know that the three items above are all separate and distinct hydraulic design methods that the designer or fire sprinkler layout technician chooses. The special design areas, in #3 above, is another method to address special design areas.

313 Service Chutes

Where the design area consists of a building service chute supplied by a separate riser, the maximum number of sprinklers that needs to be calculated is three each with a minimum discharge of 15 gpm.

314 Canopies

An area, such as a canopy, that is protected by a single line of sprinklers, the design area shall include all sprinklers on the line up to a maximum of seven.

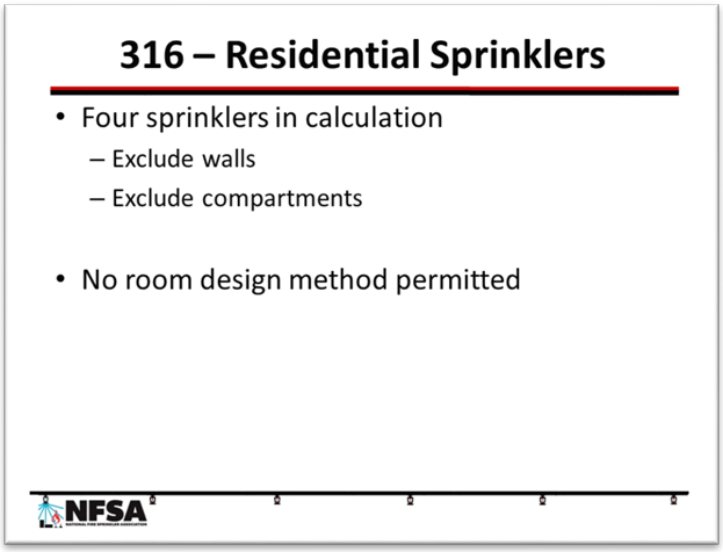
315 Duct Sprinklers

Sprinklers in ducts and commercial cooking ducts shall be hydraulically designed to provide a discharge pressure of not less than 7 psi at each sprinkler with all sprinklers within the duct flowing.

316 Residential Sprinklers

When residential sprinklers are used in a sprinkler system that complies with NFPA 13, the number of sprinklers in the design area will always be four. These four sprinklers

might be in the same room, or they might be in adjacent rooms. The most demanding four adjacent sprinklers are located and calculated.



Residential sprinklers are not permitted to use the room design method, even if the smallest room has fewer than four sprinklers. If all the rooms have fewer than four sprinklers, then additional sprinklers in adjacent rooms are added until the design of four sprinklers is met. Even in rooms with four sprinklers, depending on the piping arrangement, the four most demanding adjacent sprinklers might be in different rooms regardless of fire partitions and fire barriers. The calculations need to be conducted with the four most demanding adjacent sprinklers.

317 Exposure Protection

Exposure protection systems are sprinklers that protect and/or cool a vessel, such as petroleum tanks, or walls from a fire. Piping shall be hydraulically calculated in accordance with NFPA 13 to furnish a minimum of 7 psi at any sprinkler with all sprinklers facing the exposure operating.

The exposure protection and/or water curtain criteria is often confused with the criteria for listed window sprinklers. NFPA 13 does not have criteria for the listed window sprinklers but permits windows sprinklers to be used under the special application criteria. Window sprinklers have their own specific design and installation criteria that can only be found in the manufacturer's literature.

318 Water Curtain

Water curtains are closely spaced sprinklers to protect vertical openings (an opening in a horizontal assembly) such as stairs and escalators. Water curtains also protect large openings such as the stage and seating (called the proscenium opening) in lieu of a fire rated proscenium curtain.

The water curtain is designed to have a minimum of 3 gpm per lineal foot and every sprinkler must discharge a minimum of 15 gpm. Water curtain calculations must be included into a design area with the ceiling sprinklers.

The exposure protection and/or water curtain criteria is often confused with the criteria for listed window sprinklers. NFPA 13 does not have criteria for the listed window sprinklers but permits windows sprinklers to be used under the special application criteria. Window sprinklers have their own specific design and installation criteria that can only be found in the manufacturer's literature.

319 Combustible Concealed Attic Spaces with a Roof Pitch Exceeding 4/12

Where sprinklers are installed under a roof or ceiling in combustible concealed spaces (attics) of wood joists (rafters) or wood trusses spaced 3 feet or less on-center and with a roof slope having a pitch of 4 units in 12 units or greater the discharge pressure is specific.

When sprinkler spacing does not exceed 8 feet measured perpendicular to the slope, the minimum sprinkler discharge pressure shall be 7 psi.

When sprinkler spacing exceeds 8 feet measured perpendicular to the slope, the minimum sprinkler discharge pressure shall be 20 psi.

320 Adjacent Hazards or Design Methods

When there are two or more hazards or design methods that are adjacent to one another, NFPA 13 gives three options on how to separate the adjacent hazards.

1. Separate with a barrier that prevents heat from one area to the adjacent area.
2. Install a ceiling height change of two feet between the two hazards. Two feet is considered an appropriate barrier.
3. Extend the more demanding system into the lesser system by a minimum of 15 feet.

321 Hose Stream Allowance

Hose allowance can be defined as the local fire department connected to the same water supply as the sprinkler system. When the fire sprinkler system is flowing water on a fire, the fire department is flowing or taking water from the fire sprinkler system. The hose allowance makes this consideration.

A common question on a design review is where the hose allowance added into the calculations. The answer is wherever the hose stream is physically is part of the system. In situations where there are inside hose stations, then some of the hose stream allowance will be added to where those hose stations connect into the piping and the remainder gets added outside of the building. If there are no inside hose connections, then all the hose stream flow is added outside of the building.

As mentioned above, the hose stream is the anticipated flow that the fire department will use upon arrival to a fire situation. The nearest fire hydrant is typically the point of flow.

Where this fire hydrant is located and where its pipe connects to the underground is where the flow is added into the hydraulic calculations.

For scenarios where the building system reaches the public/municipal water supply before the hydrant is located, the hose stream would be added as the last step. The friction loss, in this case, is minimal as public water supplies are typically large enough diameters that the amount of fire flow present creates very little friction loss in that section of piping.

322 Pipe Schedule Design

The pipe schedule method is permitted only for new installations of 5,000 square feet or less or for additions or modifications to existing pipe schedule systems. Pipe schedule systems are evaluated by the fire sprinkler plans examiner through the provisions of NFPA 13 in the following sections. A hydraulically calculated system and its rules do not apply to pipe schedule systems.

323 Pipe Schedule Water Supply

NFPA 13 allows the use of pipe schedule systems for new systems less than 5,000 square feet and for additions and modifications to existing pipe schedule systems. NFPA 13 also allows the use of the pipe schedules for systems exceeding 5,000 square feet providing residual flows are available at pressures that would allow 50 psi at the highest sprinkler. Since NFPA 13 does not make a distinction between new and existing systems, it suggests that the 50-psi requirement applies to additions to existing systems larger than 5,000 square feet.

324 Pipe Schedule Size of Risers

Every system riser shall be sized to supply all sprinklers on the riser on any one floor as determined by the standard schedules of pipe sizes. New extra hazard pipe schedule systems are prohibited and must be hydraulically calculated, however, see NFPA 13 for existing system sizing.

325 Pipe Schedule Light Hazard

NFPA 13 has several figures and tables pertaining to light hazard pipe schedule system rules.

326 Pipe Schedule Ordinary Hazard

NFPA 13 has several figures and tables pertaining to ordinary hazard pipe schedule system rules.

327 Special Situations & Exemptions

NFPA 13 states that “sprinklers shall be installed throughout the premises” is a basic requirement, but it does permit areas to be exempt from sprinklers where permitted by the NFPA 13.

Sprinklers are not required inside furniture and equipment that is not intended for occupancy. For example, a portable wardrobe in a nursing home is not required to have

fire sprinklers installed within it. Another example of an area that is exempt from sprinklers are air handling units on the top of a building.

328 Concealed Spaces

Concealed spaces that have exposed combustible construction require fire sprinklers. Concealed spaces may support combustion and fire and permit it to spread without the knowledge of the occupants. When the fire reaches a sprinklered area, it may be too large for the fire sprinkler system to control. This is the reason for fire sprinklers in concealed combustible spaces.
When sprinklers are installed in a concealed space the sprinkler is not required to be accessible for inspection, testing and maintenance per NFPA 25.

Sprinklered concealed spaces are designed according to the densities assigned to light hazard occupancies.

329 Unsprinklered Concealed Spaces

This is an extensive area to consider. NFPA 13 has several very specific rules for areas that do not need fire sprinklers. The plans examiner needs to carefully consider these areas while reviewing to ensure the shop drawings comply with the NFPA 13. Removing sprinklers in a fully sprinklered building is permissible because of previous experience, data, and the low combustible properties of certain spaces.

Concealed spaces with noncombustible or limited combustible construction are typically exempt from sprinklers when the following conditions are present:

- Minimal combustible loading. Minimal combustible loading can be of small amounts of combustibles in an otherwise noncombustible space. An example would be PVC roof drains in an above ceiling concealed space. This limited amount of plastic is permitted to be in a space without sprinklers.
- No access or limited access to the concealed space. Small openings are permitted such as return air grills. The access cannot be a door or a small hatch.
- No occupancy. The concealed space cannot be occupied.
- No storage. The concealed space cannot store combustible products. The plans examiner may want to raise a concern when a space that is exempt from sprinklers can only store noncombustible products. Many people will not discern whether a product is combustible or noncombustible before stowing it in an unsprinklered concealed space.

The remainder of this section in NFPA 13 can be extensive. The specific sections in NFPA 13 are very clear and the shop drawings and the proposed locations need to be checked. While NFPA 13 is very clear, here is a summarized list of areas that are exempt from sprinklers:

- Concealed spaces where joists or studs have less than 6 inches in between are exempt. When the space is less than 6 inches, it is nearly impossible to physically get into the space to install sprinklers.
- The void space between I-joists is exempt when there is a ceiling directly attached to the bottom of I-joist or to metal channels within 1 inch of the bottom of the I-joist. The void space between I-joists must be firestopped with I-joist material into 160 cubic feet or less and with a minimum of 3 ½ inches of batt insulation installed. Filling the entire space full of noncombustible insulation is permitted.
- Concealed spaces filled entirely with noncombustible insulation with a maximum open space of 2 inches at the top of the space. This space permits ventilation of the space if it is a roof space. Insulation tends to settle over time and the installation should entirely fill the space and count on settlement to create the two-inch space.
- Spaces 55 square feet or smaller that are over isolated or remote sprinklered rooms are exempt from sprinklers.
- Concealed spaces where the material has a flame spread of 25 or lower and where the materials do not support combustion.
- Concealed spaces where all the exposed space is constructed of fire-retardant-treated wood. This is wood that is penetrated with a fire-retardant material, not spray applied in factory or in the field.
- The void space of joist and I-joists in a sprinklered space is exempt. This is the area between the ceiling material and the insulation that is laid upon the joist. This void space is exempt from sprinklers.

- Vertical pipe chases, when less than 10 square feet and firestopped at each floor. The piping shall be either noncombustible or water filled. Penetrations of the piping at each floor level are protected per the building code.
- Exterior columns that support sprinklered exterior canopies are exempt from sprinklers when less than 10 square feet.
- Drop or suspended ceiling configurations, supported by wood joists or I-joists have several variations that are exempt from sprinklers.
- The concealed space formed by paper faced or foil faced paper facing of insulation may be exempt from sprinklers if the facing can be listed as noncombustible or limited combustible.

330 Vertical Shafts

Shafts with noncombustible or limited combustible construction or surfaces with no access do not require fire sprinklers. Shafts with noncombustible or limited combustible construction with no access that is used exclusively for electrical or mechanical systems do not require fire sprinklers. If the descriptions above are not met, then one sprinkler is required at the top of the shaft. If the shaft is accessible, one sprinkler is required near the bottom.

Shafts with combustible surfaces will require one sprinkler at every other floor level. If the shaft has trapped sections, then additional sprinklers are required in the trapped section.

331 Stairways

Combustible stairways require a sprinkler at the top of the stairway, under each landing at every floor, and under the lowest intermediate landing.

Noncombustible stairways require a sprinkler at the top of the stairway and under the lowest intermediate landing. If the landings or beneath the stairs are used for storage, then sprinklers are required to protect these spaces. If the space, such as the lowest intermediate landing, is blocked off to prohibit storage, then the sprinkler can be eliminated.

When doors are installed within the stairway, sprinklers are required on each side of the door. If the stairs have multiple openings on a floor to serve that floor, sprinklers are required at each floor.

332 Vertical Openings

When there is a hole in the floor, it is called a vertical opening. The building codes permit these for certain applications, such as escalator openings, if the opening is protected by rated walls or closely spaced sprinklers with draft curtains.

Standard spray sprinklers shall be spaced no more than 6 feet apart and installed between 6 and 12 inches away from draft stop. The sprinklers are installed on the floor side of the draft stop and not on the opening side of the draft stop. The draft stop shall be curtain style and descend from the ceiling plane 18 inches. The draft stop shall be

noncombustible or limited combustible material that is substantially attached to the ceiling material.

The fire sprinkler plans examiner shall watch out that the draft stop is curtain style as describe above. Some building designers want to create an 18-inch-deep channel into the ceiling. This is not permitted.

Closely spaced sprinklers and draft stops are not required around openings that are considered large. The minimum dimensions for a large opening are where the opposite edges of the opening are greater than 20 feet in width and the area of the floor opening is greater than 1,000 square feet.

333 Elevators

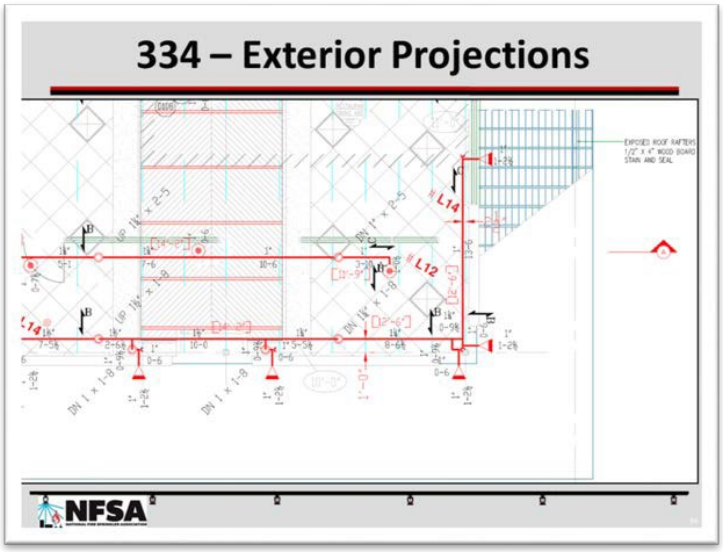
NFPA 13 has criteria for sprinklers in elevator shafts, hoistways and machine rooms. However, many states have a department that is solely dedicated to the elevator installation. These departments, or commonly called elevator divisions, have total jurisdiction over everything that pertains to the elevator and they have very specific rules for sprinklers in hoistways and machine rooms. The fire sprinkler plans examiner should know the rules of their state or jurisdiction on elevators. However, sprinklers for elevators may be outside of the jurisdiction to enforce.

Typically, the only sprinkler that is required in the elevator shaft is within two feet from the bottom. This sprinkler protects the shaft from the debris, trash and hydraulic oil that may have leaked over the years. The sprinkler at the bottom may be eliminated when the shaft is of noncombustible construction and the elevator does not use hydraulic oils or fluids that are combustible.

A sprinkler is required at the top of the elevator shaft. However, passenger elevator shaft with elevator cars that comply with ASME A17.1 are exempt from sprinklers.

334 Exterior Projections

Exterior roofs, canopies, porte-cocheres, balconies, decks, and similar exterior projections over four feet wide require sprinklers. When the exterior projection has combustibles stored underneath, sprinklers are required when the exterior projection is over two feet wide. However, sprinklers may be exempted when the exterior projection is constructed entirely of noncombustible, limited-combustible or fire-retardant-treated wood. When constructed of the materials above, sprinklers are exempted below the exterior projectionalso.



When the exterior projection is combustible, sprinklers are required within the structure and below the structure. However, sprinklers may be exempted from combustible concealed space when filled entirely with noncombustible insulation, when the void space between solid wood joists is firestopped with I-joist material into 160 cubic feet or less, or when the space is less than 55 square feet.

335 Soffits, Eaves and Overhangs

Sprinklers are exempt from soffits, eaves, overhangs, and decorative frame elements withthe following limitations:

- Do not exceed four feet in width.
- Separated from interior spaces by noncombustible or limited combustible material.
- Do not have any opening or unprotected penetrations to the interior spaces.

336 Hotel and Motel Bathrooms and Closets

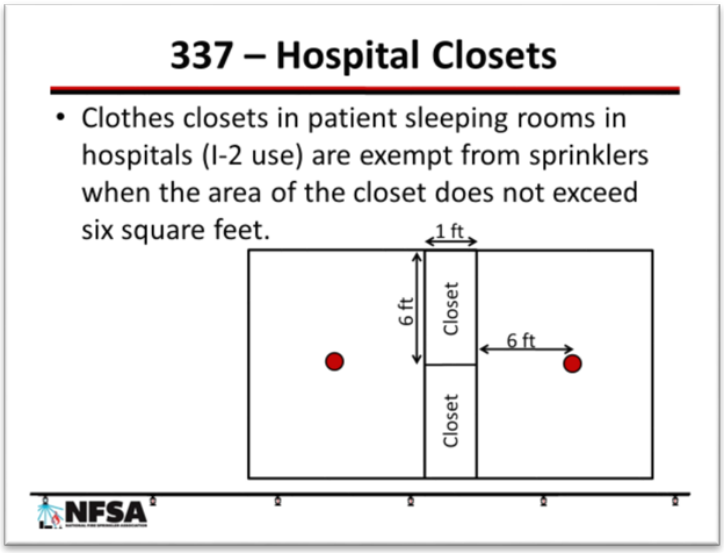
Fire sprinklers are exempt in dwelling unit bathrooms in hotels and motels when they do not exceed 55 square feet. The walls and ceilings shall have noncombustible or limited-combustible finish with a 15-minute thermal barrier rating. The 15-minute thermal barrier rating must be extended behind the tub or shower enclosure. These enclosures are typically fiberglass or acrylic, which are combustible, but with the thermal barrier (drywall, sheetrock, wall board, etc.) the hotel or motel bathroom is very limited on combustibles and the ability to store materials in cabinets and other nooks and crannies.

It is important to note here that the IBC allows bathrooms that do not exceed 55 square feet for all R-1, R-2, and R-3 occupancies to be exempt from sprinklers.

Hotel and motel closets and pantries are exempt from sprinklers when the walls and ceilings have noncombustible or limited combustible surfaces, and the area is less than 24 square feet with the smallest dimension not exceeding three feet.

337 Hospital Closets

Clothes closets in patient sleeping rooms in hospitals (I-2 use) are exempt from sprinklers when the area of the closet does not exceed six square feet.



Module 4 Hydraulic Review

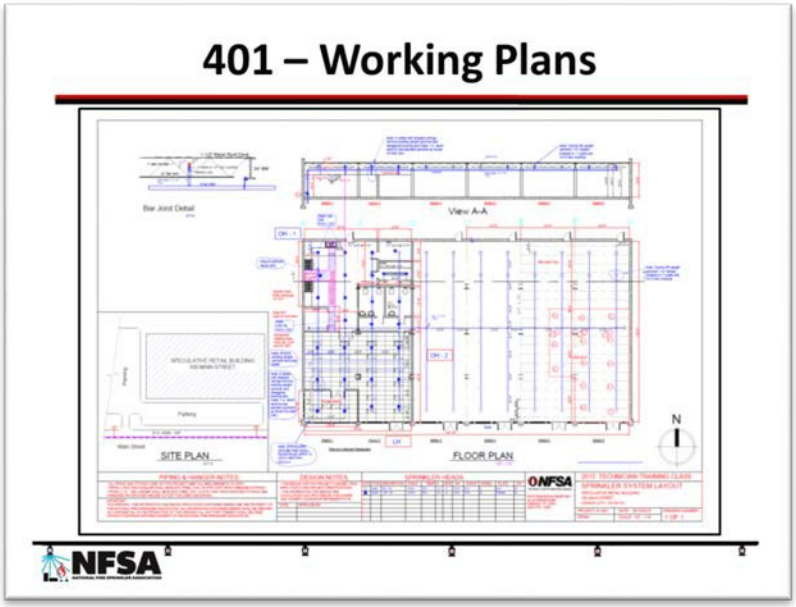
Introduction

In this stage, the fire sprinkler plans examiner reviews the hydraulic design. The hydraulic design of the fire sprinklers system in NFPA 13 is an engineered system. This is the primary reason why the shop drawings are not, or should not, be required to signed and sealed by a professional engineer.

The hydraulic review checklist follows the same style as other checklists and modules in this guide. This module will use more photos and figures to help relay what each step is trying to accomplish. In this checklist, not every step has a referenced section listed. This doesn't mean that the step isn't required by NFPA 13. When there is no NFPA 13 reference listed on a step, go to the reference section on the leading step.

401 Working Plans

NFPA 13 has a forty-six-item list of what is to be contained in the fire protection shop drawings (Step 204). Furthermore, water supply information is also necessary to complete the review and shall be part of the submittals. NFPA 13 also has a nine-item list of requirements for the water supply information.



402 Summary Sheet

The summary sheet is the first page of the hydraulic package. It contains the vital information of the project. Without this page, the fire sprinkler plans examiner cannot start the review. One of the most important items on the summary sheet is the date. This becomes the "birthday" of the hydraulic calculations. It means on this date, the available water supply was shown to be sufficient to supply the sprinkler system. The available water supply of Step 207 shall be within 12 months of the summary sheet date.

403 General Information

Make sure the general information of the project is listed. The project name and location will vary from job to job, but it is very important. Names change over the years, but the address or location never does. The address is the permanent identification of the project.

The summary sheet may also contain contract numbers and other identifiers. These are typical and are related to the construction project and do not necessarily have anything to do with the review.

404 Contractor, Technician, Designer Name

Knowing who is the fire sprinkler layout technician, designer, and contractor is important for a couple of reasons. There may not be all three listed on the summary sheet, but the fire sprinkler plans examiner should know who all three, or at least who are two of the above.

The contractor could be the contractor who installs the fire sprinkler system or the general contractor of the project. Which contractor should be listed on the summary sheet? The one that secures the permit to install the system. This is the person responsible for the fire sprinkler system at this point of the construction process. If there is no contractor listed, then the plans examination correction letter or correspondence would go to the fire sprinkler layout technician.

The fire sprinkler layout technician is the person who has laid out the piping on the shop drawings and performed all the calculation. If there is no permit to install the fire sprinkler system at the time of the review, then all correspondence would go to the fire sprinkler layout technician. Many times, the fire sprinkler layout technician either is the contractor or directly works for the contractor who installs the system. Many states or local jurisdictions require the fire sprinkler layout technician who is responsible for the system layout to be NICET III or IV certified.

Designer is usually used as a generic term for the person who designs or prepares plans. In fire sprinklers, the designer is a professional engineer or the fire protection engineer. One who is licensed by the state as a professional engineer. The designer is the person who supplies the sprinkler layout technician. Most states do not require the shop drawings to be prepared by a professional engineer, but every jurisdiction may be different.

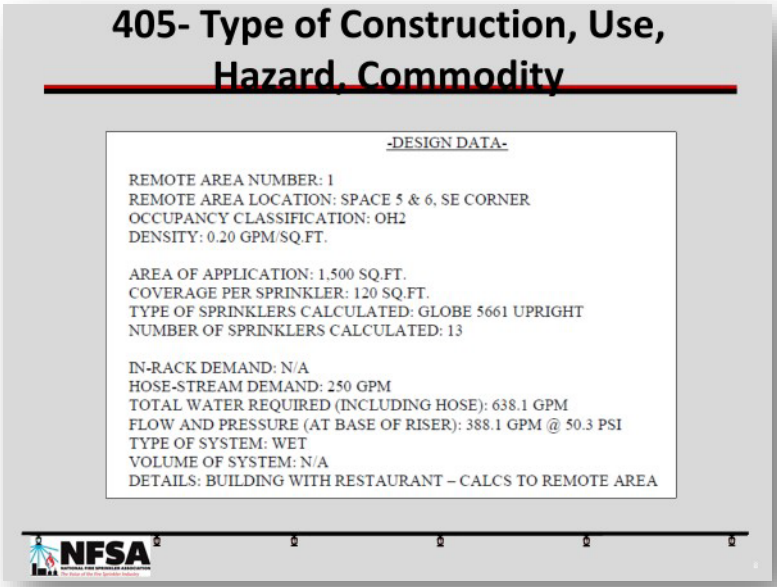
405 Type of construction/use/hazard/commodity

Much of this step was checked in the submittal review steps. Step 215 covers the use of the building. Step 216 covers the hazard classification and Step 217 addresses the commodity if it is a storage project.

