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Review of ISO 45001:2018 Implementation as Prevention Effort from Fire Occurred in PT Pertamina (Persero) Refinery Unit VI Balongan

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Abstract

PT Pertamina Refinery Unit (RU) VI Balongan has contributed significantly to providing good income for PT Pertamina and the country. The large amount of petroleum processing products produced daily causes a high fire risk. Fires and explosions at oil refineries still often occur although large oil companies have occupational safety and health systems. There was no research regarding the implementation of ISO 45001:2018 at PT Pertamina RU VI Balongan; therefore, this research was conducted to evaluate the HSE Management system implemented at PT Pertamina RU VI Balongan based on standards. This research uses a descriptive approach through literature study to collect data and obtain the necessary information by studying various journals, conference proceedings, books, and written references. The research results were obtained by PT Pertamina RU VI Balongan, based on several parameters for implementing ISO 45001:2018, aspects were found that did not meet the standards and could become problems, resulting in potential fires. This writing concludes that PT Pertamina RU VI Balongan must be able to provide firmness in implementing work safety rules or procedures for its employees. Thus, it will minimize the number of work accidents.

Keywords: Fire, ISO 45001:2018; Occupational Safety and Health; PT Pertamina Refinery Unit (RU) VI Balongan; Work Safety

Introduction

As the industrial era develops, many new jobs are needed to meet the times. It cannot be denied that the work required requires special skills or hard skills that a worker must master. From this, of course, every job has risks and disadvantages. Many workers experience injuries and even death due to work. Work safety problems in Indonesia continue to increase every year to protect capital invested in the industry (Widodo, 2021). According to BPJS Employment data, it is explained that during 2023, there were 360,000 work accident cases and an insurance claim value of IDR 2.94 billion, which is predicted to increase every year (BPJS, 2024).

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Directorate General of Development Labor Inspection and Occupational Safety and Health, Muji Handaya, explained that one of the causes of the high number of work accidents lies in the implementation and supervision of Health, Safety, and Environment (HSE) [35]. Due to this, a law emerged regarding the Occupational Health and Safety System (OHSAS) Management, published based on ISO 45001:2018, which discusses occupational health and safety (Sulistyanto & Sulistyo, 2018). Occupational Safety and Health is a procedure for protecting workers from danger to maintain the health and safety of the work environment.

Every work accident case can cause many losses, including financial loss, infrastructure, environmental damage, maintenance costs, and loss of assets. Related research was conducted by Yoshana et al., (2022), where the research examined measuring the efforts that have been designed and implementing the HSE design carried out at textile companies and measuring the suitability of initial conditions based on ISO 45001:2018. Other research conducted by Syahrullah & Febrianti (2019), through evaluation and calculation of validation and reliability tests for implementing HSE based on ISO 45001:2018 at Infrastructure Projects, can be stated that companies that implement HSE based on ISO45001:2018 are very effective in preventing and reducing the number of work accidents, as well as can increase employee awareness of potential dangers. The extreme thing that happens if the industry does not implement the HSE Management System properly is that fires occur (Fairyo & Wahyuningsih, 2018). Cases of fires in the industry have occurred recently, one of which was experienced by PT Pertamina Refinery Unit (RU) VI Balongan.

Quoted on the official website, PT Pertamina RU VI Balongan is one of seven petroleum processing units owned by PT Pertamina and focuses on processing crude oil into fuel, non-fuel, and petrochemical products (Pertamina, 2020). PT Pertamina RU VI Balongan has contributed a lot to providing good income to PT Pertamina and the country, especially on the island of Java. The large amount of petroleum processing products produced daily causes a high fire risk. Fire cases can occur in various industrial sectors, but each industry has different risks. The higher the risk of fire, the greater the losses borne by the industry.

Therefore, in its implementation, PT Pertamina RU VI Balongan requires careful planning and analysis in project management guided by the ISO 45001:2018 Occupational Health and Safety Management System. The main problem of this research is "Has PT Pertamina RU VI Balongan implemented HSE based on ISO 45001:2018 properly?". Some studies only examine aspects of HSE implementation from one aspect. This thing becomes a novelty for the author to write a review topic article on several ISO 45001:2018 implementations at PT Pertamina RU VI Balongan which has never been written before. This research was carried out to evaluate an HSE Management system implemented at PT Pertamina RU VI Balongan based on standards. This research can be a benefit as input to prevent the recurrence of the fire that occurred at PT Pertamina RU VI Balongan in the previous year. Protection against work accidents is a human right that must be fulfilled by companies to create zero accident conditions.

