Hydrant Pillar Installation According To NFPA 14 At The Sales Office Of PT. Xyz

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ABSTRACT

Catur Setyawan Kusumohadi, Pratomo Setyadi, Muhammad Ammar Zahran. 2023. Hydrant Pillar Installation According To NFPA 14 At The Sales Office Of PT. Xyz.

The Sales Area Manager Bandung office, which is located in the city of Bandung, is one of the work locations that cover the working area of Bandung and its surroundings. This Sales Area Office was built in the 90s, but originally functioned as a TNI office. In 2017 the new office was moved to PT. XYZ. However, when I made field observations. The fire protection conditions installed in the building are only Light Fire Extinguishers. Even though SNI and NFPA explain that a building with an area of more than 500 m2 must have a hydrant pillar installation, while a sales office with an area of 1,827 m2 only has active fire protection in the form of a Light Fire Extinguisher or APAR. Therefore, this report contains planning and analysis of the pillar hydrant system and water requirements for extinguishing the hydrant used in the Sales Area Manager Office Building located in the city of Bandung. With planning referring to the NFPA 14 standard, this research was conducted by observing the Marketing Office of PT. XYZ which is located in Bandung City in April-March 2022. Observation data processing was carried out at the Fire Safety Engineering Study Program, Faculty of Engineering, Jakarta State University in June-August 2022. From the design results, pillar hydrants have been installed, it can be written that the capacity of the extinguishing media used needed to overcome the fire in the sales area management building is 85,171 liters of water. Based on NFPA 14 for building sales area management, the number of pillars needed to protect the building from fire hazards is 5 pieces. The pump power required for the installation of a hydrant pillar is 12.54 hp. Installation of pipes used above the ground and around the building.

Keywords: Hydrant, NFPA, Pipe, Pump

INTRODUCTION

Introductions

The Bandung Sales Area Manager office, located on Jalan Wirayuda Timur, Lebakgede, Coblong District, Bandung City, is one of the work locations that cover the working area of Bandung and its surroundings. Due to its strategic position in running the Marketing business, risks in this area must be mitigated more deeply. Of the various potential disturbances that exist, the potential for fire is a risk that will have a significant impact both on the process as a branch of the marketing business unit and on local residents.

This research was carried out with reference to previous research entitled “Perancangan Sistem Perpipaan Hidran Dan Sprinkler di Sejahtera Family Hotel and Apartment,” made by Andreas Kurniawan in 2007. The results of this study I make reference to the discussion of the calculation of headloss and the calculation of the number of hydrants needs that refer to the Darcy-Weisbach equation.

This Sales Area Office was built in the 90s, but originally functioned as a TNI office. In 2017 the new office was moved to PT. XYZ. However, when I made field observations. The fire protection conditions installed in the building are only Light Fire Extinguishers. Even though SNI and NFPA explain that buildings with an area of more than 500 m2 must have a hydrant pillar installation, while the sales office area of 1,827 m2 only has active fire protection in the form of a Light Fire Extinguisher or APAR.

Therefore, this report contains planning and analysis of the hydrant pillar system and water requirements for extinguishing the hydrant used in the Sales Area Manager Office Building located in the city of Bandung. With planning that refers to the NFPA 14 standard

MATERIALS AND METHODS

Methods

This research was conducted at the Marketing Office of PT. XYZ which is located in Lebakgede, Coblong District, Bandung City in April-March 2022. Observation data processing was carried out in the Fire Safety Engineering Study Program, Faculty of Engineering, Jakarta State University in June-August 2022.

Flowchart

In the research flow, it is presented in the form of a research diagram that explains the steps to be taken in the research. In this study the flow used is shown in Figure 1:

