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Occupational Health and Safety

Analysis of Potential Work Accidents at PT. XYZ Using The Hazard and Operability Study Method

Akh Sokhibi^{a,*}, Moh Agung Dwiyulianto^b

^{a.b}Department of Industrial Engineering, Universitas Muria Kudus, Kayuapu Kulon, Kudus, 59327, Indonesia

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CORRESPONDING AUTHOR

Phone: E-mail: akh.sokhibi@umk.ac.id

ABSTRACT

Electricity is a major economic factor in Indonesia. Providing electric power is divided into three processes, namely generation, transmission and distribution. PLN is one of the electrical energy providers in Indonesia which plays an important role in providing sufficient electricity for daily activities, industry and other sectors. K3 is an important factor that must be applied to PLN because it is related to electricity. The Transmission and Substation Service Unit (ULTG) carried out time-based maintenance, condition-based maintenance and emergency maintenance and it was found that one of the workers was not using complete Personal Protective Equipment (PPE) when checking the Lightning Arrester (LA). So research is needed with the aim of analyzing K3 in the activity process to determine potential hazards and hazard risk levels. Descriptive research methods are used to analyze the risk of work accidents that may occur during maintenance. This research uses the Hazard and Operability Study (HAZOP) method to determine the value of possibilities and consequences by distributing questionnaires to K3 supervisors. PT. A B C. The results show six hazards with a high risk level, one hazard with a medium risk level, and six hazards with a low risk level. High risk caused by material, electrical voltage and work attitude. Risk controls include testing equipment and PPE several times a year, refilling PPE, complying with SOPs, and providing drinking water. Hazard control efforts at PT. ABC includes the use of the HAZOP method, implementation of clear SOPs, provision of appropriate PPE, routine equipment checks, and emergency response plans in emergency situations.

1. INTRODUCTION

Occupational safety and health or commonly abbreviated as K3 is important and cannot be separated from a labor system and human resources in an industry. A qualified, productive, and competitive workforce will increase work productivity. Health conditions are the main capital of workers in carrying out their duties, unhealthy work environment factors are also an additional burden for workers beyond the tasks given to them by the company. Management of worker health and the work environment is expected to create work synergies that can increase work productivity [1].

Given the important role of labor in a company, the safety and health conditions of the workforce need to be of particular concern so that workers can carry out their duties properly. In addition, occupational safety and health is the human right of every worker. A safe and healthy work environment is an important element in supporting the safety and health of the workforce. The implementation of occupational safety and health (K3) is an effort to create a workplace that is safe, healthy, and free from environmental pollution, so as to reduce or free from work accidents and occupational diseases [2].

Activities related to electricity will be very dangerous if not equipped with personal protective equipment, both for field employees and office employees. Power generation companies must have a competent workforce in accordance with their role. The company is required to be able to pay more attention to the safety and health of employees, so that they can be able to realize the goals of the company.

PT. ABC is engaged in transmission services which has the main function of managing distribution installation assets (transmission and substations) and maintaining installation assets to maintain the continuity of high-voltage electricity distribution efficiently, reliably and environmentally friendly. When carrying out routine 2-year maintenance work at PT. ABC, there is one worker who does not wear complete Personal Protective Equipment (PPE), during the process of checking the Lighting Arrester (LA) this is the cause of a work accident.



Figure 1. Maintenance of MTU Bay jepara 2

Several previous studies related to work accident prevention measures have been carried out, with the results found that the highest potential hazards occur in the classification of work procedures, namely as much as 50% [4]. Next, another study obtained results, namely the existence of 5 sources of danger (hazard) [5]. Then the highest level of risk is found in the source of danger (hazard) conveyor schingga can be considered to get the most important improvements. Then another study found 50 types of potential hazards with 3 risk categories that have the potential for work accidents to occur [6]. With the following details: one source of danger in the high risk category, 6 sources of danger in the medium risk category. Then improvements are also made such as K3 training, supervising work, and carrying out maintenance on machines and other equipment.

Based on these existing problems, this research was prepared with the aim of conducting a risk analysis of occupational safety and health at PT ABC so that it can take control and prevention measures against hazards that have the potential to appear in the workplace.

