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USE OF RISK MANAGEMENT REGISTER USING QUALITATIVE RISK ANALYSIS METHOD FOR LAND DRILLING WORKS IN ROKAN WORK AREA

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Abstract:
With the huge energy needs, especially oil, the Indonesian government is trying to manage it through the state-owned company Pertamina. Based on BP Migas data in 2022, Indonesia produced 31.4 million tons of oil, compared to the need, which was 2.2 times higher, namely 69.7 million tons. After the change of the new operator, which PMA previously managed to PHR WK Rokan, the government, represented by SKK Migas instructed to immediately carry out drilling activities so that national oil needs could be met. With the massive drilling activities carried out by PHR, where from 2021 to early 2024, drilling of more than 1000 new wells has been carried out. The purpose of this study is to map the risks of drilling activities that will be carried out in the future using the risk grouping method (Risk Register) in order to obtain an analysis of the dangers that will later be used to manage or control the possibility (probability) and impact (severity) of drilling activities that will be carried out next. The stages of work in onshore drilling are obtained from the existing drilling program, where all risks of the drilling stages to be carried out are grouped, given initial and additional barriers, so that a risk analysis is obtained in the form of initial mitigation.

Keywords: Oil production, Land Drilling, Risk Management, Mitigation, Indonesia

INTRODUCTION

Currently, the global oil and gas industry is experiencing a strong recovery in line with 2021 and 2022. Consumption figures have increased to 5.5 million barrels per day, and in 2022, it has increased again by 3.1% to reach 97.3 million barrels per day. The relaxation of Covid restrictions triggered this, according to Haitham Al-Ghais Se, secretary General of OPEC. With oil and gas prices having reached high levels, in addition to the factor of the start of production machines in a number of countries consuming black gold, even though recovery has occurred, the oil and gas industry is still shrouded in considerable uncertainty regarding future growth as a result of the ongoing Ukraine-Russia war in the European Continent (Firman Hidranto, 2023).

One of the operators given this responsibility is Pertamina Hulu Rokan (PHR); PHR itself is a new operator that processes the Rokan working area (WK) from the previous PT. Chevron Pacific Indonesia (CPI) as of August 21, 2021. PHR Rokan itself is the largest working area in Indonesia which has strategic value in meeting the production target of 1 million BOPD and 12 BSCFD in 2030. Head of SKK Migas Dwi Soetjipto also appreciated what PHR has done so far. Based on SKK Miga's records, the number of wells that PHR has drilled is 500 - 600 wells; this figure is clearly an extraordinary increase when compared to the previous operator, PT. Chevron Pacific Indonesia (CPI) before being taken over. With massive drilling activities at PHR, of course, it will also contain quite a large risk. Moreover, technology transfer is very slow in the Indonesian oil and gas industry, as it is known that a labor-intensive system still dominates drilling technology in Indonesia. From the published data, the research site has also experienced a fairly high number of accidents, where

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76 incidents occurred from August 2021 to February 2024. In the study, the author refers to the AS/NZ 4360:2004 standard with a qualitative analysis method as its scope limit, and this is used to group the risks of hazards that will arise from drilling activities based on drilling program data that have an impact on humans, equipment and the environment.

METHODS

Drilling in this study is land drilling using a Rig, . Drilling Rig installation of equipment to drill into underground reservoirs to obtain water, oil nat, natural gas, or underground mineral deposits. Meanwhile, data on work accidents, especially in the Indonesian oil and gas industry itself in 2023 recorded from SKK Miga's sources, a total of 36 victims consisting of 6 accidents that caused death, 6 incidents that caused lost workday cases (LWDC), 1 accident that caused restricted work case (RWC), 5 cases that caused medical treatment cases (MTC), 14 cases of first aid cases (FAC), and 4 cases of illness fatality.

In this study, the author uses risk management as the basic foundation of his research, where, in general, risk management can be defined as a strategic business process where management must assess whether business activities are consistent with stated strategic objectives and how risk management is linked to investment and growth decisions (Clarke & Varma, 1999). As for the risk management referred to in ISO 31000 risk management, in general, the definition of risk management according to ISO 31000, which has become the Indonesian national standard, is now known as SNI. ISO 31000 is a systematic process of implementing policies, procedures, and practices related to risk communication and consultation activities, determining the scope, context, and criteria of risk, implementing risk assessments consisting of risk identification, risk analysis, and risk evaluation, risk treatment, monitoring and review, recording, and reporting.

Each project will create a unique product, service or result. The results achieved can be tangible or intangible. Although some activities in the project are carried out repeatedly, it still does not change the definition of the project as temporary work. It has unique properties that cannot be the same in each project. For example, the construction of an office building can be made using the same materials and with the same team. However, each building will have its uniqueness in terms of location, design and situation around the project (PMI, 2013).

In general, a risk register is a grouping or list of risks, which is a tool used to identify, assess, and prioritize risks in an organization. It usually includes a detailed explanation of each identified risk, an assessment of its likelihood and potential impact, and a plan to manage or mitigate the risk. The goal is to help relevant stakeholders understand the potential risks associated with a process, project, system, or organization and develop strategies to deal with those risks effectively (Robinson, 2022). Currently, the implementation of a risk register is an important element in corporate risk management. By collecting and mapping information about the risks that may occur and the steps that will be taken to manage them, companies can be better prepared to face business uncertainty and, of course, to maintain operational sustainability.

RESULT AND DISCUSSION

This study will identify the risks that will occur during the drilling work. The risk category is obtained from the drilling program planning of the Rokan block PHR based on ISO 31000. The risk itself is divided into six phases of the drilling activities to be carried out.

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1) Land preparation phase.
   - Determining the good point
   - Land clearing
   - Land preparation
2) Rig equipment mobilization phase
   - Lifting rig equipment to transportation equipment (Loading equipment)
   - Rig equipment departure to the location
3) Rig equipment assembly and testing phase
   - Lowering rig equipment from transportation equipment to the location (Unloading equipment)
   - Assembling or arranging rig equipment (setting and installation)
   - Rig equipment testing (function test)
4) Well drilling phase
   - Rig tower erection (Rig-up)
   - Pipe assembly (stand-up tubular)
   - Mixing mud chemicals (mixing chemicals)
   - Well drilling (drilling formation)
   - Installation of initial casing in the well (running in-hole casing conductor)
   - Raising BOP (Nipple-up BOP)
   - Preparation
   - Installation of production casing in the well (running in-hole production casing)
   - Well cementing (cementing job)
5) Rig equipment dismantling phase
   - Rid down tubular
   - Nipple-down BOP
   - Dismantling rig equipment
6) Rig equipment demobilization phase
   - Loading equipment
   - Departure of rig equipment to the company's yard.

Risk analysis is carried out on drilling activities using two stages: initial control risk analysis and proposed risk analysis. If the risk from the activity is still large, an additional proposed risk analysis will be carried out. However, if the risk analysis is already small, there is no need to add a proposed risk analysis.

a). Initial control risk analysis. The next stage is the risk analysis of each stage of work in land drilling. Risk descriptions are obtained through discussions with competent personnel and reports from the Field HES Lead. The initial barrier in this stage is based on the work contract between the contractor and the employer, with risk control limited to control administration and PPE. The rig contractor is required to fulfill the contract agreement and be verified by the job owner before spud-in. The initial risk is determined based on two factors;

- Probability, which is calculated from the multiplication of the probability level and the impact.

Table 1. Probability

IMPACT		PROBABILITY				
Severity Level	Description	Almost Impossible	Rarely Occurs (20%<X≤40%)	It Can Happen (40%<X≤60%)	Very Likely to Happen (60%<X≤80%)	Almost Certain to Happen

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		to Happen (0%<X<20)				(80%<X<100)
		P1	P2	P3	P4	P5
5	VERY LARGE (NOA)	5x1	5x2	5x3	5x4	5x5
4	LARGE	4x1	4x2	4x3	4x4	4x5
3	MEDIUM	3x1	3x2	3x3	3x4	3x5
2	SMALL	2x1	2x2	2x3	2x4	2x5
1	VERY SMALL	1x1	1x2	1x3	1x4	1x5

The purpose of the color code in the table above is to represent the combined level of probability and impact of the identified risks. So, high risk is colored peacock, medium risk is yellow (amber), and low risk is green.

Severity indicates how serious an incident's impact is. Companies use severity to analyze safety standards and determine the criticality of an injury or illness. The calculation is based on the average days lost due to accidents, which reflects the organization's safety performance.

Table 2. Impact of QHSSE/ Severity Level

Degree		Impact of QHSSE/SEVERITY LEVEL events							
No. Degree	TERMS	Personal Injury	Transportation Accident	Work-Related Illness	Oil spill/ environment	Security Incident	Operation property damage with no people injury	Fire & Explosion	Reputation
5	Very large	Fatality	1. Fatality 2. Lost > USD 1 Million	1. Cause Fatality 2. Agents capable of irreversible effect leading to death, e.g., chemicals with acute toxic effect 3. Outbreaks within the facility lead to an outbreak within facility leading to a potential shutdown of the facility.	1. Spillage>15 bbl oil 2. Sensitive receptors (turtles' nesting grounds, fish spawning areas, fish apartments, recreational areas, birds, marine parks, corals, etc) are affected. 3. Response and recovery cost > USD 1 Million	1. Crimes/violence caused fatality Lost > USD 1 Million	Lost > USD 1 Million	1. A large part of facilities are exposed 2. Lost > USD 1 Million	1. National Issue 2. Potential regional and/or international media coverage of the company and parent company (Pertamina persero)
4	Big	Lost Time Incident (LTI)	1. Lost Time Incident (LTI) 2. Lost > USD 100,000<USD 1 Million	1. Lost Time Incident (LTI) 2. Hearing loss, blind 3. Agent capable of irreversible effect without loss of life but with serious disability and prolonged hospitalization	1. Spillage > 5Bbl - < 15 Bbl 2. Sensitive receptors (i.e., Turtles nesting grounds, fish spawning areas, fish apartments, recreational areas, birds, marine parks, corals, etc.)	1. Crimes/violence caused LTI injuries Lost > USD 100,000 < USD 1 Million Lost of	1. Lost > USD 100,000 < USD 1 Million 2. High potential (HiPO) Case	1. Part of the facility exposed (modal) 2. Lost > USD 100,000 < USD 1	1. Provincial Issue 2. Potential national and/or regional media coverage 3. Potential legal suit by the regulator and affected violins 4. Potential environmental remediation

