

# Implementation of Hazard Identification, Risk Assessment, and Determining Control (Hiradc) System for Hazard Risk Management in Mining Work Environment at PT XYZ

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## Abstract

The mining industry is known as a high-risk sector, which often faces challenges in identifying the causes of work accidents. This research focuses on the implementation of the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) system at PT XYZ, especially at the gold mine. The aim of this research is to improve work safety through hazard identification and effective risk management. The method used includes observation and descriptive analysis of secondary data from the Occupational Health and Safety (K3) department. The research results show that there are 9 potential dangers, with 6 of them in the extreme risk category and the other three in the high category. Through the implementation of the 50 proposed control measures, the risk level was successfully reduced to a safer category. These findings emphasize the importance of implementing HIRADC to reduce work accidents and support operational sustainability in the mining industry.

**Keywords:** Gold Mine, HIRADC, mining industry, risk assessment, workplace safety

## 1. Introduction

Throughout its history, mining has been considered a high-risk sector globally. Often, researchers have difficulty identifying the factors that cause mining accidents in the hope of preventing similar accidents from occurring in the future. The accident rate in Australia is higher than other sectors [1]. One of the components that drives Indonesia's economic growth and progress is the mining sector. The rapid development of the mining industry has led to an increase in the number of workers used in mines. As a result, the risk of work accidents increases. According to Ramli, because the number of work accidents and potential work hazards that endanger industrial workers including mining continues to increase, the expected protection for workers in this industry is still lacking [2].

As the industry grows, occupational safety and health (OHS) becomes a top priority. The mining industry is closely related to worker activities because it has many potential hazards and risk factors. Throughout its history, mining has been considered a high-risk sector globally. Mining production activities increase the risk of occupational accidents (KK) and occupational diseases (PAK), as well as damage to mining equipment.

The Occupations, Health & Safety (OHS) Department is one of the departments at PT XYZ which operates in one of the gold mines in Indonesia and has an important role in ensuring the implementation of HIRADC in all operational areas. Various work risks in this mine include exposure to mineral dust, use of heavy equipment, vehicle traffic in the mining area, and the potential for landslides due to high rainfall. The OHS Department is not only responsible for designing and implementing the K3 program, but also providing training, monitoring compliance with regulations, and conducting audits to ensure that work safety is maintained.

The HIRADC process involves identifying potential hazards, such as physical hazards from heavy equipment, chemical hazards from mining waste, and environmental hazards from extreme weather conditions. Risk assessments are conducted to estimate the impact and probability of risks, while control strategies are determined to minimize potential workplace accidents. The implementation of HIRADC in gold mines not only helps reduce the trend of workplace accidents but also improves operational efficiency by creating a safer working environment. This study aims to conduct HIRADC activities in gold mines with a focus on hazard identification and risk management in the mine work area. Through effective implementation, it is expected to improve work safety, reduce the risk of accidents, and support the sustainability of mine operations.

## 2. Literature Review

### 2.1. Occupational Health and Safety

Occupational Safety and Health (K3) is a series of activities aimed at creating a comfortable and safe working atmosphere for employees in the related industry. K3 involves supervision of individuals, machines, materials, and work procedures in designated areas, in order to prevent injury to workers. Safety focuses on protecting workers from the risk of accidents in the workplace, while health is related to efforts to ensure that workers are free from physical and mental illnesses that can arise from their work. Work activity itself is a dynamic process that involves the use of mental and physical abilities to achieve various productive goals. Thus, K3 not only contributes to the welfare of workers and companies, but also plays a vital role in creating a healthy and safe environment for the community around the factory or work location. In addition, K3 is a proactive effort to prevent unsafe actions and conditions that can potentially cause accidents [3].

### 2.2. HIRADC

HIRADC, which stands for Hazard Identification, Risk Assessment, and Determining Control, is an important component in the occupational health and safety (OHS) management system that focuses on preventing and controlling hazards in accordance with the OHSAS 18001 standard. As one of the requirements in OHSAS 18001:2007 (clause 4.3.1) and ISO 14001:2004, HIRADC plays an important role in implementing effective OHS practices. This standard requires companies to review HIRADC at least once a year. HIRADC consists of several steps, namely hazard identification, risk assessment, and determination of risk control. The results obtained from the HIRADC process will be the main basis for formulating OHS goals and targets. Thus, companies or industries can focus on efforts to prevent, reduce, and even realize the vision of zero accidents, namely eliminating the risk of work accidents [4].