The type of construction can refer to two different types: NFPA 13 or IBC. Each code has a different look at the how the building is constructed.

The type of construction for NFPA 13 pertains to the surface of the space where sprinklers are installed or not installed. Listing this type of construction on the summary sheet helps

the plans examiner, for example why sprinklers were omitted in a concealed space or why sprinklers were not installed in a ceiling pocket.



There are three types of construction defined in NFPA 13. Less formal definitions are below:

1. Combustible: The material readily burns such as, wood roof trusses.
2. Limited Combustible: A material that doesn't readily burn, but has combustible elements, such as drywall, or sheetrock. A paper coating with a gypsum core.
3. Non-combustible: Does not burn, such as steel.

The type of construction described in the IBC pertains to the primary and secondary structural members of the building. There are two primary types of construction: combustible and non-combustible. When the structural members of the building are combustible, the building is smaller in area and height. The opposite goes for non-combustible. There are several columns designated with "A" or "B". The "A" columns have fire rated construction. For example, a Type IIA building has 1-hour rated columns, floors, etc. A Type IIB does not have a fire rating on any of its structural members.

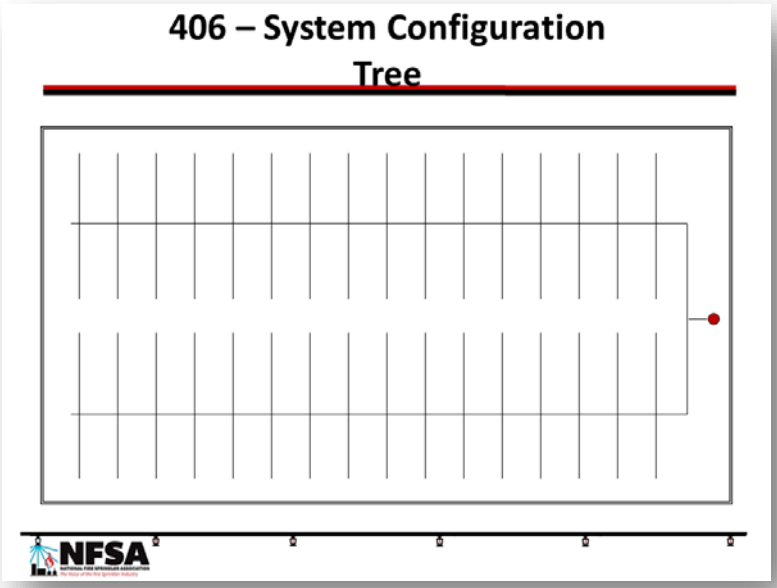
When hydraulic summary sheet lists the IBC type of construction it may help clarify requirements that come from the IBC or NFPA 13.

406 System Configuration

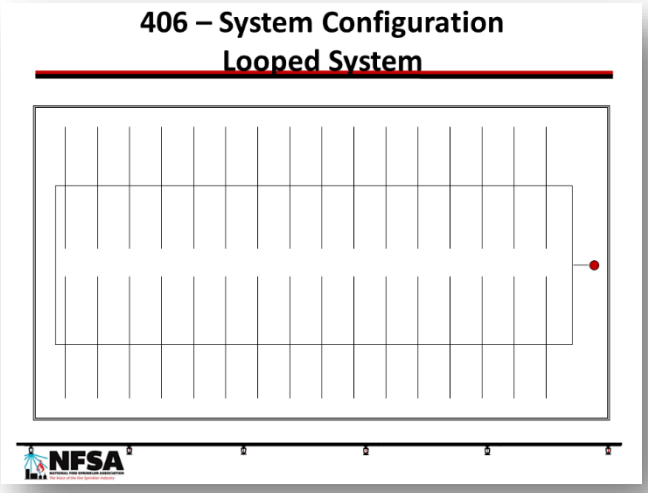
There are three types of fire sprinkler system configurations: tree systems, looped systems, and gridded systems. Below are some brief descriptions to assist the plans examiner identify the systems under review.

The tree system consists of a single larger diameter pipe (cross main) supplying many smaller pipes (branch lines) that branch away from it. Tree systems are a quick and easy

way to run the piping for a sprinkler system. The branch lines in a tree system are often typical. There is only one main to install. In a hydraulic sense, the defining characteristic of a tree system is there is only one path for the water to travel from the water supply to any given sprinkler. This makes the tree system the easiest to calculate and review because all the water traveling to the sprinklers must travel through the same pipes.

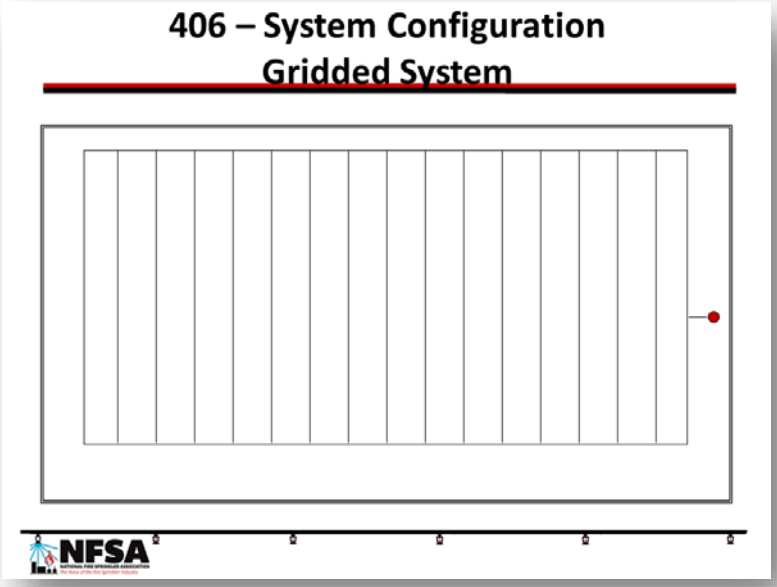


The looped system has a cross main that connects at both ends. The feed main connects to the cross main at any point around the looped cross main. This means the only a portion of the water must travel around either side of the looped cross main. The branch lines are not typically connected or tied together for looped systems. A looped system has some resemblance to two tree systems. The cross main is fed from two ends but the water flows to sprinklers only in only one direction on a branch line.



The gridded system is most hydraulically efficient system for delivering water to sprinklers. In a gridded system, the water is supplied to the sprinkler from many different directions. Not only is there more than one path in the cross mains, but the mains are also joined by branch lines that create compound loops to carry water through each branch line on the system to the open sprinklers. There two cases where gridded systems are not permitted:

- Gridded dry pipe systems are not permitted.
- Gridded preaction systems are not permitted for storage, except miscellaneous storage.



407 Remote Design Areas

There are several items for the fire sprinkler plans examiner to check on the remote design area. For starters, the remote design area is usually the design area that is the farthest way horizontally and vertically from the water supply or riser. The water going to the design area has the longest way to travel. Verify the remote design area or areas on the summary sheet are the same place on the shop drawings and decide if these areas are the most remote design area. It may be necessary for additional calculations to prove the most remote area and the plans examiner will need to request these additional calculations if they suspect the chosen remote area does not seem accurate.

The remote design area for gridded systems is usually between the two outside cross mains in the middle of the branchline piping. NFPA 13 requires the fire sprinkler layout technician to verify the location of the remote design area by requiring two additional sets of calculations with the design area shifted to the left and right adjacent sprinklers on the branchline. This is “peaking” and it the additional calculations show the most demanding design area.

The fire sprinkler plans examiner will verify the size and number of sprinklers in another step.

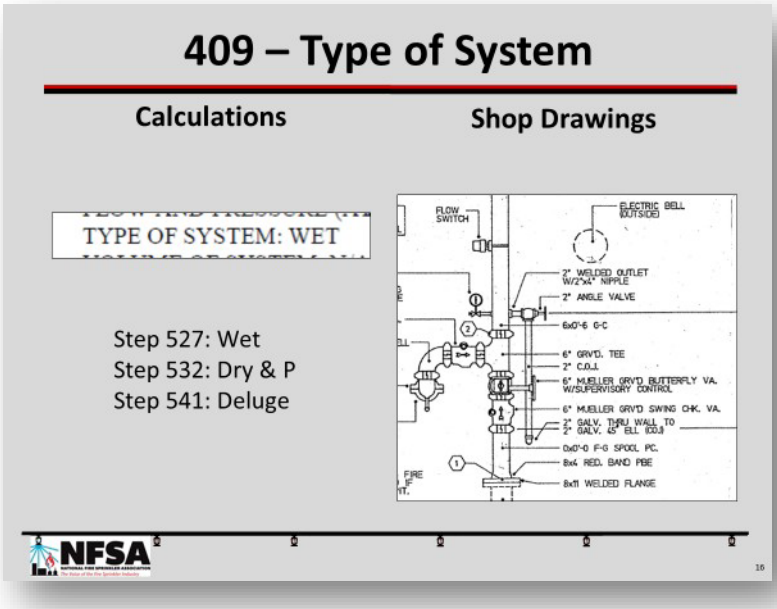
408 System Design

The types of systems are discussed in the Systems Review module. Step 527 for wet systems, Step 532 for dry and preaction systems, and Step 541 for deluge systems, however, in this step verify what type of system is installed. Make sure the shop drawings reflect the system on the summary sheet. Make sure to note the type of system in Step 408.

This is a great place to open the shop drawings and make some verifications. For example, when reviewing the hydraulic calculations, the C-factor of the pipe will change if the system is wet or dry. Also, when tracing the piping through the building, visualize the area where the pipe is in the building to make sure it is in a heated place.

409 Type of system

The summary sheet shall indicate what the hydraulic calculations are based upon. In this step, on the hydraulic review checklist, circle the type of system that is being reviewed. This helps the examiner recall this type of system during the hydraulic calculation review. It also is a quick visual aid to assist in reviewing the permit application.

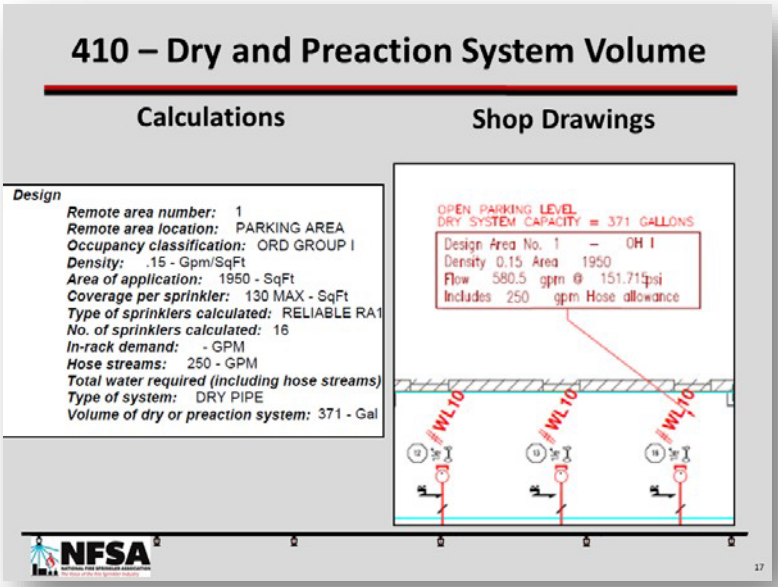


410 Dry and Preaction System Volume

The volume of the dry or double interlock system shall be stated in the summary sheet. Shop drawings shall also indicate the size of the dry pipe or preaction system. In Annex A of NFPA there is a table that provides the capacity of piping. The size of the system is determined by the fire sprinkler layout technician and while it usually isn't necessary for the fire sprinkler plans examiner to have to check the size of the system, the table referenced above provides the means to. The size of the system will correspond with the delivery of water to the open sprinklers.

Dry pipe systems are required to deliver water to the test connection within 60 seconds. This rule does not apply to systems that are 500 gallons or less or for systems that are 750 gallons or less when equipped with a quick-opening device.

Dry pipe systems are permitted to be sized for delivery times to multiple sprinklers on a manifold or through listed software programs.



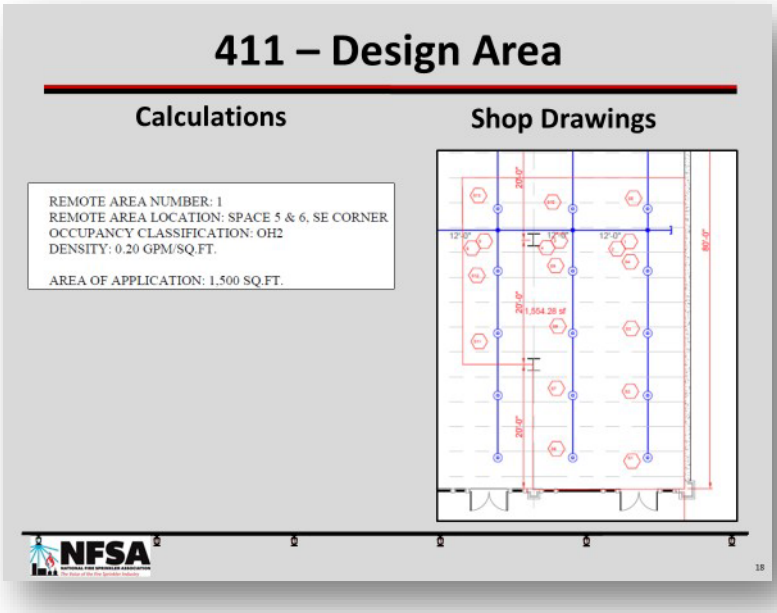
The size of preaction systems varies on the type of system installed. For single and non-interlock preaction systems, the system may not have more than 1,000 sprinklers installed for each preaction valve.

Double interlock preaction systems are sized like dry systems. A double interlock preaction system 500 gallons or less are not required to meet any delivery time. However, larger systems shall be designed to get water to the inspector's test under 60 seconds, like a dry pipe system by using quick opening devices. Manifold system designs are permitted for double interlock systems just as for dry system.

411 Design Area

In this step, the fire sprinkler plans examiner will physically verify the size of the design area. In Module 6, the plans examiner will verify through several steps, the protection area and the spacing of the sprinklers.

In this step, locate the design area size on the summary sheet. The size of the design area may have been altered in Steps 302-309. Next, find the remote design area on the shop drawings and verify that the physical area of the remote design area matches the designed design area. The design area on the shop drawings should be the same size as the size on the summary sheet. There may be times that the actual design area is slightly larger or slightly smaller, this is permissible.



If the project is using the room design method, verify the most remote room, as explained in Step 310 and make a note on the number of design sprinklers. Compare to the requirements for opening protection in Step 311.

412 Density

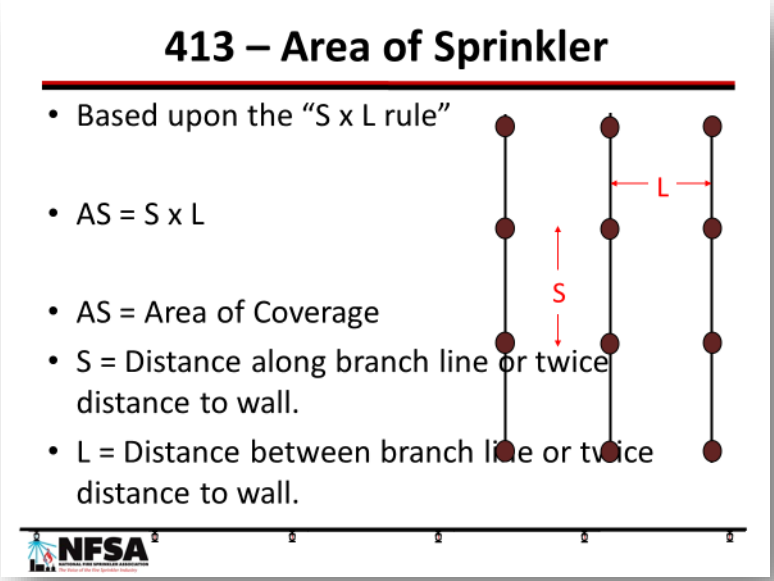
If the hydraulic calculation method is the density/area method or the room design method compare the design density on the summary sheet to the density/area curves in Step 302. The density on the summary sheet should also correspond to the remote design density note on the shop drawings.

413 Area per Sprinkler

The summary sheet shall state the maximum protection area per sprinkler. This will be the protection area per sprinkler located in the remote design area. The area per sprinkler shall not exceed the maximum protection areas. The spacing along the branchline and the spacing between sprinklers on a branchline determines the area per sprinkler. Below is the equation in NFPA 13 on the area of a sprinkler:

$$AA_{ss} = SS \; xx \; LL$$

A_s = Area per sprinkler
S = Spacing (in feet) of sprinklers along the branch line.
L= Spacing of sprinklers between branchline.



414 Total Water

The summary sheet states the total water or system demand requirements as calculated, including the allowance for inside hose, outside hydrants, and water curtain and exposure sprinklers. This is compared to the water supply capacity information on the graph sheet that is contained in the hydraulic calculations package.

415 Graph Sheet Analysis

A graphic representation of the complete hydraulic calculation shall be plotted on semi exponential graph paper (Q1.85) and shall include:

(1) Water supply curve
(2) Sprinkler system demand
(3) Hose demand (where applicable)
(4) In-rack sprinkler demand (where applicable)
(5) Additional pressures supplied by a fire pump or other source (when applicable)

416 Supply Analysis

The supply analysis sheet shall contain information summarized from the supply graph sheet. This sheet shall include:

(1) Node tag at the source
(2) Static pressure available at the source
(3) Residual pressure available at the source
(4) Total flow available at the source
(5) Available pressure at the source when the total calculated demand is flowing
(6) Total calculated demand (in gallons per minute) at the source
(7) Required pressure when flowing total calculated demand

417 Node Analysis

Organized information regarding the node tags given to each hydraulic reference point on the system as indicated on the shop drawings shall include the following information:

(1) Node tag for each specific point on the system used in the hydraulic calculations
(2) Elevation in feet of each node tag
(3) K-factor of flowing nodes (such as sprinklers)
(4) Hose allowance in gallons per minute requirements for the node tag
(5) Pressure at the node
(6) Discharge of gallons per minute calculated at the node
(7) Notes that indicate any special requirements for the node

418 Worksheet Review

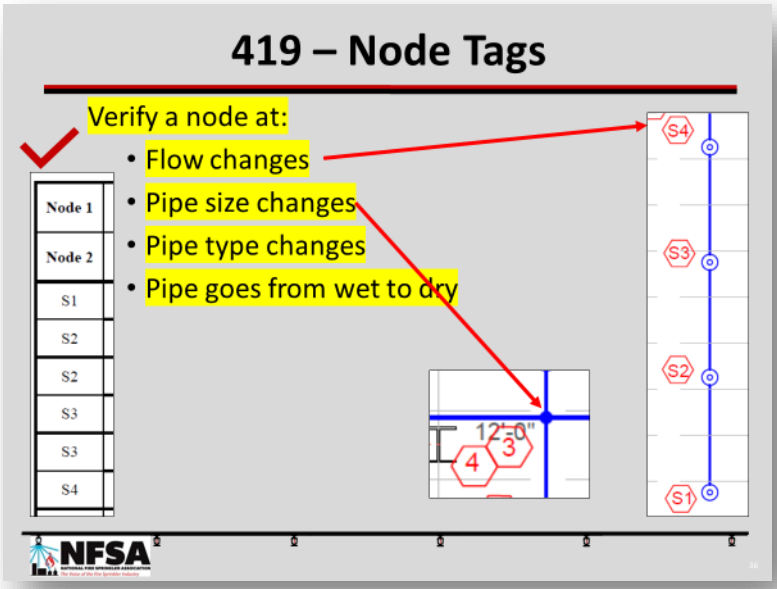
This is the step that starts the detailed review of the end sprinkler all the way back to the water source. There will be many worksheets to go through, however, the process is a system of checking and verifying. Below are the computer printout sheets, or worksheets. They contain the following information:

(1) Sheet number
(2) Hydraulic reference points used in each step
(3) Elevation in feet at each hydraulic reference point
(4) Sprinkler description and discharge constant (K-factor) for the flowing reference point
(5) Flow in gallons per minute for the flowing reference point (when applicable)
(6) Total flow in gallons per minute through each step
(7) Nominal pipe size in inches
(8) Actual internal diameter of pipe in inches
(9) Quantity and length in feet of each type of fitting and device
(10) Pipe lengths in feet, center-to-center of fittings
(11) Equivalent pipe lengths in feet of fittings and devices for the step
(12) Total equivalent length in feet of pipes and fitting for the step
(13) C-factor used in each step
(14) Friction loss in pressure per foot of pipe
(15) Sum of the pressures from the previous step (starting pressure at beginning)
(16) Elevation head between reference points
(17) Total friction loss between reference points
(18) Required pressure at each reference point
(19) Notes and other information shall include the following:
    (a) Velocity pressure and normal pressure if included in calculations
    (b) In-rack sprinkler demand balanced to ceiling demand
    (c) Notes to indicate starting points or reference to other sheets or to clarify data shown
    (d) Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area
    (e) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where calculations do not begin at the sprinkler
    (f) The pressure loss assigned the backflow device when included on a system

419 Node tags

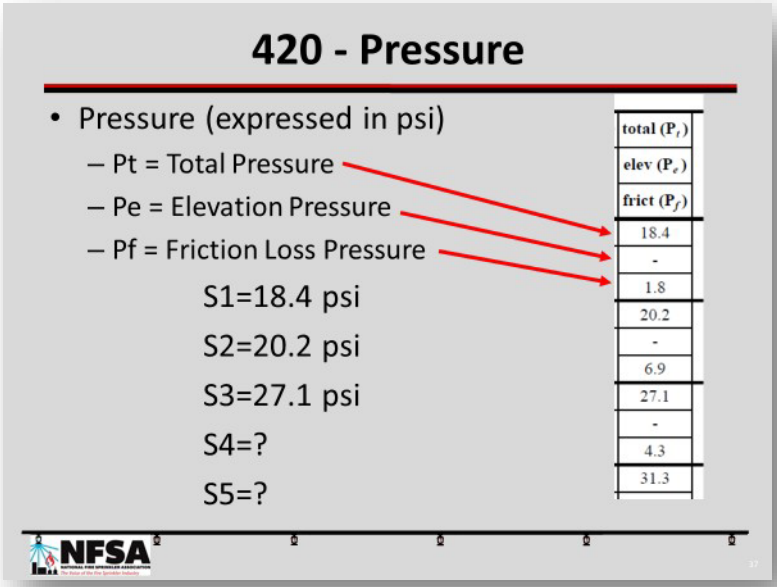
The nodes or node tags are the octagon symbols with letters or numbers printed inside. A node on the hydraulic calculation worksheets will correspond with the node on the shop drawings. At this step verify that the nodes on the worksheets are all on the shop drawings or vice versa. Get familiar with the water path, or flow of water, by tracing the steps from the worksheet onto the shop drawings.

If there are nodes missing, address on the checklist. There are times when the worksheet may contain alternate paths and all the nodes may not be used in each path.



420 Pressure

For each foot in elevation the pressure in the system changes. It is important to verify that the changes in elevation are accounted for in the pressure column of the worksheet. The pressure column has three rows: total pressure (P_t), elevation pressure (P_e) and friction pressure (P_f).



Total pressure (P_t) is the sum of the pressure in the system up to a node. The elevation pressure (P_e) and the friction pressure (P_f) is added together and increases (gets larger) as it gets closer to the water supply. The plans examiner will verify that the increases and decreases along the process are correct. While computer software does the calculations, it is wise to spot check the input in various places.

