

## Analysis of Potential Hazards in the Boiler Section Using *Hirarc* in the Steam Power Plant Implementation Unit (PLTU)

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### ABSTRACT

In every workplace there is always a risk of accidents related to company activities. Accidents are usually caused by people not meeting company standards and unsafe environmental conditions. There is potential danger which can cause work accidents. The aim of this research is to find out how to analyze potential hazards in the PLTU boiler section using *HIRARC* at the PLTU PLTU, boiler unit. Then *the HIRAR method is used*. There were 6 informants consisting of 1 main informant, 3 key informants and 2 supporting informants using *purposive sampling techniques*. The instruments used are observation sheets regarding hazard identification, risk assessment and control, as well as *HIRARC* based on the provisions of PT PLN Nusantara Power Pusat. Results: In the boiler section of Power Plant Implementation Unit X there are potential dangers, namely physical dangers, chemical dangers and psychological dangers. Risk assessment with accumulated risk levels and severity levels based on PT PLN Nusantara Power Pusat's assessment. With elimination, substitution, engineering, administrative and PPE controls. Potential hazards that occur in the work environment: physical hazards (noise, extreme temperatures and exposure to coal dust), mechanical hazards (falls, slips and trips from heights and electric shocks), chemical hazards and psychological hazards from stress/workload levels.

## Introduction

In every workplace there is always a risk of accidents, with the level of risk posed depending on the type of industry, technology and company management system. Work accidents are accidents related to company activities, this work relationship can be interpreted as work/work accidents, accidents are usually caused by people who do not meet company standards and unsafe environmental conditions (Aufarisza et al., 2017).

To achieve satisfactory work productivity, an K3 management system is implemented. The basic activity carried out by the occupational safety and health management system is hazard identification, which will then provide a risk assessment of the hazard and control of the hazard will be carried out (Srisantyorini & Safitriana, 2020). These control measures are very important. This is important to do in order to minimize the number of work accidents and work-related diseases whose impacts can be fatal and even cause death, therefore it is important to implement this work safety and health management system (Partiwi et al., 2024).

According to data from *the International Labor Organization* (ILO) (in (Putri & Lestari, 2023) globally in 2018 more than 2.7 million people died every year due to work accidents or work-related diseases, and 1.8 million deaths occurred in Southeast Asia every year. Based on BPJS Employment data, the number of JKK claims in 2019 was 182,835 cases, increasing in 2020 to 221,740 claims, and in January-November 2023, the number of work accident cases and JKK claims reached that figure. 360,635 cases (BPJS Employment, 2024)



According to the Organization for Economic Co-operation and Development (OECD), more than 2,500 people reportedly die every year at power plants due to serious accidents. The number of accidents is increasing because energy use continues to increase. Between 1969 and 2000, the number of work accidents was 1,870 and 5 people died (Yuli et al., 2022) .

Boiler explosions can occur due to welding defects, corrosion, overheating, and material degradation. Boilers crack due to internal pressure, saturated steam and sudden evaporation of water. And if at that time the volume of saturated steam and water increases to thousands of volumes, boiler failure can cause a fatal event (Ramadhani, 2022) .

Boiler Cases in Indonesia, there are several cases of accidents that occurred in boilers, both in several small and large companies. One example is; Cracker factory in Kaliwates District, Jember Regency. In May 2002 there was an accident that killed 4 workers, also at the tofu factory in Taman Sidoarjo. In January 2005 an accident occurred which killed 2 workers (Fariz & Andung Jati Nughroho, 2023).

In accordance with the research results of Muhammad Rizal Jaelani (2021) with the title Hazard Analysis and Work Safety Risk Management in the Boiler Area of PLTU Pelabuhan Ratu (Hazard Analysis and Work Safety Risk Management of PLTU Pelabuhan Ratu Boilers), in this research there are 3 factors which constitute the risk of danger. can cause accidents are; noise, slipping, oil spills due to steam pipe leaks, and extreme temperatures due to pressurized steam leaks (Jaelani, 2021) .

