RESIDENTIAL FIRE SPRINKLER DESIGN
FOR THE
PHI KAPPA PSI FRATERNITY HOUSE

BY

NOLAN FROST

BIORESOURCE AND AGRICULTURAL ENGINEERING
BIORESOURCE AND AGRICULTURAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2013
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Residential Fire Sprinkler Design for the Phi Kappa Psi Fraternity House</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTHOR</td>
<td>Nolan Frost</td>
</tr>
<tr>
<td>DATE SUBMITTED</td>
<td>June 7, 2013</td>
</tr>
</tbody>
</table>

Daniel J. Howes
Senior Project Advisor
Signature
Date

Kenneth H. Solomon
Department Head
Signature
Date
ACKNOWLEDGEMENTS

I would like to thank Dr. Howes, my advisor on this project, for helping me through it; as well as teaching me all I know about water hydraulics.

I would like to thank Dr. Korman, for providing me with the resources needed to start this project and complete the design.

I would like to thank Jeff Perko, for all he taught me throughout the years I spent working for his company, Manito Construction.

I would like to thank Dennis Javens, the alumni advisor, for providing me with information to get started on the project; and for following my progress throughout the year.

And I would like to thank my parents and family for loving and supporting me throughout my educational career.
ABSTRACT

This senior project discusses the design of a residential fire sprinkler system for a local fraternity house. The design follows NFPA 13D code, and contains design calculations, design drawings, material specifications, and cost analysis. The design was completed with the intention of being used for the installation of a fire sprinkler system in the house.
DISCLAIMER STATEMENT

The university makes it clear that the information forwarded herewith is a project resulting from a class assignment and has been graded and accepted only as fulfillment of a course requirement. Acceptance by the university does not imply technical accuracy or reliability. Any use of the information in this report is made by the user(s) at his/her own risk, which may include catastrophic failure of the device or infringement of patent or copyright laws.

Therefore the recipient and/or user of the information contained in this report agrees to indemnify, defend and save harmless the State its officers, agents and employees from any and all claims and losses accruing or resulting to any person, form, or corporation who may be injured or damaged as a result of the use of this report.
# TABLE OF CONTENTS

SIGNATURE PAGE .............................................................................................................. ii  
ACKNOWLEDGEMENTS .................................................................................................... iii  
ABSTRACT ........................................................................................................................... iv  
DISCLAIMER STATEMENT ............................................................................................... v  
LIST OF FIGURES ............................................................................................................. viii  
LIST OF EQUATIONS ......................................................................................................... ix  
INTRODUCTION .................................................................................................................. 1  
  - Background Information ............................................................................................. 1  
  - Justification .................................................................................................................. 2  
  - Objectives .................................................................................................................... 2  
LITERATURE REVIEW ....................................................................................................... 4  
  - The Center for Disease Control and Prevention Fire Death and Injuries: Fire Deaths and Injuries Fact Sheet ................................................................................................. 4  
  - The National Fire Protection Association Automatic Sprinkler Systems for Residential Occupancies Handbook .................................................................................................................. 4  
  - Materials ....................................................................................................................... 5  
  - Design Requirements and Information ...................................................................... 5  
  - Design ............................................................................................................................ 9  
  - Other Requirements .................................................................................................... 12  
PROCEDURES AND METHODS ....................................................................................... 14  
  - Surveying, Site Reconnaissance, and Initial Drawings .................................................. 14  
  - Material Selection ....................................................................................................... 15  
  - Sprinkler Location Design .......................................................................................... 16  
  - Supply Line Layout ..................................................................................................... 16  
  - Pipe Sizing ................................................................................................................... 17  
  - Final Drawings ............................................................................................................ 18  
  - Other Deliverables ...................................................................................................... 18  
  - Cost Analysis .............................................................................................................. 19  
RESULTS ............................................................................................................................. 20  
DISCUSSION ....................................................................................................................... 21  
RECOMMENDATIONS ...................................................................................................... 23  
REFERENCES ..................................................................................................................... 24  
APPENDIX A ....................................................................................................................... 25  
  - HOW PROJECT MEETS REQUIREMENTS FOR THE BRAE MAJOR  
APPENDIX B ....................................................................................................................... 28  
  - DESIGN CALCULATIONS  
APPENDIX C ....................................................................................................................... 35  
  - MATERIAL SPECIFICATIONS  

vi
LIST OF FIGURES

Figure 1: Phi Kappa Psi Fraternity House ................................................................. 1
Figure 2: Heat Source Examples (National Fire Protection Association, 2012) .......... 5
Figure 3: Multi-Purpose Fire Sprinkler System (National Fire Protection Association, 2012) .................................................................................................................. 6
Figure 4: Single-Purpose Fire Sprinkler System (National Fire Protection Association, 2012) .................................................................................................................. 7
Figure 5: Examples of Shadow Areas (National Fire Protection Association, 2012) ... 8
Figure 6: Looped Fire Sprinkler System (National Fire Protection Association, 2012) ..... 9
Figure 7: Gridded Fire Sprinkler System (National Fire Protection Association, 2012) ...... 10
Figure 8: Straight Run Fire Sprinkler System (National Fire Protection Association, 2012) .................................................................................................................. 10
Figure 9: Sprinkler Location Design ......................................................................... 16
LIST OF EQUATIONS

Equation 1: Sprinkler Flow Rate Equation ................................................................. 9
Equation 2: Bernoulli's Equation .................................................................................. 11
Equation 3: Hazen-Williams Equation ....................................................................... 11
Equation 4: Minor Losses Equation ............................................................................ 11
Equation 5: Elevation Pressure Loss ......................................................................... 17
INTRODUCTION

Background Information

Residential fires are a serious threat to any home, and are the third leading cause of home deaths according to the CDC. They report that in 2010 the United States experienced 384,000 home fires, which led to 13,350 injuries, and 2,640 deaths. Alcohol has been reported to play a part in 40% of home fires, and when coupled with college students living on their own for the first time, can lead to potentially disastrous consequences in student housing (Centers for Disease Control and Prevention, 2011). To combat this risk, fire sprinklers are used to improve the survivability during a house fire. James Shannon, the president and CEO of the National Fire Protection Association (NFPA) speaks of the effectiveness of fire sprinklers, pointing out that sprinklers decrease the risk of dying in a home fire by nearly 80 percent. The evidence has led to Maryland and California adopting legislation requiring fire sprinkler systems to be installed in all new one or two family homes (National Fire Protection Association, 2012).

The Phi Kappa Psi Fraternity’s house on Foothill Blvd., seen in Figure 1, is currently undergoing renovations to comply with city zoning ordinances. One of the requirements is the installation of a residential sprinkler system. The fraternity’s status as a nonprofit social club means that the budget is tight for these renovations. Efforts are being made to cut costs by using alumni connections, and having active brothers help with the work as much as possible. By designing the fire sprinkler system, this senior project will hopefully decrease the cost of its installation and help save the fraternity money.

Figure 1: Phi Kappa Psi Fraternity House
Justification

Initial estimates for the cost of the installation of the fire sprinkler system in the fraternity house have placed the price at more than $30,000. These estimates were from a local fire sprinkler contractor, and included the design and construction. After consulting with an alumni advisor, it was determined that designing the system ourselves could significantly reduce costs, when done in correlation with using using an alumni connected contractor to install the system at a reduced cost. By doing the design work as part of this senior project, the goal is to reduce the billable hours for the design to those required for a Professional Engineer to review and stamp the drawings.

The fire sprinkler design is a perfect BioResource and Agricultural Engineering senior project. It uses the exact same principals of a networked water system commonly found in an irrigation design, and applies them to an indoor sprinkler system. Additionally it requires surveying, drafting, and project management skills. Research is required to make sure the system meets code, as well as to find the most cost efficient materials and methods possible.

Objectives

The project aims to have a completed design, which may be stamped by a professional engineer, and then used for construction this summer.

Completion of the project objective requires the following steps:

1. Discuss project requirements with building owner.
2. Review code and meet with industry professionals to determine the requirements and design parameters of the system.
3. Research available materials and manufacturers to find the best materials for the project’s design.
4. Obtain drawings of the house from the house’s architect and complete any required surveying; in order have a complete set of “As Is” drawings for the design.
5. Contact the City of San Luis Obispo to obtain drawings of city standards, as well as information regarding existing utilities that must be tied into.
6. Complete the fire sprinkler design using hydraulic design principals, and aiming for the most cost efficient solution that meets code. The design parameters include the following:
   a. Determine the location of each sprinkler as required by code.
   b. Meet a required flow rate at each sprinkler as required by code.
   c. Design piping to meet code as efficiently and reliably as possible, accounting for pressure loss due to friction, elevation changes, minor losses, etc…
   d. Design utility tie-in, and required backflow preventer, pressure regulator, valves, etc…
   e. Create construction drawings and specifications.
7. Review the design and make any required corrections.
8. Perform cost analysis and estimate for construction cost.
10. Have a Professional Engineer stamp the design, so it can be used for construction.

To help complete these objectives, personal interviews are to provide the supplement any information not found in the National Fire Protection Association Automatic Sprinkler Systems for Residential Occupancies Handbook, which will be discussed in the literature review. This includes Professor Thomas M. Korman, Ph.D., P.E., P.L.S. A professor in the Fire Protection Engineering masters program at Cal Poly, Dr. Korman teaches courses focusing on fire suppression systems. Dr. Korman has provided design resources including: the NFPA Automatic Sprinkler Systems for Residential Occupancies Handbook, which serves as the main resource for the project; and NFPA 13D, the code referenced by the handbook. Additionally, Dr. Korman has outlined the steps needed to successfully complete the design. This includes:

1. Determining requirements for code to follow, based on building type and use.
2. Selecting sprinkler flows and location.
3. Completing hydraulic design by working backwards from sprinkler heads
4. Information to obtain from the City of San Luis Obispo, including available pressure and flow rate at City utility tie-ins, and relevant city code (Korman, 2013).

The second personal resource for this project is Jeff Perko, P.E., President and CEO of Manito Construction, Inc. As a P.E. and contractor with his fire protection licensing, Jeff advises on practical considerations of the design, including construction considerations, and how to minimize costs. I have spent 5 years working for Jeff during the summers, and have gained a very good knowledge of plumbing, construction techniques, and estimating techniques thanks to his guidance. Much of the knowledge used in this project is thanks to Jeff’s mentorship (Perko, 2013).
LITERATURE REVIEW

The Center for Disease Control and Prevention Fire Death and Injuries: Fire Deaths and Injuries Fact Sheet

This fact sheet serves as a reference for statistics regarding fire deaths and injuries in the United States. It references 384,000 home fires in the United States; leading to 13,350 injuries and 2,640 deaths (Centers for Disease Control and Prevention, 2011).


This handbook serves as the main resource for this senior project. As a comprehensive design manual, the code and standards for design are listed, along with commentary and design techniques. The applicable code for this type of residence is NFPA 13D, “Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes.” The Phi Kappa Psi Fraternity house qualifies as a one- and two-Family dwelling. For other types of residences, other code must be used. By supplementing the handbook’s information with professional’s advice, just about all there is to know about designing a residential fire sprinkler system is covered (providing one has the appropriate background knowledge of hydraulics, engineering design, and construction).

The purpose of residential fire sprinklers is to prevent injury and loss of life. James Shannon, President and CEO of the National Fire Protection Agency, mentions in the foreword that fire protection sprinklers decrease the risk of dying in a home fire by nearly 80%. They also reduce average property loss by 71%, which can help lower insurance rates, and protect family’s priceless valuables.

During home fires the most common place for fires to take place is in the kitchen, here 32% of fires occur. Following the kitchen is bedrooms and by the fireplace, which are responsible for 8% of home fires each. Despite the kitchen’s higher chance of fire, residents face the highest risk of dying when fires take place in the bedroom or living room, which are each responsible for 24% of fire deaths. Only 8% of fire deaths occur in the kitchen.

NFPA testing procedures are discussed in the beginning of the handbook. These tests are used to write the code that will be used for the design. To determine the effectiveness of fire sprinklers, mock homes are built and fires are set with different fuels, such as furniture or chemicals.
Materials

Sprinklers. Code states that only new sprinklers are allowed to be installed in residences covered by NFPA 13D. The two types of sprinklers available to be installed are: ordinary temperature-rated sprinklers with a temperature rating of 135-170 deg. F; and intermediate temperature-rated sprinklers, with a temperature rating of 175-225 deg. F. Ordinary temperature sprinklers are required to be used where the maximum ambient temperature does not exceed 100 deg F. While intermediate temperature sprinklers require ambient temperatures can range between 101 and 150 deg. F. Examples of areas can be seen in Figure 2, and include: under sky lights, in unventilated concealed spaces such as attics, in saunas or steam rooms, and near fire places, ovens, stoves, heat ducts, furnaces, or light fixtures.

![Figure 2: Heat Source Examples](image)

System Components. There are many types of pipe allowed in a fire sprinkler design. This includes: SDR 9, SDR 13.5, Schedule 5, 10, 30, and 40 steel pipe, Type K, L, and M copper tubing, CPVC pipe, and PEX tubing. The handbook lists dimensions and ASTM standards for each of these types of pipes as a reference, as well as the properties of their fittings. The most likely candidates for the pipe to be used in the design are CPVC pipe, and PEX tubing. CPVC is much easier to install than steel pipe or copper tubing, because of its flexibility and light weight, as well as its easier to use fittings. This means less labor costs, which can significantly drive down the cost of the installation. PEX tubing is even easier to install than CPVC because of its greater flexibility, as it can be bent and run around corners with fittings. But PEX tubing is also more expensive, so the tradeoff will have to be analyzed during the design.

Design Requirements and Information

Water Supply. Fire sprinklers require a certain pressure to provide the protection needed. The design determines the required pressure after friction and minor losses are included. This pressure must be able maintained at the required flow rate for 7 to 10 minutes, for the
design to meet code. Ideally, the pressure and flow can be supplied city utilities, as is anticipated with this design. But the pressure supplied by the city is too low, or if for some other reason a sufficient flow rate of water at the required pressure is not available, other methods must be used. These methods include: pumps, storage tanks, and pressure tanks. Further details are available in the handbook, but they will not be discussed here, as none of these devices are anticipated to be needed.

**Piping system types.** There are two types of sprinkler piping system designs used in residential design. The first is a multi-purpose design, which is a system that supplies domestic water and water for the fire protection system. This is commonly used when domestic water plumbing and the fire protection system are being installed at the same time, such as when a new home is built, or major renovations are taking place. It is advantageous because less materials and labor are needed to install the system. Examples of multi-purpose piping systems are shown in Figure 3.