Elevation pressure (P_e) is the pressure change from the elevation difference of the two nodes. On the left side of the worksheet is an elevation column. The change in elevation in this column is multiplied by 0.433 and is entered as either a positive number (an increase in pressure) or a negative number (a decrease in pressure) in the elevation P_e cell in the pressure column. The plans examiner looks for the elevation changes in the shop drawings and verifies these elevation changes are correctly assigned to the appropriate node.

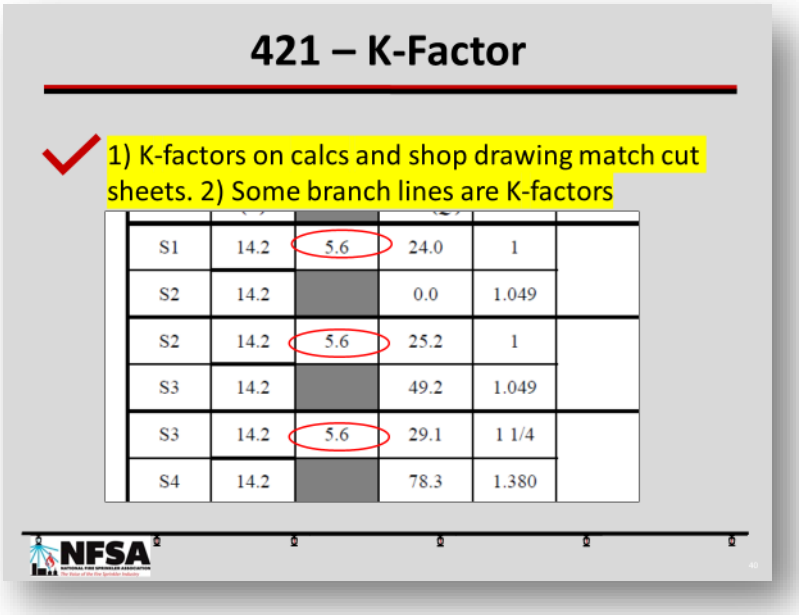
Friction pressure (P_f) is the sum of the total pipe length multiplied by the friction loss per foot. The total pipe length is found at the bottom of the equivalent pipe length column of the node row or step. The total pipe length is then multiplied by the friction loss. Friction loss is determined by the Hazen-Williams formula.

In the column under the C-Factor is a cell for the friction loss per foot. The Hazen-Williams formula isn't necessary for a plans examiner to perform this calculation during a review. However, a brief explanation of the equation is necessary to show that the information in several cells of the worksheet is critical in determining the friction loss. The Hazen-

Williams formula uses the flow (Q) from Step 422, the C-Factor in Step 427, and the inside diameter from Step 423 to determine the friction loss per foot. This number is entered in the cell below the c-factor and multiply by the total pipe length (in feet) and enter in the $P_f$cell.

421 K-factors

The k-factor of the sprinkler is the number that relates the flow that will discharge from the sprinkler to the pressure of the water at the sprinkler. The k-factor of the sprinkler is determined by the manufacturer and will be indicated on the manufacturer information sheet. In the hydraulic review, the k-factor of the sprinkler (or in some cases, the branch line) is indicated on the worksheet in the k-factor column located on the left side. Some worksheets show a blank or shaded cell below the k-factor cell. Only one k-factor is used in a step.



In this step, the plan examiner verifies the sprinkler on the shop drawing correlates with the sprinkler k-factor used in the calculations. Many sprinkler models are available in several k-factors. The hydraulic information (flow, pressure, k-factor) from the cut sheet is verified by the plans examiner to be correctly noted on the worksheet. Accuracy is critical as the k-factor determines the flow and pressure of the sprinklers.

422 Flow

This step has two cells to verify in the worksheet. The upper cell is the flow of the sprinkler of that specific step. It is indicated by the little case letter q. The flow (q) is determined by the k-factor of the sprinkler (Step 421) divided by the square root of the total pressure (P_t) (Step 420). The flow (q) at this step is the flow of the sprinkler (or branch line) in this step.

The lower cell of this step is the total flow of the previous step added to the flow (q) in the

cell above. Flow in this cell is indicated by the upper-case letter Q. This is the total flow of the system at this point.

423 Pipe Diameters

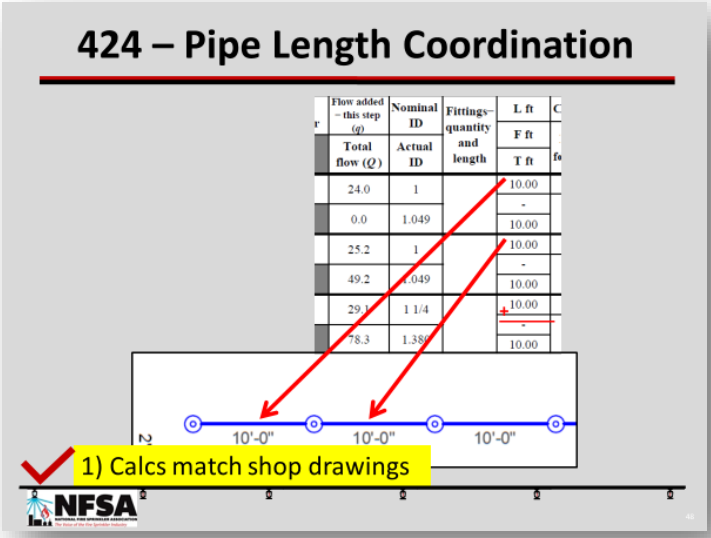
This step has two cells, an upper and lower cell to verify on the worksheet and compared to the fire sprinkler shop drawings. The upper cell is the nominal inside diameter (ID) and is the typical or nominal dimension of the pipe. In this cell, a 3-inch pipe is entered as 3 inch. It is also important to indicate the schedule of the piping. The pipe size entered in this cell is carefully checked with the piping used between the two nodes on the shop drawings.

The lower cell is the actual inside diameter (ID) of the pipe. The actual inside diameter of a pipe varies by the schedule of the pipe. The actual inside diameter of a 3-inch pipe is 3.334 inch for a Schedule 5, 3.260 inch for Schedule 10, and 3.068 inch for Schedule 40. This is an important step. The inside diameter of the pipe is part of the Hazen-Williams calculation to determine friction loss. The number entered in this cell can by verified by several sources. NFPA 13 in the annex has tables of steel pipe and copper tube dimensions. The manufacturer of the pipe will also list the diameters of their products. NFSA also publishes an extensive list in *The NEW Hydraulics Handbook.*

424 Pipe Length Coordination

In this step the plans examiner compares the pipe length from node to node on the shop drawings with the lengths entered on the worksheet.

The measurements on the shop drawing are typically center to center, and this is the measurements shown on the calculation worksheet. For example, from node to node, the pipe length is measured from the center of the tee to center of tee. The fabrication shop will take off the amount of pipe that the fitting uses, so, an actual piece of pipe will be shorter, but the path of water is the same.
It is important to check each step that each piece of pipe (along with fittings in Step 425) is accounted for. This is one of the more commonly missed areas when examining fire



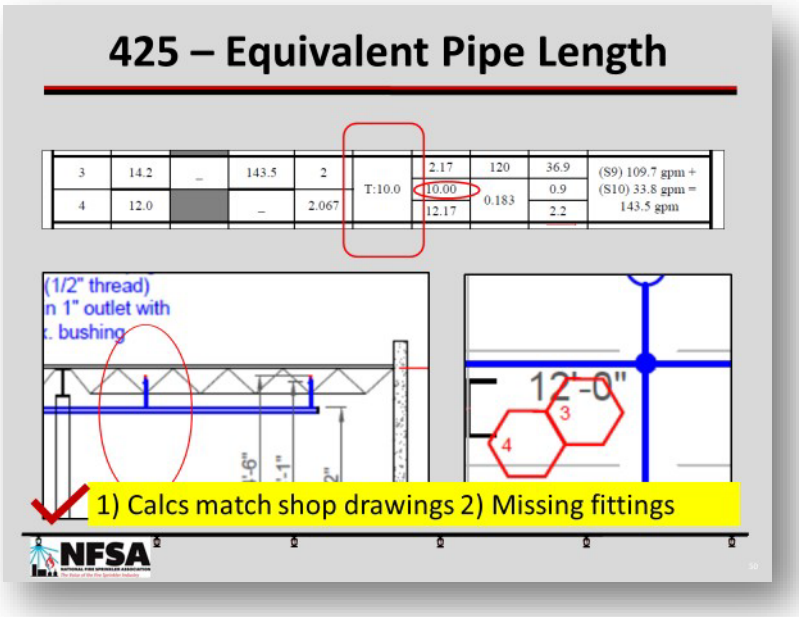
sprinkler shop drawings.

425 Equivalent Pipe Length for Fittings

This column is used to list any device, valve, tee, or elbow between the two nodes. These items cause friction loss in the system and it is critical that they are accounted for in this cell. Verify that these items are listed.

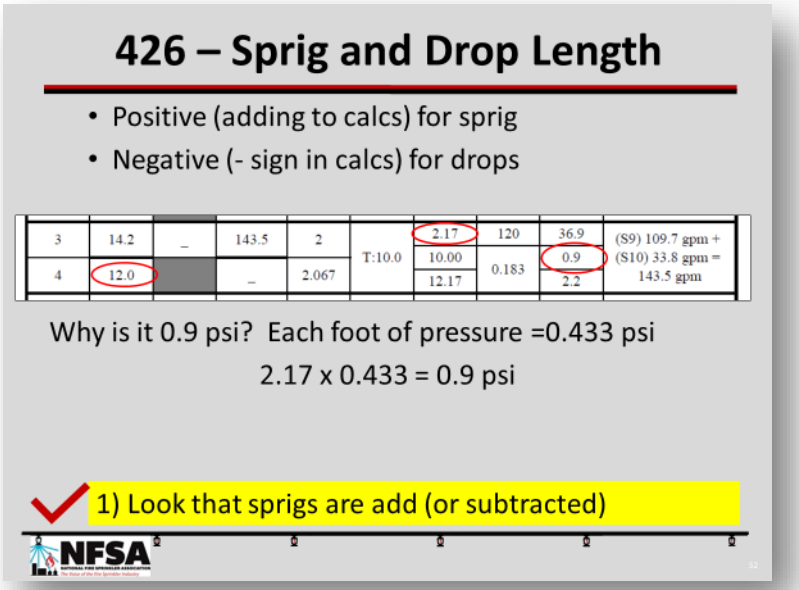
The equivalent pipe length is a measurement that equates the device into pipe length. It is the length of the same size of pipe that would create the same amount of friction loss as what occurs in the fitting or device. Each device can be verified by several sources and it is important to check that the correct pipe sizes were used. NFPA 13 has a table for equivalent lengths of steel pipe and copper tube. The manufacturer of the pipe will also list the equivalent length of their products. NFSA also publishes an extensive list in *The NEW Hydraulics Handbook.*

Tees, valves, and check valves that occur in this step (between the nodes) must be added to account for friction loss. These fittings are then converted into equivalent pipe lengths to be added with the pipe lengths and the sum of the two are used to obtain the total friction loss for this step.



426 Sprig and Drop Lengths

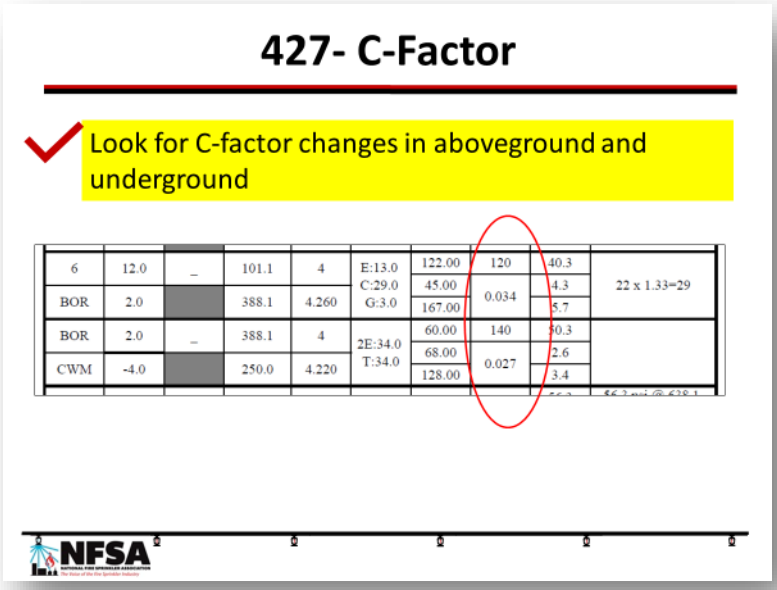
In this step, verify that the pipe lengths for sprigs and/or drops are counted for in the hydraulic calculation worksheet. It is also important to note, that if there are sprigs or drops in the step that their elevations are accounted for in the pressure column (P_e) as discussed in Step 420.



427 C-Factor

The C-factor column has a cell for each step to input the c-factor for the piping in the calculation. The C-factor is part of the Hazen-Williams formula that calculates the friction loss. The table in NFPA lists the C-factors, or values for several types of pipes. It is important to make sure the C-factor is followed through the entire set of calculations. The layout may change pipe and it is important to verify the C-factor changes. A common area where the C-factor differs is in the underground and aboveground piping. For example, the underground ductile iron has a C-factor of 100 and if the aboveground piping for the sprinkler uses CPVC, the C-factor will be 150.

The manufacturers of pipe and other standards may have listings of C-factors that are different than the NFPA table. The code official or plans examiner is permitted to accept other C-factors.



428 Equipment Friction Loss

Water flowing through a straight piece of pipe has very little friction loss. However, when the water flowing through piping makes turns, the drag, or friction loss increases. Some of these losses are accounted for in the equivalent pipe length, but other added equipment must be accounted for in the worksheet.

The equipment is accounted for in the worksheet where the equipment occurs in the system, just as fittings, tees, and valves in Step 424. Meters, strainers, seismic separation assemblies, backflow assemblies, water softeners, etc. are included in the step (from node to node) where they occur. The friction loss of the devices is found in the manufacturers specifications that were included in the submittal package. The plans examiner needs to carefully examine the shop drawings and hydraulic calculations to be sure all devices are accounted for. Many of these devices are huge friction losses and can "make or break" the system calculations and are left out of the calculations.

429 Hose Stream and Duration

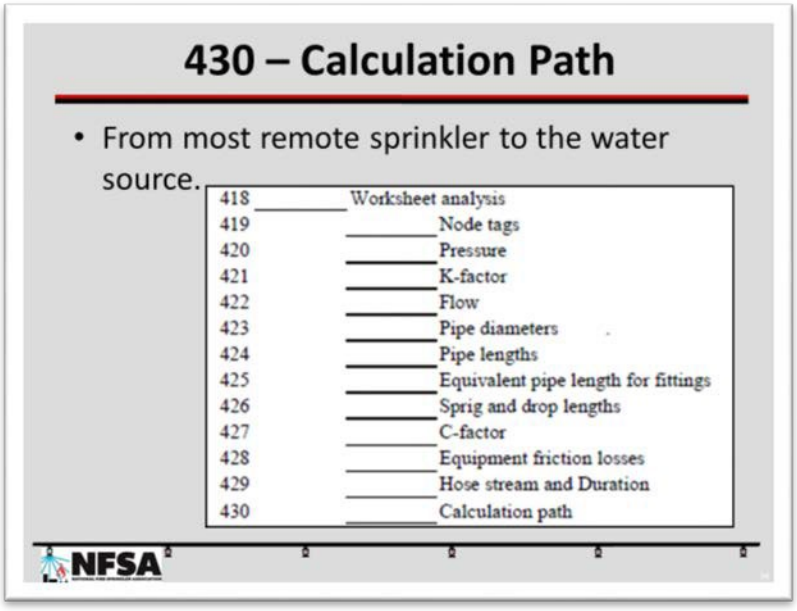
The hose stream represents the water that will be used by the fire department upon arrival. This means wherever in the system they will connect the hose(s) is the point where the flow should be added in the calculation. If the calculation reaches a city water supply connection, the flow is usually added in at that point as city mains are typically large enough that the friction loss from that connection to the hydrant location is negligible. If there are fire hydrants downstream of the fire pump, then they need to be added in at their physical location as the water would have to go through the fire pump before flowing out of the hydrant.

Buildings in areas without public water supplies are not required to provide water for use by responding fire departments, therefore, if tanks only supply sprinklers, then the hose stream allowances are therefore not required.

When hose stream is being checked on the plan review, it is traditionally the time to verify the water duration. This is not indicated in the hydraulic calculations, but it should be on the cover sheet. The table in NFPA 13 shows the minimum water duration in minutes for each hazard calculation. The lower duration is allowed where remote station or central station waterflow alarm service is provided on the assumption that the fire department will respond sooner to support the system if automatically notified of a fire. An alarm panel within the building does not satisfy this requirement unless it is configured to provide the remote or central station service.

430 Calculation path

The calculation path starts at the most remote sprinkler and continues through to the connection to the water supply.



431 Graph Sheet

Does the pressure and flow of the water supply (after reasonable adjustments for seasonal and daily fluctuations) exceed the demand of the fire protection system? Ultimately, this is the purpose of the hydraulic calculations, to make sure that the water supply is capable of meeting or exceeding the demand of the fire protection system.

Note that NFPA 13 does not include any additional safety factor beyond considering reasonable fluctuations in water supply information. If the water utility has already taken fluctuations into account in the data they have provided, no additional adjustment o safety factor is need, the sprinkler system can be design right to the water supply data. But if the water supply data was generated from a flow test, then some adjustment or safety factor is in order. Some jurisdiction has a blanket rule for a 10-psi cushion or 10% safety factor between the water supply and the sprinkler system demand. This is a legitimate way for the jurisdiction to be providing an adjustment to water supply data for fluctuations if other adjustments have not already been applied to the data.

Module 5 - Systems Review (Connections, Details and Piping)

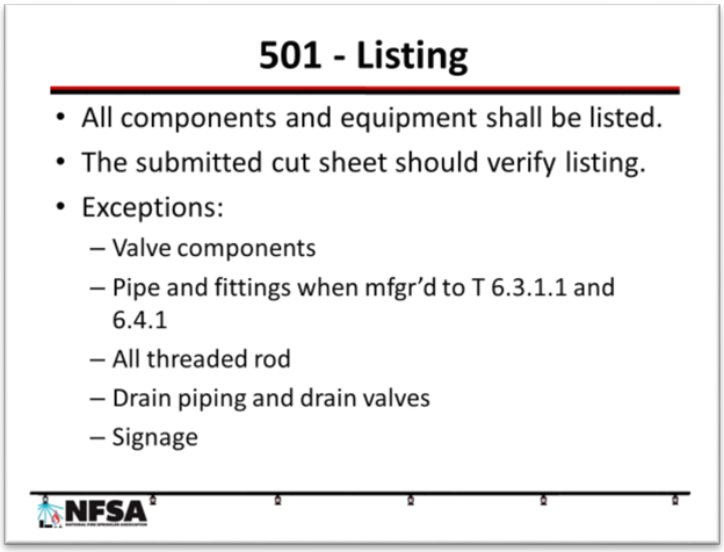
Introduction

The systems review is the portion of the review where the shop drawings are used and checked to see if the items in the checklist, where applicable, are addressed. It is important to note that the majority of the items in this portion of the checklist will be required to be listed and have a cut sheet submitted for review.

501 Listing

Nearly all the components and equipment that are installed in a NFPA 13 fire sprinkler system is listed to be used for fire protection. The listed items will have cut sheet that are required for this review. However, there are several items that are not required to be listed for fire protection, such as:

- Valve components, including trim, internal parts like springs and gaskets.
- Ferrous, copper, brass pipe and their fittings, when manufactured per the standards in Tables 6.3.1.1 and 6.4.1.
- Hangers certified by a professional engineer per Section 9.1.1.2.
- Mild steel hangers formed by rods.
- All threaded rod
- Fasteners in concrete, steel, and wood.
- Drain piping and drain valves.
- Signage.
- Any component that does not affect system performance.



502 Pipe and Fittings

There are three types of pipe and fittings that can be used in sprinkler systems: steel, copper, and any product that is specially listed, such as plastic pipe. Steel and copper pipe and their fittings are manufactured per Table 6.3.1.1 and Table 6.4.1. When steel and copper pipe are manufactured to these ASTM standards, then the pipe doesn't have to be listed for fire protection. Plastic pipe, such as CPVC, is required to be listed for fire sprinkler systems.

As with every other part of the system, the fire sprinkler plans examiner should receive the cut sheets for the materials installed in the system. The cut sheets have special installation criteria. For example, CPVC manufacturers have a manual available that addresses everything about using CPVC piping for fire sprinkler systems. There is a lot to know about CPVC piping, so it would be wise to study this manual before examining plans with CPVC piping.

CPVC pipe is only listed for use in light hazard systems and residential systems. Check areas of ordinary hazard when the system is using CPVC. When there are areas of ordinary hazard in otherwise light hazard occupancies, CPVC is permitted in these ordinary hazard areas of 400 square feet or less.

Chapter 6 is the materials chapter. There is a lot of discussion on piping when it comes to reviewing hydraulic calculations. At this point in the review, verify the piping material and fittings comply with NFPA 13.

503 Fire Department Connection (FDC)

Fire department connections, in this publication, are examined in Module 5 and Module 8. Module 5 has NFPA 13 requirements for fire department connections while Module 8 has the IBC requirement for fire department connections.

504 Fire Department Connections – Installation

Fire department connections (FDC) are not required to be installed when any of the following conditions exist:

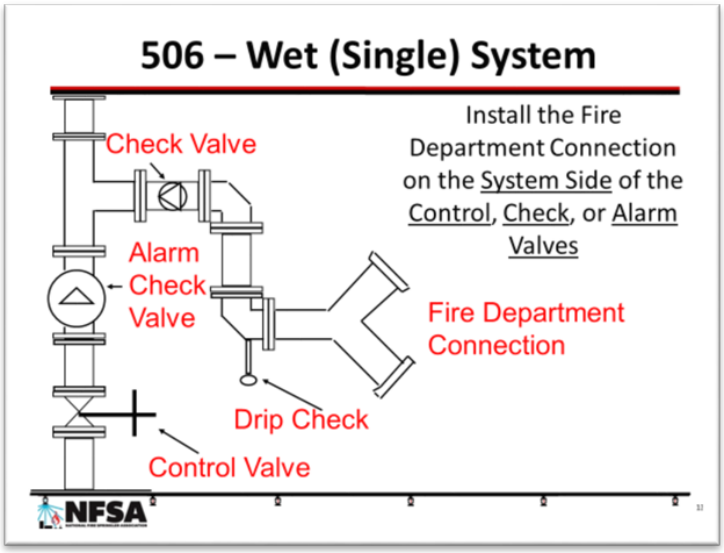
1. Buildings located in a remote or inaccessible area do not require an FDC. One of the questions the fire sprinkler plans examiner needs to ask is if the building can be reached by the fire department. For example, a ski lodge, accessible only by chair lift or helicopter does not need a FDC, as the local fire department cannot connect to it.
2. Single story buildings that do not exceed 2,000 square feet in area do not require an FDC. A fire in a small sprinklered building does not need a FDC because of the accessibility the fire department already has to the building.
3. A large capacity deluge system that exceeds the pumping capacity of the fire department does not need an FDC. When a deluge system operates, it uses tremendous amount of water and pressure that is available through tanks and pumps. A fire department pumper cannot add or supplement the demands of a deluge system.

505 Fire Department Connections – Size

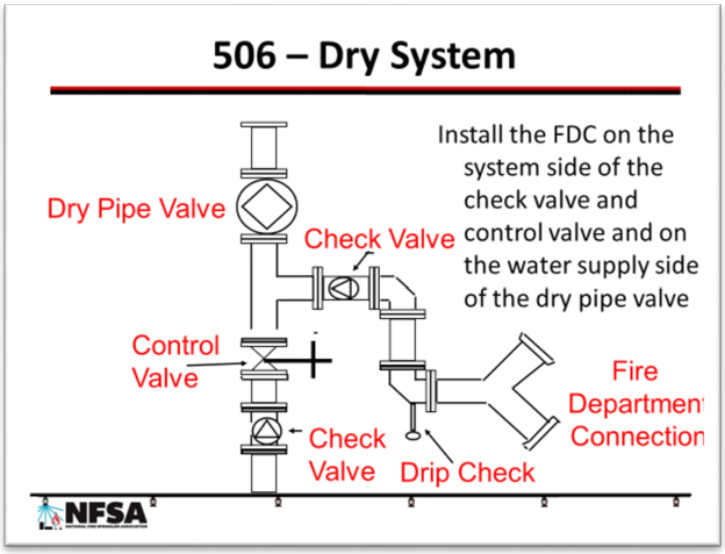
The majority of fire sprinkler systems are hydraulically calculated. When the piping for FDC for hydraulically calculated systems serves a single riser, it is permitted to be the same size of the system riser. When the FDC serves multiple risers or combined standpipe systems, then the minimum pipe size is four inches.

