

RISK MANAGEMENT ANALYSIS WITH THE AS/NZS 4360:2004 METHOD ON BOILERS AT PT. DHARMAPALA USAHA SUKSES CILACAP

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ABSTRAK

Boiler merupakan salah satu alat dengan berbagai potensi bahaya. Potensi bahaya tersebut dapat berasal dari tahapan pengoperasian maupun pada tahapan perawatan. Untuk mencegah terjadinya risiko yang dapat terjadi, di perlukan manajemen risiko yang tepat. Salah satu yang dapat digunakan yaitu manajemen risiko metode AS/NZS 4360:2004. Tujuan penelitian ini yaitu melakukan analisis risiko dengan metode AS /NZS 4360-2004 pada boiler di PT. Dharmapala Usaha Sukses Cilacap. Penelitian ini merupakan penelitian kualitatif analitik, dengan menggunakan 3 informan antara lain pimpinan, pengawas dan pekerja. Penelitian dilakukan dengan wawancara dan observasi berpedoman lembar wawancara dan lembar observasi komponen boiler, yang di analisis yaitu pada tahap pengoperasian dan perawatan boiler. Analisis dilakukan dengan metode triangulasi. Hasil penelitian menunjukkan terdapat potensi bahaya yang dapat menyebabkan risk level high pada aktivitas pengoperasian yaitu pengisian bahan bakar dan perawatan boiler yaitu aktivitas pengecekan belt conveyor. Risiko yang dapat terjadi adalah kematian akibat kebakaran. Upaya pengendalian yang sudah dilakukan perusahaan di antaranya memasang cyclone, serta dilakukan inspeksi. Peneliti menyarankan perusahaan dapat melakukan pengecekan rutin temperatur batu bara dan memasang safety sign pada area yang berbahaya.

Kata Kunci: AS/NZS 4360:2004, Boiler, Manajemen risiko

ABSTRACT

Boiler is one of the tools with various potential hazards. The potential danger can come from the operation stage or the maintenance stage. To prevent the risks that can occur, appropriate risk management is needed. One that can be used is the AS/NZS 4360: 2004 risk management method. The purpose of this study is to conduct a risk analysis using the AS / NZS 4360-2004 method on boilers at PT Dharmapala Usaha Sukses Cilacap. This research is an analytical qualitative research, using 3 informants including leaders, supervisors, and workers. The study was conducted by interview and observation guided by interview sheets and observation sheets of boiler components, which were analysed at the stage of boiler operation and maintenance. The analysis was carried out using the triangulation method. The results showed that there are potential hazards that can cause high-risk levels in operating activities, namely refueling and boiler maintenance, namely checking conveyor belt activities. The risk that can occur is death by fire. Control efforts that the company has made include installing a cyclone, and inspections. Researchers suggest that companies can carry out routine checks of coal temperature and install safety signs in dangerous areas.

Keywords: AS/NZS 4360:2004, Boiler, Risk management

INTRODUCTION

Data from the 2018 International Labour Organization (ILO) shows that every year around 380,000 workers or 13.7% of the 2.78 million workers die from workplace accidents or occupational diseases. More than 374 people are injured, wounded or fall ill every year due to accidents that occur with workers (ILO, 2018).

In Indonesia, according to Fatoni in Zeinda and Hidayat (2019), there are several cases of work accidents especially on boilers. Many cases in Indonesia occur not only caused by small companies, but also large companies. Some cases that occurred in small companies including a krupuk factory in Kaliwates, Jember in May 2001 that killed 4 people, and a tofu factory in Taman, Sidoarjo, in January 2005 that killed 2 people, caused by leakage of holes through which people pass and failure of fire sensors.

Boiler machines are used to support the production process by converting raw materials into finished materials. One industry that uses boiler machines is the sugar-making industry. In the sugar factory, the production process itself is the

process of processing raw materials, namely sugar cane into finished materials in the form of sugar crystals. The first sugar-making process is nira extraction, which is the process of milking sugar cane liquid (nira) by grinding. Then it is purified using the sulfitation method to produce a precipitate that will absorb non-sugar ingredients. After purification, evaporation is carried out, then the crystallisation process and sugar drying using hot air (Novianti, Syaukat and Ekayani, 2021). Boiler is a tool that produces steam for various purposes. The type of water and water vapour is greatly influenced by the level of efficiency itself. In boiler machines, the type of water used must be demineralised first to sterilise the water used, so that the application to be used as water vapour can be maximised properly (Rahardja, Mahfud and Bawana, 2021). One of the efforts to eliminate hazards in the boiler is with risk management to avoid work accidents that can cause victims or losses to the company.