### 2.3. HAZARD

Hazards refer to the characteristics of a material, the working mechanism of the tool, the method of carrying out the work, and the conditions of the workplace environment that can cause damage to property, occupational diseases, or injuries, both temporary and permanent. There are various types of hazards that need to be identified, including [5]:

1. Hazards from Moving Objects (Kinetic Hazards): This includes risks generated by objects moving in a straight line, rotating, moving randomly, and when lifting or transporting.
2. Hazards from Static Objects: This includes risks related to differences in elevation, the presence of water, damage to tools or work facilities, construction hazards, and risks that arise during the installation process.
3. Physical Hazards: These include risks from exposure to light, noise, extreme temperatures, pressure, and electromagnetic radiation and ionization, including vibration.
4. Electrical Hazards: This risk can arise from contact with electric current, failure of safety devices, overload, sparks, and imperfect insulation.
5. Chemical Hazards: These include the risk of fire and explosion caused by chemicals.
6. Poisoning Hazards: These include risks from corrosive substances, pesticides, and various other hazardous materials.
7. Biological Hazards: These are threats caused by toxins, germs, bacteria, viruses, fungi, parasites, and other organisms such as plants, animals, and insects.
8. Ergonomics Hazards: These include risks related to work positions, how to lift objects, and the size of the workspace available.
9. Psychological Hazards: These include stress, disharmony in interpersonal relationships, family problems, and various other factors that can affect mental health.

### 2.4. Risk Management

How an organization applies measures in mapping various existing problems by implementing various management approaches comprehensively and systematically is called risk management. In a broader sense, risk management refers to all risks that occur in society, such as loss of property, finances, business, and others. To manage, monitor, and control the organization against risk, the organization uses risk management. [6].

## 3. Research Method

Method is a technique that can be used to obtain something. However, research methods can be defined as the way the research process is carried out, both in data search and disclosure of existing phenomena. This study took place during the research period and used observational techniques to collect data from the Mining, Production, and OHS departments that did not provide any treatment to the research subjects. Furthermore, because this study does not compare between variables, this study uses a descriptive method to describe the situation objectively.

Data was collected using secondary data from the OHS department, which stores all gold mine safety data. The results of this secondary data will be processed using descriptive analysis. Data management and analysis methods are used to determine the risk assessment value for each department at PT XYZ.

## 4. Result And Discussion

### 4.1. Assessment Matrix

PERINGKAT RISIKO						Risiko Signifikan	
Kemungkinan	Konsekuensi						
	1. Kecil	2. Ringan	3. Sedang	4. Berat	5. Bencana		
A – Hampir Pasti	11	16	20	23	25		18 – 25 EKSTRIM
B – Mungkin Sekali	7	12	17	21	24		11 – 17 TINGGI
C – Mungkin	4	8	13	18	22		6 – 10 SEDANG
D – Kemungkinan Kecil	2	5	9	14	19		1 – 5 RENDAH
E - Langka	1	3	6	10	15		

Fig. 1: Assessment Matrix

The image above is a risk assessment matrix that functions to determine the risk value in an area or job at PT XYZ. The value is obtained from the possibility row multiplied by the consequence column to obtain the risk value. For example, if the possibility of occurrence is at level B-very likely and the consequence level is severe, then the risk value obtained is 21 and is included in the extreme risk category.

