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Risk Assessment in Confined Space of The Ship Repair at PT Bandar Abadi Ship Builders and Dry-Docks

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Abstract. Risk Assessment is a process for identifying hazards and analyze the risk incurred, and then decide the appropriate steps to eliminate the danger. The specific objective of this study is to identify hazards and assess the risks that can occur at work in confined spaces, as well as identifying the hazard control has been done. Confined space a workplace that has a very high potential hazard, which could endanger the safety of someone who goes into it, so that the necessary precautions to avoid accidents. Workers should have the ability to understand and identify how to work in confined spaces and follow any procedures established by the company. Preparation of this report was conducted by observing how the implementation of working in confined spaces. Collecting data on the implementation of working in confined spaces is done through direct observation to the field, interviews with the workers, and is obtained from various sources such as books, journals, and other sources. Based on risk assessments that have been made available as a whole, there are seven hazards. Potential hazards are on the job confined space in PT Bandar Abadi Ship Builders and Dry-Docks is inhaled toxic gases, oxygen deficiency or excess, crushed material, fall or slip, trapped, pipeline leaks and explosions. The risk assessment consists of two high risks, medium risk, and one four low risks. Control conducted by PT Bandar Abadi Ship Builders And DryDocks Consists of four methods of control that is a substitution, engineering controls, administrative and personal protective equipment. Personal protective equipment used is masks, safety shoes, safety gloves, face shield, and safety helmet.

Keyword: Confined space, risk assessment, hazard, risk control.

INTRODUCTION

The development program in Indonesia has brought rapid progress in all fields of life such as industry, services, mining, transportation and others. But progress in the industrial, service, mining, transportation, and other sectors besides bringing positive impacts on the development of the economy and prosperity of the nation has also caused negative impacts caused by one of them is a disaster such as pollution and occupational diseases that cause thousands of people injured each year (Ramli, 2010). Occupational safety and health is an effort to create a safe, comfortable working environment and the ultimate goal is to achieve the highest productivity (Hariandja, 2007). In the implementation of occupational safety and health it is strongly influenced by three main factors, namely human, materials and methods used, which means that these three elements cannot be separated in achieving effective and efficient implementation of K3 (Mangkunegara, 2000).

Occupational safety and health is the most important thing in doing every job, so that there is no dangerous situation that can harm or harm people who work (Yenita, 2017). One of them when working in a confined space that can endanger a person while in the room. Working in confined spaces has a risk to the safety and health of workers. Therefore, rules are needed in order to guarantee the protection of workers and other assets, both through legislation, programs enter limited spaces and requirements or procedures for entering and working in confined spaces (Bakhtiar, 2013). Confined space contains several sources of danger that come from chemicals that contain toxins and are flammable in the form of gas, steam, smoke, dust and so on. In addition there are still other hazards in the form of

oxygen deficiency or conversely excessive oxygen levels, extreme temperatures, trapped and physical risks that arise such as noise, wet or slippery surfaces and the fall of hard objects in confined spaces that can result in workplace accidents up to the death of workers who work in it (Tarwaka, 2008) (Directorate of Occupational Health Safety Monitoring, 2006).

The National Institute of Occupational Safety and Health (NIOSH) through its publication No. 94-103, January 1994, concluded that there was limited space investigation. In the publication it was stated that 432 incidents of 480 workers died in limited spaces. The investigation was carried out between December 1983 and 1993. A total of 70 investigations in confined spaces involving 109 workers died. For 25 events there were more than one person who died and people as rescuers had fatal accidents in limited space as much as 60% (NIOSH, 1994). Legislation that is used as the legal basis in supervising work in confined spaces includes Law No. 1 of 1970 concerning Occupational Safety, as a basic regulation, and related implementing regulations, namely the Decree of the Director General of Manpower Supervision Development No. Kep.113 / DJPPK / IX / 2006 concerning Guidelines and Technical Guidance for Occupational Safety and Health Officers of Confined Space. Legislation is made the legal basis because working in confined spaces is at risk of being poisoned or burned due to the presence of hazardous chemicals in the confined space. One workplace that has potential hazards is at PT Bandar Abadi Ship Builders And Dry-Docks. The company is one of the shipyard companies engaged in shipbuilding and ship repairs such as Tag Boat, Deck Barge, Tanker, Cargo, and others. In producing ships or repairing ships, they cannot be separated from activities in limited space. At the job has a high risk of accidents. Here is one picture of the confined space at PT Bandar Abadi Ship Builders And Dry-Docks.