Basically, risk management is the application of management functions in risk management, especially the

risks faced by organizations or companies (Prameswari and Aisyah, 2023). Risk management is a procedure involving specific methodologies through which an organization evaluates the risks associated with each operational endeavor in order to meet its strategic objectives. Risk management consists of risk identification, risk assessment, and risk control which means risk management can be used in the process identify, measure and ascertain risks, and develop strategies for managing risks that exist in the workplace (Fathoni, 2020).

PT Dharmapala Usaha Sukses located in Cilacap City is a company engaged in providing crystal sugar or often referred to as granulated sugar. In carrying out its functions many important systems are interconnected. One of the most important parts of the sugar processing system is the boiler. Boiler is one of the tools in the factory department division at PT Dharmapala Usaha Sukses which functions to take sugar cane juice or sap through the procession of milking and boiling water to produce steam which is used as a sap cooking process. In addition, there are risks of

hazards that exist in the boiler area, especially for components or machines that work at high temperatures and pressures that are at risk of failure or experiencing fires and explosions if the temperature reaches $>760^{\circ}\text{C}$ and the valve is not open. Based on a preliminary study by conducting interview with safety officer at PT Dharmapala Usaha Sukses, he said the workers had experienced occupational diseases due to exposure to heat and dust. The majority of the cases are dehydration, blinding, and respiratory problems. The observation results from the preliminary study also found that there are potential hazards in the form of heat and dust exposure due to flue gas emissions from boiler combustion. Previously, in carrying out risk management, PT Dharmapala Usaha Sukses had carried out risk management with a hazard and operability study (Hazop). Therefore, the researcher wants to analyse the AS/NZS 4360: 2004 method in the process of boiler machine tools at PT Dharmapala Usaha Sukses Cilacap.

RESEARCH METHOD

This type of research is analytical qualitative using data collection techniques, namely through in-depth interviews using interview guide, observation using checklist sheet, and document review to complete the required data. Risk analysis was conducted using the AS/NZS 4360:2004 method in the form of a risk analysis matrix which is used to determine the level of risk of hazards in the operation of boiler equipment and maintenance of boiler equipment components. The subjects in this study were 3 informants who were determined by purposive sampling technique. The purposive sampling technique is a technique used to determine the selection of informants based on certain considerations, namely people who are considered to know the most about the data needed in this study and workers who have been working for a long time. Informants consist of supervisors (main informants), work leaders (supporting informants 1), and workers (supporting informants 2). To test the credibility and validity of the data, triangulation of sources, data and methods was used. Source

triangulation is carried out by determining several sources such as supervisors, work leaders and workers so that identifying the suitability of one source with another can be done, Data triangulation is carried out by matching interview results with supporting observation method that can inform the validity of the information, and Method triangulation was carried out by re-analyzing using AS/NZS 4360:2004 which previously used the Hazard and Operability Study (Hazop) method.

RESULT AND DISCUSSION

Boiler is one of the most important parts of the sugar processing system at PT Dharmapala Usaha Sukses which functions to take sugar cane juice or sap through the procession of milking and boiling water to produce steam which is used as a sap cooking process. Based on the result of interview in this research, it is known that the boiler operation at PT Dharmapala Usaha Sukses consists of refueling, maintaining water pH, determining the water level in the boiler drum, and starting the boiler. Meanwhile the maintenance of boiler machine components consists of

inspecting conveyor belts, cleaning furnace parts, steam drums, inspecting all wall tubes, cleaning savers, cleaning superheaters, cleaning superheater pipes and fuel nozzles. In addition, based on the results of observations related to the maintenance of boiler components at PT Dharmapala Usaha Sukses Cilacap, it is also known that there is already an SOP document and a preventive maintenance schedule, and monitoring is also carried out through safety patrols to ensure that conditions around the company comply with existing standards.

