DESIGN OF A FIRE PROTECTION SYSTEM FOR AN INDUSTRIAL CHEMICAL PLANT WITH AUTOSPRINK – CASE STUDY

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To my family and friends,

"From success, you learn absolutely nothing. From failure and setbacks, conclusions can be drawn. That goes for your private life as well as your career."

Nikki Lauda

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I would like to express my very great appreciation to the HSE department from Worley. Thank you for welcoming me so well and for making me feel so comfortable at work. To Polina, Ahmad, Rafael, Wendy and Bjorn, a big thanks. I am particularly grateful to Tinneke, for allowing me the opportunity to learn from her and for giving me the chance to join this team.

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Thank you all.

ABSTRACT

The chemical industry is in an accelerated growth rhythm, naturally implying an increase in the associated risks, with fire being one of them. The treatment of chemical materials in the industry takes place, in most cases, at very high temperatures and pressures, thus requiring a reliable and efficient fire protection system that allows, in the event of an accident, a reliable and effective response of extinguishing and refrigerating agents.

The delay in the escalation of the fire is essential to give the competent authorities, the capacity of dealing with this type of accident in the chemical industry, time to attack and contain it.

There were two main objectives in carrying out this work. The first focused on the design and dimensioning of a network of automatic fire sprinklers, with water, for the process unit, object of study - case study. The second objective focused on the calculation of the needs of water and foam in a storage tank farm for highly flammable combustible materials.

The sprinkler network was designed in a BIM tool, with an extremely important the objective for the company where the dissertation was developed: to achieve an optimal space management in the chemical process unit. It is crucial, considering the complexity of such structures, where the chemical treatments of the flammable and combustible are processed.

As a second objective of the dissertation, a calculation sheet was developed in order to provide the engineer, in charge of the design of the storage tank farm for combustible materials, the worst fire case scenario. For this analysis, the needs of the water / foam mixture are compared, to cool (and eventually extinguish), a fire occurrence in each tank in the park. In addition, the sheet is prepared to calculate the need for water to cool adjacent tanks, subject to radiation from the one with the fire.

The amounts of water and foam are dependent on the physical characteristics of the reservoirs, such as the type of cover, either fixed, floating or interior floating, the height and diameter and even the type of liquid that is stored.

KEYWORDS: AutoSPRINK, Automatic extinguishing systems, space management, fire, fire safety, foam

RESUMO

A indústria química encontra-se num ritmo de crescimento acelerado, implicando naturalmente um incremento dos riscos associados, sendo o de incêndio um deles. O tratamento de matérias químicas na indústria acontece, na maior parte dos casos, a temperaturas e pressões muito elevadas sendo assim necessário um sistema de salvaguarda do incêndio fiável e eficaz que permita, em caso de algum acidente, uma resposta rápida e automática de agentes extintores e refrigeradores.

O retardamento no escalamento do incêndio é fundamental para dar tempo às autoridades competentes, e capazes de lidar com este tipo de sinistro na indústria química, fazerem o seu ataque e contenção.

Existiram dois objetivos principais com a realização deste trabalho. O primeiro concentrou-se no desenho e dimensionamento de uma rede de sprinklers automáticos de incêndio, com água para a unidade de processo, objeto de estudo – caso de estudo. Já o segundo objetivo, incidiu sobre o cálculo das necessidades de água e de espuma uma num parque de tanques de armazenamento de materiais combustíveis altamente inflamáveis.

A rede de sprinklers foi desenhada numa ferramenta BIM, com um grande objetivo que é de extrema importância para a empresa onde foi desenvolvida a dissertação: conseguir uma gestão ótima do espaço na unidade de processo químico. É crucial, tendo em conta a complexidade das estruturas que albergam os tratamentos químicos e a natureza inflamável e combustível dos elementos a processar.

Como segundo objetivo da dissertação, foi desenvolvida uma folha de cálculo com vista a fornecer ao engenheiro, encarregue do dimensionamento de um parque de tanques de armazenamento de materiais combustíveis, o caso de incêndio mais gravoso. Para esta análise, comparam-se as necessidades da mistura água/espuma, para arrefecer (e eventualmente extinguir) uma ocorrência de incêndio em cada tanque do parque. Adicionalmente, a folha está preparada para calcular a necessidade de água para arrefecer tanques adjacentes, sujeitos à radiação proveniente daquele que estiver com o incêndio.

As quantidades de água e de espuma estão dependentes das características físicas dos reservatórios, como o tipo de cobertura, quer seja fixa, flutuante ou interior flutuante, como a altura e diâmetro dos mesmos e ainda o tipo de líquido que está armazenado.

PALAVRAS-CHAVE: AutoSPRINK, sistemas automáticos de extinção, gestão de espaço, fogo, segurança contra incêndio, espuma

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations and Symbols

In this section, a list of symbols and abbreviations used in the realisation of this dissertations is presented. In some cases, the same symbol may have different meanings due to the extensive number of formulas, variables and parameters that were used. However, each symbol is usually associated with a specific subject, and it is easy to distinguish its meaning, given the context in which it is presented.

Abbreviations

NFPA	National Fire Protection Association
API	American Petroleum Institute
EO	Ethylene Oxide
PO	Propylene Oxide
gpm	Gallons Per Minute
lpm	Litters Per Minute
psi	Pound Per Square Inch
MTO	Material Take Off Per Minute

Symbols

A	Area or cross-section
a	Acceleration
D	Diameter
f	Frequency
H	Height
L	Length, travel length
P	Pressure
p_a	Atmospheric pressure (reference pressure)
V	Volume
m	Meters
m^2	Square meters
m^3	Cubic meters
$x\ y\ z\quad X\ Y\ Z$	Horizontal (x and y) and vertical (z) axes and directions
Δ	Increment, difference

1 INTRODUCTION

1.1 MOTIVATION

Fire safety has always had a significant impact on all engineering disciplines. It affects structural, mechanical, piping, electrical, environmental, hydraulic, among others. Given the increasing intricacy, not only of buildings but of all kind of industrial processes, efficient and effective fire safety projects are required. With the increment of the complexity, new problems arise, and this is where good engineering takes a fundamental role. The search for relevant and challenging problems led me to search for an international company outside of my home country.

The main objectives were the chance be on a corporate environment, instead of an academical one, the outlook to use more sophisticated designing methods, the opportunity to live abroad and develop the capability to handle adaptation problems and the chance to work with international clients with greater projects. Being part of a renamed company like Worley België BVBA, enabled me to achieve all this. Present in more than fifty countries around the world, the firm is a leading global provider of project and asset services in the energy, chemicals and resources sectors. Worley delivers specialist services across the full spectrum of projects within six markets: new energy, power, upstream and midstream, refining and chemicals, mining, minerals and metals and infrastructures.

The group works in a diverse geographic and cultural setting, from small brownfields services contracts to major greenfield projects including offshore and onshore, oil and gas, refining and petrochemicals and pipelines. The power customer sector group provides a full range of services to all types of powerplants, including conventional sources such as coal, nuclear and gas turbine plants. They are also experts in providing services to the renewable energy sector, solar, wind, biomass and hydroelectric.

1.2 GOALS

It is important to highlight that due to the period when this dissertation was developed, some objectives for the project were changed along the way.

The initial main focus was to design, study and compare a fire protection system that was designed without a BIM software, with this proposal, that utilises a program called AutoSPRINK. Due to external motives, the hydraulic calculation files, for the comparison, were only received late in June. Therefore, it was given a bigger significance to the second objective.

The second goal of this project was the execution of the water/foam demand calculation sheet. This study will allow the fire safety engineer to quickly calculate the worst-case scenario in case of fire in a tank farm and start designing all the firefighting procedures from there. It will be possible to quickly extract key figures that are necessary for other departments, for example, for the mechanical engineers to proceed with the design of the fire tank and fire pump.

1.3 METHODOLOGY

AutoSPRINK is a revolutionary BIM tool, highly specialised in the design and dimensioning of fire networks, namely fixed systems of automatic water extinguishing, armed fire networks, external hydrant networks and water spray extinguishing systems (with or without foam).

This tool allows not only the design and hydraulic calculation of this type of network but also the production of maps of exact quantities and adjusted to the needs of the customer, to carry out the project (prefabrication and assembly) with high precision and rigour.

It works in Windows environment, allowing direct export to BIM platform (Revit) and the creation of an IFC file. The project can also be exported to AutoCAD with 3D visualisation, if necessary.

Thanks to its total compatibility with the BIM language, it uses objects with information and physical characteristics, allowing the creation and design of a precise, intelligent and real model, through three-dimensional simulation. Components behave as physically existing, both in appearance and functionality, as well as in the interaction between them. Each component also has updated information about its existence in the market, costs, models and characteristics.

This way, the designer can have access to the information he considers relevant about the installations designed with objects, such as the hydraulic needs of the systems, behaviour reports, material lists (quantities and characteristics), work plans, assembly plans, installation costs, profit margins, among others. The design can be carried out in accordance with the NFPA Standards, or adjusted to any regulation, legislation or technical specifications.

It works through modules, added according to the user's needs, highlighting as its main feature the three-dimensional design accompanied by precise, configurable and automatic hydraulic calculation, of high performance, always associated with databases and vast libraries. Although the design and dimensioning modules are entirely adjusted to the needs of engineering and architecture, the manufacturing (Stocklisting) and budgeting (Autopricer) modules are the perfect resource for installers of fire networks and extinguishing systems.

1.4 POTENTIAL CONCLUSIONS

Given the complexity of a fire protection system, both in the hydraulic calculation and in the design, it is ideal to have one tool that allows the engineer to have a three-dimensional view, and at the same time, a quick way to calculate water flow, speeds and pressures. As we face a transitioning phase in the construction world with digitalisation, a BIM tool is the best way to design a fire protection network. There are a few options available in the market like SprinkCAD 3D, HydraCAD, and AutoSPRINK, the software chosen to use in this dissertation.

As a natural evolutionary step in the industry, Worley acquired AutoSPRINK as a successor to a previous non-BIM program used in the design of water systems for fire protection. This choice was mainly prompted by the need of to have a more precise space management tool (that was compatible with the software used for other disciplines) and to reduce mistakes, naturally made by the engineers in the design of such complex systems. It will allow the engineer to have access, in seconds, to the hydraulic calculations, exportable drawings, Material Take Off (MTO) and to budget estimations. The main improvements are transversal to all BIM tools (1):

- Reduction of manual data entry with a greater electronic information exchange;
- Reduction and elimination of low-value and no-value tasks;
- Reduction of time spent on "defensive documentation";
- Integration of construction cost estimating with building information modelling;
- Reorganisation of business processes to enable more tasks to occur concurrently;
- Increased prefabrication of construction assemblies;
- Implementation of direct design-to-fabrication processes;
- Implementation of efforts to achieve and maintain optimal performance of operating systems and equipment;
- Implementation of continuous learning processes to improve the quality and profitability of the operations.

As in all transitions, there are downsides, like the associated costs. First of all, the actual cost of the software. Secondly, there may be charges associated with hardware, because such a powerful program requires an equally powerful computer to run it. Also important in this case, are the technical support, maintenance and program updates that are an extra every year. In addition to all this, the engineers that will learn how to use this program will need some time. Not only do the basic training, but for full integration to get up to speed with the already well-known software in the rest of the disciplines.

1.5 Dissertation Outline

The dissertation is organised into six chapters, presented sequentially, in which all the work that was performed is described.

In this first chapter, it is possible to find the author's motivation as well as a brief introduction to the company where the thesis was developed. It is also presented the main goals and the basic structure of the dissertation.

Chapter two is dedicated to the presentation of the state of the art, regarding fire safety regulations and sprinklers' technological aspects. It is discussed the lack of proper rules in the firefighting in the chemical industry and how projects are developed. It is also presented some relevant concepts related to the industry and firefighting, for a better understanding of the design of the sprinkler network.

In the third chapter, it is displayed the case study. It begins with the categorisation of the project according to the NFPA and all its measures for firefighting. It is also presented the categorization according to the Portuguese standards. Chapter four is fully dedicated to the hydraulic calculation. The used formulas are shown as well as the material characteristics used.

In the fifth chapter the reader is presented with an analysis of NFPA 11 and the different approaches regarding the different kind of tanks and liquids inside. It is also shown the second goal of the dissertation, the water and foam demand for a storage tank farm. It was developed an Excel calculation sheet, according to NFPA's standards, that is capable to automatically give the amount of water and foam need for the worst-case fire scenario in the tank farm.

Finally, on the sixth and last chapter, conclusions were drawn regarding the use of the sprinkler software as well a brief comparison with the results achieved by the Contractor that originally design the network.

Contained in Appendix A is the entire hydraulic calculations and the stock listing, both exported from AutoSPRINK. There are also graphicly coloured pictures of the network regarding flow and speed rates.

Contained in Appendix B are the Excel tables both for the generic version as well as for the example created to illustrate a real fire scenario.

Contained in Appendix C is the full analysis of the NFPA 11 and its respective tables with the minimum application rates and discharge times, for water and foam, for each type of tank and substance.

2
STATE OF THE ART

2.1 FIRE PRINCIPALS

2.1.1 INTRODUCTION

There are three universal principals that fire safety measures aim to comply with, which are the safeguard of:

- Human life;
- Environment;
- Cultural heritage.

To be able to meet these standards, Fire Safety Project will equip the structure that will:

- Reduce the likelihood of fires;
- Limiting the development of fire occurrence and minimising its effects;
- Preventing escalation;
- Circumscribing the spread of combustion gases;
- Facilitate the evacuation and rescue of personnel at risk;
- Allow effective and safe intervention of the emergency services.

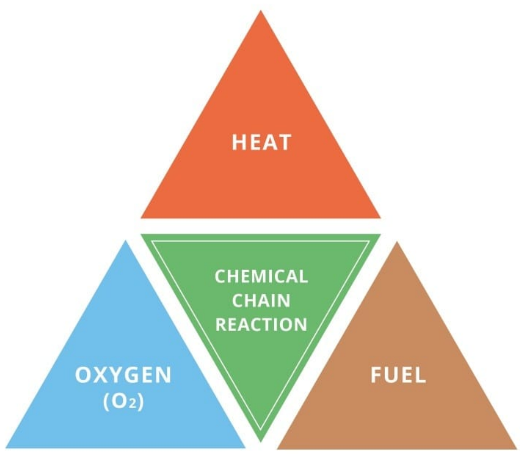


Figure 2.1 - Fire Tetrahedron (2)

Extinguishers work by creating a barrier between the fire components – fuel, heat and air – thus preventing the chemical chain reaction from happening. To disrupt the elements that form the Fire Tetrahedron and thus put out the fire, you need to do one or more of these four things (2):

- Remove fuel sources. It is a preventative measure making sure potential fire hazards are stored safely or if a fire has started you can use water to disperse the fuel sources and to cool them;
- Cool the burning materials with water;
- Exclude oxygen. For example, with a fire blanket to prevent oxygen from reaching the process.
- Break the chemical reaction. It is the chain reaction that keeps a fire going.

2.1.2 Fire Growth

The knowledge of how a fire develops (Figure 2.2), over time, will certainly allow to select the most appropriate means for each case.

The development of a fire depends on numerous factors; hence no two fires are the same. For the various possible combinations between the four elements of the fire tetrahedron, in the development of a fire, several factors are conditioning factors:

- Nature and quantity of fuel present;
- Fuel distribution and presentation;
- Amount of oxidant (oxygen) available, which depends on ventilation conditions;
- The geometry of the area on fire and the dimensions of the openings;
- Characteristics of floors, walls and coverings;
- Atmospheric conditions (temperature, wind direction).

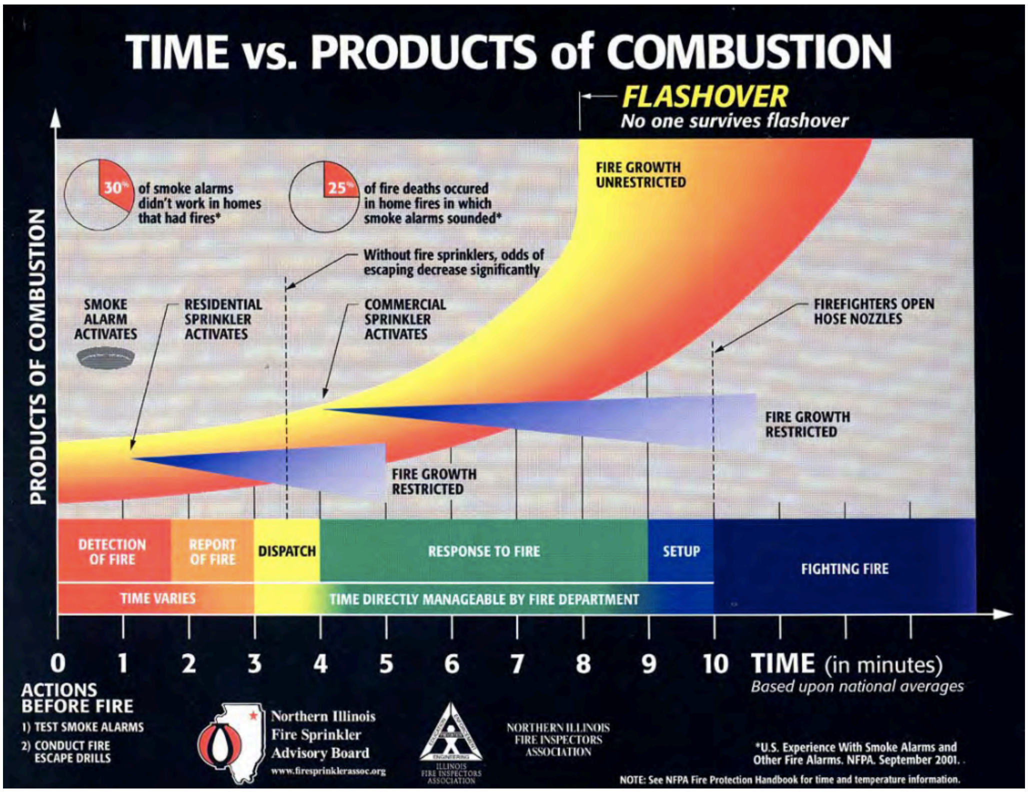


Figure 2.2 - Timeline of a fire development versus typical fire service response (3)

However, it is possible to identify certain critical phases or characteristic moments that a fire presents in its natural development. Leça Coelho (4) identifies the five phases represented in Figure 2.2, namely, the following:

- Ignition;
- Propagation;
- Widespread inflammation (flashover);
- Continuous combustion;
- Decay.

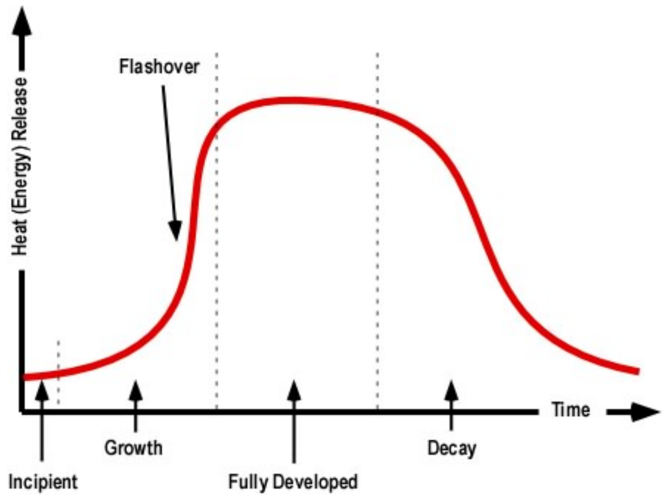


Figure 2.3 - Fire Development (5)

The effectiveness of the extinguishing means depends, in large part, on the moment in which they are used, during the process of developing a fire. If they are applied at an early stage of a fire, only light means are needed, such as a sprinkler, which is quickly triggered near the fire by temperature, a portable extinguisher or an armed fire hydrant that is easily handled by the building's occupants.

2.2 World Regulations

It is important to notice that there is very little legislation available for such a specific engineering field as firefighting in the chemical industry. Therefore, these kinds of projects are often done based on good engineering practices and past experiences. It is also possible to find the most complete set of guidelines in the companies' standards as they are used to the challenges presented.

2.2.1 NFPA

Even though there is not a standard saying what to implement in which case, the National Fire Protection Association (NFPA) produces trustworthy standards that started being produced more than a hundred years ago. This Association is a global self-funded non-profit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. NFPA delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering our mission. Our mission is to help save lives and reduce loss with information, knowledge and passion (6).

These set of rules indicate a possible way to design, install and test equipment with the objective of control the fire and limit its impacts to the maximum.

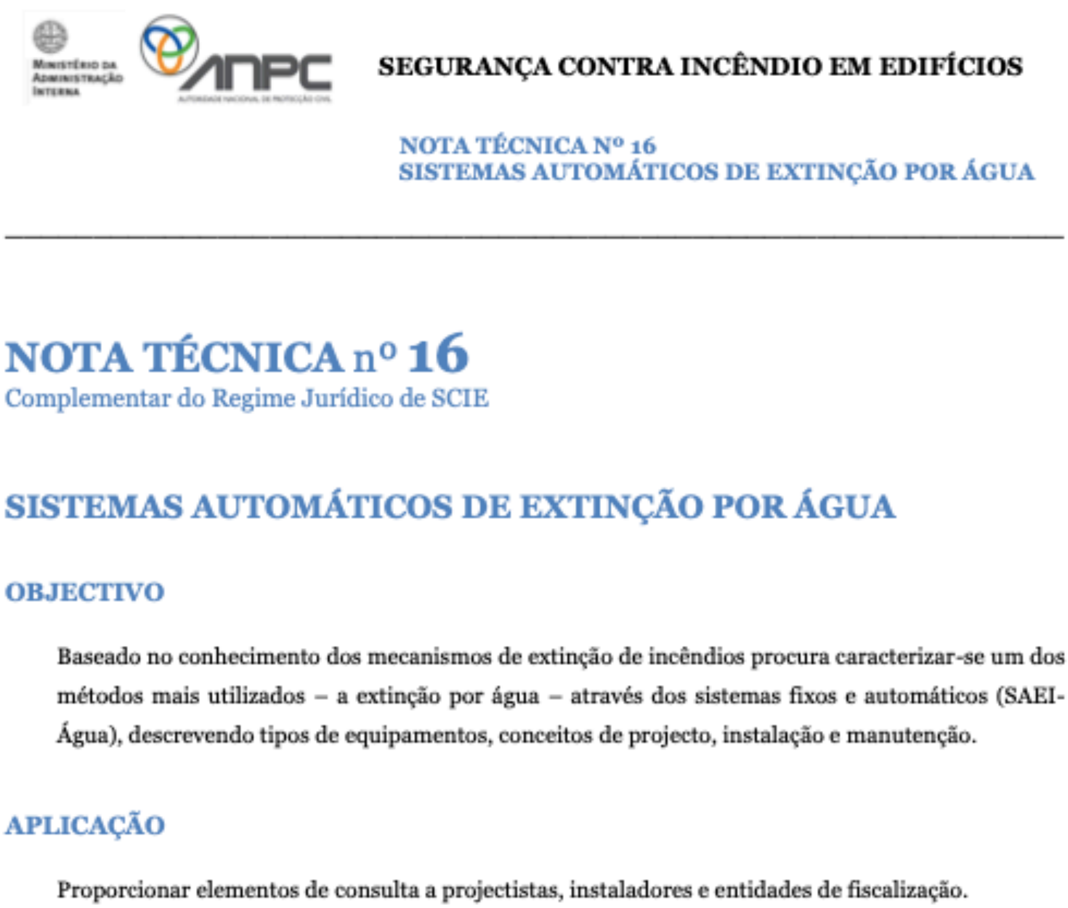
2.2.2 Belgium Legislation

As in most countries, Belgium does not have a specific firefighting legislation for process units. Consequently, the project is realized in an iterative manner with the local fire brigade and the client. Insurance companies usually have their input in the project and might be more demanding on the measures taken.

2.2.3 Portuguese Legislation

The Technical Note 16 (7) describes all types of equipment, concepts of design, installation and maintenance of the mechanisms to be used for water extinction through fixed and automatic systems applicable in Portugal. It has as references the NFPAs, European Norms and CEA 4001 (European Insurance and Reinsurance Federation).

The Technical Note (7) presents the configurations of automatic water-based fire extinguishing systems in terms of the type of installation, the type of sprinklers (being further evaluated according to the actuation element, the discharge hole), mounting position, among others. The choice of the type of sprinklers depends on what is described in the current regulation. These depend on the risk level of the spaces to be protected, the environmental conditions, the characteristics of the building elements, products manufactured and stored, among others (8).


SEGURANÇA CONTRA INCÊNDIO EM EDIFÍCIOS

NOTA TÉCNICA Nº 16
SISTEMAS AUTOMÁTICOS DE EXTINÇÃO POR ÁGUA

NOTA TÉCNICA nº 16
Complementar do Regime Jurídico de SCIE

SISTEMAS AUTOMÁTICOS DE EXTINÇÃO POR ÁGUA

OBJECTIVO

Baseado no conhecimento dos mecanismos de extinção de incêndios procura caracterizar-se um dos métodos mais utilizados – a extinção por água – através dos sistemas fixos e automáticos (SAEI-Água), descrevendo tipos de equipamentos, conceitos de projecto, instalação e manutenção.

APLICAÇÃO

Proporcionar elementos de consulta a projectistas, instaladores e entidades de fiscalização.

Figure 2.4 - Cover of the Technical Note 16 (7)

2.3 SPRINKLER SYSTEM

2.3.1 INTRODUCTION

An automatic sprinkler system is designed to detect a fire and extinguish it with water in its early stages or hold the fire in check so that extinguishment can be completed by other means.

A sprinkler system consists of a water supply (or supplies) and one or more sprinkler installations; each installation consists of a set of installation main control valves and a pipe array fitted with sprinkler heads. The sprinkler heads are fitted at specified locations at the roof or ceiling, and where necessary between racks, below shelves, and in ovens or stoves. The main elements of a typical installation are shown in Figure 2.3 (9).

The sprinklers operate at predetermined temperatures to discharge water over the affected part of the area below. The flow of water through the alarm valve initiates a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions.

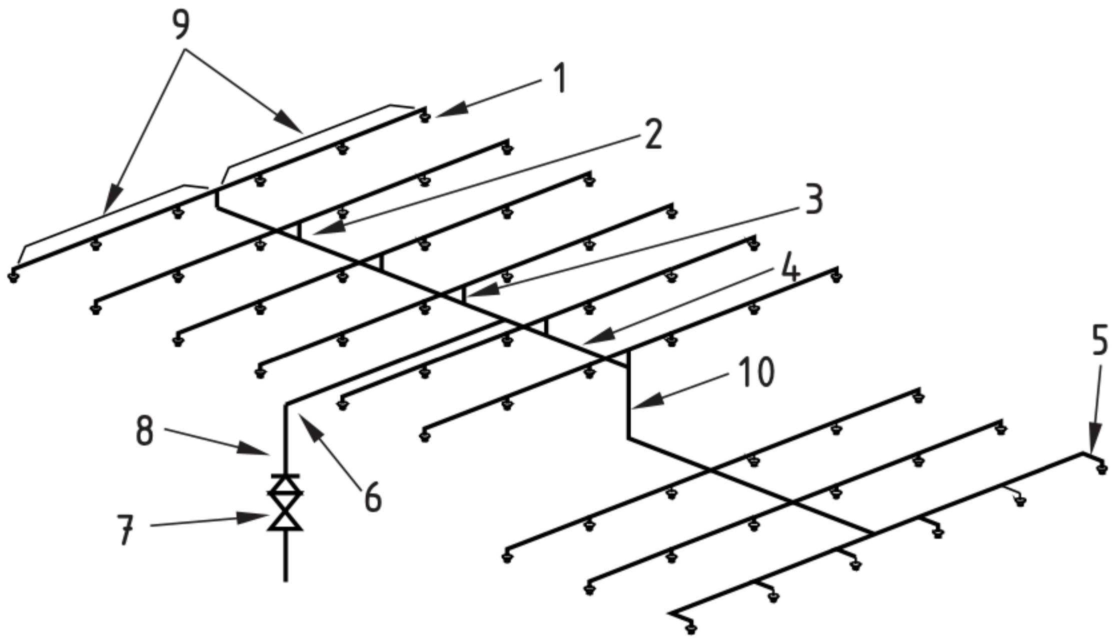


Figure 2.5 - Main elements of a sprinkler installation (9)

There are several system elements associated with the network. The caption is possible to find bellow.

1. Sprinkler Head
2. Riser
3. Design Point
4. Distribution Pipe Spur
5. Arm Pipe
6. Main Distribution Pipe
7. Control Valve Set
8. Riser
9. Range Pipes
10. Drop

2.4 SPRINKLER/NOZZLE

2.4.1 INTRODUCTION

Water spray systems as defined in NFPA 15 (10) can provide some of the most complex and challenging system designs encountered by fire protection professionals. The selection of the proper spray nozzle that achieves the coverage area and water density required for the hazard being protected is one of the most important steps necessary to ensure the successful operation of the system. Of course, there are many other steps of equal importance and complexity that are taken during the design and layout process for water spray systems, but it is the selection of the proper spray nozzles that can present one of the largest challenges and may ultimately determine whether or not the water spray system will perform as required. Because of the wide variations in the characteristics of water spray nozzles including discharge patterns, velocities, distances of projection and the variables of the hazards being protected, a careful evaluation of the nozzle selection should be completed by a professional with an in-depth knowledge of special hazards applications and water spray system design (11).

2.4.2 HOW TO SELECT THE NOZZLE

The complexity of nozzle selection can be increased in some cases where a limited amount of technical information is available de- scribing the specific features or proper application for the spray nozzle being considered. In other cases, confusion may result from the terminology used in a manufacturer's technical data, such as high, medium and low velocity nozzles and the term velocity's relationship to the application. Given the substantial number of hazards where spray nozzles can be applied, and the various listings and approvals granted by Underwriters Laboratory, Factory Mutual and LPCB (Loss Prevention Certification Board), the design engineer and layout technician are presented with a demanding selection process. This paper will attempt to clarify spray nozzle selection criteria for several of the most complex water spray applications and the terminology used to identify the unique characteristic of the spray nozzles (11).

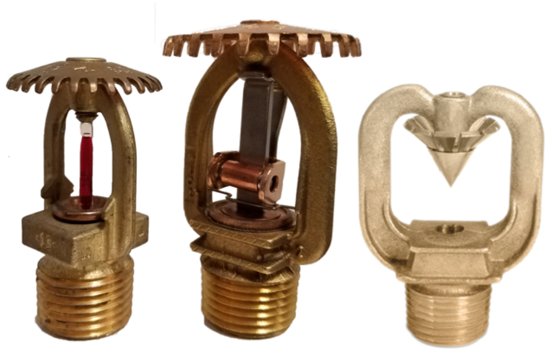
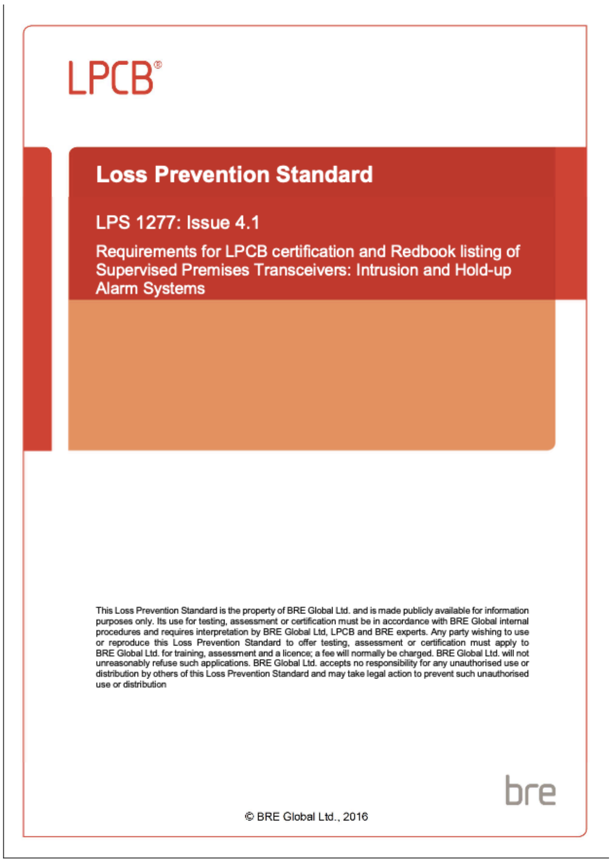


Figure 2.6 – Three different types of sprinklers (12)

The selection of spray nozzles involves consideration of several factors, primarily their ability to distribute water in a manner which allows the proper mechanism of extinguishment or control for the hazard to be achieved. Spray nozzles are available in a wide range of capacities and angles. The design elements used within the spray nozzle to manipulate the movement of water through the spray nozzle will impact the discharge velocity of the water droplets and the discharge pattern's reach or range.

The velocity of the water droplets discharged from spray nozzles is not a factor for consideration of water spray system design within NFPA 15 or 13. However, terms referencing velocity are used extensively within manufacturer's technical data and within the testing and installation standards of the Loss Prevention Certification Board (LPCB) which are used in many parts of the world. The exact meaning of this terminology and how it applies to the spray nozzle application can be confusing and at times misleading, but it can be helpful to put a definition to the terms low, medium and high velocity if for no other reason than to help the designer and layout technician gain a better understanding of the nozzle application. The only written definitions for spray nozzles that can be found within the fire protection industry commonly referenced text are within the LPCB Standard 1277 (13).


LPCB®

Loss Prevention Standard

LPS 1277: Issue 4.1

Requirements for LPCB certification and Redbook listing of Supervised Premises Transceivers: Intrusion and Hold-up Alarm Systems

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Figure 2.7 - Loss Prevention Standard (13)

LPCB Standard 1277 defines medium velocity spray nozzles as "sprayers with deflection plates producing conical discharge pat- terns having bores not less that 1⁄4 inch (6.3 mm) and meeting the test requirements of this standard apart from the fire test. These sprayers may be opened or sealed; the seal is identical to that of a sprinkler" and "sprayers with swirl chambers producing conical discharge patterns and having internal waterways not less than 1/8 inch (3.1 mm) and final exit bores not less than 1⁄4 inch (6.3 mm) and meeting the requirements of this standard at a pressure of 20 psi (1.4 bar) apart from the fire test" (11).

Fixed nozzles have certain velocity or pressure ranges of effectiveness. Below the lower limit of the force range, the discharge pattern is ineffective; above the upper limit, velocities may be reached that will result in decreased effectiveness due to reduction in the discharge pattern, delivery distance and/or the water droplets. At the point where a droplet of water is discharged from a nozzle, it is carried forward by its momentum, downward by the force of gravity, and is retarded by friction in the air. The forward velocity of water droplets becomes very important in the reach of the nozzle. Spray nozzles are designed to have various spray angles. The volume of water being discharged, and the spray angle of the nozzle will determine the actual velocity of the water droplets and the range of the spray.

The size and velocity of the water particles will have an impact on the ability to extinguish or control a fire, as shown in Figure 2.8. If the droplets are too small, they cannot penetrate to the seat of the fire but are carried upward by the fire plume. If they are too large, their surface-to- mass ratio is small, and they cannot effectively cool the fire gases (11).

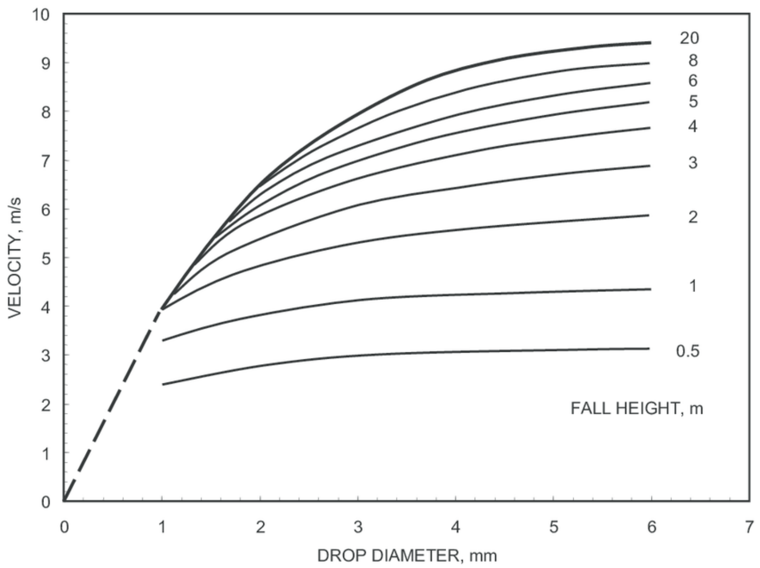


Figure 2.8 - Correlation between the particles' velocity and diameter (14)

High and medium velocity spray nozzles cover a much broader range of application. Due to a wide range of K factors and operating pressures the water droplet size can range from the larger droplets found in the discharge of a standard sprinkler to the much smaller water droplets that would be similar to the sizes found in water mist systems. When the water pressure range is between 20 psi (1.4 bar) and 50 psi (3.5 bar) the water droplet velocity is 49 ft/sec (15 m/sec) to 82 ft/sec (25 m/sec). High and medium velocity spray nozzles are used primarily within this pressure range so it can be anticipated that the water droplet velocity may be similar to this published information for many spray nozzles (11).

Extinguishing a flammable liquid fire is possible if the flammable liquid is miscible with water, and large quantities of water can di- lute the liquid to the point where it is no longer flammable and cool the liquid below its flash point; however extreme care must be taken when using this approach to ensure the container which is holding the combustible liquid does not overflow and inadvertently spread the fire. One technique that can be used to prevent this situation is to select a nozzle which discharges a fine spray with droplets less than .4mm. The fine spray will dilute and cool the surface layer of the flammable liquid limiting the amount of water introduced to the container and reducing the possibility of an overflow. Fires involving flammable liquids that are not completely miscible with water such as ether and ketones can be controlled utilizing water spray. Low to medium velocity solid cone nozzles are well suited for this type of application (Figure 2.9) (11).

Figure 2.9 - Full cone nozzle (15)

When being used to suppress flammable liquid fires with high flash points above 200ºF, the water droplets must be traveling at a velocity sufficient to penetrate the surface of the flammable liquid. Fires involving combustible liquids with flash points above 200ºF that are not miscible with water such a lubricating oil, can be suppressed using high velocity solid cone nozzles (Figure 2.10). When the water is discharged with a velocity that is sufficient to penetrate the surface of the combustible liquid, suppression is achieved by cooling the surface below the liquid's flash point (11).

Figure 2.10 - Solid cone nozzle (11)

2.5 PIPPING LAYOUT

2.5.1 INTRODUCTION

Piping Network is a system of pipes and trenches which provide the appropriate quality and quantity of water to a community. The design, construction and layout of the piping network have to be carefully prepared in order to ensure that there is enough flow pressure to supply hygienically safe water. Once the network is constructed, its maintenance has to be performed, which includes repairs, leakage control, prevention of recontamination, among others.

2.5.2 Requirements of an Adequate Distribution System

For an adequate water distribution system, the requirements are as follows (16):

- Water quality should not deteriorate while flowing through the distribution pipes.
- The system should be capable of supplying water to all the intended places with sufficient pressure head.
- It should be capable of supplying the required amount of water during firefighting.
- The layout should be such that no consumer is without water supply, during the repair of any section of the system. 6. It should be fairly watertight to minimize losses due to leakage.

The design of water distribution for firefighting consists of the following main steps: preliminary studies, design phases, network layout and hydraulic analysis (16).

1- Preliminary Studies: This is the first and the most important step in the designing of water distribution system. Before any design work can commence, thorough observations and studies have to be carried out;
2- Design Phases: After the preliminary studies are performed, the next step is setting the Design Criteria. This step involves setting the required design limitations/parameters that are required to get the most effective and economical water-distribution in the chosen network. The required limitations/parameters can determined on the basis of factors as hazard classification, demand, pressure, flow, pipe size, head loss and spacing;
3- Network Layout: After the design criteria is determined, the next step is to choose a suitable pipe network layout and to estimate pipe sizes on the basis of water demand and local code requirements. The pipes are then drawn on a digital map, starting from the water source. All the components i.e. pipes, valves, fire hydrants, etc. of the water network should be shown on the lines. These layouts are used by project executers (contractors) for implementation (installation);
4- Hydraulic Analysis (Of Distribution Systems): After the suitable type of pipe layout is chosen, the next and final step involves the analysis of the chosen layout. This involves calculating the flow rate, supplied water pressure, volume, losses, etc. The calculation process is done using hydraulic analysis software like AutoSPRINK or others described in the previous chapter (16)).

2.6 Deluge System

According to NFPA 13 (17), a deluge system is a sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or the nozzles. When this valve opens, water flows into the piping system and discharges from all sprinklers or nozzles attached thereto

Deluge-type systems are similar to dry-type systems; however, sprinklers are permanently open, with no metal fuses or glass bulbs, and the piping is completely empty downstream of the checkpoint. These systems are generally used in situations with special fire risks, where it is necessary, simultaneously, a dry type system and a fast action, over the entire protected area, in order to avoid the fire propagation as much as possible.

The discharge time, since the opening of the flood valve, should not exceed 60 s, considering the same requirement for dry type systems. The separation valve between the laden pipeline and the empty pipeline is called the flood valve and is placed at the checkpoint.

The opening of the deluge valve requires a complementary automatic detection and activation system, which allows the activation of the sprinkler system, to be faster than in the dry type systems, eliminating the need to install the opening accelerator device.

The deluge type automatic extinguishing systems have the schematic configuration shown in Figure 2.8 and are composed from the following main elements:

- Checkpoint with check valve and alarm (composed of a flood or flood check valve and connection to the alarm system);
- Alarm system (composed of a local alarm teller and an alarm pressure switch);
- Local alarm teller (composed of hydraulic motor and alarm bell);
- Alarm pressure switch (to report the alarm to the firefighters after system activation sprinklers);
- Test circuit (including drainage piping).

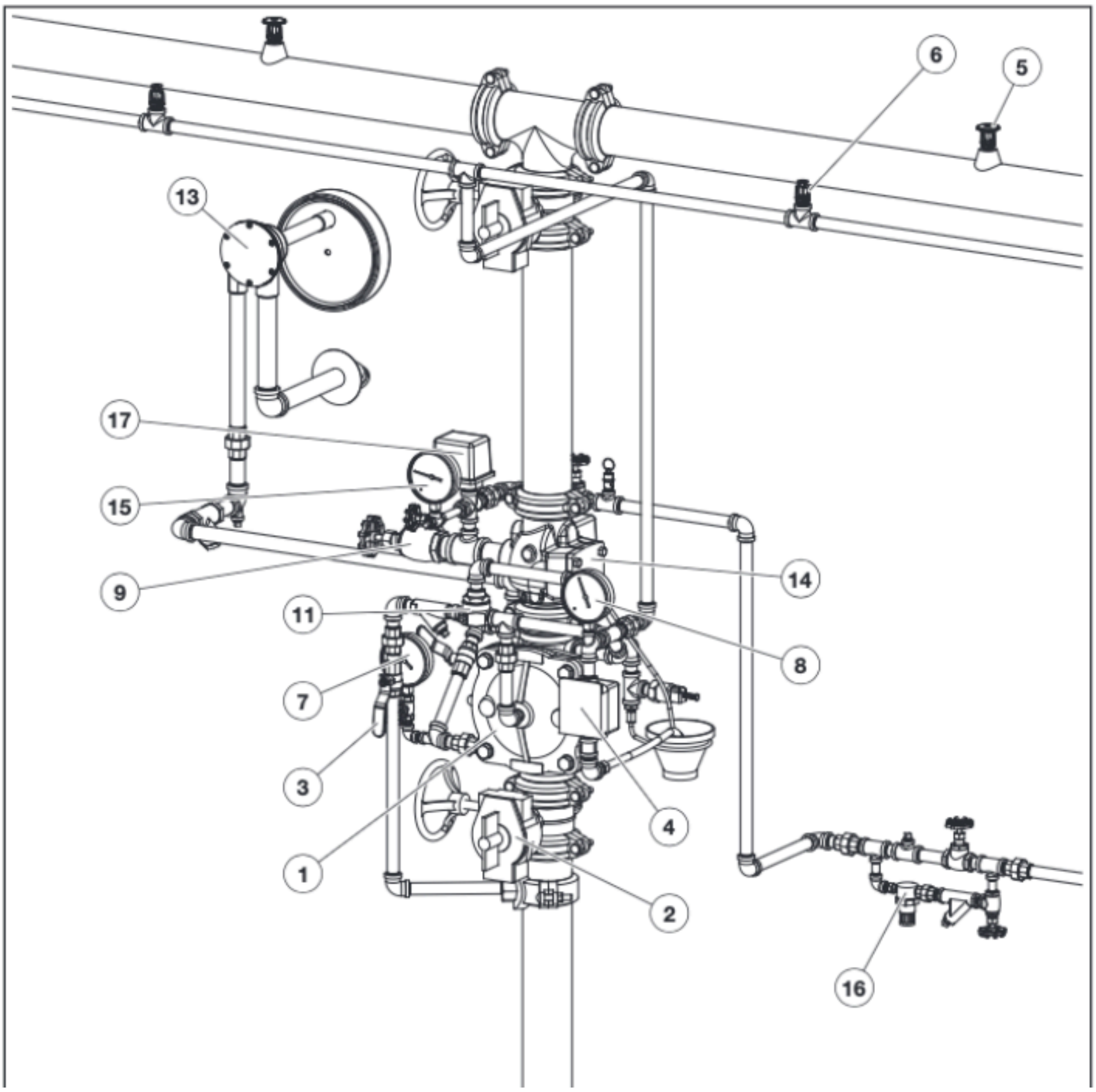


Figure 2.11 – Operating scheme from a TYCO deluge valve (18)

There are several system components. The caption is possible to find bellow.

1. Deluge Valve
2. Main Control Valve
3. Diaphragm Chamber Supply Control Valve
4. Local Manual Control System
5. Automatic Sprinklers
6. Wet Pilot Line Sprinklers (Fire Detection)
7. Water Supply Pressure Gauge
8. Diaphragm Chamber Pressure Gauge
9. Main Drain Valve
10. Diaphragm Chamber Automatic Shut-Off Valve
11. Waterflow Pressure Alarm Switch
12. Water Motor Alarm
13. Riser Check Valve
14. Supervisory Air Check Gauge
15. Automatic Supervisory Air/Nitrogen Supply
16. Supervisory Low-Pressure Alarm Switch
17. System Drain Valve

The opening of the check valve is achieved through an auxiliary activation system, which can be:

- Hydraulic (pneumatic actuator, with pilot piping filled with water, associated with fast acting sprinklers);
- Pneumatic (pneumatic actuator, with the pilot piping filled with compressed air, or pressurized inert gas, associated with fast-acting sprinklers);
- Electric (solenoid valve, with electrical piping, associated with electric fire detectors).

In order for the check valve to remain in the closed position (Figure 2.12), the valve sealing diaphragm is positioned in a chamber, which has a bypass, coming from the water supply branch, being pressurized and in hydraulic balance with the water supply circuit.

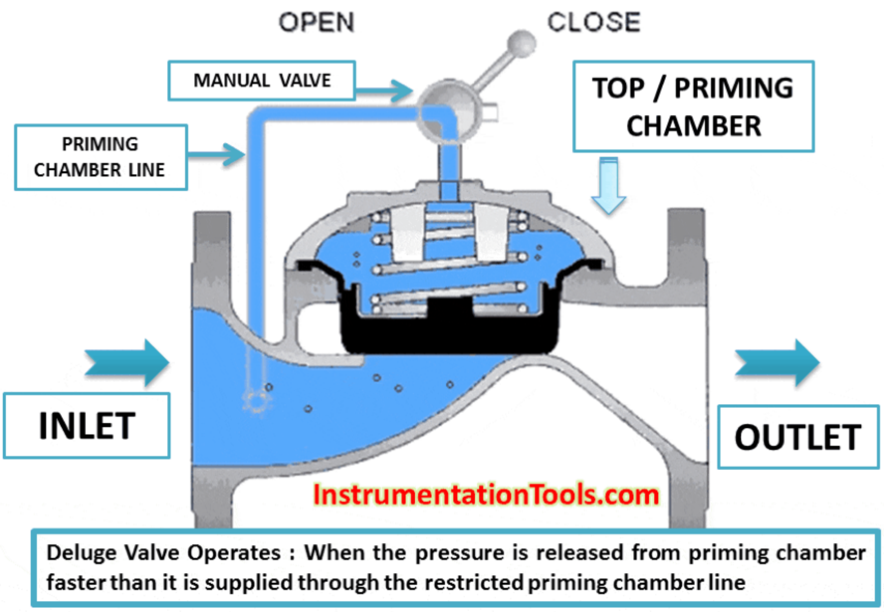


Figure 2.12 – Deluge valve in closed position (19)

The system is filled so that the diaphragm chamber is filled first (Figure 2.13), and then the manual shut-off valve on the system is opened, the system is armed and ready for use.

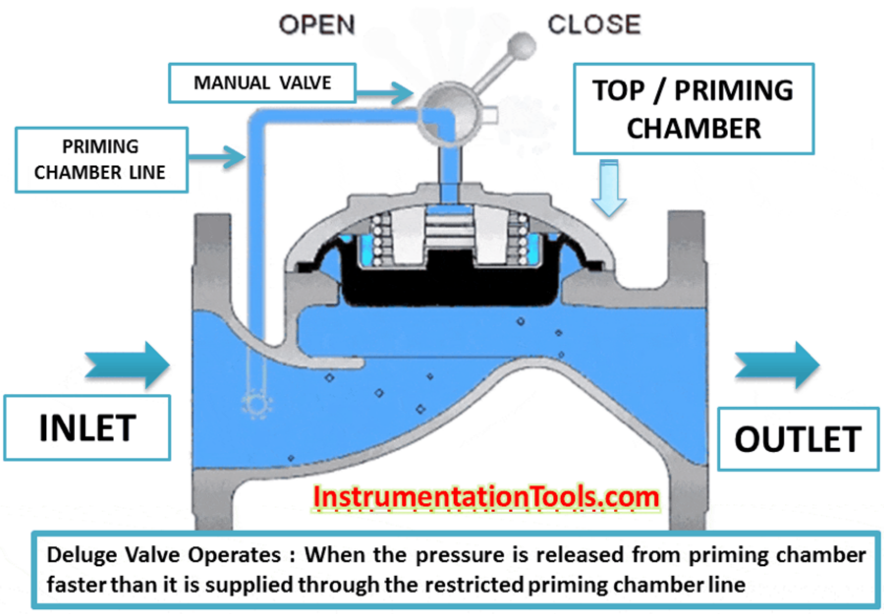


Figure 2.13 – Deluge valve opened and flowing (19)

The deluge valve opens when the auxiliary fire detection system is activated and promotes the opening of an automatic shut-off valve, which leads to the emptying of the diaphragm chamber. Immediately after opening the deluge valve, the dry tubing is flooded, and water is discharged by all open type sprinklers.

2.7 Relevant Concepts

2.7.1 Water Spray Systems

An automatic or manually actuated fixed pipe system connected to a water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area (20).

2.7.2 Process Units

Process unit means the equipment assembled and connected by pipes and ducts to process raw materials and to manufacture either a final or intermediate product used in the onsite production of other products. The process unit also includes the purification of recovered by products (21).

2.7.3 Greenfield and Brownfield

That is term used in construction and development to reference land that has never been used, where there was no need to demolish or rebuild any existing structures (22)

2.7.4 ACTIVE AND PASSIVE FIRE MEASURES

There are two kinds of measures to take into account regarding safety, and they are grouped into active and passive measures. Active fire protection includes automatic fire detection and fire suppression systems, while the passive fire protection's main purpose is to attempt to contain fires or slower their spread (23)

The realisation of the importance of these measures is increasing every year. Oil & gas industry accounted for 24.8% of the global share in 2018 on account of the prevalence of high-risk environment owing to the presence of flammable and explosive compounds at the facilities. Passive fire protection systems have gained significant importance in the oil & gas industry as they help prevent structural damages (24).

Some of the passive measures adopted in this kind of projects are:

- Imposition of suitable fire resistance of structural elements of the structure in order to guarantee stability during a fire occurrence;
- Use of materials with the appropriate classes of heat reaction, like ceilings and floors, so as not to be inappropriately flammable or combustible;
- Fire compartmentalisation (achieved with distance between block fields);
- Sleeves in the most critical fire-water sections of piping.

Active measures adopted explicitly in the building under study were as follows:

- Installation of a detection system and fire alarm;
- Installation of an emergency lighting system and escape routing signalling;
- Installation of an automatic fire protection system;
- Placement of portable fire extinguishers;
- Installation of outdoor combined units to ensure supply and readiness of emergency services.

2.7.5 FIRE AND GAS DETECTION

An automatic fire detection system aims at the early detection of a hazard so that people can be alerted, and proper action can be initiated. It senses the presence of fire, smoke or heat and activates a fire suppression system and/or an automatic alarm system (20). Upon detection, it shall initiate one or more of the following actions:

- Give a local alarm signal and an alarm signal to the control room;
- Activate the emergency shutdown system in the affected zone and adjacent zones;
- Activate the water spray system in the areas where protection by water sprays is foreseen;
- To avoid false alarms, special attention should be given to reliability. Therefore 2 out of 3 systems are recommended.

Figure 2.14 – Thermal velocimetric detector

Regarding the activation, water spray systems can be activated by:

- Pilot system;
- Manually locally;
- Manually in the control room;
- Via gas detection (requires simultaneous activation of more than one detector).

2.7.6 Fire Brigade Access

Some specific requirements must be fulfilled by the owner of the plant. The owner is responsible for the following requirements:

- The width of the road should be at least 6 m;
- The maximum slope must be 6%;
- The turning radius had to be at least 11 m at the inside and at least 15 m at the outside;
- The bearing capacity so that the vehicles with a maximum weight of 13 tons can drive and stand still without sinking, even when they deform the terrain.

3
CASE STUDY

3.1 PROJECT DESCRIPTION

This chapter presents the practical application of a water spray fixed system for fire protection of a new alkylation unit. It is possible to define the alkylation reaction is the introduction of an alkyl group into an organic compound by substitution or addition in which a hydrogen atom is converted to an alky group can be considered an addition reaction. The greatest use of the alkylation process is in refineries for the production of alkylates that are used as a blending stock to produce gasoline (25).

For confidentiality reasons the name of the client will not be revealed, as well as the exact location of the project, however, for design purposes, it is known to be on the industrial area of Antwerp.

Figure 3.1 – View of the Churchill Industrial Zone at the Port of Antwerp (26)

The project was built on a greenfield and it includes a metal structure for the process unit, a loading and unloading stations and a tank farm. Flammables will be only present in the treatment section, so that is the area that will be on the author's case study.