![Multi-purpose Piping System](image)

**Figure 3:** Multi-Purpose Fire Sprinkler System (National Fire Protection Association, 2012)

The second type is a single-purpose piping system, in which the piping for sprinkler system is dedicated solely to fire protection. Single purpose systems are the most common and practical way to install fire protection while renovating an already built house, which has existing plumbing in place. This is the system that will be used in this design. Examples of common arrangement for single system designs can be seen in Figure 4.

![Single-purpose Piping System](image)
Installation requirements. A number of requirements and rules for installation of sprinkler systems are listed in the handbook. These must be met for the system to meet code. They are listed in the following section.

1.) A single valve to shut off the domestic and fire protection system must be installed. This valve is necessary to shut off all of the water to the house in case a pipe breaks, or is damaged in some way, as well as for freeze protection, and service reasons. 2.) A minimum ½” system drain must be installed. A drain valve is necessary in case the system needs to be serviced, or the homeowner wishes to drain it for freeze protection if the house is unoccupied. 3.) If a pressure tank is used in the system, pressure gauges are required. They are not required if there is not a pressure tank. 4.) Pipe supports must meet local plumbing requirements. Support requirements may vary by location. For example, in a seismically active area the requirements may be more stringent. In addition to this, manufacturer’s requirements for pipe support should always be met or exceeded. 5.) Sprinkler installation must follow manufacturer instructions. 6.) Sprinklers are not to be painted unless approved by manufacturer. In the past, home sprinklers were not very visually appealing, which let to the desire to paint over. Manufacturers have recently made home sprinklers much more aesthetically pleasing, but if one still wishes to paint their sprinklers they must consult with the manufacturer before hand. 6.) Water flow alarms are to be installed if the home is not equipped with smoke detectors. In some areas, smoke detectors are not required. This requirement ensures that in the event of a fire residents are alerted.
Sprinkler Position and Requirements. When designing a fire protection system, the operating pressure of a sprinkler required to be at least the minimum pressure specified by the manufacturer, or 7 psi. The designer must take care to make sure that the discharge is not to be affected by obstructions, such as fans, light fixtures, etc. This often requires a site walk of the location, to make sure that the selected locations for sprinklers are okay. However, some obstructions are okay. These are called “shadow areas”, and are architectural obstructions that cannot be designed around. They can be thought of as forming a shadow over the sprinklers spray pattern. Shadow areas are acceptable as long as the total area is less than 15 square feet. Example illustrations that help define shadow areas can be found in Figure 5.

Figure 5: Examples of Shadow Areas (National Fire Protection Association, 2012)

In a design, sprinklers are required to be installed in all areas of the home except: bathrooms less than 55 square ft.; closets and pantries less than 24 square ft.; garages, porches, or car ports; attics or non-living spaces; unheated projections of the building, as long as it is not the only means for a person to escape the building; and ceiling pockets less than 100 cubic feet.

Protection from Freezing. The handbook has extensive information for methods of protecting a fire sprinkler from freezing in cold weather. The most common method of protection, and the only one that applies to the San Luis Obispo climate is insulation. Insulation is required to be used in areas where temperature may drop below 40 deg F, such as in attics. For colder weather climates, other methods are used. The most common method is the addition of anti-freeze to the water. When this is done care must be taken to prevent backflow, which could contaminate domestic water. The anti-freeze must also meet health requirements, which require it to be safe if someone is sprayed by an active sprinkler. These systems also require the anti-freeze to be periodically drained and replaced. One more type of system to protect from freezing is a dry pipe system. This is a newer technology, and as of now is more costly and takes more maintenance than wet systems. The basic principal behind a dry system is that the pipes do not contain water until the sprinklers are activated by a fire.
Discharge and Hydraulic Calculation. The basic design principal for sprinkler systems is the same as for an irrigation design. One starts by looking at the required flow rate and the coverage of the sprinklers. Code calls for sprinklers to provide a minimum flow of 0.05 gpm/sq.ft, or the sprinklers listed flow rate, whichever is greater. If necessary, corrections must be made to the sprinklers flow rate using Equation 1 below

\[ q = kp^{0.5} \]

\( q \) = sprinkler flow rate
\( k \) = sprinkler kfactor (supplied by manufacturer)
\( p \) = pressure at sprinkler head

The sprinklers must be located so that all of the required areas, listed earlier, are covered. Once the location of the sprinklers is known, the network of the piping can be laid out. There are three types of networks, the choosing of which varies based upon the sprinkler layout. The first is a looped system, with two mains tied together just after the water supply, and meeting at the end. Individual sprinklers are located at the dead ends of branch lines. An example of this can be seen below in Figure 6.

![Figure 6: Looped Fire Sprinkler System](image)

The second type of network is a gridded system in which individual systems are supplied in two directions; which are fed by two mains, and tied together by branch lines. An example can be seen in Figure 7.
The third type of network is a straight run system, also known as a tree system because of its geometry. It consists of a single main line feeding branch lines for individual sprinklers. An example of a straight run system can be seen in Figure 8.

When designing for flow rate, one is to make the assumption that a maximum of two sprinklers are active during the fire. This minimum is kept low to by the NFPA to keep the cost of fire sprinkler systems low for homeowners. By looking at the furthest two sprinklers in the system, the required pressure for the sprinkler’s required flow rate can be found.
From there, the designer is to work backwards through the system; calculating pressure change due to friction at the system flow rate, and due to elevation change. From the change in pressure, pipe can be sized to meet the required pressure. The hydraulic calculations to find the system pressure involve Bernoulli’s Equation, the Hazen-Williams Equation, and the minor losses equation.

Bernoulli’s Equation is used to find the change in pressure due to elevation change and friction loss. It can be seen below in Equation 2.

\[
P_{\text{upstream}} + \text{Elev}_{\text{upstream}} + \frac{V_{\text{upstream}}^2}{2g} = P_{\text{downstream}} + \text{Elev}_{\text{downstream}} + \frac{V_{\text{downstream}}^2}{2g} + H_f + H_l
\]

\(P = \text{pressure}\)
\(\text{Elev} = \text{elevation}\)
\(V = \text{velocity}\)
\(H_f = \text{friction loss}\)
\(H_l = \text{minor losses}\)
\(g = \text{gravity} \left(64.4 \, \text{ft} \, \text{s}^{-2}\right)\)

Hazen-Williams Equation is used to find the friction loss in the system. It can be seen below in Equation 3.

\[
H_f = 10.5 \times \left(\frac{\text{GPM}}{C}\right)^{1.852} \times L \times \text{ID}^{-4.87}
\]

\(H_f = \text{friction loss}\)
\(\text{GPM} = \text{flow rate in gallons per minute}\)
\(C = \text{pipe Cfactor (found in tables in handbook)}\)
\(L = \text{pipe length}\)
\(\text{ID} = \text{pipe inner diameter (found in tables in handbook)}\)

The minor losses equation is used to find the pressure loss through valves, bends, and other equipment. It can be found below in Equation 4.

\[
H_l = \frac{kV^2}{2g}
\]

\(H_l = \text{minor losses}\)
\(k = k - \text{factor for obstruction (found in tables in handbook)}\)
\(V = \text{velocity}\)
\(g = \text{gravity} \left(64.4 \, \text{ft} \, \text{s}^{-2}\right)\)
These hydraulic equations are tabulated in tables in NFPA 13D. Using the tables, the pressure loss throughout the system is calculated. Multiple iterations are then run, until the change in pressure and flow rate becomes negligible. While running these iterations, the pipe is sized to supply the required pressure to the sprinklers. It is important to note that when sizing pipe for the system, code requires that a minimum pipe size of: 1” for steel pipe and ¾” for non-steel pipe, be used.

Once the calculations and sizing are complete, a scaled drawing can be made. While not required, it is most often necessary to convey the design to the contractor installing the system. The drawing, if made, is required to have:

- Building address
- Size and type of domestic line, including length to city connection
- Water meter size
- Current static water pressure
- Interior walls
- Model, manufacturer, orifice size, and spacing requirements of sprinklers
- Type of pipe
- Hanger spacing requirement of pipe, from manufacturer
- Riser detail
- Installing contractor information

Other Requirements

Once installation is complete, the building owner is required to be supplied with the following information. Much of this is the responsibility of the contractor, but the designer may take part as well. This includes maintenance instructions, and how to complete periodic inspections and testing. Manufacturers instructions for the system, including painting instructions must be supplied. And contact information for the installing contractor and a sprinkler service company must be given.

TYCO Fire Products

The TYCO Fire Products website was consulted to obtain information regarding materials to be used for the project.

TYCO Rapid Response Series LFII Residential 4.9 K-factor Concealed Pendant Sprinklers were selected to be used because they sit flush with the ceiling, for visual aesthetics; and are less likely to by accidentally set off, due to the flush profile and concealing cap. The price from the TYCO website was $85 per sprinkler.

The TYCO 513D 1 Inch Riser Manifold was selected. It incorporates a drain valve, pressure gauge, and water flow alarm into one assembly, which simplifies installation. The price from the TYCO website was $750.
The TYCO Rapid Response Model RSV-1 Residential Shut-Off Valve DN25 was selected
to separate the fire protection system from the residential water system, and to act as a
check valve. The price from the TYCO website was $1100.

TYCO BlazeMaster CPVC Pipe and Fittings were selected as the standard for the CPVC piping (TYCO Fire Products, 2013).

The materials specifications from TYCO can be found in Appendix C.

US Plastic

The US Plastic website was used to find prices for CPVC pipe and fittings for the cost analysis (US Plastic Corporation, 2013). The prices used can be found in Appendix D.

Home Depot

The Home Depot website was used to find prices for Type L copper tubing and fittings for the cost analysis (Home Depot, 2013). The prices used can be found in Appendix D.

United Rentals

The United Rentals website was used to find prices equipment rentals (United Rentals, 2013). The prices used can be found in Appendix D.
PROCEDURES AND METHODS

Surveying, Site Reconnaissance, and Initial Drawings

The first step in the design procedure was updating existing architectural drawings for the house to suit the designs needs. The initial layout for the house was obtained from David Brannon at Studio Design Group Architects, Inc. These drawings provided the floor layout for the house, but were lacking elevations and interior details. The accuracy of these drawings had to be confirmed by comparing them to the house’s actual dimensions; which was done using a tape measure. The drawings were found to be accurate, and while completing this task, any interior obstructions were made note of. The next step was obtaining elevation data for each floor of the house. This was done using a tape measure and laser level. The elevation of the bottom of the basement was recorded as a relative height of 0’-0”, and the height to the ceiling was measured. The difference in height was then added or subtracted to and from each floor, using the laser level to transition between rooms when necessary. This was completed twice, once from the bottom floor to the top; and once from the top floor to the bottom. The resulting difference between the two measurements was 0.25”, which is accurate enough for the purposes of this design. The final surveying task was determining the best location to locate the sprinkler supply and header. It was decided that the header would be placed in the garage, where it would be exposed and easy to access. To locate the header in the garage, the sprinkler supply line was to hook in to the water supply just downstream of the city water meter. The supply line would then be buried from the water meter, through the front yard, and into the garage. In addition to completing surveying, the city’s supply water pressure was measured numerous times throughout the day. The pressure was subject to change, due to different flows at different times of the day. The lowest water pressure found was 110 psi. This pressure would be used later in the system’s design.

Once the site data was recorded, the drawings were updated in AutoCAD. Details were added to the interior plan drawings, such as closets and baths. A section drawing was created from scratch using the elevations measured earlier. This section drawing would be important when looking at the difference in pressure between floors. The location of the city connection and water meter was drawn in, and the city water pressure was made note of on the plans. Additionally, a title block and border were created. The title block contained: the building address, the project name, a “designed by” field, a “drawn by” field, the date of the drawings completion, sheet numbers, a scale reference, and information detailing that it was a Cal Poly senior project. A drawing cover sheet with a map of the house location and picture of the house was also created. The line weights for different components of the drawing were also adjusted as needed.
Material Selection

Before the fire protection system could be designed, the materials had to be selected. These materials included the sprinklers, pipe type, header, and valves. It was decided to use TYCO Fire products for the design because the company is an industry leader, had easy to use product manuals and price sheets, and competitive prices. The design calls for “or equivalent” products, meaning that the installing contractor could use a different product if it is shown to be equal or better than the TYCO products selected. This is useful if the contractor can obtain a less expensive but equal in performance product, or if they have a preferred supplier. The specifications for all of the selected materials can be found in Appendix C.

The sprinklers selected were “TYCO Rapid Response Series LFII Residential 4.9 K-factor Concealed Pendant Sprinklers (TY3596).” These sprinklers sit flush with the ceiling, for visual aesthetics. They are also less likely to be accidentally set off, due to the flush profile and concealing cap. The design calls for the sprinklers to provide a coverage area of 16’ x 16’, which required a pressure of 7 psi and a flow of 13 GPM, according to the specifications.

The riser manifold selected was the “TYCO 513D 1 Inch Riser Manifold (TFP960).” This riser manifold incorporates a drain valve, pressure gauge, and water flow alarm into one easy to install assembly.

The “TYCO Rapid Response Model RSV-1 Residential Shut-Off Valve DN25 (TFP980)” was selected to separate the fire protection system from the residential water system. It contains a built in check valve to prevent flow from the fire protection system to the city supply.

The CPVC pipe and fittings selected were “TYCO BlazeMaster CPVC Pipe and Fittings.” They meet the required standards for fire protection pipe, such as good heat resistance and strength. CPVC is also easier to install and has lower friction than many alternatives. CPVC is also relatively cheap, especially when compared to copper. It is to be installed in any buried or concealed applications.

Type L Copper tubing was selected for any exposed piping. NFPA 13D excludes CPVC from being used in most exposed locations. Copper tubing is easy to install, and has low friction loss.
Sprinkler Location Design

With the type of sprinkler now selected, the layout could be determined. A 16’ x 16’ coverage area was decided on for the sprinklers because it would cover the width of any room in the house. Using this coverage area, a graphic was drawn up in AutoCAD showing the coverage. This was then overlaid on the house plans, until every required area was covered. An example of this overlay can be seen in Figure 9.

![Figure 9: Sprinkler Location Design](image)

The areas that were required to have coverage are detailed in Section 8.3 of NFPA 13D. In this design, closets less than 24 square feet, bathrooms less than 55 square feet, and the attic were not required to have sprinklers. Other than those exceptions, sprinklers were laid out to cover all areas of the house. Fortunately, there were no difficult areas to cover, such as shadow areas, which are discussed in the Literature Review; and there were no significant obstructions that had to be designed around. When placing the sprinklers, a minimum spacing of 8 feet had to be observed, as well as a maximum spacing of 16 feet. Once the sprinklers were laid out, the coverage overlay was erased from the drawing, leaving just the location of the sprinkler heads.