2. LITERATURE REVIEW

2.1. Occupational Safety Health (OSH)

The general understanding of safety is aimed at ensuring that work is carried out without occupational diseases and accidents. Therefore, all workers in the workplace must create safety in the work environment so that it is not dangerous in order to achieve the goal of optimal work results. [7].

From a philosophical point of view, Occupational Safety and Health (OSH) can be interpreted as a form of effort that ensures labor is given protection, perfection of worker integrity and work culture, as a whole providing welfare to workers (both physical and spiritual). While from a scientific point of view, Occupational Safety and Health (OSH) is determined from knowledge and its application to accidents, explosions, fires, pollution, diseases and other events. [8].

2.2. Hazard and operability study (HAZOP)

HAZOP can be defined as a standardized procedure whose use aims to establish safety in new or modified systems for possible risks or potential hazards [9].

The likelihood criteria are used to calculate the probability of an accident risk occurring based on the frequency per unit of time (day, month, year). Meanwhile, the consequences criteria refer to the impact of risk, which is classified based on the severity of the impact from potential risk events [10].

In conducting hazard analysis using HAZOP, the likelihood criteria are required. These criteria can be seen in Table 1. Meanwhile, the consequences criteria for risk assessment can be found in Table 2.

. .		Description				
Leve	Criteria	Qualitative	Semi-Qualitative			
1	Rarely happens	Can be imagined,	Happens less than			
		but only in extreme cases	once in 10 years			
2	Unlikely to happen	Hasn't happened	Happens once			
		yet, but may occur	within a 10-year			
		at some point	span			
3	Likely to happen	Should happen and	Happens once in 5			
		may have occurred	years to once			
		here or elsewhere	every year			
4	Very likely to	Can easily happen,	Happens more			
	happen	may occur in the	than once a year			
		most frequent	to once a month			
		situations				
5	Almost	Happens frequently	Happens every			
	certain to	expected in most	month or more			
	happen	frequent situations	than once a month			

Table 1 The Likelihood Criteria [10]

Decomintion

-		Description					
Leve	el Criteria	Injury Severity	Work Day				
1	Insignificant	The event does not cause injuries and does not result in material losses	No lost workdays				
2	Minor	The event causes minor injuries treatable with first aid and results in material losses	Lost workday on the same day				
3	Moderate	The event causes serious injuries requiring hospital treatment and results in moderate material losses	Lost workdays below 3 days				
4	Major	The event causes severe injuries leading to permanent disability and results in significant material losses	Lost workdays more than 3 days				
5	Catastrophic	The event results in fatalities and causes extensive material losses	Permanent loss of workdays				

In the risk severity assessment process using the risk matrix table, the likelihood and consequences values obtained are processed using the risk matrix table to determine the severity of the risk. Each color means a different score or risk value or risk level.



Figure 2. Risk matrix [12]

METHODOLOGY 3.

The method chosen for this research is the descriptive method because it aligns with the research objective of providing an objective overview of risk analysis for potential workplace accidents during the biennial maintenance process at PT. ABC. The research process is divided into 5 stages, namely:

- Stage 1, observation in the K3 section at ULTG kudus a. to find problems and conduct literature studies from scientific articles.
- b. Stage 2, interviews and documentation to obtain data on potential hazards and their sources.
- Stage 3, data on potential hazards and their sources are c. obtained to determine the level of hazard risk based on the risk matrix with reference to AS / NZS: 2004.
- Stage 4, discussion is conducted to determine d. improvement efforts
- Stage 5, conclusions and suggestions from the research e.



