



# Risk Analysis and Hazard Mitigation on Pig Acceptance Process of A Gas Company based on Occupational Safety and Health

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## Abstract

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**AIM:** PT. Pertamina Gas goes through the process of pig receiving at one of its operations. To support the Occupational Safety and Health (OHS) system, a system is needed to minimize risks. This system is expected to minimize the risks that occur to employees and their environment when carrying out the operation process.

**METHODS:** Risk analysis was carried out to find information regarding the level of possibility and impact of an event in the operation. In this case, the impact analysis was done on several aspects including people, assets, image, and the environment.

**RESULTS:** The risk assessment results of the Gresik gas station pig, it was found that low risk of 0%, medium 51%, and high 49% for activity in the gas station.

**CONCLUSIONS:** The result informs that from risk assessment resulted the Gresik gas station pig level of acceptance has a low risk of 0%, medium 51%, and high 49%. This three level of risk from assessment informs about the potential for occurrence and impacts on the case study. Moreover, from high level of risk need more attention and focus to minimize the risk.

## Introduction

Occupational safety and health (OHS) is a very important thing to pay attention to everywhere, both in companies and educational institutions, schools, and universities, because the impact of accidents and occupational diseases not only harms employees or the academic community, but also causes losses to companies or universities, either directly or indirectly. This is supported by Law no. 1 of 1970 concerning Occupational Safety. OHS have been defined by several experts who essentially refer to the interaction of a worker with the machine or equipment used and the work environment. OHS refer to the physical and psychological physiological conditions of the workforce caused by the work environment provided by the institution. One of the objectives of OHS is to prevent accidents at work.

Meanwhile, in the Regulation of the Kemenakertrans No. 03/Men/1996 [1], a work accident is an unwanted and unexpected event that can cause

human and/or property casualties. Sumamur [2] said that work-related accidents are accidents related to work relations at the company [2]. The employment relationship here can mean that the accident occurred due to work or at the time of carrying out work. In Indonesia, the number of work accidents is still high; this is one of the main focuses of OHS in Indonesia. Kemenakertrans [1] states that throughout 2009 there were 54,398 cases of work accidents in Indonesia. Data from Jamsostek until the end of 2011 recorded around 99,491 cases of work accidents or about 3.9% of the 2,567,671 workers registered with Jamsostek in Indonesia. During 2010 in Indonesia, based on reports from the regions, there were 98,711 cases of work accidents. Meanwhile, based on data in the first semester of 2011 the number of work accidents was 48,511 cases.

According to data from the Ministry Kemenakertrans in 2012 [3] in terms of the source of the accident, the biggest causes were engines, transport aircraft, and hand tools. Meanwhile, based on the type of accident, most of them are the result of

being hit, in contact with a sharp object that results in being scratched, cut, stabbed, and hit by falling. This will not happen if workers orderly use personal protective equipment or PPE. Based on the findings of hazards in companies in Indonesia that 60% of workers have head injuries because they do not use safety helmets, 90% of workers face injuries because they do not use face shields, 77% of workers have foot injuries because they do not use safety shoes, and 66% workers suffer eye injuries because they do not use eye protection equipment.

Occupational health and safety (H and S) will create the realization of good workforce maintenance. This OHS will be instilled in each employee through good counseling and coaching so that they realize the importance of work safety for themselves and the company. If there are many accidents, the workforce will suffer a lot, absenteeism in the company will increase, production will decrease, and medical expenses will increase. All of this will cause losses for the workforce and the company concerned, because the workforce may be forced to stop working due to temporary illness or permanent disability caused by unsafe work processes or wrong work equipment in operation. Research is conducted to understand the framework by identifying, analyzing, evaluating, and controlling safety comprehensively. Risks that threaten the Green Building Construction Workers involved. This lack of consideration causes not only additional costs for stakeholders but also overshadows the drive to adopt sustainable development in the construction industry [4]. The construction sector has the highest accident rate. Incorporating the concept of Occupational H and S in a construction project has the potential to minimize accident rates and reduce project costs. However, these concepts must be fully incorporated throughout the building's lifecycle: Design, construction, useful life, and reintegration. Attention should be paid to the early design stage, due to its greater impact on accident reduction [5].