Supply Line Layout

With the location of the sprinklers now determined, the location for the supply pipe had to be laid out. The supply pipe had to be designed with the shortest runs possible, for cost and hydraulic reasons; but ease of installation also had to be considered. A riser was placed in the garage, leading to the house’s attic. Main lines for the house’s upper and main levels branched off of this riser in the attic. Main lines also branched off of the riser, leading to the garage and lower levels; where the pipe is to be run through the ceiling. It was decided to use a minimum pipe size of 3/4" for the riser, main lines, and branch lines. This is because code states that this is the smallest size pipe that can be used, without designing a
networked system. A networked system requires that each sprinkler be supplied by a minimum of three separate paths. By using no smaller than 3/4" pipe, a straight run design could be used; where main lines supply branch lines without any looping. This was able to cut down on materials used, and make the installation simpler. Once the path of the supply lines were decided upon, they were added to the drawings.

Pipe Sizing

With the pipe layout decided upon, the pipes could now be sized. NFPA 13D calls for worksheets to be used in the sizing of the pipe. This results in uniformity between designs, and easy crosschecking between designers. The completed worksheets for this design can be seen in Appendix B, Design Calculations. The steps for pipe sizing are:

1. Establish system flow rate, following sections 10.1 and 10.2 of NFPA 13D – These sections call for the two sprinklers with the highest hydraulic demand, on each floor, to be designed to meet minimum pressure and flow requirements. So for this design, the two furthest sprinklers on all four levels of the house had to be supplied with 7 psi, while the system was flowing at 26 GPM.

2. Determine the city supply’s water pressure – As mentioned earlier, during site reconnaissance the minimum water pressure found at the street was 110 psi.

3. Arbitrarily select pipe sizes, based on anticipated need – A pipe size must be assumed to run the necessary hydraulic calculations. If the final pressure proved to be adequate, the selection was suitable; if not the pipe had to be resized. For the first iteration a minimum pipe size of 3/4" was selected. This proved to be inadequate on one floor of the house, so the pipe size had to be increased and the calculations run again.

4. Determine pressure loss through the water meter and deduct from the water pressure at the street – Table 10.4.3(a) was used to find the pressure loss through the water meter. By knowing the meter size of 3/4" and a maximum system flow rate of 26 GPM, it could be read directly from the table that the pressure loss through the meter was 14 psi.

5. Deduct pressure loss for elevation – Equation 5 below was to be used to deduct pressure loss due to change in elevation.

\[
\text{Building height above street (ft)} \times 0.433 = \text{pressure loss (psi)} \tag{5}
\]

6. Deduct pressure loss from city main to inside control valve – The pressure loss through this section of pipe was to be found by multiplying the length of the pipe, by the pressure loss per foot associated with the pipe material and size. This value was found in Table 10.4.3.(a) in the handbook.

7. Deduct pressure loss within the building – The pressure loss through these sections of pipe were to be found by multiplying the length of the pipe, by the pressure loss per foot associated with the pipe material and size. These values were found in Table 10.4.3.(a,b) in the handbook.

8. Deduct pressure loss through valves and fittings – The valves and fittings between the city supply, and the furthest two sprinklers were to be counted and listed. Each component was then assigned an equivalent pipe length in feet, from Table
10.4.3(d). All of the equivalent pipe lengths were then added up, and multiplied by the pressure loss per foot of pipe found earlier, to find the pressure loss through all of the fittings.

9. These steps were repeated for all four floors of the house.

10. If, after all of the deductions, the pressure supplied to the last sprinkler was less than the required 7 psi, the pipes had to be resized.

11. If, after all of the deductions, the pressure supplied to the last sprinkler was more than the required 7 psi, the pipe sizes were acceptable.

Once multiple iterations of the steps above were run, an acceptable design was reached. 1” pipe was used upstream of the riser manifold, and 3/4” pipe was used downstream. This design ended up incorporating a good factor of safety, by providing more than twice the required pressure to the most hydraulically demanding sprinkler.

Final Drawings

Now that the pipe was sized, the drawings could be updated to reflect the final design. The drawings were made sure to include all of the information required. Code states that the drawings for residential sprinkler systems must contain:

- Building address
- Size and type of domestic line, including length to city connection
- Water meter size
- Current static water pressure
- Interior walls
- Model, manufacturer, orifice size, and spacing requirements of sprinklers
- Type of pipe
- Hanger spacing requirement of pipe, from manufacturer
- Riser detail

The data from the pipe sizing was added in, as well as information regarding installation, such as sloping requirements and construction details. A detail drawing of the riser manifold was created with the help CAD drawings from the TYCO website. The drawing was sized to have a 1/8” = 1’ scale when plotted on 11” x 17” paper. Lastly, the line weights needed final adjustment to emphasize the new construction, while still showing existing conditions clearly. Once the final drawings were completed, they were thoroughly reviewed. Several mistakes were found and corrected, such as the lack of sufficient drainpipes, and incorrect scaling.

Other Deliverables
In addition to the drawings, the design calculations and material specifications had to be provided. The design calculations, found in Appendix B, were created in Microsoft Excel. They were formatted in an easy to read way so that others can check and understand the work. The material specifications, found in Appendix C were obtained from the manufacturer. They provide a resource for the installing contractor to make sure the correct materials are obtained; and act as a reference when choosing “or equal” products.

Cost Analysis

The final step of the design was performing the cost analysis, which can be found in Appendix D. First a takeoff from the plans was performed; in which every length of pipe and valve or fitting was recorded step by step, throughout the entire system. Prices for these materials were then obtained from online suppliers. A trencher and core driller were each priced to be used for an 8-hour day. Next the labor had to be accounted for. A labor rate of 0.45 hours per each foot of pipe was assumed. This resulted in a work crew of 3 working for 1.5 weeks, which seems reasonable. The workers were given a flat hourly rate of $50 per hour, which takes into account the average wages for a crew and operating costs. An extra 15% for overhead and profit, and an extra 15% for consumables and miscellaneous costs were also added. When all of these costs were added up, the final project cost is estimated to be about $19,000.
RESULTS

This project resulted in four different deliverables, which will be given to the owners of the house. They were design calculations, which can be found in Appendix B; material specifications, found in Appendix C; a cost analysis, found in Appendix D; and design drawings, found in Appendix E.

The final design used 21 sprinklers to cover all required areas of the house. 1” and 3/4" CPVC pipe, and 1” and 3/4" copper tubing were used to supply water to the sprinklers. Nearly 400 feet of pipe is to be installed. A riser manifold and shutoff valve are also to be installed in the system, as well as drain lines in case service is needed.

The design calculations show that a high factor of safety was provided throughout the system, with double the require pressure available to the most hydraulically demanding sprinkler. They may be consulted in the future by engineers or contractors working on this project.

The material specifications detail the products that were designed into the system, and provide a reference for contractors purchasing materials.

The cost analysis incorporated all aspects of construction, and showed the anticipated cost of each portion of the project. The estimated cost ended up being $18,983.

The design drawings incorporated all aspects of the design into 6 sheets, which show the details of the sprinkler system. They show the pipe size throughout the system, and the location at which the sprinklers are to be placed. The riser manifold is detailed to show its installation location and position. Notes regarding construction are located throughout the drawing. Information regarding the house’s address and location is included as well. And last of all a comprehensive title block is on each page, showing the designer, drafter, page number, project name, and details calling it out as a Cal Poly Senior Project.

For further details regarding the results please see the Appendices B thru E.
DISCUSSION

This senior project proved to be very successful, completing nearly all of its objectives. A usable design, that meets code, was developed. The design calculations follow the outline laid out in NFPA 13D, allowing others to easily review and check the design. The materials selected are easy to find, and cost competitive; and their attached specifications provide a reference to future contractors. The design drawings convey all necessary information for the installation of a sprinkler system; and follow the requirements laid out by code. A cost analysis was able to provide a ballpark estimate of the cost of the project. The only objective that was not completed by this project was getting the design stamped by a professional engineer so they could be used for construction. Hopefully in the future, the design can be given to a PE who can review it, and approve it for use in construction.

The initial drawings and site reconnaissance took much more work than anticipated. These steps in the design were required to be completed before the sprinklers could be laid out, or design calculations done. The project was delayed several times when missing information was found while working on the design. When this happened, the design had to be put on hold while the house was visited and more information was sought out. Part of the problem stemmed from inexperience with these kinds of designs, and lessons were often learned after mistakes were made. If a similar project were attempted again, it would go much faster because of knowledge gained the hard way.

The backbone of the project was the design calculations. A lot of work was required to be put in surveying the house and completing the drawings and sprinkler layout before the calculations could be done. But it is the calculations that prove that the piping and sprinkler layout is acceptable by code for fire protection. The fact that code governs so much of the design actually made the calculations fairly easy. The step by step process, which is intended to make the calculations easy to read, simplified the work greatly. The minimum pipe size of 3/4" for the system prevented much of the effort that would have been required for economically sizing the pipe, using the smallest size possible.

The design calculations and most of the major parts of the design required no change after they were complete. But after further review, several small problems were discovered that had to be corrected. It was found that the system was inadequately drained, due to the supply lines having high points. This was corrected by placing drain lines that exited the building in different locations. A site walk after the initial design was complete showed that a sprinkler was located too close to a wall mounted heater. The sprinkler had to be switched from an ordinary temperature rating to an intermediate temperature rating. Reviewing code after the design showed that two sprinklers were unnecessarily placed in bathrooms; so they were removed, reducing the cost. At the end of the design calculations, the pressure at the sprinklers ended up being twice that recommended by code. This provides a good factor of safety against unforeseen issues.
Once the calculations and design were complete, the drawings had to be refined so as to be presentable, and usable. A lot of effort was put into making the dimensioning as helpful as possible, without becoming too cluttered. The line weights and plot styles required adjustment to emphasize the correct information. The correct information regarding construction had to be included in the notes on the drawings, in order for the design to be usable. It was important to create a cover page and title block that was professional and clear. This added credibility to the design, by showing attention to detail; it also clearly conveyed the source of the design and its purpose.

The cost analysis is likely a very conservative estimate for the price of the project. There is a good possibility that the labor costs and consumables are too high. Additionally, contractors are likely able to get cheaper materials than were found for this report. It will be interesting to see what the actual cost of the installation is.

An alternative design strategy that possibly could have reduced costs, is using different piping materials. Tubing could have been used instead of pipe, which would have been easier to install. This would have reduced labor cost, but the material costs would have gone up, because tubing is more expensive. A professional with more experience would have been more qualified to decide which system to use; but for this project it was decided to use the more common and standard piping design. Costs could have also been cut by using less expensive sprinkler heads, that weren’t concealed. But because this design was for a fraternity house, it seemed wise to use the concealed sprinklers, which are less likely to be set off accidentally.
RECOMMENDATIONS

This design turned out successfully, but the project did not reach its ultimate goal of being stamped by a Professional Engineer at the end of the quarter. Part of the problem was that for experienced fire sprinkler installers, the design for a residential system is very simple and straightforward. Most of the cost for the project comes from the labor and materials. Therefore, any company contracted to install the system would likely wish to develop their own design for clarity and liability purposes; and using this project’s design may not save enough money to be worth the effort for the building owner. If this project were to be completed again, the best course of action would be finding a local contractor and working with them from the start. They would have standard designs that would simplify the process, and an agreement could be worked out before hand as to the discount that might be given.

There are several recommendations to be made if someone were starting this project from the beginning. The first is to have a better idea of the type of design that will be used before starting research. A lot of time was spend reading about networked systems, and supply lines made of tubing; none of which was applicable to this project. The second recommendation is to anticipate spending more time on the pre and post design calculation parts of the project. It was anticipated that the design calculations and pipe sizing would take the most time. But it actually took the least time, with site reconnaissance and working on the drawings taking much longer than planned. The third recommendation is to rely on outside help more. There were some problems that popped up, such as trying to figure out if a sprinkler belonged in a certain area, that could have been quickly answered by a professional. Instead, hours were wasted trying to find the correct answer in the code.

Regarding continuation of the project, it is still unclear if this design will actually be used. Professional engineers qualified to approve and use this plans would likely be able to do their own design in close to the time it would take to review and approve this design. They would also be able to reduce their own liability and meet company standards if they completed the design themselves. Additionally, by not working on and charging for a design, the company would just make less money. It is recommended that local contractors and installers are contacted and presented with the plans, and the building owners try to see if a deal can be worked out.
REFERENCES


Korman, P. T. 2013. Personal communication. Thomas Korman, PH.D., P.E., P.L.S.


Perko, J. 2013. Jeff Perko, P.E. President and CEO, Manito Construction.


APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE BRAE MAJOR
BRAE PROJECT REQUIREMENTS

The BRAE senior project must include a significant engineering design experience: one that builds upon the fundamental concepts of mathematics, basic sciences, the humanities and social sciences, engineering topics and communication skills to solve a problem. Design is the process of devising a system, component, or process to meet specific needs. The design process typically includes the following fundamental elements:

Establishment of objectives and criteria. The design will involve meeting with the building owner and architect to set design objectives, as well as consulting with industry professionals.

Synthesis and analysis. The project will involve a systematic design of the fire sprinkler system to meet the required pressure and flow rates to meet code.

Design evaluation. The design will be reviewed and evaluated by a qualified individuals, with the goal of developing a final design that can be stamped by a PE and used for construction.

Incorporation on applicable engineering standards. The design will follow all building code and industry standards for residential fire sprinkler systems in California.

Capstone Project Experience. The BRAE senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses).

Incorporates knowledge/ skills from these key courses:
- BRAE 133 Engineering Graphics
- BRAE 151 AutoCAD
- BRAE 239 Engineering Surveying
- BRAE 312 Hydraulics
- BRAE 414 Irrigation Engineering
- BRAE 403 Ag Systems Engineering
- Technical Writing

Design Parameters and Constraints

The project should address a significant number of the categories and constraints listed below:

Physical. The design requires hydraulic calculations for the sprinkler system have the necessary pressure and flow rate to meet code. It will take into account the architecture of the house, and other constraints related to the construction and installation of the system.

Economic. The design will meet code and industry standards as economically as possible. It will take into account pipe sizing, equipment specified, and construction techniques such as to be high quality at as low a price as possible.
Health and Safety. The purpose of the design is to provide protection against the dangers of fire to the residents of the house. The design’s goal will be the ultimate safety of the residents, with all other aspects secondary.

Ethical. The design is for the safety of the residents of the house, therefore an ethical design will put high quality above other considerations such as economics.

Social. The design must take into account the behaviors those who will be residing in the fraternity house. Therefore items such as the location of the header, and sprinkler heads should be designed to prevent interference and tampering as much as possible.