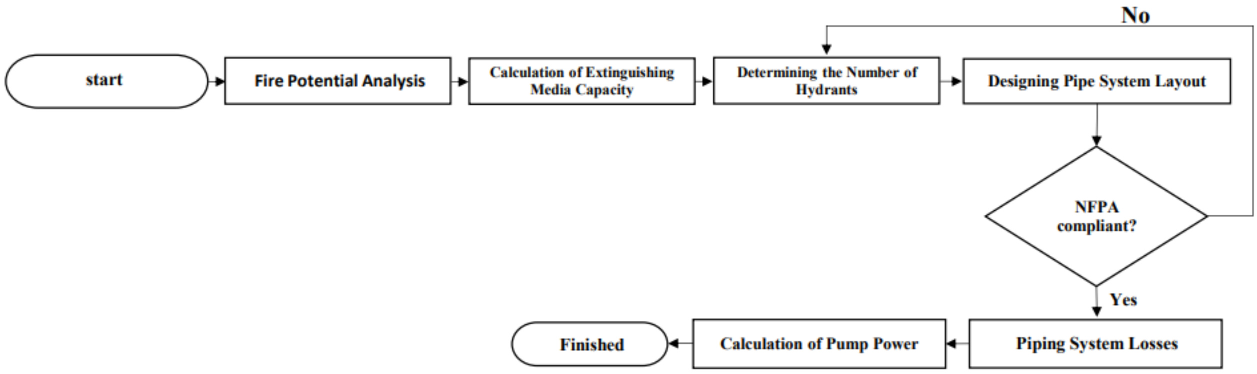

Figure 1 Flow Chart

Fire Potential Analysis

Analysis of the fire potential is the first step of this research. At this stage a fire scenario is carried out for the pre-fire planning stage. Pre-Fire Planning itself is a plan to respond to potential fire incidents that have been prepared and prepared before a fire occurs and has been socialized and trained beforehand (EPA, 2009).

In this study the researchers used a scenario where the room on the 1st floor experienced a fire. The room that I used as a fire scenario this time is the administration room, where in that room there are several admin computers that might trigger a fire from an electric short circuit and also in that room there are many items that can be fuel for a fire such as paper, tables, etc. chairs etc. Therefore, in this study the scenario used was that the fire had spread to one room and could not be controlled with an APAR.

With this in mind, the author creates a scenario where the blackout is carried out using 3 active hydrants, where 2 hydrants are used for extinguishing and 1 hydrant is used for cooling.

Calculation of Hydrant Output Speed

The distance of the hydrant beam is generated from the pressure that occurs on each floor which is flowed from the pipe system, the hose is then emitted by the nozzle. The hose used is 2.5" (63.5 mm) in diameter according to NFPA 14. As for the input diameter nozzle, adjust the hose to 2.5" with an outlet hole of 0.75" (19.05 mm). To simplify the speed calculation the jet, in the calculation of the nozzle is directed flat, with negligible frictional losses at the nozzle

Calculation of Hydrant Discharge

The hydrant discharge is obtained by multiplying the velocity at the nozzle outlet and the nozzle outlet. The amount of water supply for yard hydrants needed during a blackout according to NFPA 14 is as follows:

- With 3 active hydrants
- Maximum limit of auxiliary hydrants up to a total of 750gpm (2839.058 litres/minute)
- Minimum volume of water required:

$$V = Q \times t$$
$$= 2839.058 \times 30$$
$$= 85{,}171.74 \text{ liters}$$
$$= 85.171 \text{ m}^3$$

Determine the number of hydrants

After calculating the need for extinguishing media, the next step is to determine the number and placement of hydrants. In this study a fire hydrant was used to spray water into the combustion chamber and the surrounding rooms which were exposed to radiation. The steps taken in determining the number and placement of hydrants are as follows:

Determining the Number of Hydrants

In NFPA 14 it is explained that the distance between hydrants is calculated based on the length of the hose from one hydrant to another. In other words, the distance between the hydrant pillars is 30m

Mapping the position of the fire hydrant from the coverage area

The coverage area of the hydrant is 30m, this distance can be seen from the length of the hydrant hose which is 30m. Known in the final project ..... has been tested, for a hydrant with a 10 bar nozzle has a beam length of 47.82m.

To calculate the coverage area, it can be calculated using the following formula:

Child: Hose length = 30 m

Water spray = 47.82

Coverage Area = π (Hope length + jet)^2

Area Coverage = 3.14 (30m + 47.82)^2

Area Coverage = 3.14 (77.82)^2

Coverage Area = 19,015.69 m^2

Piping system head loss calculation

After determining the location of the hydrant, the next step is to calculate the pipe head loss. Headloss in the design of this piping system consists of 2 types of headloss, namely Major Loss and Minor Loss. The large head loss is caused by frictional losses in the pipe. To calculate the friction loss between the pipe wall and the fluid flow.

Major loses

Header pipe

Pipe diameter = 6 in = 150 mm

Pipe inside diameter = 6.065 in = 154.05 mm = 0.15405 m

Pipe inside diameter

$$A = \frac{3,14}{4} \times (0.15405)^2$$
$$= \frac{3,14}{4} \times (0.15405)^2$$
$$= 0.0186292$$

The average velocity of flow in the pipe

With known:

Q =750 gpm = 2839.0588 lpm

= 0.0473176 m^3

So,

$$V = \frac{Q}{A}$$
$$= \frac{0.0473176}{0.0186292} = 2.254$$

Reynolds number (Re)

Knowing:

The water temperature is 30oC, then μ= 0.801×〚10〛^(-6)m2/s

So,

Re = (V×D)/μ

= (2.254×0.15405)/(0.801×〚10〛^(-6))