Serious and fatal accidents occur on construction sites every year. However, the previous research has shown that the roots of accidents are often found in the early stages of the project process. This study discusses what happens in the initial phase of project management in construction that can endanger H and S in the construction phase. The investigation focused on two main research questions: (1) Can H and S in the construction phase be improved during the early phases of project management, and, if so, and (2) What are the key H and S challenges in the early phases of the project management that need to be addressed to do so? The data presented are collected by interviewees. They point to three main challenges to H and S in the early stages of construction projects: (1) Lack of competence, (2) lack of priority, and (3) lack of consequences [6]. Hazard and risk assessment (HIRA) is a method to identify the hazards and risks by analyzing each step involved

in the various processes [7]. Moreover, the HIRA also can use to evaluate the risk in the service providers like hospital [8]. PT Pertamina Gas is a company engaged in the midstream and downstream sectors of the Indonesian gas industry. Gresik gas station pig in one of part of PT. Pertamina Gas which owned by PT Perusahaan Gas Negara Tbk. (PGN) and PT Pertamina (Persero) and is part of the Gas sub-holding in Indonesia which plays a role in gas trading, gas transportation, gas processing, and gas distribution, as well as other businesses related to natural gas and its derivative products. In the process of its operation, PT. Pertamina Gas attaches great importance to OHS (K3) to maintain the safety of workers and the surrounding environment. The illustration above brings the researcher to narrow the understanding that K3 is very important for companies. This research is expected to analyze and mitigate risk one of the processes at the factory.

## Methods

This research used a descriptive-analytic study to evaluate the data by explaining or illustrating the condition in the general term [9]. This analysis explains the respondent's characteristics and evaluation of each variable for risk assessment. Risk Assessment is an attempt to calculate the magnitude of risk and determine whether the risk is acceptable or not. The risk assessment in this study considers use qualitative and quantitative analysis. The combination of qualitative and quantitative assessment is useful to evaluate the hazard and mitigate based on priority [10]. The qualitative analysis used to identify risk for the process. The quantitative analysis used to evaluate the severity and likelihood. Moreover, Risk assessment also calculates the level of risk obtained from the possibility of occurrence (probability) and the impact of severity that can be caused (severity) [11]. There are several steps involved in this process, including:

### **Risk identification**

Risk identification is the process of identifying the sources of risk, areas that will have an impact, events, causes, and possible impacts that will occur (consequence/impact). Events or potentials that will occur will be identified and if they occur will affect the company's targets. Factors or causes of risk (risk causes) from internal or external companies are things that are considered in identification [12].

### **Risk analysis**

Risk analysis is a system that uses information on the probability level and the level of

impact (severity) of risks that will arise to determine how often certain events can occur and how big the consequences. Risk analysis provides input for the risk evaluation process and in making decisions whether a risk needs to be controlled and selecting the appropriate control strategy and method. Qualitative analysis on risk analysis prioritizes risk through probability and impact that will be caused by risk. The method used in this analysis is risk scoring. The risk score is obtained from the multiplication of probability and impact. At Gresik gas station pig, risk analysis uses severity to define impact. Figure 1 will explain the probability and severity. After knowing the value of probability and severity (severity) will be carried out a risk assessment or risk scoring obtained from the multiplication of likelihood and severity (severity) to determine the magnitude of the risk that occurs and will be used as input for risk evaluation.

HSE RISK MATRIX							
		SEVERITY	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
		CONSEQUENCES	People	Slight Injury	Minor Injury	Major Injury / Health effects	Single Fatality / Permanent total disability
Environment	Slight Impact		Minor Impact	Moderate Impact	Major Impact	Massive Impact	
Asset	Slight Damage		Minor Damage	Local Damage	Major Damage	Extensive Damage	
Reputation	Slight Impact		Limited Impact	Considerable Impact	Major National Impact	Major International Impact	
LIKELIHOOD	E Almost Certain	Incident has occurred several time in company	E1	E2	E3	E4	E5
	D Likely	Incident has occurred more than once per year in company	D1	D2	D3	D4	D5
	C Possible	Incident has occurred in company or more than once in industry world wide	C1	C2	C3	C4	C5
	B Unlikely	Incident has occurred in industry world wide	B1	B2	B3	B4	B5
	A Remotely likely to happen	Never heard of in industry world wide but could occur	A1	A2	A3	A4	A5

Figure 1: Risk matrix

### Risk evaluation

Risk evaluation is an assessment that the risk is acceptable or not by comparing it to the applicable risk level standard. Risk evaluation is needed as a basis for controlling hazards and making decisions for the safety system used. In this step, the risk value will be compared with the risk matrix used by PT. Pertamina Gas (Figure 1).

