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# Occupational Safety and Health Risk Analysis with *HIRA* in Locomotive Maintenance at PT KAI (Persero) Daop VI Yogyakarta Locomotive Depot

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ABSTRACT

**Background:** Occupational Safety and Health (OSH) was an important aspect in the world of work to get degree of health productively, prosperous, and free from work disease. Risk management is required which includes hazard identification, risk analysis, likelihood, consequence, risk level, and risk treatment with Hazard Identification and Risk Assessment (HIRA). The research location in the unit of the locomotive dipo facilities of PT Kereta Api Indonesia (Persero) Operating Area VI Yogyakarta, it aims to analyze occupational safety and health risks in process of locomotive maintenance.
**Method:** This research used a qualitative descriptive by collecting data in the form of words and images. It was due to the application of qualitative methods, in addition to all the things collected will be examined. The approach used to a case study approach by determining in the form of program, activities, or a group of related individuals and this study consists of 6 informants.
**Results:** The results showed in Yogyakarta dipo locomotive unit such as gravity hazard, heat from diesel engine, limited space, noise, oil, heavy work equipment, heavy work media, electricity, and dust. In the risk assessment stage there are 2 hazards with extreme risk category, 3 high risk, 9 moderate, 4 low risk categories.
**Conclusion:** The risks from the job of locomotive maintenance were falling from the top of the locomotive, electrocuted, pinched, falling tools, exposed to engine heat, exposure form noise, dust, wind pressure, and oil slips. Administrative risk control in the form of Standard Operational Procedure (SOP) and provision of Personal Protective Equipment (PPE).



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## 1. Introduction

Occupational safety is an important aspect that must be upheld in the world of work. Likewise in the aspect of occupational health which is a healthy condition to get a degree of health, so that they are able to do things productively, prosperously, and free from Occupational Diseases (PAK).

Occupational safety and health aims to ensure the health and welfare of the workforce from their work and culture, then maintain a safe and comfortable work environment (Buntarto, 2015). An accident due to work is an event that occurs due to work or while carrying out work in the industry.

Broadly speaking, the occurrence of work accidents can be caused by two factors, namely human actions that do not meet work safety (*UNSAFE ACT*) and unsafe environmental conditions (*unsafe condition*) (Suma'mur, 2009). Hazards related to safety and health aspects in a job, in general, can be caused by hazardous activities *(unsafe action)* or hazardous conditions *(unsafe condition)* in its various forms (Ghuzdewan, 2015). Failure can arise as a result of the correct system or work procedure, but it is outdated, that is, it cannot function to keep up with technological developments, so it is not effective and efficient (Composer, 2006). This means that various things that trigger work accidents can actually be multi-caused, both as single and plural elements.

According to *International Labour Organization (ILO)* shows that accident data globally recorded as many as 313 million work accidents every year. This means that every 15 seconds there are 160 workers who are injured (International Labour Organization, 2013). Global data from *National Safety Council (NSC)* also stated that about 2.3 million workers died as a result of the incident (National Safety Council, 2015). Meanwhile, accident data in Indonesia in 2012 showed that there were 103,074 cases of work accidents with an average of 382 cases (PT Social Security [Persero], 2012). In Central Java and the Special Region of Yogyakarta (DIY) in 2015, there were 8,564 cases of work accidents in the work environment (Ariani, 2016).

PT Kereta Api Indonesia (Persero) is one of the State-Owned Enterprises (SOEs) engaged in public transportation both in the form of freight and non-freight transportation. PT Kereta Api Indonesia (Persero) has the largest facilities and infrastructure compared to other industries in Indonesia. Maintenance facilities are one of the facilities available to the company with the main task of maintaining the reliability of rail infrastructure, station bridges, electricity, signals, and other equipment. Based on the profile book data (PT Kereta Api Indonesia [Persero], 2013), explained that PT Kereta Api Indonesia (Persero) is a company that always prioritizes four main pillars, namely timeliness, service, comfort, and safety.