Research Method

A. Data Source

The type of data used is secondary data collected through a literature review of related research relevant to the implementation of HSE (Health, Safety, and Environment). Relevant data was sought to examine every aspect of HSE (Health, Safety, and Environment) implementation carried out at PT Pertamina RU VI Balongan and compare it with applicable standards. The source used to obtain application data came from national journals because no international journals were found that discussed this application. However, international journals will be able to help to strengthen and explain a theory regarding HSE. Solutions are obtained to provide understanding to readers in comparing the applied aspects with the required aspects.

B. Standard Level

Standards are a reference that becomes the basis for determining whether or not an application is appropriate. Generally, the standards widely used by industry in implementing HSE refer to ISO 45001:2018. ISO 45001:2018 is an international standardization and certification that discusses the occupational health and safety management system, which is implemented to provide guidance and protection to workers in the work area from the dangers of work accidents or occupational diseases (Karanikas, 2022). ISO 45001:2018 standard covers planning, implementation, measurement, monitoring, improvement efforts, and continuous management improvement (Asih & Latief, 2021). Discussion of ISO 45001:2018 includes 1) HSE policy regulations to emphasize organizational and company goals by reviewing the internal and external domains; 2) preparation, actualization, and utilization of HSE management; 3) continuous renewal of HSE capacity; 4) verify worker's loyalty to HSE regulations; and 5) shows worker discipline towards the ISO 45001:2018 standard (Goulart, 2016).

C. Review Procedure

The author studied and understood the theory of ISO 45001:2018 and collected various sources regarding safety standards. Of the various existing safety systems, the standard that is widely used by industry is ISO 45001:2018 which has been developed in various fields by relevant organizations at international and national levels, so that it can explore the general or unique advantages of this system (Guo et al., 2021). The stage continues with conducting a literature study to obtain data on several aspects, including 1) Installation of warning and danger signs, 2) Noise, 3) Temperature, 4) Lightning Intensity, and 5) Personal Safety Equipment. Each aspect has its standard according to ISO 45001:2018. Until data was obtained regarding the implementation of HSE at PT Pertamina RU VI Balongan, the author compared the actual implementation with the standards set based on ISO 45001:2018. The implementation of HSE is said to be feasible if all aspects discussed in the research meet the standards. If there are one or two aspects that are below standard, then the implementation of HSE is still not feasible and needs to be improved by company management.

Result and Discussion

A. Factors Affecting Fire

The theory of the fire triangle is included in a theory that can explain the factors that cause fire formation from heat, flammable materials, and oxidizing elements (Rahmatmand et al., 2023). These elements can cause exothermic physical and chemical reactions to occur so that they can produce heat, smoke, flame, and gas which is visualized in the image below (Zhao et al., 2019).

Figure 1. Fire Triangle

According to the National Fire Protection Association (NFPA), fires can be categorized into four groups based on their causal factors, presented in Table 1.

Table 1. Four Classes of Fire Based on Causal Factors (Nolan, 2019)

Code	Symbol	Material Type	Material Examples
A		Ordinary Combustibles	Wood, Paper, Cloth
B		Flammable Liquids	Grease, Oil, Paint, Solvent
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring
D		Combustible Metal	Magnesium, Aluminum
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

Based on the list of disasters by the National Disaster Management Agency of the Republic of Indonesia, up to 2020, there were 2,925 cases of non-forest and non-land fires (BNPB, 2020). Fire can cause material damage or loss and even cause loss of life. Fires occur anywhere and anytime, not only in residential and office areas but also in industrial locations such as oil and gas. Oil and gas are flammable materials. Therefore, oil and gas processing has a high fire risk, so a good Occupational Safety and Health Management System is needed.