Figure 3. Research Stages

4. **RESULTS AND DISCUSSION**

4.1. Data Collection

Hazard and Risk Identification Data а

Process Hazard Bisk									
1100055	Findings	NISK							
Making work records	Recording errors	Work delay							
Moving	Equipment	Bruises, damaged							
equipment into	falling and	equipment							
the truck	hitting the worker								
Installing hazard	High	Dehydration							
signs at the work site	temperature								
Workers wearing	Harness	Bruises							
PPE	entanglement								
Conducting safety	High	Dehydration							
briefing	temperature								
Groundman	Equipment	Bruises, damaged							
preparing work	falling and	equipment,							
equipment &	hitting the	sprains, muscle							
lifting it onto the	groundman,	injuries							
scaffold	incorrect								
	positioning								
	while lifting								
Testing all MTUs	High	Respiratory							
at Bay Jepara 2	temperature,	issues, fatigue,							
and cleaning	vehicle noise,	dehydration, heat							
isolators with the	bad weather,	stroke, hearing							
help of the PDKB	slipping from	impairment and							
team, as some	ladder,	loss of							
	equipment	concentration,							
at Bay Jepara 2 and cleaning isolators with the help of the PDKB team, as some	temperature, vehicle noise, bad weather, slipping from ladder, equipment	issues, fatigue, dehydration, heat stroke, hearing impairment and loss of concentration,							

parts are still live (tools) work (under voltage) contacting delay/failure, falling from network and height, equipment grounding, PPE leakage damage, cuts/fractures, burns/ disability Testing LA Respiratory High temperature, issues, fatigue, (Lightning Arrester) vehicle noise. including tan delta bad weather, testing, insulation slipping from testing, contact ladder. loss of resistance testing, equipment and LA counter (tools) work contacting testing network and grounding, PPE damage, leakage n bruises, Testing CVT Bad weather, Respiratory (Capacitive slipping from Voltage ladder, Transformer) equipment including tan delta (tools) testing, insulation contacting loss of network and testing, and contact resistance grounding, PPE work testing leakage falling from damage, Testing of PMS High Fatigue, Line temperatures, (DS/Disconnectio bad weather, n Switch) includes slipping from insulation testing ladders. and contact equipment resistance testing. (keys) contacting the network and ground, PPE leakage. CT (Current high fatigue. Transformer) temperature, bad testing in the form weather slipping of tan delta from stairs, testing, insulation equipment (keys) exposed testing, and to the network contact resistance and ground tools. testing leakage PPE n bones, PMT (CB/Circuit high fatigue, Breaker) testing in temperature, bad the form of weather slipping stroke, hearing breaker testing, from steger / loss & loss of simultaneous stairs, equipment concentration, testing, insulation (keys) exposed delayed/failed testing, contact to the network work, fall from resistance testing, and ground height, broken and SF6 gas leakage PPE tools, lacerations/fractur testing.

dehydration, heat stroke, hearing impairment & concentration, delay/failure, falling from height, equipment cuts/fractures/ski electrical shock, burns/disability issues, fatigue, dehydration, heat stroke, hearing impairment and concentration, delay/failure, height, equipment cuts/fractures. burns/disability dehydration, heat stroke, loss of concentration. delayed/failed work, damaged equipment, skin tears/bruises. electric shocks, burns/disabilities. dehydration, heat stroke, loss of concentration. delayed/failed labor, fall from height, broken lacerations/broke burns/disabilities dehydration, heat

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es/skin bruises,

		electrocution,
		burns/disabilities
Groundman	equipment	Bruises, sprains
unloads work	fell on the	-
equipment	groundman,	
	wrong	
	position	
	when lifting	