The results of initial observations at the facility unit of PT Kereta Api Indonesia (Persero) Operating Area (DAOP) VI Yogyakarta at the Yogyakarta Locomotive Depot show that the industry has implemented *ISO 9001:2008* quality standards and has a *SHE* Team based in Operation Area 2 Bandung and always checks in each DAOP Java Region. In addition, the care facility unit and *the SHE Team* have also carried out risk management related to Occupational Safety and Health (K3), but it has not been running well. As for risk management, it has been guided by the railway safety system, the implementation of the risk management system at the Locomotive Depot. However, in every work activity it is still necessary to do additional because the implementation of risk management is not comprehensive in every locomotive maintenance process. In the process of work, the locomotive depot facility unit cannot be separated from the risk that can cause work accidents both from work tools, materials, and work environment conditions.

Therefore, the Locomotive Dipo facility unit needs better risk management so that it can minimize high risks that can enhazards its workers. The purpose of this study is to analyze the level of occupational safety and health (K3) risk in the locomotive maintenance section in the locomotive depot facility unit of PT Kereta Api Indonesia (Persero) Operating Region VI Yogyakarta.

## 2. Research Methods

The type of research used is qualitative descriptive research by collecting data in the form of words, pictures, and not numbers, all of which are the key to what will be researched. The approach in this study uses a case study approach by determining cases in the form of programs, activities or groups related to time and place (Sayih, 2012). This research was carried out in the Locomotive Dipo facility unit of PT Kereta Api Indonesia (Persero) Operating Region VI Yogyakarta with the subjects in this study being *assistant manager* Yogyakarta locomotives, *Supervisor* Yogyakarta Locomotive Dipo, and four workers in each locomotive maintenance section of the Yogyakarta Locomotive Dipo.

The data collection technique in this study was carried out by interviews, observations with the *Job Hazard Analysis (JHA) form,* literature study and review of supporting documents. The data

analysis used is the analysis of the Milles and Huberman model which consists of *data reduction*, *display*, and *conclusion drawing* or *verification* which is carried out interactively and continuously, so that the data reaches saturation. The examination of the credibility of the data in this study was carried out by triangulation of methods and sources. Method triangulation is carried out by data collection, while source triangulation is carried out by conducting interviews and document reviews.

## 3. Results and Discussion

### 3.1. Research Results

3.1.1. Hazards in Locomotive Maintenance

Locomotive maintenance at the Yogyakarta Locomotive Dipo Facility Unit has various kinds of hazards in each part of its maintenance. The locomotive maintenance parts include diesel, electrical, mechanical, and wind inspections. The results of interviews with informants 1 and 2 showed that there were several hazards that could be experienced in the process of locomotive maintenance work, which are as follows.

> *"... In my opinion, it is hazardsous from the work environment from B3, HSD oil spills, oil. In addition, there are other hazardss from the heavy and massive work tools used, then there is also the hazards from the sound of the locomotive if it lasts for a long time can affect the workers."* (S1).

> "*Hazards in this workplace can arise from the tools used, slippery and risky work environments, as well as from the fleet itself, namely the locomotive* curtains" (S2).

This result is in accordance with the results of an interview with the supervisor of the MC section of locomotive maintenance, namely informant 3 and informant 4 who explained in detail and overall related to the hazardss that can arise in locomotive maintenance, which are as follows.

> *"... In my opinion, the hazardss in this part are the hazards of being pinched when opening the garden, being able to fall due to the high position of the locomotive roof, and heat during work due to the narrow space"* (S3).

> *"The hazards of the dismantling process of the gear box machine is because the tools used are heavy and the media being worked on is also heavy. most of the hazardss of heavy tools"* (S4).

The statement about the hazards was also strengthened by the results of interviews with the supervisor of workers in the MC section of other treatments, namely informant 5 as follows.

> *"The hazardss of locomative maintenance work include iron, heavy work tools, and slippery lower seats"* (S5).

3.1.2. Risks in Locomotive Maintenance

Locomotive maintenance work has various potential hazards that can pose a risk to its workers. Risks that can occur in the work environment, including hands pinched by the locomotive dag cover, scratched by the engine or work tool, falling from the height of the locomotive's roof, being hit by heavy objects or work tools, and so on.

