

Conference Paper

Risk Assessment on Hull Painting Process at Shipyard

Kholilulloh Nurkhasanah Wulandari, Abdul Rohim Tualeka, Noeroel Widajati, and Nafilatul Fitri

Occupational Health and Safety Department, Faculty of Public Health, Universitas Airlangga, Jl. Airlangga No. 4 - 6, Kota SBY, Jawa Timur 60115, Indonesia

Abstract

The objective of this study was to conduct risk assessment on hull painting process and give the high-risk control recommendation at PT. X Surabaya. Methods of this study was a descriptive research with three steps of analysis. The first step was to identify all the potential hazards on hull painting process through observation and interview. The next step was to specify the likelihood and the consequence from each risk. And, the final step of analysis was to determine the risk value and its ranks. The highest risk got the priority of the recommendation. The results obtained showed that high risk can occur, among others, if hit by forklift, the fall of the machine being transported by a crane, a strung ladder, a fire and explosion, a fall from a height, and a hearing loss. Recommendations for high-risk hazard control include the formulation of policies or regulations, installation of signs that support policy, socialization of risk control policies, establishment of emergency response teams and first-aid teams, and socialization, monitoring, use and maintenance of personal protective equipment. The conclusion of this study was that the hull painting process had 22 hazard risks that consist of 6 high risks, 12 moderate risks and 4 acceptable risks. The high-risk control recommendation includes engineering control, administrative and the usage of personal protection equipment.

Keywords: risk assessment, hull painting process, high-risk control recommendation

Corresponding Author:
 Nafilatul Fitri
 nafilatulfitri@gmail.com

Received: 15 May 2018
 Accepted: 3 June 2018
 Published: 19 June 2018

Publishing services provided by
Knowledge E

© Kholilulloh Nurkhasanah Wulandari et al. This article is distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use and redistribution provided that the original author and source are credited.

Selection and Peer-review under the responsibility of the ICOHS 2017 Conference Committee.

1. Introduction

PT. X is the State-owned Enterprises (SOEs) the main activities of which includes repairing and building various types of ships, cargo ships, containers, tankers, ferries and tug boats. One of the production processes in the activities of the repair and construction of the ship is the process of painting the hull. Painting is one of the very important things on hull repairs. This is done to avoid the plate from rust or corrosion [1]. At this stage of the painting, workers are potentially exposed to various hazard risks. Different types of

OPEN ACCESS

paint are classified as hazardous substances because they contain hazardous materials. Paint exposure on workers can lead to injuries and diseases caused by inhaling toxic vapors and mists or because of exposure through the skin. Other harmful substances used in the process of painting include thinner, degreaser, resin, surface preparation products, dust from sanding, rust converters and rust removers. Some hazardous substances used in the painting also pose a fire or explosion risk. Other potential hazards in the process of painting include machinery, electricity, paint injection from airless spray gun, manual handling and noise [2].

Based on the results of the initial interview, it is known that there have been several accidents in the process of painting the hull at the stage of blasting and painting, that is, workers falling from height, exposed by abrasive spray and hit by a broken airless spray hose. With the high-potential dangers on hull paint work, risk assessment is necessary to identify and analyze the risks of accidents so that control and prevention activities can be done. Workplace risk assessment is a careful examination on matters that could harm people and predicting what precautions could be taken or which should be made to avoid harm [3].

The purpose of this study is to conduct a risk assessment on the process of painting the hull in PT. X and provide recommendations on high-risk hazard control based on hazard control that has been done.

2. Methods

2.1. Data collection

Primary data was collected by direct observation in the field and interviews and discussions with parties related in order to get information about the work steps in the hull painting process, the potential danger, the possibility and severity of the hazard, risks and the controls that have been done. Whereas, secondary data was obtained from PT. X, including Hazard Identification and Risk Assessment (HIRA) documents, Work Instruction (WI) documents and other supporting data.

2.2. Data processing

The data was processed using risk analysis form. The steps in the processing of the data are as follows:

1. Sort the work steps in the process of hull painting.

2. Identify hazards at each step of the work.
3. Conduct a risk assessment to find out the level of hazard by determining the level of likelihood and consequence of those risks. The determination of likelihood and consequence is done semiquantitatively based on ISO 31000:2009, as shown in Tables 1 and 2.
4. Conduct the calculation of the level of risk with the formula:

$$\text{Risk} = \text{Likelihood} \times \text{Consequence}$$




5. Categorize the level of risk into risk categories that are available with the giving color according the level of risk.
 - (a) Score 1-6 = high risk 
 - (b) Score 7-15 = moderate risk 
 - (c) Score 16-10 = low risk 

TABLE 1: Assessment of likelihood level.

The Likelihood		
1.	<i>Be Expected</i>	One incident per day or more
2.	<i>Often</i>	One incident per week
3.	<i>Sometimes</i>	One incident every 1 month
4.	<i>Minor</i>	One incident every 3 months
5.	<i>Highly unlikely</i>	Almost never. Once per year

Source: ISO 31000:2009

2.3. Analysis of data processing results

Based on the results of data processing, the value of hazard risks and its categorization can be known. Furthermore, analysis of the controls was conducted ne so that the risk-control recommendations can be determined.