Figure 1. Confined space

Based on observations made, it was found that work accidents occur as much as 1 to 2 times in limited space each month. This data includes all incidents that have resulted in serious injury or illness. Based on this, hazard identification and risk assessment and control are needed to prevent and reduce the potential for workplace accidents in limited space work at PT Bandar Abadi Ship Builders And Dry-Docks.

METODOLOGY Occupational Health and Safety

Work safety can be interpreted as a condition that is free from the risk of accidents or damage or with a relatively very small risk below a certain level. Safe working conditions need support from safety facilities and infrastructure in the form of safety equipment, personal protective equipment and signs. Safety equipment and personal protection equipment need to be adapted to the function and purpose, namely to protect and or prevent employees from dangerous conditions resulting from work done (Simanjuntak, 1994). Occupational health is a

condition in the work environment that is free from physical and mental illness. The company runs an occupational health program to maintain the work health of its employees physically and mentally so that their company's productivity can be maintained and increased. (Simanjuntak, 1994).

Work Accident

Occupational accidents are unexpected events and unplanned causing injury, sickness, loss in humans, goods and the environment. Basically the background of the occurrence of accidents is influenced by 2 factors, namely (Suma'mur, 2004):

- a. Unsafe condition

Where accidents occur because of unsafe working conditions, as a result of: machinery, equipment, materials, etc. Work environment, work process, nature of work, ways of working. b. Unsafe action

Where accidents occur because of unsafe acts / actions, as a result of: lack of knowledge and skills, physical characteristics, mental psychological characteristics, insecure attitudes and behavior.

Risk

Risk is the possibility, danger, loss, the result of less pleasant from something deeds, business, and so on (Big Dictionary of Indonesian Language, 2005). Risk is a combination of the possibility and severity of an event. The hierarchy of risk control is a sequence of sequential stages used in the prevention and control of risks that might occur. Tarwaka (2008) explains that risk control consists of 5 stages, namely:

- a. Elimination
Elimination is a risk control that is permanent and must be tried as the first priority choice. Elimination can be achieved by moving work objects or work systems related to workplaces whose presence at a limit that cannot be accepted by provisions, regulations or standard K3 standards or levels exceeding the Threshold Limit Value is permissible.
- b. Substitution
This control is intended to replace materials that are more dangerous with less dangerous or safer ones, so that their exposure is always within acceptable limits.
- c. Engineering control
Engineering control or engineering includes changing the structure of work objects to prevent workers from being exposed to potential hazards, such as engine safety, conveyor belts, making machine foundation structures with cast concrete, giving mechanical aids, giving sound absorbents to the engine room walls that produce noise high.
- d. Administration Control (administration control)
Administration control is carried out by providing a work system that can reduce the possibility of someone being exposed to potential hazards.
- e. Personal Protective Equipment
Personal protective equipment (PPE) is a control tool used for short and temporary periods if a more permanent control system cannot be implemented.

Confined Space

Confined space is a space that is not large enough that people are less likely to enter it to do work and have limitations to get out or enter (WSHCOUNCIL, 2010). According to the OSHA (Occupational Safety and Health Administration) confined space is a room that has three characteristics, namely having a limited area and being configured so that the worker's body can enter and do its work, has limited entrances and exits and is not designed for continuous work. Confined space is not designed as a continuous workplace such as tanks, pipes and other vessels. In limited space there is no ventilation, limited air circulation and minimal oxygen. The occurrence of fatal accidents that occur in the confined space is due to not understanding and heeding OHS procedures regarding confined spaces (Khair, 2012).