> *"... if the risk is various, it can be hit by objects or work tools used, noise from the sound of the locomotive"* (S1).

> *"... In my opinion, I give an example of the risk that can arise from the work tools used because they are heavy, the work tools can come off, then from the means of transport and transport machinery if not tightened can fall or fall on the worker"* (S2).

The results are in accordance with the interviews that have been conducted with the supervisor of the diesel section, namely informant 3 and the supervisor of the electrical section of informant 5 as follows.

> *"... In my opinion, the risks in locomotive maintenance work in general can be hit by hard objects, slipped due to slippery, smashed and pinched when opening the locomotive dag, and heat from the diesel engine"* (S3).

*"... In my opinion, the risk in this work is the fall of objects from above in the form of work tools, keys, and others because of our position at the bottom. In addition, you can also slip even if you wear shoes, slippery oil can be risky"* (S5).

The following is a table of hazard and risk identification in the locomotive maintenance section at the Locomotive Dipo facility unit of PT Kereta Api Indonesia (Persero) Operation Area VI Yogyakarta.

**Table 1.** Identification of Hazards and Risks in Locomotive Maintenance

| It | Keja Process | Activity | Hazard | Risk | Control |
|---|---|---|---|---|---|
| **1.** | Diesel Inspection | Opening the top dag of the diesel motor cover | Altitude (*gravity hazard*) | Jath from the top of the locomotive (injury, broken bones) | Use of Personal Protective Equipment (PPE) |
| | | Open the diesel motor and set the valve | Diesel motor engine heat | Hands exposed to engine heat | Use of Personal Protective Equipment (PPE) |
| | | Cleaning the room of a diesel motor | Diesel motor engine heat | Hands exposed to engine heat | Use of Personal Protective Equipment (PPE) |
| | | Open the axle engine lever from the mount and check and lubricate the garden engine | Limited space | *Heat stress*, pinched | Use of Personal Protective Equipment (PPE) |
| | | Changing the oil filter on diesel | Heat from diesel engine | Hands exposed to heat, pinched filter cap | Use of Personal Protective Equipment (PPE) |
| | | Trying a diesel engine (Start the locomotive) | Locomotive noise | Workers with hearing loss | Administrative, Use of Personal Protective Equipment (PPE) |
| **2.** | Mechanical Inspection | Cleaning of bogies/wheels from soil and oil | Dirt and oil dripping on the *bogie* | Flickering eyes of earth and oil | Use of Personal Protective Equipment (PPE) |
| | | Checking and unscrewing the gear box lid | Heavy work tools and *heavy* gear box media | Pinched, and hit by the gear box | Administrative, Use of Personal Protective Equipment (PPE) |
| | | Checking and replacing the brake block | Heavy brake block | Hit by brake block | Administrative, Use of Personal Protective Equipment (PPE) |
| | | Replacing and disassembling the brake cylinder | Heavy brake cylinders and heavy work tools | Pinched and crushed by the brake cylinder | Administrative, Use of Personal Protective Equipment (PPE) |
| **3.** | Electrical Inspection:<br>1. Upper Electric | Checking and maintaining the battery parts unpacking the cover dag | Electric flow | Electrocuted | Use of Personal Protective Equipment (PPE) |

| | | | | | |
|---|---|---|---|---|---|
| | | Checking and maintenance of opening dag generator | The medium is difficult to work with, the generator cover is heavy and narrow | Pinched and when opening the heavy generator cover | Use of Personal Protective Equipment (PPE) |
| | 2. Electricity Down | Giving to the lower TM | Unscrewing the TM bolt | Hand pinched TM bolt | Use of Personal Protective Equipment (PPE) |
| | | Check the cable connection using a ladder | Dust and soil sticking to the bottom cable | Eyes and respiratory tract infected with dust | Use of Personal Protective Equipment (PPE) |
| | | Repair, replace TM components | Oil and oil droplets from TM | The eye was exposed to TM oil and oil droplets, and slipped | Use of Personal Protective Equipment (PPE) |
| **4.** | Wind Inspection | Open the compressor chamber cover dag | Heavy and wide cover dag | The hand was scratched on the side of the dag and pinched | Use of Personal Protective Equipment (PPE) |
| | | Clean the compressor room | Dust from radiator fans | Eyes and respiratory tract infected with dust | Use of Personal Protective Equipment (PPE) |
| | | Fix air leaks | Strong wind pressure | Wind pressure on the eyes | Use of Personal Protective Equipment (PPE) |
| | | Spray radiator chamber with air pressure | Dust | Eyes and breathing infected with dust | Use of Personal Protective Equipment (PPE) |
| | | Opening the upper dag of the locomotive radiator fan part | Hazards of incompetence | Fall | Use of Personal Protective Equipment (PPE) |
| | | Repair radiator chamber | Limited space and heat | *Heat stress* | Use of Personal Protective Equipment (PPE) |