Risk Identification on Boiler Equipment at PT. Dharmapala Usaha Sukses

Operation of Boiler Equipment

Determining the water level in the boiler drum

The process of determining the water level in the boiler drum at PT Dharmapala Usaha Sukses is by using a water level controller. After the water is appropriate then turn off the feed pump on the feed pump panel. From this process, researcher found potential hazards including noise, heat exposure, and altitude. These

potential hazards can cause the risk of hearing loss, dehydration, stress, fatigue, falls, and injuries.

Feed water pH

Based on the observation of the water analysis report document regarding the pH of the feed water, there is still a water pH that is too low in the boiler water sample which can result in carry over. This can cause scale along the steam line pipe to the turbine and can cause leaks in the pipe.

Checking the force draft fan

In checking the force draft fan, researcher found potential hazards including machine noise in the force draft fan area which is at risk of hearing loss. In addition, there is the potential for tripping over components that can cause the risk of falling to injury.

Coal refueling

Refueling at PT Dharmapala Usaha Sukses uses loader tools so that it does not require a lot of time and effort. At the refueling stage, researcher found an accumulation of coal dust that could pose a risk of fire, respiratory problems and glare.

Start-up boiler

In the boiler start-up operation, there are potential noise and potential

height hazards in the boiler start-up panel area. Noise can result in hearing loss, contact with steam pipes can result in burns and height hazards can risk falling which can result in serious injury or even death. Potential height hazards in the boiler start up panel area can result in the risk of falling and slipping which can result in minor or even severe injuries to workers.

Table 1. Risk Identification Boiler Operation

Boiler operation activities		Hazards		Risks
Determining the water level in the boiler drum.	-	Noise	-	Hearing impairment
	-	Heat exposure	-	Dehydration, stress, impaired concentration
	-	Altitude	-	Falls, injuries
Maintains the pH of the water.	-	Water pH too low/high	-	Corrosion of the pipe
			-	Scale on the pipe
			-	Leakage in the pipe
Checking the force draft fan.	-	Noise	-	Hearing loss
	-	Electric current	-	Electrocution
	-	Tripping over components	-	Falls, injuries
Refueling.	-	Fire	-	Material loss
	-	Coal dust exposure	-	Respiratory distress
			-	Lung damage
Start up boiler	-	Noise	-	Hearing loss
	-	Contact with high altitude water vapour pipe	-	Burns
			-	Fall, injury

Maintenance of Boiler Equipment

a. Checking the conveyor belt
Based on direct observation of the conveyor belt, there is a potential hazard in the form of coal dust accumulation which can cause fires in the conveyor belt area. Exposure to coal dust which can cause respiratory problems and blinding. Pinched conveyor belt machine running.

b. Cleaning furnace

Based on direct observation in the combustion chamber or furnace section, there are potential hazards in the form of exposure to combustion residue dust which can cause respiratory problems, blinding, tripping over nozzle components that can risk falling and hitting nozzle components or furnace walls and can cause minor or serious injuries to workers.

c. Cleaning steam drum

Based on direct observation of the steam drum, there are potential hazards in the form of limited space which can result in shortness of breath, bumping, and tripping over components which can result in minor or serious injuries to workers.

d. Wall tube checking

From the observations obtained, several potential hazards in the boiler wall tube checking area include heat exposure, noise, contact with steam pipes.

e. Checking the superheater pipe

Based on direct observation of the superheater pipe checking activity, there is potential for tripping over components, heat exposure, and contact with hot pipes.

f. Cleaning economizer

Based on direct observation of economizer cleaning activities, there are potential hazards in the form of

dust exposure which can cause respiratory problems and blinding, tripping over jet pump air hose tools which can cause falls and collisions which can cause minor or serious injuries to workers.

g. Cleaning air preheater

Based on observations of the preheater air cleaning activity using an air jet pump, there is the potential for slipping due to slippery areas. This can result in falls and can cause minor/serious injuries to workers.

h. Checking the fuel nozzle

Based on direct observation of checking the nozzle components in the combustion chamber, the potential hazards are tripping over nozzle components which can risk falling and causing injury, exposure to combustion residue dust which can cause respiratory problems, exposure to heat which can cause dehydration, stress and concentration problems.

