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ISSN (P) 2088-3536 ISSN (E) 2528-3375
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Preparation of Standard Operating Procedure (SOP) Documents on Confined Space Work at PT. X

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ABSTRACT

Confined space in the ship repair industry has high risks, such as oxygen shortages, toxic gases, fires, and explosions. Preliminary studies show that there have been several fire incidents in confined spaces, one of which was on October 15, 2024. The company already has several SOPs related to K3, but not yet for documents that specifically target workers in limited spaces. Currently, in Indonesia, there are regulations regulating K3 in limited spaces of Permenaker No. 11 of 2023. The purpose of this study is to compile a Standard Operating Procedure (SOP) document on confined space work at PT. X. The research method used is qualitative descriptive with an observation approach, interviews with the company's HSE team, as well as literature studies, and carrying out Group Discussion Forums (FGD). The results of the work in the limited space of PT. X, such as welding, tank cleaning, and inspection, is high-risk and requires extra attention, specifically welding requires close supervision, as well as work permits to ensure safety and compliance with standards. High Risk Assessment (NPP = 9) Welding and cutting, Medium risk (NPP = 4) Sludge/oil removal, Low risk (NPP = 2) Preparation of work. For safety, effective control, periodic training, equipment maintenance, and improvement of safety procedures are required. The SOP for confined space includes preparation, implementation, completion of work, and emergency response measures. The evaluation of the company's K3 document shows the need for improvement to be more effective and in accordance with safety standards.

Keywords: *Standard Operating Procedures (SOP), Occupational Safety and Health (K3), Confined Space, Ship Repair*

Published by:
Tadulako University
Address:
Jl.Soekarno Hatta KM 9. Kota Palu, Sulawesi Tengah, Indonesia.
Phone: +6282197505707
Email: preventifjournal.fkm@gmail.com

Article history :
Received : 24 02 2025
Received in revised form : 08 03 2025
Accepted : 26 04 2025
Available online : 30 04 2025

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INTRODUCTION

The ship repair industry plays a crucial role in ensuring the ship's feasibility and safety. Ship repair aims to prevent damage and keep the ship in optimal condition In the U.S., 1,030 workers died in confined space accidents between 2011-2019, with construction being the highest sector (U.S. Bureau of Labor Statistics) (1). Indonesia also experienced similar incidents, such as the Semarang barge (2019-2022) and the Mojokerto bioethanol plant 2020 (2). The Ministry of Manpower reported an increase in work accidents from 370,747 in 2023 to 399,871 in 2024. 15% of fatal incidents occur in confined spaces, which emphasizes the importance of OSH procedures. Confined spaces are high-risk areas such as tanks and ships with hazards such as toxic chemicals, flammable gases, and oxygen shortages (3).

Fires are often caused due to negligence and companies must implement K3 in accordance with Permenaker No. 11 of 2023 to prevent accidents. PT. Dewa Ruci Agung, which has been engaged in ship repair since 1975, has ISO and SMK3 certifications, but does not yet have a specific SOP for high-risk work in confined spaces(4).. The fire incident on October 15, 2024 was caused by human error and a lack of checking the area. This research focuses on the development of SOPs and administrative controls to improve safety and prevent accidents at PT. Dewa Ruci Agung (5).

METHOD

This study uses qualitative descriptive methods through observation, interviews, literature studies, and FGDs to understand working conditions in limited spaces. Primary data is obtained from field conditions, while secondary data comes from literature and regulations. The analysis is focused on identifying hazards, risks, and the preparation of SOPs and work instructions in the ship repair industry, especially on cleaning and welding the hull in accordance with Permenaker No. 11 of 2023.

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The research process is carried out in several main stages:

1. First, make direct observations at the research site to understand the work process
2. Second, conduct question-and-answer interviews with confined space workers to explore potential hazards
3. Third, determine literature studies such as Permenaker No. 11 of 2023, previous research, and company documents related to hazard identification, risk assessment, and applicable SOPs.
4. Finally, conducting a Forum Group Discussion method with experts to confirm the results of the interview, involving the company's management, including the Assistant Manager as the key informant and the HSE Supervisor as the main informant.