The Generation Implementation Unit of PT PLN Nusantara PLTU MW X in the operational area of PT PLN Unit Nusantara Power. Implementing Generation PLTU uses steam media that comes from water that is burned in a coal-fired boiler. So that it produces pressurized steam to be able to rotate a turbine whose axis is coupled to a generator so that an output is obtained in the form of electrical energy that can be utilized (UPK X Profile, 2024) .

Based on the initial data obtained in the Boiler section of the PLTU Nusantara *Power* , and large financial losses namely; The danger of injury, broken fingers and broken bones, during boiler maintenance and repair activities, with the location of the boiler at extreme heights and temperatures can potentially cause danger. The results of this data were obtained from HIRARC sources in the company. As well as selecting locations based on data and articles, it was found that there were complaints from residents regarding the impact of coal burning ash pollution, where the dust left over from burning coal contains particles that are dangerous to residents' health. (UPK X Profile, 2024) .

Based on the data obtained, the researcher will choose the title "Analysis of Potential Hazards in the Boiler Section Using HIRARC in the Steam Power Plant Implementation Unit (PLTU) X. The reason for choosing this title is based on the data obtained at that time. This started with researchers who conducted a survey where it was found that boilers had potential dangers and risks that could cause work accidents and cause work-related illnesses.

The purpose of this research is to find out how to analyze potential hazards in the PLTU boiler section using *HIRARC* in the PLTU Nusantara Power X Generation Implementation Unit.

## Method

This research is research that uses qualitative methods with an in-depth interview approach. The location of this research was carried out at *the* Steam Power Plant (PLTU ) is based on certain considerations that are based on previously known characteristics and characteristics of the informant, namely 1 main informant (K3 & Security Team Leader), 3 permanent workers who are key informants (boiler unit section and SSR team) and 2 supporting informants, namely 1 person (Junior K3 & Security Technician) and 1 person (K3 & Security Security Technician). The



instrument used is a questionnaire sheet, the questionnaire used is a measurement of potential hazards which begins with a process of hazard identification, risk assessment and control efforts. By using the HIRARC method, this method is used to analyze the level of safety and risk for workers in the PLTU X boiler unit. By comparing the existing HIRARC method with conditions in the field in accordance with the HIRARC standards that have been set for assessment. Data processing was carried out to find factors causing the high number of accident problems in the PLTU X boiler unit.

## Results

### Identify hazards

The results of interviews with key, main and supporting informants revealed that there were potential dangers in the boiler production and maintenance section. The following is the informant's statement;

1. Any activities that have potential dangers to the production and maintenance of boiler units

*"Because we work in hot places, a lot of people are exposed to heat. If you go around, check the hot boiler area and also if there are repairs in high places such as welding" (Informant 002)*

*"Potentially dangerous activities in boilers are when we want to drain the material first, secondly during combustion when we turn on the burner where the burner is the source of fire for the initial combustion in the furnace" (Informant 003)*

*"Patrol inspection is also potentially dangerous, maneuvering steam valves at high pressure is dangerous, maneuvering and monitoring valves at high temperatures and extreme temperatures is potentially dangerous" (Informant 004)*

Based on the results of interviews conducted by researchers with informants regarding activities that have the potential to cause danger in the boiler production and maintenance section, it was found that there were potential dangers when workers carried out patrol inspection activities and during the combustion and ignition processes. burner. activity. And the boiler working environment is located at a height with hot temperatures, high temperatures can pose potential dangers to workers

2. All kinds of hazards may arise in the production and maintenance of boiler units

*"Because the boiler area is hot, noisy and lots of dust, extreme temperatures" (Informant 002)*

*"The dangers that arise in boilers are exposure to heat radiation, high levels of engine noise, potential air pollution due to coal dust" (Informant 003)*

*"Because we process steam, the steam is at high pressure, the temperature is extreme because it is above 200-300 degrees, the elevation is the same because our boiler level is quite high" (Informant 004)*

Based on the results of interviews conducted with informants regarding the types of dangers that might arise in the boiler production and maintenance section, the informants stated that the dangers that arise are caused by machine sounds that cause high levels of noise, as well as boiler noise. work areas located at heights, and hot temperatures that arise because the boiler work area is a hot area so it is open to physical dangers, have the potential to arise in the boiler production and maintenance section.