3.1.3. *Likelihood* and Severity *(Consequence)* of Hazards and Risks in Locomotive Maintenance

In the locomotive maintenance process, it is also necessary to carry out a risk assessment to determine the level of risk of an activity based on the magnitude of the likelihood value (*likelihood*) and severity (*consequence*). The results of the calculation of the multiplication of likelihood (*likelihood*) and severity (*consequence*) will show the value of the risk that exists in each process and part of the work. The following are the results of interviews related to the likelihood (*likelihood*) and severity (*consequence*) in the locomotive maintenance section.

a. Diesel parts locomotive maintenance

*"... In my opinion, the risk of an accident or incident may occur, because here using Personal Protective Equipment (PPE) can be minimized. As for the effect caused, it can be said to be moderate"* (S3).

*"If it is possible in diesel, it is possible, and if it is severe, it can enter the large resulting* in injuries *and losses"* (S2).

b. Mechanical parts locomotive maintenance

*"If it happens, it may not happen until it is rare because we have to work together. The severity or effects caused can be said to be small to moderate because we have used PPE"* (S4).

*"If it is mechanical, the possibility can happen at any time, it can be seen, it means that it may happen, and for the effect caused for severity, it can be said that it is there"* (S2).

c. Maintenance of electric parts locomotive

*"If there is a work accident or the risk of incidents in this section, it may occur within 1 year, only 2 times. It can also be said that the possibility is small. Unlike the upper electricity that is related to the electric current, the possibility of occurrence may be different. Then for the effect caused, yes, it is small, the most slippery is only at the top, and it is also different from the upper electric part"* (S5).

*"... For the electrical part there are 2, namely the upper and lower, now for the upper part there is an electrical hazard, the possibility can be said to be small to possible and the severe effect is moderate. Then for the bottom, yes, it's the same as before"* (S2).

d. Wind section locomotive maintenance

*"The possibility of happening on my part can be said to be a possibility, and it may happen, and it may happen. Then for severe we have anticipated with PPE, but maybe it can be said that the severity range is moderate to medium"* (S6).

*"... for the wind it is possible that the incident may occur, such as opening the radiator cover dag and for the severity is great in that part"* (S2).

3.1.4. Risk Levels in Locomotive Maintenance

The risk level is the result of the multiplication of likelihood and severity (*consequence*) carried out during interviews and field observations. The risk level indicates the level of low risk or high impact in the locomotive maintenance process in the Yogyakarta Locomotive Dipo facility unit. The risk level in this study was obtained through multiplication calculation assisted by using *Australian Standard 4360: 2004* from a literature study to determine the risk level of each activity. The following is the risk level of the assessment of the likelihood and severity of the multiplication results (*likelihood*) and severity (*consequence*) in each process of locomotive maintenance activities.

a. Risk Level of Diesel Parts

**Table 2.** Risk Level of Diesel Parts

| Hazards | Risk | Possibility (*Likelihood*) | Severity (*Consequence*) | (L)x(C) | Risk Level |
|---|---|---|---|---|---|
| **Altitude (*gravity hazard*)** | Falling from the top of the locomotive, namely injuries and broken bones | C | 4 | 4Cs | *Extreme risk* |
| **Diesel motor engine heat** | Hands exposed to engine heat | C | 2 | 2C | *Moderate risk* |
| **Limited space** | *Heat stress* and pinching | C | 2 | 2C | *Moderate risk* |
| **Noise** | Workers with hearing loss | C | 3 | 3C | *High Risk* |