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					potentially affected 3. Response and recovery cost > USD 100,000-<1 Milion 4. High potential environmental remediation demanded by regulator	explosive material, hostage, kidnapping, etc.)		Million	demanded by the regulator
3	Currently	Restricted Work (RWDC)	1. Restricted Work (RWDC) 2. Lost > USD 10,000 - < USD 100,000	1. Restricted Work (RWDC) 2. Agents capable of moderate health effects that are reversible but with no hospitalization	1. Spillage > 3 Bbl - < 5Bbl 2. Receptors experience short-term difficulties in absorbing/adapting and recovering from the impact. 3. Response and recovery cost > USD 10,000 – USD 100,000	Crime/violence caused RWDC injuries Lost > USD 10,000-<USD 100,000	Lost > USD 10,000 - < USD 100,000	1. Local Area (part of the module) exposed 2. Lost > USD 10,000 < USD 100,000	1. Kabuapten/kodya Issue 2. Potential local press exposures
2	Small	Medical Treatment (MTC)	1. Medical Treatment (MTC) 2. Lost > USD 1,000 - < 10,000	1. Medical Treatment (MTC) 2. Agents capable of minor health effects that are reversible (no hospitalization)	1. Spillage > 1 Bbl - < 3 Bbl 2. Immediate slight impact to a non-sensitive environment and can be cleaned up to original conditions 3. Response and recovery cost > USD 1,000 - < 10,000	Crimes/violence caused MTC injuries Lost > USD 1,000 < USD 10,000	Lost > USD 1,000 - < USD 10,000	1. Low risk for facility or plant exposed 2. Lost > USD 1,000 - < USD 10,000	1. PHR Issue
1	Very small	First Aid	1. First Aid 2. Lost < USD 1,000	1. First Aid 2. No effect on work performance	1. Spillage < 1 Bbl 2. Natural dispersion 3. Insignificant impact on the environment 4. Response and recovery cost < 1,000 USD	Crimes/violence caused PAC injuries Lost < USD 1,000	Lost < USD 1,000	1. Negligible for facility or plants exposed 2. Lost < USD 1,000	1. Internal AP Issue 2. no media concern

b). Risk analysis of proposal. In the risk analysis, the proposed additional risk control is not only based on the work contract, such as the initial control but also this risk analysis is made with input or recommendations from discussions and reports from teams that are also involved or present in this onshore drilling. This team itself is formed and has its duties and responsibilities according to the function of forming this team. The team is:

- HES D & C (Drilling and Completion) consists of HES Advisor and HES Specialist
- Verification and Validation (V & V): Visit at least once a month
- Rig Inspection (Reliability and Compliance): Visit the rig every 2 weeks

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- I-CCTV online, which is always online when drilling work is in progress

The data findings and reports obtained from the teams above are as follows:

- Hazard category:

Table 3. Hazard category

Hazard category	Count of Hazard tools			
	I-CCTV	RNC	VnV	FHL
Gravity	116	511	123	863
Pressure	59	571	37	333
Motion	271	766	46	326
Chemical	17	21	2	214
Mechanical	16	138	28	208
Dokument	0	0	20	205
Electrical	11	239	12	167
Temperature	8	68	4	126
Biological	1	1	0	24
Radiation	1	0	0	11
Sound	0	4	0	6

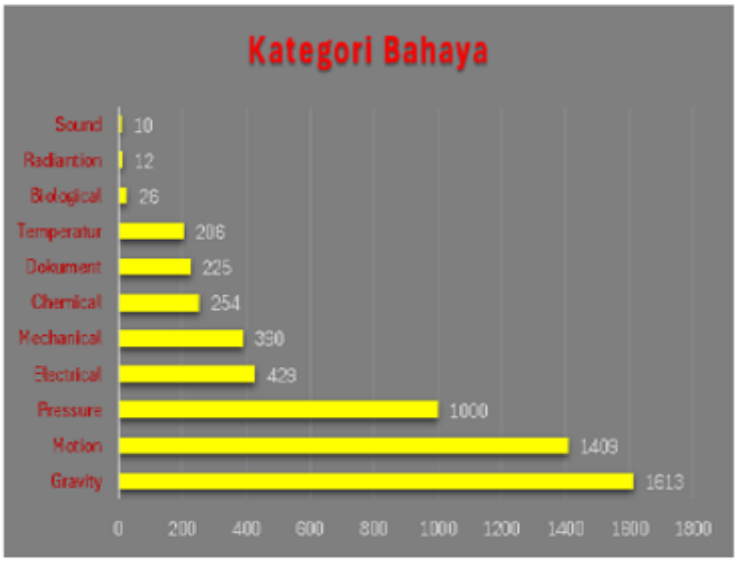

Figure 1. Hazard category

- Category findings

Table 4. Category findings

Category findings	Count of Finding tools			
	I-CCTV	RNC	VnV	FHL
Rig Facilities	171	1108	72	1678
Heavy Equipment	28	631	25	158
Well Control	53	297	9	58
Lifting Rigging	106	151	61	179
Safety Equipment	110	97	68	395
Light Vehicle	32	35	37	15

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Figure 2. Category findings

The findings data from the teams above amounted to 5574 findings spanning from 2023 to June 2024, and the hazard category grouping consists of 11 devices and 6 findings on the rig. The findings above will be used as additional analysis to increase barriers further so that the risk level in certain jobs with high risks can be reduced to a moderate or even low level. The risks in drilling work cannot be eliminated (Elementation), but what must be done is to control them. The following is a section of onshore drilling work that has been subject to additional risk control proposals, although not all hazards in this job have been subject to risk control proposals. However, this additional proposal focuses on the hazards at the work stage, where the risk level is still high.

c) Mitigation results obtained. After barriers were added to the stages of drilling work, the risk analysis results were obtained in the form of initial mitigation that must be carried out at each stage of the planned work. It allows work that has a high risk in drilling to be controlled as early as possible.

Preparation well pad.

Table 5. Preparation well pad

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
1-1	Demonstration	Social	The occurrence of demonstrations or community rejection during site construction work	Security	1. Conducting socialization with the community and local government officials 2. Reimbursement of land for residents affected by the project 3. Prioritizing unskilled workers from residents around the project	Administrative Control	P 4	S 3	1. Always communicate with community leaders and local government officials 2. Conduct public relations recruitment from local community leaders 3. Increase the number of unskilled workers employed by the	Administrative Control	P 4	S 2	1. Socialization must be carried out by involving community leaders and government officials. 2. Every major event that causes people to gather or celebrate, project work is adjusted 3. Public relations must be mandatory, and recruitment of local people and

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									surrounding community			figures must be prioritized 4. Increase the number of unskilled workers from the community around the project.
1-2	Wild animal disturbance	People	The presence of wild animals, such as snakes, tigers and elephants	Healthy	1. Provide induction to workers and guests before entering the project area 2. Have a medical site on standby at the location 3. Ambulance available	Administrative Control	P3	S3	1. The presence of HSE personnel on the project 2. There is cooperation with local clinics or hospitals 3. The nearest clinics and hospitals have anti-snake serum	Administrative Control	P2	S2	1. Induction of new personnel and guests is mandatory 2. Medical and HSE personnel must be on-site 3. Ambulance stays on site 4. Cooperation with surrounding clinics and hospitals that have anti-snake serum
1-3	Loss of equipment	Assets	There was theft of equipment used for work	Security	1. Hire security officers 2. Posts and portals are available 3. Procedures are created for checking personnel in and out 4. Former officers employ security	Administrative Control	P3	S2					1. There must be a post and portal 2. There are security officers 3. There are rules for workers and guests to enter and exit
1-4	Extreme weather	People	There is hot weather reaching more than 35 degrees and sometimes high rainfall.	Healthy	1. Workers have a valid medical check-up 2. Medical personnel are on site 3. Blood pressure and tension checks are carried out on all workers before work is carried out 4. Shelters for rest are available 5. Clear working hours 6. There are procedures for working in extreme weather (rain and heat)	Administrative Control	P3	S2					1. Valid worker MCU 2. DCU is carried out 3. There are medical personnel on standby at the location 4. Shelters for rest are available 5. Maximum work is 8 hours. If overtime is a maximum of 4 hours 6. Procedures for working in extreme weather are available
1-5	Noise of work tools	People	There are still residents living around the work location	Healthy	1. Workers are equipped with sufficient PPE 2. Noise level measurements are carried out 3. Ensure the distance between	Administrative Control	P2	S2					1. Workers are equipped with sufficient PPE 2. Noise level measurements are carried out 3. Ensure the distance between

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					the project and residents' homes is sufficiently far 4. Barriers are added with fences/tarpaulins							the project and residents' homes is sufficiently far 4. Barriers are added with fences/tarpaulins
1-6	Food waste and B3	Environment	Garbage is dumped carelessly without any management, which can cause environmental pollution.	Environment	1. Trash bins are available 2. other parties collect trash at the project	Administrative Control	P1	S2				1. Trash bins are available 2. There is a waste collection two hazards have collecting the waste has a permit for both domestic and B3 waste

At t, while, there are two hazards with high-risk levels, namely demonstrations and wild animal disturbances. While other hazards have Bynistrative controls are carried out.

a) Demonstration/Protest: The risk level is lowered from high to medium, reducing the involvement of community leaders and government officials in socialization and providing jobs for residents. It reduces the severity from 3 to 2.
b) Wild Animal Disturbance: The risk level is lowered from medium to low through cooperation with local clinics to provide anti-snake serum and increase HES personnel. This additional control reduces the probability value from P3 to P2 and the severity from S3 to S2.

Mobilization Equipment.