3. What sources of danger exist in the production and maintenance of boiler units?

*"Moreover, there is a danger of heat and temperature here, because the boiler area is open.*

*"If it rains, the floor is slippery because there are lots of puddles of water, because of the height you can slip" (Informant 002)*



*"The source of danger is that we could fall from a height, there is the potential for an explosion in the boiler equipment" (Informant 003)*

*"Danger of noise, extreme temperatures and high pressure during steaming" (Informant 004)*

Based on the results of interviews conducted with informants regarding what sources of danger exist in the boiler production and maintenance section, the informant stated that in the work environment the boiler area has a high level of elevation, and open areas can cause dangers such as; falls from heights, slippery floors due to puddles of water, and the risk of noise arising from the sound of machines in the boiler work area.

4. Are there any types of physical hazards, chemical hazards, ergonomic hazards and psychological hazards in the production section?

*"There are definitely physical, chemical, ergonomic and psychological hazards. Physical hazards such as injuries, bumps or slips, being missed while in the field, chemical hazards are definitely referred to as production parts that definitely use chemicals but what is certain is that we have PPE and HIRARC documents for identification, ergonomic hazards such as work equipment such as benches. not suitable for use, and psychological danger in the production section is definitely possible due to the level of work stress" (Informant 001)*

*"Regarding the types of hazards, including physical hazards, chemical hazards, ergonomic hazards and psychological hazards, we will definitely summarize them in UPK X and record them in HIRARC" (Informant 005)*

*" At PLN*

Based on the results of interviews conducted by researchers with the main and supporting informants who are workers in *the safety center unit* regarding the presence or absence of physical hazards, chemical hazards and psychological hazards in the boiler production and maintenance section, it was concluded that the results obtained were that the informants stated that there were potential hazards. . . related to physical dangers such as; injuries, impacts, slips and accidents while in the field, and chemical hazards arising from the use of chemicals in the production process, as well as ergonomic hazards regarding work equipment that is no longer suitable for use, and psychological hazards that arise in the work. . workers due to work stress levels.

### Results of Risk Assessment Research at PLTU X

The results of interviews conducted by researchers with informants regarding risk assessment, in activities in the boiler area of course there are risks that can cause work accidents, this was explained by key informants consisting of employees who work in the boiler and SSR areas, and is also explained in the HIRARC 2024 table carried out by the PLTU X team. The following is the informant's statement and the *PLTU*

### Risky task

1. What are the causes of work accidents in the production and maintenance section of boiler units?

*"The causes of work accidents are usually due to worker negligence, workers who are careless, lack concentration, and usually do not wear complete PPE" (Informant 002)*

*"The cause of the accident was that we did not wear PPE properly, secondly because the lighting in the area was inadequate" (Informant 003)*

*"Usually one of the causes is because it is located high, we are worried that it will cause falls and so on, our equipment leaks, steam comes out, high pressure, high temperature" (Informant 004)*



Based on the results obtained by researchers when conducting interviews with informants regarding the causes of work accidents in the boiler production and maintenance section, the informants stated that the causes of work accidents occurred due to worker negligence and lack of concentration, as did the workers. 'disobedience in using PPE when carrying out activities in the boiler work environment.

2. What are the risks arising from work accidents that occur in the boiler production and maintenance section?

*"The risk if we get injured is that there are minor injuries and there are also serious injuries, but mostly I think it's because we have earplugs from the office, but sometimes we don't use them so it's a bit messy" (Informant 002)*

*"There is the potential for injury if you do not use PPE, the second is hearing loss due to noise" (Informant 003)*

*"One of them may be the risk of burns due to exposure to high temperatures, then there is the risk of hearing due to noise, and there is also the risk of falling from a height due to the height" (Informant 004)*

Based on the results of interviews conducted by researchers with informants, regarding the risks arising from work accidents in the boiler production and maintenance section, the informants stated that there were risks such as minor injuries, serious injuries, noise and the risk of work accidents. falling from a height due to activity. working in the boiler area, this risk arises due to workers' non-compliance in using PPE such as earplugs.