Aesthetic. The design will aim to be as aesthetically pleasing as possible. A good design will be as unnoticeable as possible, while still providing the necessary fire protection.
APPENDIX B

DESIGN CALCULATIONS
For this system, the standards of NFPA 13D 10.4.3 can be used for pipe sizing. The following steps are listed, along with a calculation worksheet guide:

1. Establish system flow rate using sections 10.1 and 10.2
2. Determine water pressure in street.
3. Select pipe sizes.
4. Determine pressure loss for meter using Table 10.4.3 (a).
5. Deduct pressure loss for elevation, using the values:
   \[ \text{Building height (ft) x 0.453 = Pressure loss (psi)} \]
6. Deduct pressure losses from the city main to the inside control valve by multiplying the pressure loss of the pipe material by total pipe length.
7. Deduct pressure losses inside the building by multiplying the pressure loss of the pipe material by total pipe length.
8. Deduct pressure loss for valves and fittings by:
   a) Counting valves and fittings between control valve and furthest sprinkler.
   b) Determine and add equivalent pipe length of each fitting.
   c) Multiply equivalent pipe lengths by pressure loss associated with pipe size and material.
9. Repeat steps for each level of the building.
10. If the remaining pressure is less than required, the system is to be redesigned
11. If the remaining pressure is more than required, smaller piping may be used if justified by calculations.
12. The remaining piping is to be sized the same as piping up to the furthest sprinkler unless justified by calculations.

The system is to be designed with a maximum of two sprinklers anticipated to be used. The two sprinklers with the greatest hydraulic demand are to be designed for. (NFPA 13D 10.2.1)

With this design, the two sprinklers can not be determined without looking at multiple scenarios, and finding the worst case. This worst case is to be known as the critical path.

From looking at the sprinkler layout, one can see the potential critical paths on each level. On the garage level, the furthest two sprinklers are: SPR#1 and SPR#2
On the lower level, the furthest two sprinklers are: SPR#8 and SPR#9
On the upper level, the furthest two sprinklers are: SPR#12 and SPR#13
On the main level, the furthest two sprinklers are: SPR#21 and SPR#20

**Determine System Flow Rate**

NFPA 13D states that the system shall be designed to produce a minimum discharge density of 0.05 GPM/sq ft, or the sprinkler listing. The sprinklers selected for this system are TYCO RAPID RESPONSE Series LHI Residential 4.9 K-Factor Concealed Pendant Sprinklers (Y3596) These sprinklers in this system are designed with a 15' x 15' coverage area, and a flow of 13 GPM.

The system must meet the flow requirements of whichever flow value is greater. (NFPA 13D 10.1.1.1)

First find the required flow from the NFPA required discharge density:

**Sprinkler Coverage Area:** 15' x 15'
**Sq ft:** 225
**Required Discharge Density (GPM/sq ft):** 0.05
**Flow Required = Discharge Den. X sq ft:** 12.8 GPM

Now compare to the chosen sprinkler manufacturer’s specifications:

For 16' x 16' spacing, flow requirement: 13 GPM
Choose the larger value, 13 GPM
For two active sprinklers, the system flow rate to be designed for is:

\[ \boxed{26 \text{ GPM}} \]

**Determine Water Pressure at Street**

The static water pressure at the street was measured at a hose valve approximately 5 ft from the water meter. It was measured 5 times at different times of the day, with different water use amounts on the system. The minimum pressure measured was: 110 PSI

**Complete NFPA 13D Calculation Worksheet**

With the information above, the calculation worksheet can be used to size the system piping.
### NFPA 13D Calculation Worksheet (for 10.4.3): SPR#1 and SPR#2 – Iteration #1

<table>
<thead>
<tr>
<th>(1) Water pressure in street</th>
<th>Individual Loss</th>
<th>Net Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>110 psi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(7) Arbitrarily select pipe size:</th>
<th>3/4&quot;</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>(3) Deduct meter loss.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; Meter @ 26 GPM, using Table 10.4.3 (a)</td>
<td>14 psi 96 psi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(4) Deduct head loss for elevation.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference in elevation between street and sprinklers:</td>
<td>4.833 ft</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.833 x 0.433 psi/ft =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(5) Deduct pressure loss from city main up to and including the sprinkler control valve.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The buried pipe is 3/4&quot; Type L copper.</td>
<td></td>
</tr>
<tr>
<td>Equivalent pipe lengths were obtained from table 10.4.3(d)</td>
<td></td>
</tr>
<tr>
<td>The pressure loss in psi/ft was obtained from Table A 10.4.3(b)</td>
<td></td>
</tr>
<tr>
<td>For the backflow preventer, an equivalent pressure loss of two 1&quot; check valves was assumed, because the equivalent pipe length for 3/4&quot; check valves was 0 ft.</td>
<td></td>
</tr>
<tr>
<td>The equivalent pressure loss for the reducer was assumed to be the same as a 90 deg elbow.</td>
<td></td>
</tr>
<tr>
<td>The pressure loss through the residential shutoff valve was determined with the manufacturer's specifications.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Eq. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe 7 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>90 deg elbow 8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Cock Valve 3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Check Valve (BF Prev) 14 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>Reducer 2 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Residential Shutoff Valve 4.6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 38.6 ft x 0.58 psi/ft = 22.4 psi 71.5 psi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(6) Deduct pressure loss from the sprinkler control valve to the furthest sprinkler.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tables are not provided in NFPA 13D for the equivalent pipe length of CPVC pipe.</td>
<td></td>
</tr>
<tr>
<td>3/4&quot; Sch. 80 CPVC is equivalent to Type K copper pipe for ID and C factor, so Table 10.4.3(c) was used instead</td>
<td></td>
</tr>
<tr>
<td>Equivalent pipe lengths were obtained from Table 10.4.3(d) for the copper piping sections</td>
<td></td>
</tr>
<tr>
<td>The pressure loss in psi/ft was obtained from Table A 10.4.3(b) and Table A 10.4.3(c)</td>
<td></td>
</tr>
<tr>
<td>The TYCO Riser Manifold has the equivalent of three flow through 1&quot; copper tees.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Eq. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe 85 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>7</td>
<td>90 deg elbow 7 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 92.0 ft x 0.112 psi/ft = 28.7 psi 42.8 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe 20.3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>6</td>
<td>90 deg elbow 12 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Riser Manifold (3 Tees) 6 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>2</td>
<td>Reducer 4 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Tee (through flow) 2 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 44.3 ft x 0.58 psi/ft = 25.7 psi 17.1 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe 7.3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>90 deg elbow 1 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (turned flow) 4 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 12.3 ft x 0.312 psi/ft = 3.8 psi 13.3 psi</td>
</tr>
</tbody>
</table>

After this point, the flow is split, and the design flow becomes 13 GPM:

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Eq. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe 7.8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>90 deg elbow 1 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 8.8 ft x 0.075 psi/ft = 0.7 psi 12.6 psi</td>
</tr>
</tbody>
</table>

Remaining pressure for end sprinkler: 12.6 psi
Required pressure for end sprinkler: 7 psi

System piping is acceptable.

The piping above is acceptable. Now other potential critical paths will be checked. If the system requires larger piping, the above sprinklers will still be acceptable.
### NFPA 13D Calculation Worksheet (for 10.4.3): SPR#8 and SPR#9 - Iteration #1

1. Water pressure in street
2. Arbitrarily select pipe size: 3/4"`  
3. Deduct meter loss:  
   - 3/4" Meter @ 26 GPM, using Table 10.4.3 (a)  
   - 14 psi  
   - 96 psi  
4. Deduct head loss for elevation:  
   - Difference in elevation between street and sprinklers: 0.5 ft  
   - 0.5 x 0.433 psi/ft = 0.2 psi  
   - 95.8 psi  
5. Deduct pressure loss from city main up to and including the sprinkler control valve:  
   - The buried pipe is 3/4" Type L copper.  
   - Equivalent pipe lengths were obtained from Table 10.4.3(d)  
   - The pressure loss in psi/ft was obtained from Table A.10.4.3(b)  
   - For the backflow preventer, an equivalent pressure loss of two 1" check valves was assumed, because the equivalent pipe length for 3/4" check valves was 0 ft.  
   - The equivalent pressure loss for the reducer was assumed to be the same as a 90 deg elbow.  
   - The pressure loss through the residential shutoff valve was determined with the manufacturer's specifications.  

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Type l. Copper Pipe</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td></td>
<td>7 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>90 deg elbow</td>
<td>8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Cock Valve</td>
<td>3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Check Valve (BF Prev)</td>
<td>14 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Reducer</td>
<td>2 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Residential Shutoff Valve</td>
<td>4.6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>38.6 ft x 0.58 psi/ft</strong></td>
</tr>
</tbody>
</table>

6. Deduct pressure loss from the sprinkler control valve to the furthest sprinkler:  
   - Tables are not provided in NFPA 13D for the equivalent pipe length of CPVC pipe  
   - Sch. 80 CPVC is equivalent to Type K copper pipe for ID and C factor, so Table 10.4.3(c) was used instead.  
   - Equivalent pipe lengths were obtained from table 10.4.3(d) for the copper piping sections.  
   - The pressure loss in psi/ft was obtained from Table A.10.4.3(b) and Table A.10.4.3(c).  
   - The TICO Riser Manifold has the equivalent of three flow through 1" copper tees.  

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Sch. 80 CPVC Pipe</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td></td>
<td>85 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>7</td>
<td>90 deg elbow</td>
<td>7 ft</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>92.0 ft x 0.312 psi/ft</strong></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe</td>
<td>10.0 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3</td>
<td>90 deg elbow</td>
<td>5 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (turned flow)</td>
<td>4 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Riser Manifold (3 Tees)</td>
<td>6 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Reducer</td>
<td>4 ft</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>30.0 ft x 0.58 psi/ft</strong></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe</td>
<td>48.6 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>90 deg elbow</td>
<td>2 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Tee (turned flow)</td>
<td>8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Tee (through flow)</td>
<td>2 ft</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>58.6 ft x 0.312 psi/ft</strong></td>
</tr>
</tbody>
</table>

After this point, the flow is split, and the design flow becomes 13 GPM  

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Sch. 80 CPVC Pipe</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td></td>
<td>14.5 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>90 deg elbow</td>
<td>2 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (through flow)</td>
<td>1 ft</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>17.5 ft x 0.085 psi/ft</strong></td>
</tr>
</tbody>
</table>

Remaining pressure for end sprinkler: 7.5 psi  
Required pressure for end sprinkler: 7 psi  

System piping is acceptable.

The piping above is acceptable. Now other potential critical paths will be checked. If the system requires larger piping, the above sprinklers will still be acceptable.

Note: The low factor of safety in the design above will be corrected in further iterations that will increase the supply pipe diameter.
NFPA 13D Calculation Worksheet (for 10.4.3): SPR#12 and SPR#13 - Iteration #1

(1) Water pressure in street
(2) Arbitrarily select pipe size: 3/4"
(3) Deduct meter loss:
   3/4" Meter @ 26 GPM, using Table 10.4.3 (a)
   14 psi  96 psi
(4) Deduct head loss for elevation:
   Difference in elevation between street and sprinklers:
   9.5 ft
   9.5 x 0.433 psf/ft = 4.1 psi  91.9 psi
(5) Deduct pressure loss from city main up to and including the sprinkler control valve:
The buried pipe is 3/4" Type L copper.
Equivalent pipe lengths were obtained from table 10.4.3(d)
The pressure loss in psi/ft was obtained from Table A.10.4.3(b)
For the backflow preventer, an equivalent pressure loss of two 1" check valves was assumed, because the equivalent pipe length for 3/4" check valves was 0 ft.
The equivalent pressure loss for the reducer was assumed to be the same as a 90 deg elbow.
The pressure loss through the residential shutoff valve was determined with the manufacturer’s specifications.

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe 7 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>90 deg elbow 8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Cock Valve 3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Check Valve (BF Prev) 14 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>Reducer 2 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Residential Shutoff Valve 4.6 ft</td>
</tr>
</tbody>
</table>

Total: 38.6 ft x 0.58 psi/ft = 22.4 psi  69.5 psi

(6) Deduct pressure loss from the sprinkler control valve to the furthest sprinkler:
Tables are not provided in NFPA 13D for the equivalent pipe length of CPVC pipe
Sch. 80 CPVC is equivalent to Type K copper pipe for ID and C factor, so Table 10.4.3(c) was used instead
Equivalent pipe lengths were obtained from table 10.4.3(d) for the copper piping sections
The pressure loss in psi/ft was obtained from Table A.10.4.3(b) and Table A.10.4.3(c)
The TFCO Riser Manifold has the equivalent of three flow through 1" copper tees.

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe 85 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>7</td>
<td>90 deg elbow 7 ft</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>92.0 ft x 0.512 psi/ft = 28.7 psi 40.8 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe 30.3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>6</td>
<td>90 deg elbow 12 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (turned flow) 4 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (through flow) 1 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Riser Manifold (3 Tees) 6 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>2</td>
<td>Reducer 4 ft</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>57.3 ft x 0.58 psi/ft = 33.2 psi 7.6 psi</td>
</tr>
</tbody>
</table>

After this point, the flow is split, and the design flow becomes 13 GPM

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe 35.0 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3</td>
<td>90 deg elbow 6 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Tee (turned flow) 8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>Tee (through flow) 4 ft</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>53.0 ft x 0.312 psi/ft = 16.5 psi -9.0 psi</td>
</tr>
</tbody>
</table>

Remaining pressure for end sprinkler: -9.4 psi
Required pressure for end sprinkler: 7 psi

System piping is unacceptable

The piping above is not acceptable. A second iteration will now be attempted with larger pipe sizes.
In the second iteration, the 3/4" CPVC supply line was changed to a 1" line, and the copper tubing before the riser manifold was changed to 1" tubing.

(1) Water pressure in street

(2) Select pipe size: 1" and 3/4"

(3) Deduct meter loss:
   3/4" Meter @ 26 GPM, using Table 10.4.3 (a)
   14 psi 96 psi

(4) Deduct head loss for elevation:
   Difference in elevation between street and sprinklers:
   9.5 ft
   9.5 x 0.433 psi/ft = 4.1 psi 91.9 psi

(5) Deduct pressure loss from city main up to and including the sprinkler control valve:
   The buried pipe is 3/4" Type L copper.
   Equivalent pipe lengths were obtained from table 10.4.3(d)
   The pressure loss in psi/ft was obtained from Table A.10.4.3(b)
   For the backflow preventer, an equivalent pressure loss of two 1" check valves was assumed, because the equivalent pipe length for 3/4" check valves was 0 ft.
   The equivalent pressure loss for the reducer was assumed to be the same as a 90 deg elbow.
   The pressure loss through the residential shutoff valve was determined with the manufacturer’s specifications.