### 4.2. Level of Consequences

Matriks Risiko							
Tabel Konsekuensi							
Level	Keselamatan dan Kesehatan	Lingkungan Hidup	Masyarakat dan Pemerintah	Reputasi	Finansial	Keefektifan Organisasi	Kepatuhan
1. Kecil	Tidak ada cedera atau P3K. Dampak kesehatan yang sedikit dikhawatirkan namun dapat kembali seperti semula, tidak ada efek kesehatan merugikan yang diketahui atau diduga.	Dampak kecil. Dampak terbatas pada area yang saat ini terkena dampak operasi. Dampak ringan lingkungan hidup yang sepenuhnya dapat dipulihkan tanpa dampak permanen terhadap lingkungan.	Pengaduan terisolasi. Permintaan keterangan dari Kepala Desa. Sejumlah kecil pengaduan yang sifatnya kadang-kadang.	Reputasi perusahaan tidak terpengaruh, atau pengaduan lisan atau tertulis ditangani secara internal.	Tidak berdampak pada Jadwal Kerja, Produk dan Kualitas – kerugian kurang dari \$50.000.	Individu yang tertutup atau ketidakpuasan tim. Kurangnya tim yang terampil.	Masalah kecil kepatuhan teknis/hukum yang dihadapi di site. Insiden wajib dilaporkan ke dalam sistem pelaporan insiden internal rutin. Pelanggaran kecil terhadap standar internal.
2. Ringan	Pertolongan Medis. Dampak kesehatan yang dikhawatirkan namun dapat kembali seperti semula.	Dampak terbatas di dalam site. Dampak terbatas dalam area Kontrak Karya (KK). Kerusakan minimum terhadap lingkungan. Segera ditangani di dalam site. Tidak ada dampak signifikan terhadap sungai.	Pengaduan yang berulang dari warga di satu desa pada masyarakat setempat. Permintaan keterangan dari Pemerintah Kabupaten. Bantuan diperlukan dari Pemerintah Kabupaten.	Reputasi perusahaan di lingkup Kabupaten menurun akibat berita setempat yang merugikan.	Kerugian produksi kurang dari 1 hari – sebesar \$50.000 - \$500.000	Ketidakpuasan yang meluas. Kehilangan sementara individu-individu atau keahlian penting.	Masalah kepatuhan teknis/hukum yang dapat menimbulkan peringatan administratif tingkat rendah dari pihak regulator. Terjadinya pelanggaran kecil secara terus-menerus. Insiden wajib dilaporkan secara rutin (misalnya per bulan) dan kepada perusahaan G-PTAR. Pelanggaran menengah terhadap standar internal.
3. Sedang	LTI. Dampak kesehatan parah yang dikhawatirkan namun dapat kembali seperti semula.	Dampak di luar lokasi tambang terhadap fauna dan flora. Dampak dapat meluas di luar batas sewa operasi. Kerusakan menengah terhadap lingkungan. Tumpahan besar terkendali; Dampak kawasan tertentu; Pemulihan dalam waktu 1 tahun.	Jumlah pengaduan dalam tingkat yang serius dari suatu desa pada masyarakat setempat. Perhatian diberikan oleh Pemerintah Provinsi. Bantuan diperlukan dari Pemerintah Provinsi.	Reputasi perusahaan di lingkup Provinsi menurun akibat berita setempat yang merugikan.	Dampak signifikan terhadap Jadwal Kerja, Produk dan Kualitas – produksi dihentikan selama 1 hari hingga 1 minggu – kerugian sebesar \$500.000 - \$5.000.000.	Kerugian besar produktifitas. Kehilangan individu atau keahlian penting secara terus-menerus.	Pelanggaran berat terhadap peraturan. Insiden wajib segera dilaporkan (dalam waktu 48 jam) kepada Pemerintah dan Perusahaan G-PTAR. Pelanggaran berat terhadap standar internal.
4. Berat	Cacat permanen atau kematian. Dampak permanen terhadap kesehatan.	Dampak Berat – bahaya signifikan langsung dan/atau jangka panjang terhadap lingkungan. Kerusakan lingkungan signifikan dengan dampak yang meluas. Tumpahan tidak terkendali; Pemulihan memerlukan waktu 1 sampai 2 tahun.	Jumlah pengaduan yang meningkat, pengaduan berulang dari sejumlah desa pada masyarakat setempat. Perhatian dan tanggapan perlu diberikan oleh Pemerintah Provinsi dan/atau Pusat. Bantuan diperlukan dari Pemerintah Provinsi dan/atau Pusat. Perhatian dari Media Nasional.	Reputasi perusahaan di negara tuan rumah menurun karena kejadian merugikan yang signifikan.	Dampak besar terhadap Jadwal Kerja, Produk dan Kualitas – produksi ditangguhkan selama 1 minggu hingga 1 bulan – kerugian sebesar \$5.000.000 sampai \$20.000.000.	Kehilangan atau kurangnya ragam keahlian atau individu penting di seluruh departemen.	Pelanggaran serius terhadap peraturan berakibat pada adanya investigasi oleh pihak regulator. Penuntutan, sanksi atau tindakan lain yang serupa.
5. Bencana	Beberapa korban jiwa, mengancam jiwa atau penyakit yang menyebabkan cacat.	Dampak pada skala regional – di luar Kabupaten Tapanuli Selatan dan lebih jauh lagi. Bahaya jangka panjang atau tidak dapat diperbaiki; Pemulihan memerlukan waktu tiga tahun atau lebih.	Tingginya tingkat kekhawatiran atau perhatian dari semua desa pada masyarakat setempat dan sekitar. Perhatian media nasional dan/atau internasional.	Reputasi perusahaan menurun secara global karena berita kejadian merugikan yang signifikan.	Proyek dihentikan lebih dari 1 bulan – kerugian pendapatan mencapai lebih dari \$20.000.000.	Kehilangan atau kurangnya ragam keahlian atau individu penting di seluruh area site. Pemogokan yang berkepanjangan (> 1 bulan).	Operasi ditunda, izin dicabut.