HIRARC PLTU X in 2024, there are risks that arise in the production process and boiler maintenance activities based on risk categories and severity levels. The following is the HIRARC PLTU X table .

Table 1 Assessment (Risk Category)

Level	Criteria	Information
1	Low	Risks that have little impact on the company
2	At the moment	Risks that only cause damage to assets without disrupting the company's financial performance, only cause small losses to humans
3	Tall	Risks that cause failure to achieve performance, damage reputation, threaten human safety, environmental damage and company security
4	Very high	Major injuries and major losses
5	Extreme	Risks that cause disasters, cessation of company business and cause human deaths

NO	Activity	Danger	Risk Category	Possibility				
				1	2	3	4	5
1.	Makeup Pump Operation	Noise	Low			✓		
2.	Condenser Operation	Fall from a height	Low			✓		
3.	Induces Fan Operation	Electric shock	Low			✓		
4.	Condensate Pump Operation	Noise	Low			✓		
5	Boiler Feed Pump Operation	Noise	Low			✓		



NO	Activity	Danger	Risk Category	Possibility			
6.	Dearator Operation	Exposure to hot media	Low			✓	
7	Mixed Bed Operations	Exposure to chemicals	Low			✓	
8.	Intake and Pump Area	Dragged by the current	Low			✓	

Table 2 Risk Assessment Table (Severity Level)

Severity Level	Information
D.L	Environmental impact
dialect	Environmental Sanctions
C.M	Human Injuries
WE	Asset
MAX	Maximum

Table 3 HIRARC 2024 PLTU X

Activity	Danger	The severity				
		D.L	dialect	C.M	WE	MAX
Makeup Pump Operation	Noise	1	1	1	2	2
Condenser Operation	Fall from a height	1	1	2	1	2
Induces Fan Operation	Electric shock	1	1	2	1	2
Condensate Pump Operation	Noise	1	1	1	2	2
Boiler Feed Pump Operation	Noise	1	1	1	2	2
Dearator Operation	Exposure to hot media	1	1	2	1	2
Mixed Bed Operations	Exposure to chemicals	1	1	1	1	1
Intake and Pump Area	Dragged by the current	1	1	1	1	1

### Results of Research on Hazard Control at PLTU X

From the results of interviews conducted by researchers with main and supporting informants, regarding the control efforts carried out by the company in handling work accidents. The following is the informant's statement;

1. What actions does the company take to overcome work accidents that occur in the production department?

*"Before we start working, there is a WO (work order). This WO is the basis for every part of production to start a job, then there is IKA (work instructions) or SOP, and there is also JSA (work safety). analysis), and the production section must have a HIRARC/IBPPR document. "This document is a form of administration in preventing work accidents in the production department" (Informant 001)*

*"Regarding handling work accidents, we are related to K3 and management, we provide outreach regarding safe working conditions, then the company itself will continue to provide PPE and later we can also prepare SOPs (operational standards) so that*



*undesirable things don't happen. . occurred, provided K3 training, and also installed safety signs in the UPK X environmental area " (Informant 005)*

*"One of them is that we carry out safety inductions, we routinely carry out outreach, training, simulations, and we carry out all K3 programs regularly including patrols and so on for an K3 culture" (Informant 006)*

Based on the results of interviews conducted by researchers with informants regarding what actions the company took to overcome work accidents that occurred in the production department, the informant stated that before carrying out work activities, *WO (work orders) were implemented* as the basis. for each production part, *IKA (instruction). work) or SOP, and JSA (work safety analysis )* and of course the company has a *HIRARC/IBPPR document* as an administrative document to prevent accidents, and from the K3 side, management provides outreach regarding the creation of safe working environment conditions, and the company provides PPE, and installs safety signs in the boiler work area.

