Risk Assessment at the Plate Production Unit of PT. INKA (Persero)

Penilaian Risiko pada Unit Produksi Pengerjaan Plat PT. INKA (Persero)

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ABSTRACT

Introduction: The plate manufacturing production unit is one of the work units in PT. INKA (Persero), which involves the interaction between humans and machines in its activities, heavy equipment, and materials, all of which can cause possible hazard impacts that can impact the safety and health of workers. The purpose of this study is to conduct risk assessment on occupational safety and health aspects by identifying risks, assessing risks, identifying control efforts and assessing residual risk as a form of efforts to prevent occupational accidents and occupational diseases, using existing resources effectively and efficiently. **Method:** This research is a type of qualitative research, through interviews and observations, with cross-sectional studies and descriptive analysis. The interviewees for this study were K3LH management managers, steel managers, and machine operators in the plate production unit (PPL). The tools in this study werean interview guide, Job Safety Analysis (JSA) and Hazard Identification Risk Assessment Determining Control (HIRADC) using the AS / NZS 4360: 2004 Risk Management Worksheet Standard Risk Matrix. **Results:** From the research, it was found that there are 94 hazards for 11 different machines. Regarding the risk levels, there are 9 extreme risk levels, 46 high risk levels, 33 medium risk levels and 6 low risk levels. **Conclusion:** There are still 61 risks with medium risk level and 6 remaining risks with high risk level that still need control. Control efforts have been implemented by PT. INKA (Persero) in accordance with the hierarchy of control, such as the use of PPE and the provision of work SOPs.

Keywords: hazard identification, risk management, risk assessment, risk control, residual risk

ABSTRAK

Pendahuluan: *Unit produksi bagian pengerjaan plat merupakah salah satu tempat kerja yang ada di PT. INKA (Persero) yang memiliki aktivitas antara manusia dengan mesin, alat berat, dan material yang dapat menimbulkan kemungkinan terjadinya bahaya yang bisa berdampak pada keselamatan dan kesehatan pekerja. Tujuan penelitian ini adalah untuk melakukan penilaian risiko dalam aspek keselamatan dan kesehatan kerja dengan mengidentifikasi risiko, menilai risiko, mengidentifikasi upaya pengendalian dan menilai risiko residual sebagai salah satu bentuk upaya pencegahan terjadinya kecelakaan akibat kerja dan penyakit akibat kerja, menggunakan sumber daya yang ada secara efektif dan efisien.* ***Metode:*** *Penelitian ini merupakan jenis penelitian kualitatif, melalui wawancara dan observasi, dengan studi cross-sectional, dan analisis deskriptif. Narasumber untuk penelitian ini adalah manajer pengelolaan K3LH, manajer steel work, dan operator mesin yang ada pada bagian pengerjaan plat (PPL). Alat yang digunakan adalah panduan wawancara, Job Safety Analysis (JSA) dan Hazard Identification, Risk Assessment dan Determining Control (HIRADC) dari Lembar Kerja Manajemen Resiko AS/NZ 4360:2004 Standard Risk Matrix.* ***Hasil:*** *Dari penelitian ditemukan 94 bahaya untuk 11 mesin yang berbeda. Dengan tingkat risiko ada 9 bahaya tingkat risiko ekstrim, 46 bahaya tingkat risiko tinggi, 33 bahaya tingkat risiko sedang, dan 6 bahaya tingkat risiko rendah.* ***Simpulan:*** *Masih terdapat sisa 61 risiko sisa tingkat risiko sedang dan 6 risiko sisa tingkat risiko tinggi yang masih perlu pengendalian tambahan. Upaya pengendalian telah diterapkan oleh PT. INKA (Persero) sesuai dengan hierarki pengendalian, seperti penggunaan APD dan penyediaan SOP kerja.*

Kata kunci: *identifikasi bahaya, manajemen risiko, penilaian risiko, pengendalian risiko, risiko sisa*

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INTRODUCTION

Every workplace has hazards that can cause harm, both material and non-material hazards in accordance with the conditions of the work environment (Suma'mur, 2009). The existence of these sources of danger is unavoidable, but prevention can be taken to reduce the impact

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that might occur. Occupational accidents and occupational diseases can occur as a result of the impact of risk factors that are not prevented. In addition, Law of the Republic of Indonesia No. 13/2003 concerning Labor in Article 86 paragraph 2 states "to protect the safety of workers or laborers in order to realize optimal work productivity, work safety and health efforts are carried out". This statement implies that each workplace is required to carry out occupational safety and health efforts to protect workers or laborers who work in the workplace (Ramli, 2010).