b. Risk Level of Mechanical Parts

**Table 3.** Risk Level of Mechanical Parts

| Hazards | Risk | Possibility (*Likelihood*) | Severity (*Consequence*) | (L)x(C) | Risk Level |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Dirt and oil in the bogie | Flickering eyes of earth and oil | D | 2 | 2D | *Low Risk* |
| Heavy work tools and heavy gear box media | Pinched, and hit by the gear box | C | 2 | 2C | *Moderate Risk* |
| Heavy brake block | Hit by brake block | C | 2 | 2C | *Moderate Risk* |
| Heavy brake cylinders and heavy work tools | Pinched and crushed by the brake cylinder | C | 3 | 3C | *High risk* |

c. Risk Level of Electrical Parts

**Table 4.** Risk Level of Electrical Parts

| Hazards | Risk | Possibility (*Likelihood*) | Severity (*Consequence*) | (L)x(C) | Risk Level |
|---|---|---|---|---|---|
| 1. Upper Electric: | | | | | |
| Electric flow | Electrocuted | C | 3 | 3C | *High Risk* |
| The medium is difficult to work with, the generator cover is heavy and narrow | Pinched when opening a heavy generator cover | C | 2 | 2C | *Moderate Risk* |
| 2. Lower Electric: | | | | | |
| Unscrewing the TM bolt | Hand pinched TM bolt | D | 2 | 2D | *Low Risk* |
| Dust and soil sticking to the bottom cable | Eyes and respiratory tract infected with dust | C | 2 | 2C | *Moderate Risk* |
| Oil and oil droplets from TM | The eye was exposed to TM oil and oil droplets, and slipped | D | 2 | 2D | *Low Risk* |

d. Risk Level of Wind Parts

**Table 5.** Risk Level of Wind Parts

| Hazards | Risk | Possibility (*Likelihood*) | Severity (*Consequence*) | (L)x(C) | Risk Level |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Heavy and wide dag | The hand was scratched on the side of the dag and pinched. | D | 2 | 2D | *Low Risk* |
| Dust from radiator fans | Eyes and breathing infected with dust | C | 2 | 2C | *Moderate Risk* |
| Strong wind pressure | Wind pressure on the eyes | C | 2 | 2C | *Moderate Risk* |
| Dust | Eyes and breathing infected with dust | C | 2 | 2C | *Moderate Risk* |
| Hazards of incompetence | Fall | C | 4 | 4Cs | *Extreme Risk* |
| Limited space and heat | *Heat stress* | C | 2 | 2C | *Moderate Risk* |

3.1.5. Hazard and Risk Control in Locomotive Maintenance

Hazard and risk control is one of the processes that aims to minimize risks arising from a work activity. The results of the interviews show that they are consistent with the results of observations that have been made by researchers at the Yogyakarta Locomotive Dipo facilities unit. Based on the results of the interviews and observations, it can be seen that the control that has been carried out by the Locomotive Dipo facility unit includes the following.

a. Administration by providing appeals in the form of making safety signs in several work areas, making *Standard Operating Procedures (SOPs)* regarding how to lift work tools and heavy objects correctly.
b. The use of Personal Protective Equipment (PPE) is by providing safety *shoes*, *reflector* vests, *helmets,* gloves, work glasses and ear protection.

## 3.2. Discussion

*3.2.1* Hazards in Locomotive Maintenance

The results of interviews and observations regarding hazard identification found that the hazards in the locomotive maintenance section could be sourced from unsafe work environments, including slippery environments caused by spills of *HSD oil*, oil and hazardous and toxic material (B3) waste. In addition, hazards from the working environment can also come from the engine, namely the sound of the locomotive that causes noise when conducting diesel engine tests. Other hazards can also arise from work tools, confined space in the locomotive, electrical hazards, and the behavior of the workers themselves.