b. Hazard source data

Table	4. Hazard source data		leakag	ge
Hazard Findings	Risk	Hazard Source		-
Recording error	Work postponed	Human negligence	High t bad w	temperatu eather,
Equipment fell on the staff	Bruises, broken equipment	Work attitude	slippii scaffo	ng from lding/lad
High temperature Entangled harness	dehydration Luka memar	Work attitude Kelalaian manusia	equip contac netwo	nent (key cting the rk and
High temperature Equipment fell on the groundman,	Dehydration Bruises, broken equipment,	Work attitude Material	ground leakag	d, PPE ge
wrong position during lifting	sprains, muscle injury			
High temperature, vehicle noise, bad	Respiratory problems, fatigue,	Electricity, material,	Equip	ment fell
from ladders,	dehydration, heat stroke, hearing	work attitude, weather	ground	dman,
contacting the network and	loss, loss of concentration, delayed/failed		during	g lifting
ground, PPE leakage	work, falling from heights, broken equipment, skin		c. Risk	assessme
	tears/fractures, burns/disabilities		Anal work of B	ysis of ha ay Jepara
High temperature, vehicle noise, bad	Respiratory problems, fatigue,	Electricity, material,	by multip value as fo	lying the ollows. T
weather, slipping from ladders, equipment (keys)	dehydration, heat stroke, hearing loss. loss of	work attitude, weather	be in the find o	torm of a ut the ris
contacting the network and	concentration, delayed/failed		R = 0	C x L
ground, PPE leakage	work, falling from heights, broken equipment, skin		where, R conseque	represen ences valu
	tears/fractures/brui ses, electric		Həzərd	Rick
	shocks, burns/disabilities		Findings	Work
Bad weather,	Respiratory	Human	error	nostnoi
slipping from	problems, fatigue,	negligence,	Equipment	Bruises
ladders, equipment	dehydration, heat	electricity,	fell on the	damage
(keys) contacting	stroke, hearing	material	staff	equipm
the network and	loss, loss of		High	Dehydı
leakage	delayed/failed		temperature	on
Теакаде	work, falling from		Entangled harness	Bruises
	equipment, skin		High	Dehydı
	tears/fractures,		temperature	on
	burns/disabilities		Equipment	Bruises
High temperature,	Fatigue,	Material,	roundman	uamage
bad weather,	dehydration, heat	human	groundman,	sprain
slipping from	stroke, loss of	negligence,	position	, sprain muscle
ladders, equipment	concentration,	weather	during	injury
(keys) contacting the network and	work, broken		lifting	5.5

equipment, skin

ground,	PPE
leakage	

	,
	burns/disabilities
High temperature,	Fatigue,
bad weather,	dehydration, heat
slipping from	stroke, loss of
ladders, equipment	concentration,
(keys) contacting	delayed/failed
the network and	work, falling from
ground, PPE	heights, broken
leakage	equipment, skin
	tears/fractures,
	burns/disabilities
High temperature,	Fatigue,
bad weather,	dehydration, heat
slipping from	stroke, hearing
scaffolding/ladders,	loss, loss of
equipment (keys)	concentration,
contacting the	delayed/failed
network and	work, falling from
ground, PPE	heights, broken
leakage	equipment, skin
	tears/fractures/brui
	ses, electric
	shocks,
	burns/disabilities
Equipment fell	Bruises, sprains

tears/bruises, electric shocks,

Electricity, material, weather

Human
negligence,
material,
electricity

Work attitude

. Risk assessment using Hazard and Operability Study

Analysis of hazards and risks in the 2-year maintenance work of Bay Jepara 2 is carried out by assessing the risk level by multiplying the likelihood value with the consequences value as follows. Then the results of the risk assessment can be in the form of a risk matrix. In the risk matrix table we can find out the risk level of the hazard findings.

$$R = C x L \tag{1}$$

where, R represents the risk level result, C represents the consequences value, and L represents the likelihood value.

Table 5. Risk assessment								
Hazard	Risk	Hazard	L	С	R	Risk		
Findings		Source				Level		
Recording	Work	Human	2	1	2	Low		
error	postponed	negligence						
Equipment	Bruises,	Work	2	2	4	Low		
fell on the	damaged	attitude						
staff	equipment							
High	Dehydrati	Work	2	3	6	Medium		
temperature	on	attitude						
Entangled	Bruises	Human	3	1	3	Low		
harness		negligence						
High	Dehydrati	Work	1	2	2	Low		
temperature	on	attitude						
Equipment	Bruises,	Material	3	1	3	Low		
fell on the	damaged							
groundman,	equipment							
wrong	, sprains,							
position	muscle							
during	injury							
lifting								