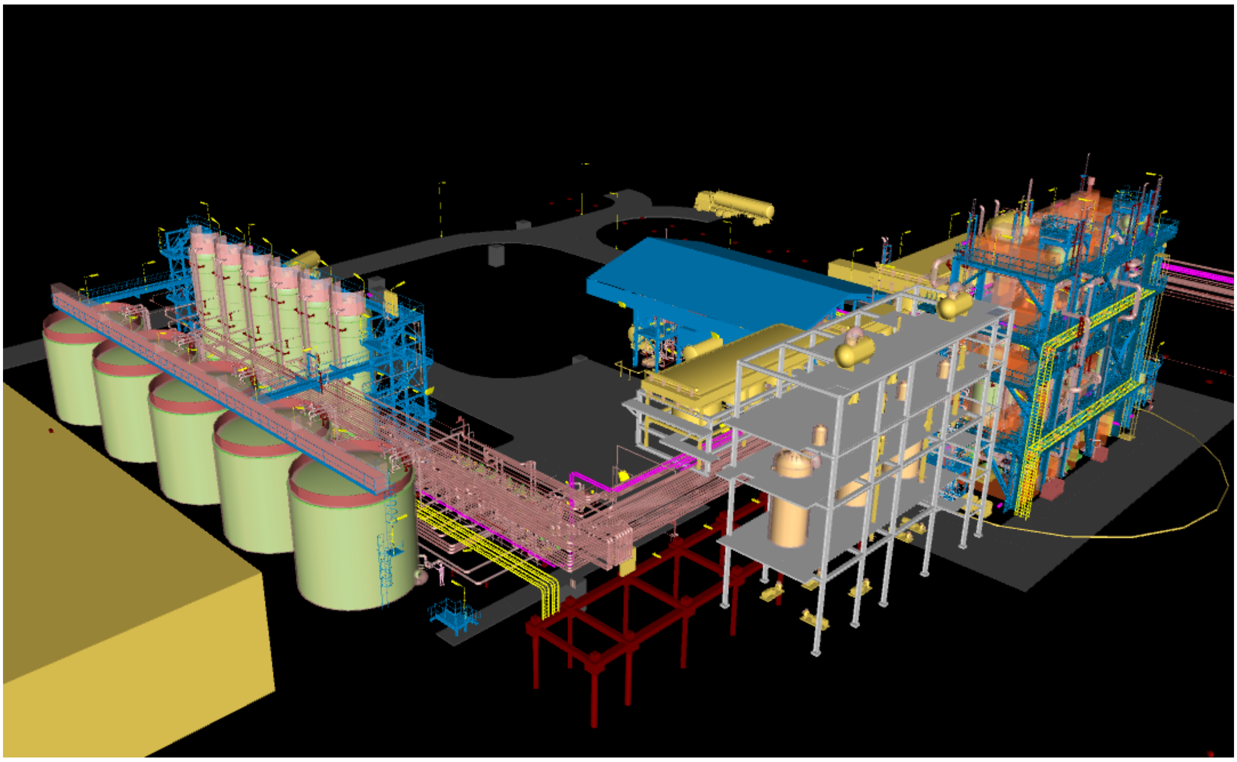


Figure 3.2 - Overview of the Alkylation Unit

The structure, represented as the blue construction on the right-hand side of the Figure 3.2, will have a ground floor, plus four other accessible levels, being the height of the last floor 20,30 meters. Regarding the plan view, the structure occupies 180 m^2.

3.2 Process Description

The process unit contains three sections:

1. Pre-treatment
2. Reaction
3. Post-treatment

In the pre-treatment section, starter product will be heated, catalysed and dried, above the flashpoint. In the reactor, this starter will react with ethylene oxide or propylene oxide to heavy polymers. It is an exothermic reaction where the heat will be extracted via an air-cooled high pressure. In the post-treatment system, the end product will be conditioned for storage. The end products are heavy polymers with high flashpoint. These products will be handled below flashpoint.

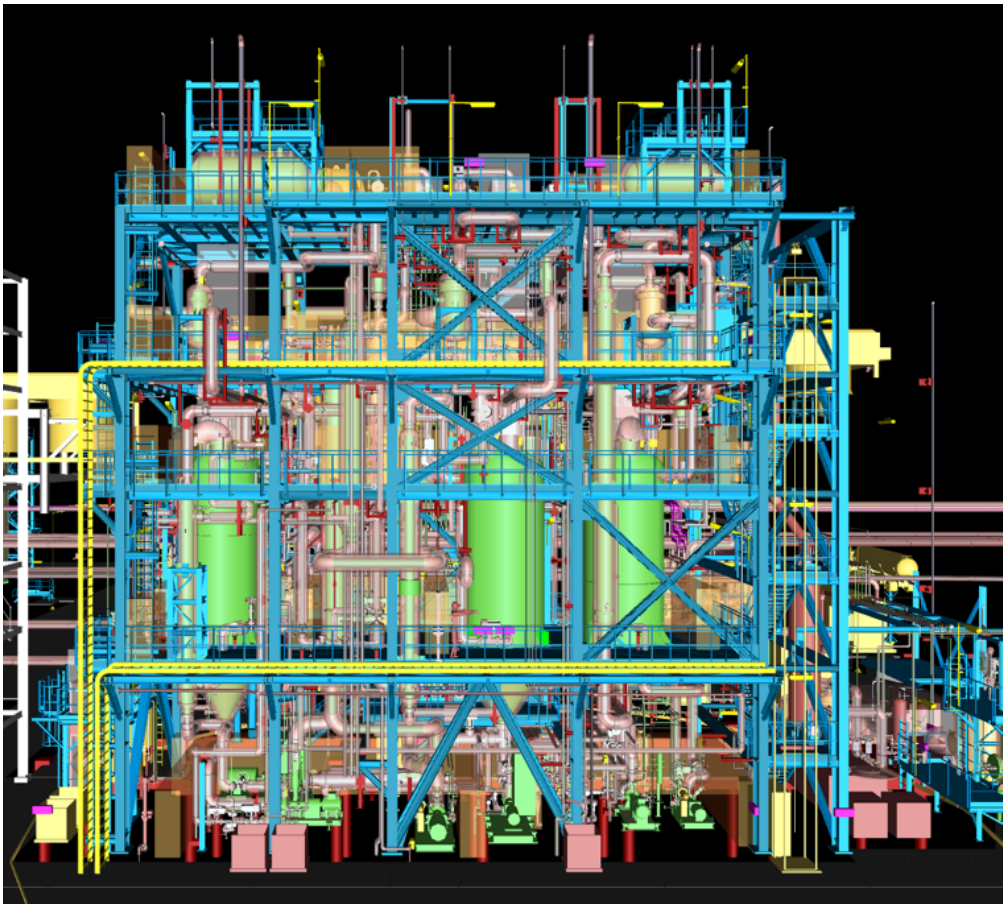


Figure 3.3 – Alkylation Unit

The process department identified the worst possible scenarios as loss of cooling or loss of circulation. Both these events can trigger a runaway reaction that is typically characterised by an exponential increase of the temperature inside the vessel so that the rate of heat generation becomes faster than the rate of heat removal/loss, with a consequent accumulation of heat and acceleration of the reaction rate (27).

3.3 PRODUCT CHARACTERISTICS

Fire risk assessment is the evaluation of the relative danger of the start and spread of fire; the generation of smoke, gases, or toxic fumes; and the possibility of explosion or other occurrence endangering the lives and safety of personnel or causing significant damage to property (28).

As mentioned before, the reaction system will be using two highly flammable products, ethylene oxide (EO) or propylene oxide (PO), as catalysts for the alkylation. The products characteristics are given below in Table 3.1 (29) and Table 3.2 (30).

There is an important property, which is the amount of heat released, in kJ/kg, that will be used later in the analysis according to the Portuguese Regulations. It is when a substance is completely oxidised to yield stable end products, including water as a vapour, as measured using an oxygen bomb calorimeter (20).

Table 3.1– Ethylene Oxide properties

Property	Value	Unit
Density	882 @ 20ºC	kg/mol
Flash Point	-18	ºC
Melting Point	-112.5	ºC
Boiling Point	10.5	ºC
Auto Ignition Temperature	429	ºC
Relative Vapor Density	1.5	-
Molecular Weight	44.05	g/mol
Heat of Combustion	-29,076	kJ/kg

Table 3.2 – Propylene Oxide properties

Property	Value	Unit
Density	882 @ 20ºC	kg/mol
Flash Point	-37	ºC
Melting Point	-112	ºC
Boiling Point	34.2	ºC
Auto Ignition Temperature	449	ºC
Relative Vapor Density	2.0	-
Molecular Weight	58.08	g/mol
Heat of Combustion	-33,035	kJ/kg

It is possible to observe that these products are extremely flammable liquefied gases because of their low boiling point and flashpoint. They can also burn without air since they furnish their own oxygen (29). It is furthermore worth to mention that EO is highly toxic (29). This is an additional reason to install a water spray system on every possible leak of these products.

3.4 Implemented Measures

3.4.1 Compartmentation

Compartmentation, similar to the one done in buildings, does not make sense in this kind of structure. It is then accomplished by distance according to Heat Radiation analysis. It is also not considered the possibility of another fire occurrence in an adjacent field, as a likely or credible scenario. Block field separation generates safe distances. Portable extinguishers are present in the structure in case a small fire is detected by a field worker.

3.4.2 Detection System

The fire detection system, including activation of the deluge valves (electrically or pneumatically), alarm and communication strategy, was designed by the firefighting contractor in compliance with the existing system of the client. The fire detection system consists of pilot lines with thermo-velocimetric detectors.

3.4.3 Fire Brigade Access

Access to the alkylation unit is possible by two different fire brigades although there is a proper fire crew at the Port of Antwerp there is well equipped and trained to deal with industrial hazards.

3.5 Above Ground (AG) Network

3.5.1 General Info

Bearing in mind that the temperatures in Antwerp will certainly drop below 4 degree Celsius, especially between November and March, (see Figure 3.4 below), dry systems will be used in all above-ground structures, water spray network and in the hydrants.

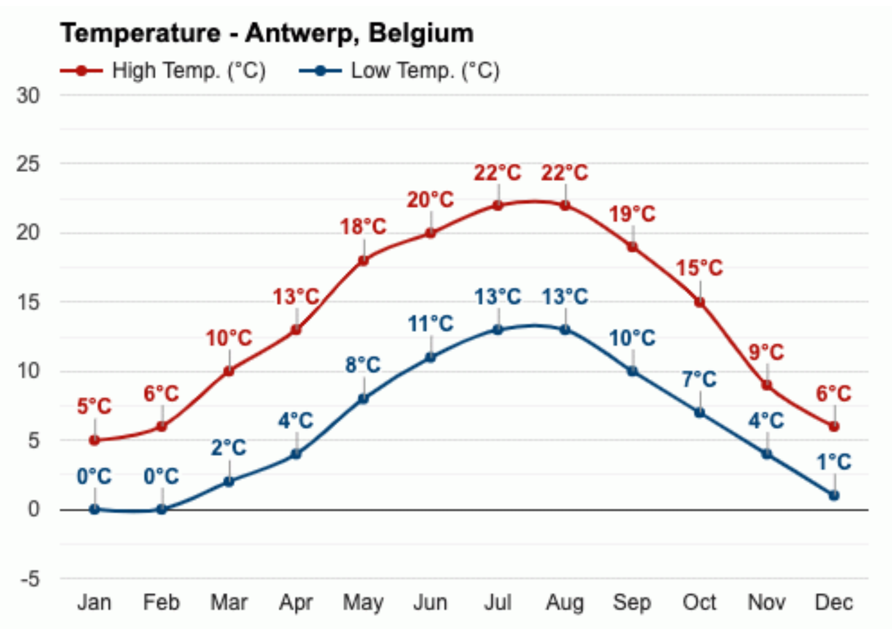


Figure 3.4 – Air Temperatures in Antwerp (31)

3.5.2 Network

The water spray system, in Figure 3.5 bellow, was designed in full compliance with NFPA 15. For each area, a fixed water spray system that fulfils the described duty was designed, supplied and installed by the Contractor. The fixed water spray system for the entire equipment area is a pilot operated system. Meaning a standard spray sprinkler or thermostatic fixed temperature release devices used as detectors to pneumatically or hydraulically release the main valve, controlling the flow of water into a fire protection system (20).

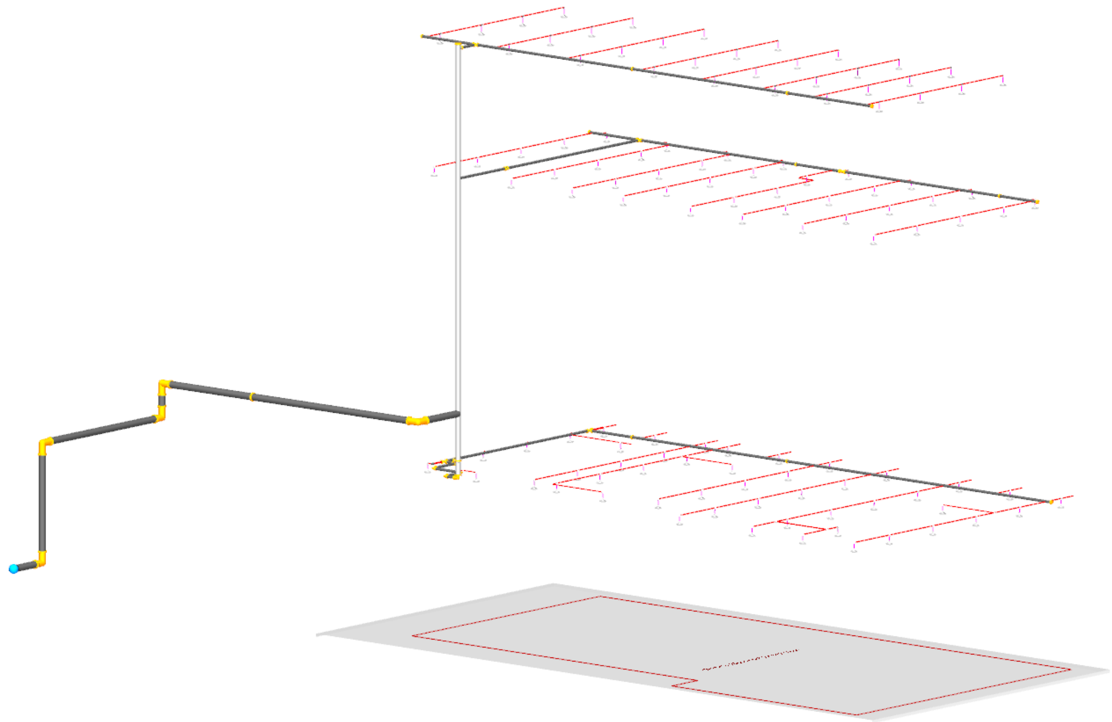


Figure 3.5 - The network on AutoSPRINK

3.5.3 MANIFOLD

The manifold, an assembly of pipe and fittings for connecting two or more cylinders for the purpose of supplying water to a piping system or directly to a consuming device (20), with all outlets and valves will be installed in a deluge house.

Figure 3.6 – Example of a manifold with several systems attached

The following minimum design criteria will be met for the manifold:

- The deluge system shall be activated automatically. It shall also be capable of being activated remotely from the control room or locally via manual override;
- All valves will have position supervision and pressure switches with indication on the fire control system and will have a block valve downstream and a drainage connection to allow testing of the valve;
- The electrical valves require the possibility for manual operation in case of electrical failure;
- Manual valves to isolate and/or test the system shall be provided (Figure 3.8):
  - One valve on the common fire water pipe;
  - Two valves on the system: 1 upstream and one downstream of deluge valve;
- All necessary drains and test connections shall be provided.

3.5.4 Deluge Valve House

The location of the deluge house should be proximate to the structure, as shown in the following figure. It shall contain a deluge valve, that will activate and allow the water to flow into the network and two section valves to permit maintenance work to be performed on both sides of the underground ring, as shown in the valve scheme in Figure 3.8.

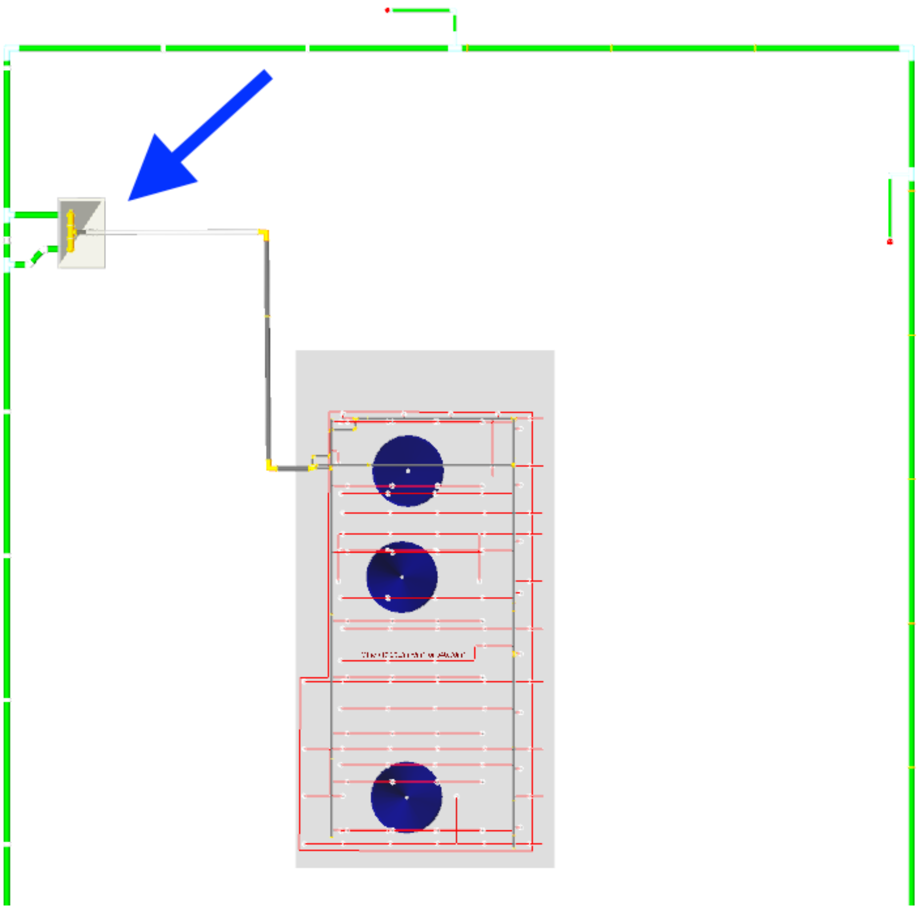


Figure 3.7 – Location of the valve house

The deluge house (represented in Figure 3.8 in an AutoSPRINK drawing and in Figure 3.9 as a scheme) shall meet the following minimum criteria:

- Constructed according to good practice and legal requirements from Energy Performance Building Regulations (EPB);
- Equipped with electrical heating and lighting;
- Door will be located on the north side (for heat radiation purposes).

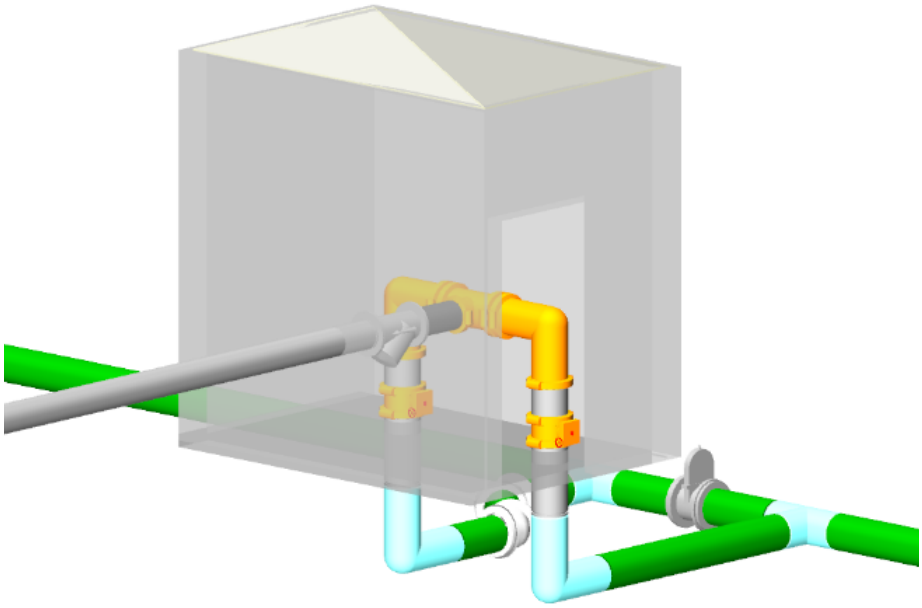


Figure 3.8 – Detail of the valve house

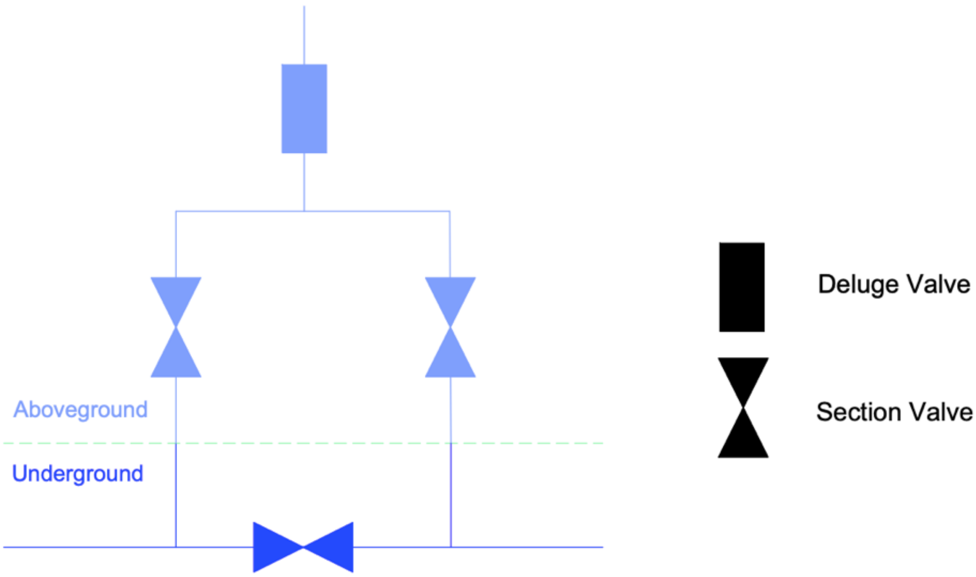


Figure 3.9 – Overview Scheme from the valve house

3.5.5 NOZZLE

The Contactor opted by a nozzle from Tyco – Fire Protection Products, type MV nozzle that are open (non-automatic) directional spray nozzles designed for use in water spray fixed systems for fire protection applications. They are external deflector-type nozzles that discharge a uniformly filled cone of medium velocity water droplets (32).

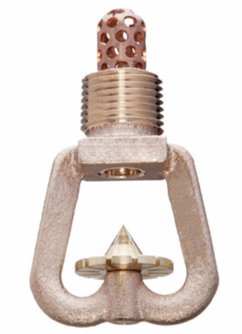


Figure 3.10 – The nozzle used in this project's network (32)

3.5.5.1 Placement

Where direct impingement of water spray onto all of the protected surface is required by the authority having jurisdiction, TYCO Type MV Nozzles are to be spaced and directed so that their spray patterns will completely cover the plane-of-protection with the minimum required average density. However, it is recommended that indoor nozzle spacing be 3,7 m (12 ft) or less and that outdoor nozzle spacing be 3,0 m (10 ft) or less (32).

3.5.5.2 Spray Pattern

The Design Spray Profiles for nozzle spray angles of 90 to 160 degrees are shown in the Figure 3.11 and apply to discharge pressures of 1,4 to 4,1 bar. Discharge pressures in excess of 4,1 bar will result in a decrease in coverage area since the spray patterns tend to draw inwards at higher pressures **(32)**.

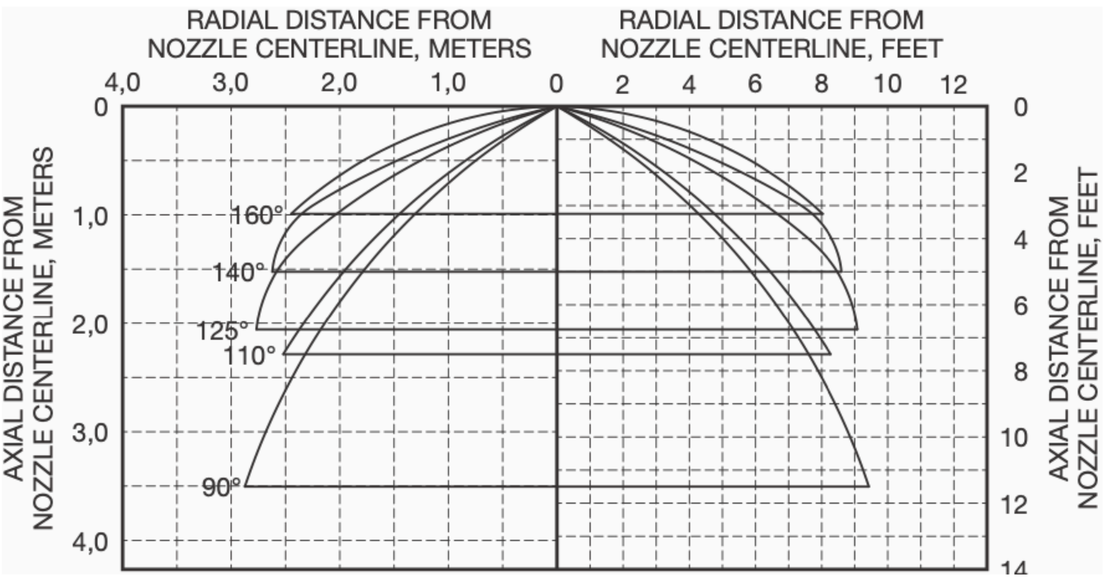


Figure 3.11 – Type MV design spray profiles

3.6 UNDER GROUND (UG) NETWORK

A ring-type fire water underground main is installed in the plant (Figure 3.11). A new loop extending the existing underground fire water main will be installed by the Contractor, connecting the new unit, the loading and unloading area and the storage tank area. The use of loops smaller than 8" (200 mm) is not recommended as per NFPA 24 (33) the pipe supplying hydrants shall not be smaller than 6" (152 mm).

Glass fiber reinforced piping with vinyl ester resins will be used for underground fire-water piping (34). When installing the glass-reinforced epoxy (GRE) and where traffic can negatively impact (e.g. at road crossings) regarding the routing proposed, the Contractor shall provide sleeve pipes to protect the fire-water pipes.

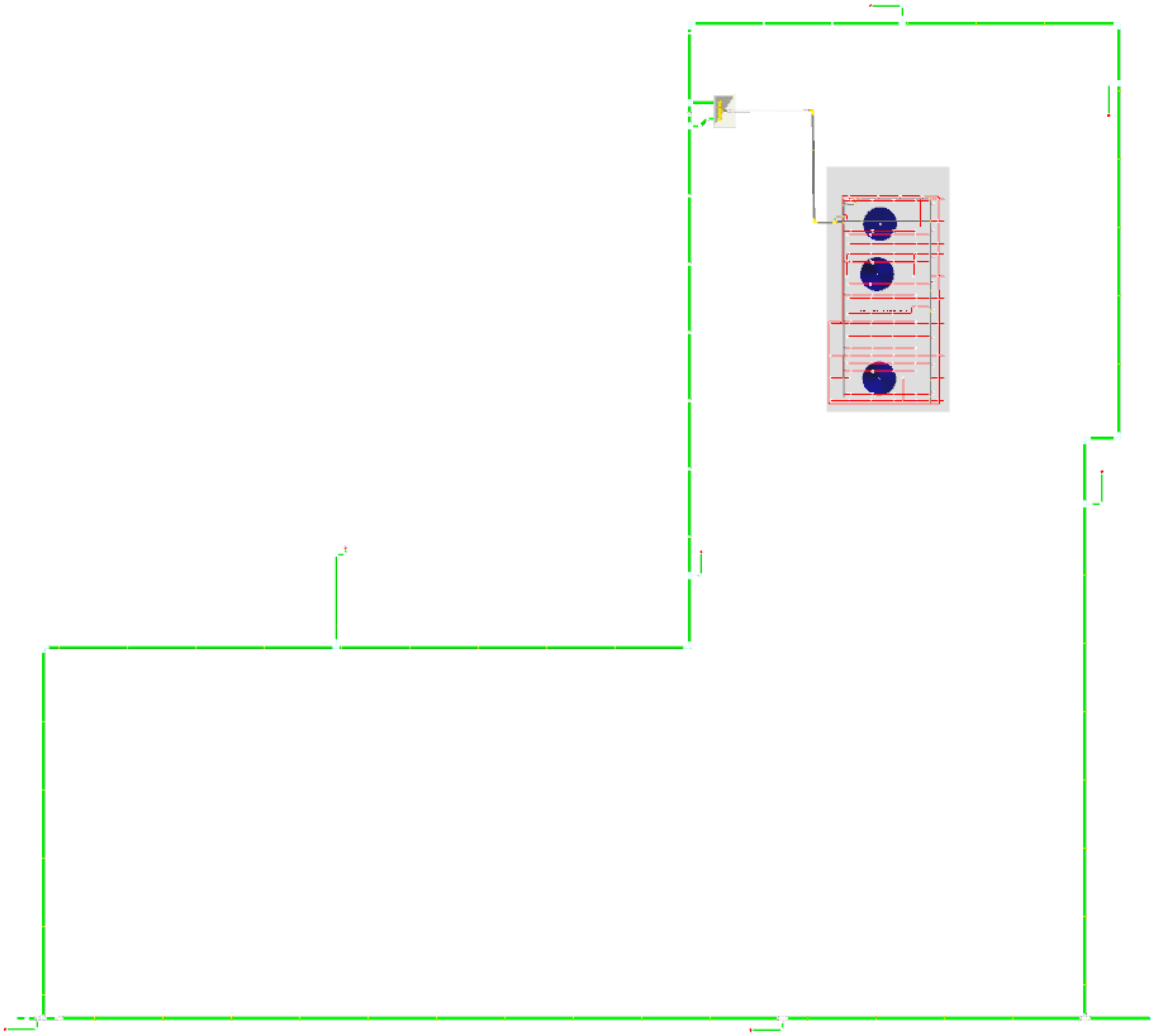


Figure 3.12 – Overview of the underground main ring

3.6.1 HYDRANTS AND FIRE MONITORS

The fire main was equipped with above ground combination units (hydrant/fire monitor as shown in Figure 3.12) located at regular intervals around the chemical plant. The minimum flow required per combination unit is 2000 L/min (35). The proposal shall include four units as a minimum so that the entire structure gets overlapped coverage.

Figure 3.13 – Combination Unit (Hydrant/Fire Monitor) at a chemical plant

The hydrants will be installed in such a way that (Figure 3.13):

- They are unobstructed (within one meter in radius), marked and accessible by emergency response personnel;
- The heat radiation from the fire to be addressed is less than 3 kW/m² at the hydrant;
- A breakaway coupling must be a part of the hydrant;
- The hydrant must be equipped with two 70 mm bronze gate valves with attached 70 mm DSP coupling, with cover and with one 110 mm AR coupling with cover.

Where hydrants/fire monitors and the post indicators of the isolation valves are vulnerable to mechanical damage, they shall be protected with high visibility bollards (Figure 3.13).

Figure 3.14 – Example of post guards protection a hydrant

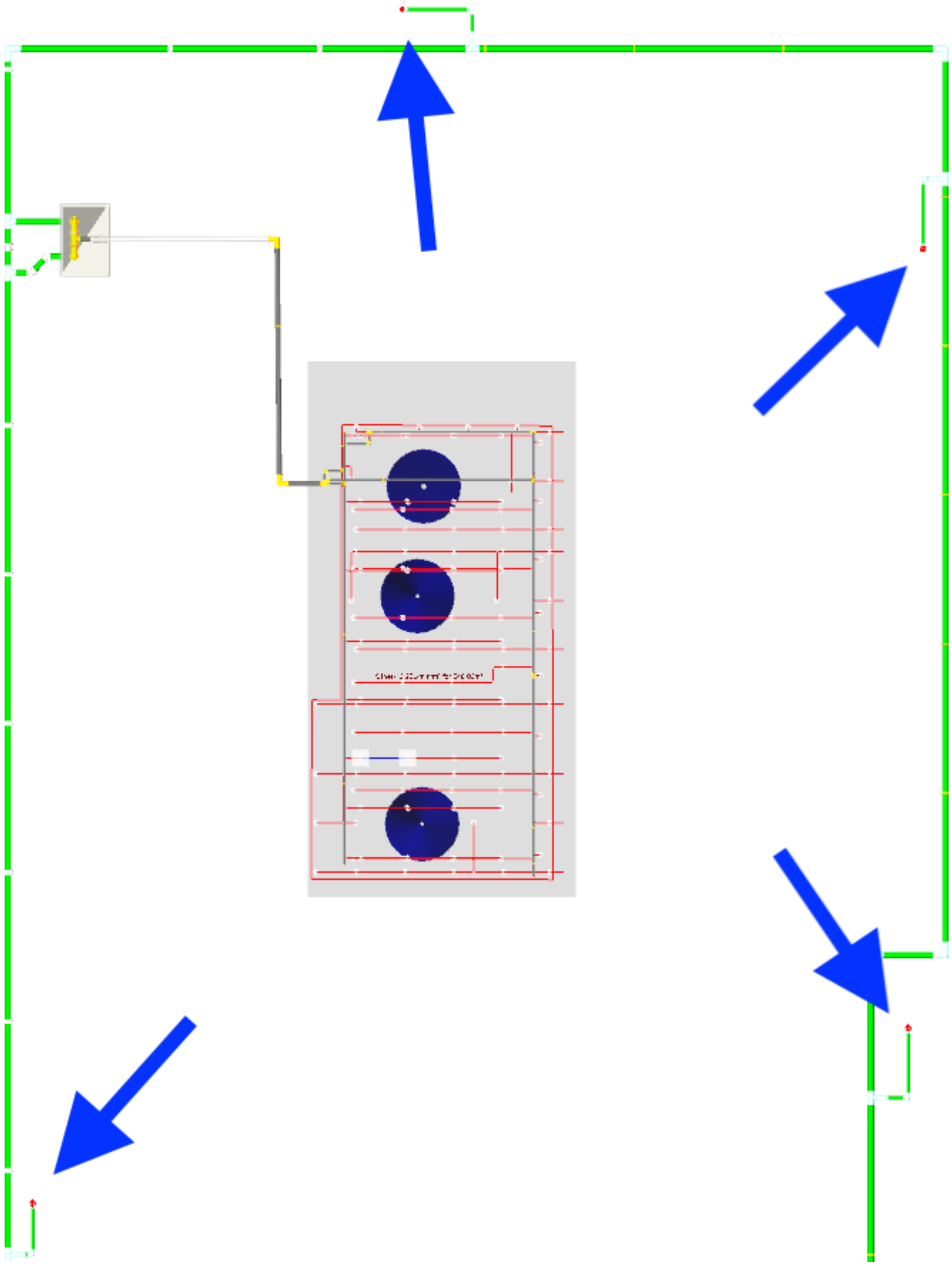


Figure 3.15 – Location of combination units

Hydrants were placed in sufficient number around the storage tank area and the loading and unloading area to provide water spray coverage around the full periphery (Figure 3.14), from at least two directions as per Client regulations.

3.7 PORTUGUESE LEGISLATION

3.7.1 RISK CLASSIFICATION

3.7.1.1 Standard Utilisation (SU)

According to the Portuguese "Legal Regulations for Safety Against Fires in Buildings and Open Spaces" (36), this structure fits in the Standard Utilisation XII, named Industries and Warehouses. It is now imperative to take notice that, for this evaluation, this dissertation's project is not about a building, but about an open structure (Figure 3.15). The entire design process changes thanks to this fact.

Portuguese legislation takes into account, that open spaces have naturally different conditions, and apply softer evaluations. The risk assessment shifts from evaluation two parameters: Modified Fire Load and Number of Stores Occupied above the Reference Level to just the Modified Fire Load (which gets multiplied by two).

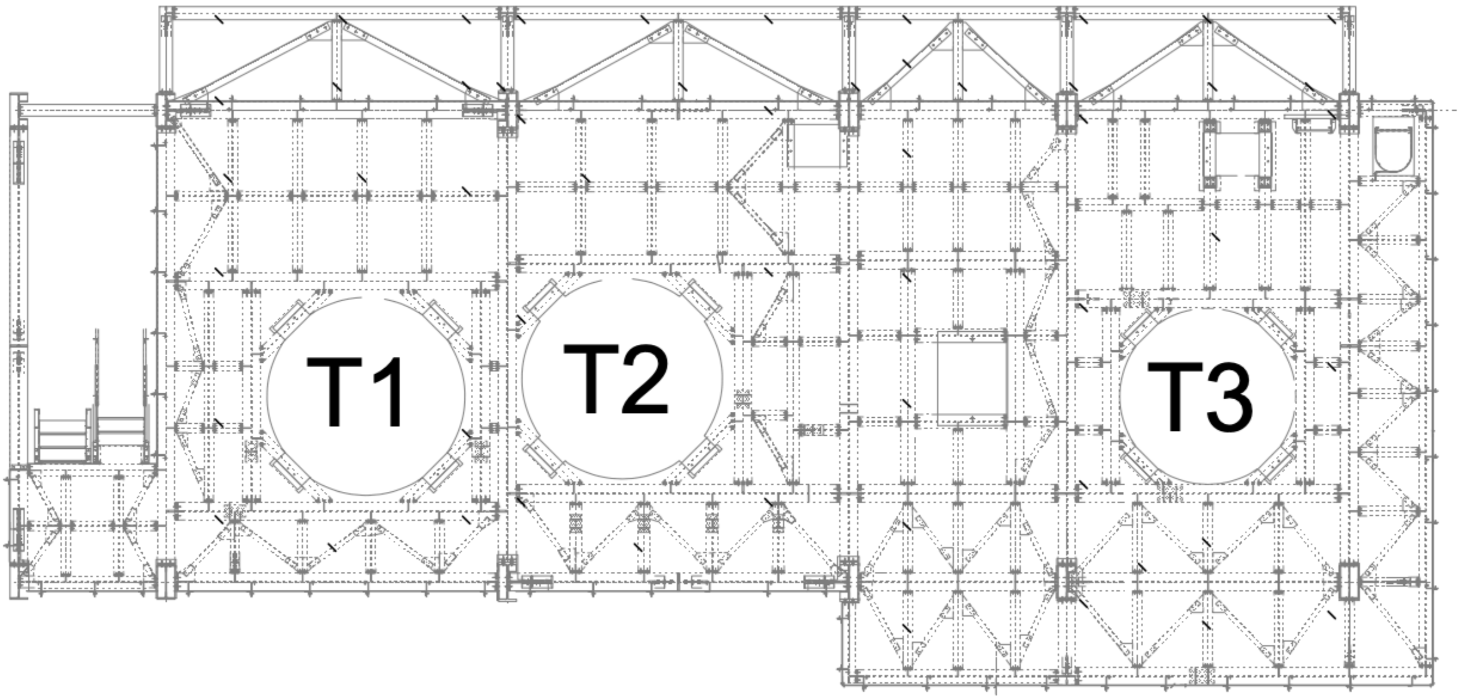
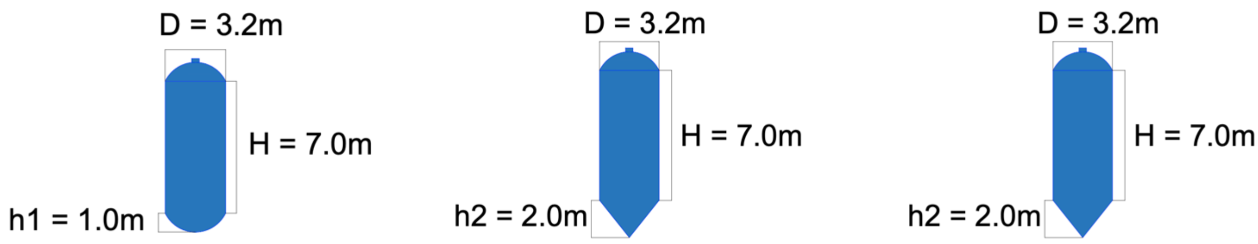


Figure 3.16 – View plant of the first level

In the next table, it was determined the capacities of the three tanks from the alkylation unit. Tank number two and number three are both composed by a main cylinder shell with a bottom part of a conical shape. Tank number one, the pre-treatment section, is also composed by the cylinder but the bottom part is part spherical.

Table 3.3 - Determination of the capacities



Tank 1	Tank 2	Tank 3
$\mathbf{VT1 = Vcylinder + {}^{1}/_{3}\ Vsphere}$	$VT2 = Vcylinder + Vcone$	$VT3 = Vcylinder + Vcone$
$VT1 = \frac{D^2 * \pi}{4} * H + \frac{1}{3}\left(\frac{4}{3} * \pi * r^3\right)$	$VT2 = \frac{D^2 * \pi}{4} * H + \left(\frac{1}{3} * \pi * r^2 * h2\right)$	$VT3 = \frac{D^2 * \pi}{4} * H + \left(\frac{1}{3} * \pi * r^2 * h2\right)$
$VT1 = \frac{3.2^2 * \pi}{4} * 7 + \frac{1}{3}\left(\frac{4}{3} * \pi * 1.6^3\right)$	$VT2 = \frac{3.2^2 * \pi}{4} * 7 + \left(\frac{1}{3} * \pi * 1.6^2 * 2\right)$	$VT3 = \frac{3.2^2 * \pi}{4} * 7 + \left(\frac{1}{3} * \pi * 1.6^2 * 2\right)$
$\mathbf{VT1 = 62\ m^3}$	$\mathbf{VT2 = 62\ m^3}$	$\mathbf{VT3 = 62\ m^3}$

It was considered that the bottom part of Tank 1 was a third of a sphere, confirmed later by the capacity calculation of the three tanks, that is naturally the same.

Table 3.4 – Determination of the heat density (per square meter)

CHARACTERISTICS	Units	Ethylene Oxide (EO)	Propylene Oxide (PO)
Density	kg/m^3	882	882
Heat of Combustion	kJ/kg	-29 076	-33 035
Total Volume	m^3	3 x 62 = 186	3 x 62 = 186
Total Weight	Kg	186 x 882 = 164 052	186 x 882 = 164 052
Heat Release	kJ	-29 076 x 164 052 = 4 769 975 952	-33 035 x 164 052 = 5 419 457 820
Heat Per Square Meter	MJ/m^2	4 769 975 952 / 180 = 26 500	5 419 457 820 / 180 = 30 108

Portuguese regulations have slightly different approaches for activities inherent to SU XI and XII, regarding the fact of being in storage or not. The modified fire load density (q_s), in MJ / m^2, was calculated following Dispatch No. 2074/2009 of January 15 (36) according to the following formula:

$$qs = \frac{\sum_{i=1}^{i=Nai} qsi * Si * Ci * Rai}{\sum_{i=1}^{i=Nai} Si} \quad (MJ/m^2) \quad (3.1)$$

In which:

q_{si} = density of fire load relative to the type of activity (i), in MJ / m^2 (previously calculated);

S_i = area assigned to the activity zone (i), in m^2;
C_i = is the combustibility coefficient, relative to the combustible material in storage area i, dimensionless, whose value depends on the combustibility risk of the material in question, taking the value of 1.60, 1.30 or 1.00, depending on the risk is high, medium, or low, respectively;
R_{ai} = is the activation coefficient, relative to the combustible material in storage area i, dimensionless, whose value depends on the risk of activation of the material in question, taking the value of 3.00, 1.50 or 1.00, depending on the risk is high, medium, or low, respectively

In this case, as the entire structure is dedicated to the same activity there is no need to calculate the Si parameter.

As it is possible to observe in Table 3.3, the presence of Propylene Oxide will be the worst-case scenario in case of a fire, therefore, to determine the structure's risk category, a fire load density of 30 108 MJ/m^2 will be used.

Thus, the density of the modified fire load in the structure was determined, taking into account the following data:

Table 3.5 – Modified Fire Load Parameters

Parameter	Description	Value	Unit
q_{si}	Fire load density	30,108	MJ / m^2
S_i	Area assigned	180	m^2
C_i	Combustibility coefficient	1.6	-
R_{ai}	Activation coefficient	3.0	-
q_s	**Modified Fire Load**	**144,518.4**	**MJ / m^2**

From this data results a modified fire load of 144,518.4 MJ/m^2 as seen in the Table 3.4. Comparing with the limit values of table X of RJ-SCIE [1], it appears that the structure in study falls into the 4th risk category, due to the fact that the modified load density of the fire is greater than 30,000 MJ/m^2.

3.7.1.2 Measures

According to the Technical Note 16 (37), SU XII structures under the 2nd, 3rd or 4th risk category will need Automatic Fire Extinction Systems (AFES), by water, meaning the use of sprinklers. Also, in case of presence of liquid or flammable gases.

Thus, in this project's case, the regulations demand as minimum design criteria (Table 3.6):

Table 3.6 – Design Criteria or Water Fixed Systems

Standard Utilization	Density [l/min/m^2]	Area of Operation [m^2]	Number of Nozzles Working Simultaneously	Calibre of the nozzle [mm]	Discharge Time [min]
XII	10	260	29	20	90

With these characteristics it is possible to conclude that most aspects of the network design would need to be changed. First of all, the area of operation is only 260m^2. As the process unit's structure is composed by three levels of 180 m^2 each, three sprinkler checkpoints would need to be activated. Secondly, the maximum number of nozzles working simultaneously in just 29, therefore that might be the need of breaking up the network again in smaller networks. Finally, NFPA 15 refers one hour as the minimum discharge time applicable as in the Technical Note 16, for SU XII, ninety minutes is advised. One aspect that remains similar is the discharge rate of 10 l/min/m^2 compared to the 10.2 l/min/m^2 the American standard recommends.

4
HYDRAULIC DESIGN

4.1 INTRODUCTION

A project for the execution of a water fire extinguishing network (BIM sprinkler system design) consists of:

- Realistic and specific designed parts and construction details;
- 2D and 3D BIM Modelling - Network layout, location and design characteristics of all its components;
- Maps of quantities and/or cost planning - List of components and characteristics of the piping and accessories;
- Definition and characterisation of the fire pumping group;
- Hydraulic system simulation - Calculation of all Sprinkler networks.

To obtain a high-quality sprinkler network design, the engineer can adopt several strategies being the most common one the following:

1- Identify Hazard Category;
2- Determine Sprinkler Spacing;
3- Determine Piping Arrangement;
4- Calculate amount of water needed per sprinkler;
5- Calculate number and location of open sprinklers in the hydraulically most demanding area;
6- Start at the most remote sprinkler and work towards the water supply calculating flows and pressures;
7- Compare demand with supply.

4.2 ACTIVE FIRE PROTECTION

The protection concept is based on a combination of measures:

- Active fire protection systems, connected to the underground fire water network:
  - Hydrants and fire monitors;
  - Fixed water spray systems (stage four of Figure 4.1);
  - Mobile firefighting (design by the client).
- Fire and gas detection and alarm system.

4.2.1 WATER SPRAY SYSTEM

According to the standard in use, open water spray nozzles shall be used. The selection of the type and size of spray nozzles shall be made with proper consideration given to such factors as discharge characteristics, physical character of the hazard involved, ambient conditions, material likely to be burning, and the design objectives of the system (10).
Water spray nozzles shall be permitted to be placed in any position, within their listing limitations, necessary to obtain proper coverage of the protected area. The positioning of water spray nozzles shall include an evaluation of all the following factors (38):

- The shape and size of the area to be protected;
- The nozzle design and characteristics of the water spray pattern to be produced;
- The effect of wind and fire draft on very small drop sizes or on large drop sizes with little initial velocity;
- The potential to miss the target surface and increase water wastage;
- The effects of nozzle orientation on coverage characteristics;
- The potential for mechanical damage.

The design of the water spray system and the application rate will depend on the fire risk. For areas with a lower risk of fire, an application rate of 10.2 L/min.m² will be assigned (10)). The main design parameters are summarised in Table 4.1.

Table 4.1 - Application rates for water spray systems

Area	Water Spray System	Application Rate [(L/min)/m^2]	Discharge Time (minutes)
Modular Unit	At all levels	10.2	60
Pipe Rack	At all levels	10.2	60

On the modular unit, the protection will be used as well to avoid a toxic cloud escape, and therefore the design shall be to cover the entire equipment. For the pipe rack, the flanges will be protected by a water spray system activated by a single deluge valve.

4.2.2 'WORST CASE' SCENARIO

To determine the maximum water capacity, the 'worst case' scenario has to be identified. For the 'worst case' it is considered that when a fire in the modular unit occurs, the water spray system of the three levels will be activated simultaneously to avoid toxic cloud release and apply water cooling over the entire equipment surface.

To determine the maximum fire water demand, the following protection systems are taken into account:

- Water spray system of the modular unit + pipe rack (in accordance with the standard, the maximum discharge from a deluge system should not be greater than 11355 l/min (39));
- Additional operation of two hydrants/monitors (120 m³/h per monitor).

4.3 CALCULATIONS

The Calculator tab (Figure 4.1) is divided into several dialogue boxes, each containing options for defining the hydraulic calculation method, sprinkler pressure minimum, maximum velocity pressure, hydraulic elevation datum, and riser tag counting method (40).

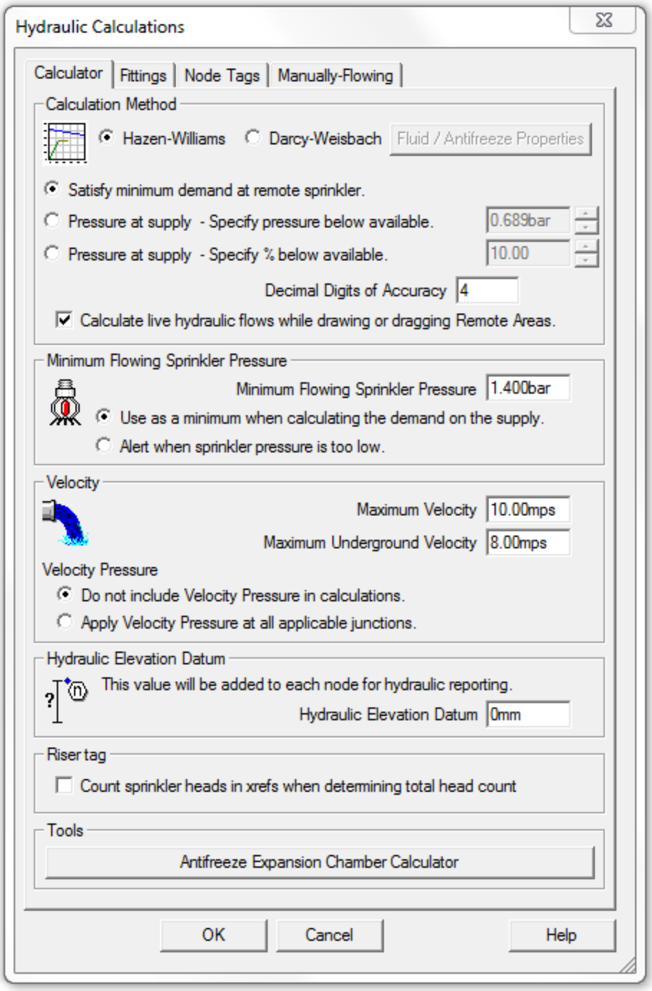


Figure 4.1 – Hydraulic Settings Calculations Tab

The Hydraulic Calculations dialogue features four tabs (Calculator, Fittings, Node Tags and Manually Flowing) with adjustable characteristics for the Calculation Method, Sprinkler Pressure, Hydraulic Loss at Fittings, Node Tag placement and individual definitions for manually flowing. Changing any of the options on these pages will force a regeneration of the Hydraulic data for the reports. See the topics for each individual page for more information [adapted from (40)].

According to NFPA 15 8.1.2, the minimum operating pressure of any nozzle protecting outdoor hazards shall be 20 psi (1.4 bar) (41). Due to a long experience in the field and designing this kind of networks, the Contractor opted to use as minimum pressure 1.8 bar instead of the 1.4 bar.

4.3.1 Calculation Method

AutoSPRINK allows the use of two hydraulic calculation methods: Hazen-Williams and Darcy-Weisbach. Hazen-Williams is the default choice; however, if anything other than water at normal temperature is to be used in the drawing, Darcy-Weisbach must be used. When this calculation method is first selected, it will default to calculate the system as if it was water at normal temperature (40). It is important that if there is a fluid used, that is different from water the designer show go to Fluid/Antifreeze Properties tab and configure according to the properties of the liquid.

By default, the first calculation method option is selected: Satisfy minimum demand at the most remote sprinkler. If desired, either of two last options that define the pressure at the water supply can be chosen. In either case, users must insert the pressure amount or percentage of pressure below the available supply. Four decimal digit-accuracy is an editable field should users need fewer (or more) digits of accuracy. By default, the last option is selected, which will calculate live hydraulic flows while drawing or dragging Remote Areas in the drawing (40).

In the Figure 4.2 below, it is possible to see one of the first remote areas being drawn on the first level of sprinklers. It was a test done on a very early design period. On the top left-hand side corner, it is possible to see a live system demand graph forming, while the red rectangle, the Remote Area, is being dragged downwards.

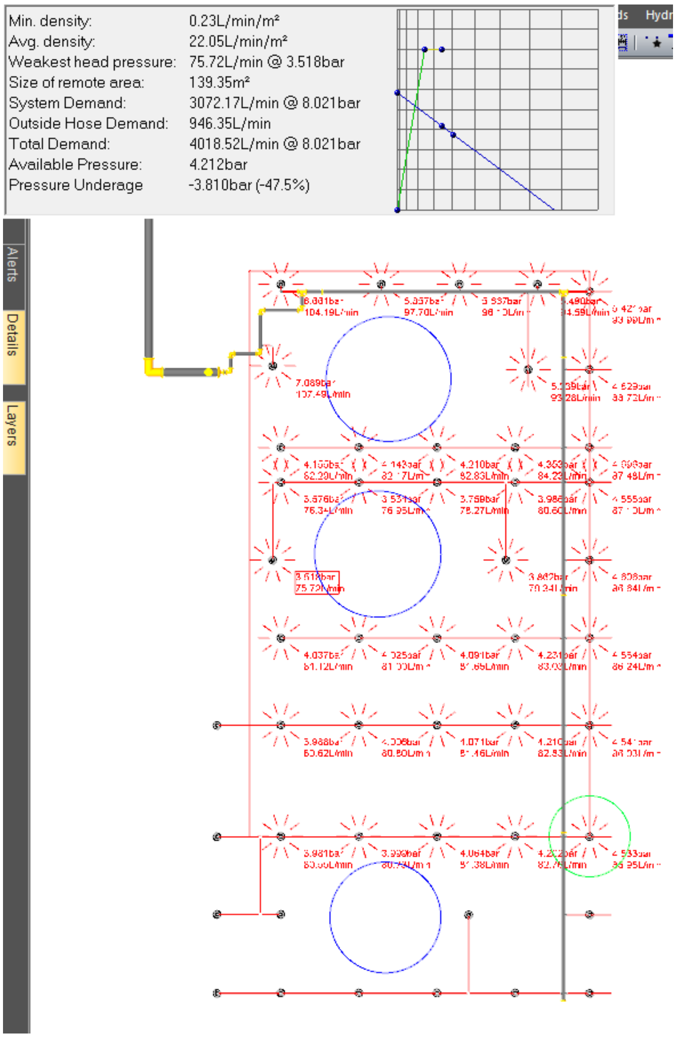


Figure 4.2 – Example of a Remote Area

Using the Darcy-Weisbach calculation method will automatically adjust all sprinklers' K-factors according to what is necessary to keep the correct pressure per the calculations. This change, however, is not visible in sprinklers' properties. It is only visible in the Analysis Reports (40).

When calculating the demand on the water supply, the user should specify the minimum flowing nozzle pressure in the field (1.8 bar in this case).

The option of choosing, whether or not, to include velocity pressure in Hydraulic Calculations is from the user. If so, the maximum velocity and maximum underground velocity has to be set. As in this case, it was not possible to get this information, velocity pressure was not considered in the calculations.

If desired, the user-specified elevation value can be added to each node tag and will be calculated in the Hydraulic Reports. By default, it is set at zero elevation, so, unless adjusted, will remain at zero elevation for the reports (40).