RESULT

Identify Work Stages in Confined Spaces

Based on the results of field observations and interviews conducted with the main informants and workers at PT. X, work in a confined space that includes the tank area, engine room and hull, there are seven stages of work carried out, such as:

Table 1. Identify the number of jobs in confined spaces

Stages	Activity Description
a. Preparation before work	Pre-Job Meeting is carried out between the ship's surveyor owener, and the company. And Preparation of PPE and work equipment
b. Mainhole door opening	The process of opening the mainhole door will be an access to be able to enter and exit a limited area for work to be done.
c. Installation of ventilation devices	Installation of suction blower to help the process of removing residual gas in the tank area.
d. Atmospheric gas test or gas free test	Measurement of the remaining gas content in the confined space area before all work in the confined space begins.

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e. Job preparation *cleaning*	Installation of installation or equipment that will be used for the cleaning process
f. Transfer of leftover products	Moving the remaining cargo or fuel on the ship's tank.
g. Removal of sludge or oil or sludge from cleaning	Removal of cleaning results such as sludge, oil and sludge deposits at temporary B3 waste storage
h. Stages of repair work	*Wealding* dan *Cutting*
i. *Housekeeping*	Cleaning of used work equipment from confined space areas

Identification of Job Hazards and Risks in Confined Spaces

During the research process, hazards and risks that exist in jobs in confined spaces are identified using the *Job Safety Analysis* (JSA) method. The following are the results of the identification of hazards and risks that exist in confined spaces:

Table 2. Hazard Identification

No.	Stages of work	Potential hazards	Risk	Types of hazards
1.	*Pre-Job Meating*	*Miss-communication*	Writing errors	Psychosocial (work systems management)
2.	Mainhole door opening	a. Thrown mainhole *locking bolt* due to error in the release process b. The lock is pinched while unscrewing the bolt	Wounds to the limbs	Physical
		Hazardous gas content that remains in the tank	Fainting, oxygen deficit and dangerous gas poisoning	Chemistry

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No.	Stages of work	Potential hazards	Risk	Types of hazards
3.	Ventilation installation (*suction blower*)	Drops, slips and bumps due to slippery work areas.	Dislocation, torn wounds until the nerves were pinched.	Physical
		Lack of oxygen, exposure to toxic gases	Oxygen deficit, decreased consciousness and dangerous gas poisoning	Chemistry
4.	Gas *free test*	Drops, slips and bumps due to slippery work areas.	*Dislocations* (sprains), torn wounds to pinched nerves.	Physical
		Lack of oxygen, exposure to toxic gases	Oxygen deficit, decreased consciousness and harmful gas poisoning	Chemistry
		Error in writing the test results	Oxygen deficit, decreased consciousness and harmful gas poisoning	Psychosocial (work systems management)
5.	Preparation for the *Celaning job*	Pinched, slipped due to slippery work area	Wounds, *dislocations* (sprains)	Physical
		Electric shock, *electrical shock,* electrical short circuit	Burns due to electric shock, fires due to electrical short circuits	Electrical
6.		Slipping, bumping due to slippery work area	Injuries, lacerations	Physical

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No.	Stages of work	Potential hazards	Risk	Types of hazards
	Transfer of leftover products	Hose leaks and engine breakdowns	Products are scattered and pollute the work environment	Mechanic
		High voltage electricity, electrical short circuit	Electrocution, burns, fire due to short circuit of electrical current	Electrical
7.	Removal *of sludge* or *oil* from cleaning	Slipped or fell due to slippery work site	Limb injury	Physical
		Hose leakage due to machine malfunction	Environmental pollution	Mechanic
		Lack of oxygen and toxic gases	Oxygen deficiency, residual harmful gas poisoning	Chemistry
8.	Stage of work or repair (*welding, cutting*)	Stumbling, stumbling, pinching plates, punching tool noise, excessive beam radiation	*Dislocations* (sprains), lacerations, decreased hearing intensity, eye irritation	Physical
		Engine breakdown, fabrication process, gas leak	Malfunctions, fires, and gas explosions due to leaks	Mechanic
		Exposure to argon gas	Shortness of breath, dizziness, irritation	Chemistry
		High voltage electricity, installation error	Electrocution, fire due to short circuit in Electricity, burns due to electrocution	Electrical

