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Design of Active Fire Protection System for Warehouse Buildings Using NFPA and Indonesian National Standard (SNI)

Afrigh Fajar Rosyidiin[1*], Agatha Hannabel Avnanta Puteri[2], Dharu Zastia Priyangga[3], Davin Danny Ivander[4], Moch. Isabil Liwaq[5]

[1,2,3,4,5]Department of Industrial Engineering, Faculty of Engineering, Universitas 17 Agustus 1945 Surabaya, Indonesia

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ABSTRACT

In the operational conduct of a company, especially those relating to the storage of materials and goods in warehouses, the occupational health and safety OHS) aspects are critical factors that cannot be neglected. Fire was one of the consequences of a non-standard OHS application. The purpose of this research was to provide a proposal for the design of fire protection systems in the Archives and Documents Company, which are light fire extinguishers, sprinkler systems, hydrants, and reservoirs. This research method is observational-descriptive. In conceptual planning, layout, and coordination with the company, the researchers directly perform observations on the PT Archives and Documents to analyze and identify the deficiencies of fire protection equipment owned by the associated companies. ADC requires a total of 9 light fire extinguishers, 192 sprinkler points, 6 hydrants, and a reservoir size of 343,000 liters as a fire protection system according to the National Fire Protection Association standards (NFPA). All buildings that are occupied by humans and have a risk of fire must be equipped with fire protection. for future research in the field of fire safety research to design an emergency response plan for a building by simulating it with advanced technology. By implementing the proposed fire protection, the Company can prevent fire and spread of fire more widely.

*Corresponding author: afrighfajar@untag-sby.ac.id

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Introduction

Occupational Safety and Health (OSH) is a systematic approach implemented in workplaces, encompassing shared responsibilities for OSH-related actions, setting workplace standards and frameworks to meet those standards, emphasizing OSH regulations, and facilitating rule/policy enforcement (Mei Brilian Harefa et al., 2022). When operating a business, particularly one that involves the storage of materials and goods in a warehouse, Occupational Safety and Health (OSH) becomes a critical factor that cannot be overlooked. Awareness of potential hazards, accident risks, and the need for preventive measures is essential to create a safe and healthy work environment for all employees. Fire is one of the risks arising from inadequate OSH implementation (Eva Jayati & Ani, 2020). A fire is defined as any flame, whether small or large, in an undesirable place that causes harm (Marfuah et al., 2020). When a fire occurs, it is typically uncontrollable and beyond human intention (Ramli, 2010). This study proposes a fire protection system design including fire extinguishers, sprinklers, hydrants, and reservoirs.

Archive and Document Company (ADC) is a pseudonym for the research object. This company specializes in archive storage and document preservation services in Indonesia, with warehouse locations in major cities across the country. The company's warehouses are equipped with specially designed racks to accommodate various sizes and types of documents. Each rack is clearly labeled and organized by category or document type for easier retrieval and identification. Given the materials stored in these warehouses, ADC falls under Fire Classification A, which is at high risk of fire due to the presence of flammable wood and paper (Kowara, 2017)

According to Decree of the Minister of Public Works Number 10 Year 2000, one of the key aspects of building management, including residential and commercial buildings, is fire safety. This is typically achieved through preventive measures and fire suppression strategies. In practice, fire safety involves the installation of fire protection equipment such as fire extinguishers, sprinklers, hydrants, and reservoirs. Despite growing awareness of the importance of fire protection systems, many buildings remain inadequately protected, with either insufficient fire protection equipment or installations that do not meet safety standards (Seydi et al., 2022).

Laksita Rini Sevriani, Head of Surabaya's Fire and Rescue Department, reported that in 2023, the department handled 793 fire incidents (Elaine, 2024). Of these, 121 involved building-related fires, including residential, industrial, commercial, and trade properties. Eighteen cases involved vehicle fires, and 654 cases were related to non-building or open-space fires, such as grassland and garbage fires (Olsen et al., 2017). Observations from Surabaya's fire incidents suggest that fire prevention and firefighting should not rely solely on fire departments. Instead, well-planned and structured fire protection systems are essential. Active fire protection systems include fire extinguishers, hydrants, and sprinklers (Ratnayanti et al., 2020). In implementing a fire safety system several strategies can be classified into four main aspects including passive building construction strategy, fire extinguishing system installation strategy, fire safety management strategy, and risk factor control strategy (Muhammad et al., 2019). Considering the limited availability of fire protection facilities in Archive and Research Company warehouses, there is a need for significant improvements in fire safety infrastructure.