According to the literature, it is explained that hazards have the potential to cause accidents in the work environment which are sourced from several things, namely a bad work environment and human factors such as habits. This statement is in line with previous research which states that every work process carried out in the work environment has hazards from various kinds of machines, work equipment, and interactions with the work environment (Sayih, 2012). The most hazardsous locomotive maintenance hazard is falling from a height (*gravity hazard*) who are at risk of falling. Other hazards come from the work environment in the form of work tools, dust, and noise. This is in accordance with previous research which states that the form of gravitational energy is a hazard that

can be at risk of falling and a bad work environment will have the potential to be hazardsous in the workplace (Sitorus, 2010).

*3.2.2* Risks in Locomotive Maintenance

Risk is the impact caused by the realization of potential hazards (*hazard events*). Each work activity in the locomotive maintenance section has different risks so that it will cause work accidents. In hazard prevention, it is necessary to prepare a mature and appropriate plan with the formulation of the implementation of risk management at the industrial level, so that these steps and policies will be able to maintain the situation of the production process running smoothly according to the expected goals of the industry leadership (Ramli, 2011-b). At the industrial management level, risk management greatly determines the condition of the production process in the long term and is a tool that must be applied both managerially and practically in all work units. The risk management developed is not only limited to OSH risk management, but also includes planned disaster risk management with good management, both related to disasters by human factors and equipment factors (Ramli, 2011-a). A wide variety of risks can be sourced from each locomotive maintenance part, such as diesel, mechanical, electrical, and wind parts.

The type of work, the work environment occupied, and the work tools used from some of these factors can pose a risk of work accidents. This is in accordance with previous research, which states that workplaces have various risks and the type of work will affect the impact of accidents from these risks (SOCRATES, 2013). The work environment greatly affects the condition of occupational safety. A poor work environment has a big impact on the occurrence of work accidents. This is because the focus of the workers' work when carrying out their duties can be disturbed. (Priono and Supriyadi, 2020). A type of work that is designed holistically in various aspects related to workers and their workplaces, will ensure the sustainability of ideal OSH conditions and achieve high work productivity (Ridley, 2006).

All parts of the locomotive work maintenance as a whole have risks from the working environment, the work tools used, oil oil, feet hit by the work tools, electrocution, oil oil slipping, and falling from a height. Here are some of the risks that come with each part of locomotive maintenance.

a. Risks on Diesel Maintenance

   Overall, in every work activity, diesel inspection has hazardss that risk causing work accidents, including hitting hard locomotive parts such as doors and cover dags, being pinched by the locomotive dag, and the most dominant risk, which is falling from the top of the locomotive and being exposed to heat generated from the diesel engine during the seal lubrication work axle engine and diesel motor inspection. The results of the observations show that these risks can arise due to unsafe work environments, machines worked, and the type of work handled by workers. Therefore, diesel parts have a high to very high level of risk.

b. Risks on Mechanical Inspections

   The mechanical examination part has a risk to the eye organs that can enter soil and oil when cleaning *the bogie* or wheels, the hand is pinched *by the gear box*, the brake block is hit, and the foot is hit by the brake cylinder. The risk will vary depending on each activity carried out in each section. On the mechanical part, the risks can vary due to the type of work arising from mechanical, electrical, chemical, and physical hazards.

c. Risks on Electrical Inspections

   The electrical part inspection process has two parts, namely upper and lower electrical. The results of interviews and observations show risks in the electrical part, including the upper electric has the risk of being electrocuted from the locomotive battery with a power of 75 *volts*, and being pinched by the generator cover. The lower electrical part has risks, including hands pinched by the TM part when opening the TM lid, eyes exposed to oil droplets, and oil slipping from the locomotive, resulting in workers falling.

d. Risks on Wind Screening

   Risks to the wind part, including hands being pinched by the locomotive cover when opening, eyes and breathing can be infected with dust during cleaning the compressor room, eyes exposed to wind pressure, and falling from a height when opening the radiator fan cover so that workers can be injured or even die. The impact of dust risk on wind inspection is also adjusted to the

Decree of the President of the Republic of Indonesia Number 22, Year 1993, which states that the risk of dust at work can result in respiratory tract infections, namely lung disease, bronchopulmonary disease, and allergies *Alveolus* (Ministry of Manpower and Transmigration of the Republic of Indonesia, 1993). Therefore, various risks in each part of the work need to be controlled properly and correctly.