Table 6. Mobilization Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
2-1	Land transportation and its situation	People	There is a potential for heavy equipment vehicle slippage due to soil-bearing capacity conditions that are not yet suitable for the weight of the heavy equipment when crossing the main access to the	Safety	1. Heavy equipment operators have SIO, and Drivers have SIM 2. Pre Job Safety Meeting before moving activities 3. Inform the maximum vehicle speed limit of 20 km/hour 4. Vehicle checks are carried out 5. Mobilization Route Checks 6. Driving Safety	Administrative Control	P2	S3	HT Standby to facilitate communication in the implementation of moving equipment Rig Repair or compaction of areas at critical road access points	Administrative Control Engineering Control	P2	S2	1. Clear driver administration 2. Pre-job meeting before the activity begins 3. Check the vehicle and equipment ties 4. Check the road before the trip is carried out 5. Road repairs 6. Escort/convoy carried out 7. Driving safety procedures and travel plans 8. Communication equipment available (HT)

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			drilling location.		Procedures, Journey Management Plan 1. SOP Journey Management Plan 2. Conduct a Pre-job safety meeting before moving activities 3. Escort for heavy/large loads 4. Special supervision for night travel from/to drilling locations 5. Re-inspection of vehicles and driver documents before carrying out night travel 6. Maximum speed restriction for heavy equipment vehicles is 20 km/hour							
2-2	Fatigue	People	Workers experience fatigue, resulting in reduced concentration	Healthy	1. Work shift arrangement 2. Sufficient rest time 3. Valid DCU & MCU	Administrative Control	P2	S3				1. Work shift arrangement 2. Sufficient rest time 3. Valid DCU & MCU
2-3	Demonstration	People	Obstruction during mobilization	Security	1. Socialization to the local government and the surrounding community that the mobilization route passes through 2. Obtaining a crossing permit from the Transportation Agency	Administrative Control	P4	S3	Security assistance during mobilization from within the company and local police	Administrative Control	P3	S2	1. Socialization to the local government and the surrounding community that the mobilization route passes through 2. Obtaining a crossing permit from the Transportation Agency 3. Escort assistance that also involves the police

Of the four hazards, three have a high risk that needs to be reduced, while one is still tolerable.

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a) Rig vehicle situation: Additional administrative and engineering control barriers include additional communication devices, B2-level driver licenses, and road repairs at critical access points. These reduce the probability from P3 to P2 and the severity from S3 to S2.
b) Community obstruction: This risk is reduced by police escorting the convoy and internal security as the vehicle passes through the vulnerable area. The probability decreases from P4 to P3 and the severity from S3 to S2.

Unloading Equipment.

Table 7. Unloading Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
3-1	Movement of objects can fall or be released from their attachments	People	Hit by material/equipment lifted by a falling crane (Drop Object)	Safety	1. PTW, JSA, and PJSM are carried out before the activity 2. Ambulance & Paramedic Standby 3. Crane operator competency has been certified and valid 4. DCU check before the activity 5. Certification of lifting equipment used 6. Sufficient lighting for night activities 7. Lifting Plan	Administrative Control	P3	S4	1. Color Coding is still valid 2. Barricading the lifting area 3. The lifting supervisor conducts a visual inspection 4. Lifting gear inspection is carried out 5. HES personnel verify the inspection carried out	Administrative Control	P3	S3	1. Permit and SOP must be valid 2. Pre-job safety meeting is conducted before work 3. Routine crane inspection is conducted 4. Competence of crane operators and riggers is mandatory 5. Lifting supervisor personnel are available 6. HES personnel are available 7. A lifting plan is available 8. Lifting SOP is available
					1. The operator ensures that the area around the unloading material is free from worker activity (Clear zone area) 2. Lifting Gear Inspection and Pre-use Inspection 3. Ensure that the load does not exceed the crane capacity 4. Tag Line is used	Engineering Control			Safety Device (Anti to block crane) installed and functioning	Engineering Control			
		Assets	"Objects fell due to broken slings. Booms broke due to overloading."	Safety	1. PTW, JSA, and PJSM are carried out before the activity 2. Ambulance & Paramedic Standby 3. Crane operator competency has been certified and valid 4. DCU check before the activity	Administrative Control	P2	S4	1. Color Coding is still valid 2. Barricading the lifting area 3. The lifting supervisor conducts a visual inspection	Administrative Control	P2	S3	

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					5. Certification of lifting equipment used 6. Sufficient lighting for night activities 7. Lifting Plan				4. Lifting gear inspection is carried out 5. The lifting supervisor supervises during the activity				
					Ensure that the load lifted does not exceed the SWL	Engineering Control							
3-2	Fatigue	People	Workers experience fatigue, which results in reduced concentration at work.	Healthy	1. Work shift arrangement according to regulations 2. Safety sign area swing 3. DCU & Health Surveillance	Administrative Control	P3	S3	HES officers are present	Administrative Control	P2	S3	1. There is a shift change 2. DCU is carried out consistently 3. HES officers are present
3-3	Land transportation and its situation.	People	During SIMOPS (2 activities in 1 area), workers are exposed to the movement of vehicles and/or heavy equipment, which can cause potential LTI.	Safety	1. Pre-job safety meeting is conducted before work begins 2. Schedule arrangements are communicated to all workers	Administrative Control	P3	S3	Use PPE Proper	PPE	P2	S3	1. Pre-job safety meeting is conducted before work begins 2. Schedule arrangements are communicated 3. Additional PPE
3-4	Extreme weather	People	high temperature over 34-40 degrees	Healthy	1. Provision of drinking water to prevent dehydration 2. Checking the health conditions of workers 3. Socialization of the dangers of high temperatures."	Administrative Control	P2	S3	The existence of a shelter as a shady place for workers	Engineering Control	P1	S2	'1. Socialization of high temperatures during the morning tailgate meeting 2. DCU 3. Shelters 4. Drinking water providers

In the equipment dismantling work, all risks are at a high level, so additional barriers are needed:

a) Movement of objects: Additional administrative barriers and engineering controls ensure that periodic inspections of lifting points reduce internal and external parties. The lifting supervisor is responsible for daily inspections and HES verification. Engineering control involves safety devices on the crane that function optimally. It reduces the severity from S4 to S3.
b) Worker fatigue: Administrative control is carried out by employing HES personnel to ensure compliance with work and overtime rules and implementing fatigue management. Severity drops from S4 to S3.
c) Land transportation: Due to the project's heavy traffic, additional PPE and lane control personnel are needed. It reduces the probability from P3 to P2.

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d) Extreme weather: Shelters with adequate facilities are needed to reduce worker fatigue and dehydration. This engineering control reduces the probability from P2 to P1 and the severity from S3 to S2.

Install Equipment.

Table 8. Install Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
4-1	Extreme weather	People	high temperature over 34-40 degrees	Healthy	1. Health checks for workers 2. Provision of drinking water to prevent dehydration 3. Arrangement of work shifts according to regulations."	Administrative Control	P2	S3	Workers are provided with additional head and neck coverings Shelters are provided for workers to rest	PPE Engineering Control	P2	S2	1. Socialization of high temperatures during the morning meeting 2. DCU 3. Availability of shelters 4. Provision of drinking water 5. Workers are given additional head and neck coverings
4-2	Land transportation and its situation	People	Equipment falls during lifting, hitting personnel and potentially causing death	Safety	1. Certified and competent workers (Rigger, certified oil and gas Crane Operator) 2. Permit, JSA and PJSM before the activity 3. Signal Man Personnel use PPE appropriate to their position 1. Ensure the load being lifted does not exceed the SWL 2. Reposition the Equipment 3. Isolate the work area 4. Check that the lifting gear is in accordance with the SWL 5. Anti-block has been inspected and is active	Administrative Control PPE Engineering Control	P2	S3	1. Hire Lifting supervisor 2. Drop object inspection is carried out by the contractor	Administrative Control	P2	S2	1. Permit, JSA dan PJSM sebelum pekerjaan dilakukan 2. Crane operator dan rigger kompeten (bersertifat dan pengalaman) 3. PPE tersedia 4. Adanya personil Lifting supervisor 5. Isolasi area kerja 6. Peralatan di cek lifting supervisor sebelum digunakan 7. schedule inpeksi di jalankan
4-3	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	Use appropriate PPE gloves (Heavy Duty/High Impact Hand Gloves) 1. Observation of equipment conditions before carrying out work 2. Socialization and requiring the crew to make BBS observations Use of Push full stick	PPE Administrative Control Engineering Control	P4	S3	1. Conduct a hazard hunt program once a week by involving all personnel 2. Installation of warning signs and banners related to pinch points 3. Coloring on the handling tool."	Administrative Control	P3	S3	1. Mandatory use of HDHG while working 2. Coloring of handling tools 3. Installation of warning signs and banners 4. Use of Push Pull sticks 5. Crew's obligation to make BBS observations

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4-4	fall from a height	People	Derrickman falls off the monkey board	Safety	1. Procedure for working at height: Derrickman has an OMB (Drill Tower Operator) oil and gas certificate 2. Derrickman's activities are listed in the JSA, and do PJSM before the activity 3. Fit to task before activity 4. DCU before the activity 5. Permit implementation Full Body Harness Usage with Double Lanyard	Administrative Control PPE	P2	S3	1. Regular inspection by HES 2. warning sign: must use Full body harness Installation of CCTV cameras on monkey boards that drillers can monitor	Administrative Control Engineering Control	P2	S2	1. Derikkman is required to have a Certificate of Competency 2. DCU is done before work 3. Regular inspection of body harness by HES 4. There is CCTV on the monkey board that can be monitored by other personnel 5. A warning sign for the use of Full body harness is present
4-5	Fatigue	People	Workers are tired due to high workloads	Safety	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P2	S2					1. DCU is consistently carried out 2. Adequate food nutrition 3. Work shift arrangements accordingly
4-6	Environmental pollution from B3	Environment	Kebocoran oil/fluida yang dapat mencemari tanah ketika pengoperasian peralatan	Evirooment	Procedur for Monitoring the Quality of Health in the Work Environment	Administrative Control	P2	S3	Availability of Oil Spill kits	Engineering Control	P2	S2	1. There is a procedure for Monitoring the Quality of Health in the Work Environment 2. Oil spill kit available
4-7	Noise	People	Noise from active machinery causes potential hearing loss.	Health	1. Ensure the condition of the equipment is in accordance with the standards 2. Installation of noise warning signs 3. Doing Noise Mapping Use of earplugs/ear	Administrative Control PPE	P3	S3	There is an addition to the installation of noise cancellation on the engine	Engineering Control	P3	S2	1. Equipment condition as per standard 2. A noise warning sign was installed 3. Noise mapping is done 4. Giving earplugs and ears to employees 5. Noise Reduction Improvements for Engine Equipment

In equipment installation work, of the seven high-risk hazards, six require additional barriers:

a) Extreme weather: Temperatures of 35-40°C can cause dehydration and fatigue. Additional PPE, such as head and neck covers, is required, as well as engineering controls in the form of air-conditioned shelters and comfortable seats. Severity drops from S3 to S2.
b) Land transportation: Heavy traffic during lifting requires a lifting supervisor and routine inspection of dropped objects. This control administration reduces the severity from S3 to S2.