The ILO estimated that around 2.3 million people worldwide die from occupational accidents or diseases each year; this is associated with than 6000 cases of death every day. Around the world, there are around 340 million occupational accidents and 160 million victims of occupational diseases each year (International Labour Organization (ILO), 2018). Based on data from the the Social Security Agency (BPJS), in the past 5 years, the number of reported cases of occupational diseases is still very small, under 100 cases. Cases of occupational diseases are dominated by spinal disorders, hearing, itching on the skin due to chemicals, and skin disorders on the hands. In 2018 there were 114,148 cases which occured, while in 2019 there were only 77,295 cases, decreasing by 33.05% (BPJS Ketenagakerjaan, 2019). Although the number of occupational accidents in 2019 decreased from the previous period, both workers and agencies must continue to improve supervision and awareness of the importance of Occupational Safety and Health (OSH).

PT. INKA (Persero) is an industry engaged in the process of making trains. The work environment at PT. INKA (Persero) is inseparable from the existence of sources of danger in the workplace. One of the sources of danger in PT. INKA (Persero) was the intensity of noise in the welding work area 1 which exceeded the predetermined Threshold Value (NAV). The intensity of noise in the welding work area 1 reached 94.8 dBA (Hanifa, 2016). Based on data from PT. INKA (Persero) in 2016-2018 there were still work accidents in the plate work unit (PPL) which was caused by work activities of 11 types of machines such as welding, milling, reforming, drilling, laser cutting, saw cutting, and bending. Some work accidents that occurred included tears caused by being scratched by the material or plate when the workers lifted and retrieved material from the machine, resulting in injuries to the body part, pain in the eyes of the workers during the drilling process, a pinched finger on machines, and other work accidents (Rofifa, 2019).

The stages of the manufacture in the work plate unit (PPL) of PT. INKA (Persero) cannot be separated from the relationship between machines and humans, so it is likely to pose hazards and risks that result in work accidents. According to the Australian Standard / New Zealand Standard (AS / NZS) 4360: 2004, risk is a change from something that happens, which will have an impact on the goal by measuring the level of likelihood and severity (Standards Association of Australia, 2004). Evaluating the risks that may arise from a potential hazard by considering the adequacy of controls in place and deciding whether the risk is acceptable or not is a process of a risk assessment. Implementing a risk assessment in a workplace, especially in a part of work that is closely related to machines, is very important because of the high risk of accidents at work (Canadian Centre for Occupational Health & Safety, 2020).

Therefore, it is necessary to do risk management in the form of hazard identification, risk assessment, risk control efforts, and residual risk assessment as one of the efforts to prevents occupational accidents and occupational diseases. The purpose of this study was to conduct a risk assessment on the production process in the plate working unit (PPL) of PT. INKA (Persero) in the aspect of work safety by identifying risks, assessing risks, identifying control efforts and assessing residual risks to prevent undesirable things such as occupational accidents and occupational diseases, using existing resources effectively and efficiently.

METHODS

This type of research is observational research because researchers only observed without providing treatment. The data analysis used in this study was descriptive analysis because the researchers only described the processes and data collected without analyzing the relationships between variables. Based on the time of data collection, this study used a cross sectional study approach because this research was carried out at a certain time. Data were collected from April 1, 2018 to April 30, 2018. Based on the research site, this study was included in the field observations carried out at the production unit of PT. INKA (Persero) Madiun, which is engaged in the BUMN's railroad industry.

Table 1. Risk Rating Matrix According to AS/NZS 4360:2004 Standards

Likelihood	Severity				
	Negligible 1	**Minor 2**	**Moderate 3**	**Major 4**	**Severe 5**
Almost Certain 5	5 Medium	10 High	15 High	20 Extreme	25 Extreme
Likely 4	4 Medium	8 Medium	12 High	16 High	20 Extrem
Possible 3	3 Low	6 Medium	9 High	12 High	15 High
Unlikely 2	2 Low	4 Low	6 Medium	8 Medium	10 High
Rare 1	1 Low	2 Low	3 Medium	4 Medium	5 High

This research study used primary data obtained through interviews and observations. Interviews were conducted to obtain further information regarding hazard identification, risk assessment, and any controls that had been implemented. Interviews using interview guidelines were conducted with K3LH management managers, steel work managers, and operators of hydraulic press (HP) machines, corner shear machines (CS), press bending machines (PB), grinding machines (GR), laser machines, automatic gas engines (GA) and CNC, manual plasma machines, manual gas engines (GM), gap shear machines (GS), drill machines (DR), and NCT machines. Observations were made to obtain a risk assessment, analyze what risk controls had been carried out, and conduct a residual risk assessment that still existed after control was implemented. The tool used for observation was the Job Safety Analysis (JSA) observation sheet (Bawang, Kawatu, and Wowor, 2018). The results of data collected were analyzed using semi-qualitative techniques by calculating the degree of the likelihood and severity to determine the level of work risk according to the Hazard Identification Risk Assessment Determining Control (HIRADC) using risk assessment worksheet, which wasthe AS Risk Management Worksheet / NZS 4360: 2004 Standard Risk Matrix. The results were then presented in the form of a narrative text (Standards Association of Australia, 2004).