Literature Review

Table 1. Previous Studies

Author, years	Type	Focus of	Method	Result
(Malik et al., 2024)	Hydrant	Design a hydrant system that complies with nfpa standards	Quantitative method following nfpa 14 and 20 standards.	Hydrant system design includes hydrant location, pump room design, reservoir design, and the number of hydrant systems required for the warehouse.
(Setiawan, 2024)	Hydrant & Fire Extinguisher	Evaluating the use and maintenance of Fire extinguishers and hydrant systems. In the gunung sindur class IIA special prison	Social assessment. Method this is used for cadets to carry out practicums to help	The fire hydrant system acts as an important emergency fire control tool to minimize loss of life and material due to fire.
(Hasna Hayba Silmiy et al., 2023)	Sprinkler	Determine the number of sprinklers needed as an automatic extinguishing system	Direct observations of the object under study, namely the coal warehouse, and took measurements of the room plan using a building meter	The number of sprinklers needed for the coal warehouse is 111 sprinklers. The volume of water required is 399.6 m^3, while the pump power required is 3 kW
(Cleo A P et al., 2024)	Sprinkler	Designing a semi-addressable fire alarm system and sprinkler system for the Tidar University Engineering Faculty building	Observation methods, literature studies, data collection, and consultation with fire safety experts.	Number of devices includes 67 smoke detectors, 222 sprinklers, a water volume of 416.35 m3, and a 500 m3 water tank.

(Djafar et al., 2022)	Fire Extinguisher	Planning an effective fire protection system for laboratories in higher education	Technical research method with an approach to applicable standards, such as nfpa 14, and nfpa 24	The results obtained are that the need for Fire Extinguishers on the 1st floor is 22 Fire Extinguishers, on the 2nd floor there are 12 Fire Extinguishers, on the 3rd floor there are 12 Fire Extinguishers.
(Rizki. et al, 2018)	Fire Extinguisher	Carry out the design of the Light Fire Extinguisher (Fire Extinguisher) and Emergency Response Plan (ERP) at the Surabaya State Shipping Polytechnic	Calculating the number of Fire Extinguishers based on NFPA No. 10 of 2013 to determine the type of Fire Extinguisher, and NFPA 101 Life Safety Code 2000 edition to determine the number of exits	The number of fire extinguishers needed for the PPNS building is 448, while the number of exit doors is 417. In addition, the evacuation time from the Pathfinder simulation takes 116.5 seconds with an error rate of 1.9%
(Anggraeni et al., 2017)	Fire Extinguisher	Design active fire protection in the workshop area of a fabrication construction services company.	FRA (Fire risk assessment) is a process to characterize risks that Associated with fires shown to fire scenarios	Fire Extinguishers required for various fabrication jobs is 4 for bottom and hold plan fabrication, 5 for crew deck fabrication, 4 for main deck fabrication, and 3 for fabrication
(Muhammad et al., 2018)	Fire extinguisher, sprinkler, hydrant, and Reservoir tank	Provide a proposal for the design of fire protection systems in archives and documents, which are light fire extinguishers, sprinkler systems, hydrants, and reservoirs.	Research design in this research is a quantitative method with direct measurements in the field. Data processing and active fire protection design based on nfpa and sni regulations.	Total of 9 units of dry chemical fire extinguishers with a total of 192 sprinkler units, a total of 6 hydrant units with 4 box hydrants and 2 pillar hydrants and the total requirements water to be able to run hydrants and sprinklers is 343,000 liters with a storage volume of 7m x 7m x 7m

This research uses an innovative integration concept between Fire Extinguisher, Hydrant, Sprinkler, and reservoir tank. This approach is designed to create a fire protection system that is more efficient, responsive, and reliable. The main novelty in this research lies in the integration between APAR, Hydrant, and Sprinkler as well as the creation of a planning layout for the placement of each fire protection device. This integrated system also utilizes a reservoir tank designed to supply water efficiently to the entire fire protection network. With this reservoir planning, the company can find out how much water is needed to design a fire protection system (Li & Zhao, 2020).

Contributing Factors to Workplace Fires

Research consistently indicates that workplace fires typically result from a complex combination of factors. Among these, human error is frequently cited as a significant contributor. This can manifest as mistakes in daily operations, such as mishandling equipment or neglecting to follow safety guidelines. Equipment failure is another common cause, with aging or poorly maintained machinery posing significant fire hazards (Bu & Gharajeh, 2019). In addition to these factors, inadequate safety protocols can greatly increase the likelihood of workplace fires (Mendo et al., 2023). This might include a lack of clear fire safety plans, inadequate emergency response training, or insufficient safety inspections. For instance, highlighted that electrical malfunctions are a leading cause of workplace fires, often resulting from outdated wiring, overloaded circuits, or faulty electrical devices. They also noted that improper storage of flammable materials—like solvents, oils, and chemicals—can create dangerous conditions that heighten fire risks (MAFRUCHATI et al., n.d.).