= 433,494

Re > 4000 then the flow is turbulent

Friction losses in the pipe (major losses)
The average height of the Galvanized pipe roughness

$$Re = \frac{V \times D}{\mu}$$
$$= \frac{2.254 \times 0.15405}{0.801 \times 10^{-6}}$$
$$= 433.494$$

Re > 4000 maka aliran bersifat turbulen
Friction losses in the pipe (major losses)
The average height of the Galvanized pipe roughness
ε=0.15mm
Pipe diameter (D) = 6 inches = 150 mm

$$Rellative\ Roughness = \frac{\varepsilon}{D}$$
$$= \frac{0.15}{150} = 0.001$$

Friction Factor (f) = 0.021
(Based on previously known Reynolds Number and Relative Roughness)
The following is the calculation of the standpipe friction loss ($h\ f$):
Longest Vertical Pipe Length (L) = 7 m
Acceleration of Gravity = 9.8 $m/s2$
So,

$$hf_{mayor} = f\frac{L \times V^2}{2 \times D \times g}$$
$$= 0.021\frac{7 \times (2.254)^2}{2 \times 0.15405 \times 9.8}$$

Standpipe
Pipe diameter = 4 in = 101.6 mm
Pipe inside diameter = 4.026 in = 102.2604 mm = 0.1022604 m
Pipe inside diameter

$$A = \frac{\pi}{4} \times (D)^2$$
$$= \frac{3,14}{4} \times (0.15405)^2$$
$$= 0.0186292$$

The average velocity of flow in the pipe
With known:
Q = 750 gpm = 2839.0588 lpm
= 0.0473176 m3
So,

$$v = \frac{Q}{A}$$
$$= \frac{0.0473176}{0.0186292}$$
= 2,254

Reynolds number (Re)
Knowing:
The water temperature is 30oC, then μ= 0.801×⟦10⟧^(-6)m2/s
So,

$$Re = \frac{v \times D}{\mu}$$
$$= \frac{2.254 \times 0.15405}{0.801 \times 10^{-6}}$$
$$= 433.494$$

Re > 4000 then the flow is turbulent

Friction losses in the pipe (major losses)
The average height of the Galvanized pipe roughness
ε=0.15mm
Pipe diameter (D) =4 inch = 101.6 mm

$$Rellative\ Roughness = \frac{\varepsilon}{D}$$
$$= \frac{0.15}{101.6}$$
$$= 0.001$$

Friction Factor (f) = 0.021
(Based on previously known Reynolds Number and Relative Roughness)

The following is the calculation of the standpipe friction loss ($h\,f$):
Longest dividing pipe length (L) = 1.5 m
Acceleration of Gravity = 9.8 $m/s2$
So,

$$hf_{mayor} = f\,\frac{L\times V^2}{2\times D\times g}$$
$$= 0.021\,\frac{1.5\times(2.254)^2}{2\times 0.1022604\times 9.8}$$
$$= 0.0798463 \text{ m}$$

Dividing pipe
Pipe diameter = 6 in = 150 mm
Pipe inside diameter = 6.065 in = 154.05 mm = 0.15405 m
Pipe inside diameter

$$A = \frac{\pi}{4}\times(D)^2$$
$$= \frac{3,14}{4}\times(0.15405)^2$$
$$= 0.0186292$$

The average velocity of flow in the pipe
With known:
Q =750 gpm = 2839.0588 lpm
= 0.0473176 m3
So,

$$v = \frac{Q}{A}$$
$$= \frac{0.0473176}{0.0186292}$$
$$= 2.254$$

Reynolds number (Re)
Knowing:
The water temperature is 30°C, then μ= $\mu = 0.801\times 10^{-6}$m^2/s
So,

$$Re = \frac{v\times D}{\mu}$$
$$= \frac{2.254\times 0.15405}{0.801\times 10^{-6}}$$
$$= 433.494$$

Friction losses in the pipe (major losses)
The average height of the Galvanized pipe roughness
ε=0.15mm

$$Rellative\ Roughness = \frac{\varepsilon}{D} = \frac{0.15}{150} = 0.001$$

$$Friction\ Factor\ (f) = 0.021$$

(Based on previously known Reynolds Number and Relative Roughness)

The following is the calculation of the standpipe friction loss ($h\,f$):
Longest dividing pipe length (L) = 212.5 m
Acceleration of Gravity = 9.8 $m/s2$
So,

$$hf_{mayor} = f\,\frac{L \times V^2}{2 \times D \times g} = 0.021\,\frac{212.5 \times (2.254)^2}{2 \times 0.15405 \times 9.8} = 7.508\ \text{m}$$

Minor losses
With known:
Pipe Diameter (D) = 6 inches = 150 mm
Pipe inside diameter = 6.065 in = 154.05 mm = 0.15405 m
The loss coefficient at the gate valve(fv) = 0.45

$$hf_{minor_1} = f_v\,\frac{v^2}{2 \times g} \times jumlah\ katup = 0.12\,\frac{2.254^2}{2 \times 9.8} \times 3 = 0.0933156\ \text{m}$$