Risk treatment is an effort made to handle risk based on the impact and probability of occurrence up to an acceptable residual level following the policies controlled by the company. Risk management is divided into four risk categories, namely accepting risk, sharing risk, reducing the possibility and impact of risk, and avoiding risk [13].

Risk mitigation is taking steps to minimize losses that can result from the impact of risk [14]. People who start a mitigation plan know more about risk than those who stop at analysis.

## Results

The risk analysis stated for identify the pig activity in the PT. Pertamina Gas. Pigging is the activity of cleaning the inside of the pipe from dirt that is considered to be able to inhibit the flow of fluid and damage the inside of the pipe, and to detect pipe thickness and leaks. While the pig is a device that is launched into the pipe and follows the fluid flow in the pipe. Figure 2 is an image of the PT. Pertamina Gas pig receiver layout. The process in the PT. Pertamina Gas pig receipts started by opening the vent valve for venting and continued by opening the valve from the bypass line valve, mainline valve to the second valve. After that open the MOV and do fluid handling. Then close and ensure the ROV is 50% covered to accept pigs. By monitoring the pig signal whether the pig has arrived, when it has arrived, reopen the ROV and open and close the MOV again. Close the valves that were previously opened after that emptied the pig receiver pressure. When you can open the drain valve and then close. After the drain valve is closed. Open the pig receiver door closure to remove the pig and if it has been removed can close the vent valve. Before completing the pig receiving process, N<sub>2</sub> is injected from the valve to fill the pig receiver pressure. When the pressure has been filled, the process of receiving pig in the PT. Pertamina Gas has been completed.

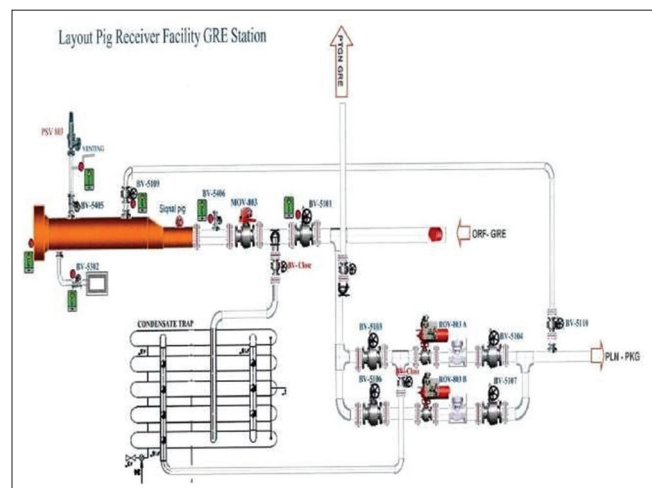


Figure 2: Layout receiver facility PT. Pertamina Gas

The first step in risk assessment is risk identification. Risk identification in the study was carried out through interviews with experts. The identification of risk events in this study is based on the process of receiving pig in the PT. Pertamina Gas. After conducting interviews with experts and obtaining data on the risks of hazards that occur impacts, and possible risks. Furthermore, risk analysis can be carried out with the information that has been obtained. The following is a risk analysis that has been carried out.

After conducting a risk analysis using the severity and probability level of impact, the next step

**Table 1: Risk matrix explanation**

Risk Category	Risk Score	Explanation
Low	0-2	The acceptable risk with low potential for occurrence and impact to the project
Moderate	3-6	Risks that are still acceptable and have the potential to occur and their impact on the project, but still need attention to prevent/minimize danger risk
High	8-25	Risks that are unacceptable and have a high potential for occurrence and impact on the project, so risk management measures are needed

is to conduct a risk evaluation. Risk matrix explanation was presented in Table 1. Based on the results obtained from the table above, the risk value for the process of receiving pigs at PT. Pertamina Gas has a low risk of 0 with a percentage of 0%, a medium of 24 with a percentage of 51%, and a high of 23 with a percentage of 49%. Information related to each risk category can be seen in Table 2. The following is a risk evaluation obtained from the results of the analysis before mitigation in the process of receiving pig in PT. Pertamina Gas.