The characteristics of confined space are having limited access to entry and exit. There is room for entry that is large enough or at least partially open, potentially containing toxic gases and inadequate ventilation. Work accidents in confined spaces mostly occur in workers who try to save someone in limited space. These accidents can occur due to a number of hazards that exist in confined spaces such as the potential for lack of oxygen, gas or flammable or explosive vapors, toxic gases or vapors and other physical hazards. All potential hazards must be recognized by the officer and then evaluated the risks for further prevention and control measures that must be taken to work safely in the limited space (California Department of Education). Examples of such confined spaces include tanks for storing

water, fuel or chemicals, bunkers, tunnels, conventional water wells, sewers, septic tanks or sewers, silos (warehouses for storing certain materials), containers and so on.

Dangers related to confined space are:

- a. A serious risk of blasting
- b. Loss of consciousness due to shortness of breath caused by gas, smoke, steam, or lack of oxygen. c. Sink, because of rising water levels
- d. Loss of consciousness due to increased body temperature
- e. Shortness of breath / suffocation because it cannot reach the air or where there is air because it is trapped inside

RESEARCH METODOLOGY

This section describes the sequence in solving problems and how to perform analysis of the existing problems. The research methodology consisted of preliminary studies, literature studies, problem identification, data collection, data processing, analysis, and problem-solving. Preliminary studies are the first step taken in completing a case. During the review interviews were also conducted with several HSE employees. In the literature study, references were sought related to the preliminary study. Literature studies are also obtained from laws and regulations that are made a legal basis in supervising work in confined spaces, namely Law No. 1 of 1970 concerning work safety as well as regulations related to the Director General Decree on Manpower Supervision Development No. Kep. 113 / DJPPK / IX / 2006 concerning Guidelines and Technical Guidance for Limited Space Occupational Safety and Health Officers. The data collected consists of primary data obtained through documents, direct observation to the field and documentation. Observations were made by observing the workplace directly in a confined space in the ship repair section at PT Bandar Abadi Ship Builders And DryDocks using the hazard protection that occurred. Interviews were conducted with several HSE employees.

DISCUSSION

Results and discussion contain a description of the work performed on the confined space at PT. The procedure of entering the confined space at PT Bandar Abadi Ship Builders And Dry-Docks is:

1. Preparation and planning
 - a. Workers are allowed to enter into the limited space must be trained and have attended training on how to work in a confined space. At PT Bandar Abadi Ship Builders And Dry-Docks workers entering confined spaces have been trained and given the authority to do the job retention by supervisor.
 - b. The supervisor tells the workers about the preparation for entering confined spaces and the hazards that may occur in the confined space.
 - c. All employees of Pt Bandar Abadi Ship Builders And Dry-Docks know what materials are contained in a limited space and any hazards that might be found and to know that show proper first aid.
2. Preparation and implementation of isolation

Confined space system should be isolated from dangerous energy around the confined space including the energy and electrical energy. Identification of the insulation system to be used, including a review of the data in a confined space to enter. The data include:

 - a. Number and location of equipment/vessel
 - b. List of insulation / Log Out Tag-Out
 - c. Data product or material that will be entered into the confined space.
3. Cleaning and disposal of gases and liquids in confined space

Once isolated, dangerous energy to do a cleanup of hazardous gases and liquids.

 - a. The pressure in the confined space should be lowered reaching atmospheric pressure through the sewer gas.

- b. Discard the rest of the liquid through the sewer system.
- c. Then purge gas (purging) with an inert gas (N₂ or CO₂) to be below the flammable region.
- d. Upon reaching the bottom, flammability (LEL), a new air may be blown.

