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Evaluation of Fire Protection System Implementation in A Production Area of Oil and Gas Company, East Java

Evaluasi Penerapan Sistem Proteksi Kebakaran pada Area Produksi Sebuah Perusahaan Minyak dan Gas di Jawa Timur

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ABSTRACT

The oil and gas industry is an industry with a high risk of fire. This is because this industry involves several types of substances that cause pressure and have the potential to cause leaks and spills. Industry's inability to detect these conditions can cause fires. Therefore, it is necessary to evaluate the implementation of fire protection systems in the industry. This research was conducted using a checklist method for fulfilling requirements according to appropriate regulations. The results of this assessment show that the company has fulfilled regulations in accordance with each system with a percentage above 75%. Some suggestions that can be considered for improvement include replacing expired fire extinguishers so that they are ready for use, providing APAR signs or symbols at each location point, providing a cover or placing the fire extinguisher outside in a roofed area, equip each hydrant point with instructions for use, carry out hydrant maintenance regarding the completeness and cleanliness of the hydrant box, and update evacuation route signs that are no longer legible and cut trees or branches that cover the signs.

Keywords: oil and gas, fire protection.

ABSTRACT

Industri minyak dan gas merupakan industri dengan risiko tinggi kebakaran. Hal ini diakibatkan karena pada industri tersebut melibatkan beberapa jenis zat yang menimbulkan tekanan dan berpotensi menyebabkan adanya kebocoran dan tumpahan. Ketidakmampuan industri dalam mendeteksi kondisi tersebut dapat menyebabkan kebakaran. Oleh karena itu dibutuhkan evaluasi terhadap penerapan sistem proteksi kebakaran di industri tersebut. Penelitian ini dilakukan dengan menggunakan metode checklist pemenuhan persyaratan sesuai regulasi yang sesuai. Hasil dari penilaian tersebut menunjukkan bahwa perusahaan telah melakukan pemenuhan sesuai regulasi pada masing-masing sistem dengan presentase di atas 75%. Beberapa saran yang dapat dijadikan pertimbangan untuk perbaikan antara lain mengganti APAR yang kadaluwarsa agar siap digunakan, menyediakan tanda atau simbol APAR di setiap titik lokasi, memberikan penutup atau menempatkan APAR di luar ruangan beratap, melengkapi setiap titik hidran dengan petunjuk penggunaan, melakukan perawatan hidrant mengenai kelengkapan dan kebersihan kotak hidrant, memperbarui rambu jalur evakuasi yang sudah tidak terbaca dan menebang pohon atau dahan yang menutupi rambu tersebut.

Kata Kunci: minyak dan gas, proteksi kebakaran.

INTRODUCTION

Every industrial sector has its own hazards, risks and ways of dealing with them. One of the hazards that can occur in many companies is fire. Based on the Law of the Republic of Indonesia Number 1 of 1970[1] about Occupational Safety which discusses the requirements for occupational safety, one of the requirements is to prevent, reduce and extinguish fires or other events. According to International Labor Organization[2]. major fire disasters that occur in the workplace are caused by the accumulation of flammable materials in the workplace, the accidental provision of ignition sources, the inability to detect fires quickly, and the inability to control fires and extinguish them. The oil and gas industry is one of the important industries to produce energy to meet the world's increasing energy consumption. Industries engaged in oil and gas have high risks in the upstream sector, namely in management and drilling activities. In addition, the downstream sector, namely in processing and distribution activities, also has almost the same risk as the upstream sector. The most important risk in the oil and gas industry is fire[3].

The annual report in the United States 2012, found that the number of fires was still high at 1.375.000 fires that resulted in 2.855 deaths, 16.500 injuries and property losses of approximately $12.400.000[4]. In the time period from 1972 to 2011, there were 53 accidents in the oil industry, 6 gas leaks, 17 fires, 4 explosions, and 20 explosions accompanied by fires[5]. On August 6, 2012 in USA, potential explosion at oil reservoir reportedly exploded and caught fire due to a pipe rupture causing minor burns to 6 workers suffered minor burns in the USA[6]. Fire incidents in oil and gas companies in Indonesia also occur frequently, even in the largest oil and gas companies in Indonesia. The first refinery fire occurred on March 29, 2021 at PT Pertamina Refinery Unit VI Balongan, Indramayu. The refinery fire was repeated on June 11, 2021 at the T-205 tank of Pertamina Cilacap Refinery Unit IV. The next fire incident occurred at the same location on November 13, 2021 at Tank 36T-102 Pertamina Cilacap. On March 4, 2022, a fire occurred at the inlet pipe of Refinery Unit (RU) V Balikpapan, and several other fires in 2022. In 2023, a large fire incident occurred at Pertamina Plumpang Depot. On April 1, 2023, a fire occurred at PT Kilang Pertamina International (PT KPI) Refinery Unit (RU) Dumai. A similar incident at Pertamina's oil refinery in Dumai did not only occur this time, the oil refinery had also caught fire on July 15, 2009 and December 15, 2008[7].