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c) Pinched: This high-risk condition requires a hazard hunt, pinch point warning signs, and additional handling tools. This control administration reduces the probability from P4 to P3.
d) Falling from a height: Personnel are at high risk, so PPE inspections, full-body harness warning signs, and CCTV installation on the monkey board are required as engineering controls. Severity drops from S3 to S2.
e) Environmental pollution: Poorly maintained rigs can pollute the environment due to engine oil and drilling fluids. Control administration in the form of spill kits reduces the severity from S3 to S2.
f) Noise: Old rig engines produce high noise, so they need dampening as engineering controls. Severity decreased from S3 to S2.

Function Test Equipment.

Table 9. Function Test Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
5-1	Extreme weather	People	high temperature over 34-40 degrees	Health	1. Provision of drinking water prevents dehydration 2. Examination of workers' health conditions 3. Socialization of the HEAT Stress program 4. Worker shift arrangement	Administrative Control	P3	S3	Creation of shelters as resting places Workers are given additional head and neck coverings	Engineering Control PPE	P2	S2	1. High-temperature socialization during morning meetings 2. DCU 3. There is a shelter 4. Drinking water provider 5. Workers are given additional head and neck coverings 6. Heat Stress campaigns/programs
5-2	Pressurized system	People	There was an explosion during the function test	Safety	1. Perform the Function Test according to the Function Test Procedure 2. Pressure gauge terkalibrasi 3. Safety pin installed 4. Me-maintain pressure based on working limit 5. LOTO (Mechanical Electrical) 6. Worker competence Use of PPE according to provisions 1. Isolate the work area (non-essential personnel should not be in the function test area) 2. Check that the lifting gear is in accordance with the SWL	Administrative Control PPE Engineering Control	P2	S4	"1. Announcement will be implemented function test area 2. Installation of Barricades"	Engineering Control	P1	S3	1. Melakukan Function Test sesuai dengan Prosedur Function Test 2. Pressure gauge terkalibrasi 3. Safety pin terpasang 4. Me-maintain pressure berdasarkan working limitnya 5. LOTO (Mechanical Electrical) 6. Kompetensi pekerja 7. PPE lengkap 8. Pemasangan barikade 9. Ada pemberitahuan saat function berlangsung (lewat radio)

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5-3	Fatigue	People	Workers are tired due to high workloads	Safety	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P2	S3	"1. Entering maximum overtime regulations 2. DCU is carried out again before the worker does overtime work."	Administrative Control	P1	S2	1. Regular health checks 2. Workers' nutritional needs are guaranteed and sufficient 3. Work shift arrangements according to regulations 4. Entering maximum overtime regulations 5. DCU is carried out again before workers do overtime work."

Three hazards in high-risk equipment testing require additional barriers:

a) Extreme weather: Workers are susceptible to dehydration because facilities are inadequate. Shelters as administrative controls and head and neck cover as engineering controls are required. Severity drops from S3 to S2.
b) Pressurized system: Pressure testing of 3000-5000 psi poses an explosion risk. Administrative controls, such as socialization via radio and installation of barricades on high-pressure pipes, reduce the severity from S4 to S3.
c) Fatigue: Workers are often exhausted due to suboptimal equipment. Administrative controls, such as overtime rules and repeated DCUs, reduce the severity from S3 to S2.

Rig-up Mast.

Table 10. Rig-up Mast

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
6-1	Extreme weather	People	high temperature over 34-40 degrees	Healthy	1. Health checks for workers 2. Provision of more drinking water to prevent dehydration in workers 3. Arrangement of work shifts according to regulations."	Administrative Control	P2	S3	Ensure that the shelter is permanent and has complete facilities, such as AC, hot cool water and good seating.	Engineering Control	P1	S2	1. Socialization of high temperatures during the morning meeting 2. DCU 3. Availability of shelters 4. Provision of drinking water 5. Workers are given additional head and neck coverings." 6. Good shelter facilities
6-2	The Mast bends and falls	Assets	The failure occurred while the mast was being lifted	Safety	1. The procedure for erecting a mast exists 2. Certified and competent workers (Toolpusher and driller) 3. Work permit, JSA, and PJSM before the activity 4. Work area in isolation	Administrative Control	P2	S3	1. Rigleader ensures the procedure is running and has been updated 2. The highest position personnel of the toolpusher, such as RSM and Rigsupt,	Administrative Control	P2	S2	1. Procedure for setting up existing mast and updates 2. Certified and competent workers (Toolpusher and driller) 3. RSM and Rigsupt are involved and supervise during the work

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					5. Mechanics and other support teams re-inspect				participate in supervised activities 3. The mechanic checks the condition of the hydraulic oil jack rig again All other work is stopped, and focus on this work	Engineering Control			4. Work permit, JSA, and PJSM before the activity 5. Work area in isolation 6. Mechanics ensure hydraulic oil is in accordance with procedures 7. All workers focus on this job, and other jobs are temporarily stopped
6-3	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	Use appropriate PPE gloves (Heavy Duty/High Impact Hand Gloves) 1. Observe the condition of the equipment before doing the work 2. Socialization and require the crew to make BBS observations Use of Push Pull stick	PPE Administrative Control Engineering Control	P 4	S 3	1. Conduct a hazard hunt program once a week by involving all personnel 2. Install warning signs and banners related to pinch points 3. Coloring on the handling tool	Administrative Control	P 2	S 2	1. Requiring the use of HDHG at work 2. Coloring on the handling tool 3. Installation of warning signs and banners 4. Use of Push Pull stick 5. Crew obligation to make BBS Observations
6-4	Falling from a height	People	Derrickman falls off the monkey board	Safety	1. Procedure for working at height: Derrickman has an OMB (Drill Tower Operator) oil and gas certificate 2. Derrickman's activities are listed in the JSA, and do PJSM before the activity 3. Fit to task before activity 4. DCU before the activity 5. Implementation of work permits Full Body Harness Usage with Double Lanyard	Administrative Control PPE	P 2	S 3	1. Regular inspection by HES 2. warning sign: must use Full body harness Installation of CCTV cameras on monkey boards that drillers can monitor	Administrative Control Engineering Control	P 2	S 2	1. Derikkman is required to have a Certificate of Competency 2. DCU is done before work 3. Regular inspection of body harness by HES 4. There is CCTV on the monkey board that can be monitored by other personnel 5. A warning sign for the use of Full body harness is present
6-5	Fatigue	People	Workers are tired due to high workloads	Healthy	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P 3	S 3	1. Include maximum overtime rules 2. DCU is done again before the worker does the overtime work 3. HES officers already exist	Administratif Control	P 2	S 3	1. Ada pertukaran shift kerja 2. DCU dilakukan secara konsisten 3. Memasukkan peraturan maksimal overtime 4. DCU dilakukan Kembali sebelum pekerjan melakukan pekerjaan overtime 5. Petugas HES sudah ada

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6-6	Noise	People	Noise from active machinery causes potential hearing loss.	Health	1. Ensure the condition of the equipment is in accordance with the standards 2. Installation of noise warning signs 3. Doing Noise Mapping	Administrative Control	P 3	S 3	1. Give ear muff to certain personnel 2. Regular PPE inspections	PPE	P 3	S 2	1. Equipment condition as per standard 2. A noise warning sign installed 3. Noise mapping is done 4. Giving earplugs and ears to employees

In this job, six high-risk hazards require additional barriers:

a) Extreme temperatures: High temperatures during the day can cause discomfort. Permanent shelters with complete facilities are needed as engineering control to reduce severity from S3 to S2.
b) Tower bending and falling: During rig-up, the tower can bend or fall. Control administration involves the presence of competent personnel such as RSM and Rigsupt, while engineering control stops other work to focus on rig-up. Severity drops from S3 to S2.
c) Pinched: This is high risk and requires a hazard hunt program, additional warning signs, and coloring on handling tools as control administration. Severity drops from S3 to S2.
d) Falling from a height: Derrickman is at high risk, so routine inspections and full-body harness warning signs are needed to administer control. Engineering control, in the form of CCTV on the monkey board, helps communication. Severity drops from S3 to S2.
e) Fatigue: Because the crew is not complete, some personnel have to work overtime. Control administration in the form of overtime rules helps reduce the probability from P3 to P2.
f) Noise: The lack of socialization for new workers requires PPE inspection and the provision of additional PPE as administrative control. Severity is down from S3 to S2.

Stand-Up Tubular Goods.