506 Fire Department Connections – Arrangement

There are many times when NFPA refers to “system side” and “supply side.” The sides are located on a certain side of the system check valve, located on the riser. The system side is the sprinkler piping side of the check valve, and the supply side is the underground piping side of the check valve.

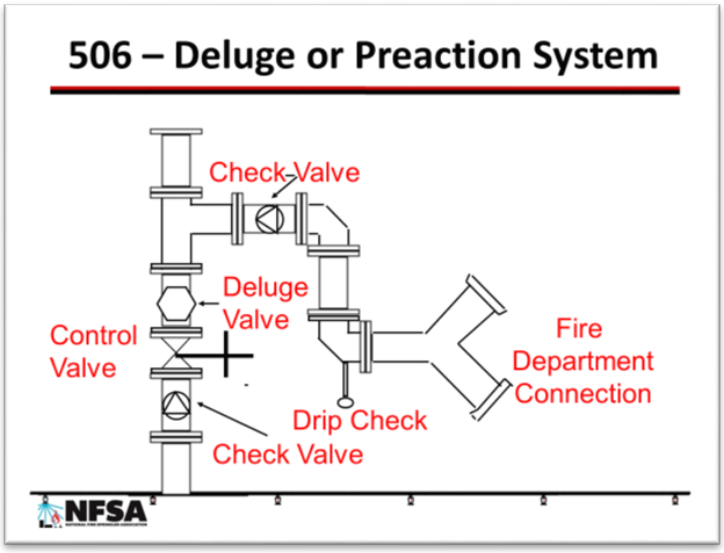


Fire department connection piping is installed on the system side of the check valve. This permits the water that is being pumped into the sprinkler system goes in the right direction. On some systems, there may be other risers and standpipes connected to the FDC. A check valve helps direct flow. This also ensures the water from the fire department pumper tank, which may come from a raw water source, does not go back into the municipal water supply.



Fire department connection piping can be several hundred feet long before it connects into the riser. The FDC location (as discussed later in this section) may be at the front of

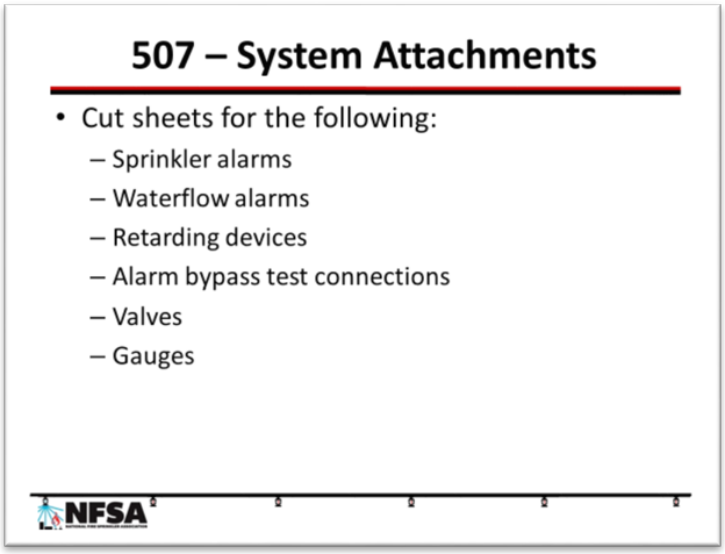
the building and the riser may be at the rear. The FDC piping may follow the perimeter of the building to connect to the riser, or it may connect to a cross main. However, it cannot connect into a branch line.



The above figure show where the FDC piping ties into the riser. On systems with multiple risers the FDC piping can be connected anywhere between the system control valves and the supply control valves.

507 System Attachments

The fire sprinkler plans examiner shall have the cut sheets for all the devices installed to the system.



508 Waterflow Alarms

Waterflow alarms shall be installed on every system with at least 21 sprinklers. The IBC will require a waterflow alarm to be installed on the exterior of the building.

509 Gauges

Pressure gauges shall have a minimum of ¼ inch connection and have a shut off valve and drain. Pressure gauges shall not be installed in freezing areas and shall be installed in the following places:

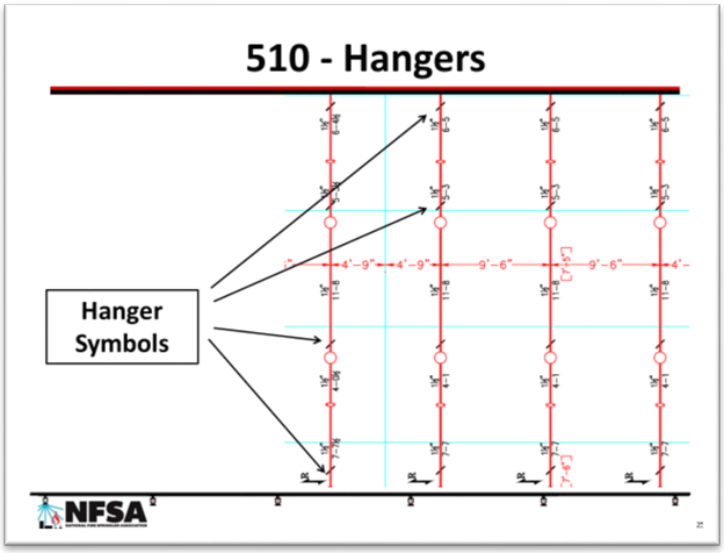
- System main drain
- Floor control valve with a drain
- On the inlet and outlet side of each pressure reducing valve

510 Hangers

NFPA 13 is the standard for hanging pipe for many other standards. One of the most important items for a fire sprinkler plans examiner is to see that the hanger details are correct on the shop drawings. Many layout technicians will not mark every location of a hanger on the shop drawings. To do so, adds a lot of detail to the plan and often makes the plan look "busy." However, the layout technician should provide an area where hangers are shown on the plans and make the area, "typical." This permits the plans examiner to perform their duties of checking for compliance.

There are three components to a hanger. The part that attaches to pipe and the part that attaches to the building are required to be listed and cut sheets should be submitted on the hangers that will be used. The part that connects the two parts of the hanger, all threaded rod, is not listed.

Hangers can be developed and used without listings; however, a professional engineer will need to certify the hanger per Section 9.1.1.2 of NFPA 13.

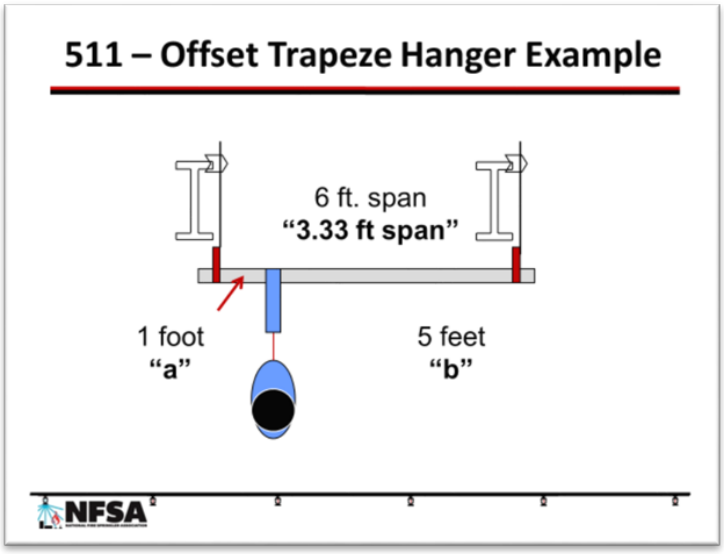


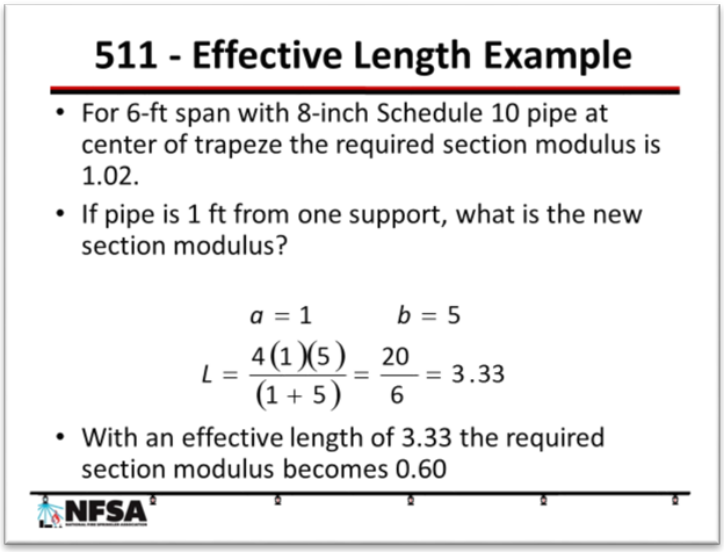
511 Trapeze

Trapeze hangers are used to support piping between structural members. They are designed to carry the loads of the sprinkler system to structural members that are spaced far apart. The shop drawings should have detailed figures and the methods used to size the trapeze. The plans examiner will check the design of the trapeze members to NFPA 13, Section 9.1.1.7.

The plans examiner will review the span of the trapeze (horizontal member) to Table 9.1.1.7(a). Double check the span of the trapeze supports to the nominal size of pipe that the trapeze is carrying (the size of the sprinkler main) and obtain the section modulus number. Then apply the section modulus to Table 9.1.1.7(b) to size the trapeze member. Both tables have several selections to pipe or angles to choose from, check the table heading carefully.

One caution on sizing trapeze members. Below the load (sprinkler piping) on the horizontal (trapeze) member is off-center. An off-center installation or design reduces the size of the trapeze because the load is closer to a structural member, thus reducing the load on the trapeze member and permitting it to be smaller. An off-center load is permitted, and a reduction of the trapeze is permitted if the installation follows. The installation is not typically the plans examiners field of jurisdiction; however, it may be a good note to pass along to the field inspection staff.





Hangers for ceiling sprinkler system, and trapeze hangers are attached directly to the structural members that are designed. There are a couple exceptions. Pipe of 1 ½ inch may be supported by a metal lath or hollow tile ceilings. 1 inch piping may be supported by metal decking. Where piping is installed for in-rack sprinklers protecting storage it is supported by the rack system.

512 Rods

Hanger rod is usually all-threaded rod or rod with threads on the ends. However, other rods, such as, u-hooks and eye rods are used to support pipe. They are not required to be listed, but shall be sized according to Table 9.1.2.1, 9.1.2.4 and 9.1.2.5.1. The minimum diameter of rod is 3/8 inch for pipe up to 4 inches. Pipe from 5-8 inches shall be supported by ½ inch rod, while pipe from 10-12 inches is supported by 5/8-inch rod.

513 Fasteners in Concrete, Steel and Wood (NFPA 13: 9.1.3, 9.1.4, 9.1.5)

NFPA 13 has many tables for the minimum sizes of fasteners for carrying pipe. The fastener tables address minimum sizes of fasteners when attached to concrete, steel, and wood. The fire sprinkler layout technician will have these fasteners states on the shop drawings. This information is required so the sprinkler fitters know what fasteners to use. Under no circumstances are nails to be specified to hang fire sprinkler piping.

514 Distance of Hangers

The maximum distance between hangers supporting sprinkler piping shall not exceed the maximum spacing in Table 9.2.2.1(a). Each section of pipe shall have a hanger, however starter lengths of pipe up to 6 feet can be without a hanger.

515 Unsupported Lengths

Unsupported lengths should be checked by the fire sprinkler plans examiner. Check over the ends of the branch lines and determine how far the end sprinkler is away from the last

structural member. An unsupported end of a branch line shall not be 36 inches for 1-inch steel pipe, 48 inches for 1-¼ inch pipe, and 60 inches for 1-½ inch or larger pipe. Refer to this section in NFPA 13 for copper, or the manufacturers installation guide for plastic pipe.
When the end sprinkler of the branch line exceeds 100 psi the distance to the nearest hanger is much shorter than described above. The maximum distance is 1 foot for steel pipe. If a hanger cannot be installed within 1 foot of the end line sprinkler, then the pipe needs to be extended to the next structural member to install an additional hanger.

516 Unsupported Armover Lengths

The measurement for hangers supporting armovers is measured on the horizontal piece of piping only. The vertical members, such as drops, nipples, or sprigs, are not included in the distance to or from hangers. The horizontal measurement is cumulative, meaning, the maximum distance to or from hangers is by adding up the lengths of all the horizontal members of the armover. The maximum distance for steel pipe armover is 24 inches before a hanger is installed.

When the armover is supplying a sprinkler with pressures over 100 psi, then the cumulative horizontal length of the pipe for hangers becomes 12 inches for steel pipe.

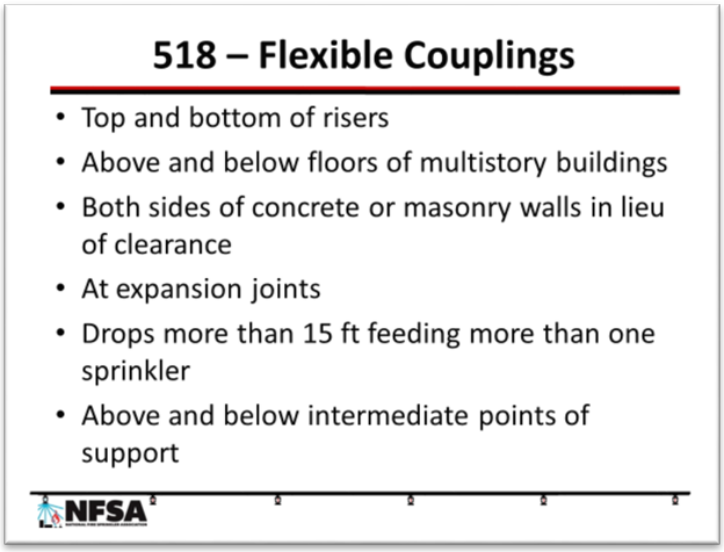
517 Seismic Bracing

When fire sprinkler systems are installed in buildings, per the IBC, located in Seismic Design Category C, D, E, or F, then the sprinkler system is required to have seismic bracing. The shop drawings and other construction documents will have this information on what the seismic loads are. The fire sprinkler plans examiner is not designing the bracing system but is reviewing for compliance to what is braced.

If a sprinkler system is not in Seismic Design Category C, D, E, or F then the remainder of the seismic section can be skipped.

518 Flexible Couplings

Flexible couplings for risers are required on several locations of the piping. The list of locations is found in NFPA 13, Section 9.3.2. Where the ceiling system supplies sprinklers in storage racks, flexible couplings are required by Section 9.3.2.4.



519 Separation Assembly

Separation assemblies are installed at the system piping at building separation joints. Where there are several stories, a separation assembly is installed at each story. The separation assembly is an assembly of several flexible couplings that permit the piping to move in several directions, as separate buildings move differently in seismic events.

As already mentioned, a seismic assembly can be built of several flexible couplings as described in A.9.3.3(a), but there are also manufactured assemblies such as shown in A.9.3.3(b). The cut sheet for this device, as well as any device, shall be submitted and reviewed for compliance to the manufacturer's installation instructions.

520 Clearance Criteria

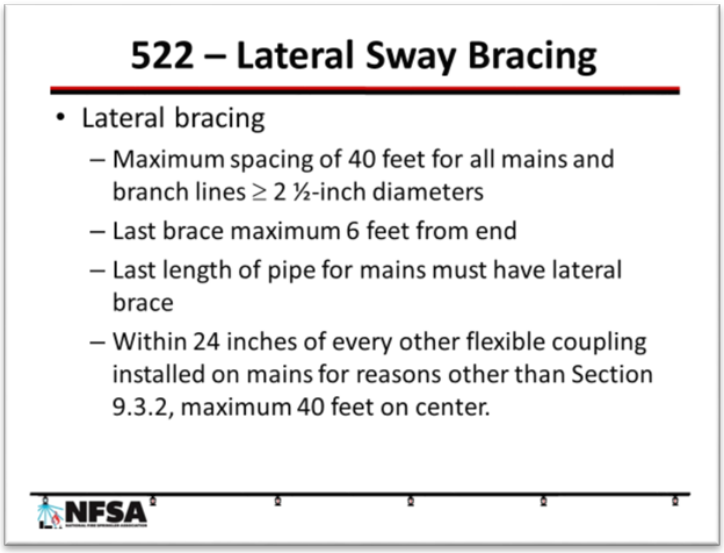
In a seismic event, fire sprinkler piping needs to move freely through walls, floors, platforms, and foundations that the sprinkler system penetrates. There are several methods permitted by NFPA 13 that allow the piping to flex or slide through building materials. Typically, when piping passes through walls and floors the hole it is sealed either for aesthetics or to keep the integrity of the fire rating. However, when fire sprinkler piping passes through walls and floors, there needs to be more room, or annular space, around the pipe. Typically, this "extra" annular space is 2 to 4 inches larger than the nominal pipe size. Refer to this section in NFPA 13 for specifics. The standard also permits the use of flexible couplings at walls or floor to eliminate the larger annular space. Where the walls are constructed of drywall, gypsum wallboard, or other frangible material, the larger annular space is not required as the movement of the pipe will enlarge the hole without damaging the pipe.

521 Lateral Sway Bracing

All sway bracing is listed and is attached to building members that can support the horizontal load. Lateral sway bracing is installed perpendicular to the piping it is supporting is spaced at maximum intervals of 40 feet. Depending on the type and size of

piping it is supporting, the maximum spacing is decreased from 40 feet to smaller intervals based on the horizontal loads. The loads in the Zone of Influence are used in Tables 9.3.5.5.2 (a)-(e) to finalize the spacing of the lateral sway bracing. The fire sprinkler plans examiner should see lateral sway bracing installed in the range of 20 – 40 feet apart.

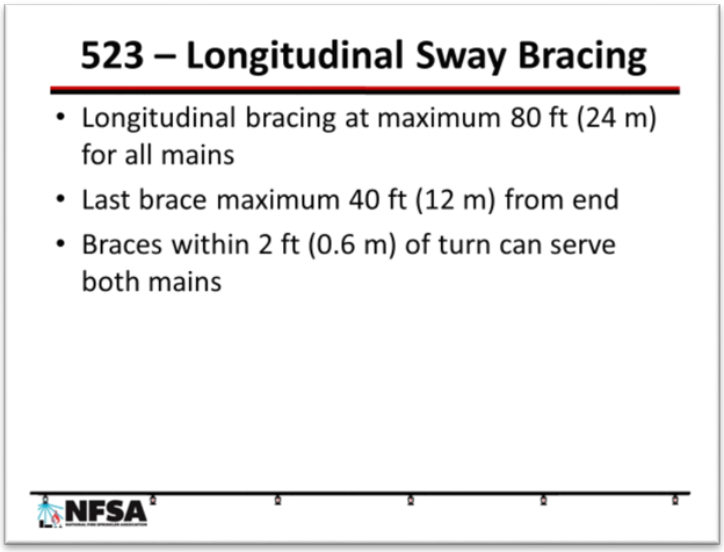
Lateral sway bracing is installed on all mains, cross mains, and branch lines over 2 ½ inches in diameter. As mentioned above, lateral sway bracing is installed from 20- 40 feet apart. The distance from the last brace from the end of the pipe cannot be more than 6 feet and the last length of main or cross main piping shall have a lateral brace. Lateral sway bracing shall be installed on every other flexible coupling (within 24 inches) installed on mains. Lateral braces within 24 inches of a turn can serve both mains.



Lateral bracing is not required where U-type hooks have legs bent to a minimum 30-degree angle and the lengths comply with Tables 9.3.5.11.8(a)-(c). Lateral bracing is also not required when the distance from the top of the pipe and the bottom of the structure is less than 6 inches.

523 Longitudinal Sway Bracing

All sway bracing is listed and is attached to building members that can support the horizontal load. Longitudinal sway bracing is installed parallel to the pipe it supports and is only required on mains and cross main piping. Longitudinal sway bracing is spaced at a maximum of 80 feet apart. The distance from the last brace to the end of the pipe or a turn in the piping shall not exceed 40 feet. Where the longitudinal sway brace is within 24 inches of a turn in the piping it can serve both mains.

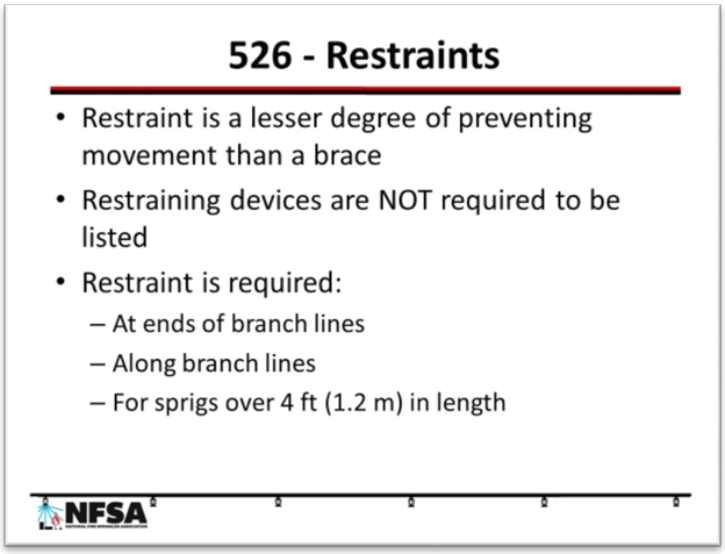


524 Sway Bracing at Risers

Four-way bracing shall be provided at risers over 3 feet in length and a four-way brace along every 25 feet of riser. The four-way brace at the top of the riser can serve both the riser and the horizontal piping when the four-way brace is within 24 inches of the turn at the top of the riser.

526 Restraints

Restraints are not required to be listed. The ends of all branch lines shall be restrained. Long branch lines shall have additional restraints (see Table 9.3.6.4(a) or (b)) and sprigs over 4 feet require restraints. Restraints can be several items, such as, a lateral brace, u-hooks, hangers (installed more than 45 degrees from vertical) and Number 12 wire.



527 Wet Pipe Systems

The wet pipe sprinkler system is installed in conditioned or heated spaces. It is the most economical system, both financially and hydraulically, to install and maintain.

528 Pressure Gauges

Pressure gauges are installed on every system riser. Where alarm check valves or riser check valves are installed, a pressure gauge is installed above and below.

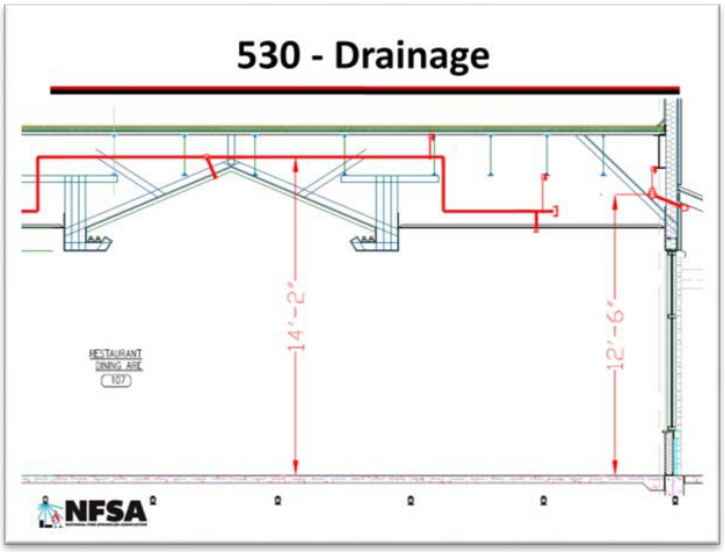
529 Relief Valves

Relief valves are required to be installed on wet pipe systems. The relief valve is required to be listed and have an operating pressure of 175 psi or be set 10 psi above the maximum system pressure. A relief valve is not required when the wet system has auxiliary air reservoirs to absorb the increased air pressure. Relief valves are required to be maintained and should be installed in an area or part of the system that is accessible.