Table 2. Risk Identification of Boiler Component Maintenance

Boiler Maintenance Activities		Hazards		Risks
Conveyor belt checking	-	Fire	-	Financial loss.
	-	Dust exposure	-	Death
	-	Engine running	-	Environmental pollution.
	-	Belt breaks	-	Respiratory distress. Pinched.
Furnace Cleaning	-	Tripping over	-	Injury
	-	nozzle components	-	Falls
	-	Exposure to dust	-	Slipping
			-	Respiratory distress Lung damage Dislocation
Steam drum cleaning	-	Limited space	-	Injury
	-	Tripping over	-	Shortness of breath
	-	components		
Walltube checking	-	Noise	-	Respiratory distress
	-	Contact with steam	-	Burns
	-	Heat exposure	-	Dehydration, work stress, impaired concentration.
Checking super heater pipes	-	Tripping over	-	Injury
	-	component	-	Dehydration, work stress, impaired concentration
	-	Heat exposure	-	Burns
Cleaning economizer	-	Contact with steam	-	
	-	pipes		
	-	Exposure to dust	-	Respiratory distress
Cleaning air pre heater	-	Tripping over a	-	Falls
	-	hose	-	Injury
			-	Dust glare
Fuel nozzle checking	-	Slippery areas	-	Slipping
	-		-	Falls
	-		-	Injury
Fuel nozzle checking	-	Tripping over	-	Falls
	-	component	-	Injury
	-	Exposure to dust	-	Respiratory distress
	-	Exposure to heat	-	Dehydration, work stress, impaired concentration

Risk Assessment on boilers at PT. Dharmapala Usaha Sukses

Based on the risk assessment of boiler equipment operation (Table 3) at PT Dharmapala Usaha Sukses Cilacap, it is known that refueling is the highest risk activity compared to other activities because it can cause death, so control is needed to prevent this risk. Besides that, the results of the

risk assessment of boiler maintenance at PT Dharmapala Usaha Sukses Cilacap shows that checking the conveyor belt is the highest risk activity compared to other activities because it can also cause death. Meanwhile the activity with the lowest risk is checking the super heater pipe.

Table 3. Risk Assessment on Boiler

Activity	Hazard	Risk	Risk analysis			Risk score	Risk level
			Exposure	Likelihood	consequences		
Operation of Boiler Equipment							
Determining the water level in the boiler drum with the feed pump	- Noise - Heat exposure - Altitude	- Respiratory distress - Dehydration, work stress, impaired concentration - Fall, minor or serious injury	6	3	3	54	Medium
Determining the feed water Ph	- Water pH too low/high	- Pipe leaks - Corrosion in pipes - Scale on pipes	0,5	3	15	22,5	Medium
Checking the force draft fan	- Height - Noise - Electric current	- Hearing loss - Electrocutted - Fall, minor/serious injury	6	3	3	54	Medium
Refueling	- Fire - Dusty area	- Death - Material loss - Production hampered - Environmental pollution - Respiratory disorders - Vision impairment - Flicker	2	3	40	240	High
Start-up boiler	Noise Contact with water vapor pipes Height	- Hearing loss - Burns - Fall, minor/serious injury	6	3	3	54	Medium
Maintenance of Boiler Equipment							
Checking the belt conveyor	- Running machine - Dusty area - Fire	- Death - Financial losses - Environmental pollution - Respiratory disorders - Visual impairment, blurring. - Stuck	2	3	40	240	High
Cleaning furnace	Tripping over nozzle components	- Injury - Fall - Slipped	3	6	3	54	Medium

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Activity	Hazard	Risk	Risk analysis			Risk score	Risk level
			Exposure	Likelihood	consequences		
	Dusty area	- Respiratory disorders, blink					
Cleaning steam drum	Limited space Tripping over a component Bumped Lack of lighting	- Falls, - Injuries - Shortness of breath - Vision impairment	3	6	3	54	Medium
Check all wall tube	Noise Heat exposure Contact with steam pipes	- Hearing loss - Dehydration, work stress, concentration disorders - Burns	2	3	3	18	Acceptable
Checking the super heater pipe	noise Tripping over a component Heat exposure Contact with water vapor pipes	- Hearing loss - Dehydration, work stress, concentration disorders - Burns	1	3	3	9	Acceptable
Cleaning economizer	Dust exposure Tripping over a hose	- Respiratory disorders, blink - Fall, minor/serious injury	3	6	3	54	Medium
Cleaning air preheater	Slippery area Tripping over a hose	- Slipped, fallen, minor/serious injury	3	6	1	18	Acceptable
Checking the fuel nozzle	Tripping over nozzle components Dusty area	- Fall, minor/serious injury - Respiratory disturbances, blink	3	6	3	54	Medium