Table 11. Stand-Up Tubular Goods

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
7-1	Movements that cause objects to fall and fly	People	Equipment falling during lifting that hits personnel and potentially causes death	Safety	1. Certified and competent workers (Rigger, Operator, Crane oil and gas certificate) 2. Work Permit, JSA & PJSM Use of PPE according to provisions 1. Ensure the lifting load does not exceed SWL 2. Equipment Repositioning 3. Insulation of the work area	Administrative Control PPE Engineering Control	P 2	S 4	1. Age of crane manufacturing 2. Regular inspections 3. Daily checklist 4. Hire lifting supervisor	Administrative Control	P 2	S 3	1. Competent workers 2. Complete documents (work permit, SOP and JSA) 3. PJSM is carried out 4. Complete PPE 5. The age of crane manufacturing according to the rules 6. Daily checklist equipment

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					4. Check that the lifting gear is in accordance with SWL 5. Anti-to-block has been inspected and activated									7. Routine inspections are carried out 8. Hire lifting supervisor
7-2	Equipment Fall	Asset	Goods damaged due to system hoisting engine failure	Safety	1. Drilling Procedure 2. Equipment Certification	Administrative Control	P4	S3	Regular inspections	Administrative Control	P3	S3		1. SOP drilling 2. Sertifikat peralatan 3. Inspeksi rutin
7-3	Ergonomics	People	Position and lifting of weights have the potential to cause injury	Health	1. Manual handling procedure for lifting loads (max 20 kg) 2. Periodic maintenance	Administrative Control	P4	S2	1. Installation of banners/banners regarding the correct manual lifting method 2. Program of the 3rd week of every month related to manual handling	Administrative Control	P3	S2		1. SOP manual handling pengangkatan beban (max 20 kg) 2. Maintenance berkala 3. Pemasangan banner/spanduk mengenai cara pengangkatan manual yang benar 4. Adanya program sosialisasi setiap 1 bulan sekali
7-4	Mesin bergerak dan berputar	People	Rotating equipment (centrifugal pump, mud pump, draw work, cat head, hydraulic winch, spinner) regarding personnel	Safety	1. Carry out pre-used inspection before using equipment 2. Use of standard equipment 3. Personnel Certification in accordance with drilling guidelines Installation of guarding rotating equipment	Administrative Control Engineering Control	P3	S3	1. Regular inspections 2. Prohibit long hair for working personnel. 3. Jewelry is prohibited from being used (iron chain watches, rings, necklaces and bracelets)	Administrative Control	P2	S3		1. Pre-user inspection equipment before use 2. Use of equipment according to procedures 3. Personnel Competence 4. Installation of rotating equipment guarding 5. Regular inspections are carried out 6. Prohibit personnel from having long hair
7-5	Cedera tangan dan terjepit	People	Power Tong equipment regarding personnel and potential MTC	Safety	1. Pre-used inspection 2. Equipment according to specifications/not modified 3. Drilling Guideline 4. Personnel Certification	Administrative Control	P2	S3	1. Regular inspections are carried out 2. Coloring on the power tong	Administrative Control	P2	S2		1. Pre-used inspection is carried out 2. Standard equipment 3. Personnel certificate 4. Equipment certificate

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		(Medical treatment case)	5. Equipment Certification 6. Lighting in the work environment is adequate 7. Personnel familiar with the tools used 8. Housekeeping work area								5. Interlock on the power barrel works 6. CCTV Installation 7. Coloring on power tongs exists 8. Personnel who work are required to wear HDHG 9. Housekeeping work area 10. Work procedures exist
			HDHG must be used when working with a power tong	PPE			1. Interlock on the power tong works 2. CCTV exists	Engineering Control			

Five high-risk hazards in this job require additional barriers:

a) Falling objects: Administrative controls such as routine inspections, daily checklists, and lifting supervisors can reduce the severity from S4 to S3.
b) Equipment failure: Risk is reduced through routine inspections as administrative controls, reducing the probability from P4 to P3.
c) Ergonomics: Administrative controls such as manual handling banners and monthly programs reduce the probability from P4 to P3.
d) Moving machinery: Routine inspections and prohibitions on long hair and jewelry reduce the probability from P3 to P2.
e) Hand injuries: Routine inspections, tool coloring (administrative controls), interlocks, and CCTV (engineering controls) reduce the severity from S3 to S2.

Mixing Mud.

Table 12. Mixing Mud

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
8-1	Material chemical	People	Workers are exposed to chemicals during mud mixing, drilling and cementing work	Health	1. MSDS chemical 2. Preparation of soap and/or antiseptic if exposed to skin exposure 3. Emergency Response of workers exposed to chemicals	Administrative Control	P2	S2	Socialization of B3 Materials and MSDS	Administrative Control	P1	S2	**1**. PPE handling complete chemicals (masks, rubber gloves and aprons) 2. Emergency shower and eye wash function 3. MSDS socialization is carried out 4. MSDS banner/banner exists 5. Wind shock installed 6. ERP Chemical victim handling exists
					1. Make sure the eye wash shower is	Engineering Control							

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					working properly 2. Installation of windsock as a wind direction guide 1. Chemical special PPE according to MSDS (Material Safety Data Sheet) 2. Use of Chemical Masks	PPE						

Administrative control provides additional barriers to reducing risk, namely the socialization of B3 materials (Hazardous and Toxic Materials) and MSDS (Material Safety Data Sheet). With these additional barriers, the probability value can be reduced from P2 to P1.

Drilling Formation.

Table 13. Drilling Formation

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
9-1	Pressurized system	People	High pressure during pressure test BOP Pressure Test Cementing Line during circulation and drilling on personnel	Safety	1. Prosedur Drilling 2. Implementasi Ijin kerja, JSA dan lakukan PJSM sebelum kegiatan. 3. SOP tanggap darurat lapangan 4. Inspeksi peralatan secara berkala 1. PSV Installation 2. Installation of Sling safety restraint on the pressurized hose 3. Periodic safety restraint	Administrative Control Engineering Control	P2	S4	1. Scheduled BOP emergency response training 2. Personnel competence	Administrative Control	P2	S3	1. Proseudr drilling 2. Emergency response procedures 3. Periodic equipment inspection runs 4. PVS Installation 5. Sling safety restraint on the pressurized hose 6. Periodic safety restraint sling inspection 7. Scheduled emergency response training 8. Personnel competence

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					sling inspection								
		People	Potential kick when the well is in a state of partial/total loss	Safety	1. Well control program 2. Perform kick drill, BOP drill, and Fire and abandon drill as scheduled 3. Driller and TP have competent certificates (APB III oil and gas cepu and IADC) 4. Coordination between company man - rig supt - mud eng. Based on data from the MLU team in the program strategy 1. Installation of BOP as a barrier/preventer 2. BOP testing is carried out 2. Preparation of mud material and mud pumping to anticipate loss (LCM pill) 3. Controlling gain in the active tank	Administrative Control Engineering Control	P 2	S 4	Drill simulations are carried out consistently 1. Additional sensors are also installed (bottom substructure, Mund tank, shale shaker and rig floor) 2. MGS and attached manifold 3. Line Flare Pit Ada	Administrative Control Engineering Control	P 2	S 3	1. Personnel competencies (driller, Toolpusher, Rigsupt, CoMan and HES) 2. Training simulations are carried out according to schedule 3. BOP installed 4. BOP testing is carried out 5. Complete mud material 6. MGS and Manifold installed 7 Line flare pit exists
9-2	Electrical	People	An electrical voltage electrocutes workers	Safety	1. Ensure the insulation of electrical equipment is in good condition 2. Provide warning signs for equipment that has the potential to be electrocuted 3, Coordination	Administrative Control	P 2	S 3	1. Installation of GFCI on electrical panels 2. GFCI function test is carried out	Engineering Control	P 2	S 2	1. Insulation of electrical equipment in good condition 2. The Gronding system exists and is measured 3. Installation of GFCI in panel box and function 4. LOTO exists 5. Warning signs related to electric shock are enough

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					with electricity for electrical installation								
					1. LOTO 2. Grounding system	Engineering Control							
9-3	Fire potential in hydrocarbon materials	Mansia	There is a potential for mud blockage or scale that causes build-up pressure that results in an impact and/or explosion	Safety	Function test equipment	Administrative Control	P2	S4	Functional test procedures exist	Administrative Control	P2	S3	1. Procedures Function Test 2. Functional test equipment
9-4	Noise	People	Rotating equipment (centrifugal pump, mud pump, draw work, cat head, hydraulic winch, spinner) regarding personnel	Health	1. Limitation of the working area around the generator, pump, draw work, cementing unit and shale shaker 2. Noise mapping is done 3. Ensure the condition of the equipment is up to standard 4. Installation of noise warning signs Mandatory use of ear plug and ear muff	Administrative Control PPE	P2	S3					1. Working area restriction of more than 85db 2. Noise mapping is done 3. Ensure the condition of the equipment is up to standard 4. Installation of noise warning signs 5. Use of PPE (ear plugs and ear muffs)
9-5	Oil and B3 waste spills	Environment	environmental pollution by oil spills, oil, completion fluid, etc	Environment	1. Drilling Procedure 2. Provide an oil spill kit (oil boom and oil absorbent) Coating the operation area with HDPE	Administrative Control Engineering Control	P3	S3	1. Establishment of an emergency response team 2. Training for personnel who enter the team	Administrative Control	P3	S2	1. Drilling procedure 2. An oil spill kit exists 3. HDPE coated well pad area 4. The existence of an emergency response team
9-6	Loss Well	People	Potensi loss circulation	Safety	1. Selection of LCM according to procedures and drilling programs	Engineering Control	P2	S3					1. Selection of LCM according to procedures and drilling programs 2. Troubleshooting Lost Circulation