When floor control valves are required for each floor, a relief valve is required for each floor after the floor control check valve. In multi-story buildings when a fire pump is provided, transient pressure spikes can be caught on the downstream side of these check valves.

530 Drainage

All sprinkler systems are supposed to drain back to the riser through the main drain. The main drain is sized per the riser size. Drain discharge should be addressed on the shop drawings in terms of how the system is to be drained. If the drains go to the exterior, it should be examined where the proposed drain is located on the exterior. If the system drains to a sidewalk or a landscape feature, the layout technician will need to reroute the drain to another location. If the drains go into a sump, it should be verified that a full system flow that the sump can handle the amount of water and if there are pumps installed, their capacities on removing water from the sump.



Wet pipe systems are permitted to be installed level. In areas where piping is trapped, an auxiliary drain is required to drain the trapped piping. The capacity of trapped piping in gallons should be stated on the shop drawings. From here, NFPA 13 has specific drainage requirements:

- Where the trapped section of piping is 50 gallons or more, the auxiliary drain shall have a minimum of a 1-inch valve. The auxiliary drainage piping shall terminate to an accessible location such as a building drain that is appropriately sized for the flow.
- Where the trapped section of piping is from 6 – 49 gallons, the auxiliary drain shall have a minimum of ¾ inch valve with a plug or a nipple and cap.
- Where the trapped section of piping is 5 gallons or less, one of the following methods can be used to drain: a ½ inch nipple and cap, or by removal of a sprinkler. The trapped piping is permitted to disassembled, such as by a flexible coupling.

531 Inspector's Test Connection

The inspector's test or alarm test connection for a wet pipe system can be installed anywhere after the waterflow switch. Typically, this is done at the system riser. The test valve shall be in an accessible location, and the connection shall be at least a 1-inch pipe that discharges to an appropriate location. At the end of the test connection pipe shall be the smallest orifice sprinkler that was installed in the system.

532 Dry, and Preaction Systems

Dry systems are installed in attics, porte-cochere's, canopies, parking garages and freezer storage. Where the sprinklers and piping are exposed to freezing temperatures a dry pipe system is used. In the dry pipe system, the system piping is dry and is under a certain amount of air pressure which is provided and maintained by a separate air compressor. The water supply is within the riser but is separated from the piping by a dry pipe valve. The dry pipe valve is a specially designed device that uses the air pressure in the piping to "hold" back the water. The dry pipe functions or opens only when the air pressure in

the piping lowers: water is only sent to fill the piping when air pressure is lost through sprinklers that open.

The amount of time it takes to bleed the air through the piping can take several minutes, but NFPA 13 limits the size (in gallons) of the dry pipe system to avoid long delays. Devices such as a quick opening device aids in exhausting the air in the sprinkler piping quicker, thus getting water to the open sprinklers faster. Piping arrangements, such as tree or looped systems can also help the air escape faster. The faster the piping fills with water results in quicker control of the fire. The dry system may not control the fire with one or two sprinklers as the wet system does, but the hydraulic design of the system is increased to compensate for the time it takes for the air to be expelled from the system.

The preaction system is activated either electrically, hydraulically, or pneumatically. Any way of acceptable, however, each system must be compatible with the preaction valve and must be listed. It is necessary for the listing to use all the same manufacturer components for the valve and trim. Review the cut sheets.

Many of the rules that apply to the dry pipe system also apply to preaction systems. Where they do not, the Module 5 checklist will make it clear. In Step 532, of the Systems Review checklist, there are two options, dry or preaction. These are both present on the same line to shorten the checklist but as the fire sprinkler plans reviewer, it may be helpful to circle the system that is being reviewed as shown below.

533 Pitch of Piping

All system piping shall be pitched back to the riser to drain through the main drain. For dry pipe and preaction systems, the piping is pitched back to the riser. Branch lines shall be pitched towards the riser ½ inch per 10 feet of run and mains and cross mains are pitched ¼ inch per 10 feet of run. When the dry pipe or preaction system is in a refrigerated area, the branch line pitch remains the same, ½ inch per 10 feet of run, but the mains and cross mains are increased to ½ inch per 10 feet of run.

While pitch of pipe is difficult to show on fire sprinkler shop drawings, it may be indicated on the elevation drawings. At the very least, there should be a note on the shop drawings addressing the pitch.

534 Pressure Gauges

For dry pipe systems, pressure gauges shall be installed at the following locations:

- One on the supply side and one on the system side of the dry pipe valve
- One at the air compressor, if an air compressor is used.
- One at the air receiver, if an air receiver is used.
- In the piping that connects air supply to the dry pipe system
- At the quick opening device.

For preaction systems, pressure gauges shall be installed at the following locations:

- One above and one below the preaction valve.
- On the piping supplying air to the preaction valves.

535 Sprinklers

Freezing water inside of piping is a concern. Having a dry system that traps water, especially water susceptible to freezing near a sprinkler is a critical flaw. The following sprinklers are permitted to be installed in dry and preaction systems:

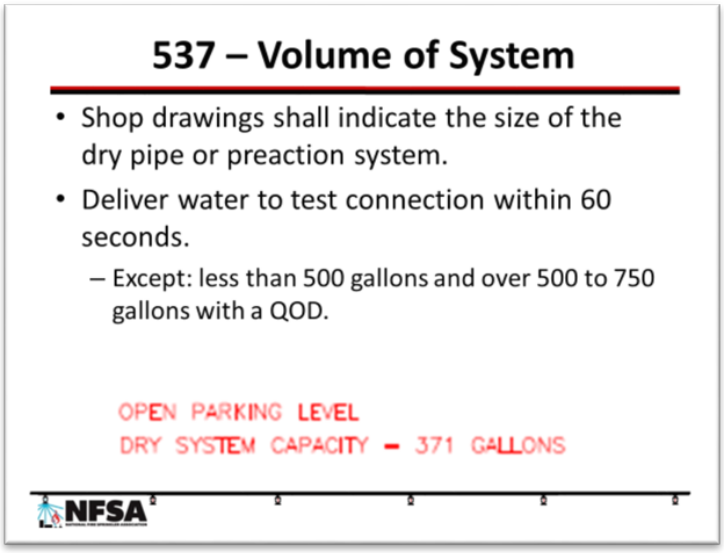
- Upright sprinklers
- Listed dry sprinklers
- Pendent sprinklers and sidewall sprinklers when located in a non-freezing area.
- Horizontal sidewall sprinklers pitched to where water isn't trapped.

536 Releasing Devices

The spacing of releasing devices shall be per the listing and the manufacturer's specifications.

537 Size or Volume of System

Shop drawings shall indicate the size of the dry pipe or preaction system. NFPA 13, Table A.7.2.3 provides the capacity of piping. The size of the system is determined by the fire sprinkler layout technician and while it usually isn't necessary for the fire sprinkler plans examiner to have to check the size of the system, the table referenced above provides the means to. The size of the system will correspond with the delivery of water to the open sprinklers.



Dry pipe systems are required to deliver water to the test connection within 60 seconds. This rule does not apply to systems that are 500 gallons or less or for systems that are 750 gallons or less when equipped with a quick-opening device.

NFPA 13, Section 7.2.3.6 also permits dry pipe systems to be sized for delivery times to multiple sprinklers on a manifold or through listed software programs.

The size of preaction systems varies on the type of system installed. For single and non-interlock preaction systems, the system may not have more than 1,000 sprinklers installed for each preaction valve.

Double interlock preaction systems are sized like dry systems. A double interlock preaction system 500 gallons or less are not required to meet any delivery time. However, larger systems shall be designed to get water to the inspector's test under 60 seconds, like a dry pipe system by using quick opening devices. Manifold system designs are permitted for double interlock systems just as for dry system.

538 Quick Opening Devices

Quick opening devices are listed, and the cut sheets shall be submitted. Their design shall be as close to the dry or preaction valve as possible and installed per the manufacturer's installation instructions.

539 Air Pressure and Supply

Air supplying the dry pipe system may come from several sources. Two of those sources are: air compressor and shop air. Any source of air shall be able pressurize the system within 30 minutes, however, some refrigerated spaces are permitted to take up to 60 minutes.

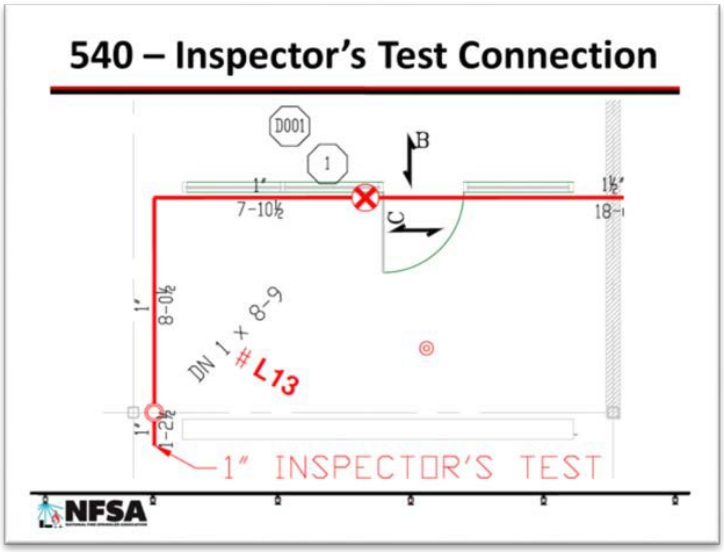
The source of air is not required to be listed. The air compressor or pump is not required to be listed. The automatic air maintenance device in Section 7.2.6.6.1 is required to be listed.

The connection to the dry pipe valve is at least ½ inch pipe with a check valve installed at the air filling connection.

The cut sheet of the dry pipe valve will have the specific air pressure for the system. However, where the manufacturer does not state the pressure for the system, NFPA 13 requires 20 psi added to the trip pressure of the dry pipe valve.

540 Inspector's Test Connection

The inspector's test or trip test connection for a dry pipe and double interlock preaction systems is installed on the end of the most distant sprinkler pipe in the highest floor or level. The test valve shall be in an accessible location, and the connection shall be at least a 1-inch pipe that discharges to an appropriate location. At the end of the test connection pipe shall be the smallest orifice sprinkler that was installed in the system.



541 Deluge System

Deluge systems have very specific uses, such as in aircraft hangers and "tank" farms. In a deluge system, all the fire sprinklers are open and there is no air pressure in the system. The water supply is held back by a preaction or deluge valve. The deluge system also has a separate detection system like the preaction systems. When the detection system alarms, then it opens the deluge valve which sends water to all the open sprinklers throughout the entire structure. Deluge systems use tremendous amounts of water and pressure, as each sprinkler must flow water to protect and cool the contents and structure.

542 Pressure Gauges

For deluge systems, pressure gauges shall be installed at the following locations:

- One below the deluge valve.
- On the piping supplying air to the deluge valves.

543 Releasing Devices

The spacing of releasing devices shall be per the listing and the manufacturer's specifications.

Module 6 - Positioning Review
Introduction

The positioning review looks over the actual position, location, spacing and use of sprinklers. The checklist looks like a matrix. This is to maximize the time and space of the fire sprinkler plans examiner, but also provide a thorough review of the common positioning rules of all sprinklers.

NFPA 13, Section 8.5 lists all the general position, location, spacing and use of all sprinklers, then the remaining seven sections gives specific information on each type of sprinkler.

The Positioning Review checklist is different than in the other modules. In the far-left column are the steps with the sprinkler position separated in specific rows. Each type of sprinkler is in a separate column and is designated with a capital letter. For example, the distance below a ceiling for sidewall sprinklers is in cell 605-B. This cell serves two purposes. The first is to provide the accurate section number. The criteria for distance below a ceiling for sidewall sprinklers can be found in Section 8.7.4. The second purpose of the cell is for the comments by the plan's examiner

601 Area of Coverage

The maximum area of coverage of any sprinkler is 400 square feet. Sprinklers do not have a minimum area of coverage, except ESFR sprinklers, of which is 80 square feet.

601-A

Pendent and upright spray sprinklers area of coverage vary depending on the hazard category. See NFPA 13, Table 8.6.2.2.1(a)(b)(c)(b). For light hazard, the maximum protection area has a range from 130 square feet to 225 square feet per sprinkler, depending on the type of construction and structural spacing. For ordinary hazard, the maximum protection area per sprinkler is 130 square feet. For extra hazard pipe schedule systems, the maximum protection area per sprinkler is 90 square feet. For hydraulically designed extra hazard systems with a density less than .25 gpm/sq.ft., the maximum protection area per sprinkler is 100 square feet. When the density is greater than .25 gpm/sq.ft. the maximum protection area per sprinkler is 130 square feet.

601-B

Sidewall spray sprinklers area of coverage varies depending on the hazard category. See NFPA 13, Table 8.7.2.2.1. For light hazard, the maximum protection area has a range from 120 square feet to 196 square feet per sprinkler, depending on whether the ceiling finish is combustible, or noncombustible or limited combustible. For ordinary hazard, the maximum protection area per sprinkler also has a range of 80 to 100 square feet, depending on whether the ceiling finish is combustible, or noncombustible or limited combustible. Sidewall sprinklers are not permitted tobe used in extra hazard pipe systems

601-C

Extended coverage upright and pendent spray sprinklers area of coverage varies depending on the hazard category. See NFPA 13, Table 8.8.2.1.2. For light hazard, the maximum protection

area has a range from 256 square feet to 400 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler. Extended coverage pendent and upright sprinklers cover a square area and have maximum areas of coverage based on the spacing of the sprinkler. For ordinary hazard, the maximum protection area has a range from 144 square feet to 400 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler. For extra hazard systems and high piled storage, the maximum protection area has a range from 144 square feet to 196 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler.

601-D

Extended coverage sidewall spray sprinklers area of coverage varies depending on the hazard category. See NFPA 13, Table 8.9.2.2.1. For light hazard, the maximum protection area is 400 square feet per sprinkler, based upon unobstructed smooth flat ceilings. For ordinary hazard, the maximum protection area is 400 square feet per sprinkler, based upon unobstructed smooth flat ceilings. Extended coverage sidewall spray sprinkler is not permitted for extra hazard systems.

601-E

Residential sprinkler maximum area of coverage is covered in the manufacturer's cut sheet.

601-F

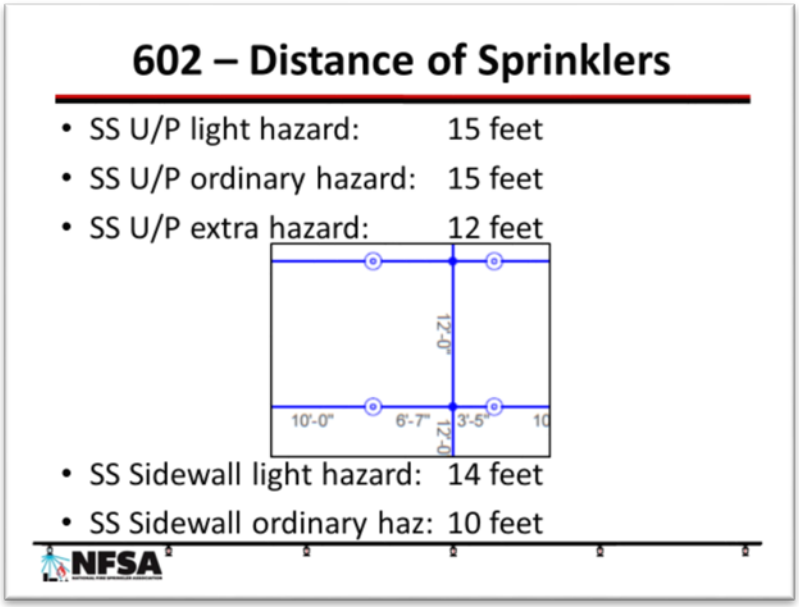
Control Mode Specific Application (CMSA) sprinklers area of coverage varies depending on the ceiling type of construction and rack storage. See NFPA 13, Table 8.11.2.2.1. CMSA sprinklers have a maximum protection area in a range from 100 square feet to 130 square feet per sprinkler.

601-G

Early Suppression Fast Response (ESFR) sprinklers area of coverage varies depending on the ceiling type of construction. See NFPA 13, Table 8.12.2.2.1. ESFR sprinklers have a maximum protection area of 100 square feet per sprinkler. There are occasions when the maximum area of coverage can be increased to 110 square feet per sprinkler based on obstructions but are very limited. Section 8.12.2.2.3 and 8.12.2.2.4 state the specific rules for increasing to 110 square feet per sprinkler. ESFR sprinklers have a minimum protection area of 64 square feet.

602 Maximum Distance Between Sprinklers

The distance between sprinklers is measured from centerline of sprinkler to centerline of sprinkler. When sprinklers are installed along a sloped ceiling, the measurement is along the slope, not the projection on the floor.



602-A

Pendent and upright spray sprinklers maximum spacing is 15 feet, but it varies depending on the hazard category. See NFPA 13, Table 8.6.2.2.1(a)(b)(c)(b). For light hazard, the maximum spacing is 15 feet until sprinkler are installed in attics in Section 8.6.4.1.4. There is specific attic spacing for sprinklers. For ordinary hazard, the maximum spacing per sprinkler is 15 feet. For extra hazard pipe schedule systems, the maximum spacing per sprinkler is 12 square feet. For hydraulically designed extra hazard systems with a density less than .25 gpm/sq.ft., the maximum spacing area per sprinkler is 15feet. When the density is greater the a.25 gpm/sq.ft. the maximum spacing area per sprinkler is 12 feet.

602-B

Sidewall spray sprinklers has two distances to maintain. See NFPA 13, Table 8.7.2.2.1. For light hazard, the maximum spacing along the wall is 14 feet. For ordinary hazard, the maximum along the wall is 10 feet. The maximum room width or "throw" of a sidewall spray sprinkler depends on the ceiling finish. For light hazard, combustible ceilings, the maximum width is 12 feet while noncombustible or limited combustible ceiling maximum width increases to 14 feet. For ordinary hazard ceilings, the maximum room width is 10 feet. Sidewall sprinklers are not permitted to be used in extra hazard pipe systems.

Sidewall sprinklers cannot be installed back-to-back unless they are separated by a lintel or soffit. Soffits or lintels with a width of 16 inches or less do not require sprinklers.

602-C

Extended coverage upright and pendent spray sprinklers area of coverage varies depending on the hazard category. See NFPA 13, Table 8.8.2.1.2. For light hazard, the maximum protection area has a range from 256 square feet to 400 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler. Extended coverage pendent and upright sprinklers cover a square area and have maximum areas of coverage based on the spacing of the sprinkler.

For ordinary hazard, the maximum protection area has a range from 144 square feet to 400 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler. For extra hazard systems and high piled storage, the maximum protection area has a range from 144 square feet to 196 square feet per sprinkler, depending on the type of construction and spacing of the sprinkler.

602-D

Extended coverage sidewall spray sprinklers area of coverage varies depending on the hazard category. See NFPA 13, Table 8.9.2.2.1. For light hazard, the maximum protection area is 400 square feet per sprinkler, based upon unobstructed smooth flat ceilings. For ordinary hazard, the maximum protection area is 400 square feet per sprinkler, based upon unobstructed smooth flat ceilings. Extended coverage sidewall spray sprinkler is not permitted for extra hazard systems.

602-E

Residential sprinkler maximum area of coverage is covered in the manufacturer's cut sheet.

602-F

Control Mode Specific Application (CMSA) sprinklers area of coverage varies depending on the ceiling type of construction and rack storage. See NFPA 13, Table 8.11.2.2.1. CMSA sprinklers have a maximum protection area in a range from 100 square feet to 130 square feet per sprinkler.

602-G

Early Suppression Fast Response (ESFR) sprinklers area of coverage varies depending on the ceiling type of construction. See NFPA 13, Table 8.12.2.2.1. ESFR sprinklers have a maximum protection area of 100 square feet per sprinkler. There are occasions when the maximum area of coverage can be increased to 110 square feet per sprinkler based on obstructions but are very limited. Section 8.12.2.2.3 and 8.12.2.2.4 state the specific rules for increasing to 110 square feet per sprinkler. ESFR sprinklers have a minimum protection area of 64 square feet.

603 Maximum Distance from Walls

Sprinklers cannot be more than one-half the maximum distance between sprinklers. For example, the maximum light hazard spacing is 15 feet. The farthest the sprinkler can be from the wall is 7 feet 6 inches. The distance is measured from the centerline of the sprinkler perpendicular to the wall.

Where there are large items against the wall, such as large portraits, furniture, trophy cases, portable closets, the sprinkler is measured to the wall. When sprinklers are adjacent to windows, and no additional floor space is created, the distance is measured to the wall line. For example, a bay window that doesn't create more floor space, the sprinkler is measured to an imaginary wall line as if the bay window didn't exist.

603-A

Pendent and upright spray sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.6.2.2.1(a)(b)(c)(b) from the wall. The distance is measured from the centerline of the sprinkler perpendicular to the wall. Where walls are angled, NFPA 13, Section

8.6.3.2.3 permits the sprinkler to be spaced up to .75 times the allowable spacing from the angled portion of the wall. However, the distance measured perpendicular to the sprinkler and angled wall may not exceed the .5 or one-half the allowable spacing. Rooms complying with the small room rule (NFPA 13, Section 3.3.21) may exceed the one-half the allowable spacing on one wall.

603-B

Sidewall spray sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.7.2.2.1 from the wall.

603-C

Extended coverage upright and pendent spray sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.8.2.1.2 from the wall. The distance is measured from the centerline of the sprinkler perpendicular to the wall. Where walls are angled, NFPA 13, Section 8.6.3.2.3 permits the sprinkler to be spaced up to .75 times the allowable spacing from the angled portion of the wall. However, the distance measured perpendicular to the sprinkler and angled wall may not exceed the .5 or one-half the allowable spacing.

603-D

Extended coverage sidewall spray sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.9.2.2.1 from the wall.

603-E

Residential sprinklers cannot be more than one-half the maximum distance stated in the manufacturers listing from the wall.

603-F

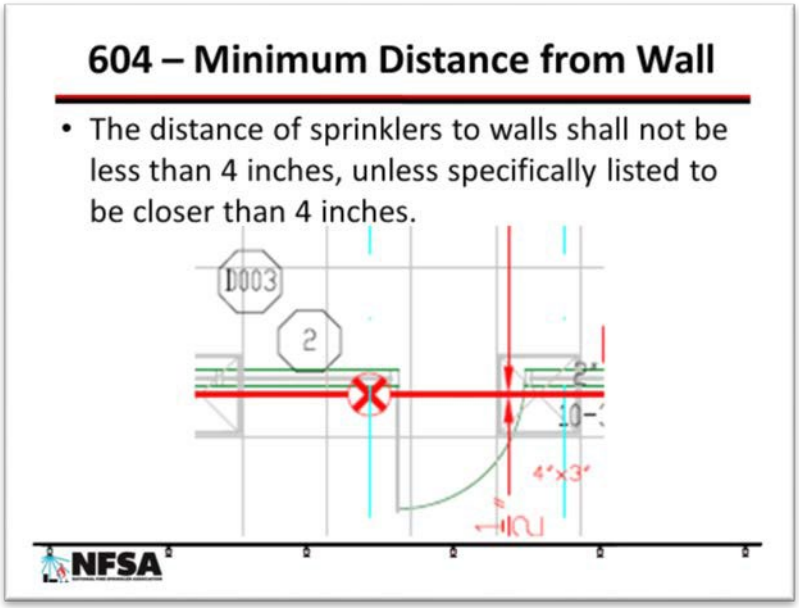
Control Mode Specific Application (CMSA) sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.11.2.2.1 from the wall.

603-G

Early Suppression Fast Response (ESFR) sprinklers cannot be more than one-half the maximum distance as stated in NFPA 13, Table 8.12.2.2.1 from the wall.

604 Minimum Distance from Walls

The distance of sprinklers to walls shall not be less than 4 inches, unless specifically listed to be closer than 4 inches.