Similarly, explored the role of human error in workplace fires, demonstrating that negligence and a lack of proper training can lead to situations where fires are more likely to occur. This might involve employees ignoring safety warnings, failing to report hazards, or improperly using equipment. Brown's study underscores the need for organizations to establish comprehensive safety protocols that include regular employee training, emphasizing fire prevention and emergency response (Brown et al., 2020).

Fire Protection Involves the Prevention

Several studies propose effective strategies for reducing the risk of workplace fires. Emphasized the importance of regular risk assessments, safety drills, and equipment maintenance in preventing fires. They suggest that a proactive approach to safety management can significantly reduce the likelihood of fire incidents (Oswald et al., 2020). Additionally, stresses the need for clear safety policies and regular safety inspections to identify and address potential hazards before they lead to fires (Johnson Martinez, 2021). Employee training is another key aspect of fire prevention. A study by (Huseyin & Satyen, 2006). found that workplaces with comprehensive training programs for fire safety experienced fewer fire-related incidents. He emphasized that training should cover fire prevention, emergency response, and the proper use of safety equipment.

Fire Extinguisher

Powder fire extinguishers, commonly known as Dry Chemical Powder (DCP) extinguishers, are well-suited for use in document storage warehouses. These areas predominantly contain solid materials like paper, making powder extinguishers effective against Class A fires (solid combustibles), Class B fires (flammable liquids and gases), and Class C fires (electrical installations). Water-based fire extinguishers, or Air-Pressurized Water (APW) extinguishers, work by cooling the burning materials through heat absorption. They are most effective for Class A fires but are not suitable for Class C fires due to the risk of electrical hazards (ANI et al., 2024). While APW extinguishers are cost-effective, non-toxic, and easy to clean, they can pose risks if used on electrical fires (Mafruchati et al., 2023).

In different countries, APW extinguishers vary in size and construction materials. In the United States, APW extinguishers typically hold 9.5 liters of water in a high-grade stainless-steel cylinder. In Europe, these extinguishers often contain 6–9 liters of water in a mild steel cylinder coated with polyethylene, painted red for visibility. This variation reflects regional differences in fire safety standards and manufacturing practices (Hong & Kong, 2021).

Sprinkler

Sprinkler systems are essential for fire protection, used in various settings from homes to large industrial facilities. There are several types of sprinkler systems, each designed for specific applications.

- Wet Pipe: Contains water, ready to release when a sprinkler head is activated.
- Dry Pipe: Pipes filled with pressurized air; water is released when the air pressure drops after a sprinkler head activates. Useful in cold areas.
- Pre-Action: Combines wet and dry systems. Water is released only when both a fire detection system and a sprinkler head activate.
- Deluge: All sprinkler heads are open; water releases quickly when a fire alarm triggers. Ideal for high-hazard areas.

Design considerations for sprinkler systems include:

- Coverage Area: The amount of space each sprinkler head covers.
- Flow Rate: The volume of water released, influenced by pressure and sprinkler design.
- Spacing: Distance between sprinkler heads to ensure proper coverage.
- Temperature Ratings: Temperature at which a sprinkler activates.

Applications vary from homes to commercial buildings and industrial sites. Regular inspection and maintenance are crucial for safety and effectiveness. Industry guidelines, like those from the National Fire Protection Association (NFPA 13, 2019) are used to ensure proper installation and operation.

Fire Hydrant

Fire hydrants are crucial components in firefighting infrastructure, providing reliable access to water during emergencies. A comprehensive firefighting system also includes various accessories and supplementary equipment, one of which is the fire hydrant box, or hydrant cabinet. This literature review explores the key specifications of fire hydrants, including the role of fire hydrant boxes, and the standards that guide their design, installation, and maintenance. Fire hydrant boxes, or hydrant cabinets, play an essential role in the firefighting system (Hong & Kong, 2021). These boxes are designed to house fire hoses, nozzles, and other firefighting equipment, providing easy and quick access during emergencies. Fire hydrant boxes are typically installed near hydrants to facilitate rapid response.

Fire hydrants and fire hydrant boxes are essential components of the firefighting infrastructure, providing a reliable source of water and storage for firefighting equipment. Understanding the specifications, standards, and maintenance requirements ensures that these components are ready for use during emergencies. Compliance with established standards and regular maintenance help guarantee the effectiveness of firefighting systems (Lee et al., 2020); (Mafruchati et al., 2022).

Methodology

Observations from fire incidents in Surabaya suggest that fire prevention and firefighting require more than just relying on fire departments; a well-planned and structured fire protection system is crucial. Active fire protection systems include fire extinguishers, hydrants, and sprinklers (Malik et al., 2024). Given the limited availability of fire protection facilities in Archive and Research's warehouses, there's a pressing need to improve the fire safety infrastructure. Research design using quantitative methods with direct measurements in the field. Data processing and active fire protection design based on NFPA and SNI regulations (Hasna Hayba Silmiy et al., 2023).