Risk Control pada Boiler di PT. Dharmapala Usaha Sukses

Tabel 4. Risk Control Boiler

Activity	Hazard	Risk	Risk analysis			Risk score	Risk level	Control	Researcher recommendations
			Exposure	Likelihood	Consequences				
Operation of Boiler Equipment									
Determining the water level in a boiler drum with a feed pump	Noise Heat exposure Height	Hearing loss Dehydration, stress, concentration disorders Fall, minor/serious injury	6	3	3	54	Medium	1. Installing handrails on stairs 2. Repair SOP 3. Boiler	1. Ensure the ladder and handrails are in safe condition 2. Installing safety signs

Activity	Hazard	Risk	Risk analysis			Risk score	Risk level	Control	Researcher recommendations
			Exposure	Likelihood	Consequences				
								operation inspection 4. B riefing 5. U sing PPE (ear plug)	in the workplace 3. P rovide drinking water in the workplace 4. E nsure workers are in good health
Determining the Ph of feed water	The PH of the water is too low/high	Corrosion in pipes Scale on pipes Leaks in pipes	0,5	3	15	22,5	Medium	1. Provide manual book standard water boiler 2. I nspection of water samples in the laboratory 3. B riefing	Ensure that the water is in accordance with the standard water boiler
Force draft fan check	Noise Height Electric current	Hearing loss Fall, minor/severe injury Electrocuted	6	3	3	54	Medium	1. I nstalling hand rails on stairs 2. I nstallation of interlock systems 3. P repare SOP 4. S afety patrol 5. B riefing 6. U sing PPE (ear plug)	1. E nsure that the ladder and handrails are in safe condition 2. I nstalling safety signs in the workplace 3. E nsure workers are in good health
Refueling	Fire Dusty area	Death Material loss Production hampered Environmental pollution Respiratory disorders Vision impairment	2	3	40	240	High	1. I nstalling cyclones 2. P repare SOP 3. S afety patrol 4. B riefing 5. U sing PPE (masks, safety glasses)	1. I nstalling safety signs in the workplace 2. R outine check of coal temperature 3. U sing KN95 masks
Start-up boiler	Noise Contact with water	Hearing loss Burns Fall, minor/severe injury	6	3	3	54	Medium	1. I nstalling handrails on stairs	1. E nsure ladders and handrails are in safe condition

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Activity	Hazard	Risk	Risk analysis			Risk score	Risk level	Control	Researcher recommendations
			Exposure	Likelihood	Consequences				
	vapor pipes Height							2. repair SOP 3. safety patrol 4. briefing 5. Use PPE (earplug, wearpack)	2. Installing safety signs in the workplace 3. Ensure workers are in good health
Boiler Equipment Maintenance									
Checking the belt conveyor	Fire Dusty display Running machine	Death Financial losses Environmental pollution Respiratory disorders Vision impairment Stuck	2	3	40	240	High	1. Installing cyclones 2. repair SOP 3. briefing 4. Use PPE (masks, safety glasses, gloves)	1. Installing safety signs in the workplace 2. Ensure workers are in good health 3. Using KN95 masks
Cleaning furnace	Tripping over nozzle components Dusty areas	Injury Fall Slipped Respiratory disorders	3	6	3	54	Medium	1. safety patrol 2. briefing 3. Use PPE (safety shoes, masks, safety glasses)	1. Installing safety signs in the workplace 2. Ensure workers are in good health 3. Using KN95 masks
Cleaning steam drum	Limited space Tripping over a component Bumped Lack of lighting	Falls, Injuries Shortness of breath Vision impairment	3	6	3	54	Medium	1. Using a flashlight 2. safety patrol 3. briefing 4. Using PPE (safety helmet, safety shoes)	1. Ensuring workers are in good health 2. Ensuring workers use PPE that meets standards
Check all wall tube	Noise Heat exposure Contact with steam pipes	Hearing loss Dehydration Burns	2	3	3	18	Acceptable	1. safety patrol 2. briefing 3. Using PPE (ear plug, wearpack, safety shoes).	1. Installing safety signs in the workplace 2. Provide drinking water in the workplace 3. Ensuring workers are