*3.2.3* Likelihood and Severity *(Consequence)* Hazards and Risks in Locomotive Maintenance

Likelihood and *severity (*consequence) are values that can support the results of the risk assessment. The following are the *likelihood* and severity (*consequence*) values of each locomotive maintenance part.

a. Diesel Parts Inspection Process

The value of the calculation results that produce the highest value is altitude hazard with the probability (*likelihood*) value C and the severity (*consequence*) value 4 resulting in disability, and loss of body function, then the likelihood value (*likelihood*) C and the severity (*consequence*) value 2 due to minor injury from the risk of engine heat, the limited space has a likelihood value (*likelihood*) C with a severity of 2 minor injuries, and noise has a *likelihood* value C with a severity value (*consequence*) of 3 which means it causes a large loss.

b. Mechanical Parts Inspection Process

The value of the calculation results produced the highest value, namely the hazards of removing the brake cylinder with a probability value (*likelihood*) C may occur with a severity value (*consequence*) 3 resulting in the loss of the working day, then for the hazards of heavy work equipment and the hazards of the brake block, each has a probability value (*likelihood*) C medium and severity (*consequence*) 2 means minor injury. Eye hazards, dirt and oil have a small likelihood (*likelihood*) of D value, with a severity (*consequence*) of 2 minor injuries.

c. Electrical Parts Inspection Process

The value of the calculation results produces a moderate value, namely the hazards when opening the generator cover and the dust hazard with a probability value (*likelihood*) C, which may occur and a severity value (*consequence*) 2 which means minor injury. For TM bolt hazards and oil drip hazards have a likelihood value (*likelihood*) D, it is unlikely and severe (*consequence*) value 2 minor injuries can be handled with First Aid in Accidents (P3K). Another hazard is an electrical hazard that has a *likelihood* value of C, with a *consequence*, requiring medical treatment and loss of workdays.

d. Wind Part Inspection Process

The value of the calculation results produces a moderate value, namely from the hazard of confined space, dust, wind pressure with a probability value (*likelihood*) C, meaning that it may occur with a severity value (consequence) 2, namely minor injury. For very high values are the hazards of being positioned at height when opening the locomotive cover with a likelihood value (*likelihood*) of C, with a severity value (*consequence*) of 4, which means that it can result in injury, disability, and loss of body function.

*3.2.4* Risk Levels in Locomotive Maintenance

The level of risk is generated from the results of the assessment carried out by multiplying the likelihood (*likelihood*) and severity (*consequence*) obtained from the results of previous interviews and observations. The calculation of the risk level has also been regulated in *the Australian Standard 4360:2004* where the risk must be analyzed to obtain the risk level in each work activity. In the standard, it is explained in detail related to the calculation of the level of risk in each type of work. The following is the risk level from the results of the risk assessment that has been carried out.

**Table 6.** Risk and Hazard Levels

| It | Risk Level | Big Risk | Number of Hazards |
|---|---|---|---|
| 1. | Very high (*Extreme Risk*) | 4Cs | 2 |
| 2. | Tall (*High Risk*) | 3C | 3 |

| | | | |
|---|---|---|---|
| 3. | Keep (*Moderate*) | 2C | 9 |
| 4. | Low (*Low Risk*) | 2D | 4 |

The level of risk in each locomotive maintenance part will result in a different amount of risk depending on the hazards contained in each maintenance part. The magnitude of the risk indicates that the part of the work has potential hazards and risks to its workers. The level of risk on each job must be known and assessed, so that workers can know every hazard that exists on the job site.

a. Risk Level of Diesel Inspection Parts

The level of risk from diesel inspection can vary from medium risk to extreme *risk*. The level of extreme risk results from height hazards when opening the top cover of a diesel locomotive which can result in workers falling and injury. In addition, the high risk of locomotive noise, namely in the form of noise that can interfere with workers' hearing and focus.