An emergency condition is a situation of release of hazardous substances outside the protection zone of a technological facility that exceeds the permissible concentration limits[8]. Fire is a rapid chemical reaction (oxidation) formed from 3 (three) elements namely: heat, air, and fuel that can cause or produce heat and light[9]. One event that can cause an emergency condition in the oil and gas industry is an oil spill or gas leak. Fires caused by explosions or gas leaks in the oil and gas industry are caused by gas detectors not working accurately[10]. This causes the gas to escape into the environment and become combustible material (fuel). The leaked gas meets the hot climate in oil and gas production areas, causing fires. Sources of oil spills that have the potential to cause emergencies such as fires are usually production facilities and reservoirs such as tanks, production wells, petroleum pipelines, tank trucks, shut-off valves and flange connections[11]. To prevent fires in the oil and gas industry, it is necessary to have early detection equipment from fires that are integrated into fire protection systems both active and passive. Planning and implementation also need to be considered and reviewed regularly so that they continue to work optimally. Review and maintenance must be carried out based on applicable regulations. This makes researchers interested in analyzing the suitability of the application and maintenance of fire protection systems in one of the oil and gas companies in East Java.

RESEARCH METHOD

This research is a type of observational research because the research data is obtained through observations in the field without any treatment on the object under study. This research was conducted at the Tanggulangin Gas Plant and Wunut Gas Plant, Minarak

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Brantas Gas, Inc., Sidoarjo in December 2023. Based on the time of implementation, this research is included in cross sectional research because the variables are studied at one time (point time approach). The data analysis used is descriptive, because the research conducted aims to make a description of a situation objectively. The object of this study is an active fire protection system consisting of 35 fire extinguishers, 13 hydrants, and a passive fire protection system, namely emergency exit routes. The checklist sheet used in field observations uses the following regulations:

Table 1. Regulations

Object	Regulation
Fire Extinguishers	NFPA 10
Hydrant	NFPA 14
Exit Access	OSHA 29 CFR 1910

The percentage of suitability of the application of fire protection systems is calculated based on the percentage of the number of objects that meet each item, then divided by the total items. The suitability of each fire protection system is calculated based on the following formula:

$$\text{Suitability of fire extinguisher application} = \frac{\text{pemenuhan item 1}+\cdots+\text{pemenuhan item 10}}{10}\text{x}100\%$$

$$\text{Suitability of hydrant application} = \frac{\text{pemenuhan item 1}+\cdots+\text{pemenuhan item 8}}{8}\text{x}100\%$$

$$\text{Suitability of exit access application} = \frac{\text{pemenuhan item 1}+\cdots+\text{pemenuhan item 5}}{5}\text{x}100\%$$

RESULT

Based on the results of observations and identification of fire extinguishers that have been carried out at both gas plants, it is possible to determine the types of fire extinguishers available in the work area and the respective quantities are as follows:

Table 1. Fire Extinguisher Type

Type of Fire Extinguisher	Freq	Precentage (%)
ABC Powder	30	85
CO2	5	15
Total	35	100

Table 2. NFPA 10 Checklist[12]

No	Requirements	Score	Suit (%)
1	Fire extinguishers are used according to the type and classification of the fire.	1.00	
2	There is a seal that must be in good condition and the tube cap is attached.	0.91	
3	Prominently placed, easily accessible, and placed along the normal crossing path.	1.00	
4	Extinguishers weighing no more than 18.14 kg should be installed at a height of no more than 1.53 m above the floor. Extinguishers weighing more than 18.14 kg must be installed at a height of no more than 1.07 m above the floor.	1.00	
5	Fire extinguishers that are outside the building, must have a protective box or lid and be unlocked.	0.97	
6	Fire extinguishers should always be in full condition and ready for operation.	0.14	
7	Every 200 square meters there is 1 fire extinguisher and <200 meters away from all positions.	1.00	
8	Fire extinguisher tubes and hoses do not leak	1.00	
9	Fire extinguisher placement accompanied by a sign or symbol	0.77	
10	Recording the month, year, and initials of personnel at the monthly inspection should be in the vicinity of the fire extinguisher.	0.29	
	Total	8.08	80.8