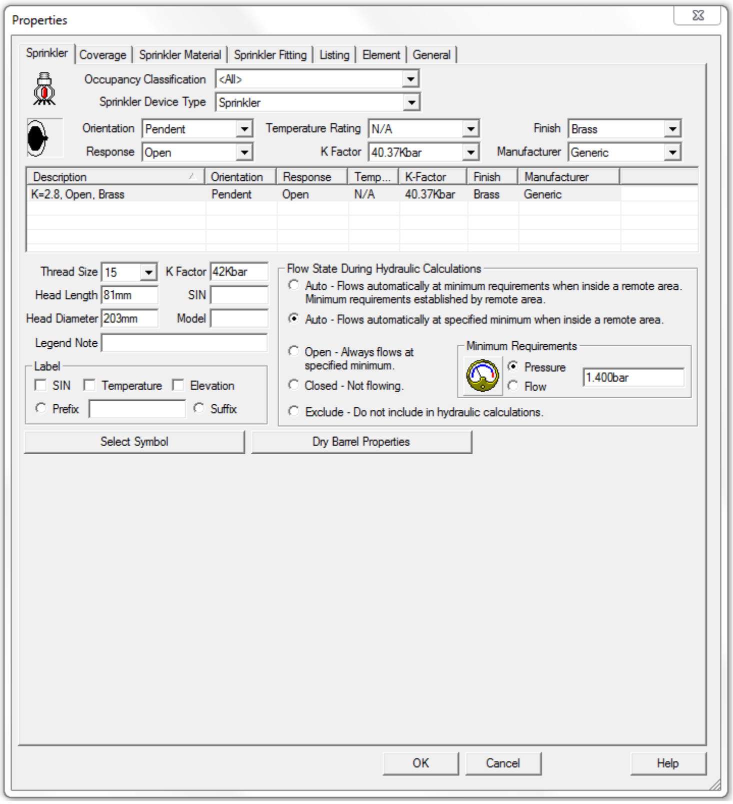
4.3.1.1 Relevant Design Characteristics

Before running the hydraulics calculations, there are still some parameters that have to be set. The nozzle characteristics inputted was based on the information available from the Contractor.

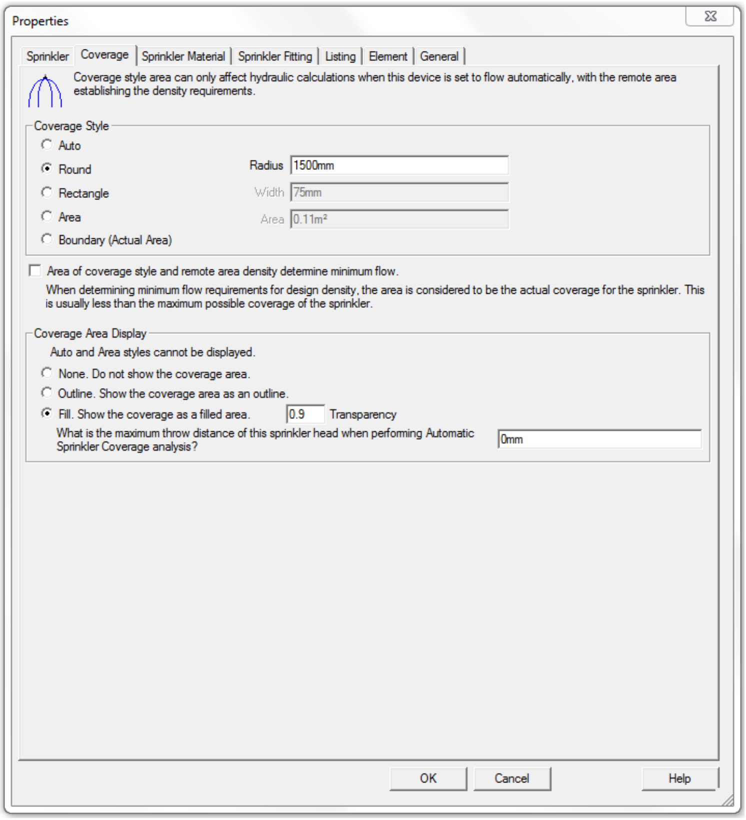
Table 4.2 – Overview of the sprinklers' characteristics

Characteristic	Input	Units
Device Type	Sprinkler	-
Orientation	Open	-
Temperature	N/A	ºC
Finish	Brass	-
Thread Size	15	Millimetres
Head Length	81	Millimetres
Head Diameter	203	Millimetres
K Factor Sprinkler 1	28.8	Kbar
K Factor Sprinkler 2	31.7	Kbar
K Factor Sprinkler 3	36.0	Kbar

In the next two images, Figure 4.3 a) and Figure 4.3 b), it is possible to see the menus where the user is able to decide and later change sprinkler's properties. Among these definitions, the designer is able to change all the existing characteristics such as type of nozzle, orientation, response and K factor. This information is based on a limited number of manufactures that have uploaded their catalogue into AutoSPRINK. Like in this case, the materials that the Contractor used were not present at the database, the software lets the user overwrite all values.



a)



b)

Figure 4.3 – Nozzles a) and Coverage b) Properties Tabs

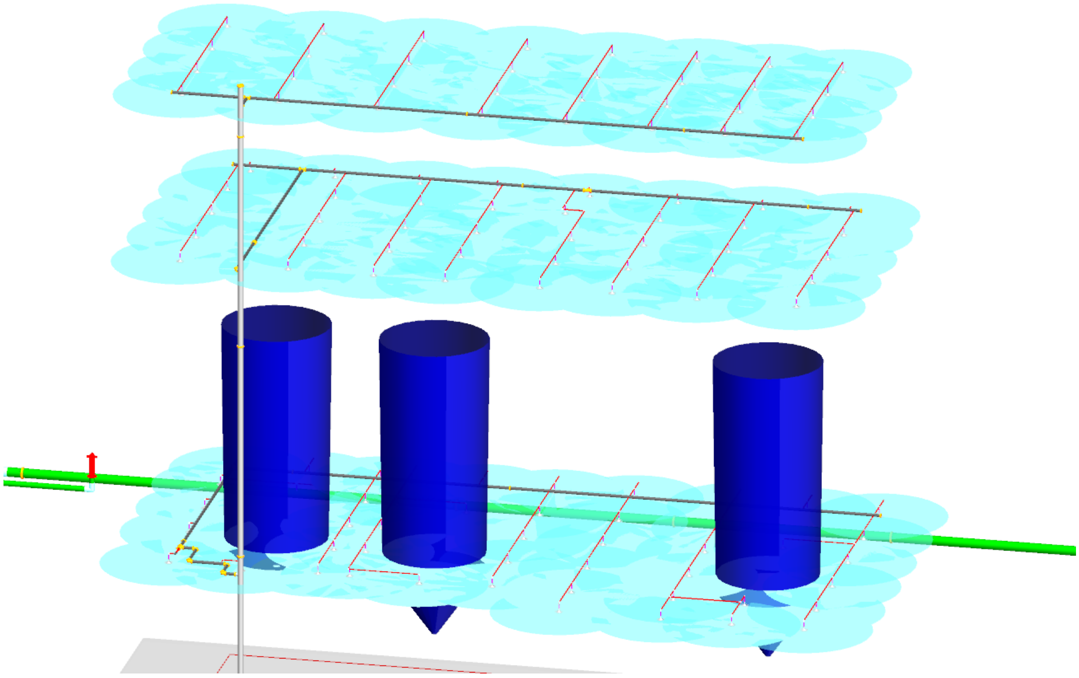


Figure 4.4 - Sprinkler coverage area at all levels

As it is possible to see in Figure 4.4 above, there are no blind spots regarding water coverage by the three levels of the sprinkler network.

4.3.2 HYDRAULIC CALCULATION PROCEDURES

According to NFPA 15, sub chapter 8.3, hydraulic calculations shall be prepared on forms that include a summary sheet, detailed worksheet, and a graph sheet. The summary sheet (is it possible to find an example in Annex B of the standard) shall contain all of the following information where applicable:

- The date;
- The location;
- The name of the owner and occupant;
- The building or plant number;
- A description of the hazard;
- The name and address of the contractor and calculator;
- The name of the authority having jurisdiction;
- The design purpose;
- The rates of the water application (density) and applied areas in L/min)/m^2;
- The total system water requirements as calculated, including allowance for hose streams;
- The total designed water demand with number of systems designed to operate simultaneously at a reference point, preferably the source of supply, including hose streams and other fire protection equipment;
- Water supply information.

The Detailed worksheets or computer printout sheets (for sample worksheet, consult Annex B of the present standard), shall contain all of the following information:

- Sheet number, date, job number, and identification of calculations covered;
- Description of discharge constant (K) (or provide the discharge curve or tabulation) for each nozzle type;
- Hydraulic reference points;
- Flow in gpm (L/min);
- Pipe size in in. (mm);
- Pipe lengths, center to center of fittings (or cut lengths) in ft (m);
- Equivalent pipe lengths for fittings and devices in ft (m);
- Friction loss in psi (bar) between reference points;
- Total friction loss in psi (bar) between reference points;
- Elevation head in psi (bar) between reference points;
- Required pressure in psi (bar) at each reference point;
- Velocity pressure and normal pressure if included in calculations;
- Notes to indicate starting points, reference to other sheets, or to clarify data shown;
- Combined K-factor calculations for nozzles on drops, armovers, or sprigs where calculations do not begin at a nozzle;
- Where extending existing equipment, hydraulic calculations indicating the previous design, volume, and pressure at points of connection, and adequate additional calculations to indicate effect on existing systems.

Water supply curves and system requirements, plus hose demand if required, shall be plotted to present a graphic summary of the complete hydraulic calculation.

The following information shall be included on the plans and calculations:

- Location and elevation of static and residual test gauge, with relation to the system actuation valve reference point;
- Flow location;
- Static pressure, psi (bar);
- Residual pressure, psi (bar);
- Flow, gpm (L/min);
- Date;
- Time;
- Source of water flow test information;
- Other sources of water supply, with pressure or elevation.

4.3.3 FORMULAS

4.3.3.1 Friction Loss

Pipe friction losses shall be determined on the basis of the Hazen-Williams formula:

$$P_m = 6.05 * \frac{{Q_m}^{1.85}}{C^{1.85} * {d_m}^{4.87}} * 10^5 \qquad \text{(in SI units)}$$

Where:

- Pm = frictional resistance (bars per meter of pipe);
- Qm = flow (L/min);
- C = friction loss coefficient;
- dm = actual internal diameter (mm).

4.3.3.2 Velocity Pressure

The velocity pressure shall be determined on the basis of the formula:

$$P_v = \frac{0.001123 * Q^2}{D^4} \qquad \text{(U.S. units)}$$

Where:

- Pv = velocity pressure (psi);
- Q = flow (gpm);
- D = inside diameter (in.).

4.3.3.3 Normal Pressure

Normal pressure shall be determined on the basis of the formula:

$$P_n = P_t - P_v$$

Where:

- Pn = normal pressure [psi (bar)];
- Pt = total pressure [psi (bar)];
- Pv = velocity pressure [psi (bar)].

4.3.3.4 Nozzle Discharge

The discharge of a nozzle shall be calculated by the formula:

$$Q_m = K_m * \sqrt{P_m}$$

Where:

- Qm = flow (L/min);
- Km = nozzle K-factor (where Km equals 14.4 K);
- Pm = total pressure at flow Qm (bar).

As some of the original formulas are not updated to SI units, it is possible to find the conversions in the Table 4.3 next page.

Table 4.3 - Conversion from US to SI units

U.S. Units	S.I. Units
1 psi	0.06895 bar
1 gpm	3.79 lpm
1 in	25.4 mm

4.3.3.5 Equivalent Pipe Lengths of Valves and Fittings

Table A.1 shall be used to determine equivalent lengths of valves and fittings, unless the manufacturer's test data indicates that other factors are appropriate. Table A.1 shall be used with a Hazen-Williams C factor of 120 only. For other values of C, the quantities in Table A.1 shall be multiplied by the factors given in Table 4.4.

Table 4.4 – C Value Multipliers for valves and fittings

Hazen-Williams C Value	Multiplying Factor
100	0.713
120	1.00
130	1.16
140	1.33
150	1.51

4.3.3.6 Pipe Friction Loss

Pipe friction loss shall be calculated in accordance with the Hazen-Williams formula, using C values as shown in Table 4.5, and using the actual internal pipe diameter in the formula. Different C values shall be permitted to be used where required by the authority having jurisdiction.

Table 4.5 – C Value Multipliers por pipes

Pipe or Tube	Hazen-Williams C Value
Unlined cast or ductile iron	100
Black steel (wet systems including deluge systems)	120
Black steel (dry systems including preaction systems)	100
Galvanized steel (wet systems including deluge systems)	120
Galvanized steel (dry systems including preaction systems)	100
Cement-lined cast or ductile iron	140
Copper tube or stainless steel	150

5
Water and Foam Fire Fighting

5.1 INTRODUCTION

With the rapid development of the chemical industry, the demand for petrochemical products increases dramatically. The oil depot's scale has expanded dramatically compared with a ten years ago. The crude oil tank farm has been drawn attention because of its serious consequence of fire or explosion. On July 16, 2005, a powerful fire and explosion devastated the thing farm of Dalian Petrochemical Company, which revealed the weakness of firefighting emergency capabilities in the tank farm. Firefighting emergency system in a tank farm plays a vital role in dealing in dealing with the fire and explosion, which will escalate the scale of the accident if the system loses out of control (42).

Information about likelihood of fire incidents in chemical or process plants (Figure 5.1) are hard to find. For industrial buildings fire frequency is $6.4*10^{-6}$ [$1/m^2/a$] referred to figures from Finland [Tillander K., 2003]. In comparison fire frequency of residential buildings is $4.7*10^{-6}$ [$1/m^2/a$], which means fire probability is 25% lower related to area. Assuming the area of mid-sized chemical plant of 5000 m^2 the probability of fire is 2.5% per year or statistically every 40 years a fire incident hits the plant (43).

The regular investigations of incidents and losses led to better understanding of process hazards and influenced best practice and legislation in a positive way.

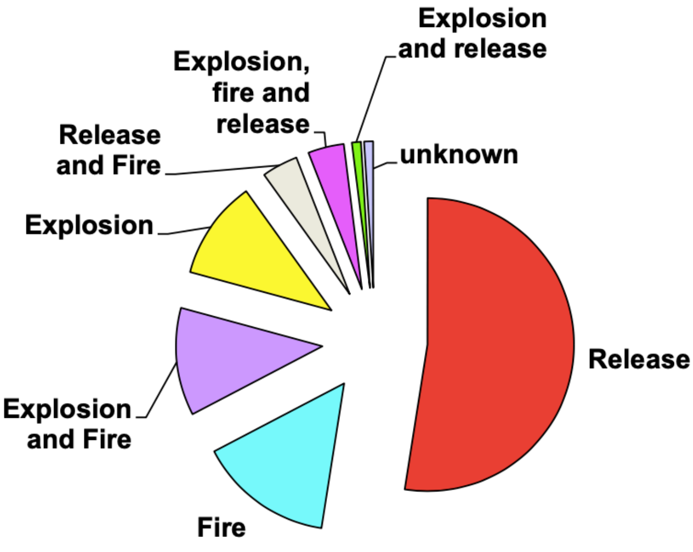


Figure 5.1 - Consequences of major accidents in process engineering facilities (43)

5.1.1 Storage Tanks

5.1.1.1 Open-top, Floating Roof Tank

Open-top, floating-roof tanks, as described in the API Standard 650 (44), have either a single deck, which has a pontoon to keep the roof deck afloat, or a double deck floating-roof, or some other approved flotation device. In Figure 5.2 shows an example of a pontoon single deck and a double deck installed in an open-top, floating-roof tank. There is a flexible seal around the rim of the floating roof to prevent liquid leakage onto the top of the roof. Sealing devices include rubber or foam tubes, spring-loaded fabric and pantograph mechanisms.

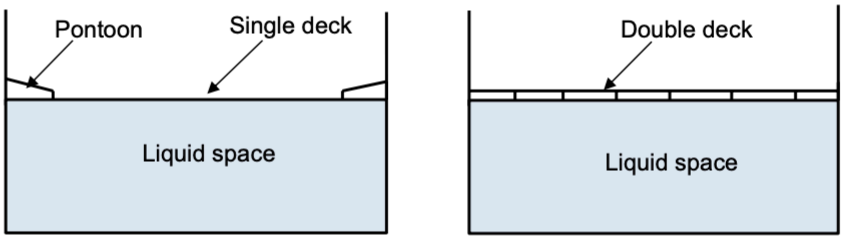


Figure 5.2 - Example of the open-top, floating-roof tanks (45)

Although there is no specific ignition source normally present in the space above the roof, various sources will exist, particularly if a major fire incident is occurring nearby. These ignition sources might include:

- Hot soot particles that may fall out of smoke arising from the nearby tank fire;
- Radiant heat may raise the temperature of the wall above the floating-roof (if it is not cooled) or the temperature of the floating-roof to a degree sufficient for ignition to take place;
- Emergency pumping out of the tank, if its roof has tilted due to vapour generation, can lead to frictional heating or sparking.

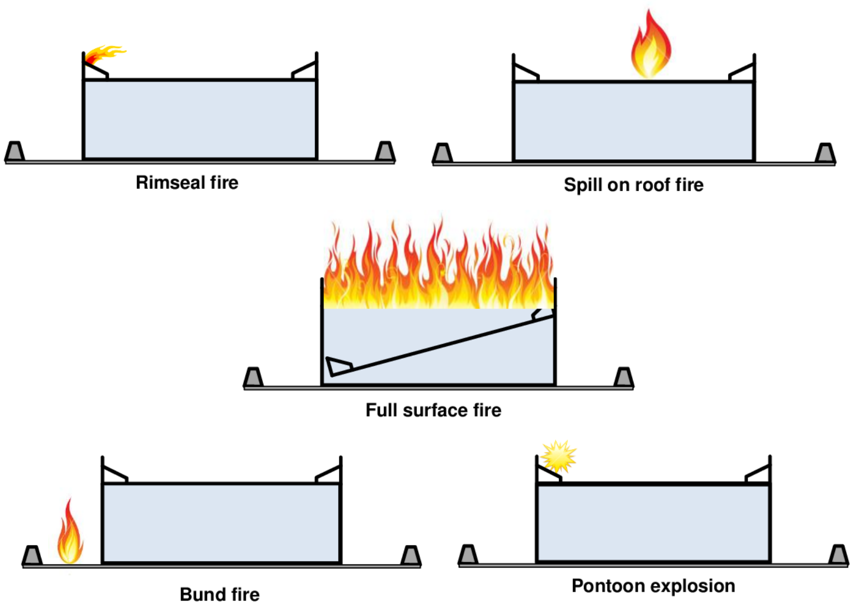


Figure 5.3 - Possible fire scenarios that might occur in an open-top, floating-roof tank (45)

In Figure 5.3, it is shown the possible fire scenarios that might occur in an open-top, floating roof tank.

5.1.1.2 Internal, Floating Roof Tank

The design of an internal, floating-roof tank is a tank that has a floating roof, which is protected by another fixed roof against the weather or for environmental control. In Figure 5.4 it is shown a typical example of an internal, floating-roof tank. During the filling operation, flammable mixture can be present in the vapour space between the floating roof and the fixed roof. Recent updates of the LASTFIRE (46) study confirmed that fixed-roof tanks fitted with an internal floating roof have a very low probability of suffering an internal fire. However, this type of tank is more vulnerable to explosion, due to the presence of an explosive mixture between the two roofs (45).

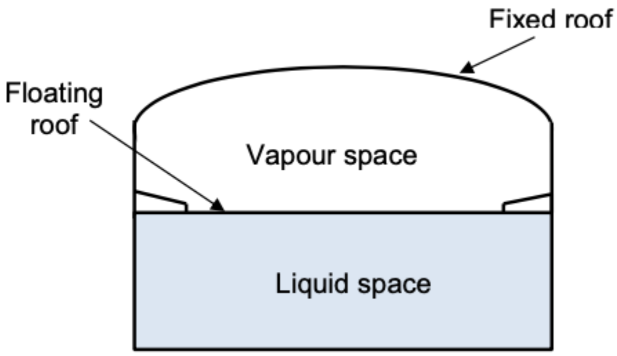


Figure 5.4 - example of an internal, floating-roof tank (45)

In Figure 5.5, it is shown the possible fire scenarios in an open top floating roof tank. As the vents are the only area in contact with the exterior, it is the most likely place where a fire can occur.

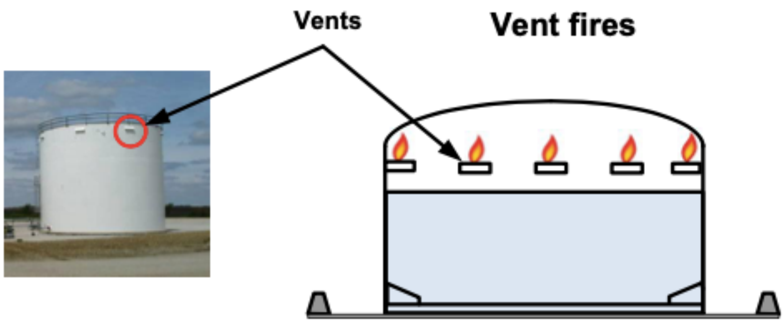


Figure 5.5 - Possible fire scenarios for an internal, floating-roof tank (45)

5.1.1.3 Fixed Roof Tanks

The fixed-roof tank is the least expensive to construct and is generally considered the minimum, in terms of acceptable equipment for the storing of petroleum products. A typical fixed-roof tank, as shown in Figure 5.6, consists of a cylindrical wall with a dome-shaped, fixed roof, which is permanently fixed to the tank wall. The fixed-roof tank is normally used to store low volatility, high flashpoint liquids, such as kerosene.

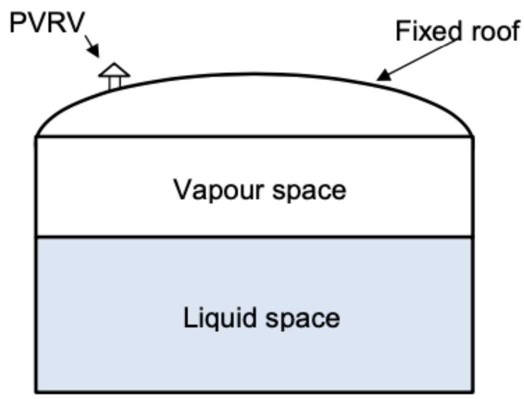


Figure 5.6 - Typical fixed-roof tank: the fixed roof may be a cone shape or a dome shape (45)

The consequences of fixed-roof tanks being exposed to fire are, initially, quite different from those associated with floating-roof tanks: radiant heat from an adjacent tank fire will enter through the wall and will be absorbed by both vapour and liquid (Figure 5.7) (45).

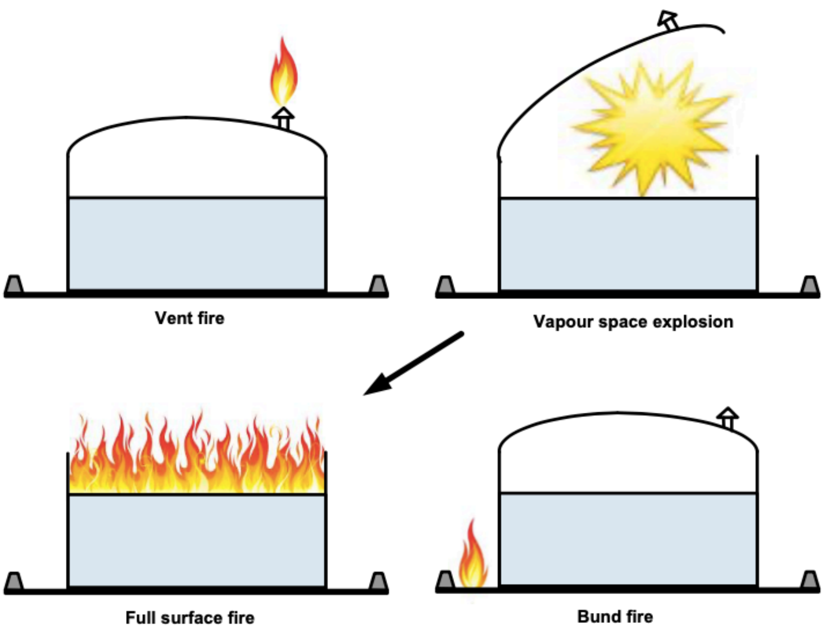


Figure 5.7 - Possible sequence of fire scenarios for a fixed-roof tank (45)

5.1.2 Ignition Sources

According to the most recent fire statistics (47) from the National Fire Protection Association, between 2011 and 2015, U.S. municipal fire departments responded to an estimated average of 37,000 fires at industrial and manufacturing properties, every year.
These incidents result in:

- 18 civilian deaths;
- 279 civilian injuries;
- $1 billion in direct property damage.

Figure 5.8 - Buncefield tank farm fire, which occurred on the 11th December, 2005, in Hertfordshire, England (48)

These disasters happen for many reasons, and the most common are (45):

- Lighting;
- Hot Work;
- Spontaneous Ignition;
- Electrostatic Electricity;
- Exposure to Radiant Heat.

5.1.2.1 Lightning

Lightning is by far the most frequent source of ignition, with regards to the occurrence of fires within floating-roof storage tanks. In the LASTFIRE (46) incident survey study from 2012, it was reported that 52 of the 62 initial fire events within the scope of the survey were lightning-ignited rim-seal fires.

5.1.2.2 Hot Work

There are several incidents where hot work, such as welding or grinding, is identified as the ignition source for fires: two rim seal fires recorded in the LASTFIRE incident survey from 1997, started as a result of hot work on live tanks. In these cases, heat from welding caused flammable vapours to be emitted from hydrocarbon deposits, or sparks were carried from gas free areas into regions where there were flammable mixtures (45).

5.1.2.3 Spontaneous Ignition

Zalosh (2003) mentioned that the spontaneous ignition of a fuel vapour/air mixture can be caused by pyrophoric iron sulphide on the tank walls, which is formed by a slow reaction between the tank wall and the hydrogen sulphide present in some petroleum liquids: the reaction can be faster under moist and oxygen deficient atmospheres (45).

5.1.2.4 Electrostatic electricity

In the LASTFIRE (46) incident survey the electrostatic electricity has been postulated as the source of ignition in several fires that have occurred when foam has been placed onto tanks, upon discovery that the roof has sunk or partially sunk. The same study reported that the electrostatic discharge may occur if the electrical bonding between the roof and shell of the tank or the earthing of the tank are inadequate (45).

5.1.2.5 Exposure to Radiant Heat

Radiant heat is the dominant mode of heat transfer, in terms of the spread of flames within premises (Karlsson and Quintiere, 2000). However, in the reviewed tank fire incidents, radiant heat was not the prime means of ignition of atmospheric storage tank fires, however, it is still the main cause for escalation. An earlier compilation of API storage tank incidents in 1976 stated that 6% of the incidents reviewed were ignited by exposure to fires (Zalosh, 2003). In a historical incident review of atmospheric storage tank fires, carried out by Pitblado et al. (1990), 5% of 85 tank fires were ignited by exposure to radiant heat from an external fire (45).

5.2 FIRE PROTECTION OF TANKS

There are many causes and types of tank fires. In general, storage tanks pose a significant potential risk to life and property. In most cases, the risk factor is substantial, due to the relatively large quantities of fuels or unstable liquids that are stored in one location. For this reason, fire protection principles have been incorporated into the engineering codes and standards and many industries have generated additional practices that are more conservative than those specified by the engineering codes (45).

5.2.1 WATER COOLING SYSTEMS

Cooling of an adjacent atmospheric storage tank wall and roof is an effective means of maintaining temperatures within acceptable limits that will not cause the steel to collapse, the flammable vapours to be discharged to the atmosphere or the hot surfaces to form a source of ignition (45).

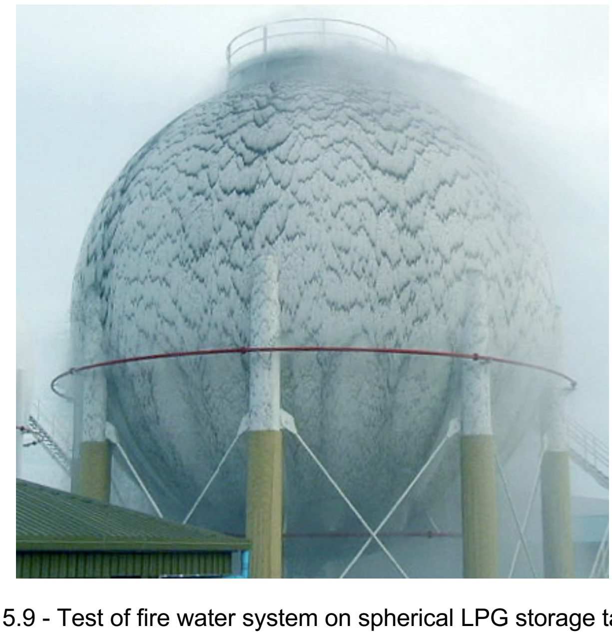


Figure 5.9 - Test of fire water system on spherical LPG storage tank (49)

5.2.1.1 Water Spray and Deluge Systems

Water spray and deluge system is the most efficient method of delivering water to the outside roof and wall of the fixed-roof storage tank and there are two principal ways of accomplishing this:

a) Using concentric rings of piping supported about 0.3 m above the roof. These rings are fitted with spray nozzles that form overlapping spray pattern to cover the whole roof with water. The wall is similarly protected, usually with one spray ring at the top of and about 0.6 m clear of the wall. Spray nozzles are fitted to this ring and are angled down slightly, in order to direct the spray of water over the whole circumference so that it can run down the wall.

b) The deluge system consists of a single water main being led to the tank roof, where the water is directed vertically onto the roof and is evenly spread over the roof, through the use of a conical nozzle at the end of the outlet pipe or a coronet attached to the roof plating. As the water streams down the roof, it is directed onto the wall by splash plates fitted to the edge of the wall: these plates are angled so that, as the water hits them, it is directed against the wall and thus runs down the wall.

These systems can be fed from a water deluge valve, which is automatically triggered by some form of electric, pneumatic or hydraulic system following fire detection (45).

5.2.1.2 Fixed and Trailer Mounted Water Monitors

Both fixed and trailer mounted water monitors are a cost-effective means of delivering water to cool storage tanks and the number, capacity, position and distribution of such monitors depends upon individual site requirements. However, problems with access and local water supply considerations must be taken into account, when considering the introduction of water monitors (45).

5.3 FOAM SYSTEMS

Foam is an aggregate of air-filled bubbles formed from aqueous solutions which is lower in density than flammable liquids. It is used principally to form a cohesive floating blanket on flammable and combustible liquids and prevents or extinguishes fire by excluding air and cooling the fuel. It also prevents reignition by suppressing formation of flammable vapors. It has the property of adhering to surfaces, which provides a degree of exposure protection from adjacent fires (50).

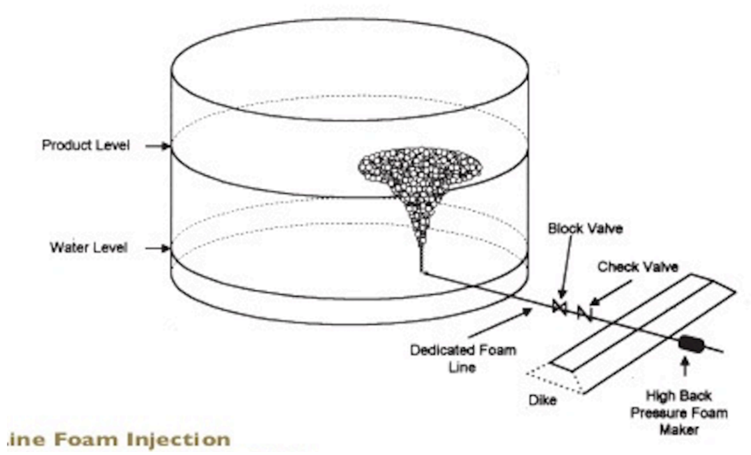


Figure 5.10 - Base Injection Method (51)

Foam methods are the most widely used firefighting system, as it is believed that they provide an acceptable overall level of protection. Foam fire-fighting systems, work by the introduction of a foam making concentrate into the firefighting water main. This produces a solution, which is fed to a foam generator, and the resulting foam is directed onto the fire. For fixed-roof, open-top, floating-roof and internal, floating-roof storage tanks, there are three principle foam systems available: these are base injection (Figure 5.10), top foam pouring (Figure 5.11) and foam monitors (Figure 5.13).

Figure 5.11 - Discharge outlets working in an Open top Floating Roof Tank (52)

5.3.1 TOP POURING SYSTEMS

As top foam pouring systems are the safest and most used systems, they are going to be the only explained. These systems are used to protect fixed-roof and internal, floating-roof storage tanks. In each case, the systems are designed on the basis that the fire risk involves the total surface area of the stored product. The system operates by introducing the foam making concentrate into the firefighting water feed line outside the tank bund area. This line is led to a foam generator, foam box and pourer, all of which are mounted in line at the top of the tank wall, as shown in Figure 5.12. When initiated, the foam solution is propelled to the tank, where the foam generator aerates the solution and delivers the resulting foam through a bursting disc in the foam box. A pourer unit immediately inside the tank wall and connected to the foam box directs the foam down the wall to form a blanket, which extinguishes the burning product.

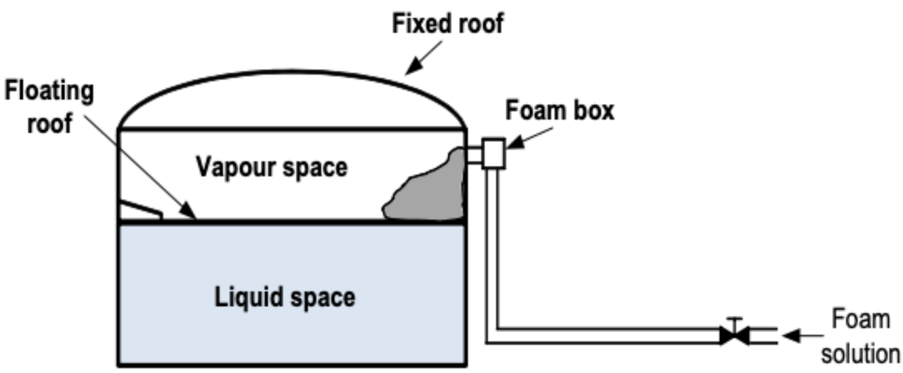


Figure 5.12 - Firefighting foam Top Pouring System (45)

5.3.2 Foam Monitors

Fixed and trailer mounted foam monitors are suitable for protecting all types of vertical storage tanks and, although subject to performance limitations, they can be used as the primary protection system for tanks up to 18 meters in diameter (Long and Garner, 2004). However, some engineering codes, such as NFPA 11, state that monitors should not be used as the primary attack method for tanks greater than approximately 20 meters in diameter. In practice, they have been used for larger tanks, although they have had limited use in tanks greater than 40m (Ramsden, 2008). Foam monitors are often better suited and more commonly installed as either a secondary fixed foam system or to tackle spill fires, with the added benefit of being able to be used for tank cooling. Ramsden (2008) also explained that the most important consideration when proposing foam monitors as the primary system is that, to be effective, the foam must reach the seat of the fire. As in most systems, foam monitors will be close to the ground and the foam produced will first be required to reach up and over the tank wall. This requirement may be difficult to achieve as a result of many factors, such as the height of the tank, the distance between the tanks, the position of the monitor and weather conditions. Figure 5.13 shows the foam monitor.

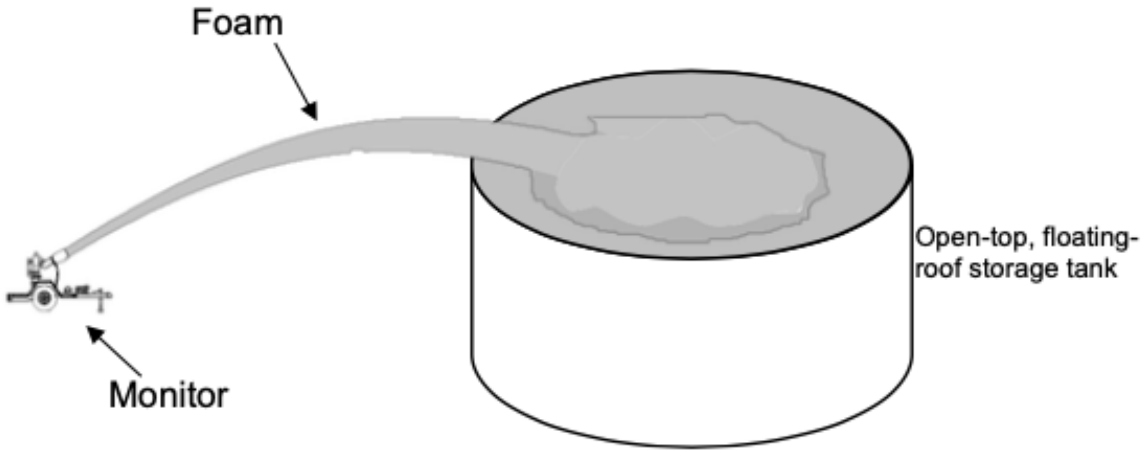


Figure 5.13 - Trailer Mounted Foam Monitor

5.4 Analysis of Low Expansion System Design

5.4.1 Introduction

NFPA's standards are often complex and lengthy documents, so to better understand and explain to the clients their options, an analysis was done to NFPA 11. This standard is applicable for Low-, Medium, and High-Expansion Foam and the version used was the latest, the 2016's.

The main objective was to analyse low-expansion systems, so chapter 5 got the most attention. Inside this section, it is examined the different types of hazards, the various roof's configurations, indoor hazards, diked areas, among others. Microsoft Visio was the program used to synthesise and make the following schemes.

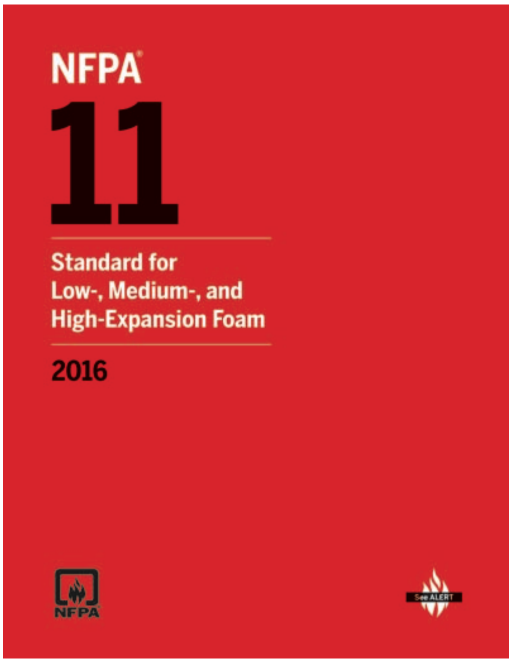


Figure 5.14 - NFPA 11, 2016 Edition cover

In this study the author focused on the needs of the company and dissected subchapter 5.2 to 5.4, regarding tanks and also 5.7 which is about diked areas. For the purpose of this standard, diked areas shall be areas bounded by contours of land or physical barriers that retain a fuel to a depth greater than 25.4 millimetres (one inch) (50).

5.4.2 NFPA 11 Analysis

5.4.3 Storage Tanks

As previously explained, there are different tank types, and the method used to fight a fire on them will depend on their characteristics. It is then essential to understand the different approaches to take, depending on what type of tank roof was being analysed.

In case we have the internal floating roof, there are two different approaches to have: design to full surface fire or to a seal area fire. The NFPA refers that, in this case, we shall have to either, design like fixed or open-top roofs, respectively. After identifying this, the standard presents three fighting systems which are, discharge outlets, monitors and handlines. As it will be possible to observe on the scheme bellow, monitors and handlines are very limited in usage for primary protection system. They are only effective in smaller tanks. Therefore, fixed system (or discharge outlets), are the most common type of protection used. For a full understanding of the analysis, consult Appendix B, where it is also located the tables with the discharge rates and duration for the applications.

5.4.4 Diked Areas

A diked area is defined as an area bounded by contours of land or a physical barrier that retains a fuel to a depth greater than 1 inch. At many manufacturing or storage facilities, the flammable liquid storage area can be a number of small tanks within a common diked area (53).

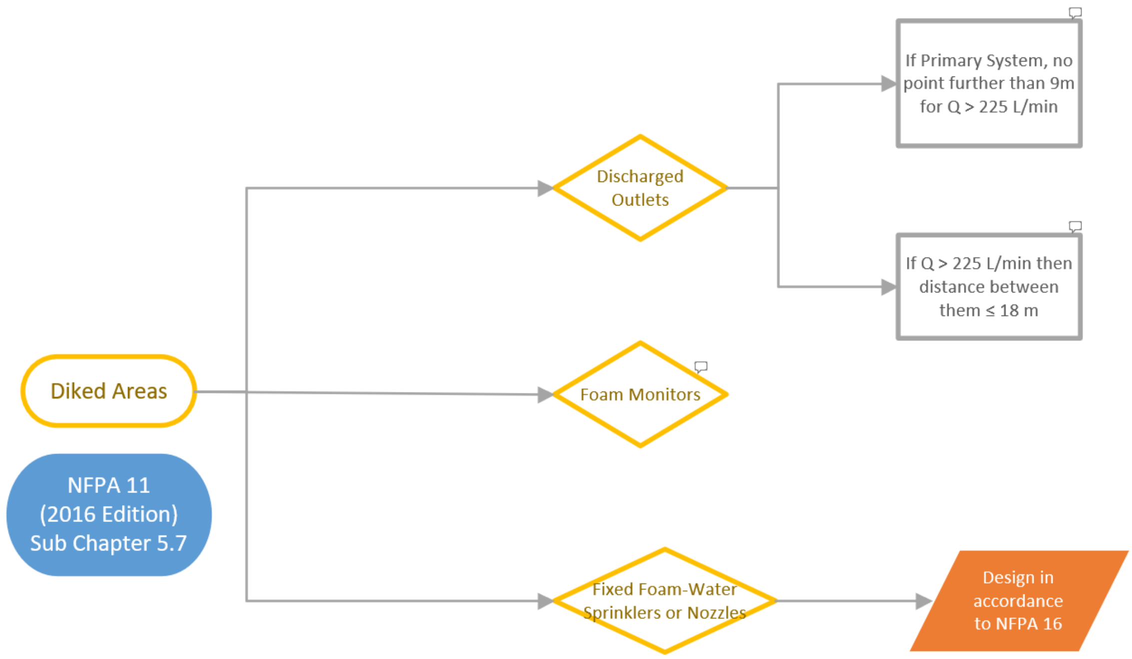


Figure 5.15 – Analysis of Fire Case in Diked Areas

It is possible to conclude from this subchapter, that for a fire in a diked area there are three ways to battle it: with discharge outlets, with foam monitors (from a distance) or by a fixed system (with water and foam simultaneously). It also says, that in case the flow is greater than 225 litters per minute, which it will always be because it is a relatively low flow rate, the engineer should use either the monitors or the fixed system as primary protection, and the first one as secondary. The discharge rates and durations are also present, along with a bigger scheme in Appendix B.

5.5 Fire-Water Demand Calculation Sheet

The records of the german major accidents reporting system – ZEMA (Zentrale Meldeund Auswertestelle für Störfälle und Störungen in verfahrenstechnischen Anlagen) shows consequences of major accidents in process engineering facilities for a time period from 2003 to 2013. It reveals that releases and fires are the most common consequences of accidents. In many cases the released substances are combustible, and the releases could lead with an ignition source to a fire, too. Summarizing it can be stated that fire is the essential hazard of chemical production plants with respect to ZEMA accidents reports (43).

5.5.1 Introduction

In an era where engineering is fast headed towards becoming more efficient, reliability cannot be forgotten. With this in mind, and with the need for a trustworthy and straightforward tool, it was developed a calculation sheet, for the needs of water and foam in case of a fire in a tank farm.

This tool was developed in Excel and, for now, it is only based on NFPA 11 (for the design and operation of medium expansion foam) and on NFPA 15 (for the water spray fixed systems).

For future developments, it would be interesting to do the same evaluation and programming of tabs for the remaining parts of a tank farm, besides the storage tanks:

- Bund;
- Process Unit;
- Loading and Unloading station.

Figure 5.16 – Example of a Loading and Unloading Station (54)

It would also be possible and helpful to set up the calculations for other than NFPA's regulations. API Standards are also worldwide recognised and with a simple change in a dropdown cell, the entire calculation sheet would be redone.

It is important to take into consideration that these automations do not exclude the firefighting engineer from doing a recheck, and if necessary, an adjustment to the calculation sheet, as it is an easily editable tool. Also, take into consideration that all values can be overwritten in the "Regulation" tab. Sometimes, either by the Clients decision or simply by past experiences or good engineering practise, this fact can happen.

5.5.2 Goal

The calculation sheet was created to define the fire protection required for the scenarios that are identified. It also had the goal of calculating the amount of water and foam needed in the different fire scenarios. The main objective is to determine the worst-case scenario and subsequently obtain the designing values for fire water and foam supply.

The current version of the calculation sheet is giving the following results:

- Blanket supply;
- Foam volume;
- Water flow;
- Water Volume.

The first two values will be related to the actual extinguishment of the fire, whereas the last two are will be used in the cooling down of the adjacent tanks.

5.5.3 Data Input

The Foam concentration cell, on the Design Basis table, is the only field needed to be introduced on the first tab of the sheet. It was created an in-cell dropdown with the three options given by NFPA, one, three or six per cent of foal concentration.

Table 5.1 – Overview of the Regulations Tab

DATA

Design Basis	
Foam concentration (%)	

FOAM		DISCHARGE OUTLETS		MONITORS		
Design parameters		Minimum Density Application Rate	Duration	Minimum Density Application Rate	Duration	References
		[l/min/m²]	[min]	[l/min/m²]	[min]	
Fixed Roof	Flammable	4,1	30	6,5	65	NFPA 11 - Table B.1
	Combustible	4,1	20	6,5	50	
Floating Roof	Flammable	12,2	20	6,5	65	
	Combustible	12,2	20	6,5	50	

WATER		FIXED WATER SPRAY SYSTEM AND WATER MONITORS		
Equipment Protection		Minimum Density Application Rate	Duration	References
		[l/min/m²]	[min]	
Static	Static Equipment	10,2	120	NFPA 15 - §7.4.3.4
	Storage Tanks	10,2		NFPA 15 - §7.4.2.1
Rotating	Compressors Area	20,4		NFPA 15 - §7.3.2
	Pumps Area	20,4		NFPA 15 - §7.3.2

RESULTS

Blanket supply Water + Foam		Foam Concentration Supply		Water for cooling	
				Flow	Volume
[l]	[m³]	[l]	[m³]	[m³/h]	[m³]
0	0	0	0	0	0

The Results table in the bottom will give the engineer the desired values after the introduction of the remaining data in the next tab.

The next Excel tab is where the tank information will be introduced. The user should fill all the light blue cells. The first four columns will not influence the rest of the sheet, but it is crucial to have an idea of the product that will be inside the tank, as well as the respective capacities. In the last two columns, it is identified if the liquid is a flammable or combustible and its respective class.

Take into consideration that the next three Tables should be read in sequence. To find the complete table, it is at Appendix C.

Table 5.2 – Overview of the Tank Data filling table

Tank Data									
Number	Name	Tag	Capacity	Roof Type	Protection Type	Flash Point	Main Dimensions		
							H	D	Rim Seal
			[m³]	(Fixed / Floating)	(Fixed / Monitor)	[°C]	[m]	[m]	[m]
Scenario 1									
1		T-001		Fixed	Fixed				-
2		T-002		Fixed	Monitor				-
3		T-003		Floating	Fixed				
4		T-004		Floating	Monitor				
5		T-005		Fixed	Fixed				-
6		T-006		Fixed	Monitor				-
7		T-007		Floating	Fixed				
8		T-008		Floating	Monitor				

5.5.3.1 Liquids Classification

Combustible liquid is any liquid that has a closed-cup flashpoint at or above 100°F (37.8°C), as determined by the test procedures. (51). Flammable liquid is any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and a Reid vapour pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D323, Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method). (51).

Flammable liquids, as just defined, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:

- Class IA Liquid — Any liquid that has a flashpoint below 73°F (22.8°C) and a boiling point below 100°F (37.8°C);
- Class IB Liquid — Any liquid that has a flashpoint below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C);
- Class IC Liquid — Any liquid that has a flashpoint at or above 73°F (22.8°C), but below 100°F (37.8°C).

Combustible liquids, as prior defined, shall be classified in accordance with the following:

- Class II Liquid — Any liquid that has a flashpoint at or above 100°F (37.8°C) and below 140°F (60°C);
- Class III Liquid — Any liquid that has a flashpoint at or above 140°F (60°C);
    - Class IIIA Liquid — Any liquid that has a flashpoint at or above 140°F (60°C), but below 200°F (93°C);
    - Class IIIB Liquid — Any liquid that has a flashpoint at or above 200°F (93°C).

5.5.4 CALCULATIONS

The next step is deciding in which tank to do the fire simulation. It is only a likely or credible scenario to have a fire in a single tank, due to the small probability of having any.

Turning the in-cell dropdown from, "No" to "Yes", will automatically assign an Application Rate and Discharge Time based in the tables already analysed and programmed in Excel. The following cell, Surface Area, was already filled by the filling of the tank's roof information's. The Flow Rate is a simple multiplication of the Application Rate times the Area as well as the Blanket supply cell, which is the Flow rate multiplied by the time. Finally, the Concentration supply is the amount of foam from the water previously calculated. It comes from multiplying the previous cell with designed based, foam concentration.

Table 5.3 – Foam Calculation table

Foam Calculation						
Addition of Foam	Application rate	Time	Surface Area	Flow rate	Blanket supply	Concentration Supply
(Yes/No)	[l/min.m²]	[min]	[m²]	[l/min]	[l]	[l]
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
				Σ=	0	0

The following phase in the design of the fire protection, is the cooling of the adjacent tanks. It might not always be the tanks right next to the one that is on fire, but with a Heat Radiation Study, it is possible to say which need the water, for cooling. It is again just the choice of turning the in-cell dropdown from, "No" to "Yes", and all the cells on the right-hand side will be automatically filled based on the information previously given.

The Roof area is just the area of a circle, the top of the tank. The Vessel Area is the area of a cylinder, the shell of the tank, and the Total Surface is the sum of the previous two. The Water Flow will be the multiplication of the water application rate with the total surface. Finally, the water volume is water flow times the duration (in this case it will always be 120 minutes (41)).

Table 5.4 – Water Calculation table

Water Calculation						
Addition of Water	Selected water application rate	Roof Area	Vessel Area	Total surface	Water Flow	Water Volume
(Yes/No)	[l/min/m²]	[m²]	[m²]	[m²]	[m³/h]	[m³]
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
No	-	-	-	-	-	-
				Σ=	0	0

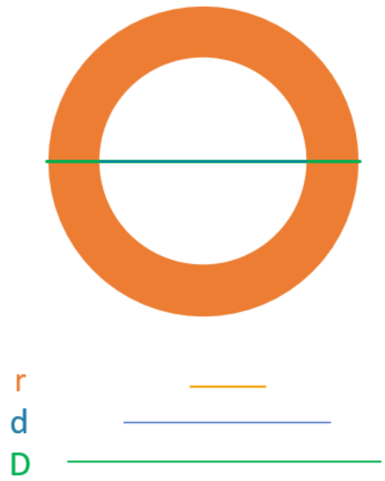
Returning to the first tab, in the Results table at the bottom, it is possible to see a summary of what happen in the calculation tab just described. It is shown the minimum flows and volumes, of water and foam needed in case of a fire in the Storage Tank Area in the Tank Farm.

To finalize it is only necessary to show the formulas used:

- Area of the circle = $D^2 * \pi / 4$
- Volume of the tank = Acircle * H
- Perimeter of the circle = $D * \pi$
- Area of sidewall = Pcircle * H
- Area of the vessel = Acircle + Asidewall
- Flowrate = Application rate * Surface Area
- Blanket supply = Flow Rate * Time
- Concentration Supply = Blanket supply * Foam %

There is only a particular formula that needs some context, the calculation of the rim seal area. In case of a studied a floating roof tank and it is being designed for a fire in the seal, the calculation sheet is ready to deliver that "ring area". There are three factors related in this formula, the diameter of both the tank and the floating roof, and the length of the rim seal:

The length of the rim seal is equal to the difference of the radius of the tank roofs (or half of their diameters).



r seal length = (D – d) / 2

A floating roof = d² * π / 4

A roof tank = D² * π / 4

Therefore...

Rim Seal Area = (π * r) * (D - r)

Figure 5.17 - Rim Seal Area Demonstration

Therefore, relating both the areas of the roofs and the rim seal, it is possible to get the formula used to calculate the surface where the fire may occur:

$$Rim\ seal\ Area = (\pi * r) * (D - r) \qquad [m^2]$$

As this study might be done in an early project phase, and the Process Department is not able yet, to give an exact size of the seal, the user will need to arbitrate a value (that is usually between one and two meters).

5.5.5 Case Study

It is now presented a small example, so that the reader can better understand how much water and foam these kinds of system require, and therefore the importance of having these numbers correctly calculated. It was created a random storage tank area with four tanks as shown next page:

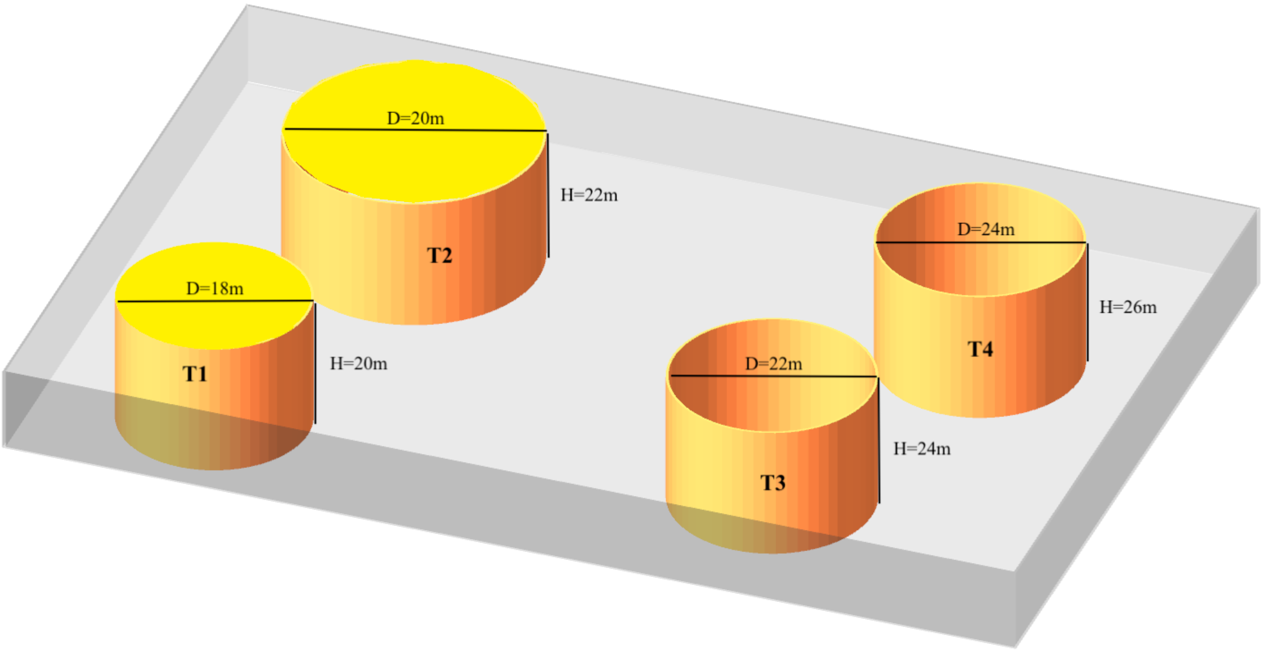


Figure 5.18 – Storage Tanks

The tank farm is constituted by four storage tanks, two fixed and two floating roofs. The four chemical products inside tanks were randomly arbitrated. It was decided to give different flash points, in order to get different flammability classes. The floating tanks will have rim seals of two meters in tank number three, and one meter in the number four. In the following table is possible to see the remaining characteristics:

Table 5.5 – Tank's Characteristics

Name	Roof Type	Protection Type	Flash Point	Main Dimensions		
				H	D	Rim Seal
	(Fixed / Floating)	(Fixed / Monitor)	[°C]	[m]	[m]	[m]
Tank 1	Fixed	Fixed	-26	20	18	-
Tank 2	Fixed	Monitor	7	22	20	-
Tank 3	Floating	Fixed	55	24	22	2
Tank 4	Floating	Monitor	100	26	24	1

It is fairly simple to fill this part of the table. The user just adds the information once, on the Scenario 1 table, and then copy and pastes, three times in this case (it will always be n, the number of tanks, or fire scenarios, minus one). On the table immediately on the right-hand side, the user should select the option addition of foam to "Yes", once per scenario, as previously explained, because its likelihood. For the complete Table, it is possible to see it in Appendix C.

