Using checklist and what if analysis for inspection fire pump room at the Faculty of Applied Science Building, KMUTNB

Teravuti Nakkam[1*], and *Kowit* Piyamongkala[2]

[1]KMUTNB Applied Sciences, Dean Office, 1518 Pracharat 1 Road, Bangsue Bangkok, Thailand
[2]KMUTNB Applied Sciences, Industrial Chemistry, 1518 Pracharat 1 Road, Bangsue Bangkok, Thailand

Abstract. The inspection and analysis of the qualitative for the fire protection system of the Faculty of Applied Science Building at King Mongkut's University of Technology North Bangkok (KMUTNB) was surveyed by a standard checklist. Using the method of consideration according to the Regulations of the Building Control Act, the investigation examined six items of the fire pump room. Then, the risk assessment was observed by a what-if analysis. There were two non-critical items that should be improved including emergency lights and smoke detectors. Therefore, the fire protection system in the Faculty of Applied Sciences Building KMUTNB is ready to operate in the event of a cause of fire because the basic equipment have been estimated to be sufficient to use and in a state of high readiness.

1 Introduction

In the period 2017-2019, there were a total of 736 fires within buildings in Bangkok, Thailand, resulting in 247 injuries and 35 deaths. They seriously impacted human life, for example causing the loss of a loved one, relative or friend, life-changing injuries requiring medical treatments, and property damage along with the resultant loss of money to renovate or rebuild. The causes of fires included negligence while using electricity, sparks from cooking fires, and the creation of sparks without warning. The location where most fires were likely to occur included residential quarters, place of work and communities with high population density, such as shopping malls, hotels, and office buildings [1].

A fire protection system is very important because a high building fire is difficult to control. Therefore, a building fire protection system is required. It can help to reduce damage very well [2]. A fire is technical that relates to unexpected accidents. Most of the causes of fire are renovations within the building and bringing combustible material such as gases and flammable substances into the building for work. If a fire occurs in a visible area, there may be an opportunity to report the incident to those involved in the fire before the fire spreads or to safely evacuate people from the building. On the other hand, an unobserved fire may spread beyond the ability to extinguish a fire.

Fires ignite with the right ratio of fuel, oxygen, and heat sources. These three configurations are therefore very important for fires to continue to exist. The success of a fire's ignition depends on several factors, and even then it can still be extinguished. A fire is extinguished when there is insufficient fuel or oxygen and the heat source cannot be ignited. Fuel burning is an exothermic reaction that occurs rapidly. The fuel may be in solid state, such as wood, plastic, cloth; a liquid state such as engine fuel, acetone, or hexane; and a gaseous state such as hydrogen or methane. Comparing ignitions, a fuel in the liquid and gas state ignites more easily than solid fuel. Burning generally occurs from a substance in a gaseous state. The liquid state must be evaporated into gas vapor, and solids must be decomposed into vapor before combustion [3].

The cause of a fire can be classified into four categories as follows. In the first, Category A fires originate from combustible solids such as wood, cloth, rubber, paper, or plastic. Category B fires originate from flammable liquids and combustible gases such as fuel oil, grease, varnish, bitumen, solvent, natural gas, or liquefied petroleum gas. Category C fires originate from short circuits of electrical equipment such as irons with damaged wires or connecting several electrical devices using a mini plug. Finally, Category D fires originate from flammable metal fires of group 1A element metals such as sodium or lithium, or 2A metals such as calcium or magnesium [4].

Hazard identification requires the understanding of the distribution of hazards in all activities that are present both directly and indirectly such as receiving, dispensing, storage, loading and unloading, usage, transportation of raw material, fuel, chemical or hazardous material, products and by-products, production process, and methods of operation of machines or equipment used in production or various situations within the organization. Risk assessment is a process of assaying a lot of factors or situations which cause both current and latent hazards which may produce accidents and adverse events such as fires,

* Corresponding author: threerawut.n@sci.kmutnb.ac.th

explosions, chemical or hazardous material spills. The risk assessment considers the opportunity and impact of those events. This result in hazard or damage to life, property, community, and environment [5].

Therefore, the purpose of this study to search and inspection the items standard of the existing equipment of the fire protection system of the Faculty of Applied Sciences Building at KMUTNB in the fire pump room to be ready for effective use. The personnel and students who come to use the building must have confidence in the fire extinguishing system that can be a present an accident. It is in accordance with the standards of inspection, testing and maintenance of water fire extinguishing systems.

2 Material and method

The fire pump room is located at Faculty of Applied Science, KMUTNB. It has an area of 21.6 square meters. The checklist method was followed as the inspection of hazards from the inspection, testing and maintenance of water fire extinguishing systems. It had six items to check [6]. Then, the What-If Analysis method was applied to hazard identification at the fire pump room. It was performed by collecting various questions together in order. Finally, hazard identification and risk assessment were carried out that consisted of hazards or consequences, measures for reducing the impact of hazards, recommendations and summaries of data obtained from studies and analyses. The study was compiled and surveyed in January to April 2022.