CATRA RESEARCH INSTITUTE
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					2. Troubleshooting Lost Circulation according to procedures and drilling programs								according to procedures and drilling programs
9-7	Exhaust emissions	Environment	Air emissions from engine exhaust	Environment	Regular maintenance Filter water replacement (air filter)	Administrative Control Engineering Control	P3	S2					1. Regular maintenance 2. Replacement of water filter (air filter)
9-8	Blow out	People	Blow Out due to a kick during a trip	Safety	1. Drilling trip procedure according to the rules of the drilling program 2. BOP and driller consule exist 3. PJSM before the activity	Administrative Control	P3	S2	The simulation training is consistently carried out according to schedule	Administrative Control	P2	S2	1. Drilling trip procedure according to the rules of the drilling program 2. BOP and driller consule exist 3. PJSM before the activity 4 Consistent simulation training
9-9	Moves, falling and flying goods	People	Equipment falling during lifting that hits personnel and potentially causes death	Safety	1. Competent and certified oil and gas workers 2. Work permit, JSA & PJSM Personnel use PPE appropriate for the position 1. Ensure the lifting load does not exceed SWL 2. Equipment Repositioning 3. Insulation of the work area 4. Check that the lifting gear is in accordance with SWL 5. Anti-to-block has been inspected and activated	Administrative Control PPE Engineering Control	P2	S4	Hire lifting supervisor	Administrative Control	P2	S3	1. Competent work 2. Work permits, JSA, and PJSM exist 3. Complete PPE 4. Additional Lifting Supervisor personnel 5. Load according to SWL 6. Repositioning tools 7. Check and inspect the crane regularly

CATRA RESEARCH INSTITUTE
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INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

9-10	Hazardous waste	Environment	Cutting production exceeding the capacity of the mud pit / balong has the potential to pollute the drilling area (over capacity)	Environment	Mud put/Balong engineering calculation estimation B3 waste management contract (3rd parties contract)	Engineering Control Administrative Control	P3	S3	Chemical supervision for treatment in Balong	Engineering Control	P2	S3	1. Mud put/Balong estimation of engineering calculations 2. Chemicals for treatment exist 3. B3 waste management contract (3rd parties contract)

In this work, there are 10 high-risk hazards, where 7 hazards still require additional barriers:

a) Pressurized system:
   - Pressure: Additional administrative control in the form of scheduled training and worker competence reduces severity from S3 to S2.
   - Kick potential: Administrative control, such as drill training, and engineering control, such as sensors, MGS, manifolds, and flare pits, reduces severity from S3 to S2.

b) Electricity: Engineering control, including installing GFCIs on the control panel and routine testing, reduces severity from S4 to S3.

c) Potential hydrocarbon fire: Administrative control in the form of equipment function testing reduces severity from S4 to S3.

d) Oil and B3 waste: Administrative control, such as forming a trained emergency response team, reduces severity from S3 to S2.

e) Wild spray: Administrative control with routine training reduces probability from P3 to P2.

f) Moving goods and falling objects: Administrative control, such as recruiting lifting supervisors, reduces the severity from S4 to S3.

g) Drilling waste: Engineering control with chemical materials for waste treatment in the borehole reduces the probability from P3 to P2.

Make Up & Break Out Tubular Goods.

Table 14. Make Up & Break Out Tubular Goods

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
10-1	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Observation of equipment condition before work 4. Socialization of BBS (Basic Behavior Safety) cards Use of HDHG is mandatory	Administrative Control PPE	P2	S3	The interlock system works	Engineering Control	P2	S2	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Obligation to use HDHG for workers on the floor 4. Interlock function 5. Observation of equipment condition before work 6. CCTV Installation 7. Socialization of BBS card top-up

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Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

10-2	Terpukul/Terhantam	People	Power Tong Equipment regarding personnel and potential MTC	Safety	1. Pre-used inspection 2. Equipment according to specifications/not modified 3. Drilling Guideline 4. Personnel Certification 5. Equipment Certification 6. Lighting in the work environment is adequate 7. Personnel familiar with the tools used 8. Housekeeping work area	Administrative Control	P3	S3	CCTV installed	Engineering Control	P2	S3	1. Pre-used inspection 2. Equipment according to specifications/not modified 3. Drilling Guideline 4. Personnel Certification 5. Equipment Certification 6. The interlock system works 7. Snapline attached 8. Lighting in the work environment is adequate 9. CCTV exists 10. Personnel familiar with the tools used 11. Work area housekeeping
					Snapline/safety device terpasang	Engineering Control			Additional supervision from personnel HES	Administrative Control			
10-3	The machine moves and rotates	People	Rotating equipment (centrifugal pump, mud pump, draw work, cat head, hydraulic winch, spinner) regarding personnel	Safety	1. Carry out pre-user inspection before using the equipment 2. Use of standard equipment 3. Personnel Certification in accordance with drilling guidelines	Administrative Control	P3	S3	1. Regular inspections 2. Prohibit long hair for working personnel	Administrative Control	P2	S3	1. Pre-user inspection equipment before use 2. Use of equipment according to procedures 3. Personnel Competence 4. Installation of rotating equipment guarding 5. Regular inspections are carried out 6. Prohibit personnel from having long hair
					Installation of guarding rotating equipment	Engineering Control							
10-4	Ergonomic	People	Position and lifting of weights have the potential to cause injury	Health	1. Manual Handling Procedure Lifting load (Max 20 kg) 2. Periodic maintenance	Administrative Control	P4	S2	Use liftgate	Engineering Control	P3	S2	1. Manual Handling Procedure Lifting load (Max 20 kg) 2. Periodic maintenance
10-5	Equipment Fall	Assets	Property damage due to system hoisting engine failure	Safety	1. ProcedureDrilling 2. Equipment Certification	Administrative Control	P4	S3	Regular inspections	Administrative Control	P2	S3	1. Drilling procedure 2. Equipment certificate 3. Regular inspections

In this job, 5 high-risk hazards require additional barriers:

a) Pinched with CCTV to reduce severity from S3 to S2.
b) Hit/struck, with interlock and HSE supervision, to reduce probability from P3 to P2.

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c) Rotating equipment, with routine inspection and prohibition of long hair, to reduce probability from P3 to P2.
d) Personnel lifting position, with lifemate device to reduce probability from P4 to P3.
e) Equipment failure, with a routine inspection to reduce probability from P4 to P3.

Make Up & Break Out casing.

Table 15. Make Up & Break Out casing

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
11-1	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI (Loss of Time Injury)	Safety	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Observation of equipment condition before work 4. Socialization of BBS cards	Administrative Control	P2	S3	CCTV available	Engineering Control	P2	S2	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Obligation to use HDHG for workers on the floor 4. Interlock function 5. Observation of equipment condition before work 6. CCTV Installation 7. Socialization of BBS card top-up
					Use of HDHG is mandatory.	PPE							
11-2	Personnel get hit	People	Power Tong equipment regarding personnel and potential MTC (Medical treatment case)	Safety	1. Pre-used inspection 2. Equipment according to specifications/ not modified 3. Drilling Guideline 4. Personnel Certification 5. Equipment Certification 6. Lighting in the work environment is adequate 7. Personnel familiar with the tools used 8. Housekeeping work area	Administrative Control	P3	S3	1. The interlock system works 2. CCTV available	Engineering Control	P2	S3	1. Pre-used inspection 2. Equipment according to specifications/not modified 3. Drilling Guideline 4. Personnel Certification 5. Equipment Certification 6. The interlock system works 7. Snapline attached 8. Lighting in the work environment is adequate 9. CCTV exists 10. Personnel familiar with the tools used 11. Work area housekeeping
					Snapline/safety device installed	Engineering Control							

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11-3	The machine moves and rotates	People	Rotating equipment (centrifugal pump, mud pump, draw work, cat head, hydraulic winch, spinner) regarding personnel	Safety	1. Carry out pre-user inspection before using the equipment 2. Use of standard equipment 3. Personnel Certification in accordance with drilling guidelines	Administrative Control	P3	S3	1. Regular inspections 2. Prohibit long hair for working personnel	Administrative Control	P2	S3	1. Pre-user inspection equipment before use 2. Use of equipment according to the Procedure 3. Personnel Competence 4. Installation of rotating equipment guarding 5. Regular inspections are carried out 6. Prohibit personnel from having long hair
					Installation of guarding rotating equipment	Engineering Control							
11-4	Electrical	People	Workers are exposed to electricity during welding jobs	Safety	1. Inspection of machine welding equipment 2. No welding activities during rain in open areas 3. Hot work procedure 4. Welder personnel certificate 5. Implementation of work permits Heat, JSA, PJSM	Administrative Control	P2	S5	Buddy System	Engineering Control	P2	S4	1. The welding machine is still good/decent 2. Routine equipment inspection is carried out 3. Competent personnel (certified and experienced 4. Hot work permit and JSA exist 5. Hot work procedures exist 6. GFCI in welding machine equipment installed 7. Grounding and bounding attached 8. PPE complete 9. The buddy system is applied during work
					1. Pemasangan grounding dan bounding 2. Ground fault current interrupted 3. Flashback arrester	Engineering Control			Apron, hand glover welder, Face shield, and safety shoes	PPE			
11-5	Objects moving, falling and being hit	People	Hit by materials/equipment lifted by the crane due to limited visibility (Blind Spot Position)	Safety	1. The operator ensures that the area around the unloading of materials is free from worker activities (Clear zone area) 2. Inspection and Pre-use Inspection of Lifting Gear 3. Sling and shackle used accordingly 4. 2 taglines used	Administrative Control	P2	S4	Ensuring that the sling is tied 2 turns at the point of the object being lifted	Engineering Control	P2	S3	1. The operator ensures that the area around the unloading of materials is free from worker activities (Clear zone area) 2. Inspection and Pre-use Inspection of Lifting Gear 3. Sling and shackle used accordingly 4. 2 taglines used 5. Competent signal/rigger

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• ISSN 2721 - 0871 (online)
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					5. Competent signal/rigger 6. Lifting procedure exists								6. The sling should be 2 turns at the point of the lifted object 7. Lifting procedure exists

In this job, 5 high-risk hazards require additional barriers:

a) Pinched with CCTV to reduce severity from S3 to S2.
b) Hit/struck, with interlock and CCTV to reduce probability from P3 to P2.
c) Rotating equipment, with routine inspection and prohibition of long hair, to reduce probability from P3 to P2.
d) Electrical, with buddy system and PPE to reduce severity from S5 to S4.
e) Movement of falling objects, with 2-twist sling attachment to reduce severity from S4 to S3.

Cementing.