RESULTS

Risk Identification

The results of hazard identification in the plate working unit (PPL) of PT. INKA (Persero) showed that at each step of the work process on 11 different machines, starting from starting the engine, preparing materials, setting up work tools to gathering the resulted materials, 94 potential hazards were found.

Starting the engine has the potential to cause electric shock and even death, included in the electrical hazard because the 11 existing machines electric power for the machines to work, and the machines are operated directly by existing workers. Moreover, preparing materials has the potential for injury to hands and feet, hand wound and scratched hand skin, included in the mechanical and kinetic hazards. The activities in the work process include picking up and carrying the plate material whose size is large enough, so workers are at risk of getting scratched or pinched. Furthermore, setting up work tools has the potential for injuries to the hands and feet and limb disorders, included in the physical and ergonomic hazards because the activities of preparing and installing work objects into machines put workers at risk of being hit by blunt or sharp objects from the machine, and being pinched by the running machine when the material is being installed; also, sometimes workers use the wrong work position. In addition, gathering the final materials has the potential for injury to hands and feet, included in the physical and kinetic hazards. This final activity is conducted after carrying out the machining process and taking the workpiece with a large and heavy plate, at risk of being pinched and scratched by a sharp plate.

Risk Assessment

The results of the risk analysis showed 9 hazards with extreme risk levels, 46 high risk hazards, 33

Table 2. Results of Hazard Identification, Risk Assessment and Determinant Control (HIRADC) of 11 Machines at the Plate Processing Unit (PPL) of PT. INKA (Persero)

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
All Machines										
Starting the engine	Electrical	Electric shock	Death	2	5	10 High	Technique: Connecting electric current directly with the machine. Administrative: Safety talk, routine checking, SOP	2	2	4 **Low**
Installing the shape / pattern prints	Mechanical	Crushed and pinched	Injuries to the hands and feet	3	2	6 Medium	Administrative: Safety talk, SOP. PPE: Safety shoes, gloves	3	1	3 Low
	Ergonomics	The head is hit by the engine	Bruises on the head	2	2	4 **Low**	Administrative: Safety talk PPE: Safety helmet	2	1	2 Low
Preparing materials	Mechanical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
	Mechanical	Scratched by a sharp and rough plate	Injury to hands	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Kinetic	Pinched by a crane hook Hit by a plate	Injury to hands and feet	4	3	12 High	Administrative: Safety talk, training crane operators, SOP PPE: Safety shoes	4	1	4 Medium
Hydraulic Press Machine (HP)										
Pressing and bending process	Mechanical	Sandwiched during the bending and pressing process	Broken bones in the hand	5	3	15 High	Administrative: Safety talk, SOP PPE: Gloves	5	2	10 High
	Ergonomics	Incorrect work position	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
Gathering the results of the pressing and bending process	Mechanical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	4 Medium
	Mechanical	Scratched by a sharp and rough plate	Injury to hands	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	4 Medium
	Kinetic	Pinched by a crane hook Hit by a plate	Injury to hands and feet	4	3	12 High	Administrative: Safety talk, training crane operators, SOP PPE: Safety shoes	4	1	4 Medium

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Corner Shear Machine (CS)										
Putting on the blade	Mechanical	Sharp blade	Injury to hands	3	2	6 Medium	Administrative: Safety talk, SOP	2	2	3 Low
Doing the plate cutting process	Mechanical	Scratched by a sharp and rough plate	Injury to hands	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	4 Medium
	Mechanical	Hands are cut off by the machine	Permanent disability	5	4	20 Extreme	Administrative: Safety talk, SOP	5	2	10 High
	Ergonomics	Incorrect work position	Back pain	4	1	4 Medium	Administrative: Safety talk, SOP	4	1	4 Medium
Gathering plates	Mechanical	Scratched by a sharp plate	Injury to hands	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
Press Bending Machine (PB)										
Bending process	Mechanical	Scratched by a sharp and rough plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Mechanical	Crushed / pinched by a large and heavy the plate	Injury to hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, Safety shoes	5	1	5 Medium
	Mechanical	Hands are pinched by the machine	Broken bones in the hand	5	3	15 High	Administrative: Safety talk, SOP	5	2	10 High
Gathering the results of the bending process	Mechanical	Scratched by a sharp and rough plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Mechanical	Crushed / pinched by a large and heavy plate	Injury to hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, Safety shoes	5	1	5 Medium
Grinding Machine (GR)										
Grinding process	Mechanical	Body parts are cut off by the spinning machine	Permanent defects in the fingers	5	4	20 Extreme	Administrative: Safety talk PPE: Gloves	5	2	10 High
	Ergonomics	Stomach slashed	Deep tear wounds	5	3	15 High	Administrative: Safety talk PPE: Apron	5	2	10 High
	Chemical	Spark	Blistered skin Burns to the skin	5	2	10 High	Administrative: Safety talk PPE: Gloves, safety shoes, long clothes	5	1	5 Medium
	Chemical	Eye and respiratory irritation	Watery / wounded eyes	4	3	15 High	Administrative: Safety talk, providing blowers PPE: Safety glasses, masks	3	2	6 Medium