b. Risk Level of Mechanical Inspection Parts

The level of risk in the mechanical examination is from the low risk, medium risk, and high risk ranges. The high *risk* level is indicated by the hazards of heavy locomotive brake cylinder release so that it can cause the risk of being pinched and hit by the brake cylinder. In addition, high risk in the mechanical inspection section also has a moderate risk, namely from the hazards of heavy work tools and the risk of workers being pinched and hit by *the gear box*.

c. Risk Level of Electrical Inspection Parts

The locomotive maintenance section of the electrical inspection process also has various levels of risk from low risk, medium risk, to high risk. High *risk* is generated from the electrical hazard that exists in the upper electrical part that has the potential to enhazards workers from high-voltage electric shock with a voltage of 75 volts, while moderate risk is generated from the hazards when opening the heavy generator cover, so there is a risk of the worker's hand being pinched when opening the radiator cover.

d. Risk Level of Wind Inspection Parts

The risk level in the wind inspection has a variety of risk levels from low risk, medium risk to extreme *risk* and this risk level can enhazards workers. Extreme risk is generated from height hazards when opening the radiator cover dag and has a very high risk, namely falling from the top of the locomotive, while moderate *risk* is generated from dust and limited space that is at risk of heat stress *(heat stress*). Strong wind pressure is also at risk of hitting or infecting workers' eyes and breathing. Low *risk* can be found from the risk of scratching the side of the locomotive cover.

*3.2.5* Hazard and Risk Control in Locomotive Maintenance

The control that has been carried out by the company based on the results of interviews and observations is as follows.

a. Control administration by providing appeals in the form of making safety signs in several work areas, making *SOPs* regarding how to lift work tools and heavy objects correctly.
b. The use of PPE is by providing complete *safety shoes*, *reflector* vests, *safety helmets*, gloves, several work glasses, and ear protection.

The control carried out by the Yogyakarta Locomotive Dipo facility unit has not followed the order of risk control hierarchy, namely elimination, substitution, engineering engineering, administration, and PPE. These results are strengthened by the results of interviews and observations conducted showing that the most important risk control emphasized in the Locomotive Dipo facility unit is the use of PPE. Based on the results of observations, it can be known that other hazard control is in the form of the installation of *SOP* appeals to work safely in the work environment. With these results, the control in the Locomotive Dipo facilities unit needs to be increased and adjusted to the priority of the existing risk level. The additional control recommendations that can be given are as follows.

a. Engineering *control* in the mechanical inspection section, namely by spraying the lower frame including the wheels and other parts to remove soil, dust, and oil that sticks to the *bogie* or locomotive wheels.

b. Administrative control, by adding signs (*safety signs*) according to the work section, creating a system of employee replacement in the work process related to limited space and heat, as well as appeals directly through apples before work.
c. The addition of PPE is complete according to the needs of each work process, such as the equitable distribution of earplugs, and the provision of work masks.

## 4. Conclusion

The results of the analysis and discussion above, can be concluded as follows.

a. Hazards to locomotive maintenance work can arise from the work environment, such as oil or oil spills, work activities, work tools, and the workers themselves.
b. The risks contained in locomotive maintenance are falling from the top of the locomotive, being electrocuted, pinched, falling work tools, exposed to engine heat, exposure to noise, dust, wind pressure, and slipping oil or engine oil.
c. The highest likelihood and *severity (*consequence*) value is from the risk of falling from the top of the locomotive with a likelihood value (*likelihood*) C means it is possible and* a severity (*consequence*) value of 4 which is a big impact, then for the likelihood value (*likelihood*) and severity (*consequence*) of high risk of hearing loss from noise with a probability value (*likelihood*) C means it is likely to occur and severity (*consequence*) value 3 i.e. high impact, and a likelihood value (*likelihood*) and low severity (*consequence*) of risk of exposure to soil and oil impurities with a probability value (*likelihood*) D means rare and severe (*consequence*) value 2, i.e. it can be handled.
d. From the risk assessment, the risk level includes very high risk at 4C as many as 2 hazardss, high *risk* at 3C level as many as 3 hazardss, moderate at 2C number as many as 9 hazardss, and low risk level at 2D number as many as 4 hazardss.
e. The Yogyakarta Locomotive Dipo facility unit has carried out risk control administratively in the form of *SOPs* and the provision of PPE.

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