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Quantity</th>
<th>Equivalent Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe</td>
<td>7 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>90 deg elbow</td>
<td>8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Cock Valve</td>
<td>3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Check Valve (BF Prev)</td>
<td>14 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>Reducer</td>
<td>2 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Residential Shutoff Valve</td>
<td>4.6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>38.6 ft x 0.58 psi/ft = 22.4 psi 69.5 psi</td>
</tr>
</tbody>
</table>

(6) Deduct pressure loss from the sprinkler control valve to the furthest sprinkler:
   Tables are not provided in NFPA 13D for the equivalent pipe length of CPVC pipe
   Sch. 80 CPVC is equivalent to Type K copper pipe for ID and C factor, so Table 10.4.3(c) was used instead
   Equivalent pipe lengths were obtained from table 10.4.3(d) for the copper piping sections
   The pressure loss in psi/ft was obtained from Table A.10.4.3(b) and Table A.10.4.3(c)
   The TVCO Riser Manifold has the equivalent of three flow through 1" copper tees

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Quantity</th>
<th>Equivalent Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe</td>
<td>85 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>7</td>
<td>90 deg elbow</td>
<td>7 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>92.0 ft x 0.1 psi/ft = 9.2 psi 60.3 psi</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Type L Copper Pipe</td>
<td>5.3 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>2</td>
<td>90 deg elbow</td>
<td>6 ft</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>Riser Manifold (3 Tees)</td>
<td>6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>17.3 ft x 0.16 psi/ft = 2.8 psi 57.5 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Type L Copper Pipe</td>
<td>25.0 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>6</td>
<td>90 deg elbow</td>
<td>17 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (turned flow)</td>
<td>4 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Tee (through flow)</td>
<td>1 ft</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>Reducer</td>
<td>2 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>44.0 ft x 0.58 psi/ft = 25.5 psi 32.0 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe</td>
<td>35.0 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3</td>
<td>90 deg elbow</td>
<td>6 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>Tee (turned flow)</td>
<td>8 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>Tee (through flow)</td>
<td>4 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>53.0 ft x 0.312 psi/ft = 16.5 psi 15.5 psi</td>
</tr>
</tbody>
</table>

After this point, the flow is split, and the design flow becomes 13 GPM

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Quantity</th>
<th>Equivalent Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>Sch. 80 CPVC Pipe</td>
<td>4.3 ft</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>90 deg elbow</td>
<td>2 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>6.3 ft x 0.085 psi/ft = 0.5 psi 14.9 psi</td>
</tr>
</tbody>
</table>

Remaining pressure for end sprinkler: 14.9 psi
Required pressure for end sprinkler: 7 psi

System piping is acceptable.

The piping above is acceptable. Now other potential critical paths will be checked. If the system requires larger piping, the above sprinklers will still be acceptable.
### NFPA 13D Calculation Worksheet (for 10.4.3): SPR#20 and SPR#21 - Iteration #1

This system incorporates the changes in Iteration #2 for SPR#12 and SPR#13.

<table>
<thead>
<tr>
<th>(1) Water pressure in street</th>
<th>Individual Loss</th>
<th>Net Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>110 psi</td>
</tr>
</tbody>
</table>

(2) Arbitrarily select pipe size: 1" and 3/4"

(3) Deduct meter loss:
- 3/4" Meter @ 26 GPM, using Table 10.4.3 (a)
  - 14 psi
  - 96 psi

(4) Deduct head loss for elevation:
  - Difference in elevation between street and sprinklers:
    - 13.33 ft
    - $13.33 \times 0.433 \text{ psi/ft} = 5.8 \text{ psi}$
  - 90.2 psi

(5) Deduct pressure loss from city main up to and including the sprinkler control valve:
- The buried pipe is 3/4" Type L copper.
- Equivalent pipe lengths were obtained from Table 10.4.3(d)
- The pressure loss in psi/ft was obtained from Table A.10.4.3(b)
- For the backflow preventer, an equivalent pressure loss of two 1" check valves was assumed, because the equivalent pipe length for 3/4" check valves was 0 ft.
- The equivalent pressure loss for the reducer was assumed to be the same as a 90 deg elbow.
- The pressure loss through the residential shutoff valve was determined with the manufacturer's specifications.

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Co. Length</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>7 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>4</td>
<td>8 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>3 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>14 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>2 ft</td>
<td>1</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>4.6 ft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 38.6 ft x 0.58 psi/ft = 22.4 psi</td>
<td>67.8 psi</td>
</tr>
</tbody>
</table>

(6) Deduct pressure loss from the sprinkler control valve to the furthest sprinkler:
- Tables are not provided in NFPA 13D for the equivalent pipe length of CPVC pipe
- Sch. 80 CPVC is equivalent to Type K copper pipe for ID and C factor, so Table 10.4.3(c) was used instead
- Equivalent pipe lengths were obtained from table 10.4.3(d) for the copper piping sections
- The pressure loss in psi/ft was obtained from Table A.10.4.3(b) and Table A.10.4.3(c)
- The TYCO Riser Manifold has the equivalent of three flow through 1" copper tees.

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
<th>Co. Length</th>
<th>Co. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>85 ft</td>
<td>1</td>
</tr>
<tr>
<td>1&quot;</td>
<td>7</td>
<td>7 ft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>92.0 ft x 0.1 psi/ft = 9.2 psi</td>
<td>58.6 psi</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>5.3 ft</td>
<td>1</td>
</tr>
<tr>
<td>1&quot;</td>
<td>2</td>
<td>6 ft</td>
<td>1</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1</td>
<td>6 ft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17.3 ft x 0.16 psi/ft = 2.8 psi</td>
<td>55.9 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>25.0 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>6</td>
<td>12 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>4 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>1</td>
<td>2 ft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>44.0 ft x 0.58 psi/ft = 25.5 psi</td>
<td>30.3 psi</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>10.0 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2</td>
<td>8 ft</td>
<td>1</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1</td>
<td>1 ft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19.0 ft x 0.312 psi/ft = 5.9 psi</td>
<td>24.4 psi</td>
</tr>
</tbody>
</table>

After this point, the flow is split, and the design flow becomes 13 GPM
- 3/4" | 1 | Sch. 80 CPVC Pipe | 8.3 ft |
- 3/4" | 1 | 90 deg elbow | 1 ft |
| Total | | 9.3 ft x 0.085 psi/ft = 0.8 psi | 23.5 psi |

Remaining pressure for end sprinkler: 23.5 psi
Required pressure for end sprinkler: 7 psi

System piping is acceptable.

The piping above is acceptable. All potential critical paths have been checked, and all piping is acceptable.
APPENDIX C

MATERIAL SPECIFICATIONS
Rapid Response Series LFII Residential
4.9 K-factor Concealed Pendent Sprinklers, Flat Plate
Wet Pipe and Dry Pipe Systems

General Description

The TYCO RAPID RESPONSE Series LFII Residential 4.9 K-factor Concealed Pendent Sprinklers (TY3596) are decorative, fast response, fusible solder sprinklers designed for use in residential occupancies such as homes, apartments, dormitories, and hotels.

The cover plate assembly conceals the sprinkler operating components above the ceiling. The flat profile of the cover plate provides the optimum aesthetically appealing sprinkler design. In addition, the concealed design of the Series LFII Residential Concealed Pendent Sprinklers (TY3596) provides 1/2 inch (12.7 mm) vertical adjustment. This adjustment provides a measure of flexibility when cutting fixed sprinkler drops.

The Series LFII Residential Concealed Sprinklers are intended for use in the following scenarios:

- wet and dry pipe residential sprinkler systems for one- and two-family dwellings and mobile homes per NFPA 13D
- wet and dry pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13
- wet and dry pipe sprinkler systems for the residential portions of any occupancy per NFPA 13

IMPORTANT
Always refer to Technical Data Sheet TFP442 for the “INSTALLER WARNING” that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

The Series LFII Residential Concealed Pendent Sprinklers (TY3596) has been designed with heat sensitivity and water distribution characteristics proven to help in the control of residential fires and to improve the chance for occupants to escape or be evacuated.

The Series LFII Residential Concealed Pendent Sprinklers (TY3596) are shipped with a Disposable Protective Cap. The Protective Cap is temporarily removed for installation, and then it can be replaced to help protect the sprinkler while the ceiling is being installed or finished. The tip of the Protective Cap can also be used to mark the center of the ceiling hole into plasterboard, ceiling tiles, etc. by gently pushing the ceiling product against the Protective Cap. When the ceiling installation is complete the Protective Cap is removed and the Cover Plate Assembly installed.

Dry Pipe System Application

The Series LFII Residential Concealed Pendent Sprinklers offers a laboratory approved option for designing dry pipe residential sprinkler systems, whereas, most residential sprinklers are laboratory approved for wet systems only.

Through extensive testing it has been determined that the number of design sprinklers (hydraulic design area) for the Series LFII Residential Concealed Pendent Sprinklers (TY3596) need not be increased over the number of design sprinklers (hydraulic design area) as specified for wet pipe sprinkler systems, as is accustomed for density area sprinkler systems designed per NFPA 13.

Consequently, the Series LFII Residential Concealed Pendent Sprinklers offer the features of non-water filled pipe in addition to not having to increase the number of design sprinklers (hydraulic design area) for systems designed to NFPA 13, 13D, or 13R. Non-water filled pipe will permit options for areas sensitive to freezing.

NOTICE
The Series LFII Residential Concealed Pendent Sprinklers described herein must be installed and maintained in compliance with this document and with the applicable standards of the National Fire Protection Association, in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Sprinkler Identification Number

TY3596
FIGURE 1
RAPID RESPONSE SERIES LFII RESIDENTIAL CONCEALED PENDENT SPRINKLER (TY5696)

FIGURE 2
W-TYPE 18 SPRINKLER WRENCH

FIGURE 3
RAPID RESPONSE SERIES LFII RESIDENTIAL CONCEALED PENDENT SPRINKLER (TY5696) INSTALLATION DIMENSIONS/PROTECTIVE CAP/ACTIVATED DEFLECTOR
Technical Data

Approvals:
- UL and C-UL Listed
- NYC Approved under MFA 44-03-E-2
- NSF Certified to NSFANSI 61

The TYCO RAPID RESPONSE Series LFI Residential Concealed Pendent Sprinklers are only listed with the Series LFI Concealed Cover Plates having a factory applied finish.

Maximum Working Pressure:
175 psi (1.2 bar)

Discharge Coefficient:
K<sub>4.9</sub> GPM/psi<sup>2</sup> (7.0 LPM/bar<sup>2</sup>)

Temperature Rating:
160°F (71°C) Sprinkler with 137°F (58°C) Cover Plate

Vertical Adjustment:
1/2 inch (12.7 mm)

Finishes:
Refer to Ordering Procedure section

Physical Characteristics:
- Brass Post
- Brass Support Cover Plate
- Sealed Assembly: Beryllium Nickel w/ Teflon
- Soldered Link Halves: Nickel
- Lever: Bronze
- Compression Screw: Brass
- Deflector: Copper or Brass
- Guide Pin Housing: Bronze
- Guide Ring: Stainless Steel or Brass
- Support Cup: Stainless Steel
- Cover Plate: Stainless Steel
- Retainer: Brass

Design Criteria

The TYCO RAPID RESPONSE Series LFI Residential Concealed Pendent Sprinklers (TY3596) are UL and C-UL Listed for installation in accordance with this section.

Note: When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the authority having jurisdiction.

System Types
Per the UL listing, wet pipe and dry pipe systems may be utilized. Per the C-UL listing, only wet pipe systems may be utilized.

Refer to Technical Data Sheet TFP485 about the use of residential sprinklers in residential dry pipe systems.

Ceiling Types
Smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R, or 13 as applicable.

Hydraulic Design (NFPA 13D and 13R)

For systems designed to NFPA 13D or NFPA 13R, the minimum required sprinkler flow rates are given in Tables A and B as a function of temperature rating and the maximum allowable coverage area. The sprinkler flow rate is the minimum required discharge from each of the total number of "design sprinklers" as specified in NFPA 13D or NFPA 13R. The number of "design sprinklers" specified in NFPA 13D and 13R for wet pipe systems is to be applied when designing dry pipe systems.

Hydraulic Design (NFPA 13)

For systems designed to NFPA 13, the number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Tables A and B as a function of temperature rating and the maximum allowable coverage area.

- A minimum discharge of 0.1 gpm/ft<sup>2</sup> over the "design area" comprised of the four most hydraulically demanding sprinklers for the four areas protected by the four sprinklers.

The number of "design sprinklers" specified in NFPA 13 for wet pipe systems is to be applied when designing dry pipe systems.

Dry Pipe System Water Delivery

When using the Series LFI Residential Concealed Pendent Sprinklers (TY3596) in dry pipe sprinkler systems, the time for water delivery must not exceed 16 seconds for the most remote operating sprinkler.

Obstruction to Water Distribution

Sprinklers are to be located in accordance with the obstruction rules of NFPA 13D, 13R, and 13 as applicable for residential sprinklers as well as with the obstruction criteria described within the Technical Data Sheet TFP490.

Operational Sensitivity

The sprinklers are to be installed relative to the ceiling mounting surface as shown in Figure 3.

Sprinkler Spacing

The minimum spacing between sprinklers is 5 ft (1.5 m). The maximum spacing between sprinklers cannot exceed the length of the coverage area (Ref. Table A or B) being hydraulically calculated (e.g., maximum 12 ft for a 12 ft x 12 ft coverage area, or 20 ft for a 20 ft x 20 ft coverage area). The Series LFI must not be used in applications where the air pressure above the ceiling is greater than that below. Down drafts through the Support Cup could delay sprinkler operation in a fire situation.
### TABLE A

**WET PIPE SYSTEM**

*SERIES LFII RESIDENTIAL 4.9 K-FACTOR FLAT-PLATE CONCEALED PENDENT SPRINKLER (TY3596)*

NFPA 13D, 13R, AND 13 HYDRAULIC DESIGN CRITERIA

<table>
<thead>
<tr>
<th>Maximum Coverage Area (sq ft)</th>
<th>Maximum Spacing (ft)</th>
<th>Ordinary Temp. Rating 160°F (71°C)</th>
<th>Flow GPM (L/min)</th>
<th>Pressure PSI (bar)</th>
<th>Deflector to Ceiling</th>
<th>Installation Type</th>
<th>Minimum Spacing (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 x 12 (3.7 x 3.7)</td>
<td>12</td>
<td>13</td>
<td>7.0</td>
<td>0.48</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>0</td>
</tr>
<tr>
<td>14 x 14 (4.3 x 4.3)</td>
<td>14</td>
<td>13</td>
<td>7.0</td>
<td>0.48</td>
<td>Smooth Ceiling</td>
<td>Beamed Ceiling per NFPA 13D or 13R, or 13, Installed in beam 7/8 to 1-1/8 inches below bottom of beam</td>
<td>12 (3.7)</td>
</tr>
<tr>
<td>16 x 16 (4.9 x 4.9)</td>
<td>16</td>
<td>13</td>
<td>7.0</td>
<td>0.48</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>8</td>
</tr>
<tr>
<td>18 x 18 (5.5 x 5.5)</td>
<td>18</td>
<td>13</td>
<td>12.0</td>
<td>0.68</td>
<td>Smooth Ceiling</td>
<td>Beamed Ceiling per NFPA 13D or 13R, or 13, Installed in beam 7/8 to 1-1/8 inches below bottom of beam</td>
<td>12 (3.7)</td>
</tr>
<tr>
<td>20 x 20 (6.1 x 6.1)</td>
<td>20</td>
<td>13</td>
<td>18.7</td>
<td>1.15</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>8</td>
</tr>
</tbody>
</table>

(a) For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (L/min) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design under the Design Criteria section.