It is possible to observe that the worst-case scenario in this situation would be the number two, by some margin. Largely due to the fact of the protection type chosen to be monitors. This increased, both the application rate and the discharge time.

Next, it is simulated that all three remaining tanks, without a fire occurrence, need to be cooled down. The user would need again to change the configuration of the "Addition of Water" cells to "Yes" and all the remaining cells are automatically calculated accordingly to the formulas previously explained in sub chapter 4.5.4.

As expected, the water volume does not vary much, due to the initial impositions of similar tank's heights and diameters. Even so, the worst-case scenario will be observed with the first set-up, with the need of more than 7500 cubic meters of water.

Going back to the first tab of the sheet it is possible to find a brief summary of the obtained results.

The reader should take into account that, for a better reading, both the pages from Appendix C should be printed in A3 size.

6
RESULTS, ANALYSIS AND DISCUSSION

6.1 CONCLUSIONS

A look on loss statistics of reportable incidents reveals that fire is the most important cause of major losses in the chemical industry. Therefore, it pays off to think about how advanced fire precautions may help to minimize the risk of such damages (43).

6.1.1 AUTOSPRINK

With a high-performance BIM Software like AutoSPRINK, the design methodologies were redefined for the designers of automatic extinguishing systems and fire networks. The software is currently recognised as the most accurate and rigorous BIM tool, it allows rapid 3D modelling, complemented by a powerful hydraulic calculation tool associated with a vast database and library of BIM objects.

As a downside, the software does not have the most user-friendly interface. The icons are very small, and some are hard to interpret. There is another detail that makes the designing process to take a longer period, that is the lack of a command bar. This way, like it happens in AutoCAD, for instance, the user would be able to type the whished command, instead of going with the mouse to find the button. Also, the ability to understand the mistakes, like leaks or the lack of water flowing. Specially in the beginning, when the designer is not used to the tools available, the water is not running through the pipes and the user does not know why.

Directly impacting my design, with the help of internet tutorials and online forums it was possible to manage most of the errors that appeared except for the valves used. Hydraulically, it does not impact the design, because it is possible to consider the local losses, but there is not a deluge valve with the diameter of 200 millimeters (eight inches). Therefore, the stock listing is not completely correct, but the engineer in charge of the design would have to leave a memorandum.

The other feature that was missed, was the approximate mathematical expression of both the supply and system demand curves. It only made possible to compare the results based on graph comparison and maximum values on flow and pressure.

6.2 RESULTS

6.2.1 NETWORK DESIGN

As previously said, the information of the hydraulic calculation only arrived late in June, therefore it was not possible to do a deeper analysis and comparison.

The Water Supply Curve for the Contractor's design is approximately, the one bellow (Formula 6.1). As for the author's, as previously explained, AutoSPRINK does not provide such information but the actual graph is at the second page of the Hydraulic Calculation file at Appendix A

$$P = (1.310 * 10^{-7} * Q^2) + (1.493 * 10^{-4} * \mathrm{Q}) + 1.132 \qquad \text{[bar]} \qquad (6.1)$$

What is possible to compare are the actual numbers for the maximum flow and pressure running in the system with all nozzles flowing (Table 6.1).

Table 6.1 – Overall Results

	Contractor	Author	Difference	
			Δ	**%**
Flow (lpm)	7180.546	7315.58	-135.034	-1.85
Pressure (bar)	8.961	8.789	+0.172	+1.94

As it is possible to perceive from the Table 6.1 above, the results attained with the software and the ones sent by the Contractor are very similar (less than 2% in difference, both on flow and pressure), which can be easily explained with some small height differences, pipe roughness, digit rounding among others.

With this information, I firmly believe that Worley can start doing a part of the sprinklers network "at home". The biggest impact of this change would be on having a quicker and most accessible network design that is a very iterative process with other disciplines, given that space management is crucial in the design at the firm.

6.2.2 NFPA 11 ANALYSIS

National Fire Protection Association Standards are, at the same time, worldwide recognized but often seen as difficult to interpret. If they are a theme of debate and discussion among specialists in the firefighting area, to explain some requirements and even concepts to clients can be challenging.

With the diagrams produced (Appendix B), it was intended to simplify these explanations and also for new engineers in the area to have a clearer picture on how to deal with the fire protection equipment depending on the type of tank that is being dealt with.

6.2.3 CALCULATION SHEET

The author hopes, with this simulation to sensitize the community for a need of a reliable tool that in the next iterations will allow the Fire Fighting Engineer to combine different standards and overwrite any values based on previous experiences and good engineering practises.

6.3 FUTURE DEVELOPMENTS PERSPECTIVES

Regarding the network design, the results achieved proved that AutoSPRINK is ready to be used. There are, of course, improvements, like the inclusion of new accessories families, like fittings and valves. It was also meant, but for lack of time, the designing of the hangers, by NFPA 13, is missing, and is an important information for the colleagues of the structural department to add as loads.

Future works on the Excel sheet, should primarily focus on adding the calculations for the remaining areas of the project (bund, loading and unloading station, pumps and compressors, and finally columns, vessels and reactors). Secondly, it would be very beneficial if, with just button click, the sheet could reorganize itself and re-calculate according to a different standard (API, for instance), or even to overwrite some values with more reliable and trusted numbers by the engineer.

REFERENCES

1. **M.E.P.CAD, Inc.** MEPCAD. [Online] 2005-2012. http://www.mepcad.com/autosprink/astestimonials.aspx.

2. **Spruce, Hannah.** High Speed Training. [Online] 16 March 2016. https://www.highspeedtraining.co.uk/hub/fire-triangle-tetrahedron-combustion/.

3. *Environmental Impact of Automatic Fire Sprinklers: Part 2. Experimental Study.* **Ditch, Ben.** s.l. : FM Global.

4. **Coelho, António Leça.** *Incêndios em edifícios.* 2010.

5. **US, CFBT -.** *http://cfbt-us.com.* [Online] http://cfbt-us.com/pdfs/FBIandFireDevelopment.pdf.

6. **National Fire Protection Association.** [Online] https://www.nfpa.org/Codes-and-Standards/Standards-development-process/How-the-process-works/History-of-standards-development.

7. *Nota Técnica Nº 16 - Sistemas Automáticos de Extinção por Água.* **Autoridade Nacional de Proteção Civil.**

8. *Meios de extinção de incêndio por água – Análise regulamentar comparativa.* **Carvalho, Joana Raquel Rodrigues de Oliveira.** November 2016.

9. **BRITISH STANDARD.** *Fixed firefighting systems — Automatic sprinkler systems — Design, installation and maintenance.* [Online] http://tomrobbo.com/dbsinfo/Regs%20&%20Data%20Sheets/BS%20EN%2012845%202004.pdf.

10. **NFPA.** NFPA 15 - Standard for Water Spray Fixed Systems for Fire Protection. 2017, p. 20.

11. **Martorano, Scott.** Viking Group. [Online] https://www.vikinggroupinc.com/sites/default/files/documents/Spray%20Nozzle%20Selections.pdf.

12. **Kinetix Fire.** Kinetixfire.com. [Online] https://kinetixfire.com/the-difference-between-various-types-of-fire-sprinklers/.

13. *Requirements for LPCB certification and Redbook listing of Supervised Premises Transceivers: Intrusion and Hold-up Alarm Systems.* **BRE Global Ltd.** 2016.

14. *Design and operation of sprinkler systems.* **Martin, D.L., Kincaid, Dennis C. and Lyle, William M.** 2007.

15. **Direct Industry. [Online] https://www.directindustry.com/prod/hd-fire-protect-pvt-ltd/product-188290-2235501.html.**

16. ***Piping layout for fire sprinkler system: An overview.* Vishnoi, Kshitiz.**

17. **NFPA. NFPA 13 - Standard for the Installation of Sprinkler Systems. 2019, p. 31.**

18. **TYCO. TYCO - Fire. [Online] https://www.tyco-fire.com/TD_TFP/TFP/TFP1420_10_2014.pdf.**

19. **Inst Tools. [Online] https://instrumentationtools.com/deluge-valve-working-principle/.**

20. ***NFPA Glossary of Terms - 2019 Edition.* 2019.**

21. **Law Insider. Law Insider. [Online] https://www.lawinsider.com/dictionary/process-unit.**

22. Beal, Vangie. Webopedia. *Webopedia.com.* [Online] https://www.webopedia.com/TERM/G/greenfield.html.

23. *Advantages and disadvantages of bim platforms on construction site.* Fernandes, Rui Pedro Lopes. July 2013, p. 136.

24. 360 Feed Wire. *Passive Fire Protection Market Size, Share & Trends Analysis Report By Application (Construction, Oil & Gas, Industrial, Warehousing), By Product (Intumescent Coating, Cementitious Material), And Segment Forecasts, 2019 - 2025.* 2019.

25. Speight, James. *Environmental Organic Chemistry for Engineers.* s.l. : Elsevier Inc., 2017. pp. 87-151.

26. www.europeanceo.com. [Online] European CEO. https://www.europeanceo.com/finance/the-port-of-antwerp-boasts-excellent-connections-at-the-heart-of-europe/.

27. Coker, A. Kayode. *Ludwig's Applied Process Design for Chemical and Petrochemical Plants.* s.l. : Gulf Professional Publishing, 2007. p. 104. Vol. 1.

28. Diebel, James, Norda, Jacob and Kretchmer, Orna. Weatherspark. *watherspark.com.* [Online] https://weatherspark.com/y/51236/Average-Weather-in-Antwerpen-Belgium-Year-Round.

29. Grumbles, Tom, et al. American Chemestry. *www.americanchemistry.com.* [Online] https://www.americanchemistry.com/ProductsTechnology/Ethylene-Oxide/EO-Product-Stewardship-Manual-3rd-edition/EO-Product-Stewardship-Manual-Design-of-Facilities.pdf.

30. BASF SE; BAYER MATERIALSCIENCE AG; INEOS Manufacturing Deutschland GmbH; DOW EUROPE GmbH; LYONDELLBASELL INDUSTRIES; REPSOL QUIMICA; SHELL CHEMICALS EUROPE BV. Lyondellbasell. *www.lyondellbasell.com.* [Online] https://www.lyondellbasell.com/globalassets/documents/polymers-technical-literature/guidelines-for-the-distribution-of-propylene-oxide---2013.pdf.

31. Weather Atlas. [Online] https://www.weather-atlas.com/en/belgium/antwerp-climate#temperature.

32. Tyco. Tyco Fire. *www.tyco-fire.com.* [Online] August 2018. https://www.tyco-fire.com/TD_TFP/TFP/TFP807_08_2018.pdf.

33. *NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their.* s.l. : National Fire Protection Association, 2019.

34. European Standard - EN 13121-1. *GRP tanks and vessels for use above ground - Part 1: Raw materials - Specification conditions and acceptance conditions.* 2003.

35. Brière, François G. Google Books. [Online] https://books.google.pt/books?id=4bO4jNGVEyUC&pg=PA369&lpg=PA369&dq=hydrant+flow+2000l/+min&source=bl&ots=TYZE1cXJ3T&sig=ACfU3U3a0ayc2cfGDyDOdvkj1HvzcDe4og&hl=pt-PT&sa=X&ved=2ahUKEwiB2Lao4obqAhUYAWMBHWXIDJcQ6AEwAnoECAkQAQ#v=onepage&q=hydrant%20flow%202000.

36. RJ-SCIE. *Regime Jurídico da Segurança Contra Incêndio em Edifícios.*

37. ProCiv. *ProCiv.* [Online] http://www.prociv.pt/en-us/Pages/default.aspx.

38. NFPA 15 - Standard for Water Spray Fixed Systems for Fire Protection. s.l. : National Fire Protection Association, 2017, p. 14.

39. NFPA 15 - Standard for Water Spray Fixed Systems for Fire Protection. 2017, p. 45.

40. AutoSPRINK Settings. *AutoSPRINK Web Site.* [Online] January 2020. https://autosprink.com/help.

41. *NFPA 15 - Standard for Water Spray Fixed Systems for Fire Protection.* s.l. : Nation Fire Protection Association, 2017.

42. *Firefighting Emergency Capability Evaluation on Crude Oil Tank Farm.* Liu, Yi, Zhou, Huan and Liu, Lu. s.l. : Procedia Engineering, 2018.

43. *Fire Protection in the Chemical Industry.* Wehmeier, Guido and Mitropetros, Konstantinos. [ed.] Eddy de Rademaeker and Peter Schmelzer. s.l. : The Italian Association of Chemical Engineering Online, 2016, Chemical Engineering Transactions, Vol. 48.

44. API. *API 650 - Welded Steel Tanks for Oil Storage.*

45. Mansour, Khalid Abusaieda. *Fires in Large Atmospheric Storage Tanks and their Effect on Adjacent Tanks.* 2012.

46. LASTFIRE. Lastfire - Large Atmospheric Storage Tank Fires. [Online] http://www.lastfire.co.uk/default.aspx?ReturnUrl=%2f.

47. NFPA. [Online] https://www.nfpa.org/News-and-Research/Data-research-and-tools/Building-and-Life-Safety/Fires-in-US-Industrial-and-Manufacturing-Facilities.

48. ENDS Report. [Online] https://www.endsreport.com/article/1563219/buncefield-firms-pay-94m-safety-pollution-offences.

49. Siraga. [Online] http://www.siraga.com/media/15543/Fire_Water_Systems_ENG.pdf.

50. [book auth.] NFPA. *NFPA 11 Standard for Low-, Medium-, and High-Expansion Foam.* 2016, p. 23.

51. WilliamsFire. Petroleum Storage Tank - Fire Protection. [Online] https://www.slideshare.net/MarcoMedrano1/tank-protection-86944431.

52. Sensor - ACM. [Online] https://www.sensor-acm.pl/our-offer/for-fuel-energy-and-chemical-industry/tank-gauging-equipment-and-solutions/foam-and-spray-systems/.

53. ChemGuard. [Online] https://www.chemguard.com/pdf/design-manuals/D10D03200.pdf.

54. B & J Group. [Online] https://www.bandjgroup.com/?p=466.

55. *NFPA 30 - Flammable and Combustible Liquids Code.* s.l. : National Fire Protection Association, 2018.

56. *Study on the Failure Probability of Occupant Evacuation with the Method of Monte Carlo Sampling.* Chen, Hao-nan and Mao, Zhan-li. 2018, Procedia Engineering, Vol. 211, pp. 55-62.

57. NCDOI. North Carolina Department of Insurance. *NCDOI.* [Online] https://www.ncdoi.com/OSFM/RPD/PT/Documents/Coursework/Ethanol/Module5_Participant Manuals.pdf.

58. NFPA. NFPA 13 - Standard for the Installation of Sprinkler Systems. 2019, pp. 292-297.

59. Guardian Fire Protection. [Online] https://www.guardianfireprotection.com/fire-sprinkler-installation.

60. Meyer Fire. Meyer Fire Blog. [Online] https://www.meyerfire.com/blog/advantages-of-return-bends-in-fire-sprinkler-systems.

61. *Nota Téncica nº 8 - Grau de Prontidão de Socorro.* ANPC.

62. Verhaert. Verhaert - Master in Inovation. [Online] https://verhaert.com/safesens-improve-safety-security/.

APPENDICES

APPENDIX A – HYDRAULIC CALCULATION

Hydraulic Calculations

for

Project Name: Thesis
Location: , ,
Drawing Name: Alkox 1.8 bar 10.06 Calculation Date: 10/06/2020

Design
Remote Area Number:

Occupancy Classification: Other

Density: 10.20L/min/m²
Area of Application: 540.00m² (Actual 186.40m²)
Coverage per Sprinkler: 9.29m²
Type of sprinklers calculated: Pendent
No. of sprinklers calculated: 120

Type of System: Volume of Dry or PreAction System: N/A
In-rack Demand: N/A L/min at Node: N/A
Hose Streams: 0.0 L/min at Node: 25 Type: Allowance at Source

Total Water Required (including Hose Streams where applicable):
From Water Supply at Node 25: 7315.58L/min @ 8.789bar

Water Supply Information:

Name of Contractor:
Address: ,
Phone Number: Name of designer: Daniel Rocha Afonso

Authority Having Jurisdiction:

Notes:

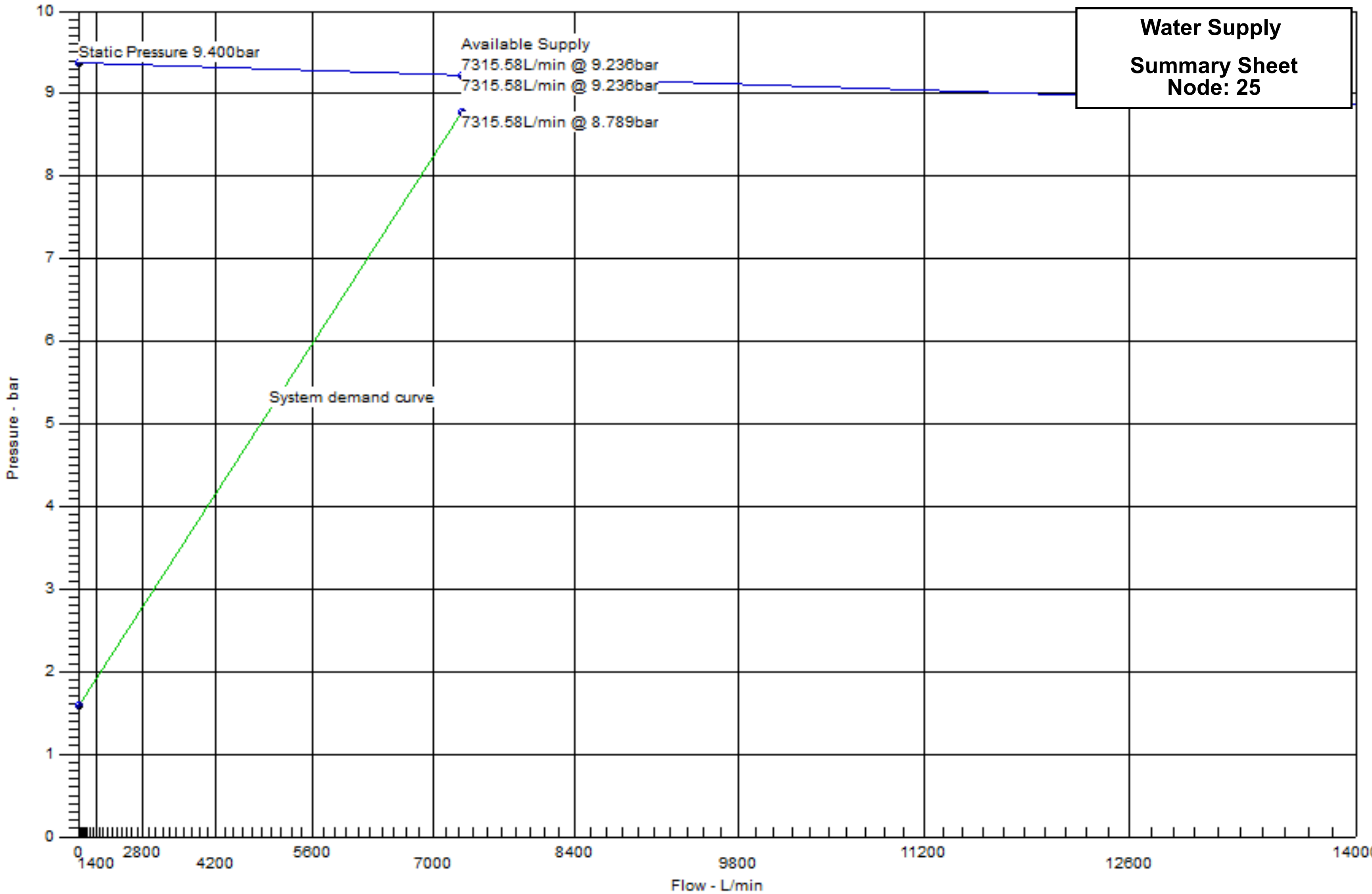
Automatic peaking results Left: N/A Right: N/A

Hydraulic Graph

Job Name: Thesis
Remote Area Number:

N 1.85

Date: 10/06/2020



Summary Of Outflowing Devices

Device		Actual Flow (L/min)	Minimum Flow (L/min)	K-Factor (K bar)	Pressure (bar)	Density (lpmpm2)	Coverage (Meter)
Sprinkler	**201**	**48.30L/min**	**48.30L/min**	**36Kbar**	**1.800bar**	**5.20L/min/m²**	9.29m²
Sprinkler	202	48.34L/min	48.30L/min	36Kbar	1.803bar	5.20L/min/m²	9.29m²
Sprinkler	203	49.14L/min	48.30L/min	36Kbar	1.863bar	5.29L/min/m²	9.29m²
Sprinkler	204	49.32L/min	48.30L/min	36Kbar	1.877bar	5.31L/min/m²	9.29m²
Sprinkler	205	50.99L/min	48.30L/min	36Kbar	2.006bar	5.49L/min/m²	9.29m²
Sprinkler	206	53.41L/min	48.30L/min	36Kbar	2.202bar	5.75L/min/m²	9.29m²
Sprinkler	207	53.47L/min	48.30L/min	36Kbar	2.206bar	5.75L/min/m²	9.29m²
Sprinkler	208	53.47L/min	48.30L/min	36Kbar	2.206bar	5.76L/min/m²	9.29m²
Sprinkler	209	53.93L/min	48.30L/min	36Kbar	2.244bar	5.80L/min/m²	9.29m²
Sprinkler	210	55.01L/min	48.30L/min	36Kbar	2.335bar	5.92L/min/m²	9.29m²
Sprinkler	211	55.07L/min	48.30L/min	36Kbar	2.340bar	5.93L/min/m²	9.29m²
Sprinkler	212	55.83L/min	48.30L/min	36Kbar	2.405bar	6.01L/min/m²	9.29m²
Sprinkler	213	55.88L/min	48.30L/min	36Kbar	2.410bar	6.02L/min/m²	9.29m²
Sprinkler	214	56.36L/min	48.30L/min	36Kbar	2.451bar	6.07L/min/m²	9.29m²
Sprinkler	215	56.84L/min	48.30L/min	36Kbar	2.492bar	6.12L/min/m²	9.29m²
Sprinkler	216	56.96L/min	48.30L/min	36Kbar	2.504bar	6.13L/min/m²	9.29m²
Sprinkler	217	57.37L/min	48.30L/min	36Kbar	2.540bar	6.18L/min/m²	9.29m²
Sprinkler	218	57.48L/min	48.30L/min	36Kbar	2.550bar	6.19L/min/m²	9.29m²
Sprinkler	219	57.53L/min	48.30L/min	36Kbar	2.554bar	6.19L/min/m²	9.29m²
Sprinkler	220	58.08L/min	48.30L/min	36Kbar	2.603bar	6.25L/min/m²	9.29m²
Sprinkler	221	59.22L/min	48.30L/min	36Kbar	2.706bar	6.37L/min/m²	9.29m²
Sprinkler	222	59.37L/min	48.30L/min	36Kbar	2.719bar	6.39L/min/m²	9.29m²
Sprinkler	223	59.51L/min	48.30L/min	36Kbar	2.732bar	6.41L/min/m²	9.29m²
Sprinkler	224	59.53L/min	48.30L/min	36Kbar	2.735bar	6.41L/min/m²	9.29m²
Sprinkler	225	60.07L/min	48.30L/min	36Kbar	2.784bar	6.47L/min/m²	9.29m²
Sprinkler	226	60.20L/min	48.30L/min	36Kbar	2.796bar	6.48L/min/m²	9.29m²
Sprinkler	227	61.25L/min	48.30L/min	36Kbar	2.895bar	6.59L/min/m²	9.29m²
Sprinkler	228	61.26L/min	48.30L/min	36Kbar	2.896bar	6.59L/min/m²	9.29m²
Sprinkler	229	61.80L/min	48.30L/min	36Kbar	2.947bar	6.65L/min/m²	9.29m²
Sprinkler	230	61.90L/min	48.30L/min	36Kbar	2.956bar	6.66L/min/m²	9.29m²
Sprinkler	231	62.03L/min	48.30L/min	36Kbar	2.969bar	6.68L/min/m²	9.29m²
Sprinkler	232	62.65L/min	48.30L/min	36Kbar	3.029bar	6.74L/min/m²	9.29m²
Sprinkler	233	63.55L/min	48.30L/min	36Kbar	3.116bar	6.84L/min/m²	9.29m²
Sprinkler	234	55.98L/min	42.53L/min	31.7Kbar	3.118bar	6.03L/min/m²	9.29m²
Sprinkler	235	56.00L/min	42.53L/min	31.7Kbar	3.121bar	6.03L/min/m²	9.29m²
Sprinkler	236	56.39L/min	42.53L/min	31.7Kbar	3.165bar	6.07L/min/m²	9.29m²
Sprinkler	237	64.74L/min	48.30L/min	36Kbar	3.234bar	6.97L/min/m²	9.29m²
Sprinkler	238	57.27L/min	42.53L/min	31.7Kbar	3.264bar	6.16L/min/m²	9.29m²
Sprinkler	239	66.01L/min	48.30L/min	36Kbar	3.362bar	7.10L/min/m²	9.29m²
Sprinkler	240	58.98L/min	42.53L/min	31.7Kbar	3.461bar	6.35L/min/m²	9.29m²
Sprinkler	241	61.09L/min	42.53L/min	31.7Kbar	3.714bar	6.58L/min/m²	9.29m²
Sprinkler	242	57.39L/min	38.64L/min	28.8Kbar	3.971bar	6.18L/min/m²	9.29m²
Sprinkler	243	57.41L/min	38.64L/min	28.8Kbar	3.974bar	6.18L/min/m²	9.29m²
Sprinkler	244	57.42L/min	38.64L/min	28.8Kbar	3.975bar	6.18L/min/m²	9.29m²
Sprinkler	245	57.44L/min	38.64L/min	28.8Kbar	3.978bar	6.18L/min/m²	9.29m²
Sprinkler	246	57.47L/min	38.64L/min	28.8Kbar	3.983bar	6.19L/min/m²	9.29m²
Sprinkler	247	57.49L/min	38.64L/min	28.8Kbar	3.985bar	6.19L/min/m²	9.29m²
Sprinkler	248	57.66L/min	38.64L/min	28.8Kbar	4.008bar	6.21L/min/m²	9.29m²
Sprinkler	249	57.68L/min	38.64L/min	28.8Kbar	4.011bar	6.21L/min/m²	9.29m²
Sprinkler	250	57.74L/min	38.64L/min	28.8Kbar	4.020bar	6.22L/min/m²	9.29m²
Sprinkler	251	57.77L/min	38.64L/min	28.8Kbar	4.024bar	6.22L/min/m²	9.29m²
Sprinkler	252	57.83L/min	38.64L/min	28.8Kbar	4.032bar	6.22L/min/m²	9.29m²
Sprinkler	253	58.01L/min	38.64L/min	28.8Kbar	4.057bar	6.24L/min/m²	9.29m²
Sprinkler	254	58.50L/min	38.64L/min	28.8Kbar	4.126bar	6.30L/min/m²	9.29m²
Sprinkler	255	58.52L/min	38.64L/min	28.8Kbar	4.128bar	6.30L/min/m²	9.29m²
Sprinkler	256	58.52L/min	38.64L/min	28.8Kbar	4.128bar	6.30L/min/m²	9.29m²
Sprinkler	257	58.57L/min	38.64L/min	28.8Kbar	4.136bar	6.30L/min/m²	9.29m²
Sprinkler	258	58.79L/min	38.64L/min	28.8Kbar	4.167bar	6.33L/min/m²	9.29m²
Sprinkler	259	58.86L/min	38.64L/min	28.8Kbar	4.176bar	6.34L/min/m²	9.29m²
Sprinkler	260	59.20L/min	38.64L/min	28.8Kbar	4.226bar	6.37L/min/m²	9.29m²
Sprinkler	261	59.22L/min	38.64L/min	28.8Kbar	4.228bar	6.37L/min/m²	9.29m²
Sprinkler	262	59.23L/min	38.64L/min	28.8Kbar	4.230bar	6.38L/min/m²	9.29m²

Summary Of Outflowing Devices

Device		Actual Flow (L/min)	Minimum Flow (L/min)	K-Factor (K bar)	Pressure (bar)	Density (lpmpm2)	Coverage (Meter)
Sprinkler	263	59.58L/min	38.64L/min	28.8Kbar	4.279bar	6.41L/min/m²	9.29m²
Sprinkler	264	59.61L/min	38.64L/min	28.8Kbar	4.284bar	6.42L/min/m²	9.29m²
Sprinkler	265	60.17L/min	38.64L/min	28.8Kbar	4.364bar	6.48L/min/m²	9.29m²
Sprinkler	266	60.21L/min	38.64L/min	28.8Kbar	4.371bar	6.48L/min/m²	9.29m²
Sprinkler	267	60.34L/min	38.64L/min	28.8Kbar	4.389bar	6.49L/min/m²	9.29m²
Sprinkler	268	60.37L/min	38.64L/min	28.8Kbar	4.394bar	6.50L/min/m²	9.29m²
Sprinkler	269	60.40L/min	38.64L/min	28.8Kbar	4.398bar	6.50L/min/m²	9.29m²
Sprinkler	270	60.42L/min	38.64L/min	28.8Kbar	4.401bar	6.50L/min/m²	9.29m²
Sprinkler	271	66.54L/min	42.53L/min	31.7Kbar	4.406bar	7.16L/min/m²	9.29m²
Sprinkler	272	66.74L/min	42.53L/min	31.7Kbar	4.432bar	7.18L/min/m²	9.29m²
Sprinkler	273	60.73L/min	38.64L/min	28.8Kbar	4.446bar	6.54L/min/m²	9.29m²
Sprinkler	274	60.77L/min	38.64L/min	28.8Kbar	4.452bar	6.54L/min/m²	9.29m²
Sprinkler	275	67.31L/min	42.53L/min	31.7Kbar	4.508bar	7.25L/min/m²	9.29m²
Sprinkler	276	61.36L/min	38.64L/min	28.8Kbar	4.539bar	6.60L/min/m²	9.29m²
Sprinkler	277	61.54L/min	38.64L/min	28.8Kbar	4.566bar	6.62L/min/m²	9.29m²
Sprinkler	278	62.22L/min	38.64L/min	28.8Kbar	4.667bar	6.70L/min/m²	9.29m²
Sprinkler	279	62.79L/min	38.64L/min	28.8Kbar	4.753bar	6.76L/min/m²	9.29m²
Sprinkler	280	62.81L/min	38.64L/min	28.8Kbar	4.757bar	6.76L/min/m²	9.29m²
Sprinkler	281	62.91L/min	38.64L/min	28.8Kbar	4.771bar	6.77L/min/m²	9.29m²
Sprinkler	282	63.13L/min	38.64L/min	28.8Kbar	4.806bar	6.80L/min/m²	9.29m²
Sprinkler	283	63.14L/min	38.64L/min	28.8Kbar	4.806bar	6.80L/min/m²	9.29m²
Sprinkler	284	63.16L/min	38.64L/min	28.8Kbar	4.810bar	6.80L/min/m²	9.29m²
Sprinkler	285	69.57L/min	42.53L/min	31.7Kbar	4.816bar	7.49L/min/m²	9.29m²
Sprinkler	286	63.25L/min	38.64L/min	28.8Kbar	4.824bar	6.81L/min/m²	9.29m²
Sprinkler	287	63.48L/min	38.64L/min	28.8Kbar	4.859bar	6.83L/min/m²	9.29m²
Sprinkler	288	63.50L/min	38.64L/min	28.8Kbar	4.862bar	6.84L/min/m²	9.29m²
Sprinkler	289	63.53L/min	38.64L/min	28.8Kbar	4.865bar	6.84L/min/m²	9.29m²
Sprinkler	290	63.59L/min	38.64L/min	28.8Kbar	4.875bar	6.84L/min/m²	9.29m²
Sprinkler	291	63.61L/min	38.64L/min	28.8Kbar	4.878bar	6.85L/min/m²	9.29m²
Sprinkler	292	63.71L/min	38.64L/min	28.8Kbar	4.894bar	6.86L/min/m²	9.29m²
Sprinkler	293	63.74L/min	38.64L/min	28.8Kbar	4.898bar	6.86L/min/m²	9.29m²
Sprinkler	294	63.83L/min	38.64L/min	28.8Kbar	4.913bar	6.87L/min/m²	9.29m²
Sprinkler	295	63.86L/min	38.64L/min	28.8Kbar	4.917bar	6.87L/min/m²	9.29m²
Sprinkler	296	63.88L/min	38.64L/min	28.8Kbar	4.919bar	6.88L/min/m²	9.29m²
Sprinkler	297	63.89L/min	38.64L/min	28.8Kbar	4.921bar	6.88L/min/m²	9.29m²
Sprinkler	298	63.97L/min	38.64L/min	28.8Kbar	4.934bar	6.89L/min/m²	9.29m²
Sprinkler	299	63.98L/min	38.64L/min	28.8Kbar	4.936bar	6.89L/min/m²	9.29m²
Sprinkler	300	64.07L/min	38.64L/min	28.8Kbar	4.949bar	6.90L/min/m²	9.29m²
Sprinkler	301	64.22L/min	38.64L/min	28.8Kbar	4.972bar	6.91L/min/m²	9.29m²
Sprinkler	302	64.24L/min	38.64L/min	28.8Kbar	4.975bar	6.91L/min/m²	9.29m²
Sprinkler	303	64.46L/min	38.64L/min	28.8Kbar	5.010bar	6.94L/min/m²	9.29m²
Sprinkler	304	64.59L/min	38.64L/min	28.8Kbar	5.030bar	6.95L/min/m²	9.29m²
Sprinkler	305	64.61L/min	38.64L/min	28.8Kbar	5.033bar	6.95L/min/m²	9.29m²
Sprinkler	306	64.78L/min	38.64L/min	28.8Kbar	5.059bar	6.97L/min/m²	9.29m²
Sprinkler	307	65.18L/min	38.64L/min	28.8Kbar	5.123bar	7.02L/min/m²	9.29m²
Sprinkler	308	65.20L/min	38.64L/min	28.8Kbar	5.125bar	7.02L/min/m²	9.29m²
Sprinkler	309	71.88L/min	42.53L/min	31.7Kbar	5.142bar	7.74L/min/m²	9.29m²
Sprinkler	310	65.34L/min	38.64L/min	28.8Kbar	5.147bar	7.03L/min/m²	9.29m²
Sprinkler	311	65.56L/min	38.64L/min	28.8Kbar	5.182bar	7.06L/min/m²	9.29m²
Sprinkler	312	66.16L/min	38.64L/min	28.8Kbar	5.277bar	7.12L/min/m²	9.29m²
Sprinkler	313	66.31L/min	38.64L/min	28.8Kbar	5.301bar	7.14L/min/m²	9.29m²
Sprinkler	314	66.58L/min	38.64L/min	28.8Kbar	5.345bar	7.17L/min/m²	9.29m²
Sprinkler	315	67.21L/min	38.64L/min	28.8Kbar	5.445bar	7.23L/min/m²	9.29m²
Sprinkler	316	67.57L/min	38.64L/min	28.8Kbar	5.505bar	7.27L/min/m²	9.29m²
Sprinkler	317	68.19L/min	38.64L/min	28.8Kbar	5.606bar	7.34L/min/m²	9.29m²
Sprinkler	318	68.35L/min	38.64L/min	28.8Kbar	5.632bar	7.36L/min/m²	9.29m²
Sprinkler	319	77.80L/min	42.53L/min	31.7Kbar	6.024bar	8.37L/min/m²	9.29m²
Sprinkler	320	83.36L/min	42.53L/min	31.7Kbar	6.914bar	8.97L/min/m²	9.29m²

Most Demanding Sprinkler Data

Supply Analysis

Node	Name	Static (bar)	Residual (bar)	@ Flow (L/min)	Available (bar)	@ Total Demand (L/min)	Required Pressure (bar)
25	Water Supply	9.400bar	9.236bar	7315.58L/min	9.236bar	7315.58L/min	8.789bar

Node Analysis

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
25	2637mm	Supply	8.789bar	7315.58L/min	
201	5306mm	Sprinkler	1.800bar	48.30L/min	Density: 5.20L/min/m² Coverage: 9.29m²
202	5306mm	Sprinkler	1.803bar	48.34L/min	Density: 5.20L/min/m² Coverage: 9.29m²
203	5306mm	Sprinkler	1.863bar	49.14L/min	Density: 5.29L/min/m² Coverage: 9.29m²
204	5306mm	Sprinkler	1.877bar	49.32L/min	Density: 5.31L/min/m² Coverage: 9.29m²
205	5310mm	Sprinkler	2.006bar	50.99L/min	Density: 5.49L/min/m² Coverage: 9.29m²
206	5306mm	Sprinkler	2.202bar	53.41L/min	Density: 5.75L/min/m² Coverage: 9.29m²
207	5310mm	Sprinkler	2.206bar	53.47L/min	Density: 5.75L/min/m² Coverage: 9.29m²
208	5306mm	Sprinkler	2.206bar	53.47L/min	Density: 5.76L/min/m² Coverage: 9.29m²
209	5306mm	Sprinkler	2.244bar	53.93L/min	Density: 5.80L/min/m² Coverage: 9.29m²
210	5306mm	Sprinkler	2.335bar	55.01L/min	Density: 5.92L/min/m² Coverage: 9.29m²
211	5310mm	Sprinkler	2.340bar	55.07L/min	Density: 5.93L/min/m² Coverage: 9.29m²
212	5306mm	Sprinkler	2.405bar	55.83L/min	Density: 6.01L/min/m² Coverage: 9.29m²
213	5306mm	Sprinkler	2.410bar	55.88L/min	Density: 6.02L/min/m² Coverage: 9.29m²
214	5306mm	Sprinkler	2.451bar	56.36L/min	Density: 6.07L/min/m² Coverage: 9.29m²
215	5310mm	Sprinkler	2.492bar	56.84L/min	Density: 6.12L/min/m² Coverage: 9.29m²
216	5306mm	Sprinkler	2.504bar	56.96L/min	Density: 6.13L/min/m² Coverage: 9.29m²
217	5306mm	Sprinkler	2.540bar	57.37L/min	Density: 6.18L/min/m² Coverage: 9.29m²
218	5306mm	Sprinkler	2.550bar	57.48L/min	Density: 6.19L/min/m² Coverage: 9.29m²

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
219	5306mm	Sprinkler	2.554bar	57.53L/min	Density: 6.19L/min/m² Coverage: 9.29m²
220	5306mm	Sprinkler	2.603bar	58.08L/min	Density: 6.25L/min/m² Coverage: 9.29m²
221	5306mm	Sprinkler	2.706bar	59.22L/min	Density: 6.37L/min/m² Coverage: 9.29m²
222	5306mm	Sprinkler	2.719bar	59.37L/min	Density: 6.39L/min/m² Coverage: 9.29m²
223	5306mm	Sprinkler	2.732bar	59.51L/min	Density: 6.41L/min/m² Coverage: 9.29m²
224	5306mm	Sprinkler	2.735bar	59.53L/min	Density: 6.41L/min/m² Coverage: 9.29m²
225	5306mm	Sprinkler	2.784bar	60.07L/min	Density: 6.47L/min/m² Coverage: 9.29m²
226	5304mm	Sprinkler	2.796bar	60.20L/min	Density: 6.48L/min/m² Coverage: 9.29m²
227	5306mm	Sprinkler	2.895bar	61.25L/min	Density: 6.59L/min/m² Coverage: 9.29m²
228	5306mm	Sprinkler	2.896bar	61.26L/min	Density: 6.59L/min/m² Coverage: 9.29m²
229	5306mm	Sprinkler	2.947bar	61.80L/min	Density: 6.65L/min/m² Coverage: 9.29m²
230	5310mm	Sprinkler	2.956bar	61.90L/min	Density: 6.66L/min/m² Coverage: 9.29m²
231	5310mm	Sprinkler	2.969bar	62.03L/min	Density: 6.68L/min/m² Coverage: 9.29m²
232	5306mm	Sprinkler	3.029bar	62.65L/min	Density: 6.74L/min/m² Coverage: 9.29m²
233	5306mm	Sprinkler	3.116bar	63.55L/min	Density: 6.84L/min/m² Coverage: 9.29m²
234	5306mm	Sprinkler	3.118bar	55.98L/min	Density: 6.03L/min/m² Coverage: 9.29m²
235	5306mm	Sprinkler	3.121bar	56.00L/min	Density: 6.03L/min/m² Coverage: 9.29m²
236	5306mm	Sprinkler	3.165bar	56.39L/min	Density: 6.07L/min/m² Coverage: 9.29m²
237	5304mm	Sprinkler	3.234bar	64.74L/min	Density: 6.97L/min/m² Coverage: 9.29m²
238	5306mm	Sprinkler	3.264bar	57.27L/min	Density: 6.16L/min/m² Coverage: 9.29m²
239	5306mm	Sprinkler	3.362bar	66.01L/min	Density: 7.10L/min/m² Coverage: 9.29m²
240	5306mm	Sprinkler	3.461bar	58.98L/min	Density: 6.35L/min/m² Coverage: 9.29m²
241	5304mm	Sprinkler	3.714bar	61.09L/min	Density: 6.58L/min/m² Coverage: 9.29m²

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
242	14856mm	Sprinkler	3.971bar	57.39L/min	Density: 6.18L/min/m² Coverage: 9.29m²
243	14854mm	Sprinkler	3.974bar	57.41L/min	Density: 6.18L/min/m² Coverage: 9.29m²
244	14856mm	Sprinkler	3.975bar	57.42L/min	Density: 6.18L/min/m² Coverage: 9.29m²
245	14856mm	Sprinkler	3.978bar	57.44L/min	Density: 6.18L/min/m² Coverage: 9.29m²
246	14856mm	Sprinkler	3.983bar	57.47L/min	Density: 6.19L/min/m² Coverage: 9.29m²
247	14856mm	Sprinkler	3.985bar	57.49L/min	Density: 6.19L/min/m² Coverage: 9.29m²
248	14856mm	Sprinkler	4.008bar	57.66L/min	Density: 6.21L/min/m² Coverage: 9.29m²
249	14856mm	Sprinkler	4.011bar	57.68L/min	Density: 6.21L/min/m² Coverage: 9.29m²
250	14856mm	Sprinkler	4.020bar	57.74L/min	Density: 6.22L/min/m² Coverage: 9.29m²
251	14856mm	Sprinkler	4.024bar	57.77L/min	Density: 6.22L/min/m² Coverage: 9.29m²
252	14856mm	Sprinkler	4.032bar	57.83L/min	Density: 6.22L/min/m² Coverage: 9.29m²
253	14856mm	Sprinkler	4.057bar	58.01L/min	Density: 6.24L/min/m² Coverage: 9.29m²
254	14856mm	Sprinkler	4.126bar	58.50L/min	Density: 6.30L/min/m² Coverage: 9.29m²
255	14856mm	Sprinkler	4.128bar	58.52L/min	Density: 6.30L/min/m² Coverage: 9.29m²
256	14856mm	Sprinkler	4.128bar	58.52L/min	Density: 6.30L/min/m² Coverage: 9.29m²
257	14856mm	Sprinkler	4.136bar	58.57L/min	Density: 6.30L/min/m² Coverage: 9.29m²
258	14856mm	Sprinkler	4.167bar	58.79L/min	Density: 6.33L/min/m² Coverage: 9.29m²
259	14856mm	Sprinkler	4.176bar	58.86L/min	Density: 6.34L/min/m² Coverage: 9.29m²
260	14856mm	Sprinkler	4.226bar	59.20L/min	Density: 6.37L/min/m² Coverage: 9.29m²
261	14856mm	Sprinkler	4.228bar	59.22L/min	Density: 6.37L/min/m² Coverage: 9.29m²
262	14856mm	Sprinkler	4.230bar	59.23L/min	Density: 6.38L/min/m² Coverage: 9.29m²
263	14856mm	Sprinkler	4.279bar	59.58L/min	Density: 6.41L/min/m² Coverage: 9.29m²
264	14856mm	Sprinkler	4.284bar	59.61L/min	Density: 6.42L/min/m² Coverage: 9.29m²

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
265	14854mm	Sprinkler	4.364bar	60.17L/min	Density: 6.48L/min/m² Coverage: 9.29m²
266	14854mm	Sprinkler	4.371bar	60.21L/min	Density: 6.48L/min/m² Coverage: 9.29m²
267	14856mm	Sprinkler	4.389bar	60.34L/min	Density: 6.49L/min/m² Coverage: 9.29m²
268	14854mm	Sprinkler	4.394bar	60.37L/min	Density: 6.50L/min/m² Coverage: 9.29m²
269	14856mm	Sprinkler	4.398bar	60.40L/min	Density: 6.50L/min/m² Coverage: 9.29m²
270	14856mm	Sprinkler	4.401bar	60.42L/min	Density: 6.50L/min/m² Coverage: 9.29m²
271	5304mm	Sprinkler	4.406bar	66.54L/min	Density: 7.16L/min/m² Coverage: 9.29m²
272	5300mm	Sprinkler	4.432bar	66.74L/min	Density: 7.18L/min/m² Coverage: 9.29m²
273	14854mm	Sprinkler	4.446bar	60.73L/min	Density: 6.54L/min/m² Coverage: 9.29m²
274	14856mm	Sprinkler	4.452bar	60.77L/min	Density: 6.54L/min/m² Coverage: 9.29m²
275	5304mm	Sprinkler	4.508bar	67.31L/min	Density: 7.25L/min/m² Coverage: 9.29m²
276	14854mm	Sprinkler	4.539bar	61.36L/min	Density: 6.60L/min/m² Coverage: 9.29m²
277	14854mm	Sprinkler	4.566bar	61.54L/min	Density: 6.62L/min/m² Coverage: 9.29m²
278	14858mm	Sprinkler	4.667bar	62.22L/min	Density: 6.70L/min/m² Coverage: 9.29m²
279	19046mm	Sprinkler	4.753bar	62.79L/min	Density: 6.76L/min/m² Coverage: 9.29m²
280	19046mm	Sprinkler	4.757bar	62.81L/min	Density: 6.76L/min/m² Coverage: 9.29m²
281	19046mm	Sprinkler	4.771bar	62.91L/min	Density: 6.77L/min/m² Coverage: 9.29m²
282	19046mm	Sprinkler	4.806bar	63.13L/min	Density: 6.80L/min/m² Coverage: 9.29m²
283	19046mm	Sprinkler	4.806bar	63.14L/min	Density: 6.80L/min/m² Coverage: 9.29m²
284	19046mm	Sprinkler	4.810bar	63.16L/min	Density: 6.80L/min/m² Coverage: 9.29m²
285	5304mm	Sprinkler	4.816bar	69.57L/min	Density: 7.49L/min/m² Coverage: 9.29m²
286	19046mm	Sprinkler	4.824bar	63.25L/min	Density: 6.81L/min/m² Coverage: 9.29m²
287	19046mm	Sprinkler	4.859bar	63.48L/min	Density: 6.83L/min/m² Coverage: 9.29m²

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
288	14854mm	Sprinkler	4.862bar	63.50L/min	Density: 6.84L/min/m² Coverage: 9.29m²
289	19046mm	Sprinkler	4.865bar	63.53L/min	Density: 6.84L/min/m² Coverage: 9.29m²
290	14856mm	Sprinkler	4.875bar	63.59L/min	Density: 6.84L/min/m² Coverage: 9.29m²
291	14856mm	Sprinkler	4.878bar	63.61L/min	Density: 6.85L/min/m² Coverage: 9.29m²
292	19046mm	Sprinkler	4.894bar	63.71L/min	Density: 6.86L/min/m² Coverage: 9.29m²
293	19046mm	Sprinkler	4.898bar	63.74L/min	Density: 6.86L/min/m² Coverage: 9.29m²
294	19046mm	Sprinkler	4.913bar	63.83L/min	Density: 6.87L/min/m² Coverage: 9.29m²
295	19046mm	Sprinkler	4.917bar	63.86L/min	Density: 6.87L/min/m² Coverage: 9.29m²
296	19046mm	Sprinkler	4.919bar	63.88L/min	Density: 6.88L/min/m² Coverage: 9.29m²
297	19046mm	Sprinkler	4.921bar	63.89L/min	Density: 6.88L/min/m² Coverage: 9.29m²
298	14856mm	Sprinkler	4.934bar	63.97L/min	Density: 6.89L/min/m² Coverage: 9.29m²
299	19046mm	Sprinkler	4.936bar	63.98L/min	Density: 6.89L/min/m² Coverage: 9.29m²
300	19046mm	Sprinkler	4.949bar	64.07L/min	Density: 6.90L/min/m² Coverage: 9.29m²
301	19046mm	Sprinkler	4.972bar	64.22L/min	Density: 6.91L/min/m² Coverage: 9.29m²
302	19046mm	Sprinkler	4.975bar	64.24L/min	Density: 6.91L/min/m² Coverage: 9.29m²
303	19046mm	Sprinkler	5.010bar	64.46L/min	Density: 6.94L/min/m² Coverage: 9.29m²
304	19046mm	Sprinkler	5.030bar	64.59L/min	Density: 6.95L/min/m² Coverage: 9.29m²
305	19046mm	Sprinkler	5.033bar	64.61L/min	Density: 6.95L/min/m² Coverage: 9.29m²
306	14856mm	Sprinkler	5.059bar	64.78L/min	Density: 6.97L/min/m² Coverage: 9.29m²
307	19046mm	Sprinkler	5.123bar	65.18L/min	Density: 7.02L/min/m² Coverage: 9.29m²
308	19046mm	Sprinkler	5.125bar	65.20L/min	Density: 7.02L/min/m² Coverage: 9.29m²
309	5304mm	Sprinkler	5.142bar	71.88L/min	Density: 7.74L/min/m² Coverage: 9.29m²
310	19046mm	Sprinkler	5.147bar	65.34L/min	Density: 7.03L/min/m² Coverage: 9.29m²

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
311	19046mm	Sprinkler	5.182bar	65.56L/min	Density: 7.06L/min/m² Coverage: 9.29m²
312	19046mm	Sprinkler	5.277bar	66.16L/min	Density: 7.12L/min/m² Coverage: 9.29m²
313	19046mm	Sprinkler	5.301bar	66.31L/min	Density: 7.14L/min/m² Coverage: 9.29m²
314	14854mm	Sprinkler	5.345bar	66.58L/min	Density: 7.17L/min/m² Coverage: 9.29m²
315	19046mm	Sprinkler	5.445bar	67.21L/min	Density: 7.23L/min/m² Coverage: 9.29m²
316	19046mm	Sprinkler	5.505bar	67.57L/min	Density: 7.27L/min/m² Coverage: 9.29m²
317	19046mm	Sprinkler	5.606bar	68.19L/min	Density: 7.34L/min/m² Coverage: 9.29m²
318	19046mm	Sprinkler	5.632bar	68.35L/min	Density: 7.36L/min/m² Coverage: 9.29m²
319	5304mm	Sprinkler	6.024bar	77.80L/min	Density: 8.37L/min/m² Coverage: 9.29m²
320	5304mm	Sprinkler	6.914bar	83.36L/min	Density: 8.97L/min/m² Coverage: 9.29m²
1	5506mm		1.792bar		
2	5506mm		1.803bar		
3	5506mm		1.861bar		
4	5506mm		1.881bar		
5	5506mm		2.013bar		
6	5506mm		2.214bar		
7	5506mm		2.504bar		
8	5506mm		3.001bar		
9	5506mm		3.062bar		
10	5506mm		3.151bar		
11	5506mm		3.271bar		
12	5506mm		3.400bar		
13	5506mm		3.489bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
14	5506mm		3.744bar		
15	5506mm		4.429bar		
16	5506mm		4.523bar		
17	5506mm		4.558bar		
18	5506mm		4.833bar		
19	5506mm		5.161bar		
20	5506mm		6.046bar		
21	5506mm		7.044bar		
22	5506mm		8.114bar		
23	7577mm		7.968bar		
24	7577mm		8.147bar		
26	5506mm		1.795bar		
27	5506mm		1.856bar		
28	5506mm		2.210bar		
29	5506mm		2.253bar		
30	5506mm		2.345bar		
31	5506mm		2.409bar		
32	5506mm		2.552bar		
33	5506mm		2.979bar		
34	5506mm		2.988bar		
35	5506mm		2.200bar		
36	5506mm		2.416bar		
37	5506mm		2.462bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
38	5506mm		2.562bar		
39	5506mm		2.734bar		
40	5506mm		2.405bar		
41	5506mm		2.567bar		
42	5506mm		2.615bar		
43	5506mm		2.720bar		
44	5506mm		2.879bar		
45	5506mm		2.912bar		
46	5506mm		2.747bar		
47	5506mm		2.799bar		
48	5506mm		2.911bar		
49	5506mm		2.732bar		
50	5506mm		2.964bar		
51	5506mm		2.973bar		
52	5506mm		2.986bar		
53	5506mm		3.047bar		
54	5506mm		3.135bar		
55	5506mm		3.129bar		
56	5506mm		3.176bar		
57	5506mm		3.276bar		
58	5506mm		3.116bar		
59	5506mm		3.254bar		
60	5506mm		3.383bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
61	5506mm		3.475bar		
62	5506mm		3.730bar		
63	15056mm		3.983bar		
64	15056mm		4.032bar		
65	15056mm		4.240bar		
66	15056mm		4.464bar		
67	15056mm		4.538bar		
68	15056mm		4.548bar		
69	15056mm		4.649bar		
70	15056mm		4.678bar		
71	15056mm		4.837bar		
72	15056mm		4.873bar		
73	15056mm		5.378bar		
74	15056mm		6.626bar		
75	15056mm		7.072bar		
76	15056mm		3.969bar		
77	15056mm		3.988bar		
78	15056mm		4.037bar		
79	15056mm		4.142bar		
80	15056mm		4.373bar		
81	15056mm		4.373bar		
82	15056mm		4.380bar		
83	15056mm		4.381bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
84	15056mm		4.403bar		
85	15056mm		4.405bar		
86	15056mm		4.455bar		
87	15056mm		3.974bar		
88	15056mm		3.995bar		
89	15056mm		4.044bar		
90	15056mm		4.149bar		
91	15056mm		3.981bar		
92	15056mm		4.021bar		
93	15056mm		4.070bar		
94	15056mm		4.181bar		
95	15056mm		4.007bar		
96	15056mm		4.139bar		
97	15056mm		4.190bar		
98	15056mm		4.299bar		
99	15056mm		4.125bar		
100	15056mm		4.242bar		
101	15056mm		4.294bar		
102	15056mm		4.405bar		
103	15056mm		4.227bar		
104	15056mm		4.362bar		
105	15056mm		4.369bar		
106	15056mm		4.392bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
107	15056mm		4.414bar		
108	15056mm		4.468bar		
109	15056mm		4.583bar		
110	15056mm		4.399bar		
111	5506mm		4.428bar		
112	15056mm		4.444bar		
113	5506mm		4.510bar		
114	15056mm		4.537bar		
115	15056mm		4.665bar		
116	19272mm		5.057bar		
117	19272mm		5.113bar		
118	19272mm		5.232bar		
119	19272mm		5.435bar		
120	19272mm		5.440bar		
121	19272mm		5.456bar		
122	19272mm		5.495bar		
123	19272mm		5.563bar		
124	19272mm		5.688bar		
125	19272mm		5.859bar		
126	19272mm		6.237bar		
127	19272mm		6.650bar		
128	19272mm		5.061bar		
129	19272mm		5.118bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
130	19272mm		5.236bar		
131	19272mm		5.077bar		
132	19272mm		5.133bar		
133	19272mm		5.252bar		
134	19272mm		5.114bar		
135	19272mm		5.170bar		
136	19272mm		5.290bar		
137	5506mm		4.819bar		
138	15056mm		4.861bar		
139	19272mm		5.177bar		
140	19272mm		5.234bar		
141	19272mm		5.355bar		
142	15056mm		4.894bar		
143	15056mm		4.953bar		
144	15056mm		5.079bar		
145	15056mm		5.359bar		
146	15056mm		5.359bar		
147	15056mm		4.877bar		
148	19272mm		5.042bar		
149	19272mm		5.046bar		
150	19272mm		5.061bar		
151	19272mm		5.098bar		
152	19272mm		5.294bar		