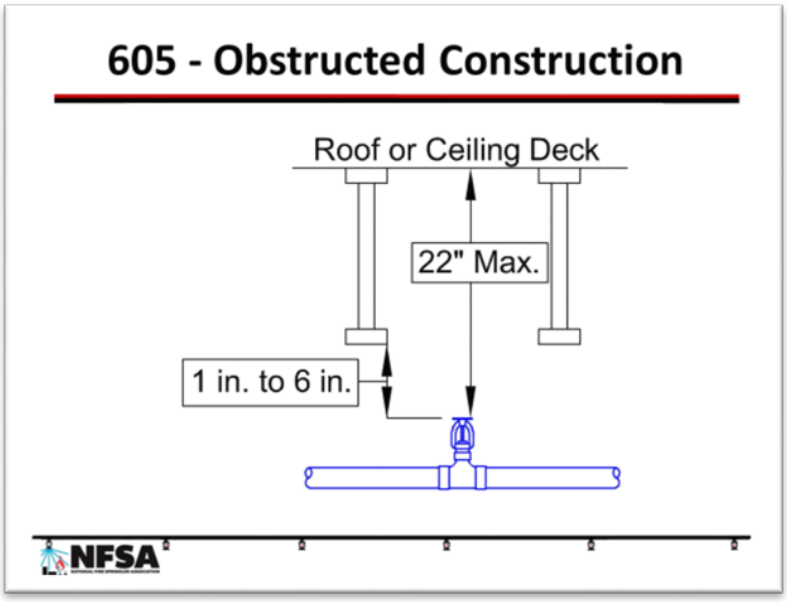


605 Distance Below Ceiling

Each type of sprinkler will have specific rules on how far the sprinkler may be down from the ceiling. The distance of a sprinkler below a ceiling or deck is always measured to the deflector. Heat collectors, pie plates, or similar devices are not permitted to be installed on sprinklers. Deflectors shall be oriented and installed parallel to the slope of the ceiling, deck, or stairs.

If the deck above the sprinkler is a corrugated metal deck, the measurement goes to the bottom of the deck if the corrugations are less than 3 inches deep. If the corrugations are greater than 3 inches in depth, then measure to the highest portion of the corrugation.

If the deck above the sprinkler has insulation, measure to the bottom of the insulation.



605-A

Pendent and upright spray sprinklers have many rules for the distance below ceilings. A summary of the rules are as follows.

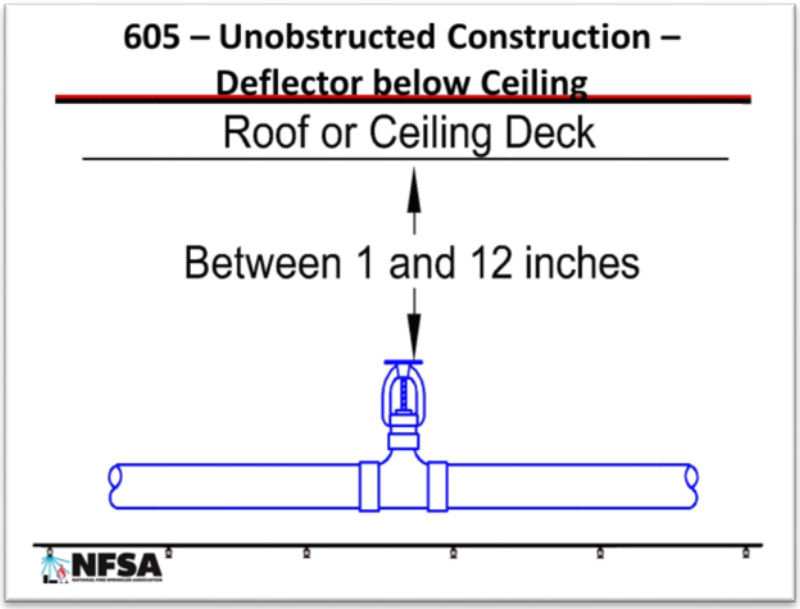
Unobstructed construction:

- 1-12 inches down from the ceiling. Recessed and concealed sprinklers may be less than 1 inch.

Obstructed construction:

- 1-6 inches below a structural member with a maximum of 22 inches below the ceiling.

Concrete tees and composite wood joists have special rules.



605-B

Sidewall spray sprinklers shall be 4-6 inches down from the ceiling. Sidewall sprinklers, where listed, may be 6-18 inches down from the noncombustible or limited combustible ceiling.

The deflectors shall be no more than 6 inches out from the wall.

605-C

Extended coverage upright and pendent spray sprinklers have many rules for the distance below ceilings. A summary of the rules are as follows.

Unobstructed construction:

- 1-12 inches down from the ceiling. Recessed and concealed sprinklers may be less than 1 inch.

Obstructed construction:

- 1-6 inches below a structural member with a maximum of 22 inches below the ceiling.

Extended coverage upright and pendent spray sprinklers shall not be more than 3 feet vertically down from peaked roofs and ceilings.

605-D

Extended coverage sidewall spray sprinklers shall be 4-6 inches down from the ceiling. Sidewall sprinklers, where listed, may be 6-18 inches down from the noncombustible or limited combustible ceiling.

The deflectors shall be no more than 6 inches out from the wall.

605-E

Residential upright and pendent sprinkler shall be 1-4 inches below the ceiling unless specifically listed for a greater distance.

Residential sidewall shall be 4-6 inches down from the ceiling unless specifically listed for a greater distance.

605-F

Control Mode Specific Application (CMSA) sprinkler for unobstructed construction shall be installed between 6-8 inches down from the ceiling. CMSA sprinklers for obstructed construction shall be installed between 6-12 inches down from the ceiling.

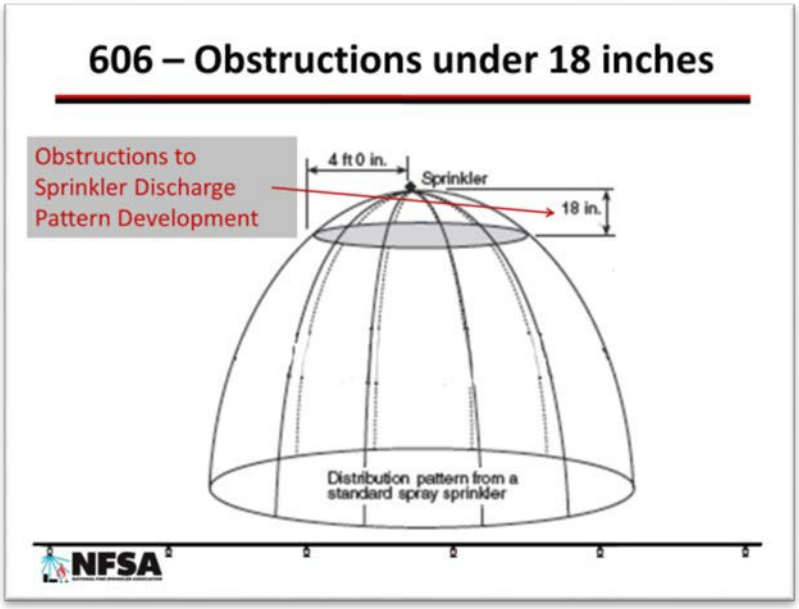
Composite wood joists, solid wood joists and concrete tees have special rules and specific operating pressures.

605-G

Early Suppression Fast Response (ESFR) sprinkler distance from the ceiling vary with the K-factor and position of the sprinkler. K-14 and K-16.8 pendent sprinklers shall be installed between 6-14 inches down from the ceiling. K-14 and K-16.8 upright sprinklers shall be installed between 3-12 inches down from the ceiling. K-22.4 and K-25.2 pendent sprinklers shall be installed 6-18 inches down from the ceiling.

606 Obstructions Less Than 18 Inches

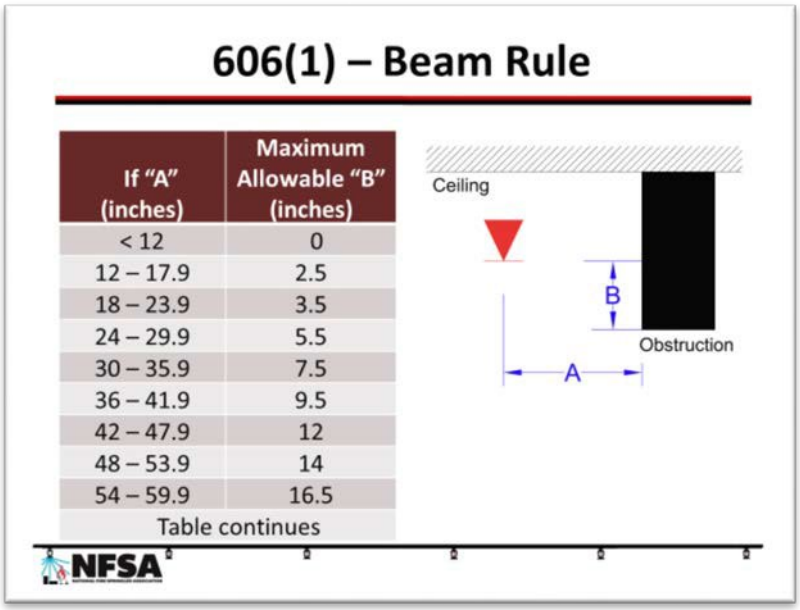
The spray of fire sprinklers can be separated into two separate zones. The zone closest to the sprinkler is the most sensitive. In this zone, even a small obstruction will disturb the sprinkler's ability to develop a complete spray pattern. NFPA 13 calls the potential obstructions in this zone, "Obstructions to Sprinkler Discharge Pattern Development."



The obstructions rules within 18 inches have unofficial names that are not listed as such in NFPA 13, however they are: The Beam Rule (606-1), The Three Times Rule (606-2), The Four Times Rule (606-3) and The Partition Rule (606-4).

606-1 A-G The Beam Rule

The "Beam Rule" is an unofficial term in NFPA 13, but it is commonly used terminology in the fire sprinkler industry. It is used to determine if sufficient water can get under the obstruction. This rule is used when obstructions are tight to the ceiling (so water cannot get over) and when obstructions are continuous (so water cannot get to the sides of the obstruction).



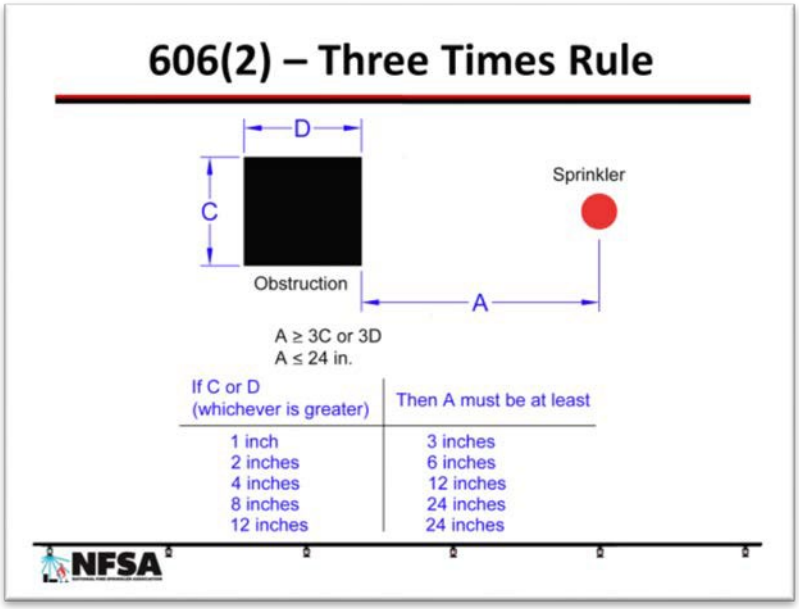
The objective of the Beam Rule is to get the sprinkler far enough away from the near edge of the obstruction that sufficient water will be able to spray under, and beyond, the obstruction. How

far the sprinkler needs to be away depends on the distance from the bottom of the obstruction to the sprinkler deflector. The higher the sprinkler is above the bottom of the obstruction, the farther away from the obstruction it needs to be.

There are variations of the beam rule allowed for obstructions against walls like soffits and cabinets, such as for residential sprinklers. These figures are more liberal than the traditional beam rule distances because the obstruction is against a wall. There is no need for large amounts of water to get past the obstruction because the wall is there. The sprinkler is not trying to get water any more than 30 inches past the near edge of the obstruction. If the obstruction is less than 4 feet wide, and the beam rule cannot be met, sprinklers can be installed on the other side of the obstruction if the distance from the sprinklers to the centerline of the obstruction is not more than half the maximum distance allowed between sprinklers.

606-2 A-F Three Times Rule

The "Three Times Rule" is an unofficial term in NFPA 13, but it is commonly used terminology in the fire sprinkler industry The Three Times Rule is used to determine if sufficient water can get to both sides of an obstruction. This applies to vertical obstructions like columns and to open horizontal obstructions like the bottom chords of trusses and the bottom flanges of bar joist members.



The Three Times Rule requires sprinklers to be a distance away from the potential obstruction of three times the maximum dimension of the obstruction up to a maximum of 24 inches. Note that the maximum dimension of 24 inches applies to the maximum required distance for the sprinkler away from the obstruction, not the maximum allowable dimension of the obstruction. For example, a sprinkler is positioned in such a manner that it can spray to both sides of a column with dimensions 3 inches by 4 inches. The sprinkler must be positioned at least 12 inches away from the near edge of the column. Note that the minimum distance is three times the 4-inch dimension even though this is not the dimension closest to the sprinkler. It is the maximum dimension that counts. Also, note that the distance is measured to the centerline of the sprinkler

deflector.

The "Three Times" rule also applies for horizontal obstructions such as the bottom flange of an open bar joist. Since the joist is open, the sprinkler can throw water both over and under the bottom flange. Since water can get to both sides of the obstruction (over and under) the "Three Times" rule is the correct rule to use. If the structural member had been some solid member, or some type of construction defined as "Obstructed" by NFPA 13, then the correct obstruction rule to follow would be the "Beam" rule.

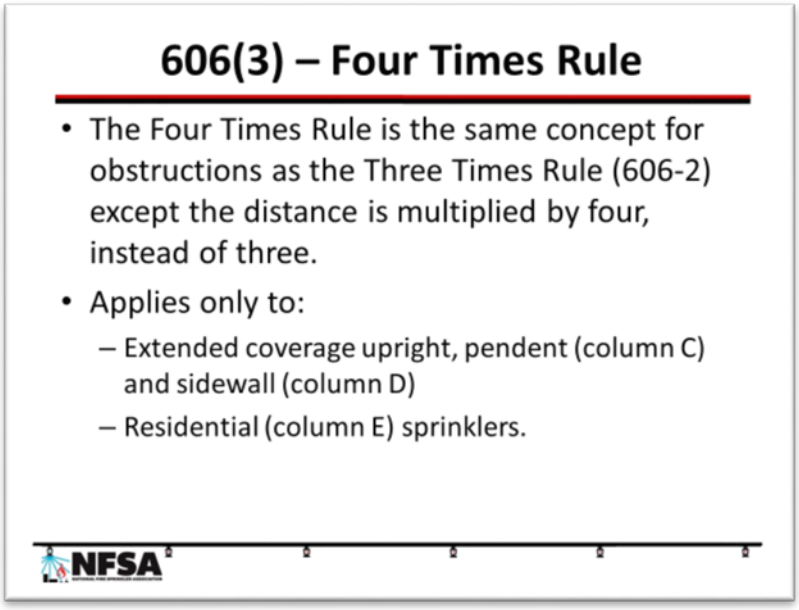
It is important to note that the minimum required distance between the sprinkler and the obstruction is measured in a straight line between the objects.

The Three Times Rule only applies to structural members for light and ordinary hazard. In other words, plans examiners can ignore lights, ducts and exit signs when locating sprinklers. It is important to note that this exception only applies to standard spray sprinklers. Other sprinklers, such as extended coverage sprinklers, CMSA and ESFR sprinklers will still need to consider these other objects as obstructions.

There are several exceptions to the Three Times Rule. Just like the Beam Rule, if sprinklers are installed on the other side of the obstruction, the Three Times Rule can be ignored, if the sprinkler on the other side of the obstruction is not more than one-half the allowable distance between sprinklers away from the centerline of the obstruction.

606-3 C, D, E Four Times Rule

The Four Times Rule is the same concept for obstructions as the Three Times Rule (606-2) except the distance is multiplied by four, instead of three. It is important to note that the Four Times Rule only applies to extended coverage upright, pendent (column C) and sidewall (column D) sprinklers along with residential (column E) sprinklers.



606-4 A-E The Partition Rule

The "Partition Rule" is a term that isn't used in NFPA 13, but it is commonly used terminology in the fire sprinkler industry. The Partition Rule is used to determine if sufficient water can get over the obstruction. In general, the way to ensure that sufficient water can get over the obstruction is to keep a minimum of 18 inches between the top of the obstruction and the sprinkler deflector (measured vertically). However, in Light Hazard occupancies, an obstruction such as a partition or a privacy curtain can encroach on the minimum clearance. In this case, it is better to have the sprinkler close to the obstruction, so that the water can be distributed over the top. This distance depends on the horizontal distance from the far side of the partition to the center of the sprinkler deflector.

The Partition Rule is frequently used with privacy curtains that hang from the ceiling. Frequently these curtains have a rope or twine mesh panel at the top before they become a solid fabric farther down. If the privacy curtain has a close mesh, the vertical distance in the tables should be measured from the top of the mesh to the sprinkler deflector. If the privacy curtain has an open mesh (1/2 inch or greater measured on the diagonal) then the vertical distance in table can be measured from the bottom of the mesh panel to the sprinkler deflector.
606 F CMSA Obstructions

It is important to note that the distance or zone for CMSA (column F) sprinklers is different than the other sprinklers in Columns A-E. Instead of 18 inches, the measurement for CMSA sprinklers is 36 inches down from the deflector.

606 G ESFR Obstructions

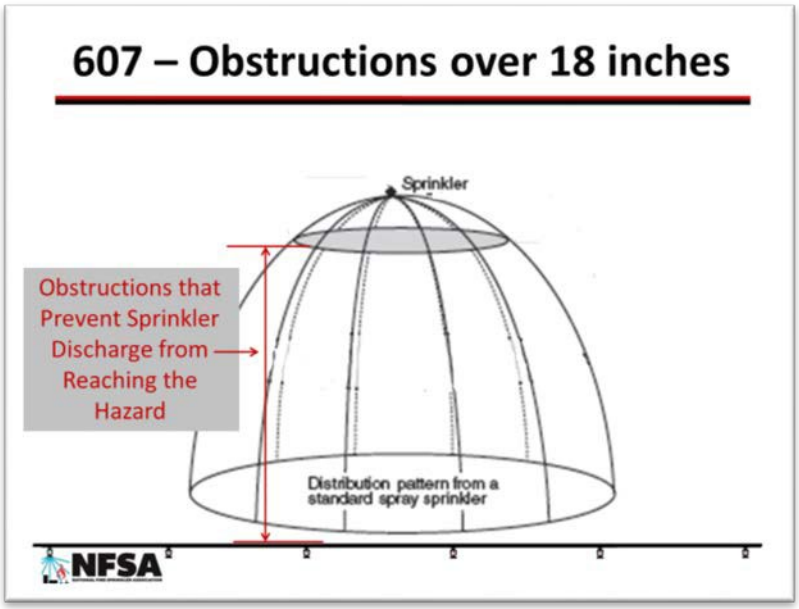
The obstructions rules are divided based on the type of obstruction that is created. ESFR sprinklers have a version of the “Beam Rule” to space them from objects such as beams, ducts, lights, and other obstructions tight to the ceiling, where water cannot get over the obstruction. The ESFR Beam Rule table in NFPA 13 displays the distances that need to be maintained to appropriately get water below the obstruction. The table is set up to allow
the sprinkler deflector to be a specified distance above the bottom of the obstruction based on how far the obstruction is horizontally from the sprinkler.

For obstructions that are isolated, affecting only one sprinkler, there are a set of rules that should be reviewed. The ESFR arrangement must comply with one of the options in this section of NFPA 13. The main rule is that additional sprinklers need to be installed below isolated non-continuous obstructions, which are below the elevation of the sprinkler. This means that if a light is below an ESFR sprinkler then a sprinkler would need to be installed below the light.

Some obstructions may be continuous. This would mean that one obstruction could block the spray pattern of more than one sprinkler or even an entire row of sprinklers. The base rule is that sprinklers need to be installed below the continuous obstruction. There is the option that the obstruction can comply with the "Beam Rule" and then sprinklers would not have to be installed below the obstruction. By arranging the sprinklers to follow the "Beam Rule" water is getting below the obstruction and still covering the intended floor space.

607 A-E Obstructions Over 18 Inches

From 18 inches below the deflector to the floor, the water distribution pattern has already been established. The only obstructions in this zone are those that are so large that a significant fire would burn under them, generating large quantities of heat, without getting direct water spray from ceiling sprinklers. The only real obstruction rule in this zone is to put a sprinkler under any permanent fixture that is over 4 feet wide. Furniture and conference tables is not considered a permanent feature.



CMSA Obstructions

It is important to note that the threshold for CMSA (column F) sprinklers is different than the other sprinklers in Columns A-E. The width for obstructions is 24 inches instead of 48 inches and the zone for this obstruction starts at 24 inches down from the CMSA deflector.

ESFR Obstructions

The obstructions rules are divided based on the type of obstruction that is created. ESFR sprinklers have a version of the "Beam Rule" to space them from objects such as beams, ducts, lights, and other obstructions tight to the ceiling, where water cannot get over the obstruction.

The ESFR Beam Rule table in NFPA 13 displays the distances that need to be maintained to appropriately get water below the obstruction. The table is set up to allow the sprinkler deflector to be a specified distance above the bottom of the obstruction based on how far the obstruction is horizontally from the sprinkler.

For obstructions that are isolated, affecting only one sprinkler, there are a set of rules that should be reviewed. The ESFR arrangement must comply with one of the options in this section of NFPA 13. The main rule is that additional sprinklers need to be installed below isolated non-continuous obstructions, which are below the elevation of the sprinkler. This means that if a light is below an ESFR sprinkler then a sprinkler would need to be installed below the light.

Some obstructions may be continuous. This would mean that one obstruction could block the spray pattern of more than one sprinkler or even an entire row of sprinklers. The base rule is that sprinklers need to be installed below the continuous obstruction. There is the option that the obstruction can comply with the "Beam Rule" and then sprinklers would not have to be installed below the obstruction. By arranging the sprinklers to follow the "Beam Rule" water is getting below the obstruction and still covering the intended floor space.

608 Clearance to Storage

The clearance to storage is measured from the deflector to the top of the storage. The clearance to storage is a minimum of 18 inches unless other sections or standards require a greater distance. Storage less than 18 inches is permitted when tested for a specific hazard.

608-A

Pendent and upright spray sprinklers clearance to storage is a minimum of 18 inches. Where storage is on a shelf against a wall, the 18-inch minimum does not apply.

608-B

Sidewall spray sprinklers clearance to storage is a minimum of 18 inches.

608-C

Extended coverage upright and pendent spray sprinklers clearance to storage is a minimum of 18 inches.

608-D

Extended coverage sidewall sprinklers clearance to storage is a minimum of 18 inches.

608-E

Residential sprinklers clearance to storage is a minimum of 18 inches.

608-F

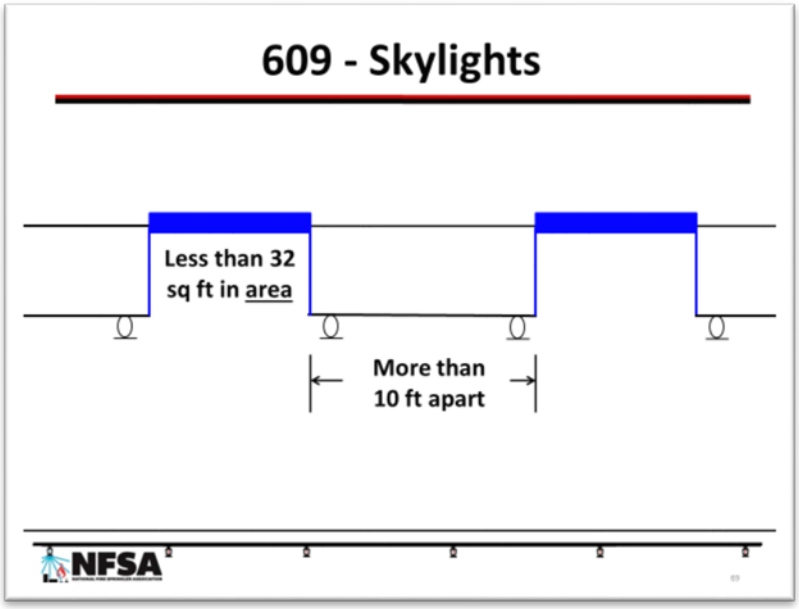
Control Mode Specific Application (CMSA) sprinklers clearance to storage is a minimum of 36 inches.