(c) For NFPA 13D residential applications, the greater of 0.1 gpm/ft² over the design area of the flow in accordance with the criteria in this table must be used.

### TABLE B

**DRY PIPE SYSTEM**

*RAPID RESPONSE SERIES LFII RESIDENTIAL 4.9 K-FACTOR FLAT-PLATE CONCEALED PENDENT (TY3596)*

NFPA 13D, 13R, AND 13 HYDRAULIC DESIGN CRITERIA

<table>
<thead>
<tr>
<th>Maximum Coverage Area (sq ft)</th>
<th>Maximum Spacing (ft)</th>
<th>Ordinary Temp. Rating 160°F (71°C)</th>
<th>Flow GPM (L/min)</th>
<th>Pressure PSI (bar)</th>
<th>Deflector to Ceiling</th>
<th>Installation Type</th>
<th>Minimum Spacing (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 x 12 (3.7 x 3.7)</td>
<td>12</td>
<td>13</td>
<td>7.0</td>
<td>0.48</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>0</td>
</tr>
<tr>
<td>14 x 14 (4.3 x 4.3)</td>
<td>14</td>
<td>13</td>
<td>8.2</td>
<td>0.57</td>
<td>Smooth Ceiling</td>
<td>Beamed Ceiling per NFPA 13D or 13R, or 13, Installed in beam 7/8 to 1-1/8 inches below bottom of beam</td>
<td>8 (2.4)</td>
</tr>
<tr>
<td>16 x 16 (4.9 x 4.9)</td>
<td>16</td>
<td>13</td>
<td>9.4</td>
<td>0.65</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>8</td>
</tr>
<tr>
<td>18 x 18 (5.5 x 5.5)</td>
<td>18</td>
<td>13</td>
<td>13.5</td>
<td>0.69</td>
<td>Smooth Ceiling</td>
<td>Beamed Ceiling per NFPA 13D or 13R, or 13, Installed in beam 7/8 to 1-1/8 inches below bottom of beam</td>
<td>8 (2.4)</td>
</tr>
<tr>
<td>20 x 20 (6.1 x 6.1)</td>
<td>20</td>
<td>13</td>
<td>18.4</td>
<td>1.27</td>
<td>Smooth Ceiling</td>
<td>Concealed</td>
<td>8</td>
</tr>
</tbody>
</table>

(a) For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (L/min) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design under the Design Criteria section.

(c) For NFPA 13D residential applications, the greater of 0.1 gpm/ft² over the design area of the flow in accordance with the criteria in this table must be used.
Installation

The TYCO RAPID RESPONSE Series LFR Residential Concealed Pendant Sprinklers (TY3958) must be installed in accordance with this section.

General Instructions
Damage to the fusible Link Assembly during installation can be avoided by handling the sprinkler by the support cup only (i.e., do not apply pressure to the fusible Link Assembly).

A 1/2 inch NPTF sprinkler joint should be obtained with a minimum to maximum torque of 7 to 14 ft-lbs (9.5 to 19.0 Nm). Higher levels of torque may distort the sprinkler inlet with consequent leakage or impairment of the sprinkler.

Do not attempt to compensate for insufficient adjustment in the Cover Plate/Retainer Assembly by under- or over-tightening the Sprinkler. Readjust the position of the sprinkler fitting to suit.

Step 1. The sprinkler must only be installed in the pendant position and with the centerline of the sprinkler perpendicular to the mounting surface.

Step 2. Remove the Protective Cap.

Step 3. With pipe thread sealant applied to the pipe threads, and using the W-Type 6 Wrench shown in Figure 2, install and tighten the Sprinkler/Support Cup Assembly into the fitting. The W-Type 18 Wrench will accept a 1/2 inch ratchet drive.

Step 4. Replace the Protective Cap by pushing it upwards until it bottoms out against the Support Cup. The Protective Cap helps prevent damage to the Deflector and Guide Pins during ceiling installation and/or during application of the finish coating of the ceiling. It may also be used to locate the center of the clearance hole by gently pushing the ceiling material against the center point of the Cap.

Note: As long as the protective Cap remains in place, the system is considered to be "Out Of Service".

Step 5. After the ceiling has been completed with the 2-1/2 inch (63 mm) diameter clearance hole and in preparation for installing the Cover Plate Assembly, remove and discard the Protective Cap, and verify that the Deflector moves up and down freely.

If the Sprinkler has been damaged and the Deflector does not move up and down freely, replace the entire Sprinkler Assembly. Do not attempt to modify or repair a damaged sprinkler.

Step 6. Screw on the Cover Plate Assembly until its flange comes in contact with the ceiling.

Do not continue to screw on the Cover Plate Assembly such that it lifts a ceiling panel out of its normal position.

If the Cover Plate Assembly cannot be engaged with the Mounting Cup or the Cover Plate Assembly cannot be engaged sufficiently to contact the ceiling, the Sprinkler Fitting must be repositioned.

Care and Maintenance

The TYCO RAPID RESPONSE Series LFR Residential Concealed Pendant Sprinklers (TY3958) must be maintained and serviced in accordance with this section.

Before closing a fire protection system main control valve for maintenance work on the fire protection system which it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

Absence of a Cover Plate may delay the sprinkler operation in a fire situation.

When properly installed, there is a nominal 1/8 inch (0.3 mm) air gap between the lip of the Cover Plate and the ceiling, as shown in Figure 3. This air gap is necessary for proper operation of the sprinkler by allowing heat flow from a fire to pass below and above the Cover Plate to help assure appropriate release of the Cover Plate in a fire situation. If the ceiling is to be repainted after the installation of the Sprinkler, care must be exercised to ensure that the new paint does not seal off any of the air gap.

Factory painted Cover Plates must not be repainted. They should be replaced, if necessary, by factory painted units. Non-factory applied paint may adversely delay or prevent sprinkler operation in the event of a fire.

Do not pull the Cover Plate relative to the Enclosure. Separation may result.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified or over heated sprinklers must be replaced.

Care must be exercised to avoid damage before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. The installing contractor or sprinkler manufacturer should be contacted relative to any questions.

The owner must assure that the sprinklers are not used for hanging any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster, otherwise, non-operation in the event of a fire or inadvertent operation may result.

Automatic sprinkler systems should be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and national codes.
Ordering Procedure

When placing an order, indicate the full product name. Contact your local distributor for availability.

Sprinkler Assembly:
Series LFH (TY3596), K=4.9, Residential Concealed Pendent Sprinkler without Cover Plate Assembly,
PN 51-121-1-160

Cover Plate Assembly:
Cover Plate Assembly having a (specify) finish for the Series LFH (TY3596), K=4.9, Residential Concealed Pendent Sprinkler, PN (specify)

Ivory (RAL9016) ...
Bisque (RAL1004) ...
Porcelain White (RAL9016) ...
Signal White (RAL9003) ...
Gray White (RAL9003) ...
Brown (RAL8017) ...
Brushed Stainless ...
Brushed Chrome ...
Custom Pant ...
PN 56-292-0-135
PN 56-292-2-135
PN 56-292-3-135
PN 56-292-4-135
PN 56-292-5-135
PN 56-292-6-135
PN 56-292-7-135
PN 56-292-8-135
PN 56-292-X-135

(a) Previously known as Light White.
(b) Eastern Hemisphere sales only.

Note: All Custom Cover Plates are painted using Sherwin Williams interior latex paint. Contact TYCO Customer Service with any questions related to custom orders.

Sprinkler Wrench:
Specify: W-Type 18 Sprinkler Wrench,
PN 56-000-1-263
Figure 513D (13D) and 513D/R (13D/R) Riser Manifolds
1, 1-1/2, and 2 Inch (DN25, DN40, and DN50)
For NFPA 13D/13R Residential Sprinkler Systems

**General Description**

The Riser Manifolds described in this technical data sheet provide the necessary airflow, pressure gauge, and drain equipment in a single assembly for use in NFPA 13D or 13R residential sprinkler systems as follows:

**NFPA 13D**
- Figure 513D (13D)
  - 1 Inch (DN25)
    - Female Thread x Female Thread

**NFPA 13D/13R**
- Figure 513D/R (13D/R)
  - 1-1/2 Inch (DN40)
    - Male Thread x Female Thread
  - 2 Inch (DN50)
    - Groove x Groove
  - Male Thread x Male Thread

The variety of sizes and end connections allow cost effective and easy transition to check valves, control valves, and system piping. The Riser Manifolds may be installed in either the horizontal (flow switch on top) or vertical (flow going up).

**WARNING**

The Riser Manifolds described herein must be installed and maintained in compliance with this document, as well as with the applicable standards of the National Fire Protection Association, in addition to the standards of any other authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

**Technical Data**

**Approvals**

The Figure 513D (13D) and 513D/R (13D/R) Riser Manifolds with a cover tamper switch for the airflow alarm switch are UL Listed, ULC Listed, and FM Approved.

The Figure 513D (13D) and 513D/R (13D/R) Riser Manifolds without a cover tamper switch for the airflow alarm switch are UL Listed and FM Approved.

**Maximum Working Pressure**

175 psi (12.1 bar)

**Assembly**

The manifold body of the Figure 513 is ductile iron, whereas the manifold body of the Figure 13 is cast iron. The two assemblies are completely interchangeable in function, application, and end-to-end laying length.

**Finish**

Red painted.

**Installation**

The Riser Manifolds may be installed in either the horizontal (flow switch on top) or vertical (flow going up). The inlet of the Riser Manifold may be directly connected to a shut-off control valve.

**NOTES**

(1) Where applicable pipe thread sealant is to be applied sparingly. Use of non-hardening pipe thread sealant is recommended.

(2) Provisions for an alarm test flow must be made. The alarm test flow is to be through an orifice having a flow capacity equal to or smaller than the smallest orifice sprinkler in the system. One of two options can be considered. The first option is to temporarily install a test orifice in the outlet of the drain line prior to performing the alarm test. The second option is to install an inspector's Test Connection downstream of the Waterflow Alarm Switch.

(3) Never remove any piping component nor correct or modify any piping deficiencies without first depressurizing and draining the system.

**Step 1.** Install the manifold body with the flow arrow pointing in the downstream position using threaded connections and/or listed mechanical grooved connections, as applicable.

**Step 2.** Connect the drain line, and then close the drain valve.

**Step 3.** Refer to Figure 4 for wiring guidance. All wiring must be performed in accordance with the Authority Having Jurisdiction and/or the National Electrical Code.

**Step 4.** Place the system in service by filling the system with water. When filling the system, open the control valve to slowly fill the system. Filling the system slowly will help avoid damaging the waterflow alarm switch. After the system is fully pressurized, completely open the control valve.

**Step 5.** Secure all supply valves open.
FIGURE 1
1 INCH (DN25) RISER MANIFOLD ASSEMBLY AND DIMENSIONS

FIGURE 2
1-1/2 INCH (DN40) RISER MANIFOLD ASSEMBLY AND DIMENSIONS
Care and Maintenance

The following inspection procedure must be performed as indicated, in addition to any specific requirements of the NFPA, and any impairment must be immediately corrected.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any authority having jurisdiction. The installing contractor or product manufacturer should be contacted relative to any questions.

It is recommended that automatic sprinkler systems be inspected, tested, and maintained by a qualified inspection service in accordance with local requirements and/or national codes.

NOTES

No attempt is to be made to repair any Riser Manifold component in the field. Only the pressure gauge or water flow alarm switch can be replaced. If any other problems are encountered the entire riser manifold must be replaced. The flow and alarm test procedure will result in operation of the associated alarms. Consequently, notification must be given to the owner and the fire department, central station, or other signal station to which the alarms are connected, and notification must be given to the building occupants.

Before closing a fire protection system control valve for inspection or maintenance work on the fire protection system that it controls, permission to shut down the affected fire protection system must first be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

After placing a fire protection system in service, notify the proper authorities and advise those responsible for monitoring proprietary and/or central station alarms.

Flow Test Procedure

Step 1. Fully open the drain valve. Make certain that drainage water will not cause any damage or injury.

Step 2. Verify that the residual (flowing) pressure indicated by the pressure gauge is no less than that originally recorded for the system when it was first installed.

Step 3. Close the drain valve.

Step 4. Verify that the static (not flowing) pressure indicated by the pressure gauge is no less than that originally recorded for the system when it was first installed.

Alarm Test Procedure With A Test Orifice (See Installation Note 2)

Step 1. Temporarily install a test orifice in the drain line outlet.

Step 2. Fully open the drain valve. Make certain that drainage water will not cause any damage or injury.

Step 3. Verify operation of the associated alarms.

Step 4. Close the drain valve.

Step 5. Remove the test orifice from the drain line outlet.

Alarm Test Procedure With An Inspector's Test Connection Valve (See Installation Note 2)

Step 1. Fully open the Inspector's Test Connection Valve. Make certain that drainage water will not cause any damage or injury.

Step 2. Verify operation of the associated alarms.

Step 3. Close the Inspector's Test Connection Valve.
SWITCH TERMINAL CONNECTIONS

CAUTION:
An uninsulated section of a single conductor is not permitted to be looped around the terminal and serve as two separate connections. The wire must be severed to serve as two separate connections, thereby providing supervision of the connection in the event that the wire becomes dislodged from the terminal.

IMPROPER CONNECTION METHOD

PROPER CONNECTION METHOD

WATERFLOW SWITCH TYPICAL ELECTRICAL CONNECTIONS

CONTACTS ............ SPDT (Form C)
CONTACT RATING .... 5A @ 125 VAC
2.5A @ 30 VDC

NO  NC
COM

LOCAL SIGNAL DEVICE

END OF LINE RESISTOR

CONTROL PANEL

POWER

NON-SUPERVISED CIRCUIT

STYLE B CLASS B SUPERVISED CIRCUIT
(SEE NOTE)

NOTE:
For supervised circuits, see "Switch Terminal Connections" above. The Waterflow Alarm Switch has two switches, one can be used to operate a central station, proprietary or remove signaling unit, while the other contact is used to operate a local audible or visual annunciator.