The Faculty of Applied Sciences Building is located in the area on the northeast side of KMUTNB. It is a large building with two buildings adjacent to it. There are walkways connecting every floor. The first building comprises 12 floors that has a total absolute area of around 13,600 square meters. The details of each floor usage are as follows. The 1st and 2nd floors belong to the Office of the Dean. The 3rd floor comprises common classrooms. The 4th floor contains the professor rooms and the laboratories of the Department of Industrial Physics and Medical Instrumentation. The 5th floor contains the professor rooms of the Department of Mathematics and the Department of Applied Statistics. The 6th floor contains the professor rooms and the laboratories of the Department of Computer and Information Science. The 7th floor has the professor rooms and the laboratories of the Department of Agro-Industrial, Food and Environmental Technology. The 8th floor houses the professor rooms and the laboratories of the Department of Industrial Chemistry. The 9th floor houses the laboratories of the Department of Industrial Chemistry and an auditorium. The 10th floor houses the laboratories of the Department of Mathematics. The 11th floor contains the laboratories of the Department of Applied Statistics. The 12th floor contains common classrooms.

The second building has 14 floors that have a total absolute space of about 5,200 square meters. It is used for classrooms and laboratories. The description of each floor is as follows. The 1st floor houses the Microelectronics Packaging Laboratory. The 2nd floor contains the Scientific Instrument and High Performance Computing Center. The 3rd floor comprises common classrooms. The 4th floor contains the laboratories of the Department of Industrial Physics and Medical Instrumentation. The 5th floor contains the laboratory computers of the Department of Mathematics. The 6th floor houses the laboratories of the Department of Computer and Information Science. The 7th, 8th, 10th, 13th, and 14th floors contain the laboratories of the Department of Agro-Industrial, Food and Environmental Technology. The 9th floor contains the laboratories of the Department of Industrial Chemistry and an auditorium. The 11th floor houses the laboratories of the Department of Applied Statistics. The 12th floor comprises common classrooms.

3 Results and discussion

The fire pump room of the Faculty of Applied Science Building is located on the 1st floor of the 1st building. It is about two meters above the ground level as is shown in Fig. 1 (a). The inspection fire pump room is a rectangular room. Its dimensions are 3.60 meters by 6.00 meters by 4 meters in width, length, and height. Then, the area and volume of the fire pump room is 21.6 square meters and 86.4 cubic meters, respectively. The plan of the fire pump room is drawn in Fig. 1 (b). The checklist inspection within fire pump room is displayed in Table 1.

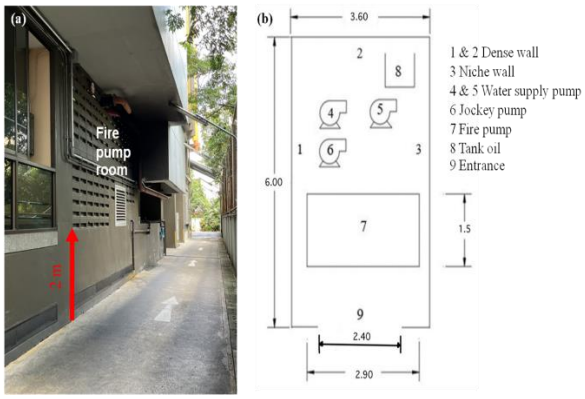

Fig. 1. Location of the fire pump room of Faculty of Applied Science at KMUTNB (a) photograph of fire pump room at the behind of building; (b) structure diagram of the behind of building.

The fire pump room inside the building must have a fire resistance of not less than two hours [7, 8]. It was found that the entrance is a steel rolling shutter with width and height equal to 2.40 by 3.00 meters. The left and front walls are made of concrete with a thickness of approximately 0.1 meters as shown in Fig. 2. The right wall is made of ventilation blocks, each containing a 0.04-meter vent. A fire rating means the time that a wall must provide sufficient fire resistance when contactable to a fire. Three necessities for fire safety of walls include temperature insulation, structural integrity, and structural adequacy [9]. Then, the walls of the fire pump room can withstand fire for more than two hours due to the thick walls and concrete, which is a fireproof material.

Fig. 2. Walls of fire pump room

There is a good ventilation system in the fire pump room. The inspection revealed that there is neither water on the floor nor bad odors within the fire pump room because the right wall is built by ventilation blocks that have a lot of channels. As a result, the air from the outside can flow and move both within and without from the fire pump room continuously as displayed in Fig. 3. Human exposure to extreme heat over short time periods gives to heat stroke, exhaustion, collapse, heat rash, fatigue, and death [10].