608-G

Early Suppression Fast Response (ESFR) sprinklers clearance to storage is a minimum of 36 inches.

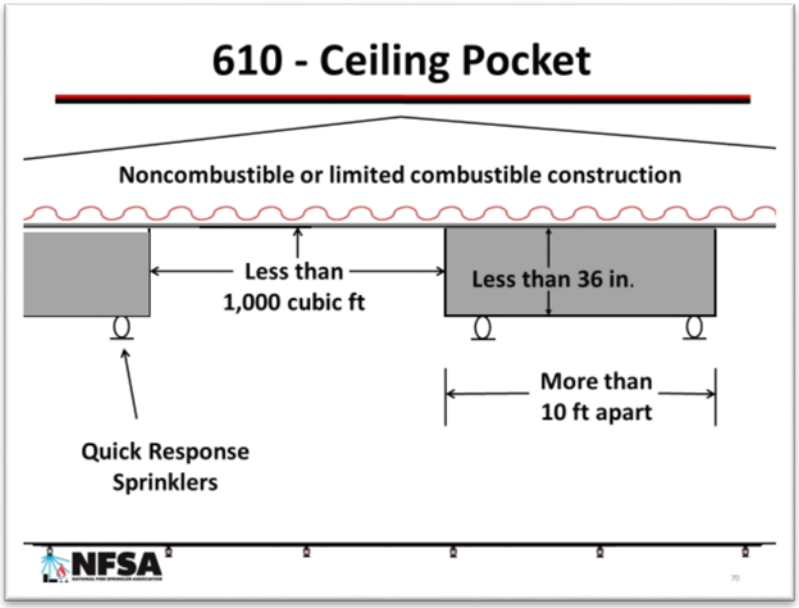
609 A-G Skylights

Skylights 32 square feet and less are not required to have sprinklers installed where separated from other unsprinklered skylights of 10 feet or greater. The area (32 sq. ft.) is the only factor for exempting sprinklers in skylights. The height of the skylight well or shaft and the hazard classification will not trigger sprinklers.



610 Ceiling Pockets

A ceiling pocket is an architectural ceiling feature that consists of a bounded area of ceiling located at a higher elevation than the attached lower ceiling. The criteria for exempting sprinklers in these areas is contained in NFPA 13. There are only a few sprinkler types that are permitted to be in the compartments where sprinklers are exempted from the ceiling pockets.



610-A

In compartments of pendent and upright spray sprinklers, ceiling pockets are exempt from sprinklers, when the following criteria is met:

1. The total volume of the unprotected ceiling pocket does not exceed 1000 cubic feet.
2. The depth of the unprotected ceiling pocket does not exceed 36 inches.
3. The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.
4. The total size of all unprotected ceiling pockets in the same compartment within 10 feet of each other does not exceed 1000 cubic feet.
5. The unprotected ceiling pocket has noncombustible or limited-combustible finishes.
6. Quick-response sprinklers are utilized throughout the compartment.

610-B

Ceiling pockets are not exempt from sprinklers in compartments protected by sidewall sprinklers.

610-C

In compartments of extended coverage pendent and upright spray sprinklers, ceiling pockets are exempt from sprinklers, when the following criteria is met:

1. The total volume of the unprotected ceiling pocket does not exceed 1000 cubic feet.
2. The depth of the unprotected ceiling pocket does not exceed 36 inches.
3. The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.
4. The total size of all unprotected ceiling pockets in the same compartment within 10 feet of each other does not exceed 1000 cubic feet.
5. The unprotected ceiling pocket has noncombustible or limited-combustible finishes.
6. Quick-response sprinklers are utilized throughout the compartment.

610-D

Ceiling pockets are not exempt from sprinklers in compartments protected by extended coverage sidewall spray sprinklers.

610-E

In compartments of residential sprinklers, ceiling pockets are exempt from sprinklers, when the following criteria is met:

1. The total volume of the unprotected ceiling pocket does not exceed 100 cubic feet.
2. The depth of the unprotected ceiling pocket does not exceed 12 inches.
3. The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.
4. The unprotected ceiling pocket has noncombustible or limited-combustible construction.

610-F

Ceiling pockets are not exempt from sprinklers compartments protected by Control Mode Specific Application (CMSA) sprinklers.

610-G

Ceiling pockets are not exempt from sprinklers in compartments protected by Early Suppression Fast Response (ESFR) sprinklers.

Module 7 - Underground Review

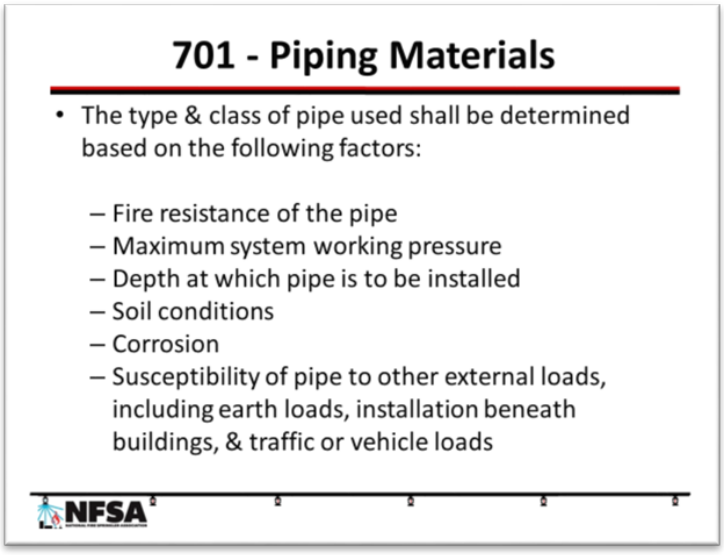
Introduction

Fire sprinkler plan examiners must include a thorough review of the underground piping that supplies the aboveground piping of the fire sprinkler system. NFPA 13 Chapter 10 provides all the necessary requirements for underground piping. Chapter 10 of NFPA 13 is the same as Chapter 10 of NFPA 24.

Examiners will quickly notice the underground review checklist is shorter than the other checklist. While it may be shorter, it doesn't necessarily mean that the review is less important. With aboveground piping, we can easily see and notice problems with the system. The same cannot be said about underground piping. Problems in the underground piping may never get noticed until it is too late.

701 Piping materials

All underground piping, fittings, and joining methods must be listed for fire protection and the cut sheets submitted for review. As it is for aboveground piping, underground piping shall meet the manufacturing standards listed in NFPA 13 Chapter 10. One of the most common aboveground pipes, steel pipe, is not permitted for underground piping unless it is specifically listed for underground use. There is one exception. Steel pipe that is internally galvanized and when externally coated with a material that resists corrosive effects and wrapped in polyethylene material, may be used for the underground fire department connection piping. Steel pipe that is listed for underground use shall be lined.



The fire sprinkler plan examiners job is to make sure all the piping, and the joints are acceptable to use, and the shop drawings address the installation requirements.

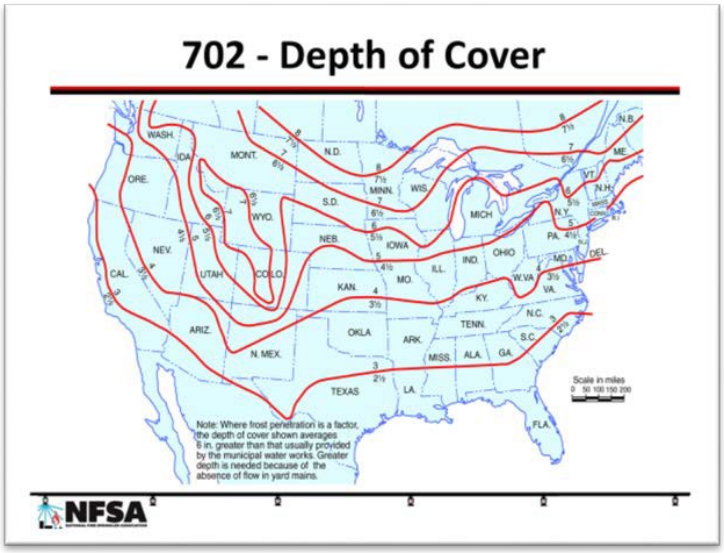
702 Depth of Cover

Depth of cover and frost protection is critical for underground piping serving fire sprinkler systems. Unlike domestic water lines, the water in fire sprinkler lines is not constantly moving. In fact, sprinkler water is usually stagnant. Stagnant water can freeze

quicker. Because of this, the depth of cover and the frost depth is used to protect the water in the pipe from freezing.

The depth of the underground pipe is buried to a depth of at least 1 foot deeper than the frost line, measured to the top of the pipe. The annex of NFPA 13 has a map of frost depths, but the local plumbing or building codes will have the specific depth for that municipality. Where frost or freezing is not a factor, the minimum depth, to the top of the pipe, shall be 30 inches.

Piping that cross under driveways shall be at least 3 feet deep and piping that cross under railroad tracks shall be at least 4 feet deep.



703 Damage Protection

Underground piping is not only susceptible to frost damage, but mechanical damage done by the structure it serves. It is a general rule to not install fire protection piping under the building. However, with the authority having jurisdiction's permission, there are three areas that piping may be installed under the building:

1. Arching the foundation walls over the pipe. The structural elements of doing this with the foundation would need the approval of a professional engineer and the building code plans examiner.
2. Run the pipe in covered trenches. This would provide easier access to maintain the pipe.
3. Provide valves to isolate the piping under the building. Valves would provide a way to shut off the piping under the building to stop a leak, however, if this section of pipe is the only supply to the overhead piping, other means must be provided to provide fire protection water.

NFPA 13 does permit the underground piping to enter under the building and then immediately turn upwards to provide the hub to connect the riser and the aboveground

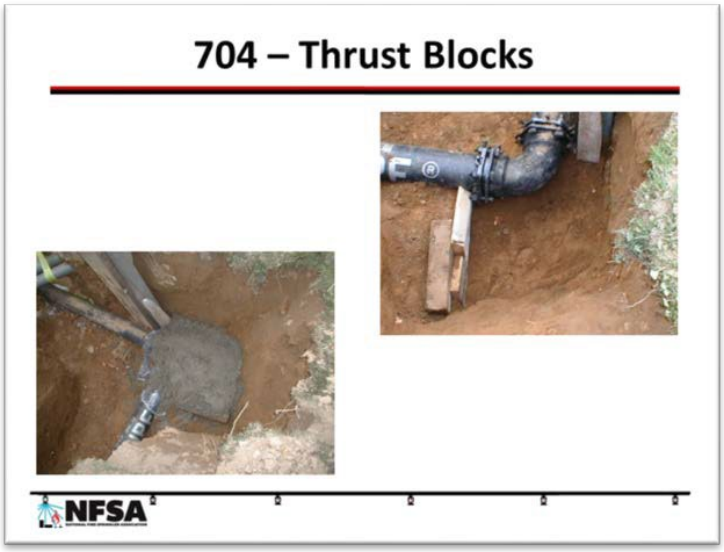
piping. The maximum run of the underground piping is no more than 10 feet from the exterior of the foundation wall. The underground piping shall not have joints installed under the foundation walls or the footings and the top of the underground piping shall be a minimum of 1 foot under the footings.

Unless underground mains are sleeved, they shall be evaluated when running under heavy loads, such as: railroads, large piles in yards, exposed to shock and vibrations.

704 Method of Joint Restraint

When water moves through piping, there is a force behind it that wants it to continue in a straight line. When water makes a turn, such as an elbow, there is enough pressure at the elbow as the water turns to want to push the elbow off. In underground systems, there are methods to hold that elbow and other fitting in place. It is called joint restraint.

Whatever method the fire sprinkler layout technician has chosen, review accordingly. If a mechanical lug joint restraint is used, review the manufacturers installation instructions. If thrust blocks are used by pouring concrete around the fittings, then make sure enough concrete has been calculated to restrain the joint.



Module 8 - Codes Review

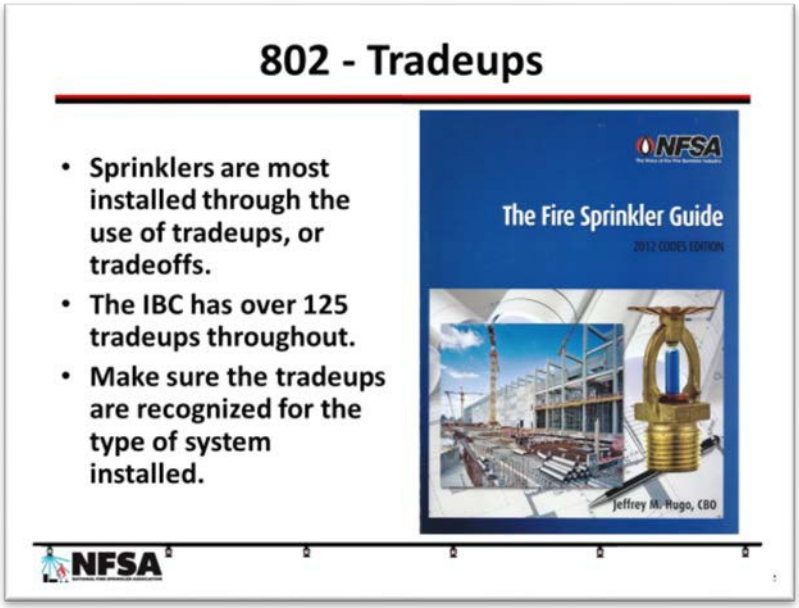
801 Architectural Plans

The architectural plans include the floor plans, elevations, reflected ceiling, and expanded views that are beneficial to the fire sprinkler plans examiner. The mechanical, electrical, and plumbing plans, along with the structural shop drawings, such as the floor and/or ceiling framing shop drawings, also assist the fire sprinkler plans examiner. While it is not stated anywhere that these plans are a requirement to have to perform the fire sprinkler examination, it is in the best interest of the fire sprinkler plans examiner to perform as thorough of a review as possible. The plans examiner will find that reviewing the architectural plans and the shop drawings together, or side-by-side beneficial.

The architectural plans have a few locations that the fire sprinkler plans examiner should check. The Reflected Ceiling Plan (RCP) shows the lighting fixtures in the ceiling. It also shows the warm air diffusers, soffits, and other potential obstructions.

802 Tradeups

Fire sprinkler tradeups are design and construction options that allow greater design flexibility while providing fire protection. They have been developed over the last 30 plus years to encourage the use of sprinkler to increase the level of fire safety over the minimum level provided by the model codes. Tradeups permit reductions in the normal passive fire protection requirements where active fire protection (fire sprinklers installed per NFPA 13 and NFPA 13R) is provided. The IBC has over 125 tradeups. NFSA's *The Fire Sprinkler Guide* is a great resource to help plans examiners find and verify the tradeups in each occupancy



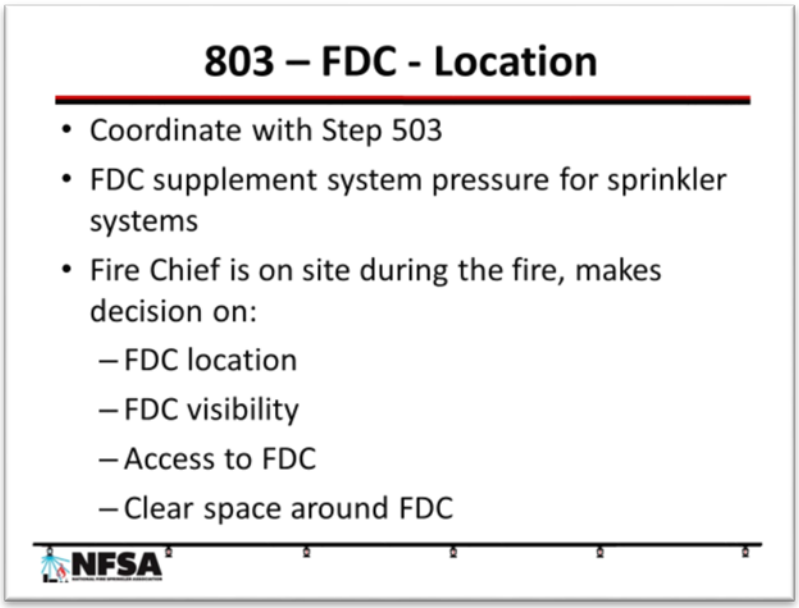
Tradeups do not affect the design or layout of the fire sprinkler system, however the fire sprinkler plans examiner should be aware of the tradeups used to design the building. Tradeups only apply when the building is sprinklered throughout and the fire sprinkler

plans examiner may be the best advisor to the building plans examiner when it comes to the sprinkler coverage in the building.

The IBC requires that buildings using sprinklers for height/area increases and tradeups to be sprinklered throughout. NFPA 13 also requires that the structure be sprinklered throughout unless specifically exempted by the standard. These areas that do not require sprinklers are commonly found in Chapter 8 of NFPA 13, and with these excepted areas, the building is still considered by the standard to be sprinklered throughout, which would comply with the requirements of the IBC.

803 Fire Department Connections – Location

The fire department connection (FDC) is installed on fire sprinkler systems to permit the fire department to supplement the system pressure. Fire sprinkler systems are designed to provide the flow and pressure without any assistance from the fire department engine. This doesn't mean that the connection to the FDC is unimportant. The fire department adds pressure to the fire sprinkler system. With more pressure, more flow occurs. More water on the active fire provides fire control and assists the firefighters in their suppression efforts.

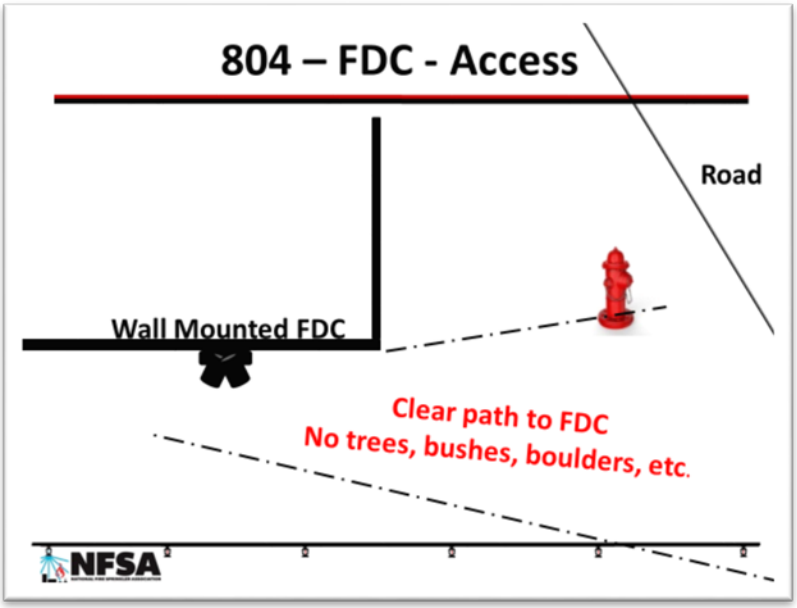


Fire department connections are located and approved by the fire chief. The FDC is to be installed on the street side of the building where it is visible to the responding fire department. The location of the FDC should be such as the fire engine and hose connected to the FDC is not blocking other fire department activities and vice versa. It should be noted that fire hoses are not made to be run over.

804 Fire Department Connection – Access

The FDC must be accessible at all times. The path to the FDC must be without fences, trees, boulders, walls, shrubs, and other structures that hamper or block access to the FDC. Fences with access gates are permitted where approved by the fire chief. The fire

sprinkler plans examiner will want to review the landscaping or civil plan and see how the final grade and landscaping is designed. In most cases, the landscaping and civil plans are reviewed long before the fire sprinkler documents are reviewed, so it may be necessary to revisit those reviews. Encourage those who do those reviews to add the fire sprinkler plans examiner or at least the fire department to comment.



805 Fire Department Connection – Clear Space and Protection

Fire department connections (FDC) are required to have 36-inch clear space all around the FDC, regardless of if it is mounted on the wall or a free-standing pedestal. The clear height above the FDC shall be a minimum of 78 inches. Review the area of the architectural, civil, and architectural plans to make sure the clearances are appropriate. Protect the FDC's that are subject to vehicle impact by Section 312 of the IFC. This section requires four-inch steel guard posts:

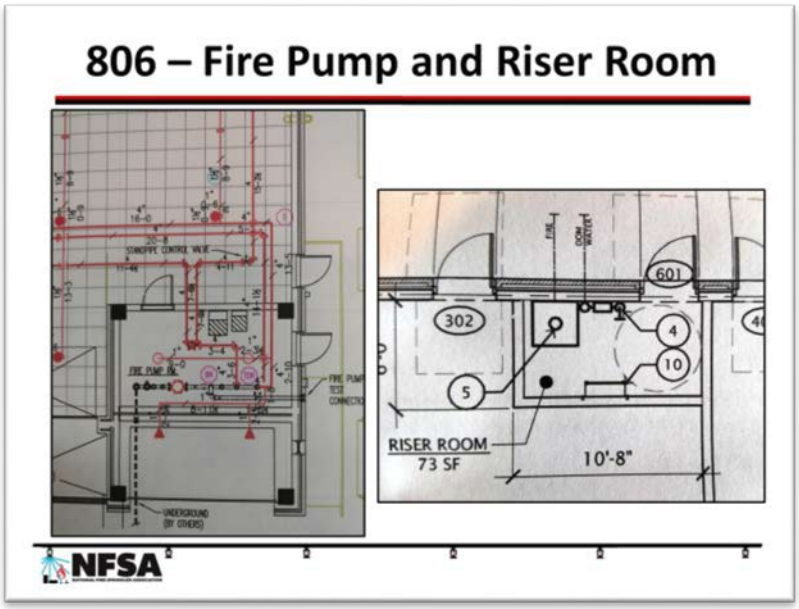
- 4 feet apart,
- 3 feet above ground,
- 3 feet from the FDC,
- Installed in a 15-inch diameter hole, 3 feet deep, filled with concrete.

806 Riser and Fire Pump Rooms

Riser rooms are required in certain cases, such as a dry pipe valve is required to be in a heated space. Fire pump and fire sprinkler riser rooms require routine maintenance, repairs, and possible replacement, adequate working clearances is needed.

The fire pump room is a dedicated room for the fire pump and other related fire protection equipment. The devices, panels, and motors that serve the fire protection equipment as close as possible to the fire protection equipment they serve. Equipment shall also be mounted on non-combustible or other substantial support structures and be protected from the possibility of physical damage. All components of the fire pump shall be in the fire pump room and only items related to fire protection can be present in the

fire pump room. Devices, panels, motors, and similar equipment, along with storage, that do not serve the fire pump are prohibited. The one exception is the domestic water piping and equipment; it is allowed to be in the fire pump room.

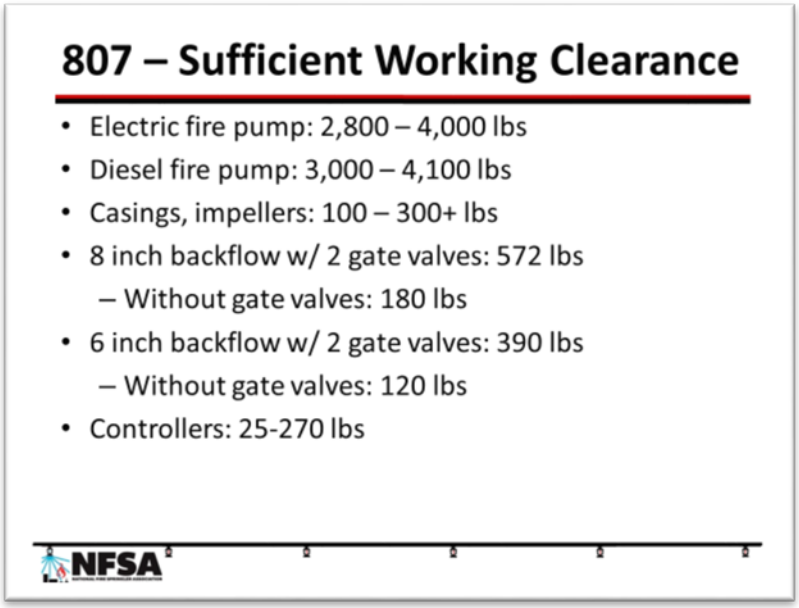


807 Sufficient Working Clearance

The building and fire codes require the fire pump room designed with adequate space around all of the equipment. The installation shall have the proper clearances and working spaces around the equipment. The minimum distance of the equipment from any wall should be four inches, but depending on the component, the minimum distance would increase accordingly.