Table 1 shows that the majority of fire extinguisher in that oil and gas company, namely 30 (85%) is a ABC powder. Table 2 shows that the suitability of fire extinguisher application is 80.8%. The lowest score in the assessment was the requirement to provide full and ready-to-use fire extinguishers, where there were only 5 (14%) fire extinguishers that were in ready-to-use condition (not expired).

The coupling used is an instantaneous type using wire and plate. The type of nozzle used is the spray type, with a single hose reel. Based on its location, the hydrant in this company is a type of yard hydrant with a closed box.

Table 3. NFPA 14 Checklist[13]

No	Requirements	Score	Suit (%)
1	Hydrant boxes are easy to open, view and reach	0.77	
2	Has instructions for use posted in an easily visible place	0.00	
3	Hydrant boxes must contain fire equipment only	0.92	
4	Each hydrant box is painted in an eye-catching color	0.92	
5	Each hydrant box must consist of a hose, hose connection, nozzle, and coupling	0.92	
6	Hydrant boxes and hose connections must not be obstructed by anything	0.85	
7	All hydrant pumping units must be installed and seated on a strong and sturdy foundation	0.85	
8	Hydrants outside the building are always in good condition and ready for use	0.85	
	Total	6.08	76

Table 3 shows that the suitability of hydrant application is 76%. The lowest score in the assessment was the requirement to provide easily visible hydrant use instructions at each hydrant point, where there is no hydrant point that has instructions for use (0%). The passive fire protection system in this oil and gas company includes exits, muster areas, and exit access roads. Each exit access road is equipped with an evacuation route sign. The sign is set to be a permanent sign. In each room an evacuation route plan has also been provided.

Table 4. OSHA 29 CFR 1910 Checklist[14]

No	Requirements	Score	Suit (%)
1	Each path and exit must be ensured to be unobstructed by any material, including locked conditions.	0.50	
2	Along the exit access must be installed with signs that are clearly visible and easily readable.	0.33	
3	Provide lighting along the exit route	1.00	
4	The choice of gathering point must be an open and airy area.	1.00	
5	Ensure that the gathering point is sufficient to accommodate all employees at the location.	1.00	
	Total	3,83	76.6

Table 4 shows that the suitability of exit access application is 76.6%. The lowest score in the assessment was the requirement to provide clearly visible and easily readable, where there were 10 clearly visible and easily readable evacuation signs (33%).

DISCUSSION

Based on the Emergency Preparedness and Response Procedure at this oil and gas

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company, an emergency is an unplanned and uncontrolled situation or event that can have an impact on the environment, including fires, explosions, gas leaks, oil and chemical spills, and work accidents. In this case, fire control and handling are carried out in accordance with emergency response procedures. In the pre-emergency stage, one of the things done in the preparation point is the procurement, installation, maintenance, and inspection of equipment, infrastructure facilities. Facilities and infrastructure that have been available then carried out inspection testing maintenance. Inspection Testing and Maintenance is important for all fire protection instruments in order to obtain the best quality of protection equipment. Inspection Testing Maintenance is one of the ways to search and find fault factors that can cause less efficient initial fire suppression, which will then take the necessary steps or actions for equipment maintenance[15].

Based on company emergency response procedures, inspection testing maintenance should be carried out every month on each fire protection system. This is in accordance with the theory that fire extinguishers must be inspected from the time they are initially placed and functioned and then at every time interval of approximately 30 days[16] but in practice, inspection testing maintenance of fire extinguishers was last carried out in February 2023. This causes the requirement to provide ready-to-use fire extinguishers to not be fulfilled. The placement of fire extinguishers around inoperable equipment is also an ineffectiveness. Based on the results of clarification with the company, it is known that the reason for not replenishing fire extinguisher that has been empty is the lack of funds due to the decreasing amount of production. This is in line with research on the application of fire protection in universities where the high costs of installing and maintaining fire protection systems are also a big concern for universities with limited financial resources[17].