B. Analysis of Hazard and Operability Study

HAZOP is a systematic approach for hazard identification and therefore used as an important tool to enable the formulation of top events or otherwise for the logic-based tree methods to be explained later (Pasman & Rogers, 2020). HAZOP analysis is carried out by translating the process data that will be used in the utility to produce several parameters that can be used as the contents of the HAZOP. The output of

HAZOP is a risk estimate used as a reference for predicting consequences (Penelas et al., 2021). The severity level is used in risk estimation, which is classified based on the risk level presented in Table 2 (Diwyastra, 2016).

Table 2. Severity Level of HAZOP

Severity	Risk Level	Score Impact	Information
0	No Risk	0	-
1	Low Risk	1 – 3	• Does not cause operational disruption • Repair cost ≤ US $1000
2	Low to Moderate Risk	4	• Disrupts operation • US $1000 ≤ Repair cost ≤ US $10,000
3	Moderate Risk	5 – 9	• Causes significant operational disruption • US $10,000 ≤ Repair cost ≤ US $100,000
4	High to Moderate Risk	10 – 12	• Causes major operational disruption • US $100,000 ≤ Repair cost ≤ US $1000,000
5	High Risk	15 – 25	• Causing extensive operational disruptions (stopping operations) • Repair costs ≥ $1000,000

Based on the information in Table 2, you can carry out risk estimation which is a structured effort to see the presence of dangers in company activities. Arifianto et al., (2023), conducted research on HAZOP in one of the high-risk jobs at PT Pertamina RU VI Balongan, including boiler work. In the research, the identification of hazards in boiler work consists of several activities which are presented in Table 3. These probability and severity values are used to determine the risk level of the potential accident.

Table 3. HAZOP in Boiler Work at PT Pertamina RU VI Balongan

Activity	Potential Hazard	Risk	Likelihood	Severity	Risk Value
Firing Boiler	High temperature	Dehydration	2	2	4
	Missed Firing Stage	Boiler Explodes	3	5	15
Operation of Boiler Equipment	High pressure	Explosion	4	5	20
	Noise	Ear Disorders	4	2	8
		Deaf	2	4	8
	Exposed to Hot Steam	Burns	4	3	12
Force Draft Fan Operation	Electric current	Electrocuted	3	4	12
	Pinched	Wounded	2	3	6
	Noise	Ear Disorders	4	2	8
		Deaf	2	4	8
Filling Boiler Water	Noise	Ear Disorders	4	2	8
		Deaf	2	4	8

Table 3. HAZOP in Boiler Work at PT Pertamina RU VI Balongan

Activity	Potential Hazard	Risk	Likelihood	Severity	Risk Value
Operating the Burner	Sparks	Fire	3	5	15
Chemical Injection	Exposure to Trisodium Phosphate	Skin Irritation	3	3	9
		Eye irritation	2	3	6
		Respiratory Irritation	2	3	6
	Exposure to Morpholine	Burns	3	4	12
	Exposure to Hydrazine	Skin Irritation	2	2	4
		Temporary Blindness	2	3	6
	Exposed to Caustic Soda	Respiratory Irritation	2	3	6
Soot Blowing Boiler	Leaking Water Vapor	Burns	4	4	16
Post-Operation Boiler Checking	Hit Head	Head injury	3	4	12
	Falling From a Height	Fracture	2	4	8
Average					**10**

Table 3 presents the risk of potential accidents which is at number ten (10), this shows that the boiler work is at the High to Moderate Risk. The existence of this shows that PT Pertamina RU VI Balongan has not implemented risk control. Risk control is important to implement to reduce the risk level to a lower level. By controlling risks, work accidents can be avoided.

C. Fire Exposure Radius

Workers in the exposure radius can be affected by direct exposure to fire and can also be exposed to the effects of air explosions (Baalisampang et al., 2019). Exposure due to the effects of heat radiation firefighters receive in the work environment is 2.5 KW/m^2 (Heus et al., 2022). The fire hazard level in oil and gas storage tanks at PT Pertamina RU VI Balongan is classified as severity level 4 “High to Moderate Risk”. According to calculations from Haqi (2018) with Pertamax samples, the Radius of Exposure can be obtained by multiplying the Fire and Explosion Index (F&EI) of 92.59 with a constant (K) of 0.84. So, the exposure radius can be calculated as follows (Aferdiansyah et al., 2022):