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No.	Stages of work	Potential hazards	Risk	Types of hazards
9.	*Housekeeping*	Tripping, slipping, pinching and material drops	Injuries, lacerations, *dislocations*	Physical

Source: Primary Data, 2024

As a result of the hazard identification carried out in the work in a confined space, there are several sources of danger that come from machine failure, the working environment and the work process carried out. Based on the results of the classification of the types of occupational safety hazard risks, it can be classified into several types of hazards, namely physical hazards, mechanical hazards, chemical hazards, and electrical and psychosocial hazards (work system management). The identification carried out at PT. X there are 7 potential hazards from 9 work activities. The risk of danger from the identified results includes, injury, fall, slip, impact, gas congestion, shortness of breath, fire, hose leakage, electric shock, injury, malfunction of engine function and environmental pollution.

Results of Risk Assessment and Control

Based on the assessment that has been carried out, it is found that there is the highest risk value at the wealding and cutting work stages, medium risk value in sludge or oil removal work, and low risk value in preparatory work before the work starts. The risk of danger obtained is related to lack of oxygen and exposure to toxic gases due to having limited or inadequate ventilation. Without sufficient air circulation, the oxygen in the chamber can be retained, while the content of other gases can increase. This is especially true in tightly enclosed spaces or those used to store chemicals or fuel.

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Table 3. Risk Control

It	Risk control	Description
1.	Implementation of *Safety Breafing*	briefings given before starting work or risky activities to alert workers to potential hazards, safety procedures, and precautions to be taken
1.	Use of Personal Protective Equipment (PPE)	Each worker is required to wear appropriate PPE, including respiratory masks, gloves, and other body armor.
2.	Gas Level Monitoring or doing *gas free*	The use of gas detectors to ensure oxygen levels remain within safe limits (19.5% - 23.5%) and to detect hazardous gases.
3.	Adequate Ventilation	The use of additional ventilation to ensure the flow of fresh air and reduce the accumulation of harmful gases in confined spaces.
4.	Effective Communication System	The use of communication radios to maintain the condition of workers in confined spaces and avoid the occurrence of errors that can endanger safety.
5.	Emergency Rescue Team	Arrangement of rescue teams on standby outside confined spaces to evacuate in case of emergencies

Preparation of SOP Documents

The SOP document prepared was made using reference to Permenaker No. 11 of 2023. Based on the results of the research studies that have been carried out, the researcher prepared SOP documents for confined space work. This SOP covers the procedures that must be followed before, during, and after work in confined spaces. Some of the stages contained in the SOP that have been prepared include:

a. Job Preparation, agrees that the work area has been properly prepared, including gas and ventilation checks, and ensures PPE workers are in good condition.
b. Procedures During Work, carrying out work in accordance with established procedures, including working using work permits, and supervision carried out during the work.

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c. Completion Procedure, cleaning and inspection of the work area before closing access to confined spaces.
d. Emergency Measures, Drafting clear emergency action procedures, including removing trapped workers and the use of rescue equipment.

DISCUSSION

The results of the risk assessment at PT. Dewa Ruci Agung with the HIRA method shows that welding and cutting have the highest risk (NPP = 9), including physical, electrical, mechanical, chemical, and radiation hazards. Prevention includes the use of standard work tools, safety training, and strict supervision. Medium-risk sludge/oil removal (NPP = 4) with physical, mechanical, and chemical hazards, which can be controlled through PPE, tool inspection, and ventilation. Work preparation has the lowest risk (NPP = 2), but still requires inspection of tools and work environment. Preparation of SOP Documents Preparation of SOPs at PT. Dewa Ruci Agung refers to Permenaker No. 11 of 2023 concerning Occupational Safety and Health (K3) in Limited Spaces to ensure work safety in confined spaces:

The first is intended for work preparation activities including several main steps, namely determining the number of workers according to the safe capacity, conducting atmospheric testing using gas detectors to ensure oxygen levels are within safe limits (19.5%-23.5%) and detecting toxic gases such as carbon monoxide and methane. Furthermore, the work area must be cleared of flammable materials, the ventilation must function optimally to reduce the accumulation of harmful gases, and the rescue team must be on standby outside the confined space(6). PPE must be used before entering, communication systems between workers inside and outside must be ensured to be effective, and safety conditions are reviewed before work begins (7).