Data collection in this research was carried out in the company's warehouse area. Data taken includes warehouse floor plan and dimensions, availability of active fire protection, and distance to the nearest fire extinguisher. Researchers provide an assumption that the protection time will run according to the time the fire brigade arrives at the location if a fire occurs. The fire protection design procedure was done by analyzing the needs of each fire protection including the Fire Extinguisher, Hydrant, and Sprinkler along with water needs by designing a reservoir. After that, determine the placement and installation of fire protection following specified regulations. The final step is to select the specific fire protection that has been determined. The procedure for analyzing active fire protection in more detail will be explained in the sub-chapter below:

Planning and Installing Fire Extinguishers

Planning and installing fire extinguishers should follow NFPA 10 standards. Below is the calculation for the required number of fire extinguishers using the following Table 2

Table 2. Calculate Fire Extinguisher Requirements

Criteria	Light-Hazard Occupancy	Ordinary-Hazard Occupancy	Extra-Hazard Occupancy
Minimum-rated single extinguisher	2-A	2-A	4-A
Maximum floor area per unit of A	3000 ft2 (279 m2)	1500 ft2 (139 m2)	1000 ft2 (92,9 m2)
Maximum floor area per extinguisher	11,250 ft2 (1045 m2)	11,250 ft2 (279 m2)	11,250 ft2 (279 m2)
Maximum travel distance to extinguisher	75 ft (22,9 m)	75 ft (22,9 m)	75 ft (22,9 m)

Installation of Fire Extinguishers based on NFPA 10 in a document storage facility is essential to ensure safety and security at the site. This standard provides guidelines on protected locations and specific requirements for Fire Extinguisher installation according to NFPA. Fire extinguishers should be placed in locations that are easily accessible, allowing for quick access in case of a fire. This typically means along common pathways. The distance between one FIRE EXTINGUISHER and another should be 15 meters. The height for Fire Extinguisher signage should be 125 cm from the floor, positioned directly above the relevant fire extinguisher or group of extinguishers. The signage should be made from durable material and resistant to fading.

Planning Sprinkler System

The first step in planning a sprinkler system is determining the hazard class of a building based on the classification established by (NFPA 13, 2019). This is followed by deciding the placement of sprinklers according to the distances specified in NFPA-13. According to the relevant table, the coverage area for each sprinkler is 12 square meters, with a maximum distance between sprinklers of 4.6 meters, as outlined in the following table:

Table 3. Classification of Hazard Levels

Commodity	Type of Storage	Storage Height		Hazard
		ft	m	
Class I	Solid-piled, palletized, bin box, shelf, single, double, multiple-row rack, and back-to-back shelf storage	≤12	≤3,7	OH1
Class II		≤10	≤3,0	OH1
Class II		>10 to ≤12	>3,0 to ≤3,7	OH2
Class III		≤12	≤3,7	OH2

Table 4. Distance Between Sprinkler

Construction Type	System Type	Protection Area		Maximum Spacing	
		ft	m	ft	m
All	All	130	12	15	4,6

Planning Hydrant System

The hydrant system is designed according to SNI-03-1745 (2000) to ensure workplace safety. The number and location of hydrants are determined by the pump's capacity, with the recommended distance between hydrants being 35-38 meters. This distance aligns with the standard fire hose length (30 meters) plus the spray range of the nozzle (5 meters). For buildings with more than 8 floors, hydrant pillars are recommended to prevent fire spread. Hydrants should be placed in easily accessible locations, typically near emergency exits, to ensure quick access in case of an emergency. Hydrant placement should also consider the building's area and classification to optimize fire safety.

Table 5. Building Classification for Hydrant System

No	Building Classification	Closed Rooms (Number/Area of Floors)	Closed and Separate Rooms (Number/Area of Floors)
1	A	1 Piece/1000$m2$	2 Piece/1000$m2$
2	B	1 Piece/1000$m2$	2 Piece/1000$m2$
3	C	1 Piece/1000$m2$	2 Piece /1000$m2$
4	D	1 Piece /800$m2$	2 Piece /800$m2$
5	E	1 Piece /800$m2$	2 Piece /800$m2$

Results and Discussion

The Results follow from the methods previously described. This chapter will explain the results of calculating fire protection needs including fire extinguishers, sprinklers, and hydrants. Water requirements for fire protection are also calculated which is useful for designing reservoirs

Fire Extinguishers

Number of Fire Extinguishers

The required number of fire extinguishers is calculated using the NFPA 10 standard as follows:

Warehouse area = 48 m × 48 m = 2.304 m^2

Maximum floor area per unit of A = 279 m^2

The number of fire extinguishers needed is calculated as:

$$= \frac{\text{Warehouse area}}{\text{Protection Area}} = \frac{2.304\ \text{m}^2}{279\ \text{m}^2} = 8{,}25 \approx 9$$

Thus, the required number of fire extinguishers for the ADC warehouse is at least 9 units.