Node Number	Elevation (Millimeter)	Node Type	Pressure at Node (bar)	Discharge at Node (L/min)	Notes
153	19272mm		5.352bar		
154	19272mm		5.476bar		
155	19272mm		5.161bar		
156	19272mm		5.277bar		
157	19272mm		5.453bar		
158	19272mm		5.513bar		
159	19272mm		5.641bar		
160	5506mm		5.146bar		
161	19272mm		5.436bar		
162	15056mm		5.346bar		
163	19272mm		5.794bar		
164	19272mm		5.857bar		
165	19272mm		5.992bar		
166	19272mm		6.222bar		
167	19272mm		5.776bar		
168	5506mm		6.032bar		
169	5506mm		6.041bar		

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
201	5306mm	36Kbar	48.30L/min	25	(See Notes)	200mm	100	1.800bar	• • • • • Route 1 • • • • • Sprinkler,
						435mm	0.000018	-0.020bar	E(435mm)
1	5506mm		48.30L/min	26.6446		635mm		0.011bar	
1	5506mm			32	(See Notes)	1166mm	100	1.792bar	
						1304mm	0.000005		T(1304mm)
2	5506mm		48.30L/min	35.0520		2470mm		0.012bar	
2	5506mm		48.34L/min	32	(See Notes)	2089mm	100	1.803bar	Flow (q) from Route 2
						1304mm	0.000017		T(1304mm)
3	5506mm		96.64L/min	35.0520		3393mm		0.058bar	
3	5506mm		49.14L/min	32		550mm	100	1.861bar	Flow (q) from Route 3
							0.000036		
4	5506mm		145.78L/min	35.0520		550mm		0.020bar	
4	5506mm		49.32L/min	32		2100mm	100	1.881bar	Flow (q) from Route 4
							0.000063		
5	5506mm		195.10L/min	35.0520		2100mm		0.131bar	
5	5506mm		50.99L/min	32		2100mm	100	2.013bar	Flow (q) from Route 5
							0.000096		
6	5506mm		246.09L/min	35.0520		2100mm		0.202bar	
6	5506mm		53.47L/min	32		2100mm	100	2.214bar	Flow (q) from Route 7
							0.000138		
7	5506mm		299.56L/min	35.0520		2100mm		0.290bar	
7	5506mm		56.84L/min	32	(See Notes)	1302mm	100	2.504bar	Flow (q) from Route 15
						1304mm	0.000191		PO(1304mm)
8	5506mm		356.39L/min	35.0520		2606mm		0.497bar	
8	5506mm		)6L/min + 62.03	80		3000mm	100	3.001bar	Flow (q) from Route 6 and 31
							0.000020		
9	5506mm		870.38L/min	77.9272		3000mm		0.061bar	
9	5506mm		)3L/min + 62.65	80		2350mm	100	3.062bar	Flow (q) from Route 12 and 32
							0.000038		
10	5506mm		1217.96L/min	77.9272		2350mm		0.089bar	
10	5506mm		6L/min + 63.55	80		2100mm	100	3.151bar	Flow (q) from Route 23 and 33
							0.000057		
11	5506mm		1521.87L/min	77.9272		2100mm		0.120bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
11	5506mm		64.74L/min	80		2100mm	100	3.271bar	Flow (q) from Route 37
							0.000062		
12	5506mm		1586.61L/min	77.9272		2100mm		0.129bar	
12	5506mm		25L/min + 66.01	80		933mm	100	3.400bar	Flow (q) from Route 16 and 39
							0.000095		
13	5506mm		2005.87L/min	77.9272		933mm		0.089bar	
13	5506mm		34L/min + 58.98	80		2100mm	100	3.489bar	Flow (q) from Route 34 and 40
							0.000122		
14	5506mm		2290.48L/min	77.9272		2100mm		0.255bar	
14	5506mm		61.09L/min	80	(See Notes)	2100mm	100	3.744bar	Flow (q) from Route 41
						3260mm	0.000128		T(3260mm)
15	5506mm		2351.57L/min	77.9272		5360mm		0.684bar	
15	5506mm		66.54L/min	80		700mm	100	4.429bar	Flow (q) from Route 71
							0.000134		
16	5506mm		2418.11L/min	77.9272		700mm		0.094bar	
16	5506mm		67.31L/min	80		250mm	100	4.523bar	Flow (q) from Route 75
							0.000141		
17	5506mm		2485.42L/min	77.9272		250mm		0.035bar	
17	5506mm		66.74L/min	80		1850mm	100	4.558bar	Flow (q) from Route 72
							0.000149		
18	5506mm		2552.15L/min	77.9272		1850mm		0.275bar	
18	5506mm		69.57L/min	80		2100mm	100	4.833bar	Flow (q) from Route 85
							0.000156		
19	5506mm		2621.72L/min	77.9272		2100mm		0.328bar	
19	5506mm		71.88L/min	80	(See Notes)	2131mm	100	5.161bar	Flow (q) from Route 109
						3260mm	0.000164		T(3260mm)
20	5506mm		2693.61L/min	77.9272		5391mm		0.885bar	
20	5506mm		77.80L/min	80	(See Notes)	2571mm	100	6.046bar	Flow (q) from Route 119
						3200mm	0.000173		2E(1600mm)
21	5506mm		2771.41L/min	77.9272		5771mm		0.999bar	
21	5506mm		83.36L/min	80	(See Notes)	1567mm	100	7.044bar	Flow (q) from Route 120
						4287mm	0.000183		2E(1600mm), LtE(1087mm)
22	5506mm		2854.77L/min	77.9272		5853mm		1.070bar	

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
22	5506mm			150	(See Notes)	2071mm	100	8.114bar	
23	7577mm		2854.77L/min	154.0510		6520mm	0.000007	-0.203bar	T(6520mm)
						8591mm		0.057bar	
23	7577mm		4460.81L/min	200	(See Notes)	12442mm	100	7.968bar	Flow (q) from Route 42
24	7577mm		7315.58L/min	202.7174		5650mm	0.000010		2LtE(2825mm)
						18093mm		0.179bar	
24	7577mm			200	(See Notes)	12120mm	120	8.147bar	
25	2637mm		7315.58L/min	209.5246		13962mm	0.000006	0.484bar	3LtE(4654mm), S
						26082mm		0.157bar	
			0.00L/min					8.789bar	Hose Allowance At Source
25			7315.58L/min						Total(Pt) Route 1
202	5306mm	36Kbar	48.34L/min	25	(See Notes)	200mm	100	1.803bar	• • • • • Route 2 • • • • • Sprinkler,
26	5506mm		48.34L/min	26.6446		435mm	0.000018	-0.020bar	E(435mm)
						635mm		0.011bar	
26	5506mm			32	(See Notes)	550mm	100	1.795bar	
2	5506mm		48.34L/min	35.0520		1304mm	0.000005		T(1304mm)
						1854mm		0.009bar	
								1.803bar	Total(Pt) Route 2
203	5306mm	36Kbar	49.14L/min	25	(See Notes)	200mm	100	1.863bar	• • • • • Route 3 • • • • • Sprinkler,
27	5506mm		49.14L/min	26.6446		435mm	0.000019	-0.020bar	E(435mm)
						635mm		0.012bar	
27	5506mm			32		1166mm	100	1.856bar	
3	5506mm		49.14L/min	35.0520			0.000005		
						1166mm		0.006bar	
								1.861bar	Total(Pt) Route 3
204	5306mm	36Kbar	49.32L/min	25	(See Notes)	200mm	100	1.877bar	• • • • • Route 4 • • • • • Sprinkler,
4	5506mm		49.32L/min	26.6446		1087mm	0.000019	-0.020bar	T(1087mm)
						1287mm		0.024bar	
								1.881bar	Total(Pt) Route 4
205	5310mm	36Kbar	50.99L/min	25	(See Notes)	196mm	100	2.006bar	• • • • • Route 5 • • • • • Sprinkler,
5	5506mm		50.99L/min	26.6446		1087mm	0.000020	-0.019bar	T(1087mm)
						1283mm		0.025bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
								2.013bar	Total(Pt) Route 5
206	5306mm	36Kbar	53.41L/min	25	(See Notes)	200mm	100	2.202bar	• • • • • Route 6 • • • • • Sprinkler,
28	5506mm		53.41L/min	26.6446		1087mm	0.000022	-0.020bar	T(1087mm)
						1287mm		0.028bar	
28	5506mm		53.47L/min	32		2100mm	100	2.210bar	Flow (q) from Route 8
29	5506mm		106.88L/min	35.0520			0.000021		
						2100mm		0.043bar	
29	5506mm		53.93L/min	32		2100mm	100	2.253bar	Flow (q) from Route 9
30	5506mm		160.81L/min	35.0520			0.000044		
						2100mm		0.092bar	
30	5506mm		55.01L/min	32		851mm	100	2.345bar	Flow (q) from Route 10
31	5506mm		215.82L/min	35.0520			0.000075		
						851mm		0.064bar	
31	5506mm		55.07L/min	32		1249mm	100	2.409bar	Flow (q) from Route 11
32	5506mm		270.89L/min	35.0520			0.000115		
						1249mm		0.143bar	
32	5506mm		57.37L/min	32	(See Notes)	1302mm	100	2.552bar	Flow (q) from Route 17
33	5506mm		328.27L/min	35.0520		1304mm	0.000164		PO(1304mm)
						2606mm		0.426bar	
33	5506mm		61.80L/min	80		2117mm	100	2.979bar	Flow (q) from Route 29
34	5506mm		390.06L/min	77.9272			0.000005		
						2117mm		0.010bar	
34	5506mm		61.90L/min	80		2100mm	100	2.988bar	Flow (q) from Route 30
8	5506mm		451.96L/min	77.9272			0.000006		
						2100mm		0.013bar	
								3.001bar	Total(Pt) Route 6
207	5310mm	36Kbar	53.47L/min	25	(See Notes)	196mm	100	2.206bar	• • • • • Route 7 • • • • • Sprinkler,
6	5506mm		53.47L/min	26.6446		1087mm	0.000022	-0.019bar	T(1087mm)
						1283mm		0.028bar	
								2.214bar	Total(Pt) Route 7
208	5306mm	36Kbar	53.47L/min	25	(See Notes)	200mm	100	2.206bar	• • • • • Route 8 • • • • • Sprinkler,
35	5506mm		53.47L/min	26.6446		435mm	0.000022	-0.020bar	E(435mm)
						635mm		0.014bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
35	5506mm			32		1716mm	100	2.200bar	
28	5506mm		53.47L/min	35.0520			0.000006		
						1716mm		0.010bar	
								2.210bar	Total(Pt) Route 8
209	5306mm	36Kbar	53.93L/min	25	(See Notes)	200mm	100	2.244bar	• • • • • Route 9 • • • • • Sprinkler,
29	5506mm		53.93L/min	26.6446		1087mm	0.000022	-0.020bar	T(1087mm)
						1287mm		0.028bar	
								2.253bar	Total(Pt) Route 9
210	5306mm	36Kbar	55.01L/min	25	(See Notes)	200mm	100	2.335bar	• • • • • Route 10 • • • • • Sprinkler,
30	5506mm		55.01L/min	26.6446		1087mm	0.000023	-0.020bar	T(1087mm)
						1287mm		0.029bar	
								2.345bar	Total(Pt) Route 10
211	5310mm	36Kbar	55.07L/min	25	(See Notes)	2313mm	100	2.340bar	• • • • • Route 11 • • • • • Sprinkler,
31	5506mm		55.07L/min	26.6446		1521mm	0.000023	-0.019bar	E(435mm), T(1087mm)
						3834mm		0.088bar	
								2.409bar	Total(Pt) Route 11
212	5306mm	36Kbar	55.83L/min	25	(See Notes)	200mm	100	2.405bar	• • • • • Route 12 • • • • • Sprinkler,
36	5506mm		55.83L/min	26.6446		1087mm	0.000023	-0.020bar	T(1087mm)
						1287mm		0.030bar	
36	5506mm		55.88L/min	32		2100mm	100	2.416bar	Flow (q) from Route 13
37	5506mm		111.71L/min	35.0520			0.000022		
						2100mm		0.047bar	
37	5506mm		56.36L/min	32		2100mm	100	2.462bar	Flow (q) from Route 14
38	5506mm		168.08L/min	35.0520			0.000047		
						2100mm		0.100bar	
38	5506mm		57.48L/min	32		2100mm	100	2.562bar	Flow (q) from Route 18
39	5506mm		225.56L/min	35.0520			0.000082		
						2100mm		0.172bar	
39	5506mm		59.37L/min	32	(See Notes)	1302mm	100	2.734bar	Flow (q) from Route 22
9	5506mm		284.93L/min	35.0520		1304mm	0.000126		PO(1304mm)
						2606mm		0.328bar	
								3.062bar	Total(Pt) Route 12

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
213	5306mm	36Kbar	55.88L/min	25	(See Notes)	200mm	100	2.410bar	• • • • • Route 13 • • • • • Sprinkler,
						435mm	0.000024	-0.020bar	E(435mm)
40	5506mm		55.88L/min	26.6446		635mm		0.015bar	
40	5506mm			32		1716mm	100	2.405bar	
							0.000006		
36	5506mm		55.88L/min	35.0520		1716mm		0.011bar	
								2.416bar	Total(Pt) Route 13
214	5306mm	36Kbar	56.36L/min	25	(See Notes)	200mm	100	2.451bar	• • • • • Route 14 • • • • • Sprinkler,
						1087mm	0.000024	-0.020bar	T(1087mm)
37	5506mm		56.36L/min	26.6446		1287mm		0.031bar	
								2.462bar	Total(Pt) Route 14
215	5310mm	36Kbar	56.84L/min	25	(See Notes)	196mm	100	2.492bar	• • • • • Route 15 • • • • • Sprinkler,
						1087mm	0.000024	-0.019bar	T(1087mm)
7	5506mm		56.84L/min	26.6446		1283mm		0.031bar	
								2.504bar	Total(Pt) Route 15
216	5306mm	36Kbar	56.96L/min	25	(See Notes)	2518mm	100	2.504bar	• • • • • Route 16 • • • • • Sprinkler,
						869mm	0.000024	-0.020bar	2E(435mm)
41	5506mm		56.96L/min	26.6446		3387mm		0.083bar	
41	5506mm		57.53L/min	32		2100mm	100	2.567bar	Flow (q) from Route 19
							0.000023		
42	5506mm		114.50L/min	35.0520		2100mm		0.049bar	
42	5506mm		58.08L/min	32		2100mm	100	2.615bar	Flow (q) from Route 20
							0.000050		
43	5506mm		172.57L/min	35.0520		2100mm		0.105bar	
43	5506mm		59.22L/min	32		1852mm	100	2.720bar	Flow (q) from Route 21
							0.000086		
44	5506mm		231.79L/min	35.0520		1852mm		0.159bar	
44	5506mm		60.20L/min	32		248mm	100	2.879bar	Flow (q) from Route 26
							0.000132		
45	5506mm		291.99L/min	35.0520		248mm		0.033bar	
45	5506mm		61.26L/min	32	(See Notes)	1300mm	100	2.912bar	Flow (q) from Route 28
						1304mm	0.000187		PO(1304mm)
12	5506mm		353.25L/min	35.0520		2604mm		0.488bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
								3.400bar	Total(Pt) Route 16
217	5306mm	36Kbar	57.37L/min	25	(See Notes)	200mm	100	2.540bar	• • • • • Route 17 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
32	5506mm		57.37L/min	26.6446		1287mm		0.032bar	
								2.552bar	Total(Pt) Route 17
218	5306mm	36Kbar	57.48L/min	25	(See Notes)	200mm	100	2.550bar	• • • • • Route 18 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
38	5506mm		57.48L/min	26.6446		1287mm		0.032bar	
								2.562bar	Total(Pt) Route 18
219	5306mm	36Kbar	57.53L/min	25	(See Notes)	200mm	100	2.554bar	• • • • • Route 19 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
41	5506mm		57.53L/min	26.6446		1287mm		0.032bar	
								2.567bar	Total(Pt) Route 19
220	5306mm	36Kbar	58.08L/min	25	(See Notes)	200mm	100	2.603bar	• • • • • Route 20 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
42	5506mm		58.08L/min	26.6446		1287mm		0.032bar	
								2.615bar	Total(Pt) Route 20
221	5306mm	36Kbar	59.22L/min	25	(See Notes)	200mm	100	2.706bar	• • • • • Route 21 • • • • • Sprinkler,
						1087mm	0.000026	-0.020bar	T(1087mm)
43	5506mm		59.22L/min	26.6446		1287mm		0.034bar	
								2.720bar	Total(Pt) Route 21
222	5306mm	36Kbar	59.37L/min	25	(See Notes)	200mm	100	2.719bar	• • • • • Route 22 • • • • • Sprinkler,
						1087mm	0.000026	-0.020bar	T(1087mm)
39	5506mm		59.37L/min	26.6446		1287mm		0.034bar	
								2.734bar	Total(Pt) Route 22
223	5306mm	36Kbar	59.51L/min	25	(See Notes)	200mm	100	2.732bar	• • • • • Route 23 • • • • • Sprinkler,
						1087mm	0.000026	-0.020bar	T(1087mm)
46	5506mm		59.51L/min	26.6446		1287mm		0.034bar	
46	5506mm		59.53L/min	32		2100mm	100	2.747bar	Flow (q) from Route 24
							0.000025		
47	5506mm		119.04L/min	35.0520		2100mm		0.053bar	

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
47	5506mm		60.07L/min	32		2100mm	100	2.799bar	Flow (q) from Route 25
							0.000053		
48	5506mm		179.11L/min	35.0520		2100mm		0.112bar	
48	5506mm		61.25L/min	32	(See Notes)	1300mm	100	2.911bar	Flow (q) from Route 27
						1304mm	0.000092		PO(1304mm)
10	5506mm		240.36L/min	35.0520		2604mm		0.239bar	
								3.151bar	Total(Pt) Route 23
224	5306mm	36Kbar	59.53L/min	25	(See Notes)	200mm	100	2.735bar	• • • • • Route 24 • • • • • Sprinkler,
						435mm	0.000026	-0.020bar	E(435mm)
49	5506mm		59.53L/min	26.6446		635mm		0.017bar	
49	5506mm			32		2100mm	100	2.732bar	
							0.000007		
46	5506mm		59.53L/min	35.0520		2100mm		0.015bar	
								2.747bar	Total(Pt) Route 24
225	5306mm	36Kbar	60.07L/min	25	(See Notes)	200mm	100	2.784bar	• • • • • Route 25 • • • • • Sprinkler,
						1087mm	0.000027	-0.020bar	T(1087mm)
47	5506mm		60.07L/min	26.6446		1287mm		0.035bar	
								2.799bar	Total(Pt) Route 25
226	5304mm	36Kbar	60.20L/min	25	(See Notes)	2302mm	100	2.796bar	• • • • • Route 26 • • • • • Sprinkler,
						1521mm	0.000027	-0.020bar	E(435mm), T(1087mm)
44	5506mm		60.20L/min	26.6446		3824mm		0.103bar	
								2.879bar	Total(Pt) Route 26
227	5306mm	36Kbar	61.25L/min	25	(See Notes)	200mm	100	2.895bar	• • • • • Route 27 • • • • • Sprinkler,
						1087mm	0.000028	-0.020bar	T(1087mm)
48	5506mm		61.25L/min	26.6446		1287mm		0.036bar	
								2.911bar	Total(Pt) Route 27
228	5306mm	36Kbar	61.26L/min	25	(See Notes)	200mm	100	2.896bar	• • • • • Route 28 • • • • • Sprinkler,
						1087mm	0.000028	-0.020bar	T(1087mm)
45	5506mm		61.26L/min	26.6446		1287mm		0.036bar	
								2.912bar	Total(Pt) Route 28
229	5306mm	36Kbar	61.80L/min	25	(See Notes)	200mm	100	2.947bar	• • • • • Route 29 • • • • • Sprinkler,
						1087mm	0.000028	-0.020bar	T(1087mm)
50	5506mm		61.80L/min	26.6446		1287mm		0.036bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
50	5506mm			32	(See Notes)	700mm	100	2.964bar	
						1304mm	0.000007		PO(1304mm)
33	5506mm		61.80L/min	35.0520		2004mm		0.015bar	
								2.979bar	Total(Pt) Route 29
230	5310mm	36Kbar	61.90L/min	25	(See Notes)	196mm	100	2.956bar	• • • • • Route 30 • • • • • Sprinkler,
						1087mm	0.000028	-0.019bar	T(1087mm)
51	5506mm		61.90L/min	26.6446		1283mm		0.036bar	
51	5506mm			32	(See Notes)	700mm	100	2.973bar	
						1304mm	0.000007		PO(1304mm)
34	5506mm		61.90L/min	35.0520		2004mm		0.015bar	
								2.988bar	Total(Pt) Route 30
231	5310mm	36Kbar	62.03L/min	25	(See Notes)	196mm	100	2.969bar	• • • • • Route 31 • • • • • Sprinkler,
						1087mm	0.000029	-0.019bar	T(1087mm)
52	5506mm		62.03L/min	26.6446		1283mm		0.037bar	
52	5506mm			32	(See Notes)	700mm	100	2.986bar	
						1304mm	0.000008		PO(1304mm)
8	5506mm		62.03L/min	35.0520		2004mm		0.015bar	
								3.001bar	Total(Pt) Route 31
232	5306mm	36Kbar	62.65L/min	25	(See Notes)	200mm	100	3.029bar	• • • • • Route 32 • • • • • Sprinkler,
						1087mm	0.000029	-0.020bar	T(1087mm)
53	5506mm		62.65L/min	26.6446		1287mm		0.037bar	
53	5506mm			32	(See Notes)	700mm	100	3.047bar	
						1304mm	0.000008		PO(1304mm)
9	5506mm		62.65L/min	35.0520		2004mm		0.015bar	
								3.062bar	Total(Pt) Route 32
233	5306mm	36Kbar	63.55L/min	25	(See Notes)	200mm	100	3.116bar	• • • • • Route 33 • • • • • Sprinkler,
						1087mm	0.000030	-0.020bar	T(1087mm)
54	5506mm		63.55L/min	26.6446		1287mm		0.038bar	
54	5506mm			32	(See Notes)	700mm	100	3.135bar	
						1304mm	0.000008		PO(1304mm)
10	5506mm		63.55L/min	35.0520		2004mm		0.016bar	
								3.151bar	Total(Pt) Route 33

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
234	5306mm	31.7Kbar	55.98L/min	25	(See Notes)	200mm	100	3.118bar	• • • • • **Route 34** • • • • • Sprinkler,
						1087mm	0.000024	-0.020bar	T(1087mm)
55	5506mm		55.98L/min	26.6446		1287mm		0.030bar	
55	5506mm		56.00L/min	32		2100mm	100	3.129bar	Flow (q) from Route 35
							0.000022		
56	5506mm		111.98L/min	35.0520		2100mm		0.047bar	
56	5506mm		56.39L/min	32		2100mm	100	3.176bar	Flow (q) from Route 36
							0.000048		
57	5506mm		168.37L/min	35.0520		2100mm		0.100bar	
57	5506mm		57.27L/min	32	(See Notes)	1300mm	100	3.276bar	Flow (q) from Route 38
						1304mm	0.000082		PO(1304mm)
13	5506mm		225.64L/min	35.0520		2604mm		0.213bar	
								3.489bar	Total(Pt) Route 34
235	5306mm	31.7Kbar	56.00L/min	25	(See Notes)	200mm	100	3.121bar	• • • • • **Route 35** • • • • • Sprinkler,
						435mm	0.000024	-0.020bar	E(435mm)
58	5506mm		56.00L/min	26.6446		635mm		0.015bar	
58	5506mm			32		2100mm	100	3.116bar	
							0.000006		
55	5506mm		56.00L/min	35.0520		2100mm		0.013bar	
								3.129bar	Total(Pt) Route 35
236	5306mm	31.7Kbar	56.39L/min	25	(See Notes)	200mm	100	3.165bar	• • • • • **Route 36** • • • • • Sprinkler,
						1087mm	0.000024	-0.020bar	T(1087mm)
56	5506mm		56.39L/min	26.6446		1287mm		0.031bar	
								3.176bar	Total(Pt) Route 36
237	5304mm	36Kbar	64.74L/min	25	(See Notes)	202mm	100	3.234bar	• • • • • **Route 37** • • • • • Sprinkler,
						1087mm	0.000031	-0.020bar	T(1087mm)
59	5506mm		64.74L/min	26.6446		1289mm		0.040bar	
59	5506mm			32	(See Notes)	700mm	100	3.254bar	
						1304mm	0.000008		PO(1304mm)
11	5506mm		64.74L/min	35.0520		2004mm		0.016bar	
								3.271bar	Total(Pt) Route 37

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
238	5306mm	31.7Kbar	57.27L/min	25	(See Notes)	200mm	100	3.264bar	• • • • • Route 38 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
57	5506mm		57.27L/min	26.6446		1287mm		0.032bar	
								3.276bar	Total(Pt) Route 38
239	5306mm	36Kbar	66.01L/min	25	(See Notes)	200mm	100	3.362bar	• • • • • Route 39 • • • • • Sprinkler,
						1087mm	0.000032	-0.020bar	T(1087mm)
60	5506mm		66.01L/min	26.6446		1287mm		0.041bar	
60	5506mm			32	(See Notes)	700mm	100	3.383bar	
						1304mm	0.000008		PO(1304mm)
12	5506mm		66.01L/min	35.0520		2004mm		0.017bar	
								3.400bar	Total(Pt) Route 39
240	5306mm	31.7Kbar	58.98L/min	25	(See Notes)	200mm	100	3.461bar	• • • • • Route 40 • • • • • Sprinkler,
						1087mm	0.000026	-0.020bar	T(1087mm)
61	5506mm		58.98L/min	26.6446		1287mm		0.033bar	
61	5506mm			32	(See Notes)	700mm	100	3.475bar	
						1304mm	0.000007		PO(1304mm)
13	5506mm		58.98L/min	35.0520		2004mm		0.014bar	
								3.489bar	Total(Pt) Route 40
241	5304mm	31.7Kbar	61.09L/min	25	(See Notes)	202mm	100	3.714bar	• • • • • Route 41 • • • • • Sprinkler,
						1087mm	0.000028	-0.020bar	T(1087mm)
62	5506mm		61.09L/min	26.6446		1289mm		0.036bar	
62	5506mm			32	(See Notes)	700mm	100	3.730bar	
						1304mm	0.000007		PO(1304mm)
14	5506mm		61.09L/min	35.0520		2004mm		0.015bar	
								3.744bar	Total(Pt) Route 41
242	14856mm	28.8Kbar	57.39L/min	25	(See Notes)	200mm	100	3.971bar	• • • • • Route 42 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
63	15056mm		57.39L/min	26.6446		1287mm		0.032bar	
63	15056mm		57.41L/min	32		2100mm	100	3.983bar	Flow (q) from Route 43
							0.000023		
64	15056mm		114.80L/min	35.0520		2100mm		0.049bar	

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
64	15056mm		57.74L/min	32	(See Notes)	2866mm	100	4.032bar	Flow (q) from Route 50
						1304mm	0.000050		2E(652mm)
65	15056mm		172.54L/min	35.0520		4170mm		0.208bar	
65	15056mm		59.20L/min	32	(See Notes)	1300mm	100	4.240bar	Flow (q) from Route 60
						1304mm	0.000086		PO(1304mm)
66	15056mm		231.75L/min	35.0520		2604mm		0.224bar	
66	15056mm		936.14L/min	80		2120mm	100	4.464bar	Flow (q) from Route 44
							0.000035		
67	15056mm		1167.88L/min	77.9272		2120mm		0.074bar	
67	15056mm		235.48L/min	80		213mm	100	4.538bar	Flow (q) from Route 54
							0.000049		
68	15056mm		1403.37L/min	77.9272		213mm		0.010bar	
68	15056mm		61.36L/min	80		1901mm	100	4.548bar	Flow (q) from Route 76
							0.000053		
69	15056mm		1464.72L/min	77.9272		1901mm		0.101bar	
69	15056mm		238.37L/min	80		400mm	100	4.649bar	Flow (q) from Route 61
							0.000070		
70	15056mm		1703.09L/min	77.9272		400mm		0.028bar	
70	15056mm		62.22L/min	80		2116mm	100	4.678bar	Flow (q) from Route 78
							0.000075		
71	15056mm		1765.30L/min	77.9272		2116mm		0.159bar	
71	15056mm		243.13L/min	80		385mm	100	4.837bar	Flow (q) from Route 69
							0.000095		
72	15056mm		2008.43L/min	77.9272		385mm		0.037bar	
72	15056mm		63.50L/min	80	(See Notes)	894mm	100	4.873bar	Flow (q) from Route 88
						4100mm	0.000101		T(4100mm)
73	15056mm		2071.93L/min	77.9272		4994mm		0.505bar	
73	15056mm		322.52L/min	80	(See Notes)	8800mm	100	5.378bar	Flow (q) from Route 90
						652mm	0.000132		EE(652mm)
74	15056mm		2394.46L/min	77.9272		9452mm		1.248bar	
74	15056mm			80	(See Notes)	219mm	120	6.626bar	
						6145mm	0.000070		PO(6145mm)
75	15056mm		2394.46L/min	82.8040		6364mm		0.446bar	

Job Name: Thesis
Remote Area Number:
Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
75	15056mm		2066.35L/min	150	(See Notes)	7479mm	120	7.072bar	Flow (q) from Route 79
						11497mm	0.000009	0.733bar	T(11497mm)
23	7577mm		4460.81L/min	161.4678		18976mm		0.163bar	
								7.968bar	Total(Pt) Route 42
243	14854mm	28.8Kbar	57.41L/min	25	(See Notes)	202mm	100	3.974bar	• • • • • Route 43 • • • • • Sprinkler,
						435mm	0.000025	-0.020bar	E(435mm)
76	15056mm		57.41L/min	26.6446		637mm		0.016bar	
76	15056mm			32		2100mm	100	3.969bar	
							0.000007		
63	15056mm		57.41L/min	35.0520		2100mm		0.014bar	
								3.983bar	Total(Pt) Route 43
244	14856mm	28.8Kbar	57.42L/min	25	(See Notes)	200mm	100	3.975bar	• • • • • Route 44 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
77	15056mm		57.42L/min	26.6446		1287mm		0.032bar	
77	15056mm		57.44L/min	32		2100mm	100	3.988bar	Flow (q) from Route 45
							0.000023		
78	15056mm		114.86L/min	35.0520		2100mm		0.049bar	
78	15056mm		57.77L/min	32		2100mm	100	4.037bar	Flow (q) from Route 51
							0.000050		
79	15056mm		172.64L/min	35.0520		2100mm		0.105bar	
79	15056mm		58.52L/min	32	(See Notes)	1400mm	100	4.142bar	Flow (q) from Route 55
						1304mm	0.000086		PO(1304mm)
80	15056mm		231.15L/min	35.0520		2704mm		0.231bar	
80	15056mm			80		163mm	100	4.373bar	
							0.000002		
81	15056mm		231.15L/min	77.9272		163mm		0.000bar	
81	15056mm		60.17L/min	80		2599mm	100	4.373bar	Flow (q) from Route 65
							0.000003		
82	15056mm		291.32L/min	77.9272		2599mm		0.007bar	
82	15056mm		60.21L/min	80		168mm	100	4.380bar	Flow (q) from Route 66
							0.000004		
83	15056mm		351.54L/min	77.9272		168mm		0.001bar	

Pipe Information

Node 1 / Node 2	Elev 1 / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length / Fitting / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
83	15056mm		231.36L/min	80		2333mm	100	4.381bar	Flow (q) from Route 46
							0.000010		
84	15056mm		582.90L/min	77.9272		2333mm		0.023bar	
84	15056mm		60.37L/min	80		167mm	100	4.403bar	Flow (q) from Route 68
							0.000012		
85	15056mm		643.27L/min	77.9272		167mm		0.002bar	
85	15056mm		232.14L/min	80		2434mm	100	4.405bar	Flow (q) from Route 48
							0.000021		
86	15056mm		875.41L/min	77.9272		2434mm		0.050bar	
86	15056mm		60.73L/min	80		366mm	100	4.455bar	Flow (q) from Route 73
							0.000023		
66	15056mm		936.14L/min	77.9272		366mm		0.009bar	
								4.464bar	Total(Pt) Route 44
245	14856mm	28.8Kbar	57.44L/min	25	(See Notes)	200mm	100	3.978bar	• • • • • Route 45 • • • • • Sprinkler,
						435mm	0.000025	-0.020bar	E(435mm)
87	15056mm		57.44L/min	26.6446		635mm		0.016bar	
87	15056mm			32		2100mm	100	3.974bar	
							0.000007		
77	15056mm		57.44L/min	35.0520		2100mm		0.014bar	
								3.988bar	Total(Pt) Route 45
246	14856mm	28.8Kbar	57.47L/min	25	(See Notes)	200mm	100	3.983bar	• • • • • Route 46 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
88	15056mm		57.47L/min	26.6446		1287mm		0.032bar	
88	15056mm		57.49L/min	32		2100mm	100	3.995bar	Flow (q) from Route 47
							0.000023		
89	15056mm		114.97L/min	35.0520		2100mm		0.049bar	
89	15056mm		57.83L/min	32		2100mm	100	4.044bar	Flow (q) from Route 52
							0.000050		
90	15056mm		172.79L/min	35.0520		2100mm		0.105bar	
90	15056mm		58.57L/min	32	(See Notes)	1400mm	100	4.149bar	Flow (q) from Route 57
						1304mm	0.000086		PO(1304mm)
83	15056mm		231.36L/min	35.0520		2704mm		0.232bar	
								4.381bar	Total(Pt) Route 46

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
247	14856mm	28.8Kbar	57.49L/min	25	(See Notes)	200mm	100	3.985bar	• • • • • Route 47 • • • • • Sprinkler,
						435mm	0.000025	-0.020bar	E(435mm)
91	15056mm		57.49L/min	26.6446		635mm		0.016bar	
91	15056mm			32		2100mm	100	3.981bar	
							0.000007		
88	15056mm		57.49L/min	35.0520		2100mm		0.014bar	
								3.995bar	Total(Pt) Route 47
248	14856mm	28.8Kbar	57.66L/min	25	(See Notes)	200mm	100	4.008bar	• • • • • Route 48 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
92	15056mm		57.66L/min	26.6446		1287mm		0.032bar	
92	15056mm		57.68L/min	32		2100mm	100	4.021bar	Flow (q) from Route 49
							0.000024		
93	15056mm		115.34L/min	35.0520		2100mm		0.050bar	
93	15056mm		58.01L/min	32		2200mm	100	4.070bar	Flow (q) from Route 53
							0.000050		
94	15056mm		173.35L/min	35.0520		2200mm		0.110bar	
94	15056mm		58.79L/min	32	(See Notes)	1300mm	100	4.181bar	Flow (q) from Route 58
						1304mm	0.000086		PO(1304mm)
85	15056mm		232.14L/min	35.0520		2604mm		0.224bar	
								4.405bar	Total(Pt) Route 48
249	14856mm	28.8Kbar	57.68L/min	25	(See Notes)	200mm	100	4.011bar	• • • • • Route 49 • • • • • Sprinkler,
						435mm	0.000025	-0.020bar	E(435mm)
95	15056mm		57.68L/min	26.6446		635mm		0.016bar	
95	15056mm			32		2100mm	100	4.007bar	
							0.000007		
92	15056mm		57.68L/min	35.0520		2100mm		0.014bar	
								4.021bar	Total(Pt) Route 49
250	14856mm	28.8Kbar	57.74L/min	25	(See Notes)	200mm	100	4.020bar	• • • • • Route 50 • • • • • Sprinkler,
						1087mm	0.000025	-0.020bar	T(1087mm)
64	15056mm		57.74L/min	26.6446		1287mm		0.032bar	
								4.032bar	Total(Pt) Route 50

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
251	14856mm	28.8Kbar	57.77L/min	25	(See Notes)	200mm	100	4.024bar	• • • • • Route 51 • • • • • Sprinkler,
78	15056mm		57.77L/min	26.6446		1087mm	0.000025	-0.020bar	T(1087mm)
						1287mm		0.032bar	
								4.037bar	Total(Pt) Route 51
252	14856mm	28.8Kbar	57.83L/min	25	(See Notes)	200mm	100	4.032bar	• • • • • Route 52 • • • • • Sprinkler,
89	15056mm		57.83L/min	26.6446		1087mm	0.000025	-0.020bar	T(1087mm)
						1287mm		0.032bar	
								4.044bar	Total(Pt) Route 52
253	14856mm	28.8Kbar	58.01L/min	25	(See Notes)	200mm	100	4.057bar	• • • • • Route 53 • • • • • Sprinkler,
93	15056mm		58.01L/min	26.6446		1087mm	0.000025	-0.020bar	T(1087mm)
						1287mm		0.032bar	
								4.070bar	Total(Pt) Route 53
254	14856mm	28.8Kbar	58.50L/min	25	(See Notes)	200mm	100	4.126bar	• • • • • Route 54 • • • • • Sprinkler,
96	15056mm		58.50L/min	26.6446		1087mm	0.000026	-0.020bar	T(1087mm)
						1287mm		0.033bar	
96	15056mm		58.52L/min	32		2100mm	100	4.139bar	Flow (q) from Route 56
97	15056mm		117.02L/min	35.0520			0.000024		
						2100mm		0.051bar	
97	15056mm		58.86L/min	32		2100mm	100	4.190bar	Flow (q) from Route 59
98	15056mm		175.87L/min	35.0520			0.000052		
						2100mm		0.108bar	
98	15056mm		59.61L/min	32	(See Notes)	1400mm	100	4.299bar	Flow (q) from Route 64
67	15056mm		235.48L/min	35.0520		1304mm	0.000089		PO(1304mm)
						2704mm		0.239bar	
								4.538bar	Total(Pt) Route 54
255	14856mm	28.8Kbar	58.52L/min	25	(See Notes)	200mm	100	4.128bar	• • • • • Route 55 • • • • • Sprinkler,
79	15056mm		58.52L/min	26.6446		1087mm	0.000026	-0.020bar	T(1087mm)
						1287mm		0.033bar	
								4.142bar	Total(Pt) Route 55
256	14856mm	28.8Kbar	58.52L/min	25	(See Notes)	200mm	100	4.128bar	• • • • • Route 56 • • • • • Sprinkler,
99	15056mm		58.52L/min	26.6446		435mm	0.000026	-0.020bar	E(435mm)
						635mm		0.016bar	

Pipe Information

Node 1 Node 2	Elev 1 (Millimeter) Elev 2 (Millimeter)	K-Factor	Flow added this step (q) Total Flow (Q)	Nominal ID Actual ID	Fittings & Devices Equiv. Length (Millimeter)	Length (Millimeter) Fitting (Millimeter) Total (Millimeter)	C Factor Pf Friction Loss Per Unit (bar)	Total(Pt) Elev(Pe) Friction(Pf)	Notes Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
99	15056mm			32		2100mm 	100	4.125bar 	
96	15056mm		58.52L/min	35.0520		2100mm	0.000007	0.014bar	
								4.139bar	Total(Pt) Route 56
257	14856mm	28.8Kbar	58.57L/min	25	(See Notes)	200mm 1087mm	100	4.136bar -0.020bar	• • • • • Route 57 • • • • • Sprinkler, T(1087mm)
90	15056mm		58.57L/min	26.6446		1287mm	0.000026	0.033bar	
								4.149bar	Total(Pt) Route 57
258	14856mm	28.8Kbar	58.79L/min	25	(See Notes)	200mm 1087mm	100	4.167bar -0.020bar	• • • • • Route 58 • • • • • Sprinkler, T(1087mm)
94	15056mm		58.79L/min	26.6446		1287mm	0.000026	0.033bar	
								4.181bar	Total(Pt) Route 58
259	14856mm	28.8Kbar	58.86L/min	25	(See Notes)	200mm 1087mm	100	4.176bar -0.020bar	• • • • • Route 59 • • • • • Sprinkler, T(1087mm)
97	15056mm		58.86L/min	26.6446		1287mm	0.000026	0.033bar	
								4.190bar	Total(Pt) Route 59
260	14856mm	28.8Kbar	59.20L/min	25	(See Notes)	200mm 1087mm	100	4.226bar -0.020bar	• • • • • Route 60 • • • • • Sprinkler, T(1087mm)
65	15056mm		59.20L/min	26.6446		1287mm	0.000026	0.034bar	
								4.240bar	Total(Pt) Route 60
261	14856mm	28.8Kbar	59.22L/min	25	(See Notes)	200mm 1087mm	100	4.228bar -0.020bar	• • • • • Route 61 • • • • • Sprinkler, T(1087mm)
100	15056mm		59.22L/min	26.6446		1287mm	0.000026	0.034bar	
100	15056mm		59.23L/min	32		2100mm 	100	4.242bar 	Flow (q) from Route 62
101	15056mm		118.45L/min	35.0520		2100mm	0.000025	0.052bar	
101	15056mm		59.58L/min	32		2100mm 	100	4.294bar 	Flow (q) from Route 63
102	15056mm		178.03L/min	35.0520		2100mm	0.000053	0.111bar	
102	15056mm		60.34L/min	32	(See Notes)	1400mm 1304mm	100	4.405bar 	Flow (q) from Route 67 PO(1304mm)
69	15056mm		238.37L/min	35.0520		2704mm	0.000091	0.245bar	
								4.649bar	Total(Pt) Route 61

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
262	14856mm	28.8Kbar	59.23L/min	25	(See Notes)	200mm	100	4.230bar	••••• Route 62 ••••• Sprinkler,
						435mm	0.000026	-0.020bar	E(435mm)
103	15056mm		59.23L/min	26.6446		635mm		0.017bar	
103	15056mm			32		2100mm	100	4.227bar	
							0.000007		
100	15056mm		59.23L/min	35.0520		2100mm		0.014bar	
								4.242bar	Total(Pt) Route 62
263	14856mm	28.8Kbar	59.58L/min	25	(See Notes)	200mm	100	4.279bar	••••• Route 63 ••••• Sprinkler,
						1087mm	0.000026	-0.020bar	T(1087mm)
101	15056mm		59.58L/min	26.6446		1287mm		0.034bar	
								4.294bar	Total(Pt) Route 63
264	14856mm	28.8Kbar	59.61L/min	25	(See Notes)	200mm	100	4.284bar	••••• Route 64 ••••• Sprinkler,
						1087mm	0.000027	-0.020bar	T(1087mm)
98	15056mm		59.61L/min	26.6446		1287mm		0.034bar	
								4.299bar	Total(Pt) Route 64
265	14854mm	28.8Kbar	60.17L/min	25	(See Notes)	202mm	100	4.364bar	••••• Route 65 ••••• Sprinkler,
						435mm	0.000027	-0.020bar	E(435mm)
104	15056mm		60.17L/min	26.6446		637mm		0.017bar	
104	15056mm			32	(See Notes)	300mm	100	4.362bar	
						1304mm	0.000007		PO(1304mm)
81	15056mm		60.17L/min	35.0520		1604mm		0.011bar	
								4.373bar	Total(Pt) Route 65
266	14854mm	28.8Kbar	60.21L/min	25	(See Notes)	202mm	100	4.371bar	••••• Route 66 ••••• Sprinkler,
						435mm	0.000027	-0.020bar	E(435mm)
105	15056mm		60.21L/min	26.6446		637mm		0.017bar	
105	15056mm			32	(See Notes)	300mm	100	4.369bar	
						1304mm	0.000007		PO(1304mm)
82	15056mm		60.21L/min	35.0520		1604mm		0.011bar	
								4.380bar	Total(Pt) Route 66
267	14856mm	28.8Kbar	60.34L/min	25	(See Notes)	200mm	100	4.389bar	••••• Route 67 ••••• Sprinkler,
						1087mm	0.000027	-0.020bar	T(1087mm)
102	15056mm		60.34L/min	26.6446		1287mm		0.035bar	
								4.405bar	Total(Pt) Route 67

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
268	14854mm	28.8Kbar	60.37L/min	25	(See Notes)	202mm	100	4.394bar	• • • • • Route 68 • • • • • Sprinkler,
						435mm	0.000027	-0.020bar	E(435mm)
106	15056mm		60.37L/min	26.6446		637mm		0.017bar	
106	15056mm			32	(See Notes)	300mm	100	4.392bar	
						1304mm	0.000007		
84	15056mm		60.37L/min	35.0520		1604mm		0.011bar	PO(1304mm)
								4.403bar	Total(Pt) Route 68
269	14856mm	28.8Kbar	60.40L/min	25	(See Notes)	200mm	100	4.398bar	• • • • • Route 69 • • • • • Sprinkler,
						1087mm	0.000027	-0.020bar	T(1087mm)
107	15056mm		60.40L/min	26.6446		1287mm		0.035bar	
107	15056mm		60.42L/min	32		2100mm	100	4.414bar	Flow (q) from Route 70
							0.000026		
108	15056mm		120.82L/min	35.0520		2100mm		0.054bar	
108	15056mm		60.77L/min	32		2100mm	100	4.468bar	Flow (q) from Route 74
							0.000055		
109	15056mm		181.58L/min	35.0520		2100mm		0.115bar	
109	15056mm		61.54L/min	32	(See Notes)	1400mm	100	4.583bar	Flow (q) from Route 77
						1304mm	0.000094		PO(1304mm)
71	15056mm		243.13L/min	35.0520		2704mm		0.254bar	
								4.837bar	Total(Pt) Route 69
270	14856mm	28.8Kbar	60.42L/min	25	(See Notes)	200mm	100	4.401bar	• • • • • Route 70 • • • • • Sprinkler,
						435mm	0.000027	-0.020bar	E(435mm)
110	15056mm		60.42L/min	26.6446		635mm		0.017bar	
110	15056mm			32		2100mm	100	4.399bar	
							0.000007		
107	15056mm		60.42L/min	35.0520		2100mm		0.015bar	
								4.414bar	Total(Pt) Route 70
271	5304mm	31.7Kbar	66.54L/min	25	(See Notes)	202mm	100	4.406bar	• • • • • Route 71 • • • • • Sprinkler,
						1087mm	0.000032	-0.020bar	T(1087mm)
111	5506mm		66.54L/min	26.6446		1289mm		0.042bar	
111	5506mm			50		700mm	100	4.428bar	
							0.000001		
15	5506mm		66.54L/min	52.5018		700mm		0.001bar	

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
								4.429bar	Total(Pt) Route 71
272	5300mm	31.7Kbar	66.74L/min	25	(See Notes)	2306mm	100	4.432bar	• • • • • Route 72 • • • • • Sprinkler,
17	5506mm		66.74L/min	26.6446		2173mm	0.000033	-0.020bar	T(1087mm), PO(1087mm)
						4480mm		0.146bar	
								4.558bar	Total(Pt) Route 72
273	14854mm	28.8Kbar	60.73L/min	25	(See Notes)	202mm	100	4.446bar	• • • • • Route 73 • • • • • Sprinkler,
112	15056mm		60.73L/min	26.6446		435mm	0.000027	-0.020bar	E(435mm)
						637mm		0.017bar	
112	15056mm			32	(See Notes)	300mm	100	4.444bar	
86	15056mm		60.73L/min	35.0520		1304mm	0.000007		T(1304mm)
						1604mm		0.012bar	
								4.455bar	Total(Pt) Route 73
274	14856mm	28.8Kbar	60.77L/min	25	(See Notes)	200mm	100	4.452bar	• • • • • Route 74 • • • • • Sprinkler,
108	15056mm		60.77L/min	26.6446		1087mm	0.000027	-0.020bar	T(1087mm)
						1287mm		0.035bar	
								4.468bar	Total(Pt) Route 74
275	5304mm	31.7Kbar	67.31L/min	25	(See Notes)	202mm	100	4.508bar	• • • • • Route 75 • • • • • Sprinkler,
113	5506mm		67.31L/min	26.6446		435mm	0.000033	-0.020bar	E(435mm)
						637mm		0.021bar	
113	5506mm			32	(See Notes)	200mm	100	4.510bar	
16	5506mm		67.31L/min	35.0520		1304mm	0.000009		PO(1304mm)
						1504mm		0.013bar	
								4.523bar	Total(Pt) Route 75
276	14854mm	28.8Kbar	61.36L/min	25	(See Notes)	202mm	100	4.539bar	• • • • • Route 76 • • • • • Sprinkler,
114	15056mm		61.36L/min	26.6446		435mm	0.000028	-0.020bar	E(435mm)
						637mm		0.018bar	
114	15056mm			32	(See Notes)	300mm	100	4.537bar	
68	15056mm		61.36L/min	35.0520		1304mm	0.000007		PO(1304mm)
						1604mm		0.012bar	
								4.548bar	Total(Pt) Route 76
277	14854mm	28.8Kbar	61.54L/min	25	(See Notes)	202mm	100	4.566bar	• • • • • Route 77 • • • • • Sprinkler,
109	15056mm		61.54L/min	26.6446		1087mm	0.000028	-0.020bar	T(1087mm)
						1289mm		0.036bar	

Job Name: Thesis
Remote Area Number:
Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
								4.583bar	Total(Pt) Route 77
278	14858mm	28.8Kbar	62.22L/min	25	(See Notes)	198mm	100	4.667bar	• • • • • **Route 78** • • • • • Sprinkler,
						435mm	0.000029	-0.019bar	E(435mm)
115	15056mm		62.22L/min	26.6446		633mm		0.018bar	
115	15056mm			32	(See Notes)	300mm	100	4.665bar	
						1304mm	0.000008		PO(1304mm)
70	15056mm		62.22L/min	35.0520		1604mm		0.012bar	
								4.678bar	Total(Pt) Route 78
279	19046mm	28.8Kbar	62.79L/min	15	(See Notes)	226mm	100	4.753bar	• • • • • **Route 79** • • • • • Sprinkler,
						652mm	0.000372	-0.022bar	T(652mm)
116	19272mm		62.79L/min	15.7988		878mm		0.327bar	
116	19272mm		63.71L/min	32		2000mm	100	5.057bar	Flow (q) from Route 92
							0.000028		
117	19272mm		126.50L/min	35.0520		2000mm		0.056bar	
117	19272mm		63.13L/min	32		2000mm	100	5.113bar	Flow (q) from Route 82
							0.000059		
118	19272mm		189.64L/min	35.0520		2000mm		0.119bar	
118	19272mm		63.86L/min	32	(See Notes)	700mm	100	5.232bar	Flow (q) from Route 95
						1304mm	0.000101		PO(1304mm)
119	19272mm		253.50L/min	35.0520		2004mm		0.203bar	
119	19272mm			80		2150mm	100	5.435bar	
							0.000002		
120	19272mm		253.50L/min	77.9272		2150mm		0.004bar	
120	19272mm		253.60L/min	80		2150mm	100	5.440bar	Flow (q) from Route 80
							0.000007		
121	19272mm		507.10L/min	77.9272		2150mm		0.016bar	
121	19272mm		253.98L/min	80		2500mm	100	5.456bar	Flow (q) from Route 81
							0.000016		
122	19272mm		761.08L/min	77.9272		2500mm		0.040bar	
122	19272mm		254.90L/min	80		2500mm	100	5.495bar	Flow (q) from Route 83
							0.000027		
123	19272mm		1015.99L/min	77.9272		2500mm		0.068bar	

Job Name: Thesis
Remote Area Number:
Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
123	19272mm		256.47L/min	80		3050mm	100	5.563bar	Flow (q) from Route 89
							0.000041		
124	19272mm		1272.46L/min	77.9272		3050mm		0.125bar	
124	19272mm		259.35L/min	80		2950mm	100	5.688bar	Flow (q) from Route 102
							0.000058		
125	19272mm		1531.81L/min	77.9272		2950mm		0.170bar	
125	19272mm		263.23L/min	80	(See Notes)	780mm	100	5.859bar	Flow (q) from Route 108
						4100mm	0.000077		T(4100mm)
126	19272mm		1795.04L/min	77.9272		4880mm		0.378bar	
126	19272mm		271.31L/min	80	(See Notes)	850mm	100	6.237bar	Flow (q) from Route 115
						3260mm	0.000101		PO(3260mm)
127	19272mm		2066.35L/min	77.9272		4110mm		0.413bar	
127	19272mm			150		4216mm	120	6.650bar	
							0.000002	0.413bar	
75	15056mm		2066.35L/min	161.4678		4216mm		0.009bar	
								7.072bar	Total(Pt) Route 79
280	19046mm	28.8Kbar	62.81L/min	15	(See Notes)	226mm	100	4.757bar	• • • • • Route 80 • • • • • Sprinkler,
						652mm	0.000372	-0.022bar	T(652mm)
128	19272mm		62.81L/min	15.7988		878mm		0.327bar	
128	19272mm		63.74L/min	32		2000mm	100	5.061bar	Flow (q) from Route 93
							0.000028		
129	19272mm		126.55L/min	35.0520		2000mm		0.056bar	
129	19272mm		63.16L/min	32		2000mm	100	5.118bar	Flow (q) from Route 84
							0.000059		
130	19272mm		189.71L/min	35.0520		2000mm		0.119bar	
130	19272mm		63.89L/min	32	(See Notes)	700mm	100	5.236bar	Flow (q) from Route 97
						1304mm	0.000102		PO(1304mm)
120	19272mm		253.60L/min	35.0520		2004mm		0.203bar	
								5.440bar	Total(Pt) Route 80
281	19046mm	28.8Kbar	62.91L/min	15	(See Notes)	226mm	100	4.771bar	• • • • • Route 81 • • • • • Sprinkler,
						652mm	0.000373	-0.022bar	T(652mm)
131	19272mm		62.91L/min	15.7988		878mm		0.328bar	