Activity	Hazard	Risk	Risk analysis			Risk score	Risk level	Control	Researcher recommendations
			Exposure	Likelihood	Consequences				
									in good health 4. Ensuring workers use PPE that meets standards
Checking the super heater pipe	noise Tripping over a component Heat exposure Contact with water vapor pipes	Hearing loss Dehydration Burns	1	3	3	9	Acceptable	1. Safety patrol 2. Briefing 3. Using PPE (ear plug, safety shoes, wearpack).	1. Installing insulation on pipes 2. Installing safety signs in the workplace 3. Provide drinking water in the workplace 4. Ensuring that the work tools are in accordance with ergonomic principles
Cleaning economizer	Dust exposure Tripping over a hose No ergonomics	Respiratory disorders, dizziness. Falls, minor/serious injuries. Easily tired, spinal and neck disorders.	3	6	3	54	Medium	1. Conducted inspections 2. Safety patrol 3. Briefing 4. Use PPE (masks, glasses, safety shoes)	Ensuring workers are in good health
Cleaning air preheater	Slippery area Tripping over a hose No ergonomics	Slipped, fallen, minor/serious injury Injuries and injuries Easily tired, spinal and neck disorders	3	6	1	18	Acceptable	1. Conducted inspections 2. Safety patrol 3. Briefing 4. Use PPE (masks, safety shoes)	1. Ensure workers are in good health 2. Ensure employees use PPE that complies with standards
Checking the fuel nozzle	Tripping over nozzle components Dusty areas	Falls, minor/serious injuries. Respiratory disorders, dust flickering.	3	6	3	54	Medium	1. Safety patrol 2. Briefing 3. Using PPE (safety shoes, masks, glasses)	1. Ensure workers are in good health 2. Using KN95 masks

Based on the research results (Table 4), several potential hazards were obtained including noise, heat exposure, contact with hot pipes, dust exposure, explosion, electric current and height. Noise can be caused by the activity of determining the water level in the steam drum, boiler start-up activity and force draft fan checking activity. Noise hazards in boiler operations include continuous noise. If the noise with high intensity for a long time can cause hearing loss. Noise that continuously heard by workers will reduce the sharpness and function of the worker's hearing organs especially in timpani membrane and become a decrease in the worker's hearing ability (Putri et al, 2021). In this case, the control actions that carried out are preparing SOP, doing inspection of boiler operation, giving direction or briefing to workers before starting work, and using ear plug when working in boiler operations. This is in line with research conducted by Rimantho and Cahyadi (2015) which states that among the many disorders caused by noise, the most serious disorder is deafness.

Heat exposure comes from the activity of determining the water level in the steam drum. Exposure to heat can cause dehydration because working in a hot environment the body sweats a lot, this is in line with research conducted by Wahyuni, Entianopa and Kurniawati (2020) which states that high environmental temperatures or heat cause the release of body fluids through breathing to increase, resulting in dehydration. The results of the interview the highest air temperature was 30°C. Contact with hot water vapour pipes can cause burns. This hazard can be caused by boiler start-up activities. Exposure to dust can cause shortness of breath, blinding and lung damage. This is similar to a research conducted by Abidin et al. (2021) which states that exposure to dust can cause lung problems in workers. This is because dust inhaled by workers can irritate the respiratory tract so that respiratory problems can occur in the worker's lungs (Maradjabessy et al, 2021). Dust exposure is caused in the area of boiler refuelling activities with coal. Electric current hazards can cause electric shock. The danger of electric current is found in the activity of

checking the force draft fan. Height hazards come from activities in boilers that use stairs. Height hazards can pose a risk of falling which can cause injury or even death. Leakage hazards come from crusted water pipes when the pH of the water is not in accordance with the standard. Water pipe leakage hazards can cause damage to components, stop production and can threaten the safety of workers.