Radius of Exposure (ft) = K χ F & EI (1)
= 0,84 χ 92,59
= 77,775 ft
= 23,70 m

The area exposed if the tank experiences a fire:

Area of Exposure (m^2) = π χ Radius of Exposure^2 (2)
= 3,14 χ (23,70 m)^2
= 1.763,706 m^2

To determine the Damage Factor Material Factor (MF) and Process Unit Hazards Factor (F3) analysis is used to determine the Damage Factor, as follows:

Material Factor = 21

Process Unit Hazards Factor (X) = 14,22

$$\text{Damage Factor (Y)} = 0{,}340314 + (0{,}076531 \times (X)) + (0{,}003912 \times (X)^2 - (0{,}00073 \times (X)^3) \quad (3)$$

$$= 0{,}340314 + (0{,}076531 \times (14{,}22)) + (0{,}003912 \times (14{,}22)^2 - (0{,}00073 \times (14{,}22)^3)$$

$$= 1{,}2079$$

Data was also obtained from the Damage Factor calculation regarding the exposure radius and radiant heat flux obtained from research by Sukma et al., (2017) based on the guidelines from the Dow's Fire and Explosion Index, which are clearly explained in Table 3.

Table 4. Fire Exposure Radius and Explosion Index for Several Types of Materials

Tank	Product	General Process Hazards (F1)	Special Process Hazard Factor (F2)	Process Unit Hazard Factor (F3)	F & EI (F x F3)	Exposure Radius from Tank Edge (m)	Exposure Area (m^2)
T – 05	Pertamax	1,70	3,40	5,79	92,59 Moderate	14,03	1764,42
T – 06	Pertamax	1,70	3,40	5,79	92,59 Moderate	14,03	1764,41
T – 08	Pertamax	1,70	3,39	5,76	92,23 Moderate	15,87	1750,96
T – 09	Pertamax	1,50	3,39	5,09	81,38 Moderate	13,09	1363,23
T – 10	Pertamax	1,50	3,38	5,09	81,37 Moderate	13,10	1362,84
T – 12	Pertamax	1,50	3,37	5,07	81,10 Moderate	20,76	4496,6
T – 13	Premium	1,50	3,37	5,05	80,86 Moderate	20,70	4772,71
T – 14	Premium	1,59	3,37	5,05	80,87 Moderate	20,71	4773,26

Table 5. Radiant Heat Flux Several Types of Materials

Underground Tank		Dimensions		Luminous Heat Flux from Tank Edge at Ground Surface (KW/m^2)									
Tank	Product	Diameter	Height	5 m	10 m	15 m	20 m	25 m	30 m	35 m	40 m	45 m	50 m
T – 05	Pertamax	19,35	9,10	4,93	4,99	4,64	4,14	3,61	3,13	2,71	2,35	2,04	1,79
T – 06	Pertamax	19,36	9,23	4,87	4,94	4,60	4,11	3,59	3,12	2,70	2,34	2,04	1,79
T – 08	Pertamax	15,49	9,16	4,08	4,19	3,87	3,41	2,93	2,50	2,14	1,83	1,58	1,37
T – 09	Pertamax	15,49	9,22	4,05	4,17	3,86	3,39	2,92	2,49	2,13	1,83	1,58	1,37
T – 10	Pertamax	15,47	9,05	4,12	4,22	3,90	3,42	2,94	2,51	2,14	1,83	1,58	1,37
T – 12	Pertamax	34,16	11,22	5,38	5,33	5,06	4,69	4,28	3,88	3,49	3,14	2,83	2,55

T – 13	Premium	36,57	11,09	5,34	5,29	5,04	4,69	4,29	3,90	3,52	3,18	2,87	2,59
T – 14	Premium	36,57	11,09	5,34	5,29	5,04	4,69	4,29	3,90	3,52	3,18	2,87	2,59

Within a 5 − 50 m radius from the tank, workers are easily affected by heat radiation averaging 3.43 KW/m^2 so they will get 2nd-degree burns. Chen et al., (2019) recommend a safe distance to avoid exposure to high temperatures, workers should be at a distance of at least 100 meters from the location of the fire.