Pipe Information

Node 1 / Node 2	Elev 1 / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length / Fitting / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
131	19272mm		63.83L/min	32		2000mm	100	5.077bar	Flow (q) from Route 94
132	19272mm		126.74L/min	35.0520			0.000028		
						2000mm		0.056bar	
132	19272mm		63.25L/min	32		2000mm	100	5.133bar	Flow (q) from Route 86
133	19272mm		190.00L/min	35.0520			0.000060		
						2000mm		0.119bar	
133	19272mm		63.98L/min	32	(See Notes)	700mm	100	5.252bar	Flow (q) from Route 99
121	19272mm		253.98L/min	35.0520		1304mm	0.000102		PO(1304mm)
						2004mm		0.204bar	
								5.456bar	Total(Pt) Route 81
282	19046mm	28.8Kbar	63.13L/min	15	(See Notes)	226mm	100	4.806bar	• • • • • Route 82 • • • • • Sprinkler,
117	19272mm		63.13L/min	15.7988		652mm	0.000376	-0.022bar	T(652mm)
						878mm		0.330bar	
								5.113bar	Total(Pt) Route 82
283	19046mm	28.8Kbar	63.14L/min	15	(See Notes)	226mm	100	4.806bar	• • • • • Route 83 • • • • • Sprinkler,
134	19272mm		63.14L/min	15.7988		652mm	0.000376	-0.022bar	T(652mm)
						878mm		0.330bar	
134	19272mm		64.07L/min	32		2000mm	100	5.114bar	Flow (q) from Route 100
135	19272mm		127.20L/min	35.0520			0.000028		
						2000mm		0.057bar	
135	19272mm		63.48L/min	32		2000mm	100	5.170bar	Flow (q) from Route 87
136	19272mm		190.69L/min	35.0520			0.000060		
						2000mm		0.120bar	
136	19272mm		64.22L/min	32	(See Notes)	700mm	100	5.290bar	Flow (q) from Route 101
122	19272mm		254.90L/min	35.0520		1304mm	0.000102		PO(1304mm)
						2004mm		0.205bar	
								5.495bar	Total(Pt) Route 83
284	19046mm	28.8Kbar	63.16L/min	15	(See Notes)	226mm	100	4.810bar	• • • • • Route 84 • • • • • Sprinkler,
129	19272mm		63.16L/min	15.7988		652mm	0.000376	-0.022bar	T(652mm)
						878mm		0.330bar	
								5.118bar	Total(Pt) Route 84

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length / Fitting / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
285	5304mm	31.7Kbar	69.57L/min	25	(See Notes)	202mm	100	4.816bar	••••• **Route 85** ••••• Sprinkler,
						435mm	0.000035	-0.020bar	E(435mm)
137	5506mm		69.57L/min	26.6446		637mm		0.022bar	
137	5506mm			32	(See Notes)	200mm	100	4.819bar	
						1304mm	0.000009		PO(1304mm)
18	5506mm		69.57L/min	35.0520		1504mm		0.014bar	
								4.833bar	Total(Pt) Route 85
286	19046mm	28.8Kbar	63.25L/min	15	(See Notes)	226mm	100	4.824bar	••••• **Route 86** ••••• Sprinkler,
						652mm	0.000377	-0.022bar	T(652mm)
132	19272mm		63.25L/min	15.7988		878mm		0.331bar	
								5.133bar	Total(Pt) Route 86
287	19046mm	28.8Kbar	63.48L/min	15	(See Notes)	226mm	100	4.859bar	••••• **Route 87** ••••• Sprinkler,
						652mm	0.000380	-0.022bar	T(652mm)
135	19272mm		63.48L/min	15.7988		878mm		0.333bar	
								5.170bar	Total(Pt) Route 87
288	14854mm	28.8Kbar	63.50L/min	25	(See Notes)	202mm	100	4.862bar	••••• **Route 88** ••••• Sprinkler,
						435mm	0.000030	-0.020bar	E(435mm)
138	15056mm		63.50L/min	26.6446		637mm		0.019bar	
138	15056mm			32	(See Notes)	300mm	100	4.861bar	
						1304mm	0.000008		PO(1304mm)
72	15056mm		63.50L/min	35.0520		1604mm		0.013bar	
								4.873bar	Total(Pt) Route 88
289	19046mm	28.8Kbar	63.53L/min	15	(See Notes)	226mm	100	4.865bar	••••• **Route 89** ••••• Sprinkler,
						652mm	0.000380	-0.022bar	T(652mm)
139	19272mm		63.53L/min	15.7988		878mm		0.334bar	
139	19272mm		64.46L/min	32		2000mm	100	5.177bar	Flow (q) from Route 103
							0.000029		
140	19272mm		127.99L/min	35.0520		2000mm		0.057bar	
140	19272mm		63.88L/min	32		2000mm	100	5.234bar	Flow (q) from Route 96
							0.000061		
141	19272mm		191.86L/min	35.0520		2000mm		0.121bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
141	19272mm		64.61L/min	32	(See Notes)	700mm	100	5.355bar	Flow (q) from Route 105
						1304mm	0.000104		
123	19272mm		256.47L/min	35.0520		2004mm		0.208bar	PO(1304mm)
								5.563bar	Total(Pt) Route 89
290	14856mm	28.8Kbar	63.59L/min	25	(See Notes)	200mm	100	4.875bar	• • • • • Route 90 • • • • • Sprinkler,
						1087mm	0.000030	-0.020bar	
142	15056mm		63.59L/min	26.6446		1287mm		0.038bar	T(1087mm)
142	15056mm		63.61L/min	32		2100mm	100	4.894bar	Flow (q) from Route 91
							0.000028		
143	15056mm		127.19L/min	35.0520		2100mm		0.059bar	
143	15056mm		63.97L/min	32		2100mm	100	4.953bar	Flow (q) from Route 98
							0.000060		
144	15056mm		191.16L/min	35.0520		2100mm		0.126bar	
144	15056mm		64.78L/min	32	(See Notes)	1400mm	100	5.079bar	Flow (q) from Route 106
						1304mm	0.000103		
145	15056mm		255.94L/min	35.0520		2704mm		0.279bar	PO(1304mm)
145	15056mm			80		300mm	100	5.359bar	
							0.000002		
146	15056mm		255.94L/min	77.9272		300mm		0.001bar	
146	15056mm		66.58L/min	80	(See Notes)	1605mm	100	5.359bar	Flow (q) from Route 114
						4100mm	0.000003		
73	15056mm		322.52L/min	77.9272		5705mm		0.018bar	T(4100mm)
								5.378bar	Total(Pt) Route 90
291	14856mm	28.8Kbar	63.61L/min	25	(See Notes)	200mm	100	4.878bar	• • • • • Route 91 • • • • • Sprinkler,
						435mm	0.000030	-0.020bar	
147	15056mm		63.61L/min	26.6446		635mm		0.019bar	E(435mm)
147	15056mm			32		2100mm	100	4.877bar	
							0.000008		
142	15056mm		63.61L/min	35.0520		2100mm		0.017bar	
								4.894bar	Total(Pt) Route 91
292	19046mm	28.8Kbar	63.71L/min	15	(See Notes)	226mm	100	4.894bar	• • • • • Route 92 • • • • • Sprinkler,
						217mm	0.000382	-0.022bar	
148	19272mm		63.71L/min	15.7988		444mm		0.169bar	E(217mm)

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
148	19272mm			32		2000mm	100	5.042bar	
							0.000008		
116	19272mm		63.71L/min	35.0520		2000mm		0.016bar	
								5.057bar	Total(Pt) Route 92
293	19046mm	28.8Kbar	63.74L/min	15	(See Notes)	226mm	100	4.898bar	• • • • • Route 93 • • • • • Sprinkler,
						217mm	0.000382	-0.022bar	E(217mm)
149	19272mm		63.74L/min	15.7988		444mm		0.170bar	
149	19272mm			32		2000mm	100	5.046bar	
							0.000008		
128	19272mm		63.74L/min	35.0520		2000mm		0.016bar	
								5.061bar	Total(Pt) Route 93
294	19046mm	28.8Kbar	63.83L/min	15	(See Notes)	226mm	100	4.913bar	• • • • • Route 94 • • • • • Sprinkler,
						217mm	0.000383	-0.022bar	E(217mm)
150	19272mm		63.83L/min	15.7988		444mm		0.170bar	
150	19272mm			32		2000mm	100	5.061bar	
							0.000008		
131	19272mm		63.83L/min	35.0520		2000mm		0.016bar	
								5.077bar	Total(Pt) Route 94
295	19046mm	28.8Kbar	63.86L/min	15	(See Notes)	226mm	100	4.917bar	• • • • • Route 95 • • • • • Sprinkler,
						652mm	0.000384	-0.022bar	T(652mm)
118	19272mm		63.86L/min	15.7988		878mm		0.337bar	
								5.232bar	Total(Pt) Route 95
296	19046mm	28.8Kbar	63.88L/min	15	(See Notes)	226mm	100	4.919bar	• • • • • Route 96 • • • • • Sprinkler,
						652mm	0.000384	-0.022bar	T(652mm)
140	19272mm		63.88L/min	15.7988		878mm		0.337bar	
								5.234bar	Total(Pt) Route 96
297	19046mm	28.8Kbar	63.89L/min	15	(See Notes)	226mm	100	4.921bar	• • • • • Route 97 • • • • • Sprinkler,
						652mm	0.000384	-0.022bar	T(652mm)
130	19272mm		63.89L/min	15.7988		878mm		0.337bar	
								5.236bar	Total(Pt) Route 97
298	14856mm	28.8Kbar	63.97L/min	25	(See Notes)	200mm	100	4.934bar	• • • • • Route 98 • • • • • Sprinkler,
						1087mm	0.000030	-0.020bar	T(1087mm)
143	15056mm		63.97L/min	26.6446		1287mm		0.039bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
								4.953bar	Total(Pt) Route 98
299	19046mm	28.8Kbar	63.98L/min	15	(See Notes)	226mm	100	4.936bar	• • • • • Route 99 • • • • • Sprinkler,
						652mm	0.000385	-0.022bar	T(652mm)
133	19272mm		63.98L/min	15.7988		878mm		0.338bar	
								5.252bar	Total(Pt) Route 99
300	19046mm	28.8Kbar	64.07L/min	15	(See Notes)	226mm	100	4.949bar	• • • • • Route 100 • • • • • Sprinkler,
						217mm	0.000386	-0.022bar	E(217mm)
151	19272mm		64.07L/min	15.7988		444mm		0.171bar	
151	19272mm			32		2000mm	100	5.098bar	
							0.000008		
134	19272mm		64.07L/min	35.0520		2000mm		0.016bar	
								5.114bar	Total(Pt) Route 100
301	19046mm	28.8Kbar	64.22L/min	15	(See Notes)	226mm	100	4.972bar	• • • • • Route 101 • • • • • Sprinkler,
						652mm	0.000388	-0.022bar	T(652mm)
136	19272mm		64.22L/min	15.7988		878mm		0.340bar	
								5.290bar	Total(Pt) Route 101
302	19046mm	28.8Kbar	64.24L/min	15	(See Notes)	226mm	100	4.975bar	• • • • • Route 102 • • • • • Sprinkler,
						652mm	0.000388	-0.022bar	T(652mm)
152	19272mm		64.24L/min	15.7988		878mm		0.341bar	
152	19272mm		65.18L/min	32		2000mm	100	5.294bar	Flow (q) from Route 107
							0.000029		
153	19272mm		129.42L/min	35.0520		2000mm		0.059bar	
153	19272mm		64.59L/min	32		2000mm	100	5.352bar	Flow (q) from Route 104
							0.000062		
154	19272mm		194.02L/min	35.0520		2000mm		0.124bar	
154	19272mm		65.34L/min	32	(See Notes)	700mm	100	5.476bar	Flow (q) from Route 110
						1304mm	0.000106		PO(1304mm)
124	19272mm		259.35L/min	35.0520		2004mm		0.212bar	
								5.688bar	Total(Pt) Route 102
303	19046mm	28.8Kbar	64.46L/min	15	(See Notes)	226mm	100	5.010bar	• • • • • Route 103 • • • • • Sprinkler,
						217mm	0.000390	-0.022bar	E(217mm)
155	19272mm		64.46L/min	15.7988		444mm		0.173bar	

Job Name: Thesis
Remote Area Number: Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
155	19272mm			32		2000mm	100	5.161bar	
139	19272mm		64.46L/min	35.0520		2000mm	0.000008	0.016bar	
								5.177bar	Total(Pt) Route 103
304	19046mm	28.8Kbar	64.59L/min	15	(See Notes)	226mm	100	5.030bar	••••• Route 104 ••••• Sprinkler,
						652mm		-0.022bar	
153	19272mm		64.59L/min	15.7988		878mm	0.000392	0.344bar	T(652mm)
								5.352bar	Total(Pt) Route 104
305	19046mm	28.8Kbar	64.61L/min	15	(See Notes)	226mm	100	5.033bar	••••• Route 105 ••••• Sprinkler,
						652mm		-0.022bar	
141	19272mm		64.61L/min	15.7988		878mm	0.000392	0.344bar	T(652mm)
								5.355bar	Total(Pt) Route 105
306	14856mm	28.8Kbar	64.78L/min	25	(See Notes)	200mm	100	5.059bar	••••• Route 106 ••••• Sprinkler,
						1087mm		-0.020bar	
144	15056mm		64.78L/min	26.6446		1287mm	0.000031	0.040bar	T(1087mm)
								5.079bar	Total(Pt) Route 106
307	19046mm	28.8Kbar	65.18L/min	15	(See Notes)	226mm	100	5.123bar	••••• Route 107 ••••• Sprinkler,
						217mm		-0.022bar	
156	19272mm		65.18L/min	15.7988		444mm	0.000399	0.177bar	E(217mm)
156	19272mm			32		2000mm	100	5.277bar	
152	19272mm		65.18L/min	35.0520		2000mm	0.000008	0.016bar	
								5.294bar	Total(Pt) Route 107
308	19046mm	28.8Kbar	65.20L/min	15	(See Notes)	226mm	100	5.125bar	••••• Route 108 ••••• Sprinkler,
						652mm		-0.022bar	
157	19272mm		65.20L/min	15.7988		878mm	0.000399	0.350bar	T(652mm)
157	19272mm		66.16L/min	32		2000mm	100	5.453bar	Flow (q) from Route 112
158	19272mm		131.36L/min	35.0520		2000mm	0.000030	0.060bar	
158	19272mm		65.56L/min	32		2000mm	100	5.513bar	Flow (q) from Route 111
159	19272mm		196.92L/min	35.0520		2000mm	0.000064	0.127bar	

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
159	19272mm		66.31L/min	32	(See Notes)	700mm	100	5.641bar	Flow (q) from Route 113
						1304mm	0.000109		PO(1304mm)
125	19272mm		263.23L/min	35.0520		2004mm		0.218bar	
								5.859bar	Total(Pt) Route 108
309	5304mm	31.7Kbar	71.88L/min	25	(See Notes)	202mm	100	5.142bar	• • • • • **Route 109** • • • • • Sprinkler,
						435mm	0.000037	-0.020bar	E(435mm)
160	5506mm		71.88L/min	26.6446		637mm		0.024bar	
160	5506mm			32	(See Notes)	200mm	100	5.146bar	
						1304mm	0.000010		PO(1304mm)
19	5506mm		71.88L/min	35.0520		1504mm		0.015bar	
								5.161bar	Total(Pt) Route 109
310	19046mm	28.8Kbar	65.34L/min	15	(See Notes)	226mm	100	5.147bar	• • • • • **Route 110** • • • • • Sprinkler,
						652mm	0.000400	-0.022bar	T(652mm)
154	19272mm		65.34L/min	15.7988		878mm		0.352bar	
								5.476bar	Total(Pt) Route 110
311	19046mm	28.8Kbar	65.56L/min	15	(See Notes)	226mm	100	5.182bar	• • • • • **Route 111** • • • • • Sprinkler,
						652mm	0.000403	-0.022bar	T(652mm)
158	19272mm		65.56L/min	15.7988		878mm		0.354bar	
								5.513bar	Total(Pt) Route 111
312	19046mm	28.8Kbar	66.16L/min	15	(See Notes)	226mm	100	5.277bar	• • • • • **Route 112** • • • • • Sprinkler,
						217mm	0.000410	-0.022bar	E(217mm)
161	19272mm		66.16L/min	15.7988		444mm		0.182bar	
161	19272mm			32		2000mm	100	5.436bar	
							0.000008		
157	19272mm		66.16L/min	35.0520		2000mm		0.017bar	
								5.453bar	Total(Pt) Route 112
313	19046mm	28.8Kbar	66.31L/min	15	(See Notes)	226mm	100	5.301bar	• • • • • **Route 113** • • • • • Sprinkler,
						652mm	0.000411	-0.022bar	T(652mm)
159	19272mm		66.31L/min	15.7988		878mm		0.361bar	
								5.641bar	Total(Pt) Route 113
314	14854mm	28.8Kbar	66.58L/min	25	(See Notes)	202mm	100	5.345bar	• • • • • **Route 114** • • • • • Sprinkler,
						435mm	0.000033	-0.020bar	E(435mm)
162	15056mm		66.58L/min	26.6446		637mm		0.021bar	

Job Name: Thesis
Remote Area Number:
Date: 10/06/2020

Pipe Information

Node 1 / Node 2	Elev 1 (Millimeter) / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length (Millimeter) / Fitting (Millimeter) / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
162	15056mm			32	(See Notes)	300mm	100	5.346bar	
						1304mm	0.000009		PO(1304mm)
146	15056mm		66.58L/min	35.0520		1604mm		0.014bar	
								5.359bar	Total(Pt) Route 114
315	19046mm	28.8Kbar	67.21L/min	15	(See Notes)	226mm	100	5.445bar	**• • • • • Route 115 • • • • •** Sprinkler,
						652mm	0.000422	-0.022bar	T(652mm)
163	19272mm		67.21L/min	15.7988		878mm		0.370bar	
163	19272mm		68.19L/min	32		2000mm	100	5.794bar	Flow (q) from Route 117
							0.000032		
164	19272mm		135.39L/min	35.0520		2000mm		0.064bar	
164	19272mm		67.57L/min	32		2000mm	100	5.857bar	Flow (q) from Route 116
							0.000067		
165	19272mm		202.97L/min	35.0520		2000mm		0.134bar	
165	19272mm		68.35L/min	32	(See Notes)	700mm	100	5.992bar	Flow (q) from Route 118
						1304mm	0.000115		PO(1304mm)
166	19272mm		271.31L/min	35.0520		2004mm		0.231bar	
166	19272mm			80	(See Notes)	2070mm	100	6.222bar	
						4100mm	0.000002		T(4100mm)
126	19272mm		271.31L/min	77.9272		6170mm		0.014bar	
								6.237bar	Total(Pt) Route 115
316	19046mm	28.8Kbar	67.57L/min	15	(See Notes)	226mm	100	5.505bar	**• • • • • Route 116 • • • • •** Sprinkler,
						652mm	0.000426	-0.022bar	T(652mm)
164	19272mm		67.57L/min	15.7988		878mm		0.374bar	
								5.857bar	Total(Pt) Route 116
317	19046mm	28.8Kbar	68.19L/min	15	(See Notes)	226mm	100	5.606bar	**• • • • • Route 117 • • • • •** Sprinkler,
						217mm	0.000433	-0.022bar	E(217mm)
167	19272mm		68.19L/min	15.7988		444mm		0.192bar	
167	19272mm			32		2000mm	100	5.776bar	
							0.000009		
163	19272mm		68.19L/min	35.0520		2000mm		0.018bar	
								5.794bar	Total(Pt) Route 117

Pipe Information

Node 1 / Node 2	Elev 1 / Elev 2 (Millimeter)	K-Factor	Flow added this step (q) / Total Flow (Q)	Nominal ID / Actual ID	Fittings & Devices / Equiv. Length (Millimeter)	Length / Fitting / Total (Millimeter)	C Factor / Pf Friction Loss Per Unit (bar)	Total(Pt) / Elev(Pe) / Friction(Pf)	Notes: Fitting/Device (Equivalent Length) Fixed Pressure Losses, when applicable, are added directly to (Pf) and shown as a negative value.
318	19046mm	28.8Kbar	68.35L/min	15	(See Notes)	226mm	100	5.632bar	• • • • • Route 118 • • • • • Sprinkler,
						652mm	0.000435	-0.022bar	T(652mm)
165	19272mm		68.35L/min	15.7988		878mm		0.382bar	
								5.992bar	Total(Pt) Route 118
319	5304mm	31.7Kbar	77.80L/min	25	(See Notes)	202mm	100	6.024bar	• • • • • Route 119 • • • • • Sprinkler,
						435mm	0.000043	-0.020bar	E(435mm)
168	5506mm		77.80L/min	26.6446		637mm		0.028bar	
168	5506mm			32	(See Notes)	200mm	100	6.032bar	
						652mm	0.000011		E(652mm)
169	5506mm		77.80L/min	35.0520		852mm		0.010bar	
169	5506mm			50	(See Notes)	569mm	100	6.041bar	
						2173mm	0.000002		T(2173mm)
20	5506mm		77.80L/min	52.5018		2742mm		0.004bar	
								6.046bar	Total(Pt) Route 119
320	5304mm	31.7Kbar	83.36L/min	25	(See Notes)	1085mm	100	6.914bar	• • • • • Route 120 • • • • • Sprinkler,
						1956mm	0.000049	-0.020bar	2E(435mm), PO(1087mm)
21	5506mm		83.36L/min	26.6446		3041mm		0.150bar	
								7.044bar	Total(Pt) Route 120

Equivalent Pipe Lengths of Valves and Fittings (C=120 only)

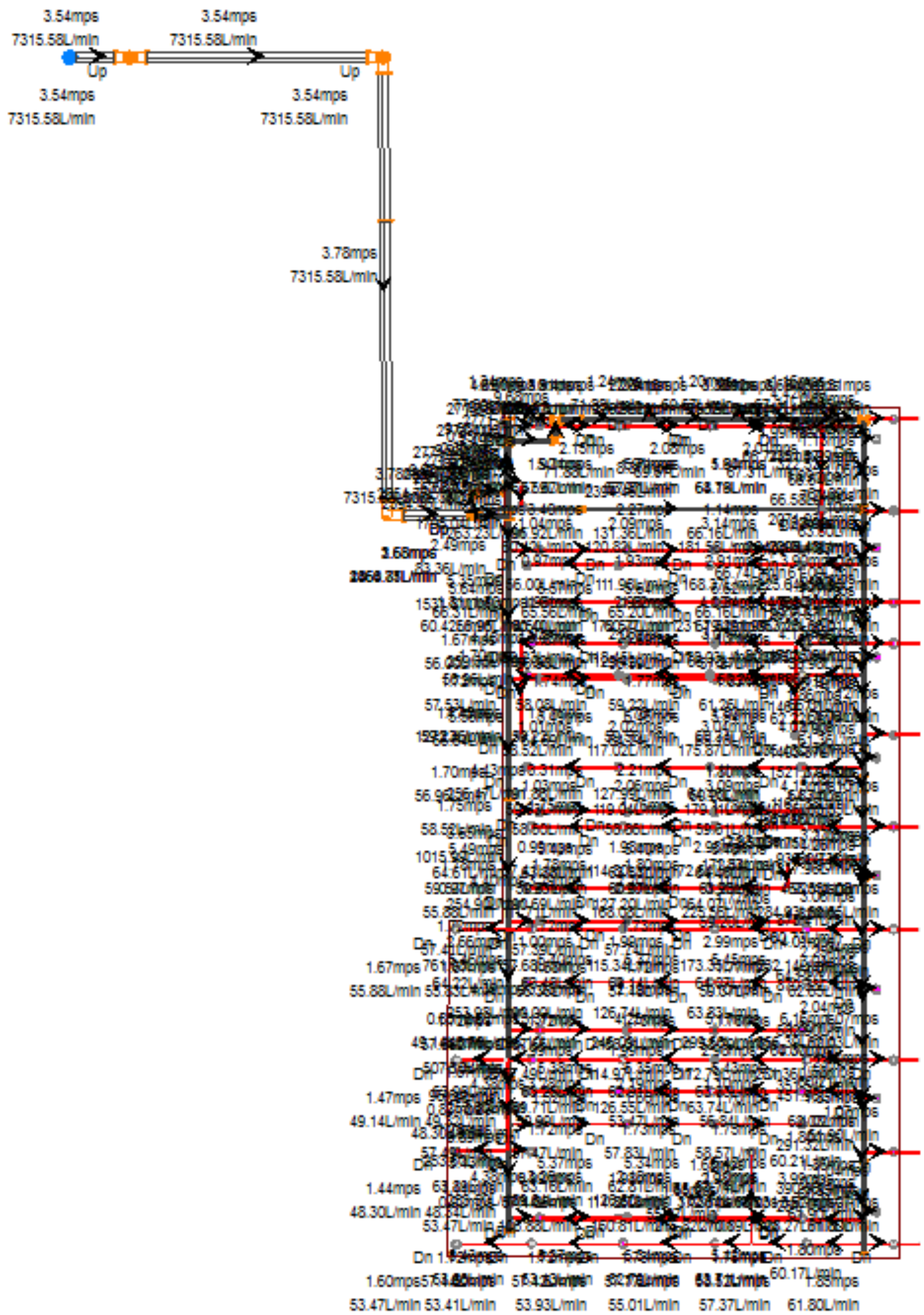
$$\left(\frac{\text{Actual Inside Diameter}}{\text{Schedule 40 Steel Pipe Inside Diameter}}\right)^{4.87} = \text{Factor}$$

C Value Multiplier

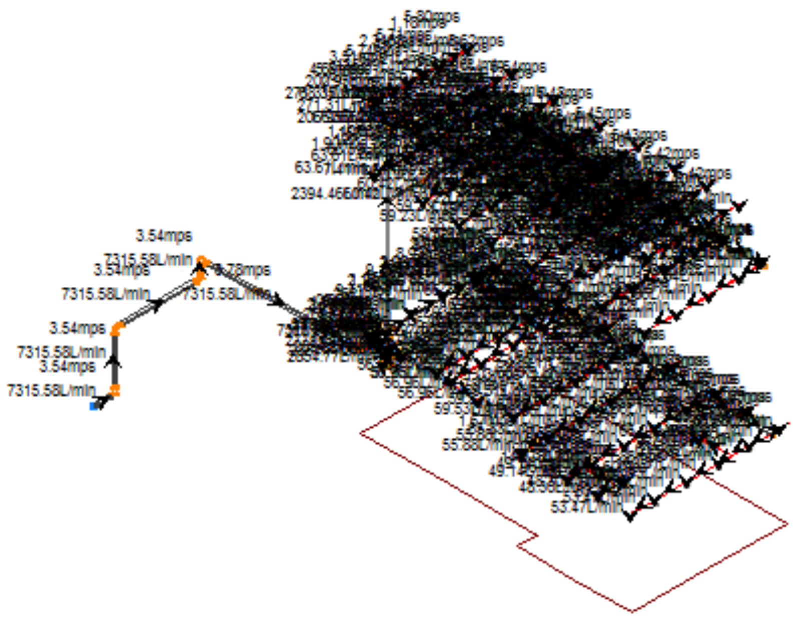
Value Of C	100	130	140	150
Multiplying Factor	0.713	1.16	1.33	1.51

Fittings Legend

ALV	Alarm Valve	AngV	Angle Valve	b	Bushing
BalV	Ball Valve	BFP	Backflow Preventer	BV	Butterfly Valve
C	Cross Flow Turn 90°	cplg	Coupling	Cr	Cross Run
CV	Check Valve	DelV	Deluge Valve	DPV	Dry Pipe Valve
E	90° Elbow	EE	45° Elbow	Ee1	11¼° Elbow
Ee2	22½° Elbow	f	Flow Device	fd	Flex Drop
FDC	Fire Department Connection	fE	90° FireLock(TM) Elbow	fEE	45° FireLock(TM) Elbow
flg	Flange	FN	Floating Node	fT	FireLock(TM) Tee
g	Gauge	GloV	Globe Valve	GV	Gate Valve
Ho	Hose	Hose	Hose	HV	Hose Valve
Hyd	Hydrant	LtE	Long Turn Elbow	mecT	Mechanical Tee
Noz	Nozzle	P1	Pump In	P2	Pump Out
PIV	Post Indicating Valve	PO	Pipe Outlet	PRV	Pressure Reducing Valve
PrV	Pressure Relief Valve	red	Reducer/Adapter	S	Supply
sCV	Swing Check Valve	Spr	Sprinkler	St	Strainer
T	Tee Flow Turn 90°	Tr	Tee Run	U	Union
WirF	Wirsbo	WMV	Water Meter Valve	Z	Cap

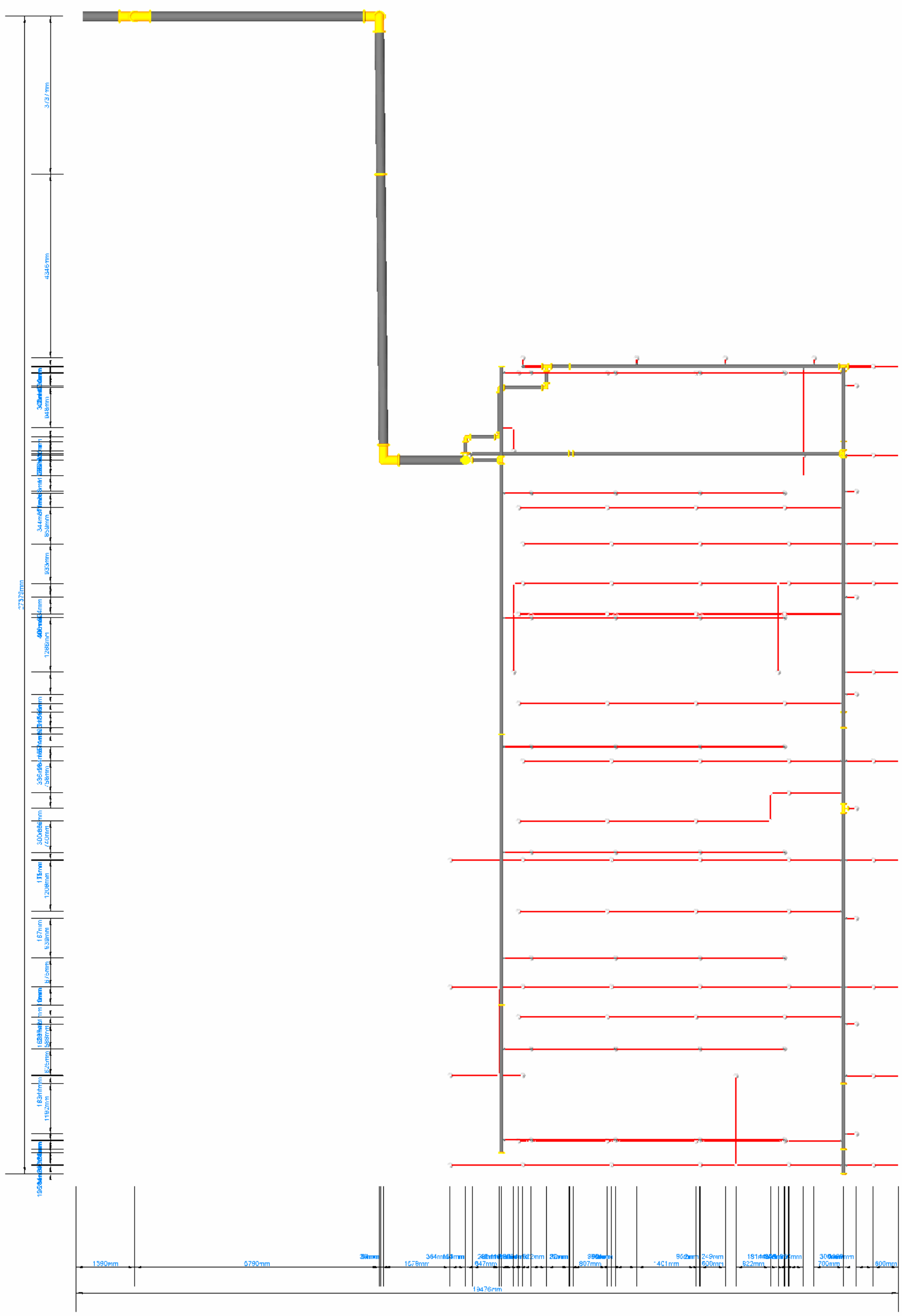


3.54mps
7315.58L/min
3.54mps
7315.58L/min
Up
Up
3.54mps
7315.58L/min
3.54mps
7315.58L/min
3.78mps
7315.58L/min



3.54mps
7315.58L/min
3.54mps
7315.58L/min
7315.58L/min
3.54mps
7315.58L/min
3.54mps
7315.58L/min
63.67L/min
53.47L/min

Multiple Connection Diagram



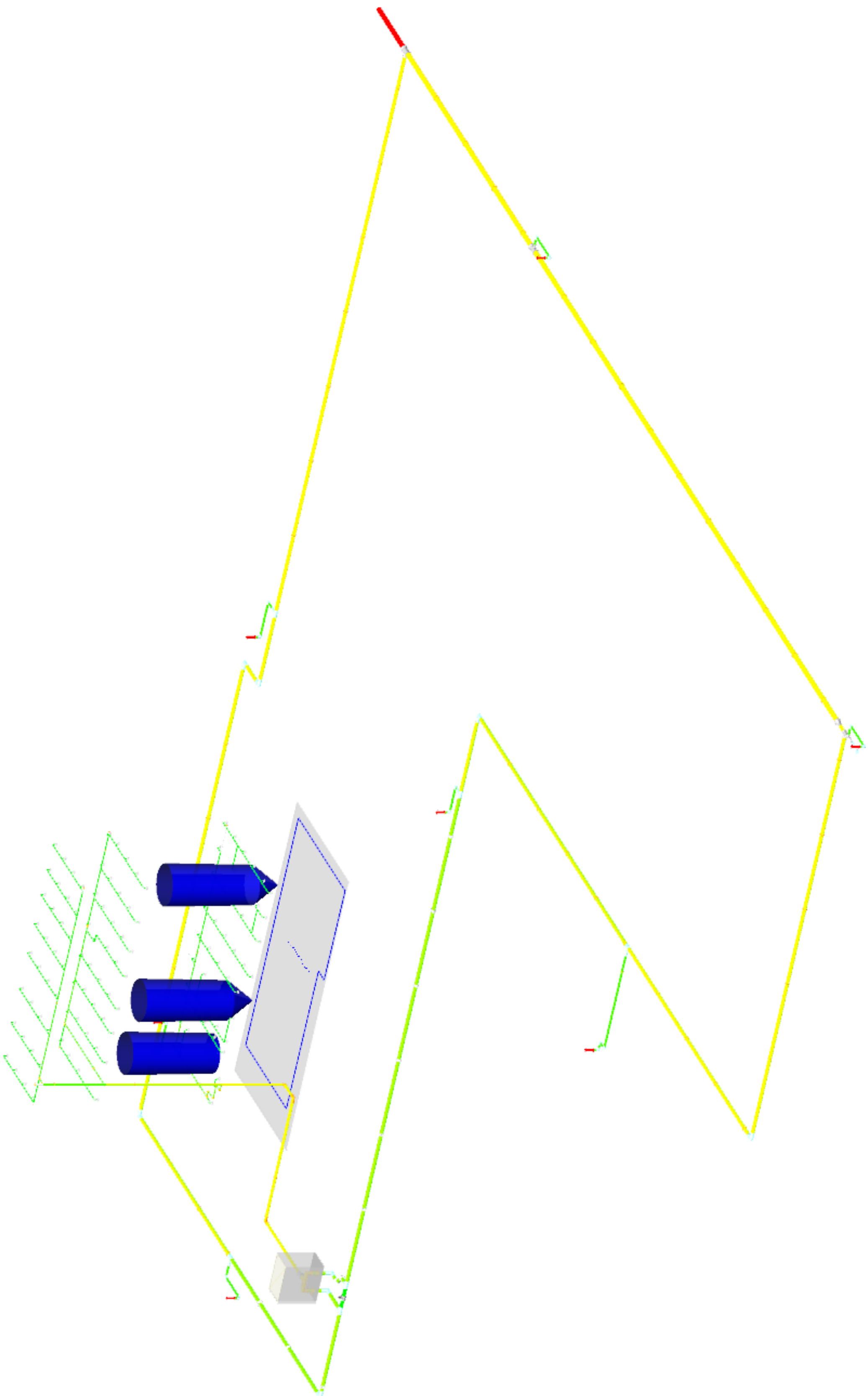


Figure A.1 – Flow Coloured Graph

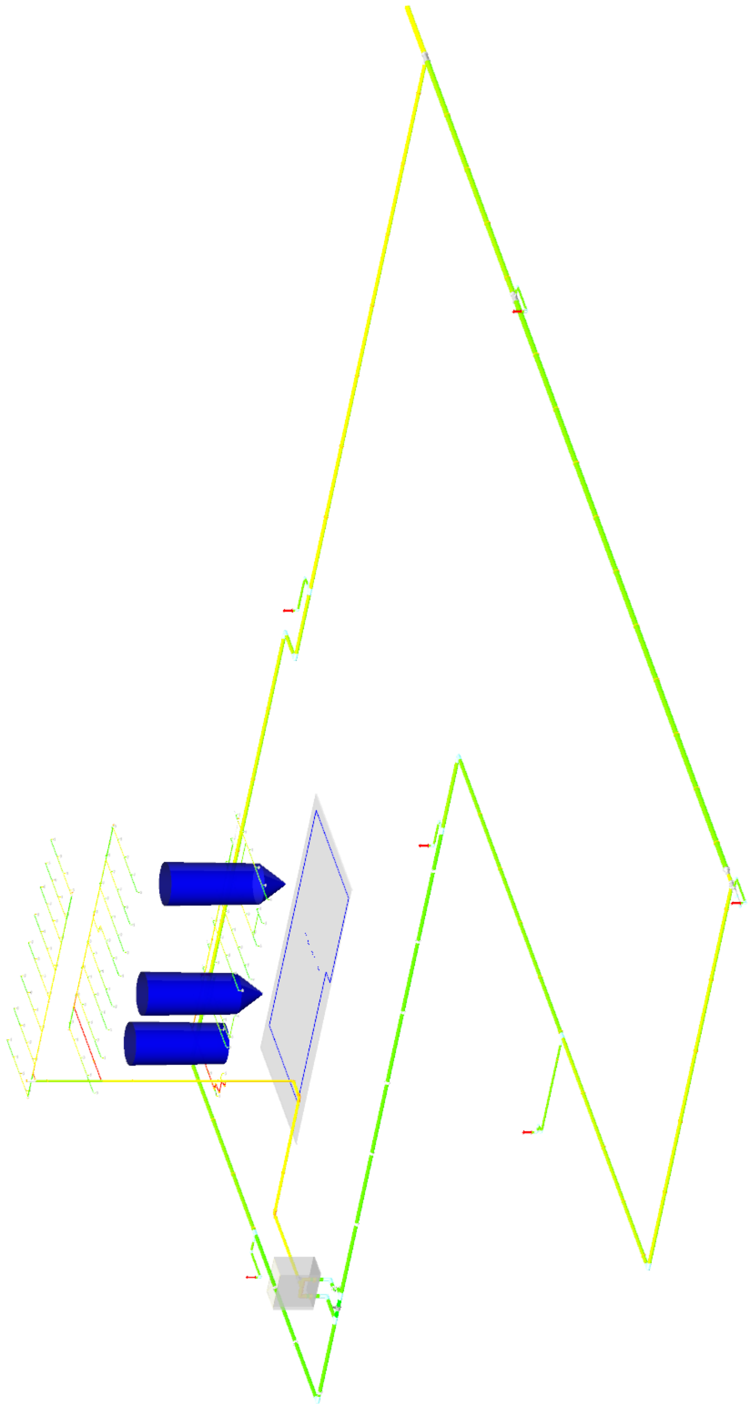


Figure A.2 – Velocity Coloured Graph

Contract Information

Contractor:		Contact:	:
		Phone:	
		FAX:	
		E-mail:	
		Web-Site:	

Design Engineer:	Daniel Rocha Afonso
Phone:	
FAX:	

Job Information

Job Number:	1	List Area:	Default List Area
Job Name:	Thesis	Last Listed:	10/06/2020
Customer:		Black-Black:	
Customer Name:		Number of Heads:	120
		Total Weight:	4474lb 0oz
		Weld Count:	46

Shipping Information

Ship To:		POJ:	
	,		
Ship Via:			

Table of Contents

Black-Black	Material Summary	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Quantity	Size	Description, Finish	Part Number	Manufacturer
Grooved Fittings				
1	150	Grooved 90º Elbow		
4	80	Grooved 90º Elbow, style 06	06P088	Modgal Metal Ltd
5	200	Grooved 90º Lg Rad Steel Elbow		
6	80	Grooved Cap, style 02	02P088	Modgal Metal Ltd
1	150	Grooved Cap, style 02	02P168	Modgal Metal Ltd
1	80 x 80 x 32	Grooved Reducing Tee, SS		
2	80	Grooved Short Radius Tee, style 65	65P088	Modgal Metal Ltd
2	80	Grooved Tee		
Threaded Fittings				
6	25	Threaded 90º Elbow, Equal nr. 90		Georg Fischer
2	32	Threaded 90º Elbow, Equal nr. 90		Georg Fischer
27	32 x 25	Threaded 90º Elbow, reducing nr. 90R		Georg Fischer
8	32 x 15	Threaded 90º Reducing Elbow		
1	50 x 32	Threaded 90º Reducing Elbow		
1	25	Threaded Cap, nr.300		Georg Fischer
10	32	Threaded Cap, nr.300		Georg Fischer
24	32 x 32 x 15	Threaded Reducing Tee		
1	32 x 25 x 25	Threaded Reducing Tee, reducing, nr. 130R		Georg Fischer
56	32 x 32 x 25	Threaded Reducing Tee, reducing, nr. 130R		Georg Fischer
1	50 x 32 x 25	Threaded Reducing Tee, reducing, nr. 130R		Georg Fischer
88	25 x 15	Threaded Socket, reducing, nr. 240		Georg Fischer
1	25	Threaded Straight Tee, equal, nr. 130		Georg Fischer
2	32	Threaded Straight Tee, equal, nr. 130		Georg Fischer
Pipe				
74900mm	80	Pipe, Schedule 10 (8 Sticks x 10922mm) 0.42 Bundles Welded		
13740mm	150	Pipe, Schedule 10 (2 Sticks x 11840mm) 0.20 Bundles Welded		
9600mm	200	Pipe, Schedule 10 (2 Sticks x 7408mm) 0.29 Bundles Welded		
4110mm	25	Pipe, Schedule 40 (Galv) (1 Stick x 6401mm) 0.01 Bundles Threaded		
5050mm	25	Pipe, Schedule 40 (1 Stick x 6401mm) 0.01 Bundles Threaded		
173550mm	32	Pipe, Schedule 40 (29 Sticks x 6401mm) 0.57 Bundles Threaded		
2440mm	32	Pipe, Schedule 40 (1 Stick x 6401mm) 0.02 Bundles Threaded		
1000mm	50	Pipe, Schedule 40 (1 Stick x 6401mm) 0.03 Bundles Threaded		
11360mm	200	Pipe, Schedule 40 (2 Sticks x 6401mm) 0.13 Bundles Welded		
Couplings				
2	80 x 50	Grooved Reducer Coupling		
1	32	Grooved Rigid Coupling		
39	80	Grooved Rigid Coupling		
4	150	Grooved Rigid Coupling		
11	200	Grooved Rigid Coupling		
Pipe Outlets				
2	80 x 25	Thread-O-Let		
41	80 x 32	Thread-O-Let		
3	150 x 80	Welded Outlet-Grooved		
Sprinklers				
88	15	K=1.9, Open, Brass (Pendent)		
32	15	K=2.8, Open, Brass (Pendent)		
Nipples				
32	15 x 191	Nipple, Schedule 40		
87	25 x 165	Nipple, Schedule 40		
1	25 x 178	Nipple, Schedule 40		

Quantity	Size	Description, Finish	Part Number	Manufacturer
1	25 x 178	Nipple, Schedule 40 (Galv)		
1	25 x 250	Nipple, Schedule 40		
3	32 x 114	Nipple, Schedule 40		
1	32 x 140	Nipple, Schedule 40		
1	32 x 191	Nipple, Schedule 40		
7	32 x 216	Nipple, Schedule 40		

Black-Black	Material Summary, Threaded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Quantity	Size	Description, Finish	Part Number	Manufacturer
Pipe				
4110mm	25	Pipe, Schedule 40 (Galv) (1 Stick x 6401mm) 0.01 Bundles Threaded		
5050mm	25	Pipe, Schedule 40 (1 Stick x 6401mm) 0.01 Bundles Threaded		
173550mm	32	Pipe, Schedule 40 (29 Sticks x 6401mm) 0.57 Bundles Threaded		
2440mm	32	Pipe, Schedule 40 (1 Stick x 6401mm) 0.02 Bundles Threaded		
1000mm	50	Pipe, Schedule 40 (1 Stick x 6401mm) 0.03 Bundles Threaded		
Threaded Fittings				
6	25	Threaded 90º Elbow, Equal nr. 90		
2	32	Threaded 90º Elbow, Equal nr. 90		
27	32 x 25	Threaded 90º Elbow, reducing nr. 90R		
8	32 x 15	Threaded 90º Reducing Elbow		
1	50 x 32	Threaded 90º Reducing Elbow		
1	25	Threaded Cap, nr.300		
10	32	Threaded Cap, nr.300		
24	32 x 32 x 15	Threaded Reducing Tee		
1	32 x 25 x 25	Threaded Reducing Tee, reducing, nr. 130R		
56	32 x 32 x 25	Threaded Reducing Tee, reducing, nr. 130R		
1	50 x 32 x 25	Threaded Reducing Tee, reducing, nr. 130R		
88	25 x 15	Threaded Socket, reducing, nr. 240		
1	25	Threaded Straight Tee, equal, nr. 130		
2	32	Threaded Straight Tee, equal, nr. 130		

Black-Black	Material Summary, Welded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Quantity	Size	Description, Finish	Part Number	Manufacturer
Pipe				
74900mm	80	Pipe, Schedule 10 (8 Sticks x 10922mm) 0.42 Bundles Welded		
13740mm	150	Pipe, Schedule 10 (2 Sticks x 11840mm) 0.20 Bundles Welded		
9600mm	200	Pipe, Schedule 10 (2 Sticks x 7408mm) 0.29 Bundles Welded		
11360mm	200	Pipe, Schedule 40 (2 Sticks x 6401mm) 0.13 Bundles Welded		
Pipe Outlets				
41	80 x 32	Thread-O-Let		
2	80 x 25	Thread-O-Let		
3	150 x 80	Welded Outlet-Grooved		

Branch Line

BL1, a **Quantity: 4**

Attached Lines	Qty Per Line
DR1	1

BL2, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	6

BL3, a **Quantity: 4**

Attached Lines	Qty Per Line
DR1	1

BL4, a **Quantity: 6**

Attached Lines	Qty Per Line
DR1	4

BL5, a **Quantity: 7**

Attached Lines	Qty Per Line
DR1	1

BL6, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	7

BL7, a **Quantity: 8**

Attached Lines	Qty Per Line
DR2	4

BL8, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	1

BL9, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	5

BL10, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	4

BL11, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	4

BL12, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	6

BL13, a **Quantity: 1**

Attached Lines	Qty Per Line
DR3	1

BL14, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	4

BL15, a **Quantity: 3**

Attached Lines	Qty Per Line
DR1	1

BL16, a **Quantity: 1**

Attached Lines	Qty Per Line
DR4	1

BL17, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	1

BL18, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	4

BL19, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	1

BL20, a **Quantity: 1**

Attached Lines	Qty Per Line
DR1	1

Quantity	Thread Size	Description	Part Number	Manufacturer
		Pendent		
88	15	K=1.9, Open, Brass		
32	15	K=2.8, Open, Brass		

Black-Black	Loose Material	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Quantity	Size	Description, Finish	Part Number	Manufacturer
Grooved Fittings				
1	150	Grooved 90º Elbow		
4	80	Grooved 90º Elbow, style 06	06P088	Modgal Metal Ltd
5	200	Grooved 90º Lg Rad Steel Elbow		
6	80	Grooved Cap, style 02	02P088	Modgal Metal Ltd
1	150	Grooved Cap, style 02	02P168	Modgal Metal Ltd
1	80 x 80 x 32	Grooved Reducing Tee, SS		
2	80	Grooved Short Radius Tee, style 65	65P088	Modgal Metal Ltd
2	80	Grooved Tee		
Couplings				
2	80 x 50	Grooved Reducer Coupling		
1	32	Grooved Rigid Coupling		
39	80	Grooved Rigid Coupling		
4	150	Grooved Rigid Coupling		
11	200	Grooved Rigid Coupling		
Sprinklers				
88	15	K=1.9, Open, Brass (Pendent)		
32	15	K=2.8, Open, Brass (Pendent)		

Quantity	Size	Nipple	Make-on
32	15 x 191	Nipple, Schedule 40	No Fitting
87	25 x 165	Nipple, Schedule 40	25 x 15 Threaded Socket, reducing, nr. 240
1	25 x 178	Nipple, Schedule 40	25 x 15 Threaded Socket, reducing, nr. 240
1	25 x 178	Nipple, Schedule 40 (Galv)	25 Threaded 90º Elbow, Equal nr. 90
1	25 x 250	Nipple, Schedule 40	25 Threaded 90º Elbow, Equal nr. 90
3	32 x 114	Nipple, Schedule 40	32 x 25 Threaded 90º Elbow, reducing nr. 90R
1	32 x 140	Nipple, Schedule 40	32 x 25 Threaded 90º Elbow, reducing nr. 90R
1	32 x 191	Nipple, Schedule 40	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
7	32 x 216	Nipple, Schedule 40	32 x 25 Threaded 90º Elbow, reducing nr. 90R

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - A	1	200 - SCH 40	1580mm	GG

ARROW: Down

G ---- 0mm
: (1580mm)
G ---- 1580mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - B	1	200 - SCH 40	6400mm	GG

ARROW: Down

G ---- 0mm
: (6400mm)
G ---- 6400mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - C	1	200 - SCH 40	3380mm	GG

ARROW: Down

G ---- 0mm
: (3380mm)
G ---- 3380mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - D	1	200 - SCH 10	380mm	GG

ARROW: Down

G ---- 0mm
: (380mm)
G ---- 380mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - E	1	200 - SCH 10	5070mm	GG

ARROW: Down

G ---- 0mm
: (5070mm)
G ---- 5070mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - F	1	200 - SCH 10	3120mm	GG

ARROW: Down

G ---- 0mm
: (3120mm)
G ---- 3120mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM1 - G	1	200 - SCH 10	1030mm	GG

ARROW: Down

G ---- 0mm
: (1030mm)
G ---- 1030mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - A	1	80 - SCH 10	60mm	GG

ARROW: Down

G ---- 0mm
: (60mm)
G ---- 60mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - B	1	80 - SCH 10	2290mm	GG

ARROW: Down

G ---- 0mm
: (2290mm)
G ---- 2290mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - C	1	80 - SCH 10	100mm	GG

ARROW: Down

G ---- 0mm
: (100mm)
G ---- 100mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - D	1	80 - SCH 10	6320mm	GG

ARROW: Down

G ---- 0mm
: (6320mm)
G ---- 6320mm

TOTAL NUMBER OF WELDS: 0

Black-Black	Non-Graphical Welded Mains	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - E	1	80 - SCH 10	6400mm	GG

ARROW: Down

G	----	0mm	
:			(246888mm)
X	----	246888mm	3 x 1¼ Thread-O-Let @ LEFT
:			(115824mm)
X	----	362712mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(646176mm)
X	----	1008888mm	3 x 1¼ Thread-O-Let @ LEFT
:			(121920mm)
X	----	1130808mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(579120mm)
X	----	1709928mm	3 x 1¼ Thread-O-Let @ LEFT
:			(64008mm)
X	----	1773936mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(176784mm)
G	----	6400mm	

TOTAL NUMBER OF WELDS: 6

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - F	1	80 - SCH 10	1800mm	GG

ARROW: Down

G	----	0mm	
:			(469392mm)
X	----	469392mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(79248mm)
G	----	1800mm	

TOTAL NUMBER OF WELDS: 1

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM2 - G	1	80 - SCH 10	6400mm	GG

ARROW: Down

G	----	0mm	
:			(710184mm)
X	----	710184mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(48768mm)
X	----	758952mm	3 x 1¼ Thread-O-Let @ LEFT
:			(713232mm)
X	----	1472184mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(48768mm)
X	----	1520952mm	3 x 1¼ Thread-O-Let @ LEFT
:			(429768mm)
G	----	6400mm	

TOTAL NUMBER OF WELDS: 4

Black-Black	Non-Graphical Welded Mains	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

MAIN I.D.: CM2 - H | **QUAN.** 1 | **PIPE DESCRIPTION** 80 - SCH 10 | **LENGTH** 1560mm | **EP** GG

ARROW: Down

G	----	0mm	
:			(362712mm)
X	----	362712mm	3 x 1¼ Thread-O-Let @ LEFT
:			(51816mm)
X	----	414528mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(60960mm)
G	----	1560mm	

TOTAL NUMBER OF WELDS: 2

MAIN I.D.: CM2 - I | **QUAN.** 1 | **PIPE DESCRIPTION** 80 - SCH 10 | **LENGTH** 1970mm | **EP** GG

ARROW: Down

G	----	0mm	
:			(463296mm)
X	----	463296mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(91440mm)
X	----	554736mm	3 x 1¼ Thread-O-Let @ LEFT
:			(45720mm)
G	----	1970mm	

TOTAL NUMBER OF WELDS: 2

MAIN I.D.: CM3 - A | **QUAN.** 1 | **PIPE DESCRIPTION** 80 - SCH 10 | **LENGTH** 600mm | **EP** GG

ARROW: Down

G	----	0mm	
:			(600mm)
G	----	600mm	

TOTAL NUMBER OF WELDS: 0

MAIN I.D.: CM3 - B | **QUAN.** 1 | **PIPE DESCRIPTION** 80 - SCH 10 | **LENGTH** 6400mm | **EP** GG

ARROW: Down

G	----	0mm	
:			(210312mm)
X	----	210312mm	3 x 1¼ Thread-O-Let @ LEFT
:			(899160mm)
X	----	1109472mm	3 x 1¼ Thread-O-Let @ LEFT
:			(841248mm)
G	----	6400mm	

TOTAL NUMBER OF WELDS: 2

Black-Black	Non-Graphical Welded Mains	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM3 - C	1	80 - SCH 10	6400mm	GG

ARROW: Down

G	----	0mm	
:			(88392mm)
X	----	88392mm	3 x 1¼ Thread-O-Let @ LEFT
:			(762000mm)
X	----	850392mm	3 x 1¼ Thread-O-Let @ LEFT
:			(762000mm)
X	----	1612392mm	3 x 1¼ Thread-O-Let @ LEFT
:			(338328mm)
G	----	6400mm	

TOTAL NUMBER OF WELDS: 3

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM3 - D	1	80 - SCH 10	3500mm	GG

ARROW: Down

G	----	0mm	
:			(316992mm)
X	----	316992mm	3 x 1¼ Thread-O-Let @ LEFT
:			(655320mm)
X	----	972312mm	3 x 1¼ Thread-O-Let @ LEFT
:			(94488mm)
G	----	3500mm	

TOTAL NUMBER OF WELDS: 2

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM3 - E	1	80 - SCH 10	2130mm	GG

ARROW: Down

G	----	0mm	
:			(606552mm)
X	----	606552mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(42672mm)
G	----	2130mm	

TOTAL NUMBER OF WELDS: 1

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - A	1	80 - SCH 10	160mm	GG

ARROW: Down

G	----	0mm	
:			(160mm)
G	----	160mm	

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - B	1	80 - SCH 10	280mm	GG

ARROW: Down

G ---- 0mm
: (280mm)
G ---- 280mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - C	1	80 - SCH 10	580mm	GG

ARROW: Down

G ---- 0mm
: (580mm)
G ---- 580mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - D	1	80 - SCH 10	950mm	GG

ARROW: Down

G ---- 0mm
: (33528mm)
X ---- 33528mm 3 x 1 Thread-O-Let @ RIGHT
: (256032mm)
G ---- 950mm

TOTAL NUMBER OF WELDS: 1

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - E	1	80 - SCH 10	900mm	GG

ARROW: Down

G ---- 0mm
: (900mm)
G ---- 900mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - F	1	80 - SCH 10	290mm	GG

ARROW: Down

G ---- 0mm
: (290mm)
G ---- 290mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - G	1	80 - SCH 10	440mm	GG

ARROW: Down

G ---- 0mm
: (440mm)
G ---- 440mm

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - H	1	80 - SCH 10	6380mm	GG

ARROW: Down

G ---- 0mm
: (484632mm)
X ---- 484632mm 3 x 1¼ Thread-O-Let @ LEFT
: (640080mm)
X ---- 1124712mm 3 x 1¼ Thread-O-Let @ LEFT
: (563880mm)
X ---- 1688592mm 3 x 1 Thread-O-Let @ RIGHT
: (76200mm)
X ---- 1764792mm 3 x 1¼ Thread-O-Let @ LEFT
: (179832mm)
G ---- 6380mm