2. Does the company provide personal protective equipment for workers during the production process?

*"Regarding personal protective equipment, you can check Law NO 1 OF 1970 in chapter 8 of workers' obligations and rights, we have provided personal protective equipment and we do this based on Law NO 1 of 1970 and PP 50 of 2012, in chapter 8. article 12, and Article 9 is the obligation when entering the workplace and article 10 is the operator's obligation, so the instructions in article 8 are that workers must wear the required personal protective equipment, and we have arranged the PLTU itself into 4 zones, namely green, red, yellow and purple zone. Chapter 9 article 13 everyone who enters the workplace is obliged to comply with safety instructions and wear personal protective equipment that is required for the workers they lead and so on, so that we adapt everything to statutory regulations. (Informant 001)*

*"The company has provided PPE including safety helmets and safety shoes" (Informant 005)*

*"We provide mandatory PPE and additional PPE to support friends in carrying out their work activities in accordance with the potential dangers that exist, for example at height wearing a body harness and welding using a welding helmet and so on" (Informant 006)*

Based on the results of interviews conducted by researchers regarding whether the company provides personal protective equipment for workers during the production process, the informant stated that regarding PPE, the company implements regulations in accordance with Law NO 1 of 1970 in CHAPTER 8 Article 12 concerning the obligations and rights of workers and waste. . defecate. 9 Article 13 Concerning obligations when entering the world of work

3. In the production system are there elimination control efforts?

*"There must be elimination, for example we carry out an inspection of the work environment regarding ergonomic hazards, for example we carry out an inspection, check or audit from an outside party, we find a table or chair that is not functioning. it is no longer suitable for use" (Informant 001)*

*"If elimination rarely happens, most of us are more administrative, for example in operations how to carry out good operations so that accidents don't happen, we prepare SOPs, entry permits, and if for example we want to work, we have to have them. safety permit" (Informant 005)*

*"As far as I know there has never been an elimination effort" (Informant 006)*

Based on the results of interviews conducted by researchers regarding whether there were elimination control efforts in the production system, informant 001 stated that



elimination would definitely occur, especially in the field of ergonomics related to benches, chairs and tables that were no longer suitable for use, the company carried out elimination actions, and informant 005 and informant 006 stated that there had been no elimination control efforts, what companies often do in controlling efforts is administrative efforts.

4. Has there ever been a replacement of materials in the production system?

*"Of course in the name of production there must be a period of use of these materials" (Informant 001)*

*"As for the materials, of course we will replace materials that are time to be replaced because if they are not replaced, for example the ID fan motor will last a lifetime. both personnel in the field and "for example, the equipment itself is tired, the bearings are dry, the bullet will break if rotated, eventually the fragments will hit personnel at that location and can also cause damage. fan ID motor part" (Informant 005)*

*"Yes, that's why we replace it with more sophisticated, safer materials, so that more electricity can be produced" (Informant 006)*

Based on the results of interviews conducted by researchers with informants regarding whether there had ever been an effort to replace materials in the production system, in these efforts the informant stated that this would definitely happen, especially for materials that had expired and were suitable for replacement. . , the company replaces the material, because if not done so it could endanger both personal and equipment itself

5. In the control effort there is technical control, has this ever happened in a production system?

*"What is certain is that technical control is definitely in place" (Informant 001)*

*Regarding modifications, repairs need to be made to the unit. For example, if we analyze a furnished boiler, there is a boiler pipe containing water which is protected by the refractory. Here the system is for burning blown coal material. "So if, for example, coal is eroded then the refractory is damaged and if it is damaged the pipes are automatically eroded and if they are eroded thinly and leak then the unit cannot operate and as a result, in the end, apart from improving the refractory, the pipes will also be coated" (Informant 005)*

*"Each overhaul carries out comprehensive repairs, there is a role for engineering control so that there is engineering so that the equipment is safe to operate" (Informant 006)*

Based on the results of interviews conducted by researchers regarding whether there had been an effort to control engineering on the production system, in this effort the informant stated that engineering control was an effort to modify the boiler work equipment system, so that when the equipment could operate. This can create safe tools and reduce the risk of work accidents.