Hydrant is a permanent fire extinguisher installation in the form of a piping network containing pressurized water[18]. The fire water system is the main component in an active fire protection system[19]. Fire water systems usually consist of four components, where the first component is water, which can be sea water[20]. The hydrant system in this oil and gas company consists of a pump water supply system, piping, outlet coupling (pillar), hose, and nozzle. The water source used for hydrants comes from artesian well which is stored in a pool near the fire pump. The second component in a fire water system is a pumping system, to ensure sufficient water flow to extinguish the fire. The water pump used in this oil and gas company consists of 2, namely the main pump and jockey pump. The main pump serves to always maintain water pressure in the pipe that is channeled to the hydrant. Jockey pump is a pump that functions to cover emergencies when the main pump has not worked. This pump has a sensor that serves to activate the main pump when the jockey pump pressure is no longer able to cover the emergency. The third component is a pipeline which functions to distribute water from the pump to the fire location through a ring on the hydrant pillar[21]. The final component is the fire ring or usually called the pillar hydrant, which can be a ball valve or butter valve[22].

Based on the SOP for the maintenance of the fire water system in the company, maintenance of the hydrant and its supporting parts consists of weekly maintenance of the fire water system, monthly maintenance of the fire water system, annual maintenance of the fire water system, and monthly maintenance of the hydrant. Weekly maintenance of the fire water system is carried out by cleaning the fire pump unit, checking the radiator cooling water level, lubricating oil level, and fuel level. Monthly maintenance of the fire water system is carried out by cleaning the air filter, checking the oil pump, and the condition of the v-belt. Annual maintenance of the fire water system is carried out by removing or draining the fuel in the tank and replacing it with a new one, replacing the fuel filter, air filter, checking valves and hoses to prevent leaks. Monthly maintenance of the hydrant is carried out by checking the physical condition of the hydrant box and pillar, checking the bonding of the water outlet, checking the completeness of the contents of the box, conducting a nozzle experiment. A requirement that has not been fulfilled at all is that the hydrant is equipped with instructions for use. Based on the requirements referring to NFPA 14, hydrants must be accompanied by signs and labels explaining that 'they may only be used by trained personnel'[23].

Based on the results of observations in the field, passive fire protection at the oil and gas

company is in accordance with the technical requirements in OSHA 29 CFR 1910 (OSHA 3122-06R, 2004), including ensuring that every path and exit is not blocked by any material, including being locked. In this aspect, there is only tall grass around the exit. However, you can be sure the door can still open. The second aspect that meets the requirements is the presence of lighting along the exit route. In terms of gathering points, the company has also provided a "Muster Area" which is an open, spacious area located near a security post. Assembly point is critical so that people who save themselves know where the safe gathering place is[24]. This gathering point can accommodate all employees at each location.

Things that do not comply with the technical requirements for exit and evacuation routes are the condition of evacuation signs that are not clear enough to read. These unclear signs are mostly on the walls surrounding the gas plant. In emergency evacuation conditions, a successful evacuation sign system will reduce the time to find a way out, while a poor system can cause more congestion or choose the wrong route, resulting in evacuation delays[25]. Evacuation signs play an important role in guiding pedestrians to the correct emergency exit[26]. Therefore, evacuation signs need to be equipped with clear arrows. The left, right and up arrows on signs have proven to be effective in directing people in the desired direction, including even on signs that sound[27]. However, you need to pay attention to the direction you use. Often in an environment where the people in it are less familiar with the signs, this can lead to misunderstandings. Arrows pointing downwards are often interpreted as forward or backward sound[27]. In addition, during a mass evacuation, disturbances will occur everywhere and must be considered both in the simulation model and in designing the evacuation plan[25]. This can be overcome by adding more signs in various positions to prevent signs being obscured by crowds. Some attractive factors should be designed to get more attention from pedestrians, such as flashing lights, bold letters and so on.

The limitation of this research is that the evaluation was carried out based on visual observation. Requirements for the quality and effectiveness of each protection system such as the amount of APAR pressure, water flow rate at the hydrant pump, and other data that require further testing are obtained from the latest test data.

CONCLUSION

The conclusion of this research shows that the majority of the implementation of fire protection systems in oil and gas companies has complied with existing regulations with an assessment of 80.8% for APAR compliance, 76% for hydrant compliance, and 76.6% for exit access. Things that companies need to pay attention to are that the APAR must be in a ready-to-use condition, provide instructions for use at each hydrant location point, and update evacuation route signs so that they can be read clearly.

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