**Table 2: Risk category contingency**

Risk Category	Risk Score	Explanation
Low	0-2	Accept the risk
Moderate	3-6	Accept the risk, minimize the likelihood, and risk impact
High	8-25	Avoid the risk and minimize the likelihood or risk impact

Based on the percentage results in Figure 3, it can be seen that the high-risk category still has a large percentage, which is 49%, this shows that in the process of receiving pig in the PT. Pertamina Gas, it still has risks that have a high potential for occurrence and impact on the project so that there is a need for immediate risk control to address and reduce the hazardous risks of this process or mitigation is required. In this study, mitigation will be carried out on every existing risk. The following is the mitigation carried out along with the risk analysis after the mitigation has been carried out which is shown in Table 4.

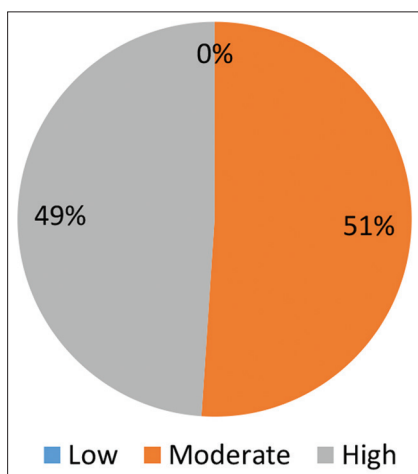


Figure 3: Risk analysis before mitigation

After performing a risk analysis again using the severity and probability level of impact, the next step is to conduct a risk evaluation for risk analysis after mitigation (risk residual value). Based on the results obtained

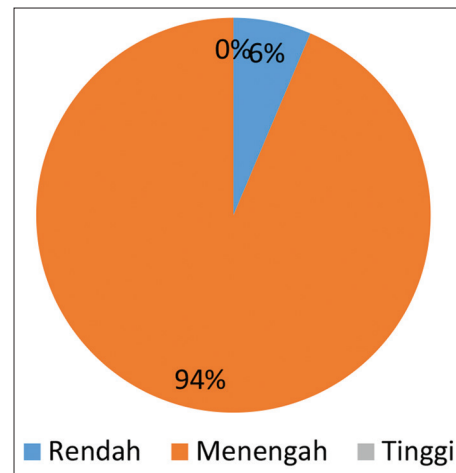


Figure 4: Risk percentage after mitigation

from the table above, the risk value after mitigation for the pig acceptance process for the PT. Pertamina Gas was presented in Figure 4. The pig acceptance process has a low risk of 3 with a percentage of 6%, medium of 44 with a percentage of 94%, and a high of 0 with a percentage of 0%. Information related to each risk category is shown in Table 5. The following is a risk evaluation obtained from the results of the analysis after mitigation in the process of receiving pig in the PT. Pertamina Gas.

Based on the percentage results, it can be seen that the medium risk category has the largest percentage, which is 94%, this shows that in the process of receiving pig in PT. Pertamina Gas after mitigation, it has risks that have moderate potential for occurrence and impact on the project so that even though it has become a risk, However, attention is still needed to prevent high-risk hazards. So with the risk treatment or mitigation, it can change the process risk that previously had high risk into medium risk or from medium risk to low risk.