Fig. 3. Ventilation of fire pump room

There is a material blocking the entrance and exit of the fire pump room. The entrance-exit door of the fire pump room is spacious. There is no obstruction in the entrance and exit. The operators can walk in and out easily. The illustration of the fire pump room is shown in Fig. 4.

Fig. 4. Entrance-exit of fire pump room

There is sufficient lighting for the operation within the fire pump room. For inspection it was found that there are six fluorescent lamps of 38 watts which attach to the left, right and entrance walls as shown in Fig. 5. The luminous flux and the illuminance were calculated to be 16,200 lumens and 750 luxes, respectively, a sufficient amount of light intensity to work for process and machine operation. The standard of intensity of light at the general area and production area within the business establishments of Thailand is 300 luxes [11].

There is emergency lighting able to work at least two hours. The inspection revealed that there is no emergency lighting system within the fire pump room. When a fire occurs within the building, the building's electrical system shuts down. As a result, the lighting in the fire pump room is extinguished. Operators must use the light from a flashlight, which has limited brightness and can only illuminate a narrow area. In addition, it is difficult to hold or carry them. The introduction of a new light source from the outside of a building for use in the fire pump room can be done, but it takes a long time to install the new system. This may result in the loss of much manpower to maintain the fire extinguishing system in other parts and can occur in an operating delay when there is an emergency.

The fire pump room must be equipped with a smoke detection system. Inside the fire pump room is a 500-liter diesel fuel tank, which is used to fuel the engines that drive the pump to work. It starts in case of fire when

Fig. 5. Lighting within fire pump room

the electrical system in the building shuts down. As a result, the installation of smoke detectors inside the fire pump room is necessary.

As a result, the fire pump room system does not have both emergency lighting and smoke detectors. This risk must be assessed by the What-If Analysis method as shown in Table 2 which is found to be suitable and applicable technique for the safe storage for flammable liquid [12]. This analysis shows that the fire pump room system is at moderate risk that will cause harm to both persons and property. There is no emergency lighting system installed, and in the event of a fire, the building's electricity shuts down. As a result, the control room of the fire pump room does not have both electricity and lighting to see all equipment in the fire pump room.

Furthermore, using a flashlight requires time for the operator to retrieve one from a locker and return to the fire pump room. Moreover, one hand of the operator holds a flashlight, making work difficult to do. With the absence of a smoke detection system, there is a moderate risk of causing harm to both persons and properties. Smoke detectors are not installed within the fire pump room, and there is a 500-liter diesel fuel tank, which is used to fuel the engine. The engine spins the motor and runs the pump. The absence of an abnormal alarm signal, when smoke is generated in the fire pump room may prevent anyone noticing the fire until it becomes severe. Because the fire pump room is in the heart of the whole building, a severe fire can damage the entire building.

Table 1. Inspection within fire pump room [6].

Order	Items	Ready to use	Reform	Note
1	Fire pump room inside the building must have a fire resistance of not less than 2 hours.	√		
2	There is a good ventilation system in the fire pump room.	√		
3	There is sufficient lighting for the operation.	√		
4	There is a material blocking the entrance and exit of the fire pump room.	√		
5	There is emergency lighting able to work at least 2 hours.		√	
6	The fire pump room must be equipped with a smoke detection system.		√	

Table 2. What-if analysis worksheet for reform of fire pump room

What-if	Consequences/hazard	Hazard prevention and control	Recommendations	Risk assessment			
				Probability	Impact	Result	Risk level
1. What if there is no emergency lighting in the fire pump room?	Hazards for humans - The operator crashes into the water pump or the operator's head collides with the fire water piping system when the electrical system is interrupted during a fire. Hazards for property - The operator walks on the devices on the ground and crashes into the water pump, which wrecks the water and jockey pumps.	Purchase and install the emergency lighting equipment.	Install 2 sets of the emergency lighting equipment on the inside and the entrance of the fire pump room.	2 2	3 3	6 6	2 2
2. What if the fire pump room does not have a smoke detection system in the fire pump room?	Hazards for humans - No one is aware that an emergency has occurred. The operator is not notified in advance. In the case of a fire, it breaks out easily and spreads to a large area. Hazards for property If there is a fire in the fire pump room during anyone's absence, the fire destroyed the entire building's fire suppression system. It brings a lot of damage to the whole building.	Purchase and install a smoke or heat detection system.	Install a set of smoke or heat detection system at the central ceiling of the fire pump room.	2 2	3 3	6 6	2 2

4 Conclusion

Six items of inspection within the fire pump room was surveyed at the Faculty of Applied Sciences Building of KMUTNB by checklist standard. It has two things that need to be improved in order to ensure safety during a fire in the building. The first is the lack of emergency lighting in the fire room. Then, the lack of smoke detectors. There is moderate level of risk to both people and property. Therefore, installation of emergency lighting and smoke detector increases the safety and builds confidence for staffs and students very well.

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