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Grinding Machine (GR)										
Grinding process	Physical	Heat engine	Blistered hands Burns on the hands	4	2	8 Medium	Administrative: Safety talk PPE: Leather gloves	4	1	4 Medium
	Physical	Exposed to noise	Impaired hearing function	5	4	20 Extreme	Administrative: Safety talk PPE: Ear plug	5	1	5 Medium
	Chemical	Respiratory tract irritation	Respiratory disorders	5	3	15 High	Administrative: Safety talk, procurement of blowers PPE: Mask	4	1	4 Medium
Gathering the results of the grinding process	Mechanical	Pinched by a large and heavy plate	Injury to hands and feet	5	2	10 High	Administrative: Safety talk PPE: Gloves, safety shoes	5	1	5 Medium
	Mechanical	Scratched by a sharp plate	Hand wound	5	2	10 High	Administrative: Safety talk PPE: Gloves	5	1	5 Medium
	Kinetic	Pinched by a crane hook Hit by a plate	Injury to hands and feet	4	3	12 High	Administrative: Safety talk, training on crane operators, SOP PPE: Safety shoes	4	1	4 Medium
Laser Machine										
Putting the plate on the jig table / work table	Mechanical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
	Mechanical	Scratched by a sharp plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Mechanical	Scratched by a sharp jig table / work table	Tear / incision on the skin	3	2	6 Medium	Administrative: Safety talk, SOP PPE: Gloves	3	1	3 Low
Doing the plate cutting process	Physical	Plate heat	Blistered skin Burns on the hands	4	2	8 Medium	Administrative: Safety talk, SOP PPE: Gloves	4	1	4 Medium
	Kinetic	Falls and gets scratched by a jig table / work table	Tear injuries to the skin and broken bones	3	3	9 High	Administrative: Safety talk, SOP	3	2	6 Medium
Taking the results of cutting plates	Physical	Plate heat	Blistered skin Burns on the hands	4	2	8 Medium	Administrative: Safety talk PPE: Gloves	4	1	4 Medium
	Mechanical	Plate heat	Blistered skin Burns on the hands	4	2	6 Medium	Administrative: Safety talk, SOP PPE: Gloves	3	1	3 Low

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Gas Automatic (GA) and CNC Machine										
Plate locking / welding	Electrical	Got electric shock	Death	2	5	10 High	Administrative: Safety talk, SOP	2	2	4 Low
	Chemical	Radiation beam welding	Eye irritation Vision loss	3	4	12 High	Administrative: Safety talk, SOP PPE: Face shield	3	1	3 Low
	Chemical	Welding sparks	Eye irritation Vision loss	3	4	12 High	Administrative: Safety talk PPE: Long sleeve shirt	4	1	3 Low
		Blistered skin	Burns to the skin	3	2	6 Medium	Administrative: Safety talk	3	2	3 Low
	Ergonomics	Position is not ergonomic	Back pain	4	1	4 Medium	Administrative: Safety talk	3	2	4 Medium
	Kinetic	Falls and gets cratched by a jig table / work table	Tear injuries to the skin and broken bones	3	3	9 High	Administrative: Safety talk PPE: Mask	3	1	6 Medium
	Chemical	Falls and gets cratched by a jig table / work table	Tear injuries to the skin and broken bones	3	3	9 High	Administrative: Safety talk, SOP PPE: Gloves	3	1	6 Medium
	Physical	Flame	Burning hands and blistering skin	3	2	6 Medium	Administrative: Safety talk, SOP PPE: Gloves	3	1	3 Low
Cutting a plate	Chemical	Radiation of fire rays	Eye irritation Watery eyes	3	2	6 Medium	Administrative: Safety talk, SOP	3	1	3 Low
	Chemical	Sparks of fire	Blisters on the skin Skin sores	3	2	6 Medium	Administrative: Safety talk, SOP PPE: Long clothes, safety shoes	3	1	3 Low
	Kinetic	Hit by a hammer	Bruises on hands and feet	2	2	4 Low	Administrative: Safety talk, SOP PPE: Safety shoes	2	1	2 Low
Taking the results of the plate cutting process	Physical	Exposed to noise	Impaired hearing function	2	4	8 Medium	Administrative: Safety talk, SOP PPE: Ear plug	2	1	2 Low
	Physical	Heat plate	Blistered skin Skin sores	4	2	8 Medium	Administrative: Safety talk, providing steel stick aids, SOP PPE: Gloves, long clothes	4	1	4 Medium