6. Administratively, are the efforts applied to the production system in accordance with standards?

*"Many of the things called administration are in the form of documents, such as work permits, what the WO is like, what the JSA is like, whether there is an IKA or SOP which is a form of administrative control to prevent accidents. in the field" (Informant 001)*

*"While we update the SOP, and IKA and related matters, they are according to standards, yes they are according to standards" (Informant 005)*

*"For the administration itself, there are many SOPs, IKA, JSA, permits and work orders, then there are also IBPPR procedures" (Informant 006)*

Based on the results obtained by researchers in interviews regarding whether administrative control efforts have been implemented and in accordance with applicable standards, the informant stated that the company implements IKA (work instructions), JSA (



work safety analysis), HIRARC/IBPPR , as well as work accident prevention efforts to realizing a ZERO ACCIDENT company

Table 4 HIRARC PLTU X Hazard Control

NO	Activity	Control Efforts				
		Elimination	Replacement	Manipulation	Administrative	PPE
1.	Makeup Pump Operation	Engineering, Administration, and PPE				
2.	Condenser Operation	Administration, and PPE				
3.	Induces Fan Operation	Engineering, Administration, and PPE				
4.	Condensate Pump Operation	Engineering, Administration, and PPE				
5.	Boiler Feed Pump Operation	Engineering, Administration, and PPE				
6.	Dearator Operation	Administration, and PPE				
7.	Mixed Bed Operations	Administration, and PPE				
8.	Intake and Pump Area	Administration, and PPE				

## Discussion

### Identify hazards

Based on the results of observations made in the boiler area unit, in the *Drain bed material work activities, and in the Firing (Start burner) process*, where the burner activity is related to the fire source which is the initial combustion process in the furnace. in the boiler area. According to workers at PLTU SSR Dangers that have the potential to arise in the boiler area are noise, radiation and exposure to dust due to coal dust.

Based on the results of the hazard identification carried out in the working area of the X Electric Power Plant (PLTU) boiler, there are types of hazards, namely; physical, mechanical, chemical and psychological hazards. Based on the theory used by researchers according to (K.Ima Ismara & Eko Prianto, 2016) regarding the types of hazards consisting of, mechanical hazards, electrical hazards, physical hazards, biological hazards, chemical hazards and ergonomic hazards, and based on the source and cause of the hazards they are differentiated. . into 3 types, namely human factors, external factors, and management systems, and according to related research (Suci Ramdhani, 2020) states that at industrial work locations there are types of hazards consisting of physical hazards, chemical hazards, mechanical hazards, electrical hazards, biological, chemical hazards, and ergonomic hazards.

Regarding the types of hazards that can cause noise, based on the threshold value (NAB) in accordance with the Decree of the Minister of Manpower number 51/MEN/1999 concerning the maximum noise threshold in the work area, for 8 working hours/day. Without using ear protection, 85 Db. If the noise level exceeds the threshold, it will cause hearing loss and cause deafness (Minister of Manpower of the Republic of Indonesia, 1999) . The resulting noise can cause hearing problems for workers. This danger comes from unsafe conditions due to noise generated by components on machines in the boiler work area, and in this work activity there is a gap where there are workers who do not comply with the regulations for using PPE in the form of *earplugs/earmuffs*. when carrying out work activities. .

Based on observations made directly by the researcher, there are dangers in the boiler work environment which can cause accidents to workers, so the researcher is of the opinion that there is a need for hazard identification measures when the K3 party supervises/ *monitors* boiler work



activities. , and it would be better if the company makes preventive efforts by making hazard warning boards placed in every area of the boiler work environment, and the company continues to maintain the creation of *HIRARC recording documents* which consist of hazard identification, risk assessment and hazard control. . , as well as providing hazard awareness to workers.