The results of the risk assessment show that most of the risks in the boiler operation of PT Dharmapala Usaha Sukses are in the medium category, namely hearing loss, dehydration, stress, fatigue, falls, injuries and burns. The risk is classified as medium because it has an important impact on workers and has a fairly high probability of occurrence, this is in line with Bastuti (2021), which states that a potential hazard is declared to be of medium value if it causes serious injury but not permanent disability or for the company to suffer losses. The risk of fire is in the high category, because it is possible to occur and has an impact related to death and minor damage to the environment. This is in line with

Bastuti (2021) which states that the potential danger is considered high because of severe injury and triggers death or triggers a serious impact on the company's business continuity. Fire is one of the most detrimental events because it can disrupt national productivity and reduce community welfare. In various countries, the losses are enormous because they involve high asset values, production processes and employment opportunities (Serani, Lina and Isyatun, 2015).

In boiler maintenance, several potential hazards are obtained including fire, tripping over components, exposure to dust, limited space, lack of lighting, slipping and heat exposure. Fire comes from the accumulation of coal dust in the conveyor belt checking activity area. Fire hazards can cause component damage, burns and stop production. Tripping over components comes from furnace cleaning and nozzle checking activities. Tripping over components can risk falling and bumping which can cause injury. Dust exposure comes from the activities of checking conveyor belts, cleaning furnaces, and cleaning

economizers. Exposure to dust can result in shortness of breath, blinding and lung disorders. Confined space comes from pipe cleaning activities in the boiler drum. Confined space can cause hazards in the form of collisions with components and shortness of breath. This is in line with the research conducted by Nuzuliyah, Sujoso and Hartanti (2014) which states that working in confined spaces has hazards that can result in injury to loss of life, the main danger contained in confined spaces is low oxygen levels.

The results of the risk assessment found that most of the risks in the boiler maintenance of PT Dharmapala Usaha Sukses are in the medium category, namely injuries, falls, slips, respiratory problems, hearing loss, and visual impairment. The risk is classified as medium because based on the risk level >20 which has a serious impact on workers and has a fairly high probability of occurring in the activities of cleaning furnaces, cleaning steam drums, cleaning economizers and checking nozzles. This is in line with the research conducted by Bastuti (2021) which states that a potential hazard is

declared to be of medium value if it causes serious injury but not permanent disability or loss to the company. The risk from the activities of checking the superheater pipe, checking all walltube and cleaning preheater air is in the acceptable or low category because it has a risk level <20 has a mild impact on workers and does not cause losses to the Company. This is in line with the research of Sabrina and Widharto (2016) which states that the potential danger is declared low value because it only causes minor injuries or does not cause losses to the company. Fire can occur in the conveyor belt checking activity area. Fire is included in the high category, based on the risk level obtained a number >200 because it is possible to occur and has an impact related to death and minor damage to the environment. This is in line with the research of Safitri and Megasukma (2021), which states that the potential danger is declared high because of severe injury and triggers death or a serious impact on the Company's business continuity.

Risk control efforts in boiler operation and maintenance activities

that have been carried out by PT Dharmapala Usaha Sukses include installing cyclones, providing SOP schedule preventive maintenance, installing handrails on stairs, installing interlock systems and providing personal protective equipment.

The risk level that is quite high for workers is fire and exposure to coal dust which can cause fire, shortness of breath and blinding. Risk control carried out by PT Dharmapala Usaha Sukses is installing bag filers or cyclones and providing personal protective equipment, namely masks and safety glasses. These control efforts have gone quite well but some improvements are still needed to maximize control efforts. Recommendations from researchers are to provide health services in the form of general medical check-up periodically to workers. This is useful for initial screening of workers if work-related illnesses occur, install safety signs and routine checking of coal temperature. Installation of safety signs in the workplace serves to inform workers about the occupational safety and health

hazards of a particular activity, area, or work equipment in order to give workers awareness of the importance of occupational safety and health. This is in line with the research of Hamidi et al (2022), which states that the installation of safety signs aims as a sign or message to everyone in the work area to always be careful and stay away from sources of danger. Routine checking of coal temperature is carried out to determine the increase or change in coal temperature that can cause a fire. This is in line with the research of Triono and Ambak (2015) which states that routine checking of coal temperature is one of the prevention of self-burning carried out using a thermometer, if the temperature reaches 50-60⁰C, spreading, FIFO (first in first out), and stockpile compaction will be carried out.