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Manual Plasma Machine										
Lighting a fire	Physical	Hands on fire	Burns on the hands	4	2	8 Medium	Administrative: Safety talk PPE: Leather gloves	4	1	4 Medium
	Physical	Hands on fire	Burns on the hands	4	2	8 Medium	Administrative: Safety talk PPE: Leather gloves	4	1	4 Medium
	Electrical	Electric shock	Death	2	5	10 High	Administrative: Safety talk	2	2	4 Low
	Chemical	Sparks	Blistered skin Burns to the limbs	5	2	10 High	Administrative: Safety talk PPE: Gloves, safety shoes, long clothes	5	1	5 Medium
Cutting the plate	Ergonomics	Work position is not ergonomic	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
	Chemical	Gram smooth and small	Eye & respiratory irritation	4	2	8 Medium	Administrative: Safety talk, providing blowers PPE: Mask	4	1	4 Medium
	Physical	Material heat	Blistered skin Burns to the skin	4	2	8 Medium	Administrative: Safety talk PPE: Gloves, long clothes	4	1	4 Medium
Collecting the results of the plate cutting process	Physical	Sharp and rusty plate	Hand wound	5	2	10 High	Administrative: Safety talk PPE: Gloves	5	1	5 Medium
	Physical	Material heat	Blistered skin Burns on the hands	4	2	8 Medium	Administrative: Safety talk PPE: Gloves, long clothes	4	1	4 Medium
Manual Gas Machine (GM)										
Putting the plate	Physical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
	Physical	Scratched by a sharp plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
Cutting process / plate samper process	Chemical	Flame	Burning hands and blistering skin Hand wound	3	2	6 Medium	Administrative: Safety talk, SOP PPE: Leather Gloves	3	1	3 Low
	Chemical	Radiation of fire rays	Eye irritation Watery eyes	3	1	3 Low	Administrative: Safety talk, SOP	3	1	3 Low

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Manual Gas Machine (GM)										
Cutting process / plate samper process	Chemical	Sparks of fire	Blisters on the skin Skin sores	3	2	6 Medium	Administrative: Safety talk, SOP PPE: Gloves, safety shoes, long clothes	3	1	3 Low
	Ergonomicss	Position is not ergonomic	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
	Physical	Scratched by an iron knife	The wound on the palm	4	2	8 Medium	Administrative: Safety talk. SOP PPE: Gloves	4	1	4 Medium
Samper plate	Chemical	The existence of grams	Eye irritation Blindness	3	4	12 High	Administrative: Safety talk, blower provision, SOP	3	3	9 High
	Chemical	The existence of grams	Blistered skin Skin sores	3	3	9 High	Administrative: Safety talk, blower provision, SOP. PPE: Long clothes	3	1	3 Low
Gap Shear Machine (GS)										
Doing the cutting process	Physical	Pinched by a large and heavy plate	Cut on the hand	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
	Physical	Scratched by a sharp plate	Cut on the hand	5	2	10 High	Administrative: Safety talk. SOP PPE: Gloves	5	1	5 Medium
	Mechanical	Hands are cut off by the machine	Permanent deformity of the fingers	5	4	20 Extreme	Administrative: Safety talk, tools for inserting plates into machinery, SOP	3	2	6 Medium
Taking the results of the cutting process	Ergonomics	Incorrect work position	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
	Physical	Scratched by a sharp plate	Cut on the hand	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
Drill Machine (DR)										
Locking materials	Kinetic	Pinched by falling work tools	Injury to hands and feet	2	2	4 Low	Administrative: Safety talk, SOP PPE: Safety shoes, gloves	2	1	2 Low
	Ergonomics	Incorrect work position	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
	Physical	Scratched by a sharp plate	Cut on the hand	5	2	10 High	Administrative: Safety talk. SOP PPE: Gloves	5	1	5 Medium