Location and Installation of Fire Extinguishers

Fire extinguishers should be placed in locations that comply with standards to ensure easy access in case of fire. Proper location and placement of fire extinguishers are crucial to assist in controlling a fire until the fire department arrives (NFPA 10, 2018)

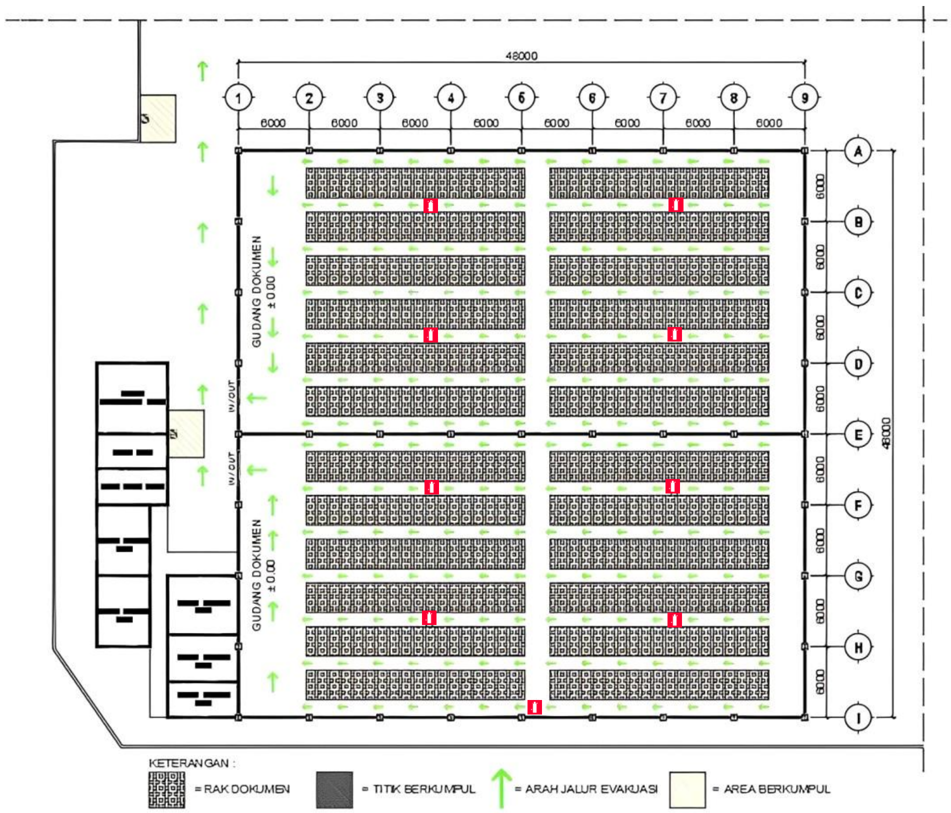

Figure 1. Layout of Fire Extinguisher Installation Points

Sprinkler

Number of Sprinkler Heads

The number of sprinkler heads required can be calculated by dividing the total area of a room by the coverage area for each sprinkler (12.1 m²) as specified in NFPA 13. The total area of ADC warehouse is 48 × 48 m = 2,304 m². Therefore, the number of sprinkler heads is calculated as follows:

$$\text{Number of sprinklers} = \frac{\text{room area}}{\text{sprinkler protection area}}$$