D. Analysis of the Implementation of ISO 45001 PT Pertamina Refinery Unit (RU) VI Balongan

Every job has work risks that cannot be avoided. To reduce opportunities and risks from the HSE aspect, PT Pertamina RU VI Balongan always tries to implement an appropriate Occupational Safety and Health Management System based on ISO 45001:2018 by complying with reasonable work procedures and permits, including aspects of inspection, prevention, and authorization to supply, supervise and carry out maintenance. Based on technical and non-technical aspects. Technical aspects are related to operations that assess the readiness of the industry to carry out its activities. In contrast, non-technical elements are not directly related to operations but support the smooth running of technical aspects. PT Pertamina RU VI Balongan implements several rules regarding technical safety work, which are required as steps to implement ISO 45001:2018, including:

1. Installation of Warning Signs and Signs

The installation of warning signs is intended to warn employees and the public about the dangers (Gungor, 2023). PT Pertamina RU VI Balongan also explained general matters and specific instructions regarding the facilities that must be used. The warning signs are in pictures/posters, writing/logos, and symbols with specific meanings (Hasan & Indriyati, 2020).

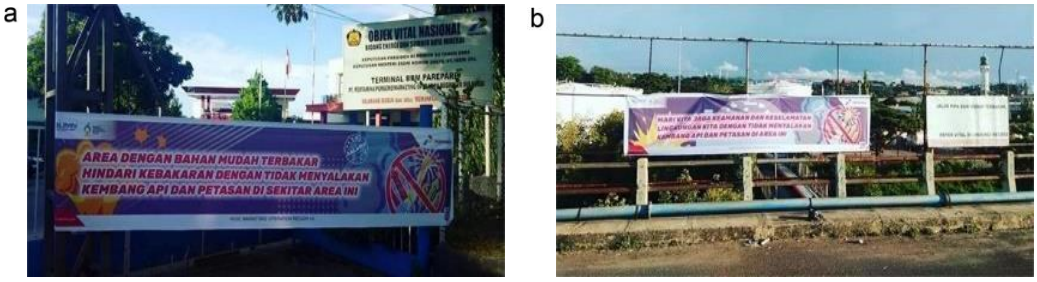

Figure 2. Warning Banner at PT Pertamina RU VI Balongan

Apart from implementing warning signs, at certain points, warning signs are also installed in the form of prohibition signs, warning signs, help signs, and

prerequisite signs. One illustration of warning signs is presented in the following picture (Hasan & Indriyati, 2020).

Figure 3. Warning Sign at PT Pertamina RU VI Balongan

2. Noise

Noise is a collection of unexpected sounds or sounds in inappropriate areas and times because they can affect communication and hearing capabilities in industrial processes (Lee et al., 2023). Two conditions prove the quality of a sound, namely by checking its frequency and intensity. Frequency is assumed to be in Hertz (Hz), meaning the number of sounds that enter the ear each second, while intensity is the rate of energy flow per unit area, expressed in decibels (dB). The intensity of disturbances that occur at PT Pertamina RU VI Balongan is visualized in the Noise Hazard Map in Figure 4 below (Miyanda & Hermawati, 2021).