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
Drill Machine (DR)										
Setting up tools	Physical	Pinched by falling work tools	Injury / Injury to hands and feet	2	2	4 Low	Administrative: Safety talk, SOP PPE: Safety shoes, gloves	2	1	2 Low
Drilling process	Mechanical	Sharp drill / chisel	Fingers clipped Permanent deformity of the fingers	3	4	12 High	Administrative: Safety talk, SOP	3	2	6 Medium
	Physical	Hot drill / chisel	Burnt skin Burns to the skin	3	2	6 Medium	Technique: Giving cooler Administrative: Safety talk, SOP PPE Control: Gloves	3	1	3 Low
	Chemical	Gram rolled	Cut on the hand	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Kinetic	Material bounced	Injury to limbs	3	3	9 High	Administrative: Safety talk, SOP	3	1	3 Low
	Ergonomics	Incorrect work position	Back pain	4	1	4 Medium	Administrative: Safety talk	4	1	4 Medium
	Physical	Hot material	Blistered skin Burns to the skin	4	2	8 Medium	Administrative: Safety talk PPE: Gloves, long clothes	4	1	4 Medium
	Physical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
Taking the results of the drilling process	Physical	Scratched by a sharp plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Physical	Gram rolled	Cut wounds on the fingers	4	2	8 Medium	Administrative: Safety talk, SOP PPE: Gloves	4	1	4 Medium
	Kinetic	Clamped on the crane hook Crashed by the plate	Injury to hands and feet	4	3	12 High	Administrative: Safety talk, training crane operators, SOP PPE: Safety shoes	4	1	4 Medium
NCT Machine										
Setting up work tools	Physical	Crushed and pinched	Injuries to the hands and feet	2	2	4 Low	Administrative: Safety talk, SOP PPE Control: Safety shoes, gloves	2	1	2 Low

Continued Table 2

Risk Identification			Risk Assessment			Risk Level	Control	Residual Risk Assessment		Level of Residual Risk
Type of activity	Source of Hazard	Potential Hazard	Pure Risk	Likelihood	Severity			Likelihood	Severity	
NCT Machine										
Setting up work tools	Ergonomics	Head is hit the engine	Bruises / wounds on the head	3	1	3 Low	Administrative: Safety talk, SOP PPE: Safety helmet	3	1	3 Low
Punching a plate	Physical	Wind pressure Exposed to noise	Impaired hearing function	5	4	20 Extreme	Administrative: Safety talk, SOP PPE: Ear plug	5	1	5 Medium
	Physical	Pinched by a large and heavy plate	Injuries to the hands and feet	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves, safety shoes	5	1	5 Medium
Taking plate results	Physical	Scratched by a sharp plate	Hand wound	5	2	10 High	Administrative: Safety talk, SOP PPE: Gloves	5	1	5 Medium
	Kinetic	Pinched by a crane hook Hit by a plate	Injury to hands and feet	4	3	12 High	Administrative: Safety talk, training crane operators, SOP PPE: Safety shoes	4	1	4 Medium

medium risk hazards, and 6 low risk hazards. The analysis on hydraulic press (HP) machines showed 4 high risk hazards, and 1 medium risk hazard. The analysis on corner shear machines (CS) showed 1 hazard with an extreme risk level, 2 high risk hazards, and 2 medium risk hazards. The analysis on press bending machines (PB) showed 5 high risk hazards. The analysis on grinding machines (GR) showed 2 hazards with extreme risk levels, 7 high risk hazards, and 1 medium risk hazard. The analysis on laser machines showed 3 high risk hazards and 4 medium risk hazards. The analysis on automatic gas engines (GA) and CNC machines showed 5 high risk hazards, and 8 medium risk hazards. The analysis on manual plasma machines showed 3 high risk hazards and 6 medium risk hazards. The analysis on manual gas engines (GM) showed 4 high risk hazards, 4 medium risk hazards, and 1 low risk hazard. The analysis on gap shear machines (GS) showed 1 hazard with an extreme risk level, 3 high risk hazards, and 1 medium risk hazard. The analysis on drill machines (DR) showed 7 high risk hazards, 5 medium risk hazards, and 2 low risk hazards. The analysis on NCT machines showed 1 hazard with extreme risk level, 3 high risk hazards, and 2 low risk hazards.

Determinant Control

The results of the control assessment showed risk categories of several hazards that can be derived from a hierarchy of controls. Workers in the engineering control for 11 different machines have the same role to connect the electric current directly to the machine. The workers in the administrative control for 11 different machines conduct safety talks every time they start working, conduct routine checks for each machine, repair and update existing SOPs so that they can be more adapted to current needs. Training on using the crane is also conducted for cranes operators. PPE is also adjusted for each operator working on 11 existing machines, namely: gloves and safety shoes for workers working on hydraulic press machines (HP) machines, press bending machines (PB), laser machines, and drill machines (DR). Gloves for workers working on corner shear machines (CS) and gap shear machines (GS). Leather gloves, aprons, safety shoes, ear plugs and masks for workers working on grinding

machines (GR) and NCT machines. Gloves, safety shoes, face shields, long sleeve shirts, and masks for workers working on automatic gas engines (GA) and CNC, manual plasma machines and manual gas engines (GM).