4. Air supply

Before workers allowed into the confined space, it must examine the whole place is in the confined space. This is because of the possibility of a trapped gas section is limited space because methane is lighter than air at PT Bandar Abadi Ship Builders And Dry-Docks for testing oxygen levels, gas and flammable vapors to use the gas detector that has been calibrated. Normally the air contained in the confined space is 19.5% to 23.5%. A lack of oxygen can occur when the oxygen content is less than 19.5%. A lack of oxygen can occur due to the burning of combustible substances, fermentation, and chemical reactions. Excess oxygen also does well in the confined space because it also triggered a fire and explosion.

5. At work in confined space, PT Bandar Abadi Ship Builders And Dry-Docks sets of personal protective equipment should be used such as gloves, hats headwear, work clothes or coverall, safety shoes, safety glasses and more. The equipment is used to reduce the impact of hazards that can be caused by workers who were in the confined space.

Given the many dangers that can occur when an employee is working in confined spaces or confined space, workers are required to have a work permit tau known as a work permit. Workers can ask for a work permit at K3 expert or supervisor appointed in each factory or workplace. In addition to a work permit workers also touched wear Personal Protective Equipment (PPE) is complete, the required PPE include: a.

Respirator (breathing apparatus); Gas mask, Water supply system

- b. Lifeline
- c. Gloves
- d. Sneakers
- e. Safety helmet
- f. Protective headgear with chin strap.
- g. Goggles or eye protection.
- h. Ear protector.
- i. Intrinsically safe flashlight.
- j. Protective clothing

6. Supervision during work in confined spaces

At PT Bandar Abadi Ship Builders And Dry-Docks surveillance conducted during work in confined spaces are:

- a. Inspection equipment, PPE, gas detector, a tools detector, etc.
- b. Inform about the way of dangers and emergency response plans.
- c. Correct placement and proper equipment

7. Work Permit

When working in a confined space, PT Bandar Abadi Ship Builders And Dry-Docks provides licensing regulations should be used to enter a confined space or potentially dangerous hazards. Licensing is an authority for job placement location and type of work to be carried out. It ensures that all the conditions of potential danger have been evaluated by a qualified person and a measure of protection to be applied or to know to ensure the safety of all workers. Licensing must be prepared and signed by a supervisor who is responsible for the safe operation and facilities. Copies of these licenses described with tape at the entrance of the limited space. Records should be kept for all permits must be returned at the time of completion of the work or when it ends. Working in Confined Space is dangerous, this is because various hazards can cause injury and death to workers who perform work in the confined space, therefore for the workers who will do the workplace must obtain a Work Permit of HSE Department and the knowledge of his superiors.

Hazard Identification

Results of hazard identification on work in the confined space at PT Bandar Abadi Ship Builders And DryDocks is:

1. Inhalation of toxic gases
2. Lack of oxygen or excess oxygen
3. Crushed material
4. A fall or slip
5. Caught
6. Leaking pipes
7. Explosion

Risk Assessment

The potential danger of further hazard identification risk assessment using the criteria of likelihood and severity refers to the risk assessment methods. The risk assessment can be seen in Table 1.

Table 1. Risk assessment

No	Work	Risk assessment
1	Inhalation of toxic gases	High
2	Lack of oxygen or excess oxygen	Medium
3	Crushed material	Medium
4	A fall or slip	Low
5	Caught	High
6	Leaking pipes	Medium
7	Explosion	High

Note:

	Low
	Medium
	High

Source: PT Bandar Abadi Ship Builders And Dry-Docks

Risk area analysis is categorized using the following approach:

- a. High-risk level = Area is red
The risks at this level are the risks with the odds of occurring very often up to and occasionally and having an impact value from very large to large.
- b. Medium risk level = Green area
The risks at this level are the risks with the odds of occurring very often that are very rare and have an impact effect from very small to very large.
- c. Low-risk level = Area is yellow
The risks at this level are the risks with the odds of occurrence that are often very rare and have a significant impact effect from large to very small.