## Discussion

HIRA has main role for industrial audit. The result of audit can help industry in developing safety planning and policy in term of identifying, measuring, controlling, and mitigating. Safety analysis for activity based on HIRA assessment also can evaluate the issue of worker's well-being and performance which may related with workers safety and stress [15]. Hence, the HIRA analysis can use to quickly improve the efficiency of the process and product quality, reducing the number of accidents, and defective goods while also saving money and time [7]. The priority is based on risk level from the evaluation ranging from low until high. The level of risk for the evaluation usually depicted by different color in the table or diagram. The



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**Table 3: Risk assessment of pig acceptance process for PT. Pertamina Gas before mitigation**

No	Job description	Hazard	Impact	Probability	Basic Impact Matrix				Highest impact	Risk Score	Risk Category
					Human	Asset	Environment	Image			
1	Open and close vent valve 5405	Injured by handtools	Minor injuries, bruises	4	1	0	0	0	1	4	M
		Poisoned by Gas release	Respiratory distress, poisoning, pollute environment	3	3	0	2	0	3	9	T
2	Open bypass line valve 10" No. 5109	Noise more than 85 db	Hearing loss, PAK	3	2	0	0	0	2	6	M
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	M
3	Open valve main line 28" No. 5101	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		High pressure	Pig rejected and hurt the human	2	2	1	1	0	2	4	M
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
4	Open second valve bypass line No. 5110 for pig receiver pressure filling	Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		High pressure	Pig tertolak masuk dan melukai manusia	2	2	1	1	0	2	4	M
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
5	Open MOV-803	Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
6	Material handling	Excessive condensat liquid	Liquid leakage	3	3	2	2	1	3	9	T
7	Close 50%, ROV-803B for receiving pig	Hot temperatures around the work site	Dehydration, tired easily	3	2	0	0	0	2	6	M
8	Ensuring the pig condition by checking pig signal ZAH-V-803	Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
9	Open ROV-803B	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
10	Close MOV-803	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
11	Close bypass valve line No. 5110	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
12	Close main valve line 28" No. 5101.	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
13	Close bypass valve line No. 5109	Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		High pressure	Pigs don't enter and hurt humans	2	2	3	1	0	2	4	M
14	Gently open the 3/4" No. 5405 vent valve to empty the pig receiver pressure. (Beware of the liquid that may come out)	Liquid mengalami kebocoran	Work accidents, minor injuries	2	4	3	1	0	4	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	3	0	0	0	1	3	M
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
15	Open and close drain valve 2" No. 5302	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
16	Ensuring the pig barrel pressure level (see pressure gauge). Open the pig receiver door closure and remove the pig. Replace the O-ring seal closure door pig barrel. Close the closure door again	Suhu panas disekitar lokasi kerja	Dehydration, tired easily	3	1	0	0	0	1	3	M
		Bekerja tidak ergonomis	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		High pressure	Ledakan, kebakaran	1	3	3	2	2	3	3	M
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
		O-ring seal dimension selection error	Leakage, prone to fire	2	3	3	3	2	3	6	M
		closure door leakage	Explosions, fires	3	3	2	2	3	3	9	T
17	Close vent valve No. 5405	Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M
		Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Injured by handtools	Minor injuries, bruises	4	2	0	0	0	2	8	T
18	Inject N2 from valve 3/4" No. 5404 for pig receiver pressure filling	Unergonomics work posture	Musculoskeletal disorders	4	2	0	0	0	2	8	T
		Hot temperatures around the work site	Dehydration, tired easily	3	1	0	0	0	1	3	M

risk assessment started from defines and analyze the hazard. This first step will used as references and guide to establish the likelihood and severity evaluation.

**Table 4: Risk evaluation before mitigation**

Risk Category	Risk Event
Low	0
Moderate	24
High	23

Risk assessment was shown in Table 3. The risk score will calculate based on the quantitative analysis in the likelihood and severity rating. Nevertheless, there is limitation in the resources; the priority can address for the most dangerous condition [16]. Based on the risk score the result categorized in the risk zone. The risk zone also can help us to prioritize the urgency

Table 5: Risk assessment of pig acceptance process for PT. Pertamina Gas after mitigation