Next is the calculation of the pipe bend loss. There are thirteen 90o turns on the dividing pipe, so to get the value of minor losses you can use the following formula:
So,

$$hf_{minor_2} = f_v\,\frac{v^2}{2 \times g} \times jumlah\ katup = 0.45\,\frac{2.254^2}{2 \times 9.8} \times 13 = 1.51638\ \text{m}$$

Next is the calculation of the pipe bend loss. There are two 45o turns on the dividing pipe, so to get the value of minor losses you can use the following formula:

$$hf_{minor_3} = f_v\,\frac{v^2}{2 \times g} \times jumlah\ katup = 0.24\,\frac{2.254^2}{2 \times 9.8} \times 2 = 0.124421\ \text{m}$$

So, the total loss of minor losses as follows

$$hf_{minor} = hf_{minor_1} + hf_{minor_2} + hf_{minor_3} = 0.0933156 + 1.51638 + 0.124421 = 1.7341166\ \text{m}$$

Static Heads
Static head (Ha) is the height difference between the outside water level/nozzle ($Z2$) and the suction side ($Z1$). The static head of this hydrant installation is 2 m

Pressure Heads
Suction Pressure $(P1)$ $P1 = \rho \times g \times Ha$
Where:
ρ = 995.65 $kg/m3$ (density or specific gravity of water at 30oC)
g = 9.8 $m/s2$ (gravitational acceleration)
So,
$P1 = \rho \times g \times Ha$
= 995.65 × 9.8 × 2
= 19,514.74 kg/m2
Pressure on the pipe installation
$P2$ = pressure for hydrants – air pressure
Where :
Pressure for hydrants = 10 bar
Air pressure = 1 atm = 1.01325 bar
$P2$ = pressure for hydrants – air pressure
= 10 bars – 1.01325 bars
= 8.9865 bars
=91636.80 kg/m2
So,

$$\Delta hp = \frac{P_2 - P_1}{\rho \times g}$$

$$= \frac{91636{,}80 - 19.514{,}74}{995{,}65 \times 9{,}8}$$

=7,39 m

Total Head (HLT)

The total head is the sum of the total loss head, static head, and pressure head calculations. Then the calculation of the total head as follows:

$$\text{Head total} = \sum hf_{mayor} + hf_{minor} + h_{statis} + h_{tekanan}$$
$$= 7{,}89 + 1{,}73 + 2 + 7{,}39$$
= 19,01 m

Hydrant Pump Capacity

Judging from the fire scenario, the number of standpipes that are planned to be active when a fire occurs is 3 units. Based on this plan, the calculation of the total discharge in the hydrant pump system is as follows:

Total flow rate = 3 standpipes

= 500 + 250 gpm = 750 gpm

Based on the calculation of flow rate in the hydrant pump system, the fire pump capacity that can be selected is 750 gpm

pump power calculation

After calculating the losses from the piping system, the next step is to calculate the pump. The first step is to calculate the NPSHA. Can be calculated by the following formula:

hydrant pressure = 10 bar = 101,9 m
Hs = 1 m
Hd = 1,5 m
Hf = 19,01 m
Hi = 0,35 m

HA = NPSH + Loses
HA = Hs + Hd + hydrant pressure + Hf + Hi
HA = 1 + 1,5 + 101,9 + 19,01 + 0,35 = 123,76 m

maximum pump power (Pw)

Pw = 0,163 × γ × Q × HA

γ = determining the specific gravity of water per unit volume = 9,765 $kN/m3$
Q = 0,0473176 $m3/s$
HA = 123,76 m
Maka,
Pw = 0,163 × γ × Q × HA
= 0,163 × 9,765 $kN/m3$ × 0,0473176 $m3/s$ × 123,76 m
= 9,32 kW = 12,5 hp

Maximum shaft power (P)

$$P = \frac{P_w}{np}$$

Dimana :
np = centrifugal pump standard efficiency = 80%
P = Maximum shaft power
P_w = maximum pump power

$$P = \frac{P_w}{np}$$

$$P = \frac{12{,}5}{80\%}$$

$$P = 15{,}6\ hp$$

CONCLUSION

From the results of the design of the hydrant pillar installation that has been carried out, conclusions can be drawn. The capacity of the extinguishing media needed to tackle fires in the sales area manager building is 85,171 liters for water. Based on NFPA 14 for the sales area manager building, the number of hydrant pillars needed to protect the building from fire hazards is 5. The required pump power for pillar hydrant installation is 12.54 hp. The pipe installation used is above the ground and surrounds the building.

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