TOTAL NUMBER OF WELDS: 4

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - I	1	80 - SCH 10	1670mm	GG

ARROW: Down

G ---- 0mm
: (1670mm)
G ---- 1670mm

TOTAL NUMBER OF WELDS: 0

Black-Black	Non-Graphical Welded Mains	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - J	1	80 - SCH 10	6400mm	GG
ARROW: Down				

G	----	0mm	
:			(100584mm)
X	----	100584mm	3 x 1¼ Thread-O-Let @ LEFT
:			(640080mm)
X	----	740664mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	740664mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(283464mm)
X	----	1024128mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	1024128mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(640080mm)
X	----	1664208mm	3 x 1¼ Thread-O-Let @ LEFT
:			(286512mm)
G	----	6400mm	

TOTAL NUMBER OF WELDS: 6

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
CM4 - K	1	80 - SCH 10	10920mm	GG
ARROW: Down				

G	----	0mm	
:			(353568mm)
X	----	353568mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	353568mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(716280mm)
X	----	1069848mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	1069848mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(914400mm)
X	----	1984248mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	1984248mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(640080mm)
X	----	2624328mm	3 x 1¼ Thread-O-Let @ LEFT
:			(646176mm)
X	----	3270504mm	3 x 1¼ Thread-O-Let @ LEFT
:			(0mm)
X	----	3270504mm	3 x 1¼ Thread-O-Let @ RIGHT
:			(57912mm)
G	----	10920mm	

TOTAL NUMBER OF WELDS: 9

Black-Black	Non-Graphical Welded Mains	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
FR1 - A	1	150 - SCH 10	11840mm	GG

ARROW: Down

G	----	0mm	
:			(42702mm)
X	----	42702mm	6 x 3 Welded Outlet-Grooved @ RIGHT
:			(1286256mm)
X	----	1328958mm	6 x 3 Welded Outlet-Grooved @ RIGHT
:			(2279874mm)
G	----	11840mm	

TOTAL NUMBER OF WELDS: 2

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
FR1 - B	1	150 - SCH 10	1500mm	GG

ARROW: Down

G	----	0mm	
:			(1500mm)
G	----	1500mm	

TOTAL NUMBER OF WELDS: 0

MAIN I.D.:	QUAN.	PIPE DESCRIPTION	LENGTH	EP
FR1 - C	1	150 - SCH 10	400mm	GG

ARROW: Down

G	----	0mm	
:			(6096mm)
X	----	6096mm	6 x 3 Welded Outlet-Grooved @ Up
:			(115824mm)
G	----	400mm	

TOTAL NUMBER OF WELDS: 1

CM1 Quantity: 1

Piece: A (200 - SCH 40 1580mm G-G)

No Fitting **No Fitting**

G G

1580mm

1580mm

Piece: B (200 - SCH 40 6400mm G-G)

No Fitting **No Fitting**

G G

6400mm

6400mm

Piece: C (200 - SCH 40 3380mm G-G)

No Fitting **No Fitting**

G G

3380mm

3380mm

Piece: D (200 - SCH 10 380mm G-G)

No Fitting **No Fitting**

G G

380mm

380mm

Piece: E (200 - SCH 10 5070mm G-G)

No Fitting **No Fitting**

G G

5070mm

5070mm

Piece: F (200 - SCH 10 3120mm G-G)

No Fitting **No Fitting**

G G

3120mm

3120mm

Piece: G (200 - SCH 10 1030mm G-G)

No Fitting **No Fitting**

G G

1030mm

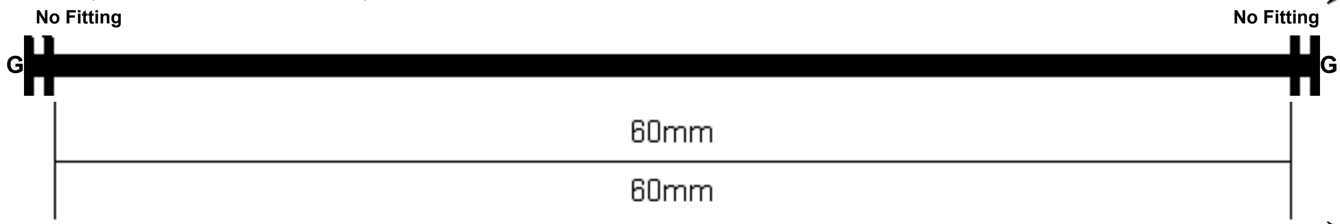
1030mm

CM2 Quantity: 1

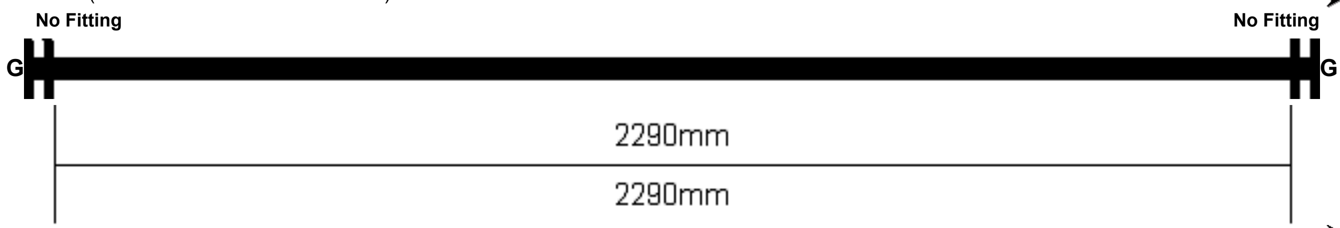
Black-Black	Welded Mains - Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

CM2 Quantity: 1

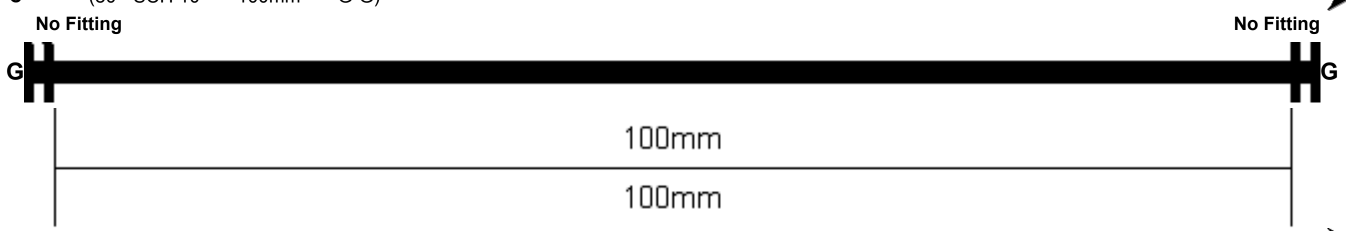
Piece: A (80 - SCH 10 60mm G-G)



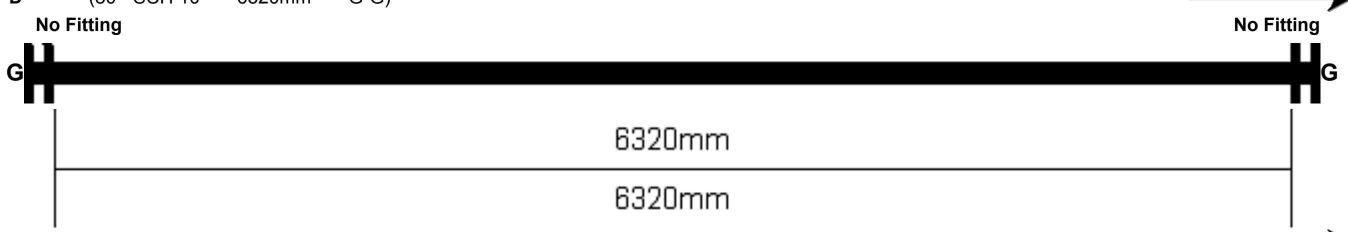
Piece: B (80 - SCH 10 2290mm G-G)



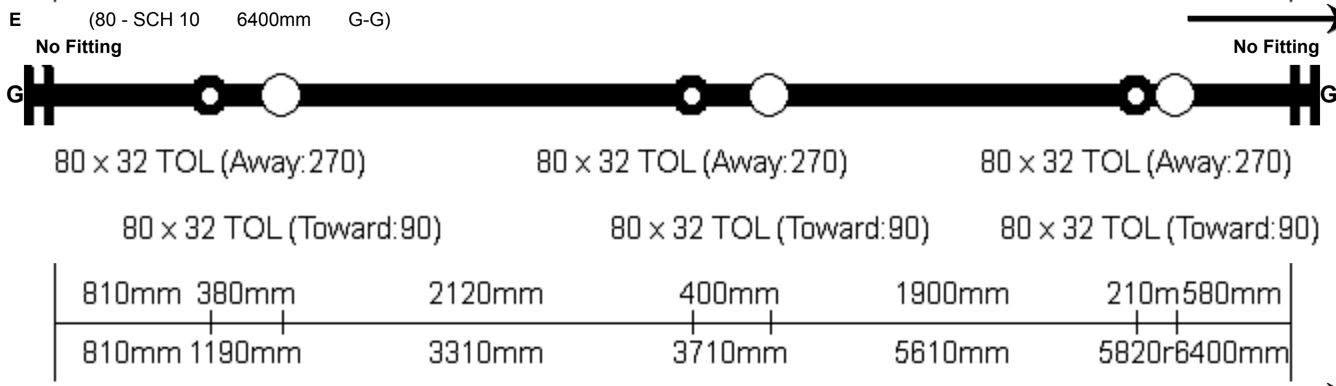
Piece: C (80 - SCH 10 100mm G-G)



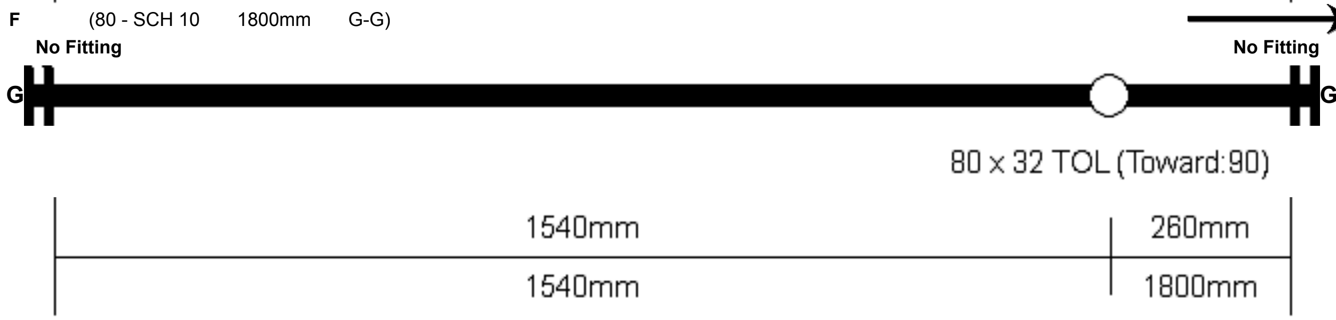
Piece: D (80 - SCH 10 6320mm G-G)



Piece: E (80 - SCH 10 6400mm G-G)

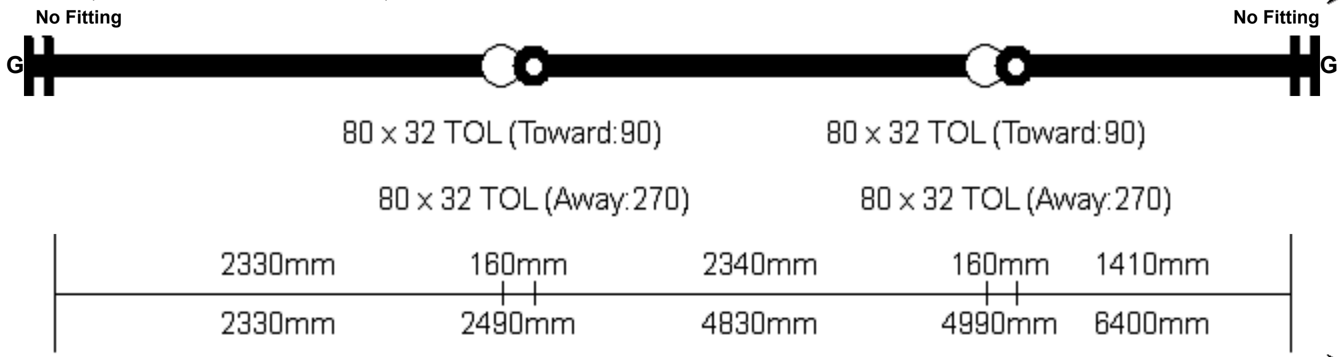


Piece: F (80 - SCH 10 1800mm G-G)

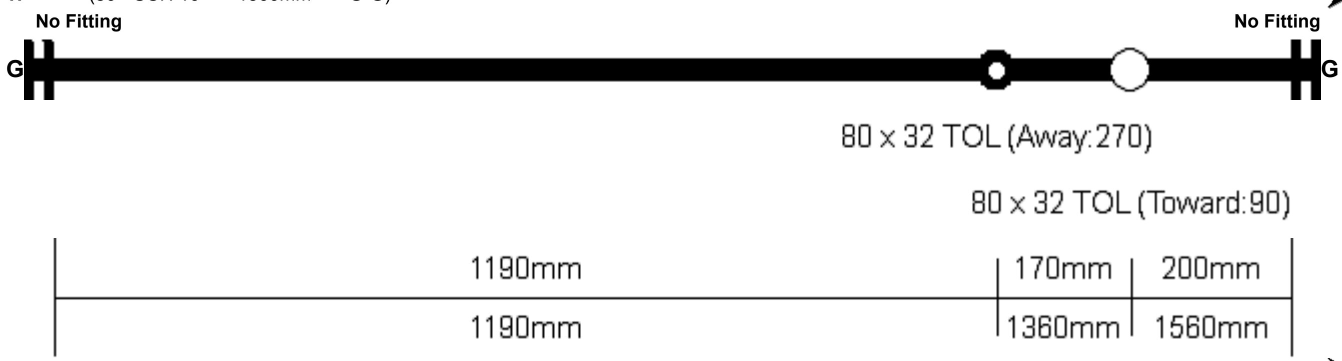


CM2 Quantity: 1

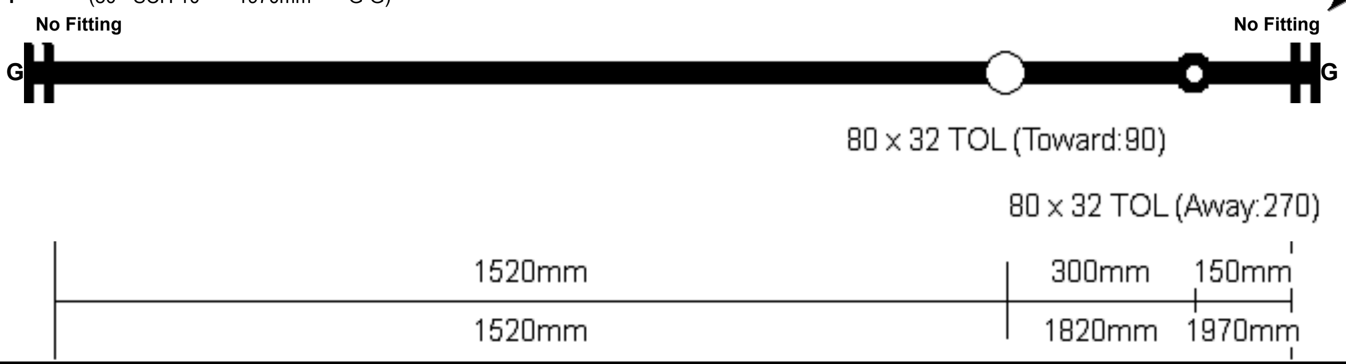
Piece: G (80 - SCH 10 6400mm G-G)



Piece: H (80 - SCH 10 1560mm G-G)

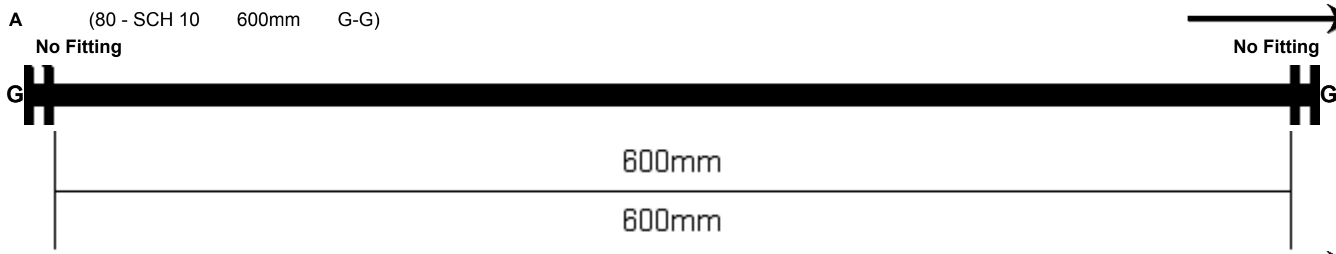


Piece: I (80 - SCH 10 1970mm G-G)

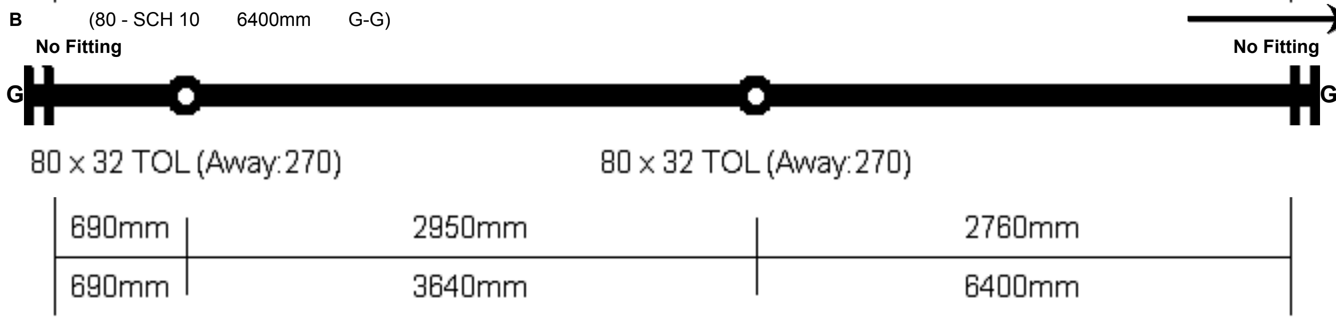


CM3 Quantity: 1

Piece: A (80 - SCH 10 600mm G-G)



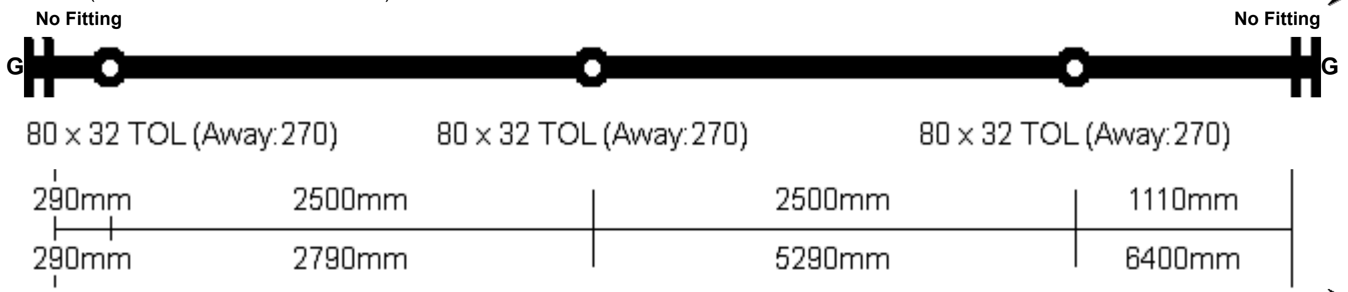
Piece: B (80 - SCH 10 6400mm G-G)



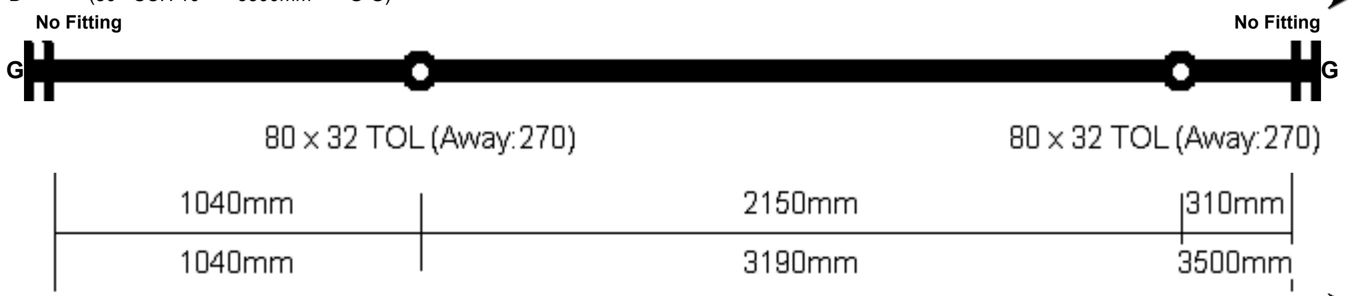
Black-Black	Welded Mains - Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

CM3 Quantity: 1

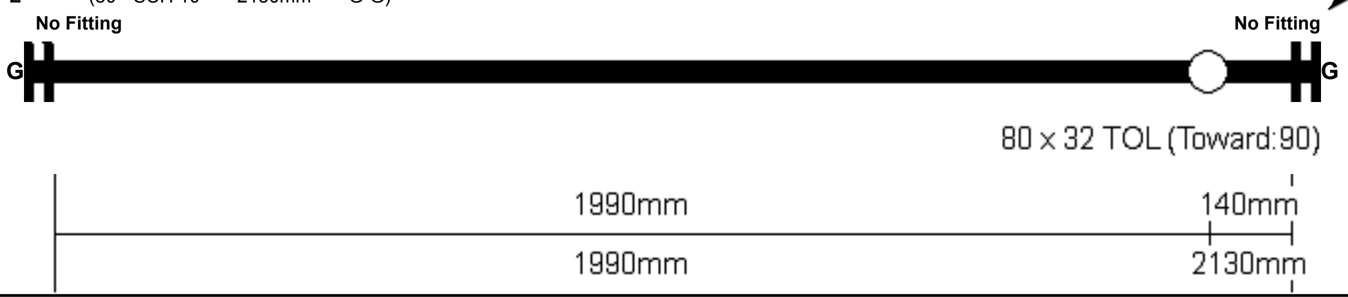
Piece: C (80 - SCH 10 6400mm G-G)



Piece: D (80 - SCH 10 3500mm G-G)

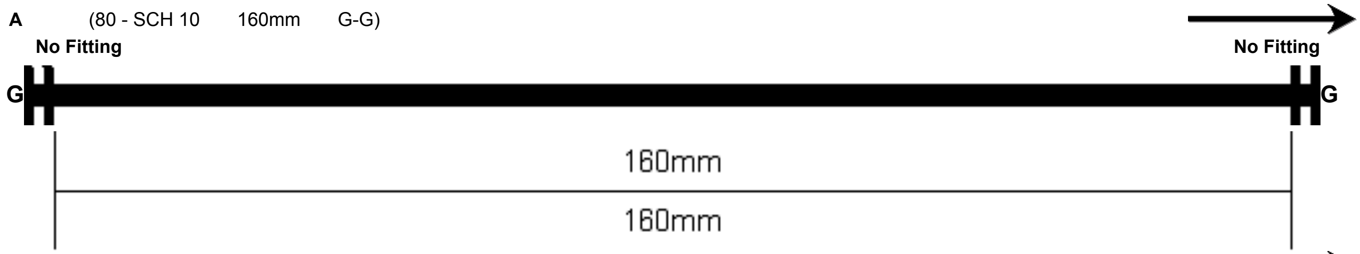


Piece: E (80 - SCH 10 2130mm G-G)

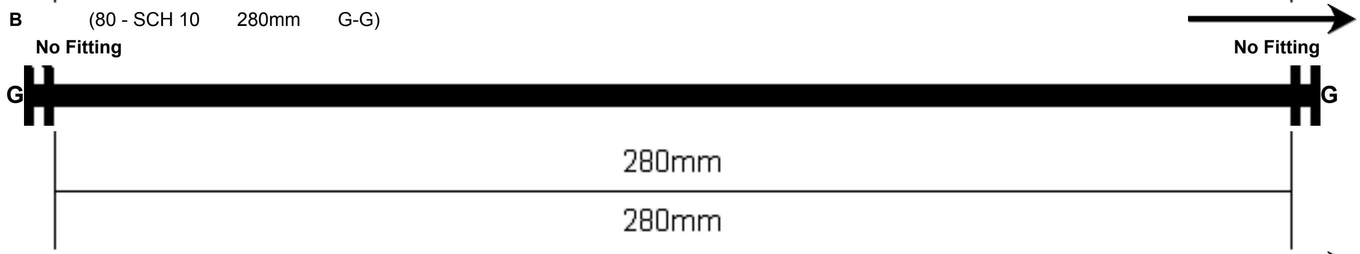


CM4 Quantity: 1

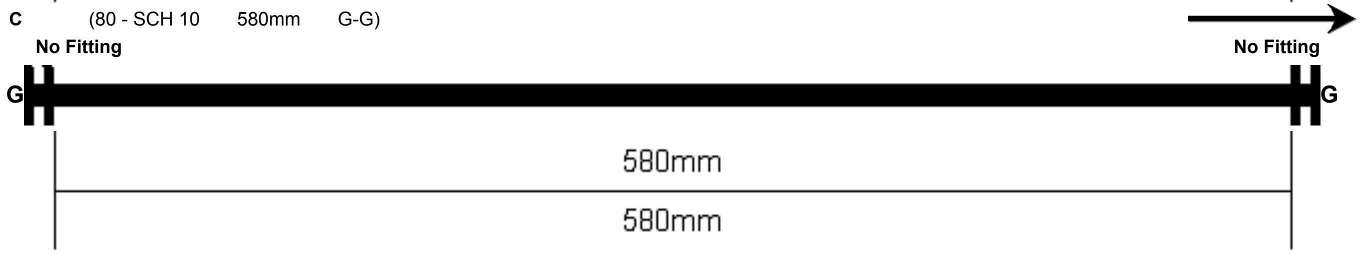
Piece: A (80 - SCH 10 160mm G-G)



Piece: B (80 - SCH 10 280mm G-G)



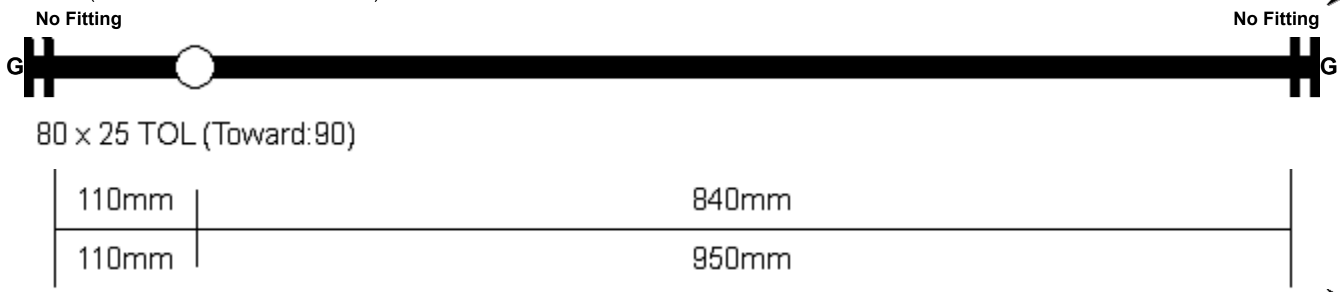
Piece: C (80 - SCH 10 580mm G-G)



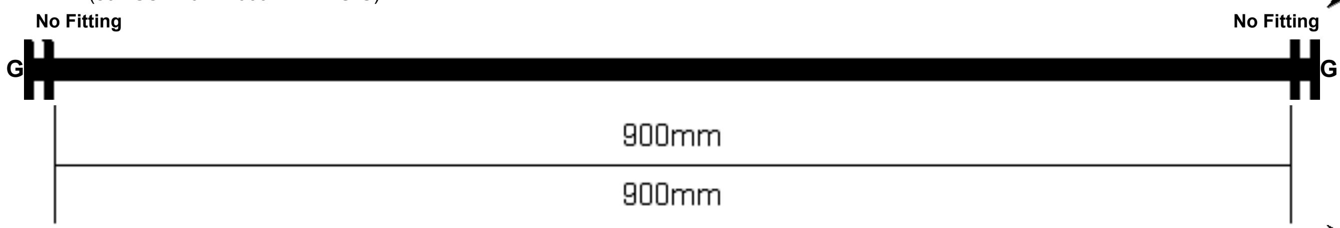
Black-Black	Welded Mains - Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

CM4 Quantity: 1

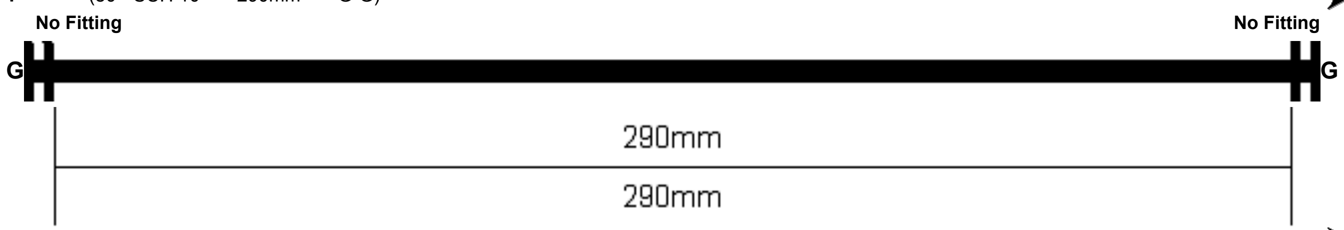
Piece: D (80 - SCH 10 950mm G-G)



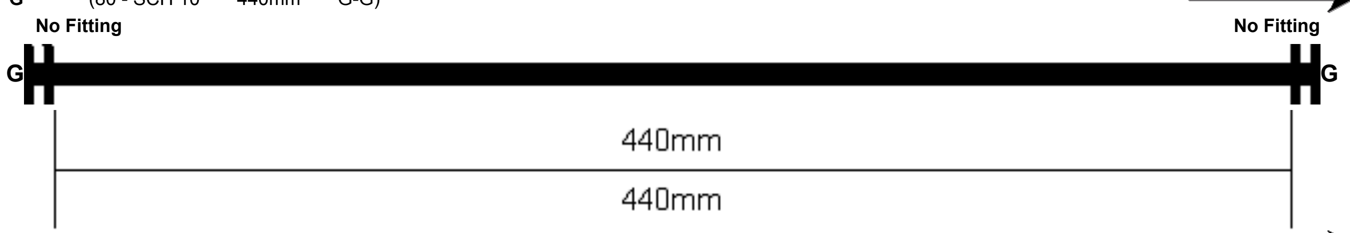
Piece: E (80 - SCH 10 900mm G-G)



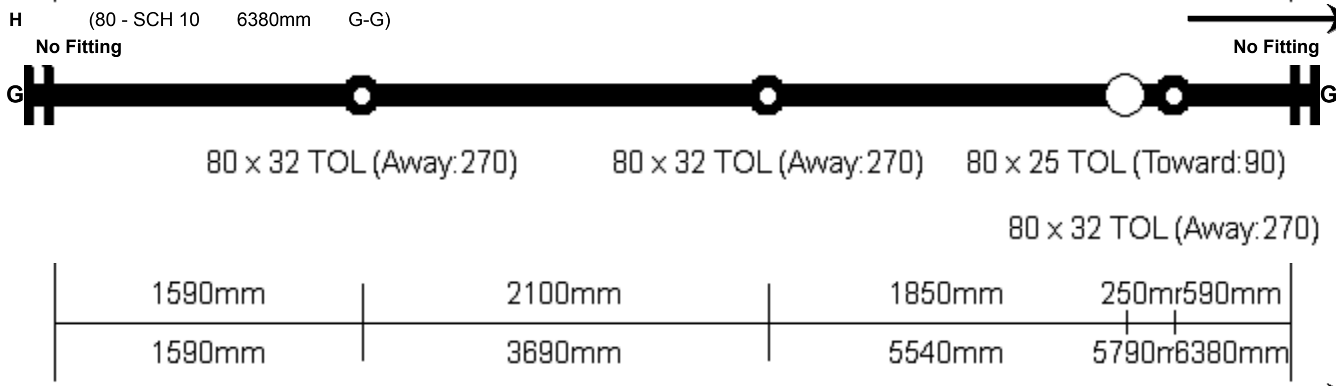
Piece: F (80 - SCH 10 290mm G-G)



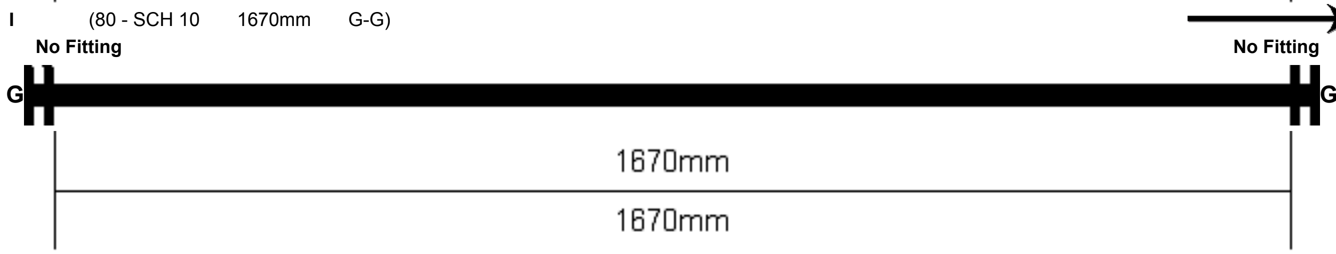
Piece: G (80 - SCH 10 440mm G-G)



Piece: H (80 - SCH 10 6380mm G-G)



Piece: I (80 - SCH 10 1670mm G-G)

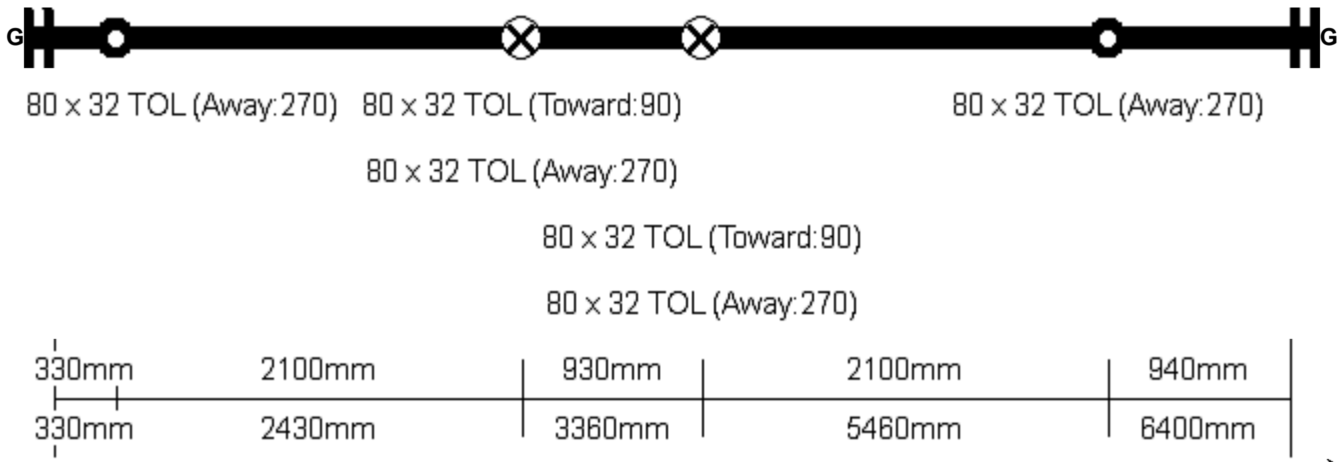


Black-Black	Welded Mains - Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

CM4 Quantity: 1

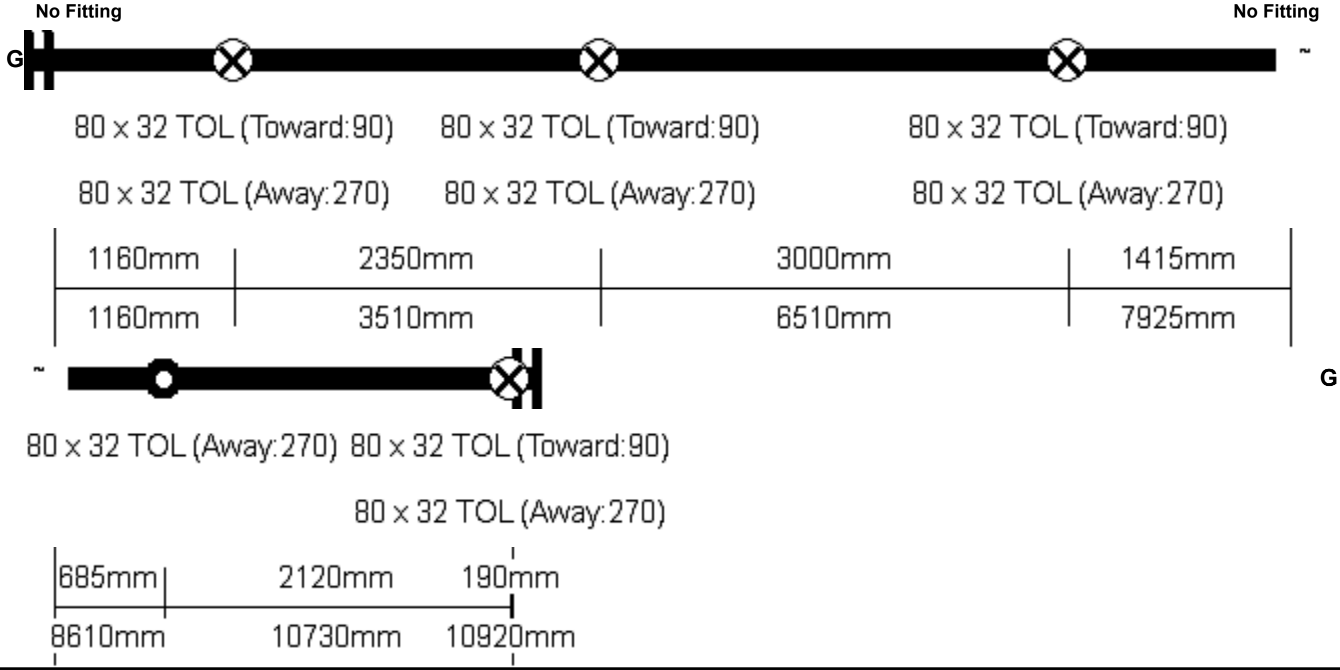
Piece: J (80 - SCH 10 6400mm G-G)

No Fitting **No Fitting**



Piece: K (80 - SCH 10 10920mm G-G)

No Fitting **No Fitting**

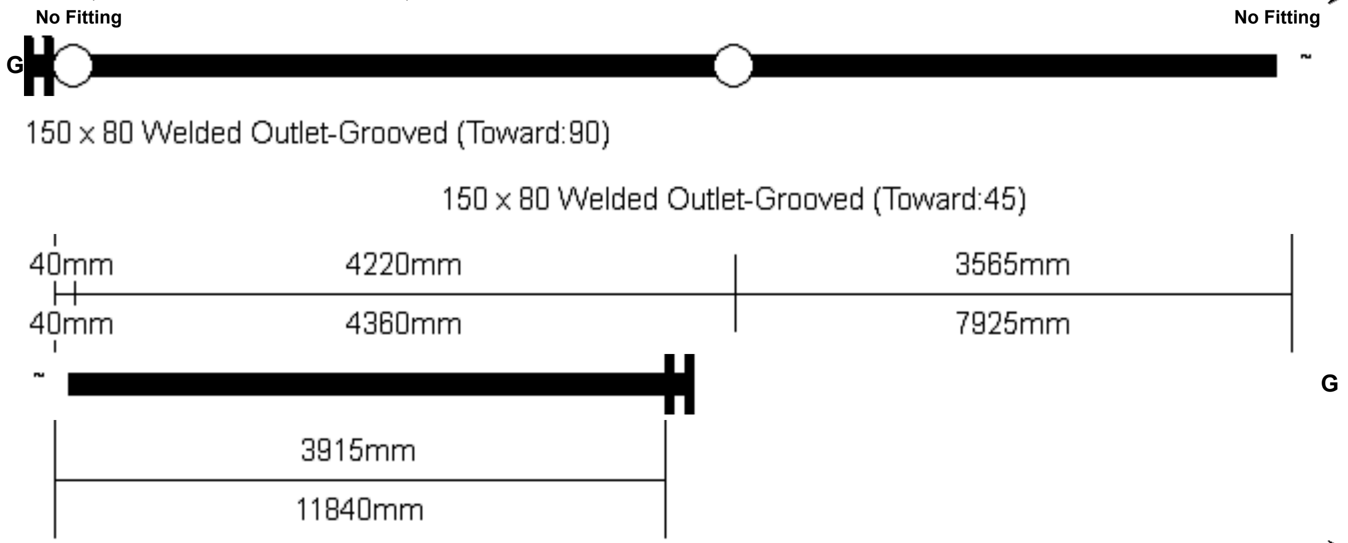


FR1 Quantity: 1

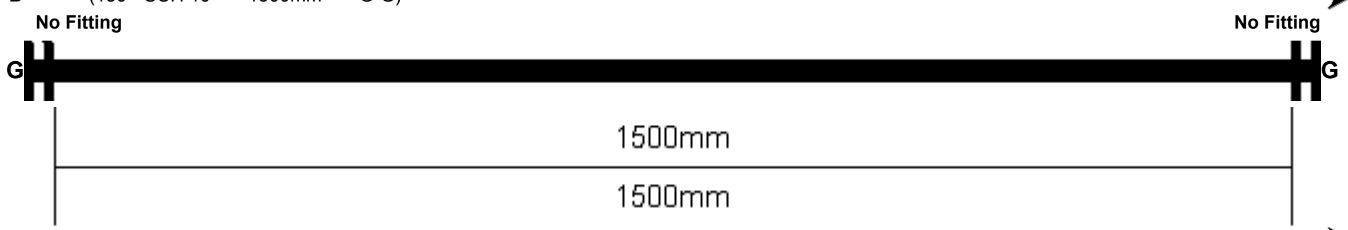
Black-Black	Welded Mains - Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

FR1 Quantity: 1

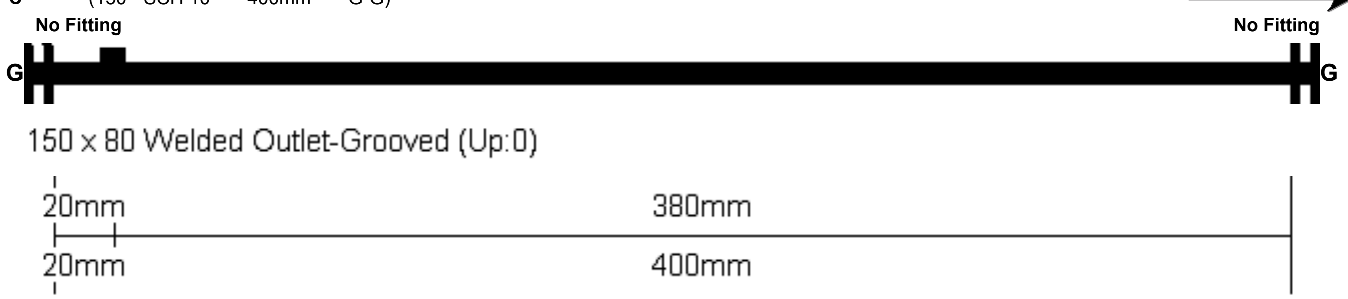
Piece: A (150 - SCH 10 11840mm G-G)



Piece: B (150 - SCH 10 1500mm G-G)



Piece: C (150 - SCH 10 400mm G-G)



Black-Black	Threaded Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Length	Description	Quantity	End Prep	Fitting	Line
Size: 50					
570mm	Pipe, Schedule 40	1	G-T	Threaded Reducing Tee, reducing, nr. 130R	BL13a
430mm	Pipe, Schedule 40	1	G-T	50 x 32 Thrd Red 90	BL19a
Size: 32					
2140mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL11a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL10a
2050mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL10a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL11a
2050mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL11a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL12a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL14a
2050mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL14a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL18a
2050mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL18a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL2a
2050mm	Pipe, Schedule 40	6	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL4a
2050mm	Pipe, Schedule 40	6	T-T	Threaded 90º Elbow, reducing nr. 90R	BL4a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL6a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL6a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL9a
2050mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL9a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL10a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL12a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL14a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL2a
2040mm	Pipe, Schedule 40	6	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL4a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL6a
2040mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL9a
2030mm	Pipe, Schedule 40	1	T-T	Threaded Straight Tee, equal, nr. 130(Bull Head)	BL6a
1970mm	Pipe, Schedule 40	8	T-T	32 x 32 x 15 Thrd Red T	BL7a
1960mm	Pipe, Schedule 40	8	T-T	32 x 32 x 15 Thrd Red T	BL7a
1960mm	Pipe, Schedule 40	8	T-T	32 x 15 Thrd Red 90	BL7a
1800mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL12a
1710mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL18a
1670mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL9a
1660mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL2a
1310mm	Pipe, Schedule 40	6	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL4a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL10a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL11a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL12a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL14a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL18a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL2a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL6a
1210mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL9a
1200mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL2a
1120mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL6a
1120mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL6a
800mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL2a
620mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL18a
620mm	Pipe, Schedule 40	8	T-T	32 x 32 x 15 Thrd Red T	BL7a
610mm	Pipe, Schedule 40	4	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL1a
610mm	Pipe, Schedule 40	4	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL3a
610mm	Pipe, Schedule 40	1	T-T	Threaded Reducing Tee, reducing, nr. 130R	BL8a
570mm	Pipe, Schedule 40	1	T-T	Threaded Cap, nr.300	BL13a
570mm	Pipe, Schedule 40	4	T-T	Threaded Cap, nr.300	BL1a
570mm	Pipe, Schedule 40	4	T-T	Threaded Cap, nr.300	BL3a
570mm	Pipe, Schedule 40	1	T-T	Threaded Cap, nr.300	BL8a
500mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, reducing nr. 90R	BL6a
490mm	Pipe, Schedule 40	1	T-T	Threaded Straight Tee, equal, nr. 130	BL6a
370mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL18a
170mm	Pipe, Schedule 40	1	G-T	Threaded 90º Elbow, reducing nr. 90R	BL17a

Black-Black	Threaded Fabrication Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Length	Description	Quantity	End Prep	Fitting	Line
Size: 25					
2070mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL2a
2060mm	Pipe, Schedule 40 (Galv)	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL12a
2050mm	Pipe, Schedule 40 (Galv)	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL12a
2010mm	Pipe, Schedule 40	1	T-T	Threaded Straight Tee, equal, nr. 130	BL16a
500mm	Pipe, Schedule 40	1	T-T	Threaded 90º Elbow, Equal nr. 90	BL20a
470mm	Pipe, Schedule 40	1	T-T	Threaded Cap, nr.300	BL16a

Line	Description	Quantity	Length	End Prep	Fitting
Size: 25					
BL2a	Pipe, Schedule 40	1	2070mm	T-T	Threaded 90º Elbow, Equal nr. 90
BL12a	Pipe, Schedule 40 (Galv)	1	2050mm	T-T	Threaded 90º Elbow, Equal nr. 90
BL12a	Pipe, Schedule 40 (Galv)	1	2060mm	T-T	Threaded 90º Elbow, Equal nr. 90
BL16a	Pipe, Schedule 40	1	2010mm	T-T	Threaded Straight Tee, equal, nr. 130
BL16a	Pipe, Schedule 40	1	470mm	T-T	Threaded Cap, nr.300
BL20a	Pipe, Schedule 40	1	500mm	T-T	Threaded 90º Elbow, Equal nr. 90
Size: 32					
BL1a	Pipe, Schedule 40	4	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL1a	Pipe, Schedule 40	4	570mm	T-T	Threaded Cap, nr.300
BL2a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL2a	Pipe, Schedule 40	1	1200mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL2a	Pipe, Schedule 40	1	800mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL2a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL2a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL2a	Pipe, Schedule 40	1	1660mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL3a	Pipe, Schedule 40	4	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL3a	Pipe, Schedule 40	4	570mm	T-T	Threaded Cap, nr.300
BL4a	Pipe, Schedule 40	6	1310mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL4a	Pipe, Schedule 40	6	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL4a	Pipe, Schedule 40	6	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL4a	Pipe, Schedule 40	6	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL6a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL6a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL6a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL6a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL6a	Pipe, Schedule 40	1	490mm	T-T	Threaded Straight Tee, equal, nr. 130
BL6a	Pipe, Schedule 40	1	1120mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL6a	Pipe, Schedule 40	1	2030mm	T-T	Threaded Straight Tee, equal, nr. 130(Bull Head)
BL6a	Pipe, Schedule 40	1	1120mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL6a	Pipe, Schedule 40	1	500mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL7a	Pipe, Schedule 40	8	620mm	T-T	32 x 32 x 15 Thrd Red T
BL7a	Pipe, Schedule 40	8	1960mm	T-T	32 x 32 x 15 Thrd Red T
BL7a	Pipe, Schedule 40	8	1970mm	T-T	32 x 32 x 15 Thrd Red T
BL7a	Pipe, Schedule 40	8	1960mm	T-T	32 x 15 Thrd Red 90
BL8a	Pipe, Schedule 40	1	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL8a	Pipe, Schedule 40	1	570mm	T-T	Threaded Cap, nr.300
BL9a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL9a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL9a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL9a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL9a	Pipe, Schedule 40	1	1670mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL10a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL10a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL10a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL10a	Pipe, Schedule 40	1	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL11a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL11a	Pipe, Schedule 40	1	2140mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL11a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL11a	Pipe, Schedule 40	1	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL12a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL12a	Pipe, Schedule 40	1	1800mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL12a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL12a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL13a	Pipe, Schedule 40	1	570mm	T-T	Threaded Cap, nr.300
BL14a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL14a	Pipe, Schedule 40	1	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL14a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL14a	Pipe, Schedule 40	1	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
BL17a	Pipe, Schedule 40	1	170mm	G-T	Threaded 90º Elbow, reducing nr. 90R
BL18a	Pipe, Schedule 40	1	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL18a	Pipe, Schedule 40	1	370mm	T-T	Threaded 90º Elbow, Equal nr. 90

Line	Description	Quantity	Length	End Prep	Fitting
Size: 32					
BL18a	Pipe, Schedule 40	1	620mm	T-T	Threaded 90º Elbow, Equal nr. 90
BL18a	Pipe, Schedule 40	1	1710mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL18a	Pipe, Schedule 40	1	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
BL18a	Pipe, Schedule 40	1	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Size: 50					
BL13a	Pipe, Schedule 40	1	570mm	G-T	Threaded Reducing Tee, reducing, nr. 130R
BL19a	Pipe, Schedule 40	1	430mm	G-T	50 x 32 Thrd Red 90

Black-Black	Threaded Branchline Report	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Quantity	Description	Length	End Prep	Fitting
Armovers/Drop/Sprigs				
Line: DR1				
86	25 x 165-Nipple, Schedule 40	170mm	T-T	Threaded Socket, reducing, nr. 240
Line: DR2				
32	15 x 191-Nipple, Schedule 40	200mm	T-T	No Fitting
Line: DR3				
1	25 x 165-Nipple, Schedule 40	160mm	T-T	Threaded Socket, reducing, nr. 240
Line: DR4				
1	25 x 178-Nipple, Schedule 40	180mm	T-T	Threaded Socket, reducing, nr. 240
Branch Line				
Line: BL1a				
4	32-Pipe, Schedule 40	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
4	32-Pipe, Schedule 40	570mm	T-T	Threaded Cap, nr.300
Line: BL2a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	1200mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	25-Pipe, Schedule 40	2070mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	32-Pipe, Schedule 40	800mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	1660mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL3a				
4	32-Pipe, Schedule 40	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
4	32-Pipe, Schedule 40	570mm	T-T	Threaded Cap, nr.300
Line: BL4a				
6	32-Pipe, Schedule 40	1310mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
6	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
6	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
6	32-Pipe, Schedule 40	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL5a				
7	32 x 216-Nipple, Schedule 40	210mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL6a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	490mm	T-T	Threaded Straight Tee, equal, nr. 130
1	32-Pipe, Schedule 40	1120mm	T-T	Threaded 90º Elbow, reducing nr. 90R
1	32-Pipe, Schedule 40	2030mm	T-T	Threaded Straight Tee, equal, nr. 130(Bull Head)
1	32-Pipe, Schedule 40	1120mm	T-T	Threaded 90º Elbow, reducing nr. 90R
1	32-Pipe, Schedule 40	500mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL7a				
8	32-Pipe, Schedule 40	620mm	T-T	32 x 32 x 15 Thrd Red T
8	32-Pipe, Schedule 40	1960mm	T-T	32 x 32 x 15 Thrd Red T
8	32-Pipe, Schedule 40	1970mm	T-T	32 x 32 x 15 Thrd Red T
8	32-Pipe, Schedule 40	1960mm	T-T	32 x 15 Thrd Red 90
Line: BL8a				
1	32-Pipe, Schedule 40	610mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	570mm	T-T	Threaded Cap, nr.300
Line: BL9a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	1670mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL10a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R

Branch Line

Quantity	Description	Length	End Prep	Fitting
Line: BL10a				
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL11a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2140mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL12a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32 x 191-Nipple, Schedule 40	190mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	1800mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	25 x 178-Nipple, Schedule 40 (Galv)	180mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	25-Pipe, Schedule 40 (Galv)	2050mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	25-Pipe, Schedule 40 (Galv)	2060mm	T-T	Threaded 90º Elbow, Equal nr. 90
Line: BL13a				
1	50-Pipe, Schedule 40	570mm	G-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	570mm	T-T	Threaded Cap, nr.300
Line: BL14a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2040mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL15a				
3	32 x 114-Nipple, Schedule 40	110mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL16a				
1	25-Pipe, Schedule 40	2010mm	T-T	Threaded Straight Tee, equal, nr. 130
1	25-Pipe, Schedule 40	470mm	T-T	Threaded Cap, nr.300
Line: BL17a				
1	32-Pipe, Schedule 40	170mm	G-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL18a				
1	32-Pipe, Schedule 40	1210mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	370mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	32-Pipe, Schedule 40	620mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	32-Pipe, Schedule 40	1710mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded Reducing Tee, reducing, nr. 130R
1	32-Pipe, Schedule 40	2050mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL19a				
1	50-Pipe, Schedule 40	430mm	G-T	50 x 32 Thrd Red 90
1	32 x 140-Nipple, Schedule 40	140mm	T-T	Threaded 90º Elbow, reducing nr. 90R
Line: BL20a				
1	25 x 250-Nipple, Schedule 40	250mm	T-T	Threaded 90º Elbow, Equal nr. 90
1	25-Pipe, Schedule 40	500mm	T-T	Threaded 90º Elbow, Equal nr. 90