Hazard	Risk	Hazard	L	С	R	Risk	Hazard	Risk	Hazard	L	С	R	Risk
Findings High	Dognizator	Source Electricity	2	Л	10	Level	Findings	aquinment	Source				Level
tomporatura	Respirator	meterial	3	4	12	rign		equipment					
vehicle	y problems	material,						, SKIII toors/fract					
, venicie noise bad	fatique	attitude						ures					
weather.	dehydratio	weather						burns/disa					
slipping	n, heat	weather						bilities					
from	stroke.						High	Fatigue.	Material.	3	4	12	High
ladders,	hearing						temperature	dehydratio	human	-	-		8
equipment	loss, loss						, bad	n, heat	negligence,				
(keys)	of						weather,	stroke,	weather				
contacting	concentrat						slipping	loss of					
the network	ion, work						from	concentrat					
and ground,	delayed/fa						ladders,	ion, work					
PPE	iled,						equipment	delayed/fa					
leakage	falling						(keys)	iled,					
	Irom baighta						the network	damaged					
	damaged						and ground	equipment					
	equipment						PPF	, SKIII tears/bruis					
	skin						leakage	es electric					
	tears/fract						leakage	shocks.					
	ures.							burns/disa					
	burns/disa							bilities					
	bilities						High	Fatigue,	Electricity,	3	4	12	High
High	Respirator	Material,	3	4	12	High	temperature	dehydratio	material,				Ŭ
temperature	у	work					, bad	n, heat	weather				
, vehicle	problems,	attitude,					weather,	stroke,					
noise, bad	fatigue,	sun,					slipping	loss of					
weather,	dehydratio	electricity					from	concentrat					
slipping	n, heat						ladders,	ion, work					
from	stroke,						equipment	delayed/fa					
ladders,	loss loss						(Keys)	folling					
(keys)	1088, 1088						the network	from					
contacting	concentrat						and ground	heights					
the network	ion. work						PPE	damaged					
and ground,	delayed/fa						leakage	equipment					
PPE	iled,						e	, skin					
leakage	falling							tears/fract					
	from							ures,					
	heights,							burns/disa					
	damaged							bilities					
	equipment						High	Fatigue,	Human	3	4	12	High
	, skin						temperature	dehydratio	negligence,				
	tears/fract						, bad	n, neat	material,				
	es electric						slipping	bearing	electricity				
	shocks						from	loss loss					
	burns/disa						scaffolding/	of					
	bilities						ladders,	concentrat					
Bad	Respirator	Human	3	4	12	High	equipment	ion, work					
weather,	у	negligence,				-	(keys)	delayed/fa					
slipping	problems,	electricity,					contacting	iled,					
from	fatigue,	material					the network	falling					
ladders,	dehydratio						and ground,	from					
equipment	n, heat						PPE	heights,					
(keys)	stroke,						leakage	damaged					
the network	loss loss							equipment					
and ground	1088, 1088							, SKIII toors/froct					
PPF	concentrat							ures/hruis					
leakage	ion, work							es, electric					
Be	delayed/fa							shocks,					
	iled,							burns/disa					
	falling							bilities					
	from						Equipm	Bruises,	Work	3	1	3	Low
	heights,						ent fell	sprains	attitude				
	damaged						on the						

Hazard Findings	Risk	Hazard Source	LCR	Risk Level	[7]
ground					
man,					
wrong					
position					[8]
during					
lifting					
					LO1

Based on the hazard identification table, hazard sources and hazard risk level assessment, 6 activity processes with a high level of potential hazard risk, 1 activity process with a medium level of potential hazard risk and 6 activity processes with a low level of potential hazard risk are found. It is necessary to improve the 6 activity processes with a high level of potential hazard risk as soon as possible by implementing OHS controls in the form of Implementing clear Standard Operating Procedures (SOPs) for all operations and activities in the work environment. Providing appropriate PPE such as helmets, gloves, goggles, safety shoes, and ear protection, and ensuring all employees use them as needed. Conduct regular inspections of all equipment and machinery to ensure they are in good working order and safe to use. Prepare emergency response plans for situations such as fires, explosions or workplace accidents.

5. CONCLUSION

Based on the results of the research, it can be concluded that the source of hazard or potential danger at a high level of risk comes from materials, electrical voltage, and also work attitudes. Then 6 activity processes were found with a high level of potential hazard risk, 1 activity process with a medium level of potential hazard risk and 6 activity processes with a low level of potential hazard risk.