Table 16. Cementing

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
12-1	Noise	People	Noise from active machinery causes potential hearing loss.	Health	1. Ensure the condition of the equipment is in accordance with the standards 2. Installation of noise warning signs 3. Doing Noise Mapping	Administrative Control	P3	S3	Area restriction with barricade/yellow line installation	Administrative Control	P2	S3	1. Equipment condition pass inspection 2. Warning sign installed and sufficient 3. Noise mapping is done 4. Earplug/ear used by crew involved in work 5. Restriction of the area with the installation of barricades/yellow lines
					Use of earplugs/ear	PPE							
12-2	Pressurized system	People	High pressure during the Pressure Test Cementing Line during circulation and cementing work on personnel	Safety	1. Cementing Procedure 2. Implementation of work permits, JSA and PJSM before activities. 3. Field emergency response procedures 4. Periodic inspection of equipment	Administrative Control	P2	S4	Sling safety restraint attached to the joint	Engineering Control	P2	S3	1. Cementing Procedure 2. Implementation of work permits, JSA and PJSM before activities. 3. Field emergency response procedures 4. Equipment inspection report is still valid 5. Sling safety restraint is installed thoroughly and specifically at the joint

CATRA RESEARCH INSTITUTE
ISSN 2720 - 9644 (print)
ISSN 2721 - 0871 (online)
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Indexed By : GARUDA Google dor Crossref ROAD INDEX COPERNICUS INTERNATIONAL oneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

12-3	Chemical	People	Workers are exposed to chemicals during mud mixing, drilling and cementing work	Safety	1. MSDS chemical 2. Preparation of soap and/or antiseptic if exposed to skin exposure 3. Emergency Response of workers exposed to chemicals 1. Make sure the eye wash shower is working properly 2. Installation of windsock as a wind direction guide 1. Chemical special PPE, according to MSDS 2. Use of Chemical Masks	Administrative Control Engineering Control PPE	P2	S3	1. Installed drain 2. Dust collector	Engineering Control	P2	S2	1. MSDS chemical 2. Preparation of soap and/or antiseptic if exposed to skin exposure 3. Emergency Response of workers exposed to chemicals." 4. Make sure the eye wash shower is working properly 5. Installation of windsock as a wind guide." 6. Special chemical PPE, according to MSDS 7. Use of Chemical Masks." 8. Installed drain 9. Dust collector

In this work, 3 high-risk hazards require additional barriers:

a) Noise, with area restrictions, using barricades/yellow lines to reduce the probability from P3 to P2.
b) System pressure, with the installation of sling safety restraints at each pipe connection, to reduce the severity from S4 to S3.
c) Chemical exposure, with the installation of drains and dust collectors to reduce the severity from S3 to S2.

Perforation.

Table 17. Perforation

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
13-1	Material explosion	People	Ignition of explosives	Safety	1. Work permit, JSA, and PJSM are carried out before the activity 2. Ambulance & Paramedic Standby 3. Disable radio communication and welding	Administrative Control	P2	S4					1. Work permit, JSA, and PJSM are carried out before the activity 2. Ambulance & Paramedic Standby 3. Disable radio communication and welding

Killing well.

Table 18. Killing well

CATRA RESEARCH INSTITUTE
• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
IJESSS
INTERNATIONAL JOURNAL OF ENVIRONMENTAL, SUSTAINABILITY AND SOCIAL SCIENCE
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No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
14-1	Pressurized system	People	High pressure during ablation and circulation can result in injury	Safety	1. Killing Procedure 2. Implementation of work permits, JSA and PJSM before activities 3. Emergency response procedures have been established 4. Ambulance and medic standby	Administrative Control	P2	S4					1. Killing Procedure 2. Implementation of work permits, JSA and PJSM before activities 3. Emergency response procedures have been established 4. Ambulance and medic standby
14-2	Potential for material explosion	People	There is a potential for pocket gas to be carried during circulation and burn in the annulus when there is heat	Safety	1. Follow the Killing Procedure 2. Ambulance & Paramedic Standby	Administrative Control	P2	S4	Circulation until SG in = SG Out	Engineering Control	P1	S4	1. Perform the Killing Procedure 2. Ambulance & Paramedic Standby 3. Chemical mixture materials are available

Only 1 of the 2 types of hazards in this job has a risk value that can be reduced. Additional chemicals are needed as engineering control; with the addition of this barrier, the probability value can be reduced from P2 to P1.

Production Test.

Table 19. Production Test.

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
15-1	Potential for material explosion	People	Flammable gas released in production tanks	Safety	1. Certified and competent workers (Rigger, oil and gas certified Crane Operator) 2. Work permit, JSA and PJSM before the activity	Engineering Control	P3	S4	1. Additional gas detection sensor 2. Personnel involved are provided with portable personal sensors	Engineering Control	P2	S4	1. Check the gas regularly in the mud tank 2. Additional gas detection sensor 3. Personnel involved are provided with portable personal sensors 4. Installation of Bug blower with one electric switch system

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Indexed By : GARUDA Google dof Crossref ROAD INDEX COPERNICUS OneSearch ISJD sinta 4 EBSCO Clarivate Analytics WEB OF SCIENCE

Additional barriers in this work, such as engineering control in the form of additional sensor devices for gas detection and personnel involved in the work, are given Portable Personal Sensors (sensors for one person). With the addition of this barrier, the probability value of P3 becomes P2.

Nipple Up & Nipple Down BOP.

Table 20. Nipple Up & Nipple Down BOP

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
16-1	Objects moving, falling and being hit	People	Raising and Lowering BOP (Nipple Up & Nipple Down BOP)	Safety	1. Pekerja yang bersertifkat dan kompeten (Rigger, Operator Crane bersertifikat migas) 2. Ijin kerja, JSA dan PJSM sebelum kegiatan Personnel use PPE appropriate for the position 1. Ensure the lifting load does not exceed SWL 2. Equipment Repositioning 3. Insulation of the work area 4. Check that the lifting gear is in accordance with SWL 5. Anti-to-block has been inspected and activated	Administrative Control PPE Engineering Control	P2	S4	Hire lifting supervisor	Administrative Control	P2	S3	1. Workers have competence 2. Work permits, JSA and PSJM are carried out before the activity 3. Crane in good condition 4. Sling and shackle fit 5. There is a Lifting supervisor as a supervisor 6. Workers involved are required to wear HDHG
16-2	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	1. Observe the condition of the equipment before doing the work 2. Socialization of BBS Observation Use appropriate PPE gloves (Heavy Duty/High Impact Hand Gloves)	Administrative Control PPE	P2	S3	1. Use of Push Pull stick 2. The use of Rope and galvanized iron to hold the bolt when it is struck	Engineering Control	P2	S2	1. Observation of equipment before use 2. HDHG is mandatory 3. BBS Obsession 4. Use of push-pull stick 5. The use of Rope and galvanized iron to hold the bolt when struck

In this job, 2 high-risk hazards require additional barriers:

a) Equipment falling during lifting, with lifting supervisor tightening to reduce severity from S4 to S3.

b) Pinching, with the use of Push push-pull stick, rope, and galvanized iron to hold bolts during hammering, reducing severity from S3 to S2.

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• ISSN 2720 - 9644 (print)
• ISSN 2721 - 0871 (online)
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Rig Down Mast.

Table 21. Rig Down Mast

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
17-1	Extreme weather	People	high temperature over 34-40 degrees	Health	1. Provision of drinking water prevents dehydration 2. Examination of workers' health conditions 3. Worker shift arrangement	Administrative Control	P3	S3	Workers are given additional head and neck coverings	Engineering Control	P3	S2	1. High-temperature socialization during morning meetings 2. DCU 3. Shelters for permanent worker rest should not be dismantled first 4. Drinking water provider 5. Workers are given additional head and neck coverings 6. Heat Stress campaigns/programs
					There is a shelter for workers to rest	Engineering Control			Shelters for workers' rest should not be dismantled first	PPE			
17-2	Objects moving, falling and being hit	People	Equipment falling during lifting that hits personnel and potentially causes death	Safety	1. Certified and competent workers (Rigger, oil and gas certified Crane Operator) 2. SIKA, JSA and PJSM before the activity	Administrative Control	P2	S4	Lifting supervisors still exist	Administrative Control	P2	S3	1. Competent work 2. Work permits, JSA, and PJSM exist 3. Complete PPE 4. Lifting personnel supervisors remain 5. Load according to SWL 6. Repositioning tools 7. Check and inspect the crane regularly
					Personnel use PPE appropriate for the position	PPE							
					1. Ensure the lifting load does not exceed SWL 2. Equipment Repositioning 3. Insulation of the work area 4. Check that the lifting gear is in accordance with SWL 5. Anti-to-block has been inspected and activated	Engineering Control							
17-3	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Observation of equipment condition before work 4. Socialization of BBS cards	Administrative Control	P2	S3	CCTV fixed installed	Engineering Control	P2	S2	1. Coloring rig floor equipment 2. Applying pinch point stickers in areas with the potential for pinch points 3. Obligation to use HDHG for workers on the floor 4. Interlock function 5. Observation of equipment condition before work 6. CCTV fixed installed 7. Socialization of BBS card top-up
					Use of HDHG is mandatory	PPE							

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17-4	Fatigue	People	Workers are tired due to high workloads	Healthy	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P3	S3	HSE officers remain	Administrative Control	P2	S3	1. There is an exchange of work shifts 2. DCU is done consistently 3. HES officers exist
17-5	Biological hazard	People	Workers are exposed to attacks by wild animals or venomous animals that cause potential MTC	Healthy	1. Pest Control Program 2. Regular housekeeping during drilling work Use PPE proper	Administrative Control Engineering Control	P2	S3	Extension of cooperation with the nearest clinic or hospital	Administrative Control	P2	S2	1. Pest Control Program 2. Regular housekeeping during drilling work 3. Use of certain PPE 4. Extension of cooperation with the nearest clinic or hospital

This job is in the final stages of drilling with high risk. Some additional barriers are needed:

a) Extreme weather, with head protection and permanent shelter to reduce severity from S3 to S2.
b) Falling object movement, with the lifting supervisor still present, to reduce severity from S4 to S3.
c) Pinching, with CCTV still installed, to reduce severity from S3 to S2.
d) Fatigue, with HSE personnel, to reduce probability from P3 to P2.
e) Biological hazard, with cooperation with the hospital, to reduce severity from S3 to S2.