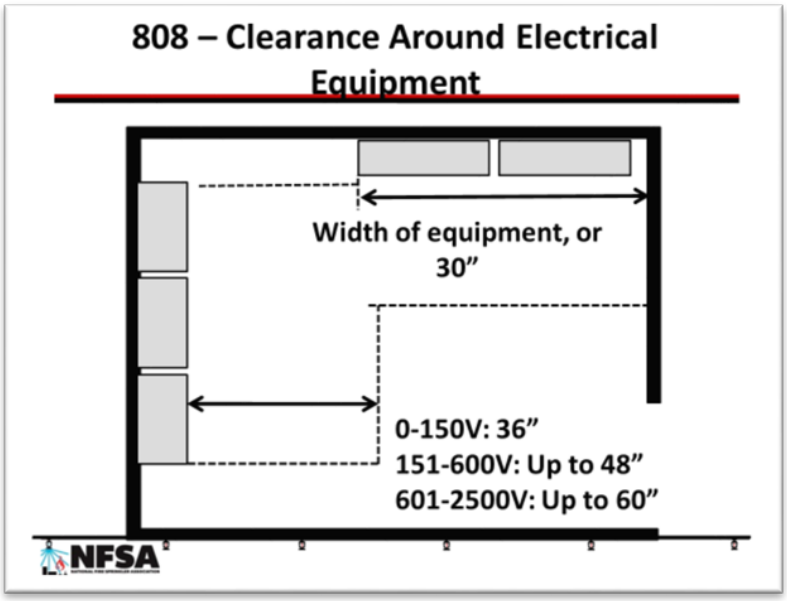
As the fire sprinkler plans examiner, consider the amount of space it takes to test and maintain any of the devices in the fire pump or riser room. Testing and maintenance of some equipment in the fire pump room may require two people, along with an arrangement of hoses, tools, parts, hoists, and additional lighting.

Consider the weight of the equipment installed and need to potentially move or replace this equipment in the future. Below are weights of some common components found in the fire pump room. Some of these components may need a fork truck, chain fall, duct lift, pulleys, and/or carts in the fire pump room, along with additional personnel to assist in moving the device for repair or replacement.



808 Clearance Around Electrical Equipment

The fire pump room contains many pieces of electrical equipment. Energized electrical equipment must be a minimum of 12 inches above the floor of the fire pump room. NFPA 70 requires dedicated workspaces for all electrical equipment. Slides from the presentation below show the requirements for the height, width, and depth of the dedicated space for electrical equipment. These minimum workspaces are devoted to the electrical worker and the layout of the room needs to be adjusted to follow these clearances mandated by the electrical code.



809 Fire Pump Suction Flange Orientation

Important consideration must be used when examining the piping in the fire pump room in regard to the suction flange of the fire pump and the suction piping. In NFPA 20, Figure A.4.14.6 shows many different positions of the elbows and tees in relation to the suction flange. When tees and elbows are installed improperly, they can introduce turbulence into the fire pump, which causes costly fire pump problems and interruptions.

810 Equipment Removal and Path

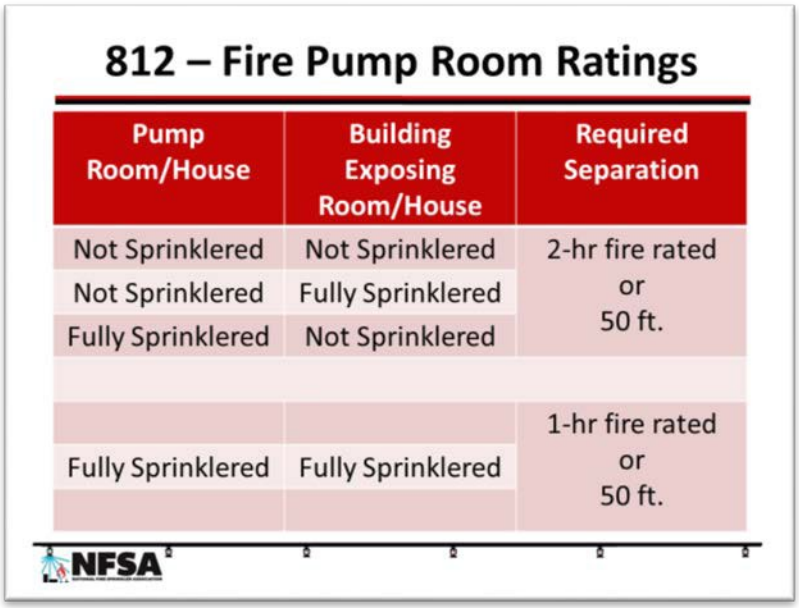
The IBC/IFC state that the equipment installed in the fire pump room must be able to go through the door or doors. The largest piece of equipment must fit through the door opening. This requirement is no different from the requirements in the mechanical or electrical codes for those trades. Building codes do not want the fire rated wall removed or disassembled in an event that the largest piece of equipment, such as the fire pump or controller, has to be removed. The repair of the wall may never occur or be reassembled correctly. The integrity of the fire rated walls, floor, and ceiling of a fire pump room is critical not only to protect the fire protection system but the personnel in the fire pump room. NFPA 20 requires someone to be in the fire pump room while it is running. By sizing the doors to the largest piece of equipment, it dramatically decreases the cost of maintenance for the system(s) in the future.

811 Unobstructed Path

The building and fire codes not only require the door sized for the largest piece of equipment, but also a path to move the equipment through the building. Fire pump rooms are usually located at the back of the building or by the loading dock. This provides an easy way to move parts and equipment that may need to be replaced without causing damage to floor and wall coverings.

812 Fire Pump Room Ratings

The building and fire codes require the floors, walls, and ceilings to have a fire resistance rating of 2-hours for fire pump rooms in high rises and 1-hour floors, walls, and ceilings for fire pump rooms located in buildings not considered a high rise. In the event of a fire, this room must remain in operation. In many cases the fire pump room and the building surrounding the fire pump room have fire sprinklers, but not always. Fire pump rooms are first protected by passive construction. It is very important to not forget the floors and ceilings are required to have a fire rating. This would also include the structural elements supporting the fire pump room. For example, if the fire pump room is on the third floor, the floor of the third floor along with the walls or columns that support the third floor shall have the same fire rating as the fire pump room.



813 Openings and Penetrations Protection

The openings through all the floors, walls and ceilings are required to be protected by approved opening protection. Every penetration is a breach in the integrity of the fire rated assembly, and every penetration has several methods of protection and is addressed by the building and fire codes.

Doors are fire rated with fire rated frames, hardware, and self-closers. Steel or copper piping (including diesel exhaust pipe), when 6-inches or less in diameter, may pass through masonry or concrete walls with the annular space filled in with mortar. All other penetrations such as conduit, plastic piping, electrical boxes, and ductwork are required to be protected by an approved firestop system such as intumescent caulking, collars, wraps, and pillows, fire dampers, and other approved methods.

814 Fire Pump Room Pre-Planning

NFPA 20 requires that qualified personnel occupy the fire pump room during a fire. When everyone else needs to exit the building during a fire, someone needs to go the opposite way and monitor the fire pump. NFPA 20 is emphatic that the fire pump room construction is pre-planned with the fire department. It is very important to get the fire department involved in the design of the fire pump room to ensure that the room is located and constructed properly.

NFPA 20 requires the fire pump room to be directly accessible from the outside or from an enclosed passageway or enclosed stairway. Not all fire pump rooms are on the first floor. In the case of tall buildings, the fire pump room(s) could be located several stories from the first floor. NFPA 20 would require the accessible path to the fire pump room to have the same fire resistance rating as the fire pump room. For high rise buildings, the 2-hour fire pump room would be accessed by the 2-hour stair enclosure.
As the plan's examiner, here are two items for consideration. One, the building codes do

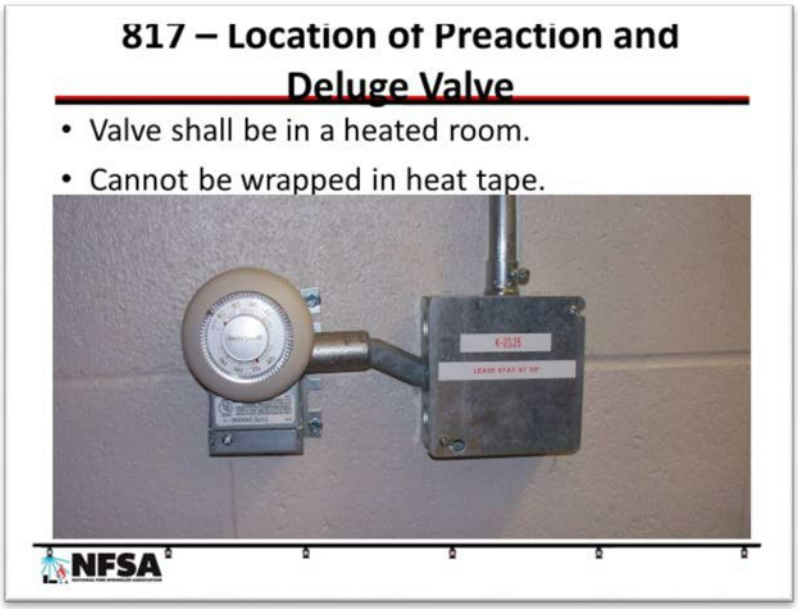
not permit access into any room from inside the stair enclosure. Two, if the fire pump room is not accessed from the stair enclosure, then it would be from a corridor or exit passageway. The corridor and exit passageway, in the building code, is only required to be of 1-hour construction. Both exiting components would need to be upgraded to serve as the access route for the fire pump room. The preplanning meeting with the fire department is imperative to resolve some of the current building and fire code requirements that are not coordinated with NFPA 20.

815 Room Temperature

When it comes to fire protection, the temperature of space or room is required to be above 40 degrees Fahrenheit. A reliable source of heat is required to maintain the minimum temperatures. When the fire pump room contains diesel fire pumps, the manufacturer's literature may require the minimum temperature to be increased.

816 Location of dry pipe valve

Dry pipe systems are installed in areas that are susceptible to freezing temperatures. However, the dry pipe valve, which separates the water supply from the dry piping, shall be in a heated room. The room shall be kept to a minimum of 40 degrees Fahrenheit by a permanent heat source and have permanent lighting installed. The permanent heat source shall not be a heat trace tape.

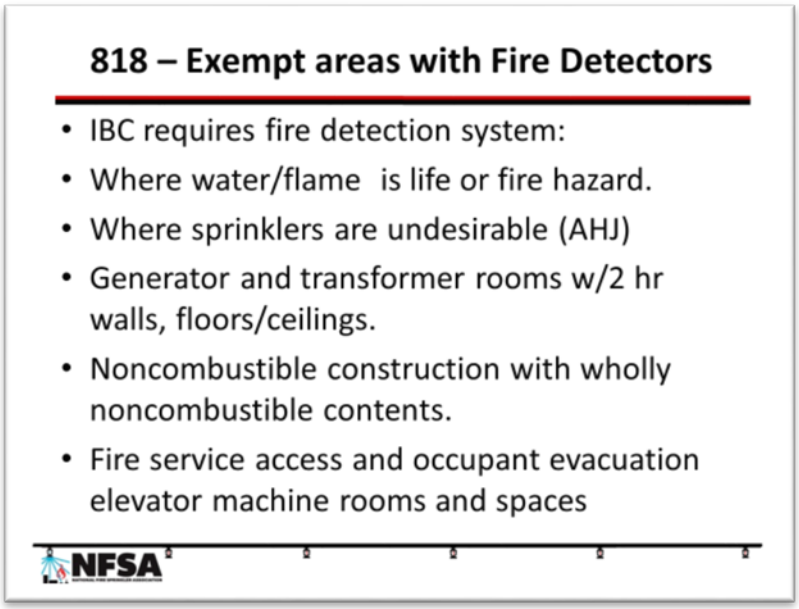


817 Location of preaction and deluge valve

Dry pipe systems are installed in areas that are susceptible to freezing temperatures. However, the dry pipe valve, which separates the water supply from the dry piping, shall be in a heated room. The room shall be kept to a minimum of 40 degrees Fahrenheit by a permanent heat source and have permanent lighting installed. The permanent heat source shall not be a heat trace tape.

818 Exempt areas w/ fire detectors

The IBC has several areas that are exempt from fire sprinklers. Some of these areas are like the exempt areas in NFPA 13, however the key difference is the IBC requires an automatic fire detection system to be installed in the area that is exempt from sprinklers. The heat detection system shall be installed according to the IBC and NFPA 72. The exempt areas, where allowed in NFPA 13 and NFPA 13R do not require a fire detection system.



819 NFPA 13R balconies/decks

The balconies, decks, and ground floor patios of Group R, Type V construction require fire sprinklers in the IBC and NFPA 13R. The sprinkler is exempted where no roof or floor structure is located above to collect the heat. Where there is a floor or roof above, the sprinkler is located 1 - 6 inches below the ceiling and up to 14 inches below the floor of an open joist construction.

820 High Rise Buildings

Sprinklers in high rises use several codes and standards. The majority of high-rise sprinkler design is how the water travels vertically. The plans examiner will need to use NFPA 14, NFPA 20 and other standards to perform the review. The hydraulics and spacing follow protocol as any other building. The plans examiner will need to know that there are four different categories of high-rise buildings and that due to overlapping codes and standards, a building might fall into one, two or three of the categories at the same time, which influences the code requirements that apply to that building. The four categories are:

1. A regular high-rise building - A building that has a floor for occupancy more than 75 ft above the lowest level of fire department vehicle access. All codes and standards have similar versions of this definition.

2. A high-rise building that is above the pumping capacity of the fire department – As mentioned above there are other standards that are used to install sprinklers for

a high rise. These are not directly referenced by the IBC or IFC, but when a high rise is built, NFPA 14 and NFPA 20 become the "drivers" of how sprinklers are supplied on each floor. NFPA 20 expresses this concept as a "Very Tall Building". NFPA 14 has also adopted similar language for some standpipe requirements. The height of these buildings varies from one city to thenext depending on how much pressure the fire department is willing to pump into an FDC. This will depend on the types of pumps the fire department carries on their trucks, the type of hose that they carry and the procedures that they are willing to undertake.

3. A building more than 420 ft in height – Special rules for the water supply in Section 403.3.2 in the IBC apply at this building height. See Step 821
4. A building in a seismic zone – Section 403.3.3 of the IBC has special rules for on-site water supplies for these buildings. See Step 822.

A building might fall into just category 1. Or a building might fall into both categories 1 and 4. Or a building might fall into categories 1, 2, and 3, but not 4. There are many possible combinations. The building needs to meet all the code and standards requirements for all the categories it falls into. A comprehensive checklist for high rise buildings is beyond the scope of this program.

821 Water Supply for High Rises over 420 feet

If a pump is connected to a water main, the IBC requires it to have two different connections on two different mains. Note that this could be connections to two different mains or two connections to the same main with valves that allow the connection to be isolated in case of a main break.

822 Secondary water supply in Seismic Areas

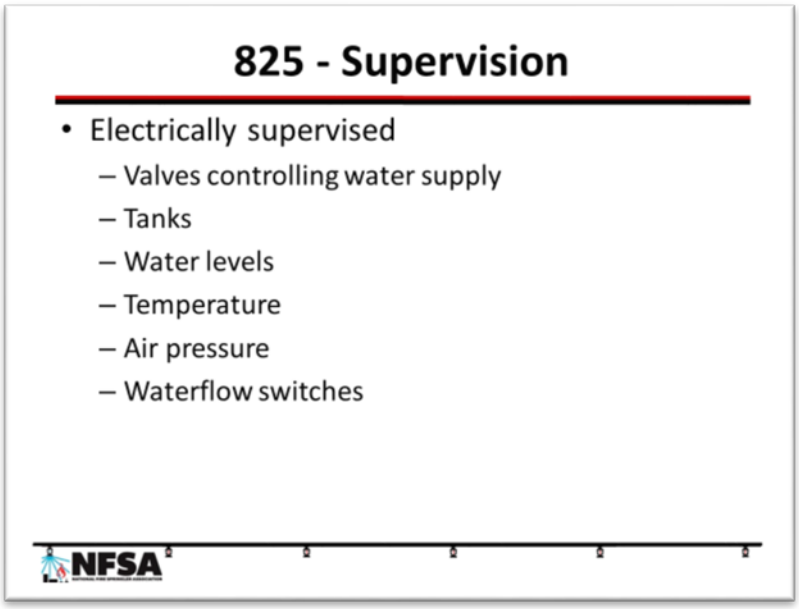
A secondary water supply is required for high rise buildings located in Seismic Design Categories: C, D, E, or F. The duration shall be a minimum of 30 minutes. This water supply does not have to be redundant as required by Chapter 5 of NFPA 20.

823 Floor control valves

Floor control valves for fire sprinklers are required for each floor of a high rise where the system is connected to the riser. The floor control valve shall be supervised. See Step 825.

824 Hose thread compatibility

The fire sprinkler plans examiner verifies the submitted cut sheets of all the hose connections on the project (standpipe, FDC, etc.) have threads that are compatible with the local fire department.



825 Supervision

The IBC requires critical elements that contribute to the water supply and to the function of the sprinkler system shall be electrically supervised by a listed fire alarm control unit. Here is a list of what is required by the IBC to be electrically supervised:

- Valves on connections to water supplies
- Valves on backflow preventers
- Pumps
- Water tanks
- Water levels and temperatures
- Air pressure maintenance devices
- Waterflow switches

The IBC lists a few exceptions to the above supervisory requirements for certain systems, such as NFPA 13D and IRC P2904 systems, limited area systems and NFPA 13R systems when the water line feeding the domestic and fire system is common or combined.

While NFPA 13 permits any valve to be sealed and locked in the correction position, the IBC does limit to only five types of valves to be sealed in the open position:

1. The jockey pump control valve
2. Control valves to commercial kitchen hoods, paint spray booths and dip tanks
3. Fuel supply control valves for fire pumps
4. Trim valves to pressure switches for dry, preaction, and deluge sprinkler system
5. Backflow preventer test valves on limited area fire sprinkler systems.

The plans examiner is to check that this list is thoroughly checked, and the shop drawings clearly indicate compliance. Recent changes to the IBC require that the supervision is connected to a listed fire alarm control unit. NFPA 13 and some other standards permit a

chain and lock and other methods, however, the building code requirement supersedes the installation standards such as NFPA 13. No new sprinkler systems shall have a chain and lock solely for supervision.

826 Monitoring

Automatic sprinkler systems must be supervised as a means of determining that the system is operational. Required systems are then required to be monitored by an approved supervising service to comply with NFPA 72. Monitoring these signals ensures that someone is always watching over the system, whether it is being tampered with or is in operation.

The IBC requires that the alarm, supervisory and trouble signals to be (distinct in sound) automatically sent to an approved supervising station. The fire code official does have the authority to permit these signals to annunciate at a constantly attended location, such as a guard's station. There is one exception; key or hub box valves located at the street that are provided by the water authority are not required to be monitored.

NFPA 72 recognizes central stations, remote supervising stations or proprietary supervising stations as approved supervising stations:

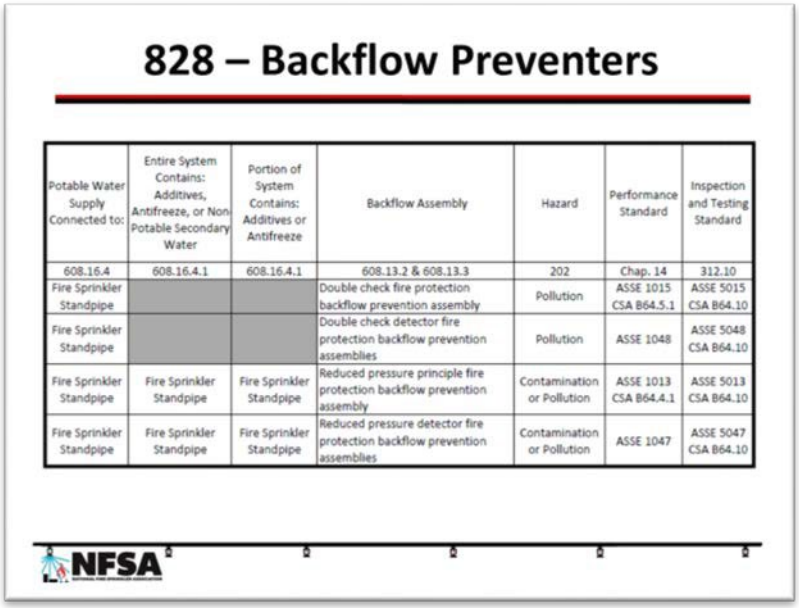
- Central station is an independent off-site facility operated and maintained by personnel whose primary business is to furnish, maintain, record, and supervise a signaling system.
- Proprietary system is like a central station system; however, a proprietary system is typically an on-site facility monitoring several buildings on the same site for the same owner.
- Remote station system has an alarm signal that is transmitted to a remote location acceptable to the authority having jurisdiction and that is attended 24 hours a day, typically a fire station or telephone answering service.

827 Exterior Alarm

Each sprinkler system shall have an audible alarm installed on the exterior of the building. When the building has a fire alarm system, the waterflow of the sprinkler system shall activate the fire alarm system.

828 Backflow preventers

The International Plumbing Code (IPC) doesn't have too much to do with fire sprinkler systems with one exception and that is for backflow protection. Backflow is required for fire sprinklers and standpipe systems and these requirements come from the IPC.



Column one references IPC Section 608.16.4 that requires backflow protection for fire sprinkler systems and standpipe systems when connected to a potable water supply. This is the most common system connection. The most common and most economical backflow assembly is the double check fire protection backflow assembly or the double check detector fire protection backflow assembly. These two assemblies also offer the least friction loss when designing fire sprinkler systems. This section exempts backflow protection from fire sprinkler and standpipe systems that do not have fire department connections. Dry, preaction and deluge fire sprinkler systems are also exempt from backflow protection.

Column two and three reference IPC Section 608.16.4. These two columns address when a fire sprinkler or standpipe system or a portion thereof, is connected to a potable water supply and the system has additives or antifreeze installed in the piping system or additional connections are made to a non-potable secondary supply. This is where the "RPZ" requirement comes from for antifreeze loops.
Column four is designates the type of backflow assembly. The 2012 IPC made some minor changes in their backflow assembly terminology to match the titles of the performance standard's titles.

Column five references the correct hazard that a backflow assembly should protect against. In IPC Table 608.1, the hazard reference is low or high and it is up to the user to find out the definitions. Table 1-1 states the correct hazard terminology. The IPC ties the two double check assemblies to protect from pollution and the two "RPZ's" to protect against contamination. 2012 IPC defines the two hazards as follows:

> Pollution: An impairment of the quality of the potable water to a degree that does not create a hazard to the public health but that does adversely and unreasonably

affect the aesthetic qualities of such potable water for domestic use.

Contamination: An impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids, or waste.

The sixth column references the correct performance standard as referenced throughout IPC Section 608. The appropriate year for the referenced standards in any ICC code can be found in the Referenced Standards chapter. In the IPC, referenced standards are in Chapter 14.

The seventh and last column addresses the standard for the inspection and testing of these backflow devices. This requirement comes from IPC Section 312.10. Annual inspections are required for all backflow assemblies and testing is required for the device annually, after installation (new or relocation), and after repairs.

End of fire sprinkler plan review participant guide