The second is intended for activities during work that require workers to follow predetermined safety measures, with supervisors who always monitor their condition from outside the confined space (8). If workers experience dizziness, nausea, or shortness of

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breath, they must be evacuated immediately and work stopped. The prohibition of carrying heat sources or fires without special permits is enforced to avoid the risk of fire, and gas levels must be monitored periodically with gas detection devices to ensure the atmosphere remains safe(9).

Third, it is used in activities after completing work, first workers must get out safely, then housekeeping, re-checking atmospheric conditions before closing access to confined spaces, and cleaning and restoring all equipment used. Lastly, employees are required to report work results and obstacles to their supervisors to ensure that all procedures have been carried out properly (10). The last SOP when there is an emergency, the emergency response measures that must be taken include immediate evacuation if the worker experiences shortness of breath or loss of consciousness, by using appropriate rescue equipment such as PPE, oxygen masks, or other emergency evacuation tools (11). After being evacuated, workers must be immediately taken to a safe area and receive medical care (12). In the event of a serious emergency, rescue teams or medics must be contacted immediately, and other workers are prohibited from entering confined spaces without PPE and special rescue training (13). With the implementation of strict SOPs, the risk of accidents can be minimized, and work safety at PT. Dewa Ruci Agung can be optimally guaranteed (14,15).

Evaluation

The results of the evaluation show that several stages of work need to be recorded completely and adjusted to several work procedures. From the results of *the Group Discussion Forum* (FGD) that has been carried out with key informants and main informants, document improvements were obtained before finally the document received approval from the assistant manager and can be determined by the company. From the results of the FGD, the improvements needed are:

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a. Element number 5 about the implementation procedure in the sub-chapter of element 5.1 which discusses the procedure before entering the confined space
b. Sub-element 5.3 procedures after completion of work are carried out with the addition of points and the sequencing of stages according to the needs of the company.

CONCLUSIONS AND RECOMMENDATIONS

The conclusion of the research conducted at PT. X with the title of preparation of standard operating procedure (SOP) documents on confined space work at PT. X, as follows: The results of identification at the stages of work in a limited space were obtained in a limited space at PT. X, such as welding, ship tank cleaning, and inspection, has a high level of risk that requires extra attention regarding safety and environmental working conditions. Work in a limited space at PT. X, such as welding, cutting, and grinding, has a variety of potential hazards that can threaten worker safety, including physical, mechanical, electrical, temperature, chemical, and radiation hazards. Therefore, it is very important to take preventive measures, such as the use of PPE. The results of the risk assessment at PT. X indicates the variation in hazard levels in work activities in confined spaces. Welding and cutting have the highest risk (NPP = 9) with potential physical, electrical, mechanical, chemical, and radiation hazards, requiring strict control, complete PPE, and regular supervision. Removal of sludge or oil has an intermediate risk (NPP = 4), especially related to physical and mechanical hazards, which requires serious attention in the use of PPE and equipment inspection. Preparation before work has the lowest risk (NPP = 2), which is more related to administrative and communication errors, but still requires good supervision and coordination.

Based on the results of the research, here are some suggestions that can be applied to improve the implementation of PT. X The establishment of this procedure will improve the

accuracy of risk assessment and minimize the potential risk of work accidents. Socialization and training of updated procedures before the implementation of procedures, socialization and training related to the latest regulations will be carried out to all workers and related parties. This is to ensure that the entire team understands the new procedures and can implement them well. Further research can expand the scope by analyzing the effectiveness of the implementation of SOPs that have been imposed on companies. The advice for companies is to conduct daily *safety briefings* before work starts to ensure clarity of tasks, work locations, and safe working environment conditions. The main factor causing the incident found is *human error*, so with regular briefings, the risk of work accidents can be significantly reduced.

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