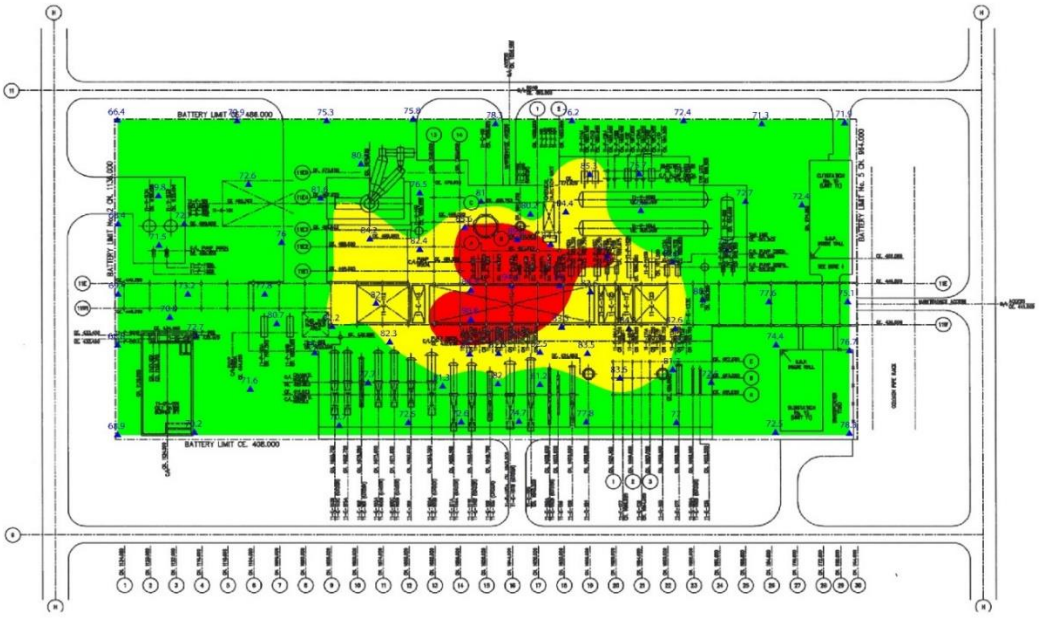

Figure 4. Noise Hazard Map of PT Pertamina RU VI Balongan

Based on research by Tanoga et al., (2019), data obtained from noise measurements at PT Pertamina RU VI Balongan uses a computerized sound level meter, where the noise level fluctuates between 85 – 96 dB, especially in the

compressor area. In this area, a turbine is used to convert gas into liquid. This value is outside the maximum standard value in several places that have been determined based on the Decree of the Minister of Manpower Republic of Indonesia No. 13 of 2011, which is 85 dB at a maximum time of 8 hours per day (Lestiyani et al., 2021).

3. Temperature

Temperature affects the heat exchange rate of both the process and the environment. Several factors, such as air humidity, absolute humidity, relative humidity, dust, gas, steam, condensation, mists, etc influence temperature. Excessive temperature in the work environment will cause a decline in the physical condition of workers and quickly reduce the level of performance capacity of workers (Amoadu et al., 2023). Decree Minister of Health number 1405/MENKES/SK/XI/2002 has determined the standard temperature in industrial work areas in the range of 18 − 30°C (Sihombing & Arvianto, 2019). However, in this parameter, no related studies were found explaining the average temperature in the PT Pertamina RU VI Balongan environment, so the data on this parameter cannot be measured with certainty.

4. Lighting Intensity

Lighting intensity is related to illumination. Lighting functions to provide lighting for work objects such as work equipment machines, production processes, and work environments. Light intensity is the amount of irradiance that falls on the surface in illumination level (lux) units (Paret & Crégo, 2019). According to IES (Illuminating Engineering Society), a work area is declared to have good lighting if it has a minimum value of 300 lux (Ikuzwe et al., 2020). Lighting less than 300 lux will cause discomfort at work, which can reduce work effectiveness (Wikurendra et al., 2021). Based on research, Rahmayanti et al., (2015) obtained sample data from light intensity measurements using a lux meter in a sample work area, namely at the several room units of PT Pertamina RU VI Balongan. The results of light intensity and feasibility measurements at PT Pertamina RU VI Balongan's room units are presented in the graph in Figure 5 – 7, which was remodeled using a better graphic presentation.