Residual Risk Assessment

There are still 61 remaining risks at medium risk level and 6 remaining risks at high risk level which still require additional control. The analysis on hydraulic press (HP) machines showed 1 high risk residual hazard, and 4 medium residual hazards. The analysis on corner shear machines (CS) showed 1 high residual risk hazard, 3 medium residual risk hazards and 1 low residual risk hazard. The analysis on press bending machines (PB) showed 1 high residual risk hazard, and 4 medium residual risk hazards. The analysis on grinding machines (GR) showed 2 high residual risk hazards and 8 medium residual risk hazards. The analysis on laser machines showed 5 medium residual risk hazards and 2 residual low risk hazards. The analysis on automatic gas engines (GA) and CNC machines showed 3 medium residual risk hazards and 10 low = residual risk hazards. The analysis on manual plasma machines showed 8 medium residual risk hazards and 1 low residual risk hazard. The analysis on manual gas engines (GM) showed 1 high residual risk hazard, 4 medium residual risk hazardsand 4 low residual risk hazards. The analysis on gap shear machines (GS) showed 5 medium residual risk hazards. The drill machines (DR) showed 10 medium = residual risk hazards and 4 low residual risk hazards. The analysis on NCT machines showed 4 medium residual hazards and 1 low residual hazard. However, some risks remained even when controls are in place. Controls cannot reduce or diminish the risk categories. Residual risk showed the effectiveness of the controls that resulted in the residual risk value as shown in Table 2.

DICUSSION

Risk Identification

Risk identification was seen from each work stage of the 11 existing machines in the plate working unit (PPL) of PT. INKA (Persero). Starting the engine has the potential to cause electric shock and even death, which is included in the electrical hazard. This could occur because the 11 existing machines use electric power to run the machines, and the machines are also operated directly by the existing workers. This work area allows workers to be at risk of electric shock when starting the machine as the main source of operation, which can cause fatal events due to the entire working processes that use machines. According to Ramli (2010), accidents are always related to one form of energy, including electricity. However, the danger of getting an electric shock is rare due to a rare electrical short circuit (Darmawan, Ummi, and Umyati, 2017).

Preparing materials has the potential for injury to hands and feet, hand wound and hand-scratched skin, included in the mechanical and kinetic hazards (Irawan, Panjaitan, and Yenny Bendatu, 2015). The activity of picking up and carrying the plate for the work process is risky and has potential hazards because the materials are large, heavy plates which can create a danger of being pinched, and rough and sharp edges can also cause scratches (Government Regulation of the Republic of Indonesia , 2012).

Setting up work tools has the potential for injuries to the hands and feet and limb disorders, included in the physical and ergonomic hazardsbecause the activities of preparing and installing work objects into the machines put workers at risk of being hit by blunt or sharp objects from the machine, at risk of being pinched by the machine which is running when the material is installed and at risk of having wrong work position for workers. According to (Government Regulation of the Republic of Indonesia , 2012), the potential hazards can be sourced from unsafe work methods carried out by workers. Incorrect crane operation could also cause the plate to fall , which was often done by workers, while the risk of back pain almost is non-existent. This is in line with the statement of Purbayanti and Hidayat (2018) that all activities involving human factors have potential hazards that are at risk of causing work accidents and health problems.

Drilling process has the potential for slash wounds on the hands of workers who are affected by a gram of thread resulting from the drilling process, and the slack lock will make the plate bounce so it can hurt the workers. According to (Government Regulation of the Republic of Indonesia , 2012), potential hazards can originate from the production process or work process and the machines used. Grinding machines generate noise above the NAV (85 db for 8 working hours), and the wind pressure used to perforate the plate using an NC machine can

cause hearing loss. Noise is one of the factors of physical hazard that can cause hearing loss (Zeinda and Hidayat, 2016). Burns to workers' hands can also occur due to exposure to the heat of fire coming out of automatic gas (GA) and CNC machines, manual plasma machines, and manual gas engines. Leaking gas hoses are nitrogen gas, oxygen gas and wind, all of which can cause fires and explosions. According to Ramli (2010), one of the dangers that can occur due to chemicals is fire and explosion caused by several flammable and explosive chemicals.

Gathering the results has the potential for injury to hands and feet. This final activity is done after carrying out the machining process and taking the workpiece with risk of being pinched and scratched by a sharp plate.

Risk Assessment

There are four categories of risk assessment, namely extreme risk, high risk, medium risk and low risk. There is an extreme risk for working on corner shear machines (CS) when the workers cut the plate using the cutting machine as it can cause permanent defects; on the grinding machines (GR) when workers do the grinding process as the body part can be cut off by the spinning machine, causing permanent defects in the fingers and exposure to noise could cause hearing loss; on gaps shear machines (GS) when workers cut their hand due to the use of the cutting machine, causing permanent deformities in fingers; and on NCT machines which can occur when wind pressure is exposed to noise causing hearing loss. All of these risks always occur when workers use the machines so that the likelihood value is 5 (almost certain), and the severity value is 4 (major) because these risks cause disability to workers. Meanwhile, the risk level is 20 (extreme risk).