$$\text{Number of sprinklers} = \frac{2304 \text{ m}^2}{12{,}1 \text{ m}^2}$$

$$\text{Number of sprinklers} = 192 \text{ units}$$

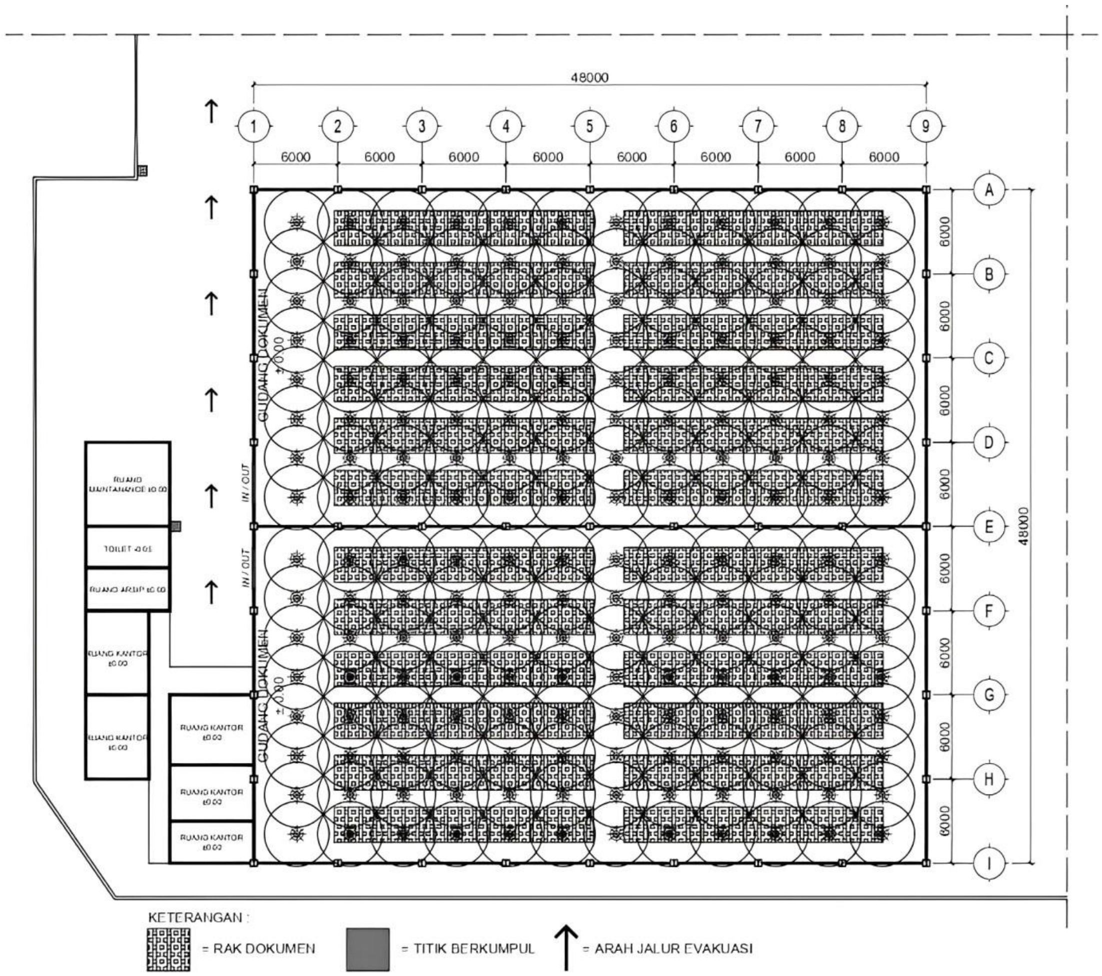

Figure 2. Layout of Sprinkler Installation Points

Distance Between Sprinklers

According to NFPA 13, the minimum distance between sprinklers is 1.8 meters, and the maximum is 4.5 meters. This can be calculated as follows:

$$= \frac{\text{length of branch pipe}}{\text{number of sprinkler heads}} = \frac{23{,}8}{8} = 2{,}9\ m$$

Distance from Sprinklers to Wall

NFPA-13 specifies that the minimum distance from a sprinkler to a wall is 1 meter, with a maximum distance of 3 meters. The distance to the wall can be calculated as follows:

$$= \frac{\text{Distance between sprinklers}}{2} = \frac{2{,}9}{2} = 1{,}45\ \text{m}$$

Distance Between Branches to Sprinklers

The distance between branches is calculated by dividing the coverage area for each sprinkler by the distance between sprinklers

$$.= \frac{\text{sprinkler coverage area}}{\text{distance between sprinklers}} = \frac{12{,}1}{2{,}9} = 4{,}17\ \text{m}$$

Distance Between Branches to Wall

To calculate the distance between branches and the wall:

$$= \frac{\text{distance between branches}}{2} = \frac{4{,}17}{2} = 2{,}085\ \text{m}$$

Water Requirements

The duration for sprinkler activation is based on the estimated time for fire department response, preparation, and an allowance factor. If the nearest fire station is 1.8 km away, and the fire engine's speed is assumed to be 56 km/h, the time for the fire department to arrive is calculated as:

$t = \frac{S}{v} = \frac{1{,}8\ \text{km}}{56\ \text{km/h}} = 0{,}03 = 2\ \text{minutes}$

With additional preparation time of 3-5 minutes and an allowance factor of 3 minutes, sprinklers should operate for at least 15 minutes.

Average Water Flow Calculation

The coverage area for each sprinkler is 18.8 m^2 (or 202.47 ft^2). The flow rate can be calculated as follows:

Coverage Area 1 sprinkler = 18,8 m^2 = 202,47 ft

$Q = A \times \mathit{Density} = 202{,}47 \times 0{,}15 = 30{,}37$ gpm

The sprinkler design aligns with NFPA 13, with a flow rate of 80 liters/minute for 15 minutes. The water volume requirement can be calculated using the following formula:

V = Q x t

Where,

V = Volume requirement (m^3)

Q = Flow rate (liter/minute)

t = the time (in minutes).