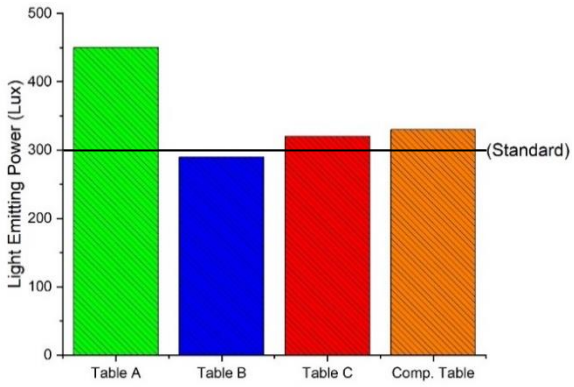

Figure 5. Light Intensity Measurement Chart and Feasibility in HSE Units Room

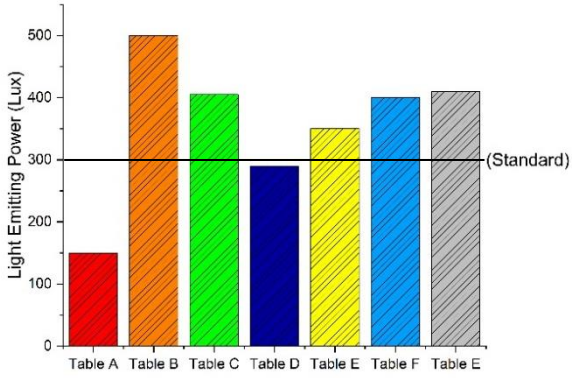

Figure 6. Graph of Light Intensity Measurement and Feasibility in Administration Units Room

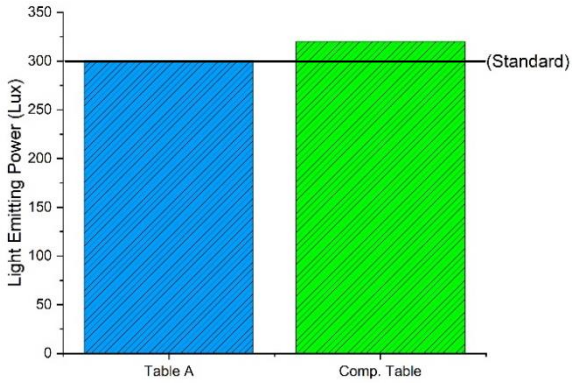

Figure 7. Graph of Light Intensity Measurement and Feasibility in Environmental Units Room

Based on the graphic data above, it can be seen that there are still parts in the work area that have values outside the good lighting standards according to the IES (Illuminating Engineering Society), namely below 300 lux. So, improving the lighting facilities in the work area is necessary.

5. Personal Safety Equipment

Personal Protective Equipment (PPE) must be used to maintain the worker's safety and those around them (Exposto et al., 2022). Companies are required to facilitate PPE for their employees who work with high risks. These tools include 1) Head Protection, Full Body Harness, 2) Work Clothes, 3) Vision Protection, and so on. Based on observations regarding the use of PPE in the PT Pertamina RU VI Balongan work area, according to Hasan et al. (2020), it was found that procedures for using PPE were not implemented optimally by some workers. This is because workers think it is normal for them to do work according to their field, so they tend to ignore the SOP for using Personal Protective Equipment (PPE) (Najihah et al., 2023).

Apart from technically implementing ISO 45001:2018, PT Pertamina also applies non-technical regulations based on administration and licensing in the form of a Safe Work Permit or Surat Izin Kerja Aman (SIKA) (Hasan et al., 2020). SIKA is a permit issued by a company to carry out work activities where there is an

explanation of the steps that must be complied with by all Pertamina employees in carrying out work (Nareshwari & Paskarini, 2018). The SIKA application procedure must include a permit for the work involved based on the temperature of the work area.

In general, a Work Permit is divided into two main parts, including a Hot Work Permit or Surat Izin Kerja Panas (SIKP), a permit required for any work that uses or causes ignition sources (Permana, 2015). Cold Work Permit or Surat Izin Kerja Dingin (SIKD), is a permit required for any work that does not result in a source of ignition but can potentially cause direct or indirect danger to operations and humans (PT Safety First Indonesia, 2021).

Conclusion

The significant contribution made by PT Pertamina Refinery Unit (RU) VI Balongan poses a high risk of fire. A fire can trigger an explosion with exposure to heat radiation in the work environment. Within a $5 - 50$ m radius from the tank, workers are easily affected by heat radiation averaging 3.43 KW/m^2. Based on analytical calculations, the Radius of Exposure (ft) was 76.45 m, the Area of Exposure (m^2) was 18,352.07 m^2, and the Damage Factor (Y) was 1.2079. So, workers are advised to stay at a safe distance of at least 100 m from the fire or explosion area. The study results of parameters for implementing ISO 45001:2018 found several aspects that did not meet the standards. It can be concluded that PT Pertamina RU VI Balongan has not implemented HSE based on the ISO 45001:2018 standard properly, this has the potential to cause fires to recur. So, recommendations were given to PT Pertamina RU VI Balongan to improve several aspects that did not meet standards.

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