COVER TAMPER SWITCH (ULC ASSEMBLIES ONLY)

CONTACTS ............ SPDT (Form C)
CONTACT RATING .... 3A @ 250 VAC
5A @ 125 VAC
1.5A @ 30 VDC min.

NO  NC
COM

CONTACTS SHOWN WITH COVER IN PLACE

FIGURE 4
WIRING GUIDANCE
**Limited Warranty**

Products manufactured by Tyco Fire & Building Products (TFBP) are warranted solely to the original Buyer for ten (10) years against defects in material and workmanship when paid for and properly installed and maintained under normal use and service. This warranty will expire ten (10) years from date of shipment by TFBP. No warranty is given for products or components manufactured by companies not affiliated by ownership with TFBP or for products and components which have been subject to misuse, improper installation, corrosion, or which have not been installed, maintained, modified or repaired in accordance with applicable Standards of the National Fire Protection Association, and/or the standards of any other Authorities Having Jurisdiction. Materials found by TFBP to be defective shall be either repaired or replaced, at TFBP’s sole option. TFBP neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of products or parts of products. TFBP shall not be responsible for sprinkler system design errors or inaccurate or incomplete information supplied by Buyer or Buyer’s representatives.

In no event shall TFBP be liable, in contract, tort, strict liability or under any other legal theory, for incidental, indirect, special or consequential damages, including but not limited to labor charges, regardless of whether TFBP was informed about the possibility of such damages, and in no event shall TFBP’s liability exceed an amount equal to the sales price.

The foregoing warranty is made in lieu of any and all other warranties, express or implied, including warranties of merchantability and fitness for particular purpose.

This limited warranty sets forth the exclusive remedy for claims based on failure of or defect in products, materials or components, whether the claim is made in contract, tort, strict liability or any other legal theory.

This warranty will apply to the full extent permitted by law. The invalidity, in whole or part, of any portion of this warranty will not affect the remainder.

**Ordering Information**

Riser Manifold:
Specify. Size (specify). Figure (specify 513D or 513D/R, specify connection type inlet x outlet) Riser Manifold (specify - without or with) a cover tamper switch for the water flow alarm switch, PIN (specify).

**NOTES**

Orders for Figure 513D or 513D/R may be filled with a Figure 13D or 13D/R, respectively. The two assemblies are completely interchangeable in function, application, and end-to-end laying length.

If a ULC Listing is required, the Riser Manifold must be ordered with a cover tamper switch for the water flow alarm switch.

**UL/LC/FM Assemblies With Cover Tamper Switch**

<table>
<thead>
<tr>
<th>Size</th>
<th>Pin Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch DN25</td>
<td></td>
</tr>
<tr>
<td>1-1/2 inch DN40</td>
<td></td>
</tr>
<tr>
<td>2 inch DN65</td>
<td></td>
</tr>
<tr>
<td>2 inch DN65</td>
<td></td>
</tr>
</tbody>
</table>

**UL/FM Assemblies Without Cover Tamper Switch**

<table>
<thead>
<tr>
<th>Size</th>
<th>Pin Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch DN25</td>
<td></td>
</tr>
<tr>
<td>1-1/2 inch DN40</td>
<td></td>
</tr>
<tr>
<td>2 inch DN65</td>
<td></td>
</tr>
</tbody>
</table>

**Replacement Parts**

Specify. (description) for use with Figure 513D, 513D/R, 13D, or 13D/R. Riser Manifold, PIN (Ref. Figure 1, 2 or 2, as applicable).
RAPID RESPONSE Model RSV-1 Residential Shut-Off Valve, 1 Inch and 2 Inch (DN25 and DN50) for Dual-Purpose Residential Water Supply

General Description
The TYCO RAPID RESPONSE Model RSV-1 Residential Shut-Off Valves are intended for use in dual-purpose residential water supply piping that serves both domestic and residential fire protection sprinkler system needs. The 1 Inch (DN25) Valve is intended for NFPA 13D system needs, whereas the 2 Inch (DN50) Valve is intended for systems designed in accordance with either NFPA 13D or NFPA 13R.

When a fire sprinkler operates, the Model RSV-1 Residential Shut-Off Valve automatically diverts the available water supply to the fire sprinkler system. Consequently, when the Model RSV-1 Valve is utilized, the system designer does not need to add the domestic flow demand to the fire sprinkler system flow demand, as would otherwise be required by NFPA 13R.

Consider use of the Model RSV-1 Residential Shut-Off Valve when either the water supply cannot adequately provide for both the domestic design demand and the fire sprinkler flow demand, or it is necessary to increase the effectiveness of the fire sprinkler system by automatically diverting the domestic flow.

The Model RSV-1 Residential Shut-Off Valve maximizes the effective use of an existing water supply. Therefore, in areas with limited water supplies, it may eliminate the need to add costly pumps, pressurized reservoirs, or electrically operated domestic shut-off valves. The Model RSV-1 Valve has a built-in check valve in the fire sprinkler system outlet that eliminates the need for a separate check valve. Also, the Model RSV-1 Valve automatically resets, thereby eliminating the need for valve disassembly after a fire sprinkler system test or operation.

Technical Data
Approvals
• The 1 Inch (DN25) Model RSV-1 Residential Shut-Off Valve is UL and C-UL Listed and NSF-61 Annex G Approved. It is suitable for use in water supply arrangements for residential fire sprinkler systems designed per NFPA 13D.
• The 2 Inch (DN50) Model RSV-1 Residential Shut-Off Valve is UL and C-UL Listed and NSF-61 Annex G Approved. It is suitable for use in water supply arrangements for residential fire sprinkler systems designed per NFPA 13D or 13R.

Maximum Pressure
1/2 psi (12.1 bar)

Weight
1 Inch (DN25): 11 lbs. (6 kg)
2 Inch (DN50): 29 lbs. (11 kg)

Pressure Loss
Refer to Figures 4 and 5.

Patents
2 Inch (DN50) Model RSV-1 Valve: Patent Pending

Physical Characteristics
Refer to Figures 2 and 3.

• 1 Inch (DN25) Valve
  Body: Copper Alloy
  Top and Bottom Cover: Copper Alloy
  Upper Cap: Brass
  Bottom Seal: Brass
  Piston: Glass Reinforced Polyphenylene Oxide
  Differential Ring: Glass Reinforced Polyphenylene Oxide
  Sleeve: Glass Reinforced Polyphenylene Oxide
  Upper and Lower Seals: EPDM
  Piston Spring: Stainless Steel
  Piston Screws: Stainless Steel
  Cap Screw: Stainless Steel

• 2 Inch (DN50) Valve
  Body and Cover: Copper Alloy
  Piston Insert: Copper Alloy
  Bottom Seal: Copper Alloy
  Piston Cover: Glass Reinforced Polyphenylene Oxide
  Insert Sleeve: Glass Reinforced Polyphenylene Oxide
  Piston Seal: EPDM
  O-Rings: EPDM
  Piston Spring: Stainless Steel
  Piston Nut: Stainless Steel
  Retainer Ring: Stainless Steel
Design Criteria

The TYCO RAPID RESPONSE Model RSV-1 Residential Shut-Off Valve must be installed vertically with the Water Supply Port at the bottom, the Fire Sprinkler Port at the top, and the Domestic Port at the side (Figures 6 and 7). Figure 1 shows the typical installation arrangement. Refer to the Installation section for additional design considerations.

Water Supply Requirements

- **1 Inch (DN25) Valve**
  In order for the 1 Inch (DN25) Model RSV-1 Valve to operate automatically upon sprinkler operation, the fire sprinkler system from the water main to the most hydraulically remote sprinkler must be designed to provide a minimum single sprinkler flow rate of 12.5 GPM (47.3 LPM) when the supply pressure at the main is at its minimum expected value.
  
  The minimum single sprinkler flow rate of 12.5 GPM (47.3 LPM), required for use with the 1 Inch (DN25) Model RSV-1 Valve, does not take precedence over any more hydraulically demanding single sprinkler flow rate specified for the residential sprinklers in use.

  When performing hydraulic design calculations for the fire sprinkler system, you must account for the trick flow through the 1 Inch (DN25) Model RSV-1 Valve By-Pass Restriction into the domestic system.

  For the 1 Inch (DN25) Model RSV-1 Valve, the maximum water supply service line is 1 Inch (DN25).

- **2 Inch (DN50) Valve**
  In order for the 2 Inch (DN50) Model RSV-1 Valve to operate automatically at sprinkler activation, the fire sprinkler system from the water supply main to the most hydraulically remote sprinkler must be designed to provide a minimum single sprinkler flow rate of 8 GPM (30.5 LPM) when the water supply pressure at the water supply main is at its minimum expected value.

  The minimum single sprinkler flow rate of 8 GPM (30.5 LPM), required for use with the 2 Inch (DN50) Model RSV-1 Valve, does not take precedence over any more hydraulically demanding single sprinkler flow rate specified for the residential sprinklers in use.

Operating Principles

When a fire sprinkler activates during domestic usage, the TYCO RAPID RESPONSE Model RSV-1 Residential Shut-Off Valve automatically diverts flow to the domestic system and diverts the available water supply to the fire sprinkler system, thereby eliminating a reduced flow condition in the sprinkler system that might otherwise be caused by possible significant domestic water usage.

When the Model RSV-1 Valve is in the normal standby position as shown in Figures 6 and 7, the Piston Assembly, assisted by its Spring, is in the down position. With the Piston Assembly in the down position, the Fire Sprinkler Seal permits the Model RSV-1 Valve to perform as a conventional check valve. Also, with the Piston Assembly in the down position, water is available on demand through the Domestic Flow Passage and out the Domestic Port.

Upon operation and with a minimum design water flow (e.g., 12.5 GPM 47.3 LPM for the 1 Inch Valve or 8 GPM (30.5 LPM) for the 2 Inch Valve) to the automatic residential fire sprinkler system, the Piston Assembly moves upward. With the Piston Assembly in the up position, any water flow to the Domestic Port is diverted to the Fire Sprinkler Port.

The contours of the Piston Assembly are specifically configured to minimize its upward movement except under the level of sustained fire sprinkler system flow resulting from operation of one or more fire sprinklers. However, because most fire sprinkler systems contain air pockets, the Piston Assembly tends to move momentarily upward when there is a surge in supply pressure.

The momentary opening and re-closing of the Piston Assembly at the Fire Sprinkler Line Seal traps a portion of the pressure increase within the fire sprinkler system. Trapped pressure increases within the fire sprinkler system help to prevent a subsequent surge in the supply pressure from causing the fire-water detector to signal a false alarm.

As indicated above, domestic system usage can reduce the pressure available to the fire sprinkler system. However, when utilizing the Model RSV-1 Valve, you do not need to include additional hydraulic flow of the domestic system, when otherwise required by...
NFPA standards (NFPA 13R), to determine the minimum possible residual (flowing) pressure available to the fire sprinkler system.

For operation of the Model RSV-1 Residential Shut-Off valve, you need only design the fire sprinkler system from the water supply main to the most hydraulically remote sprinkler. Domestic flow does not require consideration. As long as the single sprinkler flow is equal to or greater than 12.5 GPM (47.3 LPM) for the 1 Inch Valve or 8 GPM (30.5 LPM) for the 2 Inch Valve when the supply pressure at the main is at its minimum expected value, the Model RSV-1 Valve automatically diverts the domestic flow.

After the Piston Assembly has moved to the full up position, only a small amount of water is permitted to trickle through the Internal By-Pass Restriction to the Domestic Port (Figures 6 and 7). The trickle flow through the Internal By-Pass Restriction permits the Model RSV-1 Valve to reset automatically after a sprinkler operation or test without draining the fire sprinkler system.

When the Domestic Control Valve is closed, the Internal By-Pass Restriction allows the Supply and Domestic Port pressures to equalize and the Piston Assembly to move back down to the standby position.

When using the 1 inch RSV-1, the maximum flow rate through the Internal By-Pass Restriction, when the Model RSV-1 Valve is in the operated position, is no greater than .25 GPM (.90 LPM) for a typical residual (flowing) pressure of 40 psi (2.8 bar) at the inlet. Consequently, when performing hydraulic design calculations for the fire sprinkler system, you do not need to consider trickle flow through the Model RSV-1 Valve Internal By-Pass Restriction into the domestic system.

When using the 2 inch RSV-1, the maximum flow rate through the Internal By-Pass Restriction, when the Model RSV-1 Valve is in the operated position, is no greater than 1.5 GPM (5.7 LPM) for a typical residual (flowing) pressure of 40 psi (2.8 bar) at the inlet. Consequently, when performing hydraulic design calculations for the fire sprinkler system, a 1.5 GPM (5.7 LPM) flow demand is required to be added at the FSV-1 and calculated back to the source.
**Installation**

Figure 1 illustrates a typical installation arrangement using the TYCO RAPID RESPONSE Model RSV-1 Residential Shut-Off Valve. The arrangement may need to be modified to meet the requirements of the authority having jurisdiction. However, the Model RSV-1 Valve must be installed in accordance with this section.

**General Instructions**

A fire sprinkler water supply connection to a public water supply is usually subject to local regulations concerning metering and backflow prevention requirements. Consult with the local water authorities concerning local requirements that may apply to the arrangement of these components in the fire sprinkler system water supply.

For the 1 inch (DN25) Valve, the maximum water supply service line is 1 inch (DN25).

**Step 1.** Ensure that the water supply to the Model RSV-1 Valve is free of contaminants and particles of a size greater than 1/8 inch (3.2 mm).

**Step 2.** Install the Model RSV-1 Valve vertically with the Supply Port at the bottom, the Fire Sprinkler Port at the top, and the Domestic Port at the side. Ensure that the arrows cast on the Body point in the direction of flow.

A suitable clamp along the water supply riser piping is recommended to provide support for the weight of the Model RSV-1 Valve.

**Step 3.** Place a Domestic Control Valve between the Model RSV-1 Valve and the domestic system. Position the inlet to the Domestic Control Valve within 12 inches of the Domestic Port of the Model RSV-1 Valve.

**Step 4.** The Drain and Flow Test Connection (Figure 1) is recommended to be a minimum 1/2 inch (DN15) size for systems per NFPA 13D, and it must be a minimum 1 inch (DN25) size for systems per NFPA 13R.

**Step 5.** Install an Alarm Test Connection with a test orifice equal to or less than the smallest K-factor sprinkler in the system downstream of the Waterflow Detector.

**Step 6.** Apply pipe-thread sealant sparingly only to the male pipe threads that are to be assembled to the three ports of the Model RSV-1 Valve. The use of a non-hardening pipe-thread sealant such as TEFLOW is recommended.