Fig. 2: Level of Consequences

The image above is a consequence table that serves to provide an overview of the severity level if an accident occurs, especially in the mining area. The value levels start from small, light, medium, heavy to disaster and the resulting consequences can have an impact on safety and health, the environment, society and government, reputation, finance, organizational effectiveness and compliance. For example, at the level of severe safety and health, the consequences are permanent disability or death and permanent impacts on the health of the victim.

4.3. Level of Probability

Tabel Kemungkinan				
A – Hampir Pasti	B – Mungkin Sekali	C – Mungkin	D – Kemungkinan Kecil	E – Langka
Akibat yang akan terjadi. Kemungkinan terjadi 99%.	Akibat yang akan terjadi dalam beberapa situasi. Kemungkinan terjadi 90%.	Akibat yang terjadi di tempat lain. Khususnya akibat yang terjadi setiap 5 tahun.	Akibat yang terjadi di tempat lain. Akibat yang diperkirakan terjadi sekali di area tambang.	Akibat yang jarang terjadi di area industry dan tidak diharapkan terjadi dalam area tambang.

Fig. 3: Level of Probability

The image above is a probability table that functions to provide information on the percentage of the possibility of an accident occurring. The value levels are A-Almost certain, B-Very likely, C-Possible, D-Less likely and E-rare. For example, at level A-almost certain, the probability of occurrence is 99%, which means that the probability of an accident or incident occurring at the job or area is very high.

4.4. HIRADC

Division / Department : Processing/Production  
Section / Area : Crusher & Reclaim