Suggestions for mandatory control measures from hazards in the high risk level category found are by testing equipment and PPE two to 4 times a year, adding PPE such as safety shoes, full face helmets and wearpacks. Linesman comply with SOPs and provide sanctions if they do not carry out SOPs, provide sufficient drinking water so that dehydration does not occur.

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APPENDIX

Table 6. Hazop Worksheet

No	Process	Hazard Findings	Risk	Sources of Hazard	L	С	R	Risk Level
1	Making work notes	Recording errors	Work Postponements	Human error	2	1	2	Low
2	Moving equipment into the truck	Equipment falling and hitting personnel	Bruising, damaged equipment	Work attitude	2	2	4	Low
3	Installing warning signs at the work site	High temperature	Dehydration	Work attitude	2	3	6	Medium
4	Personnel wearing Personal Protective Equipment (PPE)	Harness entanglement	Bruising	Human error	3	1	3	Low
5	Conducting a safety briefing	High temperature	Dehydration	Work attitude	1	2	2	Low
6	Groundman preparing work equipment & raising it onto the scaffold	Equipment falling and hitting the groundman, incorrect positioning while lifting	Bruising, damaged equipment, sprain, muscle injury	Material	3	1	3	Low
7	Workers testing all MTUs at Bay Jepara 2 and cleaning isolators with the help of the PDKB team, as there are still parts that are not de-energized (under voltage)	High temperature, vehicle noise, bad weather, slipping from the ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Respiratory disturbances, fatigue, dehydration, heat stroke, hearing impairment and loss of concentration, workers delayed/failed, falls from height, damaged equipment, lacerations/broken bones, burns/disabilities	Electricity, material, work attitude, weather	3	4	12	High
8	Testing LA (Lightning Arrester) including tan delta testing, insulation testing, contact resistance testing, and LA counter testing	High temperature, vehicle noise, bad weather, slipping from the ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Respiratory disturbances, fatigue, dehydration, heat stroke, hearing impairment & loss of concentration, work delayed/failed, falls from height, damaged equipment, lacerations/broken bones/bruised skin, electric shock, burns/disabilities	Material, work attitude, sun, electricity	3	4	12	High
9	Testing CVT (Capacitive Voltage Transformer) including tan delta testing, insulation testing, and contact resistance testing	Bad weather, slipping from the ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Respiratory disturbances, fatigue, dehydration, heat stroke, hearing impairment and loss of concentration, workers delayed/failed, falls from height, damaged equipment, lacerations/broken bones, burns/disabilities	Human error, electricity, material	3	4	12	High
10	Testing PMS Line (DS/Disconnection Switch) including insulation testing and contact resistance testing	High temperature, bad weather, slipping from the ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Fatigue, dehydration, heat stroke, loss of concentration, work delayed/failed, damaged equipment, lacerations/bruised skin, electric shock, burns/disabilities	Material, human error, weather	3	4	12	High
11	Testing CT (Current Transformer) including tan delta testing, insulation testing, and contact resistance testing	High temperature, bad weather, slipping from the ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Fatigue, dehydration, heat stroke, loss of concentration, workers delayed/failed, falls from height, damaged equipment, lacerations/broken bones, burns/disabilities	Electricity, material, weather	3	4	12	High
12	Testing PMT (CB/Circuit Breaker) including breaker testing, synchronism testing, insulation testing, contact resistance testing, and SF6 gas testing	High temperature, bad weather, slipping from scaffold/ladder, equipment (tools) contacting the network and grounding issues, PPE leaks	Fatigue, dehydration, heat stroke, hearing impairment & loss of concentration, work delayed/failed, falls from height, damaged equipment, lacerations/broken bones/bruised skin, electric shock, burns/disabilities	Human error, material, electricity	3	4	12	High
13	Groundman lowering work equipment	Equipment falling and hitting the groundman, incorrect positioning while lifting	Bruising, sprain	Sources of Hazard	3	1	3	Low