## Risky task

### 1. Noise

Noise during boiler work activities such as; *Make Up Pump Operation* , *Condensate Pump Operation* , *Boiler Feed Pump Operation* . Has potential dangers that can cause hearing loss. With a probability level of 3 and categorized as low risk and a severity level of 1 (environmental impact), 1 (environmental sanctions), 1 (human injury), 2 (assets), and 2 (maximum). This assessment was carried out by PLTU X company within the last 1 year. This condition occurs because of unsafe conditions caused by the boiler work area containing components with high noise levels, and this condition also occurs because workers do not comply with the use of PPE such as earplugs/earmuffs.

According to research conducted by (Ningrum, 2021), not using personal protective equipment during boiler work activities can cause noise hazards. It is categorized as low because in the boiler work environment a special room with thicker walls/soundproof room is provided, and a monitor is provided so that SSR team workers can monitor machine activity via the monitor.

### 2. Falling, stumbling and stumbling from a height

In the boiler working system, in the activity of operating *the condenser* by opening/closing *the condenser machine* there are risks that can occur such as falling, slipping and tripping from a height. These factors can cause mild to moderate injuries and can even cause death. With a probability level of 3 and categorized as low and a severity level of 1 (environmental impact), 1 (environmental sanctions), 2 (human injury), 1 (assets), and 2 (maximum). The results of this assessment were carried out by PLTU X within the last 1 year.

According to *the New British Standard* in (Ningrum, 2021) dangers that can occur include falling, slipping and tripping when working at heights.

This risk can occur because work activities are at a height and the work environment is in an open boiler area so that when it rains the floor is slippery due to standing water.

### 3. Electric shock

In work activities, *the Indunce Draft Fan operating system* has risk factors that cause work accidents with the danger of burns and seizures. This condition has a probability factor of 3 and is categorized as low and the severity level is 1 (environmental impact), 1 (environmental sanctions), 2 (human injury), 1 (assets), and 2 (maximum). The results of this assessment were carried out by PLTU X within the last 1 year. In line with research conducted by (Suci Ramdhani, 2020) that electrical hazards can result in dangers such as; fire, lightning and electric shock

This danger comes from unsafe conditions and if this danger is not followed up then one of the boiler components will not only experience financial and material losses for the company but will endanger the safety of workers.

### 4. Exposure to hot media

*Dearator* , in the action of opening/closing *Steam Extraction To Dearator*. There is a risk of causing health problems because this activity involves hot equipment and hot temperatures. With a probability factor of 3 and categorized as low. And severity levels 1 (environmental impacts), 1 (environmental sanctions), 2 (human injury), 1 (assets), and 2 (maximum). The results of this assessment were carried out by PLTU X within the last 1 year. This danger occurs



because unsafe conditions when checking the opening/closing of the machine involve high steam pressure, which poses a risk to workers.

#### 5. Exposure to chemicals

*Mix Bed* , the *mix bed regeneration process uses acid and caustic* chemicals . It has a dangerous level of risk because the chemical itself can cause health problems such as; corrodes the skin, eyes and mucous membranes (lining of the nose, mouth and throat and lungs) if it comes into direct contact with this chemical. And it has a probability factor of 4 with a low risk level and a severity level of 1 (environmental impact), 1 (environmental sanctions), 1 (human injury), 1 (assets), and 1 (maximum).

The results of this assessment were carried out by PLTU X within the last 1 year. In line with research conducted (Suci Ramadhani, 2020). This danger occurs due to unsafe conditions resulting from oil spills which, if exposed to workers, can be dangerous and cause irritation to the skin and make breathing difficult due to inhaling the smell of oil. And in the activities carried out by workers at PLTU X, this danger can also occur if they do not use complete PPE when carrying out their actions, such as; gloves, and mask.

#### 6. Swept away by the current

*Intake and Pump Area* , carrying out rubbish cleaning activities can pose a risk of drowning and being carried away by the current. With a probability factor of 3 and low risk categories and severity levels of 1 (environmental impact), 1 (environmental sanctions), 1 (human injury), 1 (assets), and 1 (maximum). The results of this assessment were carried out by PLTU X in the last 1 year. These activities can occur because workers are not focused in carrying out their activities and there is negligence on the part of the workers.