No	Task description	Hazard	Mitigation	Probability	Basic Impact Matrix				Highest impact	Risk Score	Risk Category
					Human	Asset	Environment	Image			
1	Open and close vent valve 5405	Injured by handtools	Wearing PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M
		Poisoned by Gas release	Wearing mask	3	2	0	2	0	2	6	M
2	Open bypass line valve 10" No. 5109	Noise more than 85 db	Wearing earplugs	3	1	0	0	0	1	3	M
		Injured by handtools	Using PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M
		Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
3	Open valve main line 28" No. 5101	High pressure	Wearing PPE and maintain distance from receiver	2	1	1	1	0	1	2	R
		Injured by handtools	Wearing PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
4	Open second valve bypass line No. 5110 for pig receiver pressure filling	High pressure	Wearing PPE and maintain distance with receiver	2	1	1	1	0	1	2	R
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
5	Open MOV-803	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Excessive condensate liquid	Prepare a vacuum truck to accommodate the condensate liquid	3	1	1	1	1	1	3	M
7	Close 50%, ROV-803B for receiving pig	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
8	Ensuring the pig condition by checking pig signal ZAH-V- 803.	Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
9	Open ROV-803B	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
10	Close MOV-803	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
11	Close bypass valve line No. 5110	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
12	Close main valve line 28" No. 5101.	Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Hot temperatures around the work site	There are facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Injured by handtools	Wearing PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M
13	Close bypass valve line No. 5109, Gently open the 3/4" No. 5405 vent valve to empty the pig receiver pressure. (Beware of the liquid that may come out)	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Injured by handtools	Wearing PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M

(Contd...)

Table 5: (Continued)

No	Task description	Hazard	Mitigation	Probability	Basic Impact Matrix				Highest impact	Risk Score	Risk Category
					Human	Asset	Environment	Image			
14	Open and close drain valve 2" No. 5302	High pressure	Provide facilities for rest and drinking water is available at the nearest place	2	1	3	1	0	1	2	R
		Liquid leakage	Provide guides for work (SOP)	2	3	3	1	0	3	6	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture Injured by handtools	Terdapat panduan dan alat bantu peralatan Wearing PPE and providing first aid kits in the field	4 4	1 1	0 0	0 0	0 0	1 1	4 4	M M
15	Ensuring the pig barrel pressure level (see pressure gauge). Open the pig receiver door closure and remove the pig. Replace the O-ring seal closure door pig barrel. Close the closure door again.	Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
		Unergonomics work posture Injured by handtools	Provide guides for work (SOP) Wearing PPE and providing first aid kits in the field	4 4	1 1	0 0	0 0	0 0	1 1	4 4	M M
		Close vent valve No. 5405	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
16	Close vent valve No. 5405	Unergonomics work posture	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		High pressure	Wearing PPE and preventive actions	1	1	3	2	2	3	3	M
		Injured by handtools	Wearing PPE and providing first aid kits in the field	4	1	0	0	0	1	4	M
		O-ring seal dimension selection error	Provide guides for work (SOP)	2	2	1	1	0	2	4	M
		Closure door leakage	Wearing PPE, first aids, and fire estinguisher	3	2	1	1	2	2	6	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M
17	Inject N2 from valve 3/4" No. 5404 for pig receiver pressure filling.	Unergonomics work posture Injured by handtools	Provide guides for work (SOP) Wearing PPE and providing first aid kits in the field	4 4	1 1	0 0	0 0	0 0	1 1	4 4	M M
		Open and close vent valve 5405	Provide guides for work (SOP)	4	1	0	0	0	1	4	M
		Hot temperatures around the work site	Provide facilities for rest and drinking water is available at the nearest place	3	1	0	0	0	1	3	M

to mitigate the risk. The purpose of this mitigation is reducing the level to become as low as possible [17]. The risk evaluation after mitigation was presented in Table 6 that shows the high risk is eliminated from 24 (before mitigation) to 0.

## Conclusions

Based on the results of the risk assessment on the pig acceptance of PT. Pertamina Gas, it was found that it had a low risk of 0%, medium 51%, and

high 49%. Where low risk means, it is acceptable and has a low potential for occurrence and impact on the project, medium means it is acceptable and has moderate potential for occurrence and impact on the project, but still requires attention to minimize hazard risk, while high means it is unacceptable and has a high potential. Occurrence and impact on the project, so that risk management measures are needed. After the risk assessment is carried out, the value of the risk can be known so that risk management efforts can be carried out to minimize the impact of hazard risk, namely, mitigation.

Table 6: Risk evaluation after mitigation

Risk category	Risk Event
Low	3
Moderate	44
High	0

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