So,

Q = 80×192=15.390 liter/m

V = 15.390 liter/m×15 minutes = 230.400 l

Hydrant

Hydrant Design

Hydrant pillars must be placed within 3.7 meters of the fire department access roads. recommends a distance between hydrant pillars of 35 to 38 meters. This distance is based on the capacity of a single hydrant to cover an area of 1000 square meters, with the standard fire hose length being around 30 meters and the nozzle's spray reaching up to 5 meters. When determining the distance between hydrants, both SNI and NFPA standards consider these factors to ensure each hydrant can effectively cover a wide area. With a distance of 35-38 meters, hydrants can provide optimal protection while adhering to safety regulations.

Number of Hydrant Boxes Needed

Total Area	= 9.333 m^2
Warehouse Area	= 2.304 m^2
Total hydrants needed	= 6 units

Hydrant Placement

For a building classified as Category D, which requires one hydrant per 800 m^2 in enclosed spaces, a warehouse with a total area of 2,304 m^2 needs six hydrants and one hydrant pillar.

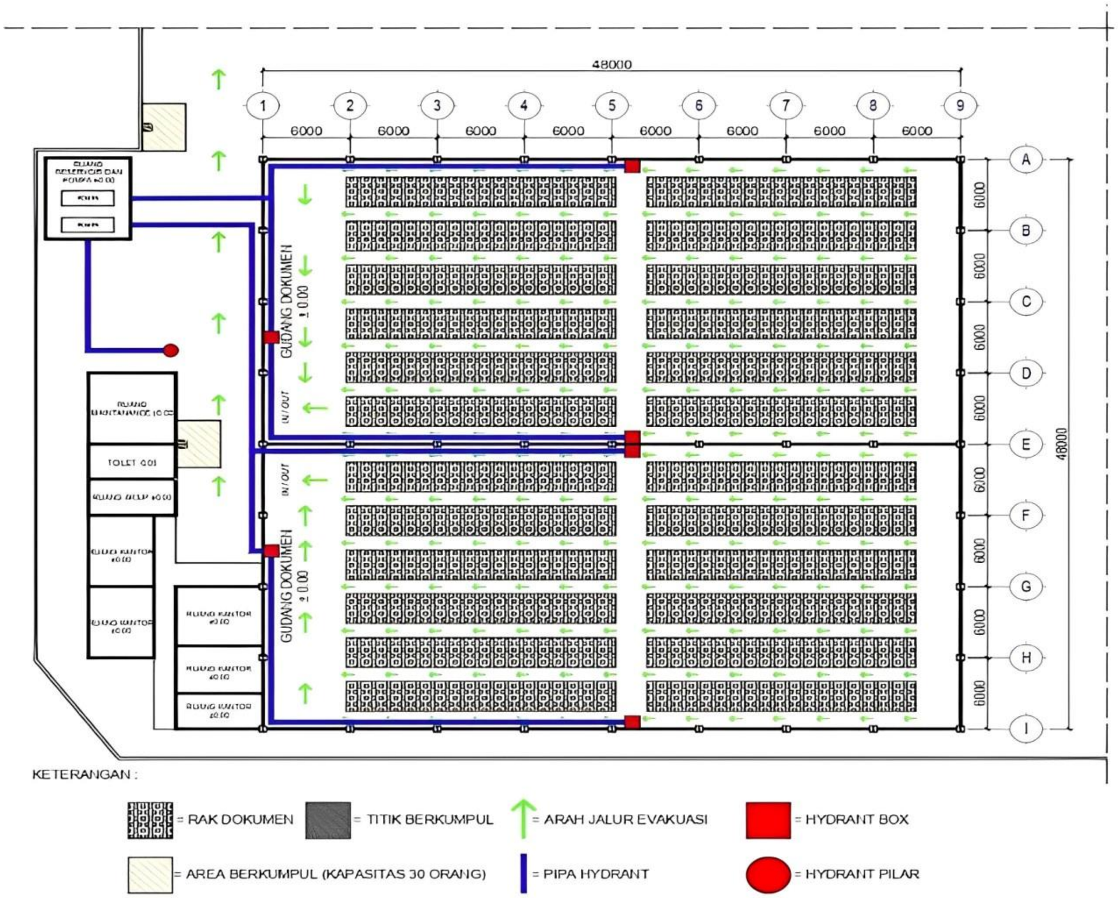

Figure 3. Hydrant Point Placement

Water Requirements

The required duration for hydrant activation can be calculated by considering the time it takes for the fire department to arrive, the preparation time for fire crews, and an allowance factor. If the nearest fire station is 1.8 km away, with fire trucks traveling at an assumed speed of 56 km/h, the estimated arrival time can be calculated as follows:

$$t = \frac{S}{v} = \frac{1{,}8\ \text{km}}{56\text{km/h}} = 0{,}03\ hours = 2\ minutes$$