Activity / Process / Material / Equipment	Type of Activity (Routine / Non-Routine)	Hazard #	Hazard	OS / OH	Potential Risks / Incidents	Inherent Risks (Without Control)			Existing Control	Existing Risks (With Control)			Residual Risk (Acceptable or Not Acceptable)	Risk Status (Acceptable or Not Acceptable)	Corrective Action Plan / Additional Mitigation Control Plan	Type of Hierarchy Control	Residual Risks			Risk Status (Acceptable or Not Acceptable)	Required EOP (Yes / No)
						L	C	Risk Level		L	C	Risk Level					L	C	Risk Level		
Working in a confined space	Routine	1	Hazardous atmosphere > 19.5%Vol process fluids and hazardous chemicals	OS	Personnel overcome by hazardous gas causes injury or illness.	C	4	18	Gas Testing pre entry Complete Confined Space Work permit Rescue Plan CS Clearance LOTO	D	2	5	Available and No	Acceptable						No	
		2	Falling rocks and scale, equipment by material dumped from ADT (SCM Bin)	OS	Worker struck down by falling objects causes serious injury or fatality	A	4	23	Isolation and lock for area energy, broken back and hand. Clean up pre work Hard barricades installed at ROM bridge. Gate above the jaw crusher, four openings PTW AFD Rescue Plan	D	2	5	Available and No	Acceptable						No	
		3	Falling rocks from Jaw Crusher	OS	Personnel struck down by falling rocks while entering Underpass Jaw Crusher causes injury or fatality	A	4	23	Complete isolation and remove all tags to maintain area to be used for maintenance Install steel plate hand barrier at the header as identified in the isolation region sheet (IRS) PTW and associated clearance SOP for Accumulator Complete Maintenance personnel complete hardware inspection to identify any hang up material Emergency procedure, ERT, First Aid, Medical Centre, RIG (Incident Register Sheet) standard Install new sign and maintain the concept to avoid people and equipment to be in the region Safety helmet, safety footwear, high visibility vest, long sleeve, long trouser, safety gloves	D	2	5	Available and No	Acceptable						No	
Working at height	Routine	1	Height > 1.8 M	OS	Falling from height causes serious injury	A	4	23	Scalability, ALD Hard barricades and isolation Barricaded work area zone (barricade) before work at height Scalability created by certified scaffolding Certified scaffold Inspector, seal tag, lead testing for scaffolding Work at Height Code of Practice Work at height safety harness and lanyard, Safety helmet and clean work high visibility clothing, long sleeve and trousers, safety gloves area barricade	D	2	5	Available and No	Acceptable						No	
		2	Struck by falling rocks from Jaw Crusher	OS	Personnel crushed in Jaw Crusher causes serious injury or fatality	A	4	23	Complete Isolation of Energy test step Remove accumulators internal energy Install steel gate plate on the header then and lock Erect good safety hand rail above area of the jaw Isolation and/or permit for safety permit required Only use mobile crane to lift jammed rock (over the head rail indicator) Standard AFD First Aid Kit PTW, Isolation clearance, CS clearance SOP for SCM Bin Change Stockpile from jaw crusher	D	2	5	Available and No	Acceptable						No	
Working on Conveyer One Stockpile	Routine	1	Slumping rockpile	OS	Personnel and / or equipment engulfed causes personal injury or property damage	A	4	23	Conveyer Header isolation must be completed by Supervisor and operator prior to entry into the Conveyer One Stockpile (COS) SOP isolation - risk at COS - all personnel who work at COS must complete SOP notification Two way radio communication A notification one begins around the reclaim header HSE observation is prohibited from leaving the cabin. If the HSE equipment is not working it must not be used from the COS area AFD Standard	D	2	5	Available and No	Acceptable						No	
		2	Interaction with HME	OS	Person struck by HME (Excavator, Dozer, Grader, Reversing Truck (Rocks falling down rockpile)) cause injury or fatality	C	3	13	Safety belts erected at the base of conveyer one stockpile (COS) PTW and Associated clearance SOP - JSEA for working on the COS (2 personnel access required) 30m exclusion zone HME Speaker at starting point and blind spot area JSEA for CVOT calibration while mobile equipment operating at COS Block area underneath along CVOT conveyor while maintaining Safety helmet and clean work, high visibility clothing, long sleeve and trousers, safety gloves and boots, safety shoes	D	2	5	Available and No	Acceptable						No	
Routine Inspection	Routine	1	Working near rotating equipment	OS	Worker pinched by rotating equipment causes serious injury	A	3	17	Not remove guarding without isolation Call Plant reduction to all Operators, all working high rotating equipment Caution	D	2	5	Available and No	Acceptable						No	
		2	Noise > 85dB	OH	exposure by high noise causes hearing disorders or loss	C	3	13	Use ear plugs 3M Libbitt can be reduce noise 25db Use ear plug / ear muff sign in place Isolation of workers so that they are not exposed to noise for too long	D	2	5	Available and No	Acceptable						No	

Fig 4: HIRADC Production Area Crusher Department

Based on the image above, it can be seen that there is hazard control in the processing department, especially in the crusher area. For example, working activities in a confined area have the danger of falling rocks when dumping material from the ADT which risks causing workers to fall on objects from above which can result in serious injury to fatality. The risk value before the control was 23. The controls carried out to reduce the risk value were area isolation, cleaning up the area before work, installing barricades around the ROM bin area, permission to do work, use of complete PPE and a rescue plan so that the risk value could drop to 5 and the risk level became acceptable.

5. Conclusion

Based on the results of the implementation of the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) method in the crusher processing area department, 9 potential hazards were identified. These potential hazards consist of 6 hazards with risk levels in the extreme category and 3 other hazards in the high risk category. After further analysis through the risk control determination process, a

total of 50 control steps were found to be proposed and implemented to manage these potential hazards. With this risk control, the risk level that was previously in the extreme and high categories was successfully reduced to a lower risk level. This reduction ensures that the risk level is acceptable in accordance with the applicable occupational safety and health standards in the mining industry.

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