Noise exposure in the boiler operation and maintenance area is above the noise threshold value which can lead to safety and health problems (Said et al., 2022). In this case, PT Dharmapala Usaha Sukses has provided personal protective equipment in the form of ear plugs, but some improvements are still

needed to maximize control efforts. Control efforts for the potential hazards of noise exposure can be done by conducting provide health services in the form of general medical check-up periodically to workers, and routine measurements of noise intensity in the work area and requiring workers to use ear protection equipment while in the work area. This is in line with the research of Hidayat et al. (2019), efforts that can be made are the measurement of noise intensity carried out periodically, the results of which are used as data as a basis for determining the working period and length of work. So that workers can know how long they have to be in a work environment where the noise intensity does not meet the requirements, the need for the use of PPE, especially APT (ear protective equipment) such as earplugs to reduce noise 8 - 30 dB to minimize the risk of hearing loss.

Workers operating and maintaining boiler equipment at PT Dharmapala Usaha Sukses are at risk of dehydration. This is due to heat exposure in closed work areas or due

to hot weather. Therefore, researchers suggest that management needs to provide drinking water in work areas exposed to heat. This is in line with the research of Nofianti and Koesyanto (2019) which states that workers exposed to heat must consume one glass of drinking water (250 ml) every 20 minutes to avoid dehydration.

Boiler is a building with a height of approximately 18 meters. The activities of operating boiler equipment and maintaining boiler components sometimes use stairs. The risk that can be caused by height hazards is falling and slipping which can cause injury to workers. The risk control carried out by PT Dharmapala is to install handrails on the stairs. However, some improvements are still needed to maximize control efforts. Control efforts for potential height hazards can be carried out by ensuring that workers are in good health so that work accidents do not occur because workers find it difficult to concentrate. This is in line with the research of Nofianti and Koesyanto (2019) which states that to maintain the physical condition of employees, regular general health checks are

carried out. This helps in controlling unwanted risks.

CONCLUSION AND SUGGESTION

Based on the results of the research that has been conducted, the researcher can draw the following conclusions:

a. The results of boiler risk identification at PT Dharmapala Usaha Sukses can be summarized as follows:

1) Operation stage

Based on the results of the research that has been carried out, it is known that there are various potential hazards, including acceptable to medium risks such as [1] noise which can be at risk of causing hearing impairment, [2] exposure to heat at risk of dehydration, [3] exposure to dust at risk of respiratory problems, [4] contact with water vapor pipes at risk of burns, to high risk which can cause fatal problems or death such as [1] explosions at risk of component damage, obstruction of production and injury to workers, [2] electric current at risk of electric shock, and [3] height at risk of falling which can cause injury.

2) Maintenance stage

Based on the results of this research, it is known that risk identification can be concluded that the potential hazards contained in boiler maintenance are [1] fire, [2] dust exposure, [3] noise, [4] heat exposure, [5] contact with water pipes, [6] pinched, [7] tripping over components [8] bumped and [9] slippery areas. These potential hazards can cause risks of hazards ranging from acceptable risk to even death if not controlled properly, and can cause losses for the company.

b. The results of the risk assessment on the boiler at PT Dharmapala Usaha Sukses can be summarized as follows:

1) Broiler operation

Based on the results of the research that have been carried out, it is known that the risk assessment on operation can be concluded that most of the risk levels are in the medium category, namely in the activity of determining the water level in the boiler drum with a feed pump, checking the force draft fan, and starting up the boiler. While the refueling activity is in the high category.

2) Maintenance stage

The results of the risk assessment on boiler maintenance activities at PT Dharmapala Usaha Sukses know that most of the risk levels are in the medium category, namely in the activities of cleaning furnaces, cleaning steam drum, cleaning economizers and checking fuel nozzles. Risk level in the acceptable category is in the activity of checking all wall tube, checking the superheater pipe and cleaning the preheater water while the risk level in the high category is in the activity of checking the conveyor belt.

3) Risk control that has been carried out by PT Dharmapala Usaha Sukses on boiler operation and maintenance includes safety patrols, briefings, installing cyclones, providing boiler operation SOPs and SOP schedule preventive maintenance, installing handrails on stairs, installing interlock systems and providing personal protective equipment. To maximize control efforts, safety signs are needed, routine checking of coal temperature, routine measurement of noise intensity in the work area, providing water.

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