Dismantle Equipment.

Table 22. Dismantle Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
18-1	Extreme weather	People	high temperature over 34-40 degrees	Health	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P3	S3	Workers are given additional head and neck coverings	PPE	P2	S3	1. High-temperature socialization during morning meetings 2. DCU 3. Shelters for permanent worker rest should not be dismantled first 4. Drinking water provider 5. Workers are given additional head and neck coverings 6. Heat Stress campaigns/programs
					There is a shelter for workers to rest	Engineering Control			Shelters for workers' rest should not be dismantled first	Engineering Control			

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18-2	Trasportasi darat dan situasinya	People	Equipment falls during lifting, hitting personnel and potentially causing death	Safety	1. Certified and competent workers (Rigger, oil and gas certified Crane Operator) 2. Work permit, JSA and PJSM before the activity 3. Signal Man Personnel use PPE appropriate for the position 1. Ensure the lifting load does not exceed SWL 2. Equipment Repositioning 3. Insulation of the work area 4. Check that the lifting gear is in accordance with SWL 5. Anti-to-block has been inspected and activated Use of HDHG is mandatory	Administrative Control PPE Engineering Control PPE	P2	S3	1. Lifting supervisors are still there 2. Inspection of partner drop objects remains consistent	Administrative Control	P2	S2	1. Permit, JSA and PJSM before the work is carried out 2. Competent crane operator and rigger (certified and experienced) 3. PPE available 4. Lifting supervisors still exist 5. Insulation of the work area 6. The lifting supervisor checks equipment before use 7. The inspection schedule is carried out consistently
18-3	Pinch point	People	Personnel trapped in equipment resulting in potential for medical treatment and/or LTI	Safety	1. Observe the condition of the equipment before doing the work 2. Socialization and require the crew to make BBS observations Use of Push Pull stick	Administrative Control Engineering Control	P4	S3	1. Consistent warning signs and banners related to pinch points 2. The color of the handling tool remains	Administrative Control	P3	S2	1. Requiring the use of HDHG at work 2. The color of the handling tool remains 3. Consistent warning signs and banners related to pinch points 4. Use of Push Pull stick 5. Crew obligation to make BBS Observations 6. Mandatory use of HDHG
18-4	Terjatuh dari ketinggian	People	Derrickman terjatuh dari monkey board	Safety	1. Procedure for working at height: Derrickman has an OMB (Drill Tower Operator) oil and gas certificate 2. Derrickman's activities are listed in the JSA, and do PJSM before the activity 3. Fit to task before activity 4. DCU before the activity	Administrative Control	P2	S3	CCTV in the drilling console remains installed	Engineering Control	P2	S2	1. Procedure for working at height: Derrickman has an OMB (Drill Tower Operator) oil and gas certificate 2. Derrickman's activities are listed in the JSA, and do PJSM before the activity 3. Fit to task before activity 4. DCU before the activity

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					5. SIKA Implementation								5. Permit Implementation 6. CCTV in the drilling console is fixed
18-5	Fatigue	People	Workers are tired due to high workloads	Healthy	1. Regular health checks 2. Workers' food nutrition is guaranteed and sufficient 3. Work shift arrangements that follow the rules	Administrative Control	P3	S3	HES officers remain	Administrative Control	P2	S3	1. There is an exchange of work shifts 2. DCU is done consistently 3. HES officers remain
18-6	Oil dan cecera n limbah B3	Environment	Oil/fluid leakage that can contaminate the soil during equipment operation	Environment	Procedures for Monitoring the Quality of Health in the Work Environment	Administrative Control	P2	S3	The oil Spill kit is still available, and enough	Engineering Control	P2	S2	1. Procedures for Monitoring the Quality of Health in the Work Environment 2. Underground surface in HDPE coating 3. The Oil Spill kit is still available and sufficient
					All soil surfaces in the well pad have been protected by HDPE underneath	Engineering Control							
18-7	Noise	People	Noise from active machinery causes potential hearing loss.	Health	1. Ensure the condition of the equipment is in accordance with the standards 2. Installation of noise warning signs 3. Doing Noise Mapping	Administrative Control	P3	S3	The damper on the engine is still working properly	Engineering Control	P2	S3	1. The condition of the equipment is still up to standard 2. Noise mapping is done 3. Earplugs and ears are used 4. A warning sign exists." 5. The damper on the engine is still working properly
					Use of earplugs/ear	PPE							

Equipment dismantling work at the end of drilling still has a high risk, so additional barriers are needed to control the existing risks. Some hazards that require additional barriers include:

a) Extreme weather, with additional head and neck covers and shelters that remain in place to reduce the probability from P3 to P2.
b) Falling equipment, with drop object inspection and maintaining a lifting supervisor to reduce the severity from S3 to S2.
c) Being trapped, with consistent warning signs, banners and colors on the equipment to reduce the severity from S3 to S2.
d) Falling from a height, with CCTV on the driller console to reduce the severity from S3 to S2.
e) Fatigue, with the presence of HSE personnel to reduce the probability from P3 to P2.
f) Oil/fluid leaks: Ensure that the Oil Spill kit is available to reduce the severity from S3 to S2.
g) Noise, by ensuring that the machine silencer is functioning to reduce the probability from P3 to P2. All of these barriers are important to keep risks under control during the work.

Demobilization Equipment.

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Table 23. Demobilization Equipment

No	Hazard Categories	Main Impact	Risk Description	Risk Group	Existing control/Barrier		Initial Risk		Propose additional control		Residual Risk		Mitigasi Risiko
					Action Description	Control	P	S	Action Description	Control	P	S	
19-1	Land transport and its situation	People	Potential slip of heavy equipment vehicles due to the condition of the carrying capacity of the soil that is not in accordance with the weight of the heavy equipment when crossing at the main access to the drilling site	Safety	1. The machine operator has SIO, and the Driver has a driver's license 2. Pre Job Safety Meeting for moving activities 3. Inform the maximum vehicle speed limit of 20 km/h 4. Vehicle checks are carried out 5. Checking the Mobilization Path 6. Driving Safety Procedures, Journey Management Plan	Administratif Control	P2	S3	Communication tools in the form of HT are used as communication in the implementation of Rig equipment demobilization Compaction and repair of damaged roads	Administrative Control Engineering Control	P2	S2	1. Clear driver administration 2. Conduct a meeting before work 3. Check the vehicle and equipment ties 4. Check the road before the trip 5. Road repair 6. Escort/convoy 7. Vehicle safety procedures and trip planning 8. Communication tools available (HT) 9. Compaction and repair of damaged roads
		People	Collision between vehicles during the implementation of moving Rig	Safety	1. Journey Management Plan 2. Safety briefing is carried out before demobilization activities 3. Escort for heavy/large loads 4. Special surveillance for night travel from/to drilling sites 5. Re-inspection of vehicles and driver's documents before the implementation of the night trip 6. Maximum speed limit of heavy equipment	Administrative Control	P2	S3	1. HSE remains 2. Ensure that drivers are equipped with additional B2 SIM competencies	Administrative Control	P2	S2	1. Journey Management Plan 2. Safety briefing is carried out before moving activities 3. The driver has sufficient competence 4. Escort for heavy/large loads 5. HSE personnel remain 6. Special supervision for night travel from/to the drilling site by the truck pusher 7. Ensure that the drivers involved are equipped with additional SIM B2 competencies 8. Re-inspection of vehicles and driver's documents before the implementation of the night trip 9. Maximum speed limit of heavy equipment vehicles is 20 km/h

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					vehicles is 20 km/h								
19-2	Fatigue	People	Workers experience fatigue, resulting in reduced concentration	Healthy	1. Work shift arrangement 2. Sufficient Rest Time 3. DCU & MCU valid	Administratif Control	P2	S3					1. Work shift arrangement 2. Sufficient Rest Time 3. DCU & MCU valid
19-3	Demonstration	People	Obstruction at the time of demobilization	Security	1. Socialization of the local government and surrounding communities that are passed by the mobilization route 2. Cross permit from the Transportation Department	Administratif Control	P4	S3	Security assistance during mobilization from within the company and the local police	Administrative Control	P3	S3	1. Socialization of the local government and surrounding communities that are passed by the mobilization route 2. Cross permit from the Transportation Department 3. Escort assistance that also involves the police

At the end of this work, 3 hazards require additional barriers:

a) Vehicle slip, with HT for communication and compaction and road repair to reduce severity from S3 to S2.
b) Vehicle collision with HSE officers and ensuring the driver has a B2 driving license to reduce severity from S3 to S2.
c) Demonstration/protest, with internal and external security assistance (Police) to reduce probability from P3 to P2.

After additional barriers were applied to the hazards from the stages of onshore drilling work above, the following were obtained:

Table 24. onshore drilling

Activity	Amount of Risk	initial risk				
		Very Small	Small	Currently	Big	Very Big (NOA)
Drilling Onshore	83	0	15	56	11	1
	Amount of Risk	Risk after being given additional barriers				
		Very Small	Small	Currently	Big	Very Big (NOA)
	83	0	41	42	0	0

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Table Comparison table of initial risk amount with risk that has been given additional barrier. From the table above, it is clear that with additional barriers given. Then, the risks that were initially large are no longer there, while the risks that were initially moderate have decreased to small.

CONCLUSION

Based on the results of the research that has been conducted, the following conclusions were obtained, namely:

1) The risk analysis obtained in this study for onshore drilling shows that, based on the existing work contract, the risk is still quite high and additional barriers are needed to control the dangers of the work and keep the percentages of possibility (probability) and impact (severity) low.
2) The risk analysis in the work contract, where an initial barrier is present, still requires additional barriers. Many shortcomings remain in terms of procedures, personnel and equipment, so the percentage of possibility (probability) and impact (severity) is at a moderate level.
3) The risk analysis that has been given additional barriers still requires additional observation to ensure that the initial mitigation results will be effective and consistently implemented.

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