Risk Control

Risk control conducted by PT Bandar Abadi Ship Builders And Dry-Docks can be seen in Table 2.

Table 2. Risk Control

No	Hazard	Controlling the risk
1	Inhalation of toxic gases	a. Engineering controls: a gift from the circulatory system and auxiliary exhaust fan b. Administration: air quality measurement c. PPE: gas detector, respirator or masks, self-rescue
2	Lack of oxygen or excess oxygen	a. Engineering controls: the provision of an air circulation system b. Administration: air quality measurement c. PPE: gas detector, mask
3	Crushed material	PPE: safety helmet
4	A fall or slip	Administration: do housekeeping after work
5	Caught	PPE: safety helmet
6	Leaking pipes	a. Engineering controls: checking the area could cause an explosion b. PPE: use face shield, wearpack

Fishbone Analysis

The fishbone diagram is a diagram used to determine the factors that cause accidents at work in the confined space in PT Bandar Abadi Ship Builders And Dry-Docks. Factors causing concern in the manufacture of a fishbone diagram is a human, the methods, equipment and work environment.

Based on the above diagram Fishbone is known that factors are causing or affecting the accidents that working environment factors, methods, equipment, and humans.

Work environment

The work environment work is very influential on accidents, such as the narrow room, hot conditions and the lack or excess of oxygen. Therefore, workers must always be careful and ensure the proper use of PPE and appropriate work procedures and SOPs exist, to avoid the danger posed by the state of the working environment.

Method

In their work, the worker did not use the method to work properly and not by the SOP that has been made by the company, which led to workplace accidents occur as well as workers' lack of understanding of the K3 also factored into labor in violation of SOP. Therefore, the supervision and control system of the company is necessary, to reduce and prevent infringement K3 happens, by way of reprimand or commemorate each operator before the emergence of workplace accidents.

Equipment

Equipment used when working in a confined space is not adequate. Such equipment often leads to accidents to workers, such as inhalation of toxic gases, and other material stricken. Therefore, to avoid this, workers are expected to use the PPE. PT Bandar Abadi Ship Builders And Dry-Docks have had the PPE and has implemented procedures for the use of PPE according to the SOP, but the amount of labor that much, causing the existing PPE does not correspond to the amount of labor. In other words, it is not adequate PPE. Therefore it is necessary to add PPE so that workers can work safely.

Human

Accidents that occur in the confined space in PT Bandar Abadi Ship Builders And Dry-Docks are generally caused by the human factor itself which acts as a worker. Hasty action and neglect can cause potential workers to a work accident. In this case, the workers only pay attention to speed, without considering the safety aspect for him. Most of the workers themselves have been accustomed to such work, so many operators who think the job is easy and safe. Factors affecting accidents that often occur is not paying attention to the work area well, does not work according to SOP, do not wear PPE properly, do not follow the training that led to workers injured at work, such as falls, crushed material.

CONCLUSION

The results of this research are a confined space is not big enough space and the possibility of people go into it to do the work and have limitations for outgoing or incoming. Confined space has three characteristics that have a limited area and configuration so that workers can enter the body and perform their duties, have limited the door for entry and exit and is not designed to work on. Potential hazards are in confined space work in PT Bandar Abadi Ship Builders And Dry-Docks is inhaled toxic gases, oxygen deficiency or excess, crushed material, fall or slip, trapped, pipeline leaks and explosions. Risk control has been done by PT Bandar Abadi Ship Builders And Dry-Docks consists of four methods of control that is a substitution, engineering controls, administrative and personal protective equipment. Wear personal protective equipment, namely masks, safety shoes, safety gloves, face shield, and safety helmet.

Recommendations for the company are workers should have been compliant companies using PPE which has been prepared, given the importance of the use of in protecting workers against potential hazards. Confined should be given access to know the number of existing workers in the confined space.

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