Preparation for fire suppression typically takes 3-5 minutes at the site, with an additional allowance factor of 3 minutes. Therefore, sprinkler systems should operate for at least 15 minutes. To determine the required water supply for fire suppression, the National Fire Protection Association (NFPA) suggests:

- For indoor hydrant boxes, a minimum flow of 400 Liters per minute is required, with at least a 30-minute duration.
- For outdoor hydrant pillars, the minimum flow should be 2,400 Liters per minute, with at least a 45-minute duration.

The total water supply required for hydrants can be calculated using the following formula:

$V = Q \times T$

Where:

V = volume of water required (m^3)

Q = flow rate (L/minutes)

t = duration

Given that there are 6 hydrant boxes and 1 hydrant pillar, the required water flow rate is:
Water requirement
= 6 hydrant box +1 hydrant pillar = (6×400) L/minutes+ 2.400 L/minutes
= 4.800 L/minutes

Water for 15 minutes
= 4.800 L/minutes ×15 minutus
= 72.000 L= 72 m^3

Reservoir

The reservoir is designed to meet the combined water requirements for both sprinklers and hydrants to operate for 15 minutes. From previous calculations, the total water volume needed is 302,400 liters. The reservoir's dimensions can be determined by taking the cube root of the required volume:

$$= \sqrt[3]{302.400} = 67{,}1 \text{ dm} = 6{,}7 \text{ m}$$

Thus, the reservoir's dimensions would be:
= S×S×S = 6,7 m ×6,7 m ×6,7 m

However, to ensure safety, the reservoir should not be filled. Therefore, the dimensions should allow for additional space, leading to the following design:
= S×S×S = 7 m ×7 m ×7 m= 343.000 liter

Table 6. Result of Fire Protection System

No	Fire Protection	Qty	Description
1	Fire Extinguishers	9 units	3kg Dry Chemical Powder
2	Sprinkler	192 units.	Standard coverage sprinkler
3	Hydrant	6 units	4 Box hydrant and 2 Pillar hydrant
4	Reservoir	7m x 7m x 7m	Hold up to 343.000 Liters of water

With this fire protection model, it can be used as an appropriate mitigation effort, this is in line with research (Sasana & Lestari, 2023) because there are hydrant systems, fire extinguishers, and integrated sprinkler systems which later in this study fire protection is coupled with planning water needs for hydrants and sprinklers in reservoirs. It is hoped that this research can later be used as a recommendation for fire system protection for archives and document companies.

Conclusion

After conducting research, shows that fire prevention and control must use a fire protection system. To create a fire protection system for Archives and Documents Company, a total of 9 units of dry chemical fire extinguishers with a size of 3 kg were obtained, a total of 192 sprinkler units with standard sprinkler coverage specifications, a total of 6 hydrant units with 4 box hydrants and 2 pillar hydrants and the total requirements water to be able to run hydrants and sprinklers is 343,000 liters with a storage volume of 7m x 7m x 7m. With this, the creation of a fire protection system for archives and documents companies can be implemented.

Research gap in fire safety research is that there is no integration of fire extinguishing systems and the need for extinguishing media. So, the novelty in this research lies in the integration between APAR, Hydrant and Sprinkler as well as creating a layout planning for the placement of each fire protection device. This integrated system also utilizes a reservoir tank designed to efficiently supply water to the entire fire protection network. With this reservoir planning, companies can know how much water is needed to design a fire protection system. Every building inhabited by humans and at risk of fire must be equipped with a fire protection system. By implementing this fire protection proposal, companies can prevent fires from occurring and prevent the fire from spreading more widely. Future research in the field of fire safety needs to focus on designing building emergency response plans using advanced simulation technology.

Author's Contribution

All authors have contributed to the final manuscript. The contribution of each author is as follows. Afrigh was responsible for compiling the main conceptual ideas and evaluation. Davin and Dharu were in charge of collecting data and compiling images. Isabil and Agatha were responsible for processing the data and compiling the manuscript. All authors discussed the results and contributed to the final manuscript.

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Declaration of Competing Interest

Author confirms that this research was conducted without any commercial or financial involvement that could be considered a potential conflict of interest. All research stages from planning, implementation, to reporting results were carried out independently. Therefore, author ensures that the integrity and objectivity of this research is maintained and free from external influences that could influence the results or interpretation of the data.

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