Description	Length	End Prep	Fitting
Line: BL1-a Quantity: 4			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL2-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1200mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
25 - Pipe, Schedule 40	2070mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	800mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1660mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL3-a Quantity: 4			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL4-a Quantity: 6			
32 - Pipe, Schedule 40	1310mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL5-a Quantity: 7			
32 x 216 - Nipple, Schedule 40 (Single Stick)	210mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL6-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	490mm	T - T	32 Threaded Straight Tee, equal, nr. 130
32 - Pipe, Schedule 40	1120mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40	2030mm	T - T	32 Threaded Straight Tee, equal, nr. 130(Bull Head)
32 - Pipe, Schedule 40	1120mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40	500mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL7-a Quantity: 8			
32 - Pipe, Schedule 40	620mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1960mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1970mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1960mm	T - T	32 x 15 Threaded 90º Reducing Elbow
Line: BL8-a Quantity: 1			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL9-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R

Description	Length	End Prep	Fitting
Line: BL9-a Quantity: 1			
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1670mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL10-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL11-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2140mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL12-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 x 191 - Nipple, Schedule 40 (Single Stick)	190mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1800mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 x 25 Threaded Reducing Tee, reducing, nr. 130R
25 x 178 - Nipple, Schedule 40 (Single Stick) (Galv)	180mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40 (Galv)	2050mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40 (Galv)	2060mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
Line: BL13-a Quantity: 1			
50 - Pipe, Schedule 40	570mm	G - T	50 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL14-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL15-a Quantity: 3			
32 x 114 - Nipple, Schedule 40 (Single Stick)	110mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL16-a Quantity: 1			
25 - Pipe, Schedule 40	2010mm	T - T	25 Threaded Straight Tee, equal, nr. 130
25 - Pipe, Schedule 40	470mm	T - T	25 Threaded Cap, nr.300
Line: BL17-a Quantity: 1			
32 - Pipe, Schedule 40	170mm	G - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL18-a Quantity: 1			

Description	Length	End Prep	Fitting
Line: BL18-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	370mm	T - T	32 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	620mm	T - T	32 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	1710mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL19-a Quantity: 1			
50 - Pipe, Schedule 40	430mm	G - T	50 x 32 Threaded 90º Reducing Elbow
32 x 140 - Nipple, Schedule 40 (Single Stick)	140mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL20-a Quantity: 1			
25 x 250 - Nipple, Schedule 40 (Single Stick)	250mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40	500mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
Line: CM1- Quantity: 1			
200 - Pipe, Schedule 40	1580mm	G - G	No Fitting
200 - Pipe, Schedule 40	6400mm	G - G	No Fitting
200 - Pipe, Schedule 40	3380mm	G - G	No Fitting
200 - Pipe, Schedule 10	380mm	G - G	No Fitting
200 - Pipe, Schedule 10	5070mm	G - G	No Fitting
200 - Pipe, Schedule 10	3120mm	G - G	No Fitting
200 - Pipe, Schedule 10	1030mm	G - G	No Fitting
Line: CM2- Quantity: 1			
80 - Pipe, Schedule 10	60mm	G - G	No Fitting
80 - Pipe, Schedule 10	2290mm	G - G	No Fitting
80 - Pipe, Schedule 10	100mm	G - G	No Fitting
80 - Pipe, Schedule 10	6320mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	1800mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	1560mm	G - G	No Fitting
80 - Pipe, Schedule 10	1970mm	G - G	No Fitting
Line: CM3- Quantity: 1			
80 - Pipe, Schedule 10	600mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	3500mm	G - G	No Fitting
80 - Pipe, Schedule 10	2130mm	G - G	No Fitting
Line: CM4- Quantity: 1			
80 - Pipe, Schedule 10	160mm	G - G	No Fitting
80 - Pipe, Schedule 10	280mm	G - G	No Fitting
80 - Pipe, Schedule 10	580mm	G - G	No Fitting
80 - Pipe, Schedule 10	950mm	G - G	No Fitting
80 - Pipe, Schedule 10	900mm	G - G	No Fitting
80 - Pipe, Schedule 10	290mm	G - G	No Fitting
80 - Pipe, Schedule 10	440mm	G - G	No Fitting
80 - Pipe, Schedule 10	6380mm	G - G	No Fitting
80 - Pipe, Schedule 10	1670mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	10920mm	G - G	No Fitting
Line: DR1- Quantity: 86			
25 x 165 - Nipple, Schedule 40 (Single Stick)	170mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: DR2- Quantity: 32			
15 x 191 - Nipple, Schedule 40 (Single Stick)	200mm	T - T	No Fitting
Line: DR3- Quantity: 1			
25 x 165 - Nipple, Schedule 40 (Single Stick)	160mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240

Description	Length	End Prep	Fitting
Line: DR3- Quantity: 1			
Line: DR4- Quantity: 1			
25 x 178 - Nipple, Schedule 40 (Single Stick)	180mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: FR1- Quantity: 1			
150 - Pipe, Schedule 10	11840mm	G - G	No Fitting
150 - Pipe, Schedule 10	1500mm	G - G	No Fitting
150 - Pipe, Schedule 10	400mm	G - G	No Fitting

Black-Black	Threaded Pipelines	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Description	Length	End Prep	Fitting
Line: BL1-a Quantity: 4			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL2-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1200mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
25 - Pipe, Schedule 40	2070mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	800mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1660mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL3-a Quantity: 4			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL4-a Quantity: 6			
32 - Pipe, Schedule 40	1310mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL5-a Quantity: 7			
32 x 216 - Nipple, Schedule 40 (Single Stick)	210mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL6-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	490mm	T - T	32 Threaded Straight Tee, equal, nr. 130
32 - Pipe, Schedule 40	1120mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40	2030mm	T - T	32 Threaded Straight Tee, equal, nr. 130(Bull Head)
32 - Pipe, Schedule 40	1120mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40	500mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL7-a Quantity: 8			
32 - Pipe, Schedule 40	620mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1960mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1970mm	T - T	32 x 32 x 15 Threaded Reducing Tee
32 - Pipe, Schedule 40	1960mm	T - T	32 x 15 Threaded 90º Reducing Elbow
Line: BL8-a Quantity: 1			
32 - Pipe, Schedule 40	610mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL9-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R

Description	Length	End Prep	Fitting
Line: BL9-a Quantity: 1			
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1670mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL10-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL11-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2140mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL12-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 x 191 - Nipple, Schedule 40 (Single Stick)	190mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	1800mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 x 25 Threaded Reducing Tee, reducing, nr. 130R
25 x 178 - Nipple, Schedule 40 (Single Stick) (Galv)	180mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40 (Galv)	2050mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40 (Galv)	2060mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
Line: BL13-a Quantity: 1			
50 - Pipe, Schedule 40	570mm	G - T	50 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	570mm	T - T	32 Threaded Cap, nr.300
Line: BL14-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2040mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL15-a Quantity: 3			
32 x 114 - Nipple, Schedule 40 (Single Stick)	110mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL16-a Quantity: 1			
25 - Pipe, Schedule 40	2010mm	T - T	25 Threaded Straight Tee, equal, nr. 130
25 - Pipe, Schedule 40	470mm	T - T	25 Threaded Cap, nr.300
Line: BL17-a Quantity: 1			
32 - Pipe, Schedule 40	170mm	G - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL18-a Quantity: 1			

Black-Black	Threaded Pipelines	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

Description	Length	End Prep	Fitting
Line: BL18-a Quantity: 1			
32 - Pipe, Schedule 40	1210mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	370mm	T - T	32 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	620mm	T - T	32 Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40	1710mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40	2050mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL19-a Quantity: 1			
50 - Pipe, Schedule 40	430mm	G - T	50 x 32 Threaded 90º Reducing Elbow
32 x 140 - Nipple, Schedule 40 (Single Stick)	140mm	T - T	32 x 25 Threaded 90º Elbow, reducing nr. 90R
Line: BL20-a Quantity: 1			
25 x 250 - Nipple, Schedule 40 (Single Stick)	250mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40	500mm	T - T	25 Threaded 90º Elbow, Equal nr. 90
Line: DR1- Quantity: 86			
25 x 165 - Nipple, Schedule 40 (Single Stick)	170mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: DR2- Quantity: 32			
15 x 191 - Nipple, Schedule 40 (Single Stick)	200mm	T - T	No Fitting
Line: DR3- Quantity: 1			
25 x 165 - Nipple, Schedule 40 (Single Stick)	160mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: DR4- Quantity: 1			
25 x 178 - Nipple, Schedule 40 (Single Stick)	180mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240

Description	Length	End Prep	Fitting
Line: CM1- Quantity: 1			
200 - Pipe, Schedule 40	1580mm	G - G	No Fitting
200 - Pipe, Schedule 40	6400mm	G - G	No Fitting
200 - Pipe, Schedule 40	3380mm	G - G	No Fitting
200 - Pipe, Schedule 10	380mm	G - G	No Fitting
200 - Pipe, Schedule 10	5070mm	G - G	No Fitting
200 - Pipe, Schedule 10	3120mm	G - G	No Fitting
200 - Pipe, Schedule 10	1030mm	G - G	No Fitting
Line: CM2- Quantity: 1			
80 - Pipe, Schedule 10	60mm	G - G	No Fitting
80 - Pipe, Schedule 10	2290mm	G - G	No Fitting
80 - Pipe, Schedule 10	100mm	G - G	No Fitting
80 - Pipe, Schedule 10	6320mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	1800mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	1560mm	G - G	No Fitting
80 - Pipe, Schedule 10	1970mm	G - G	No Fitting
Line: CM3- Quantity: 1			
80 - Pipe, Schedule 10	600mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	3500mm	G - G	No Fitting
80 - Pipe, Schedule 10	2130mm	G - G	No Fitting
Line: CM4- Quantity: 1			
80 - Pipe, Schedule 10	160mm	G - G	No Fitting
80 - Pipe, Schedule 10	280mm	G - G	No Fitting
80 - Pipe, Schedule 10	580mm	G - G	No Fitting
80 - Pipe, Schedule 10	950mm	G - G	No Fitting
80 - Pipe, Schedule 10	900mm	G - G	No Fitting
80 - Pipe, Schedule 10	290mm	G - G	No Fitting
80 - Pipe, Schedule 10	440mm	G - G	No Fitting
80 - Pipe, Schedule 10	6380mm	G - G	No Fitting
80 - Pipe, Schedule 10	1670mm	G - G	No Fitting
80 - Pipe, Schedule 10	6400mm	G - G	No Fitting
80 - Pipe, Schedule 10	10920mm	G - G	No Fitting
Line: FR1- Quantity: 1			
150 - Pipe, Schedule 10	11840mm	G - G	No Fitting
150 - Pipe, Schedule 10	1500mm	G - G	No Fitting
150 - Pipe, Schedule 10	400mm	G - G	No Fitting

Description	Length	End Prep	Fitting
Line: DR1- Quantity: 86			
25 x 165 - Nipple, Schedule 40 (Single Stick)	170mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: DR2- Quantity: 32			
15 x 191 - Nipple, Schedule 40 (Single Stick)	200mm	T - T	No Fitting
Line: DR3- Quantity: 1			
25 x 165 - Nipple, Schedule 40 (Single Stick)	160mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: DR4- Quantity: 1			
25 x 178 - Nipple, Schedule 40 (Single Stick)	180mm	T - T	25 x 15 Threaded Socket, reducing, nr. 240
Line: FR1- Quantity: 1			
150 - Pipe, Schedule 10	11840mm	G - G	No Fitting
150 - Pipe, Schedule 10	1500mm	G - G	No Fitting
150 - Pipe, Schedule 10	400mm	G - G	No Fitting

Black-Black	Cut Pipe Report - Threaded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

	Piece	Length	End Prep	Fitting
50 - Pipe, Schedule 40				
1 @ 6401mm :	BL13-a-A	570mm	GxT	Threaded Reducing Tee, reducing, nr. 130R
	BL19-a-A	430mm	GxT	50 x 32 Thrd Red 90
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL9-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL18-a-C	620mm	TxT	Threaded 90º Elbow, Equal nr. 90
	BL8-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
1 @ 6401mm :	BL11-a-B	2140mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL11-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL18-a-E	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL17-a-A	170mm	GxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL18-a-F	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL6-a-D	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL9-a-D	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL2-a-F	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL9-a-B	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL12-a-E	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL14-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL10-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL10-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL6-a-B	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL11-a-C	2050mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL14-a-D	2050mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				

	Piece	Length	End Prep	Fitting
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL6-a-C	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL10-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL9-a-C	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL2-a-E	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL12-a-D	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL14-a-B	2040mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL6-a-G	2030mm	TxT	Threaded Straight Tee, equal, nr. 130(Bull Head)
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL18-a-B	370mm	TxT	Threaded 90º Elbow, Equal nr. 90
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL6-a-E	490mm	TxT	Threaded Straight Tee, equal, nr. 130
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-C	1970mm	TxT	32 x 32 x 15 Thrd Red T
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
	BL6-a-I	500mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
32 - Pipe, Schedule 40				

Black-Black	Cut Pipe Report - Threaded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

	Piece	Length	End Prep	Fitting
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-D	1960mm	TxT	32 x 15 Thrd Red 90
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-B	1960mm	TxT	32 x 32 x 15 Thrd Red T
	BL12-a-C	1800mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL18-a-D	1710mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL2-a-D	800mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL9-a-E	1670mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL2-a-G	1660mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL4-a-A	1310mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL6-a-H	1120mm	TxT	Threaded 90º Elbow, reducing nr. 90R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL2-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL6-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL11-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL12-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL18-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL10-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL14-a-A	1210mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL2-a-B	1200mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL6-a-F	1120mm	TxT	Threaded 90º Elbow, reducing nr. 90R
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
32 - Pipe, Schedule 40				

Black-Black	Cut Pipe Report - Threaded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

	Piece	Length	End Prep	Fitting
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL7-a-A	620mm	TxT	32 x 32 x 15 Thrd Red T
	BL1-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL3-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL3-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL3-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL1-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL1-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL1-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL3-a-A	610mm	TxT	Threaded Reducing Tee, reducing, nr. 130R
	BL1-a-B	570mm	TxT	Threaded Cap, nr.300
	BL1-a-B	570mm	TxT	Threaded Cap, nr.300
	BL1-a-B	570mm	TxT	Threaded Cap, nr.300
	BL3-a-B	570mm	TxT	Threaded Cap, nr.300
	BL3-a-B	570mm	TxT	Threaded Cap, nr.300
	BL13-a-B	570mm	TxT	Threaded Cap, nr.300
32 - Pipe, Schedule 40				
1 @ 6401mm :	BL1-a-B	570mm	TxT	Threaded Cap, nr.300
	BL3-a-B	570mm	TxT	Threaded Cap, nr.300
	BL3-a-B	570mm	TxT	Threaded Cap, nr.300
	BL8-a-B	570mm	TxT	Threaded Cap, nr.300
25 - Pipe, Schedule 40 (Galv)				
1 @ 6401mm :	BL12-a-H	2060mm	TxT	Threaded 90º Elbow, Equal nr. 90
	BL12-a-G	2050mm	TxT	Threaded 90º Elbow, Equal nr. 90
25 - Pipe, Schedule 40				
1 @ 6401mm :	BL2-a-C	2070mm	TxT	Threaded 90º Elbow, Equal nr. 90
	BL16-a-A	2010mm	TxT	Threaded Straight Tee, equal, nr. 130
	BL20-a-B	500mm	TxT	Threaded 90º Elbow, Equal nr. 90
	BL16-a-B	470mm	TxT	Threaded Cap, nr.300

Black-Black	Cut Pipe Report - Welded	Current Date 10/06/2020
	1 - Thesis	Date Required
	Default List Area	POJ

	Piece	Length	End Prep	Fitting
200 - Pipe, Schedule 10				
1 @ 7408mm :	CM1--E	5070mm	GxG	No Fitting
	CM1--G	1030mm	GxG	No Fitting
	CM1--D	380mm	GxG	No Fitting
200 - Pipe, Schedule 10				
1 @ 7408mm :	CM1--F	3120mm	GxG	No Fitting
150 - Pipe, Schedule 10				
1 @ 11840mm :	FR1--A	11840mm	GxG	No Fitting
150 - Pipe, Schedule 10				
1 @ 11840mm :	FR1--B	1500mm	GxG	No Fitting
	FR1--C	400mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM4--K	10920mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM4--J	6400mm	GxG	No Fitting
	CM3--D	3500mm	GxG	No Fitting
	CM4--D	950mm	GxG	No Fitting
	CM2--A	60mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM2--G	6400mm	GxG	No Fitting
	CM2--B	2290mm	GxG	No Fitting
	CM3--E	2130mm	GxG	No Fitting
	CM2--C	100mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM3--C	6400mm	GxG	No Fitting
	CM2--I	1970mm	GxG	No Fitting
	CM2--F	1800mm	GxG	No Fitting
	CM3--A	600mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM3--B	6400mm	GxG	No Fitting
	CM4--I	1670mm	GxG	No Fitting
	CM2--H	1560mm	GxG	No Fitting
	CM4--E	900mm	GxG	No Fitting
	CM4--F	290mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM2--E	6400mm	GxG	No Fitting
	CM4--C	580mm	GxG	No Fitting
	CM4--G	440mm	GxG	No Fitting
	CM4--B	280mm	GxG	No Fitting
	CM4--A	160mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM4--H	6380mm	GxG	No Fitting
80 - Pipe, Schedule 10				
1 @ 10922mm :	CM2--D	6320mm	GxG	No Fitting
200 - Pipe, Schedule 40				

	Piece	Length	End Prep	Fitting
200 - Pipe, Schedule 40				
1 @ 6401mm :	CM1--B	6400mm	GxG	No Fitting
200 - Pipe, Schedule 40				
1 @ 6401mm :	CM1--C	3380mm	GxG	No Fitting
	CM1--A	1580mm	GxG	No Fitting

Black-Black **BL13a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL13a
Fitting: 50 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 50 - SCH 40 G-T Length: 570mm

Pipe: 50 - SCH 40 Length: 570mm

Black-Black **BL11a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL11a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2140mm

Pipe: 32 - SCH 40 Length: 2140mm

Black-Black **BL4a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL18a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 Threaded 90º Elbow, Equal nr. 90
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL4a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL19a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL19a
Fitting: 50 x 32 Thrd Red 90
Pipe: 50 - SCH 40 G-T Length: 430mm

Pipe: 50 - SCH 40 Length: 430mm

Black-Black **BL4a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL9a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL9a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL8a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL8a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Black-Black **BL11a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL11a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL18a**

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL18a**

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL17a**

Job: 1 - Thesis
Area: Default List Area

Line: BL17a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 G-T Length: 170mm

Pipe: 32 - SCH 40 Length: 170mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL9a**

Job: 1 - Thesis
Area: Default List Area

Line: BL9a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL14a**

Job: 1 - Thesis
Area: Default List Area

Line: BL14a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL10a**

Job: 1 - Thesis
Area: Default List Area

Line: BL10a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL9a**

Job: 1 - Thesis
Area: Default List Area

Line: BL9a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL12a**

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 32 x 25 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL10a**

Job: 1 - Thesis
Area: Default List Area

Line: BL10a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL11a**

Job: 1 - Thesis
Area: Default List Area

Line: BL11a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL14a**

Job: 1 - Thesis
Area: Default List Area

Line: BL14a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 2050mm

Pipe: 32 - SCH 40 Length: 2050mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL10a**

Job: 1 - Thesis
Area: Default List Area

Line: BL10a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL9a**

Job: 1 - Thesis
Area: Default List Area

Line: BL9a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL4a

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL4a

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL14a

Job: 1 - Thesis
Area: Default List Area

Line: BL14a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL7a

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black BL18a

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 Threaded 90º Elbow, Equal nr. 90
Pipe: 32 - SCH 40 T-T Length: 370mm

Pipe: 32 - SCH 40 Length: 370mm

Black-Black BL12a

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL4a

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 2040mm

Pipe: 32 - SCH 40 Length: 2040mm

Black-Black BL6a

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 Threaded Straight Tee, equal, nr. 130(Bull Head)
Pipe: 32 - SCH 40 T-T Length: 2030mm

Pipe: 32 - SCH 40 Length: 2030mm

Black-Black BL7a

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black BL7a

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 Threaded Straight Tee, equal, nr. 130
Pipe: 32 - SCH 40 T-T Length: 490mm

Pipe: 32 - SCH 40 Length: 490mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1970mm

Pipe: 32 - SCH 40 Length: 1970mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 500mm

Pipe: 32 - SCH 40 Length: 500mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a** →

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 15 Thrd Red 90
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 1960mm

Pipe: 32 - SCH 40 Length: 1960mm

Black-Black **BL12a**

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1800mm

Pipe: 32 - SCH 40 Length: 1800mm

Black-Black **BL18a**

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1710mm

Pipe: 32 - SCH 40 Length: 1710mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 800mm

Pipe: 32 - SCH 40 Length: 800mm

Black-Black **BL9a**

Job: 1 - Thesis
Area: Default List Area

Line: BL9a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 1670mm

Pipe: 32 - SCH 40 Length: 1670mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 1660mm

Pipe: 32 - SCH 40 Length: 1660mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 1120mm

Pipe: 32 - SCH 40 Length: 1120mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL12a**

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL4a**

Job: 1 - Thesis
Area: Default List Area

Line: BL4a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1310mm

Pipe: 32 - SCH 40 Length: 1310mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL11a**

Job: 1 - Thesis
Area: Default List Area

Line: BL11a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL18a**

Job: 1 - Thesis
Area: Default List Area

Line: BL18a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL10a**

Job: 1 - Thesis
Area: Default List Area

Line: BL10a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1200mm

Pipe: 32 - SCH 40 Length: 1200mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL14a**

Job: 1 - Thesis
Area: Default List Area

Line: BL14a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 1210mm

Pipe: 32 - SCH 40 Length: 1210mm

Black-Black **BL6a**

Job: 1 - Thesis
Area: Default List Area

Line: BL6a
Fitting: 32 x 25 Threaded 90º Elbow, reducing nr. 90R
Pipe: 32 - SCH 40 T-T Length: 1120mm

Pipe: 32 - SCH 40 Length: 1120mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Black-Black **BL7a**

Job: 1 - Thesis
Area: Default List Area

Line: BL7a
Fitting: 32 x 32 x 15 Thrd Red T
Pipe: 32 - SCH 40 T-T Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Pipe: 32 - SCH 40 Length: 620mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 x 32 x 25 Threaded Reducing Tee, reducing, nr. 130R
Pipe: 32 - SCH 40 T-T Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Pipe: 32 - SCH 40 Length: 610mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL1a**

Job: 1 - Thesis
Area: Default List Area

Line: BL1a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL13a**

Job: 1 - Thesis
Area: Default List Area

Line: BL13a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL3a**

Job: 1 - Thesis
Area: Default List Area

Line: BL3a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL8a**

Job: 1 - Thesis
Area: Default List Area

Line: BL8a
Fitting: 32 Threaded Cap, nr.300
Pipe: **32 - SCH 40 T-T Length: 570mm**

Pipe: 32 - SCH 40 Length: 570mm

Black-Black **BL12a**

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 25 Threaded 90º Elbow, Equal nr. 90
Pipe: **25 - SCH 40 T-T Length: 2060mm**

Pipe: 25 - SCH 40 Length: 2060mm

Black-Black **BL12a**

Job: 1 - Thesis
Area: Default List Area

Line: BL12a
Fitting: 25 Threaded 90º Elbow, Equal nr. 90
Pipe: **25 - SCH 40 T-T Length: 2050mm**

Pipe: 25 - SCH 40 Length: 2050mm

Black-Black **BL2a**

Job: 1 - Thesis
Area: Default List Area

Line: BL2a
Fitting: 25 Threaded 90º Elbow, Equal nr. 90
Pipe: **25 - SCH 40 T-T Length: 2070mm**

Pipe: 25 - SCH 40 Length: 2070mm

Black-Black **BL16a**

Job: 1 - Thesis
Area: Default List Area

Line: BL16a
Fitting: 25 Threaded Straight Tee, equal, nr. 130
Pipe: **25 - SCH 40 T-T Length: 2010mm**

Pipe: 25 - SCH 40 Length: 2010mm

Black-Black **BL20a**

Job: 1 - Thesis
Area: Default List Area

Line: BL20a
Fitting: 25 Threaded 90º Elbow, Equal nr. 90
Pipe: **25 - SCH 40 T-T Length: 500mm**

Pipe: 25 - SCH 40 Length: 500mm

Black-Black **BL16a**

Job: 1 - Thesis
Area: Default List Area

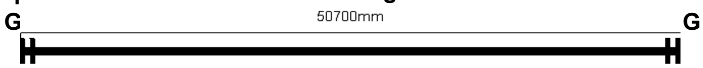
Line: BL16a
Fitting: 25 Threaded Cap, nr.300
Pipe: **25 - SCH 40 T-T Length: 470mm**

Pipe: 25 - SCH 40 Length: 470mm

Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

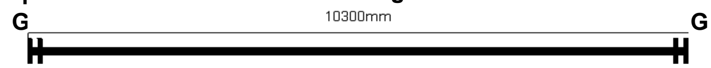
Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 10 G-G Length: 5070mm



Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

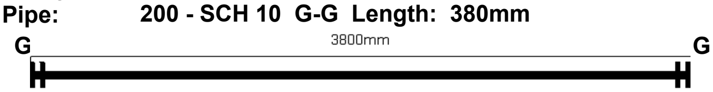
Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 10 G-G Length: 1030mm



Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

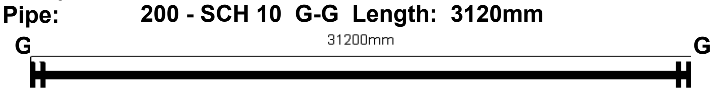
Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 10 G-G Length: 380mm



Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

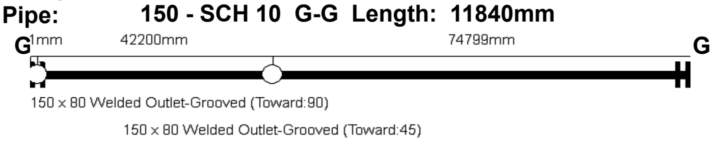
Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 10 G-G Length: 3120mm



Black-Black **FR1**

Job: 1 - Thesis
Area: Default List Area

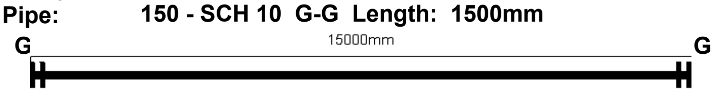
Line: FR1
Fitting: No Fitting
Pipe: 150 - SCH 10 G-G Length: 11840mm



Black-Black **FR1**

Job: 1 - Thesis
Area: Default List Area

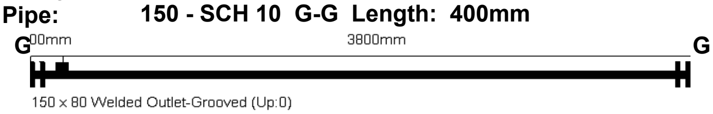
Line: FR1
Fitting: No Fitting
Pipe: 150 - SCH 10 G-G Length: 1500mm



Black-Black **FR1**

Job: 1 - Thesis
Area: Default List Area

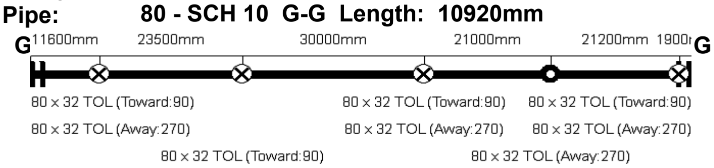
Line: FR1
Fitting: No Fitting
Pipe: 150 - SCH 10 G-G Length: 400mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

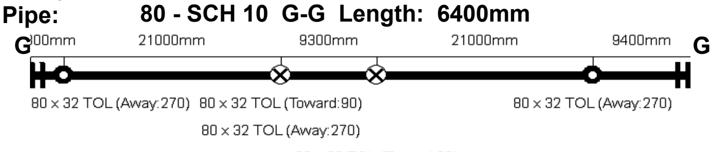
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 10920mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

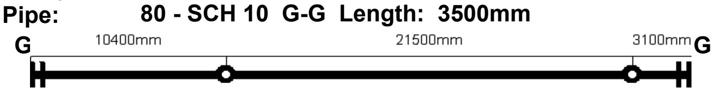
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6400mm



Black-Black **CM3**

Job: 1 - Thesis
Area: Default List Area

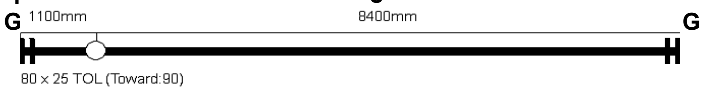
Line: CM3
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 3500mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

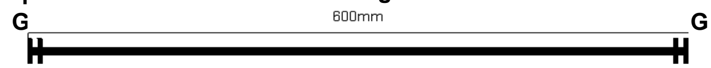
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 950mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

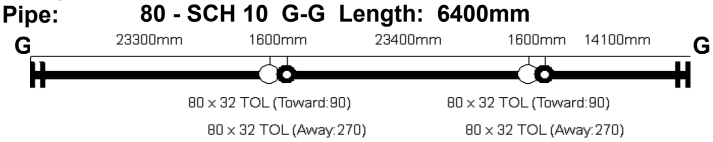
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 60mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

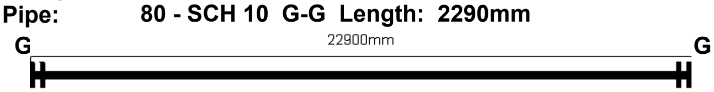
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6400mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

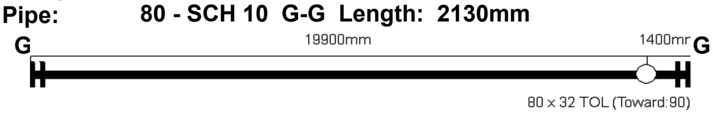
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 2290mm



Black-Black **CM3**

Job: 1 - Thesis
Area: Default List Area

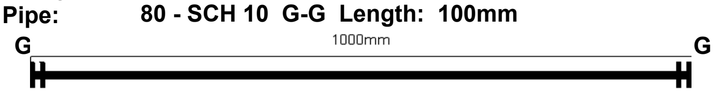
Line: CM3
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 2130mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

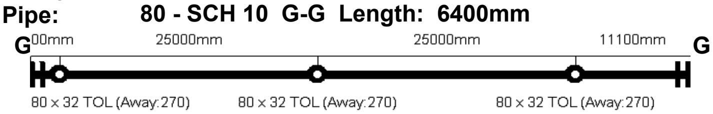
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 100mm



Black-Black **CM3**

Job: 1 - Thesis
Area: Default List Area

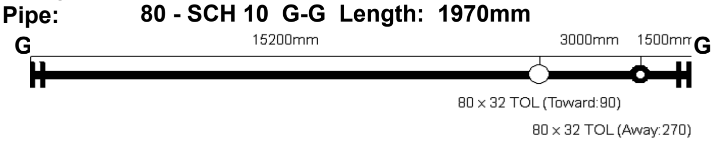
Line: CM3
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6400mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

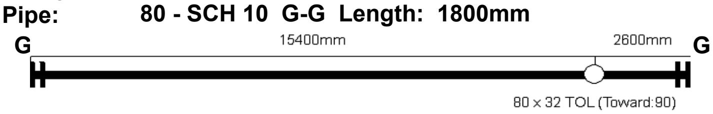
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 1970mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

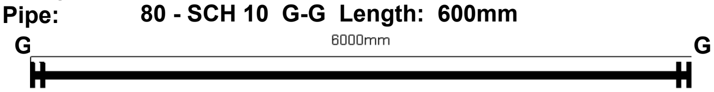
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 1800mm



Black-Black **CM3**

Job: 1 - Thesis
Area: Default List Area

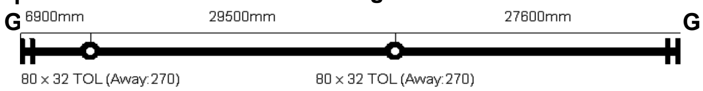
Line: CM3
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 600mm



Black-Black **CM3**

Job: 1 - Thesis
Area: Default List Area

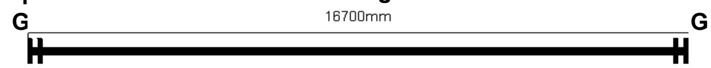
Line: CM3
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6400mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

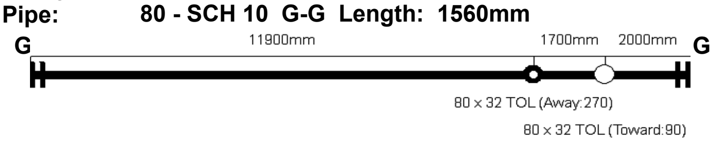
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 1670mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

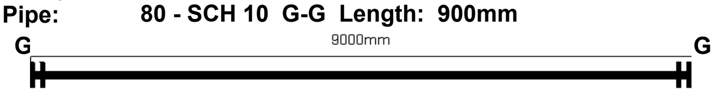
Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 1560mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

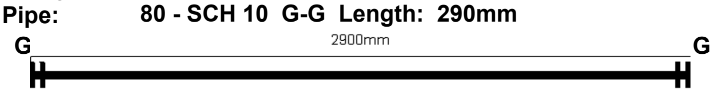
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 900mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

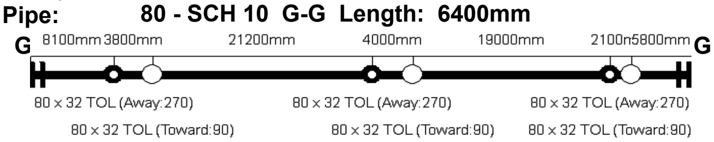
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 290mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6400mm



Black-Black **CM4**

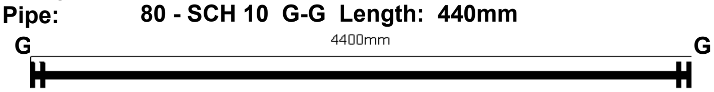
Job: 1 - Thesis
Area: Default List Area

Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 580mm

Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 440mm



Black-Black **CM4**

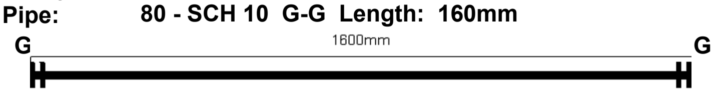
Job: 1 - Thesis
Area: Default List Area

Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 280mm

Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

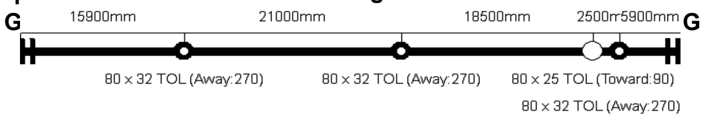
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 160mm



Black-Black **CM4**

Job: 1 - Thesis
Area: Default List Area

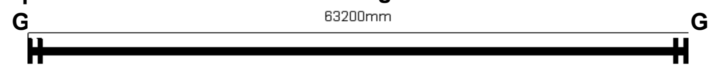
Line: CM4
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6380mm



Black-Black **CM2**

Job: 1 - Thesis
Area: Default List Area

Line: CM2
Fitting: No Fitting
Pipe: 80 - SCH 10 G-G Length: 6320mm



Black-Black **CM1**

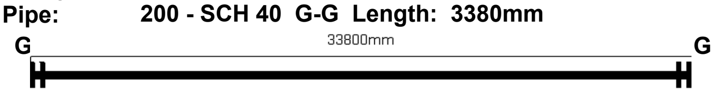
Job: 1 - Thesis
Area: Default List Area

Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 40 G-G Length: 6400mm

Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

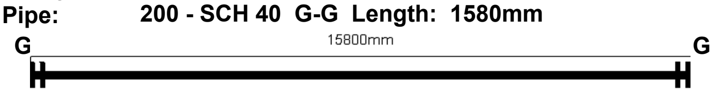
Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 40 G-G Length: 3380mm



Black-Black **CM1**

Job: 1 - Thesis
Area: Default List Area

Line: CM1
Fitting: No Fitting
Pipe: 200 - SCH 40 G-G Length: 1580mm



Black-Black

Other Pipe
1 - Thesis
Default List Area

Current Date 10/06/2020
Date Required
POJ

Quantity	Description	Length	End Prep	Fitting

Armovers/Drop/Sprigs

Line: DR1 Quantity: 86

Threaded Pieces

Quantity	Description	Length	End Prep	Fitting
1	25 x 165 - Nipple, Schedule 4025 x 165 - Nipple, Sched	170mm	T-T	25 x 15 Threaded Socket, reducing, nr. 240

Line: DR2 Quantity: 32

Threaded Pieces

Quantity	Description	Length	End Prep	Fitting
1	15 x 191 - Nipple, Schedule 4015 x 191 - Nipple, Sched	200mm	T-T	No Fitting

Line: DR3 Quantity: 1

Threaded Pieces

Quantity	Description	Length	End Prep	Fitting
1	25 x 165 - Nipple, Schedule 4025 x 165 - Nipple, Sched	160mm	T-T	25 x 15 Threaded Socket, reducing, nr. 240

Line: DR4 Quantity: 1

Threaded Pieces

Quantity	Description	Length	End Prep	Fitting
1	25 x 178 - Nipple, Schedule 4025 x 178 - Nipple, Sched	180mm	T-T	25 x 15 Threaded Socket, reducing, nr. 240

Feed Risers

Line: FR1 Quantity: 1

Threaded Pieces

Non - Threaded Pieces

Quantity	Description	Length	End Prep	Fitting
1	150 - Pipe, Schedule 10150 - Pipe, Schedule 10	400mm	G-G	No Fitting
1	150 - Pipe, Schedule 10150 - Pipe, Schedule 10	1500mm	G-G	No Fitting
1	150 - Pipe, Schedule 10150 - Pipe, Schedule 10	11840mm	G-G	No Fitting

Fittings and Valves	Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe													
	¾ in.		1 in.		1¼ in.		1½ in.		2 in.		2½ in.		3 in.	
	ft	m	ft	m	ft	m	m	ft	ft	m	ft	m	ft	m
45°elbow	1	0.3	1	0.3	1	0.3	2	0.6	2	0.6	3	0.9	3	0.9
90°standard elbow	2	0.6	2	0.6	3	0.9	4	1.2	5	1.5	6	1.8	7	2.1
90°long turn elbow	1	0.3	2	0.6	2	0.6	2	0.6	3	0.9	4	1.2	5	1.5
Tee or cross (flow turned 90°)	4	1.2	5	1.5	6	1.8	8	2.4	10	3.1	12	3.7	15	4.6
Gate valve	—	—	—	—	—	—	—	—	1	0.3	1	0.3	1	0.3
Butterfly valve	—	—	—	—	—	—	—	—	6	1.8	7	2.1	10	3.1
Swing check*	4	1.2	5	1.5	7	2.1	9	2.7	11	3.4	14	4.3	16	4.9

Fittings and Valves	Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe													
	3½ in.		4 in.		5 in.		6 in.		8 in.		10 in.		12 in.	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
45°elbow	3	0.9	4	1.2	5	1.5	7	2.1	9	2.7	11	3.4	13	4.0
90°standard elbow	8	2.4	10	3.1	12	3.7	14	4.3	18	5.5	22	6.7	27	8.2
90°long turn elbow	5	1.5	6	1.8	8	2.4	9	2.7	13	4.0	16	4.9	18	5.5
Tee or cross (flow turned 90°)	17	5.2	20	6.1	25	7.6	30	9.2	35	10.7	50	15.3	60	18.3
Gate valve	1	0.3	2	0.6	2	0.6	3	0.9	4	1.2	5	1.5	6	1.8
Butterfly valve	—	—	12	3.7	9	2.7	10	3.1	12	3.7	19	5.8	21	6.4
Swing check*	19	5.8	22	6.7	27	8.2	32	9.8	45	13.7	55	16.8	65	19.8

Table A.1 – Equivalent Pipe Length

APPENDIX B – NFPA 11 ANALYSIS

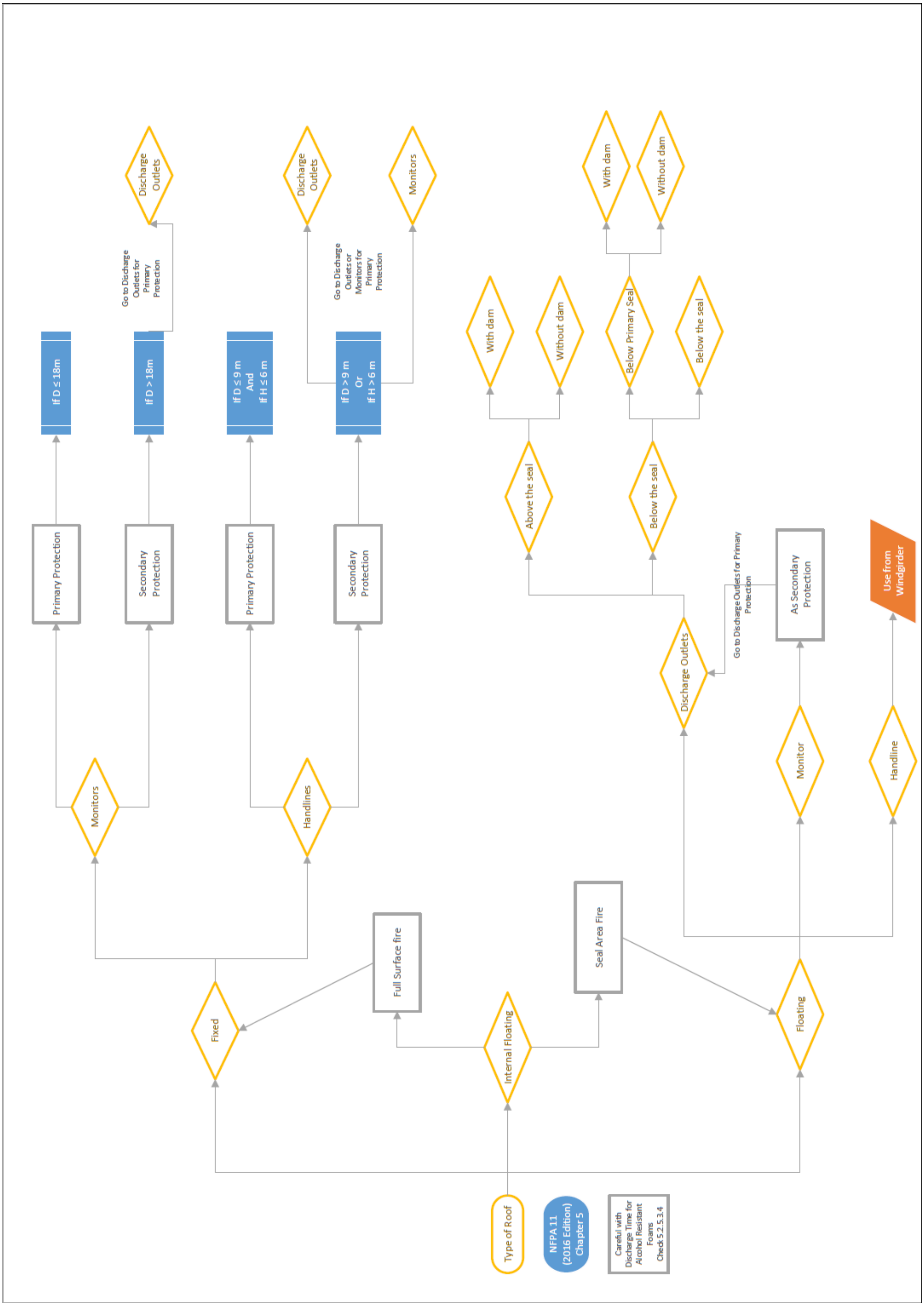

Type of Roof
NFPA 11 (2016 Edition) Chapter 5
Careful with Discharge Time for Alcohol Resistant Foams Check 5.2.5.3.4
Fixed
Internal Floating
Floating
Full Surface fire
Seal Area Fire
Monitors
Handlines
Primary Protection
Secondary Protection
Primary Protection
Secondary Protection
If D ≤ 18m
If D > 18m
If D ≤ 9 m And If H ≤ 6 m
If D > 9 m Or If H > 6 m
Go to Discharge Outlets for Primary Protection
Discharge Outlets
Go to Discharge Outlets or Monitors for Primary Protection
Discharge Outlets
Monitors
Discharge Outlets
Above the seal
Below the seal
With dam
Without dam
Below Primary Seal
Below the seal
With dam
Without dam
Monitor
Handline
As Secondary Protection
Go to Discharge Outlets for Primary Protection
Use from Windgirder

Table B.1 – Number of Fixed Foam Discharge Outlets for Fixed-Roof Tanks Containing Hydrocarbons or Flammable and Combustible Liquids Requiring Alcohol-Resistant Foams

Tank Diameter (or Equivalent Area)		Minimum Number of Discharge Outlets
m	**ft**	
Up to 24	Up to 80	1
Over 24 to 36	Over 80 to 120	2
Over 36 to 42	Over 120 to 140	3
Over 42 to 48	Over 140 to 160	4
Over 48 to 54	Over 160 to 180	5
Over 54 to 60	Over 180 to 200	6
Over 60	Over 200	6 Plus 1 outlet for each additional 465 m^2 (5000 ft^2)

Table B.2 – Minimum Discharge Times and Application Rates for Type II Fixed Foam Discharge Outlets on Fixed-Roof (Cone) Storage Tanks Containing Hydrocarbons

Hydrocarbon Type	Minimum Application Rate		Minimum Discharge Time (minutes)
	$L/min \cdot m^2$	gpm/ft^2	
Flash point between 37.8°C and 60°C (100°F and 140°F)	4.1	0.10	30
Flash point below 37.8°C (100°F) or liquids heated above their flash points	4.1	0.10	55
Crude petroleum	4.1	0.10	55

Table B.3 – Foam Handline and Monitor Protection for Fixed-Roof Storage Tanks Containing Hydrocarbons

Hydrocarbon Type	Minimum Application Rate		Minimum Discharge Time (minutes)
	$L/min \cdot m^2$	gpm/ft^2	
Flash point between 37.8°C and 60°C (100°F and 140°F)	6.5	0.16	50
Flash point below 37.8°C (100°F) or liquids heated above their flash points	6.5	0.16	65
Crude petroleum	6.5	0.16	65

Table B.4 – Top-of-Seal Fixed Foam Discharge Protection for Open-Top and Internal Floating Roof Tanks

Seal Type	Applicable Illustration Detail	Minimum Application Rate		Minimum Discharge Time (minutes)	Maximum Spacing Between Discharge Outlets with 305 mm (12 in.) Foam Dam		Maximum Spacing Between Discharge Outlets with 610 mm (24 in.) Foam Dam	
		L/min · m²	gpm/ft²		m	ft	m	ft
Mechanical shoe seal	A	12.2	0.3	20	12.2	40	24.4	80
Tube seal with metal weather shield	B	12.2	0.3	20	12.2	40	24.4	80
Fully or partly combustible secondary seal	C	12.2	0.3	20	12.2	40	24.4	80
All metal secondary seal	D	12.2	0.3	20	12.2	40	24.4	80

Note: Where the fixed foam discharge outlets are mounted above the top of the tank shell, a foam splashboard is necessary due to the effect of winds.

Table B.5 – Bellow-the-Seal Fixed Foam Discharge Protection for Open-Top Floating Roof Tanks

Seal Type	Applicable Illustration Detail	Minimum Application Rate L/min · m²	Minimum Application Rate gpm/ft²	Minimum Discharge Time (minutes)	Maximum Spacing Between Discharge Outlets
Mechanical shoe seal	A	20.4	0.5	10	39 m (130 ft) — Foam dam not required
Tube seal with more than 152 mm (6 in.) between top of tube and top of pontoon	B	20.4	0.5	10	18 m (60 ft) — Foam dam not required
Tube seal with less than 152 mm (6 in.) between top of tube and top of pontoon	C	20.4	0.5	10	18 m (60 ft) — Foam dam required
Tube seal with foam discharge below metal secondary seal*	D	20.4	0.5	10	18 m (60 ft) — Foam dam not required

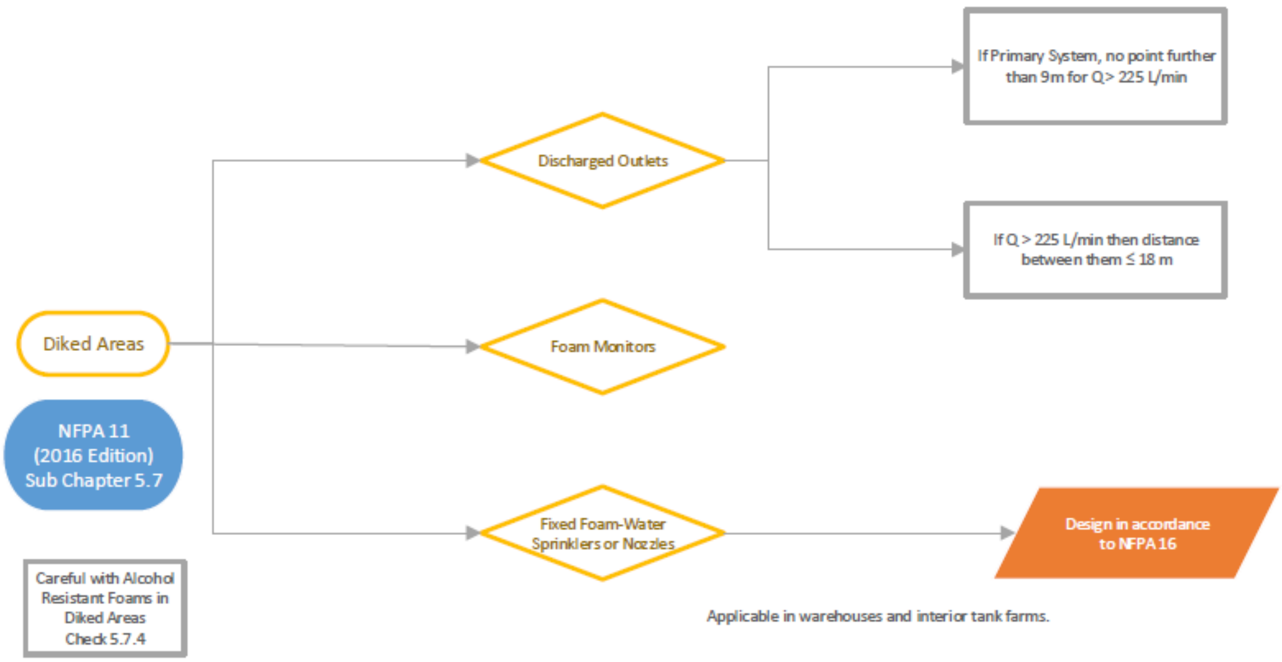


Figure B.2 – Analysis of NFPA 11 Sub Chapter 5.7 – Diked Areas

Table B.6 – Minimum Application Rates and Discharge Times for Fixed Foam Application on Diked Areas Involving Hydrocarbon Liquids

Type of Foam Discharge Outlets	Minimum Application Rate		Minimum Discharge Time (minutes)	
	$L/min \cdot m^2$	gpm/ft^2	Class I Hydrocarbon	Class II Hydrocarbon
Low-level foam discharge outlets	4.1	0.10	30	20
Foam monitors	6.5	0.16	30	20

APPENDIX C – CALCULATION SHEET

DATA

Design Basis	
Foam concentration (%)	3

FOAM		DISCHARGE OUTLETS		MONITORS		References
Design parameters		Minimum Density Application Rate	Duration	Minimum Density Application Rate	Duration	
		[l/min/m²]	[min]	[l/min/m²]	[min]	
Fixed Roof	Flammable	4,1	30	6,5	65	NFPA 11 - Table B.1
	Combustible	4,1	20	6,5	50	
Floating Roof	Flammable	12,2	20	6,5	65	
	Combustible	12,2	20	6,5	50	

WATER		FIXED WATER SPRAY SYSTEM AND WATER MONITORS		References
Equipment Protection		Minimum Density Application Rate	Duration	
		[l/min/m²]	[min]	
Static	Static Equipment	10,2	120	NFPA 15 - §7.4.3.4
	Storage Tanks	10,2		NFPA 15 - §7.4.2.1
Rotating	Compressors Area	20,4		NFPA 15 - §7.3.2
	Pumps Area	20,4		NFPA 15 - §7.3.2

RESULTS					
Blanket supply Water + Foam		Foam Concentration Supply		Water for cooling	
				Flow	Volume
[l]	[m³]	[l]	[m³]	[m³/h]	[m³]
132732	133	3982	4	3763	7525

Tank Data										Foam Calculation							Water Calculation						
Number	Name	Tag	Capacity	Roof Type	Protection Type	Flash Point	Main Dimensions			Addition of Foam	Application rate	Time	Surface Area	Flow rate	Blanket supply	Concentration Supply	Addition of Water	Selected water application rate	Roof Area	Vessel Area	Total surface	Water Flow	Water Volume
							H	D	Rim Seal														
			[m³]	(Fixed / Floating)	(Fixed / Monitor)	[°C]	[m]	[m]	[m]	(Yes/No)	[l/min.m²]	[min]	[m²]	[l/min]	[l]	[l]	(Yes/No)	[l/min/m²]	[m²]	[m²]	[m²]	[m³/h]	[m³]
Scenario 1																							
1	Hexene	T-001	500	Fixed	Fixed	-26	20	18	-	Yes	4,1	30	254,5	1043	31300	939	No	-	-	-	-	-	-
2	Octane	T-002	1000	Fixed	Monitor	7	22	20	-	No	-	-	-	-	-	-	Yes	10,2	314	1382	1696	1038	2076
3	Decene	T-003	2000	Floating	Fixed	55	24	22	2	No	-	-	-	-	-	-	Yes	10,2	380	1659	2039	1248	2496
4	Alcohol	T-004	4000	Floating	Monitor	100	26	24	1	No	-	-	-	-	-	-	Yes	10,2	452	1960	2413	1477	2953
														Σ=	31300	939					Σ=	3763	7525
Scenario 2																							
1	Hexene	T-001	500	Fixed	Fixed	-26	20	18	-	No	-	-	-	-	-	-	Yes	10,2	254	1131	1385	848	1696
2	Octane	T-002	1000	Fixed	Monitor	7	22	20	-	Yes	6,5	65	314,2	2042	132732	3982	No	-	-	-	-	-	-
3	Decene	T-003	2000	Floating	Fixed	55	24	22	2	No	-	-	-	-	-	-	Yes	10,2	380	1659	2039	1248	2496
4	Alcohol	T-004	4000	Floating	Monitor	100	26	24	1	No	-	-	-	-	-	-	Yes	10,2	452	1960	2413	1477	2953
														Σ=	132732	3982					Σ=	3572	7145
Scenario 3																							
1	Hexene	T-001	500	Fixed	Fixed	-26	20	18	-	No	-	-	-	-	-	-	Yes	10,2	254	1131	1385	848	1696
2	Octane	T-002	1000	Fixed	Monitor	7	22	20	-	No	-	-	-	-	-	-	Yes	10,2	314	1382	1696	1038	2076
3	Decene	T-003	2000	Floating	Fixed	55	24	22	2	Yes	12,2	20	125,7	1533	30662	920	No	-	-	-	-	-	-
4	Alcohol	T-004	4000	Floating	Monitor	100	26	24	1	No	-	-	-	-	-	-	Yes	10,2	452	1960	2413	1477	2953
														Σ=	30662	920					Σ=	3363	6725
Scenario 4																							
1	Hexene	T-001	500	Fixed	Fixed	-26	20	18	-	No	-	-	-	-	-	-	Yes	10,2	254	1131	1385	848	1696
2	Octane	T-002	1000	Fixed	Monitor	7	22	20	-	No	-	-	-	-	-	-	Yes	10,2	314	1382	1696	1038	2076
3	Decene	T-003	2000	Floating	Fixed	55	24	22	2	No	-	-	-	-	-	-	Yes	10,2	380	1659	2039	1248	2496
4	Alcohol	T-004	4000	Floating	Monitor	100	26	24	1	Yes	6,5	50	72,3	470	23483	705	No	-	-	-	-	-	-
														Σ=	23483	705					Σ=	3134	6268