### Risk control

Once a hazard is identified, the next step is to take action to control the risk. This is done with the aim of reducing the risk of work accidents that can arise, the many dangers that arise can cause risks as well as disruption and loss in carrying out work activities.

Based on the results of observations and direct observations made by researchers at the Steam Power Plant (PLTU) X, the company has implemented risk control efforts in accordance with the applicable risk control hierarchy standards. In line with related research according to (Ningrum, 2021) that the control hierarchy consists of elimination, substitution, engineering, administration and PPE. In preventing and controlling dangerous risks arising from several levels sequentially.

According to workers in the K3 environment at the *Safety Canter unit*, in controlling hazards the company carries out outreach actions, creates SOPs, creates a safe work location, and completes *safety signs* in the work environment. The company also implements an K3 risk control hierarchy consisting of; elimination, substitution, technique, administration, and PPE. Based on Law NO 1 of 1970 concerning PPE, the company has provided personal protective equipment that can be used by workers in an effort to reduce work accidents, as well as K3 parties who always carry out patrol checks in monitoring the work environment of PLTU X. area. . And companies must also maintain administrative control efforts so that not just any outside party enters the industrial area.

PLTU itself has implemented hazard control efforts to minimize the dangers that can arise as a result of work activities, because PLTU itself is a large industry that has high risks and dangers. And the following are the control efforts carried out by the company in taking action to reduce the risk of work accidents and achieve the goal of making the work environment *ZERO ACCIDENTS*.



## Source Triangulation

Table 5 Source Triangulation

Informant Questions	Informant's Answer	
	Infoman 003	Informant 004
What activities have potential dangers in boiler production and maintenance activities?	During <i>the Drain Bed Material activity</i> and during <i>the Burning process (Start Burner)</i> it is a source of fire and initial combustion in furniture.	During patrol inspection activities, maneuver high pressure, high temperature, and altitude steam valves
	Informant 001	Informant 005
In the production system, are there elimination control efforts?	Elimination control will definitely occur, perhaps from an ergonomic perspective, such as chairs and tables that are no longer suitable for use.	Elimination control has not yet occurred, more emphasis is placed on administration, by creating SOPs, entry permits, and carrying out good operational actions

## Data Triangulation

Data triangulation is the act of exploring information using data sources, such as; documents, archives and interview results. Based on data obtained by researchers regarding existing hazards, from HIRARC PLTU

## Research Limitations.

In conducting research there are limitations regarding resources, considering the limited number of informants which only consists of 6 informants, so the research results cannot be generalized to a wider population.

## Conclusion

Based on the results of research that has been carried out, it is known that from the activities carried out by workers there are potential dangers that may occur in the boiler environment, namely: physical dangers (noise, extreme temperatures, and exposure to coal dust). , mechanical hazards (falling, slipping, tripping from heights and electric shock), chemical hazards (use of oil/chemical lubricants), and psychological hazards due to stress/workload levels. Australian Standard/New Zealand Standard (AS/NZS) 4360:2004 risk assessment classification and based on the HIRARC Table PLTU , severity levels are based on: environmental impact, environmental sanctions, human injury, assets, and maximum. And 3 activities on *condenser operation, induction fan operation, and deaerator operation*. This activity has a severity rating of 2 for human injury. In controlling hazards, the Steam Power Plant (PLTU) X company applies risk controls in the form of: elimination, substitution, engineering, administration and PPE. Regarding PPE, the company has provided and workers have the right to use PPE, in accordance with the regulations contained in UUD NO 1 OF 1970 in chapter 8 article 12 and chapter 9 article 13 concerning the obligations and rights of workers as well as obligations when carrying out work. enter the world of work. workplace. And regarding workers' behavior in using PPE, it is still found that workers do not comply with the use of PPE (personal protective equipment) which causes a high risk of work accidents.



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