A high risk exists in all 11 existing machines. The danger of electric shock rarely occurs due to a rare electrical short circuit (Darmawan, Ummi, and Umyati, 2017), so the probability value is 2 (impossible) but the electric shock can cause death, and therefore the value severity is 5 (severe) while the risk level for starting the engine is 10 (high risk). Adjustment of work tools can make workers be pinched and squashed and even die as it can cause injury to the hands and feet while preparing the materials. This condition might always occur because the same types of material will be installed on these 11 existing machines so that the likelihood value is 5 (almost certain), the severity value is 2 (small), and the risk level is 10 (high risk). Taking the plate causes the skin to be scratched, causing the hand wound so that the likelihood value is 4 (maybe) because this is a definite activity, but for the risk of injury it is rare so the severity is 3 (moderate), and the risk levelis 12 (high) risk). When taking the plate, the hot materials cause the skin to blister during the machine process causing eye skin and respiratory irritation so that the likelihood value is 3 (maybe), and because sometimes there are sparks the risk weighs 4 (major), and the risk level is 12 (high risk). The high category risk should be a priority of the company before controlling other low hazards. The high category risk cannot be tolerated and has a greater impact on work processes and workers (Sari and Wahyudiono, 2020).

A medium risk existed in all 11 existing machines. The risk of being pinched by the machine running when the material is installed, and sometimes workers use the wrong work position causing back pain. According to (Government Regulation of the Republic of Indonesia, 2012), potential hazards can be sourced from unsafe work methods carried out by workers. Incorrect crane operation can also cause the plate to fall. This is often done by workers so that the likelihood value is 4 (likely) while the risk of back pain is almost non-existent so the severity value is 1 (Negligible). The risk level of incorrect work position is 4 (medium risk). This is in line with Purbayanti and Hidayat (2018) suggesting that all activities involving human factors have potential hazards that are at risk of causing work accidents and health problems.

There is a low risk for hydraulic press machines (HP), press bending machines (PB), automatic gasoline engines (GA) and CN, manual gas engines (GM), drilling machines (DR) and NCT machines when installing a mushroom head shape / pattern hitting the engine and being hit by a hammer causes bruises / injuries to the head, hands and feet. This rarely happens because it can only happen if the workers are less concentrated so that the possible value is 2 (impossible), and the severity value is 1 (negligible) because it does not really affect the risk level 2 (low risk). Moreover, getting pinched by the work tools and falls cause injury to the hands and feet, yet this rarely happens because it can only happen if the worker is daydreaming so that the likelihood value is 2 (impossible), the severity value is 2 (minor) because it can be treated with first aid with the risk level of 4 (low risk). Radiation rays cause watery eyes, and this is possible because

every machine that uses radiation is used so that the likelihood value is 3 (maybe), and the severity value is 1 (negligible) because it does not have much effect if the worker used PPE correctly, so the risk level is 3 (low risk).

Determinant Control

From the control hierarchy it was found that PT. INKA (Persero) has used 2 existing controls, namely SOPs and APD, but the existing SOPs have still not been updated and have not been adjusted to the latest conditions so that there is a need for updating SOPs and training for workers who need training. Moreover, the use of PPE is also inadequate in terms of quality and quantity according to the needs of workers. It is advisable to carry out engineering control on 11 different machines by connecting an electric current directly with these machines. Control can be further improved by conducting routine and scheduled inspections, conducting safety talk before work and educating workers on the importance of using PPE (Sari and Wahyudiono, 2020).

Residual Risk

After controlling, there is a reduction in the risk that previously contained extreme risks to zero for extreme risks. For high risks the number is very small, only up to 6 and many risks decrease to medium risk and low risk. This means that control is very effective in reducing the risk of occupational accidents and occupational diseases. The purpose of this residual risk research is to reduce previous risks by conducting risk control assessments, so that risks can be fully accepted (Zeinda and Hidayat, 2016) because after all the risk may not diminish even after controlling.

CONCLUSION

The conclusion of the risk assessment using Job Safety Analysis (JSA) was known from observations and interviews with K3LH management managers, steel work managers, and machine operators in the PT. INKA (Persero). There are 94 hazards identified from 11 existing machines. After controlling, there is only a small number of risks at high risk level, and most of is the hazardsare at a medium risk level and a low risk level. Risk control measures carried out by PT. INKA (Persero) is in accordance with the hierarchy of control such as the use of PPE and the provision of work SOPs.

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