---

**Figure 4**

Nominal Pressure Loss Versus Flow for 1 Inch (DN25) Model RSV-1 Valve

**Figure 5**

Nominal Pressure Loss Versus Flow for 2 Inch (DN50) Model RSV-1 Valve
**FIGURE 6**
STANDBY AND OPERATED POSITIONS FOR 1 INCH (DN25) MODEL RSV-1 VALVE

**FIGURE 7**
STANDBY AND OPERATED POSITIONS FOR 2 INCH (DN50) MODEL RSV-1 VALVE
Valve Setting Procedure

Perform steps 1 through 9 when initially filling the fire sprinkler and domestic system piping with water or after a fire sprinkler operation (Figure 1).

Step 1. Close the Main Control Valve.

Step 2. Close the Domestic Control Valve and all water outlets in the domestic piping system.

Step 3. In addition to the Drain and Flow Test Connection in the fire sprinkler system, close all drain valves and replace all operated sprinklers as necessary.

Step 4. Partially open the Main Control Valve until the sound of flowing water just begins, then close the Main Control Valve in the partially open position.

Step 5. After the fire sprinkler system pressure gauge indicates approximately the same pressure as the supply pressure gauge, fully open the Main Control Valve.

Step 6. Open the highest elevation outlet on the domestic system.

Step 7. Partially open the Domestic Control Valve until the sound of flowing water begins. Allow the domestic piping to fill slowly with water.

Step 8. Close the highest elevation water outlet on the domestic system when the demand water begins to flow.

Step 9. Completely open the Domestic Control Valve, then check that the domestic system is properly pressurized by verifying that at least three water outlets in the domestic system can flow full at the same time.

- If the water outlets flow fully, the Model RSV-1 Valve is set and ready for service. Close the water outlets on the domestic system.

- If the water outlets do not flow fully, re-close the Domestic Control Valve, wait a minimum of ten seconds, and ensure that there is no flow from the fire sprinkler system piping. Reopen the Domestic Control Valve, then recheck that the water outlets are flowing fully.

Care and Maintenance

The following inspection procedure for the TYCO RAPID RESPONSE Model RSV-1 Residential Shut-Off Valve must be performed as indicated, in addition to any specific requirements of the NFPA. Any impairment must be immediately corrected.

Before closing a fire protection system control valve for inspection or maintenance work on the fire protection system that it controls, obtain permission to shut down the affected fire protection system from the proper authorities and notify all personnel who may be affected by this action.

Make no attempt to repair any Model RSV-1 Valve component in the field. The Model RSV-1 Valve is not field-repairable. If malfunction occurs, the entire unit must be replaced.

The operational test and flow test procedures result in operation of the associated alarms, as well as an interruption of the domestic water supply service. You must notify the owner, building occupants, and the fire department, central station, or other signal station to which the alarms are connected.

After placing a fire protection system in service, notify the proper authorities and advise those responsible for monitoring proprietary and/or central station alarms.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any authority having jurisdiction. Contact the installing contractor or product manufacturer regarding any questions.

Automatic sprinkler systems should be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and national codes and standards.

Operation Test Procedure

Step 1. Fully open two or three water outlets in the domestic piping system.

Step 2. To simulate a sprinkler operation, open the Alarm Test Connection of the fire sprinkler system.

Step 3. Verify that any alarms are operating and that the flow from the domestic water outlets decreases to no more than a trickle.

Flow Test Procedure

Step A. While there is no water flowing in the domestic system, completely open the Drain and Flow Test Connection.

Step B. While water is flowing, record the pressure reading on the fire sprinkler system pressure gauge and then compare this reading to previous readings.

If there is a significant decrease in pressure since the last time the pressure reading was taken and this decrease is not due to a normally expected drop in the water supply pressure, an impairment may exist that should be immediately identified and corrected.

Step C. Close the Drain and Flow Test Connection to allow the Model RSV-1 Valve to reset automatically. Automatic resetting occurs within ten seconds.

Step D. After waiting ten seconds, completely open at least three water outlets in the domestic system and allow these outlets to flow simultaneously.

If the water outlets flow fully, the Model RSV-1 Valve is set and ready for service. Close the water outlets on the domestic system.

If the water outlets do not flow fully, close the Domestic Control Valve and verify that there is no flow from the fire sprinkler system piping, such as at the Inspector's Test Connection. Wait a minimum of ten seconds. Re-open the Domestic Control Valve and then recheck that the domestic system water outlets are flowing full.

Ordering Procedure

Contact your local distributor for availability. When placing an order, indicate the full product name and Part Number (P/N).

Valves with NPT Connections

Specify 1 inch NPT (DN25) Model RSV-1 Residential Shut-Off Valve, P/N 52-540-1-001.

Specify 1 inch NPT (DN25) Model RSV-1 Residential Shut-Off Valve, P/N 52-540-1-002.
BlazeMaster®
CPVC Fire Sprinkler Pipe & Fittings
Submittal Sheet

General Description
Tyco® CPVC Pipe and Fittings produced by Tyco Fire & Building Products (TFBP) are designed exclusively for use in wet pipe automatic fire sprinkler systems. The Tyco CPVC Pipe and Fittings are produced from BlazeMaster® CPVC compound that is a specially developed thermoplastic compound composed of post chlorinated polyvinyl chloride (CPVC) resin and state-of-the-art additives. Tyco CPVC Pipe and Fittings are easier to install than traditional steel pipe systems, and at the same time, provide superior heat resistance and strength as compared to traditional CPVC and PVC piping materials used in the plumbing trade. Various adapters are available to connect CPVC pipe to metallic piping. All female pipe thread adapters have brass inserts for durability. Grooved adapters connect directly to grooved end valves and metallic pipe, with flexible grooved end couplings.

NOTICE
Tyco® CPVC Pipe and Fittings produced with BlazeMaster® CPVC compound described herein must be installed and maintained in compliance with this document and with the applicable standards of the National Fire Protection Association, in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Technical Data
Sizes
3/4” to 3”
Maximum Working Pressure
175 psi
Approvals
UL, FM, C-UL, NSF, LPCB, MEA, and the City of Los Angeles. (Refer to Installation Handbook IH-1000 dated June 2008 for exact listing/approval information.)
Manufacturer Source
U.S.A.
Material
- Pipe: ASTM F442, SDR 13.5
- Fittings: ASTM F438 (Sch. 40) and ASTM F490 (Sch. 80), ASTM F1070
Color
Orange

BlazeMaster® is a registered trademark of The Lubrizol Corporation

Page 1 of 2  JUNE, 2008  TFP1915
Installation
Tyco® CPVC Pipe and Fittings produced by Tyco Fire & Building Products (TFBP) are to be installed in accordance with Installation Handbook IH-1900 dated June 2008.

Limited Warranty
Products manufactured by Tyco Fire & Building Products (TFBP) are warranted solely to the original Buyer for ten (10) years against defects in material and workmanship when paid for and properly installed and maintained under normal use and service. This warranty will expire ten (10) years from date of shipment by TFBP. No warranty is given for products or components manufactured by companies not affiliated by ownership with TFBP or for products and components which have been subject to misuse, improper installation, corrosion, or which have not been installed, maintained, modified or repaired in accordance with applicable Standards of the National Fire Protection Association, and/or the standards of any other Authorities Having Jurisdiction. Materials found by TFBP to be defective shall be either repaired or replaced, at TFBP’s sole option. TFBP neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of products or parts of products. TFBP shall not be responsible for sprinkler system design errors or inaccurate or incomplete information supplied by Buyer or Buyer’s representatives.

In no event shall TFBP be liable, in contract, tort, strict liability or under any other legal theory, for incidental, indirect, special or consequential damages, including but not limited to labor charges, regardless of whether TFBP was informed about the possibility of such damages, and in no event shall TFBP’s liability exceed an amount equal to the sales price.

The foregoing warranty is made in lieu of and all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose.

This limited warranty sets forth the exclusive remedy for claims based on failure of or defect in products, materials or components, whether the claim is made in contract, tort, strict liability or any other legal theory.

This warranty will apply to the full extent permitted by law. The invalidity, in whole or part, of any portion of this warranty will not affect the remainder.

© 2008 TYCO FIRE & BUILDING PRODUCTS, 451 North Cannon Avenue, Lansdale, Pennsylvania 19446
# Residential Fire Sprinkler Cost Estimate for the Phi Kappa Psi Fraternity House, 1335 E. Foothill Blvd.

**Estimated By:** Nolan Frost  
**Date:** June 1, 2013

## Piping

<table>
<thead>
<tr>
<th>Size</th>
<th>Material</th>
<th>Type</th>
<th>Amount</th>
<th>Unit Price</th>
<th>Total Price</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>CPVC</td>
<td>Pipe</td>
<td>100 ft</td>
<td>$2.60</td>
<td>$260.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>1&quot;</td>
<td>CPVC</td>
<td>90 deg Elbow</td>
<td>6 ea</td>
<td>$5.50</td>
<td>$33.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>1&quot;</td>
<td>CPVC</td>
<td>Coupler</td>
<td>5 ea</td>
<td>$3.50</td>
<td>$17.50</td>
<td>US Plastic</td>
</tr>
<tr>
<td>1&quot;</td>
<td>CPVC/Copper</td>
<td>Adaptor</td>
<td>1 ea</td>
<td>$45.00</td>
<td>$45.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>CPVC/Copper</td>
<td>Adaptor</td>
<td>1 ea</td>
<td>$20.00</td>
<td>$20.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>3/4&quot; - 1&quot;</td>
<td>Brass</td>
<td>Reducer</td>
<td>2 ea</td>
<td>$3.00</td>
<td>$6.00</td>
<td>Home Depot</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>CPVC</td>
<td>Pipe</td>
<td>240 ft</td>
<td>$1.80</td>
<td>$432.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>1&quot;</td>
<td>CPVC</td>
<td>Coupler</td>
<td>12 ea</td>
<td>$2.50</td>
<td>$30.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>CPVC</td>
<td>90 deg Elbow</td>
<td>22 ea</td>
<td>$4.00</td>
<td>$88.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>CPVC</td>
<td>Tee</td>
<td>17 ea</td>
<td>$4.00</td>
<td>$68.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>CPVC</td>
<td>Cross</td>
<td>1 ea</td>
<td>$5.00</td>
<td>$5.00</td>
<td>US Plastic</td>
</tr>
<tr>
<td>1&quot;</td>
<td>Type L Copper</td>
<td>Tubing</td>
<td>10 ft</td>
<td>$4.50</td>
<td>$45.00</td>
<td>Home Depot</td>
</tr>
<tr>
<td>1&quot;</td>
<td>Type L Copper</td>
<td>90 deg Elbow</td>
<td>2 ea</td>
<td>$3.50</td>
<td>$7.00</td>
<td>Home Depot</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>Type L Copper</td>
<td>Tubing</td>
<td>30 ft</td>
<td>$3.00</td>
<td>$90.00</td>
<td>Home Depot</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>Type L Copper</td>
<td>90 deg Elbow</td>
<td>8 ea</td>
<td>$2.00</td>
<td>$16.00</td>
<td>Home Depot</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>Type L Copper</td>
<td>Tee</td>
<td>1 ea</td>
<td>$5.00</td>
<td>$5.00</td>
<td>Home Depot</td>
</tr>
</tbody>
</table>

## Components

<table>
<thead>
<tr>
<th>Size</th>
<th>Material</th>
<th>Type</th>
<th>Amount</th>
<th>Unit Price</th>
<th>Total Price</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>Riser Manifold</td>
<td>TYCO</td>
<td>1 ea</td>
<td>$750.00</td>
<td>$750.00</td>
<td>TYCO Fire</td>
</tr>
<tr>
<td>Ord. Temp Sprinkler</td>
<td>TYCO</td>
<td>20 ea</td>
<td>$85.00</td>
<td>$1,700.00</td>
<td>(TYCO Fire)</td>
<td></td>
</tr>
<tr>
<td>Inter. Temp Sprinkler</td>
<td>TYCO</td>
<td>1 ea</td>
<td>$85.00</td>
<td>$85.00</td>
<td>(TYCO Fire)</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>Shut Off Valve</td>
<td>TYCO</td>
<td>1 ea</td>
<td>$1,100.00</td>
<td>$1,100.00</td>
<td>TYCO Fire</td>
</tr>
</tbody>
</table>

## Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trencher</td>
<td>8 hr</td>
<td>$50.00</td>
<td>$400.00</td>
</tr>
<tr>
<td>Core Drill</td>
<td>8 hr</td>
<td>$50.00</td>
<td>$400.00</td>
</tr>
</tbody>
</table>

## Labor

- 400 ft pipe @ 0.45 hr per ft for 3 man crew  
- Approx 1.5 weeks work  
- Total: $14,602.50

## Additional Costs

- 15% Consumables and Misc: $2,190.38
- 15% Overhead and Profit: $2,190.38

**Total Cost:** $18,983.25
GENERAL NOTES:

1. ALL SPRINKLERS SHALL BE:
   a) TYCO SERIES LFI RESIDENTIAL CONCEALED PENDANT SPRINKLERS (TY359B) OR EQ.
   b) K-FACTOR – 4.9
   c) MIN. SPACING – 8 FT
   d) MAX. SPACING – 16 FT
   e) ORDINARY TEMPERATURE RATED UNLESS OTHERWISE NOTED

2. CPVC PIPE SUPPORTS SHALL BE SPACED AT A MINIMUM OF 6 FT.
3. COPPER PIPE SUPPORTS SHALL BE SPACED AT A MINIMUM OF 5 FT.
4. ALL EXPOSED PIPING AND SHALL BE TYPE-L COPPER TUBING.
5. ALL EXPOSED FITTINGS SHALL BE WROUGHT COPPER AND COPPER ALLOY SOLDER JOINT PRESSURE FITTINGS, CAST COPPER ALLOY SOLDER JOINT PRESSURE FITTINGS, OR CAST BRONZE THREADED FITTINGS.
6. ALL NON EXPOSED PIPE AND FITTINGS SHALL BE CPVC UNLESS OTHERWISE NOTED.
7. CPVC PIPE AND FITTINGS SHALL BE TYCO BLAZEMASTER OR EQ.
8. ALL PIPE SHALL BE SLOPED 1/4" PER 10 FT TO FACILITATE DRAINING.
9. ALL LOCAL PLUMBING CODES ARE TO BE FOLLOWED.
UPPER LEVEL FLOOR PLAN  1/8" = 1'-0"
FROM CITY SUPPLY

TYCO 5130 RISER MANIFOLD
OR EQ.

(1"-COPPER)

(3/4"-COPPER)

TO SPRINKLERS

CMU WALL PENETRATION

DETAIL A: RISER MANIFOLD N.T.S.