2.4. Recommended risk control

Based on the results of the analysis of the likelihood and consequence level of hazard risks and controls that have been carried out, the cause of the value of hazard risk included in the high category (high risk) can be known. Based on this analysis, some recommendations for company improvement can be determined.

TABLE 2: The assessment of consequence level.

Level	Criteria	Detail Description
1	<i>Catastrophic</i>	Death, the release of toxic materials, huge financial losses.
2	<i>Major</i>	Serious injuries (limb or partial defect), loss of production capacity, large financial losses.
3	<i>Moderate</i>	Injuries requiring medical treatment, the employee does not enter employment, high financial losses.
4	<i>Minor</i>	Treatment, first aid, moderate financial losses.
5	<i>Insignificant</i>	No injuries, low financial loss.

Source: ISO 31000:2009

3. Results

Based on Table 3, it is known that there are 22 hazard risks in the hull painting process consisting of 4 low risk (acceptable risk), 12 moderate risk and 6 high risk.

TABLE 3: Risk assessment on ship hull painting process at PT. X.

Hazard Risk	Likelihood	Consequence	Risk Level	Existing Control
Fainting due to electrocution	5	4	20	Complete PPE, electrical equipment maintenance, execution by experts
Mild burns due to electrocution	5	4	20	Complete PPE, electrical equipment maintenance, execution by experts
Bruising or minor injuries due to equipment and materials	3	4	12	Complete PPE
Minor injuries from the fall of the machine being transported using a crane	5	4	20	Complete PPE, alarm sound of crane, there is direction officer
Died from the fall of the machine being transported using a crane	5	1	5	Complete PPE, alarm sound of crane, there is direction officer
Minor injuries due to getting hit by a forklift	5	4	20	Special routes for pedestrians, alarm sound of forklift
Fractures due to getting hit by a forklift	5	2	10	Special routes for pedestrians, alarm sound of forklift
Died from getting hit by a forklift	5	1	5	Special routes for pedestrians, alarm sound of forklift
Fractures due to the fall of the ladder	5	2	10	Lock ladder, supervision, complete PPE
Died due to the fall of the ladder	5	1	5	Lock ladder, supervision, complete PPE
Moderate burns due to fire	5	3	15	Inspection and maintenance of machine tools on a regular basis, installation of APAR

Hazard Risk	Likelihood	Consequence	Risk Level	Existing Control
Severe burns due to explosion	5	2	10	Inspection and maintenance of machine tools on a regular basis, installation of APAR
Died due to fires and explosions	5	1	5	Inspection and maintenance of machine tools on a regular basis, installation of APAR
Skin irritation	3	4	12	Gloves, uniform, safety shoes
Irritation of the eyes	3	4	12	Safety glasses
Respiratory disorders	3	3	9	Mask
Hearing disorders	3	2	6	Earplug
Mild burns due to sparks	3	4	12	Complete PPE
Fracture due to a fall from a height	5	2	10	Work supervision, safety body harness
Died due to a fall from a height	5	1	5	Work supervision, safety body harness
Fatigue due to awkward posture	3	5	15	Job rotation
Muscle pain due to awkward posture	3	4	12	Job rotation

Source: Primary Data, 2017

4. Discussion

4.1. Hazards identification

Based on the results of observation and interviews, hull painting process at PT. X consists of 3 main stages, namely, preparation stage, implementation stage and completion stage. Potential hazards are at the preparation stage, such as the fall of the airless spray machine being transported using a crane, getting hit by a forklift while picking up equipment in the warehouse, catching of fire when picking up paint and thinner on ship as workers work while smoking, getting pinched, crushed or strung down the ladder and falling materials from above when moving the ladder, getting exposed to and inhaling paints or thinners, getting cut, punctured or scratched when preparing paint and thinner, and electrocuted with the switch on the compressor.

Airless spray machine transport from the workshop to the outfitting dock areas using cranes are particularly susceptible to the dangers of the falling of the airless spray machine if the wire sling brakes, errors in determining the point of lift, or incorrect hook installation. This accident can cause workers to suffer minor injuries to death.

Another potential hazard in this preparation phase is the workers being hit by forklifts that are operating at the time of taking the equipment and materials from material warehouses to the ship which will be painted. This potential hazard can occur when a worker walks in a forklift area or walks less concentrated, for example, was using a cell phone or was chatting with other workers, so as not to hear the alarm sound or bell forklifts. This accident can cause workers to suffer minor injuries to death. Every year, nearly 100 workers are killed and injured in the accident forklift. According to the National Traumatic Occupational Fatalities (NTOF), 1530 workers died due to forklift accidents between 1980 and 2001 [4].

The fire at the time of taking the paint and thinner in storage vessels may occur if there is a leak of paint or the thinner cans open, which then releases a flammable gas and the presence of a heat source, for example, workers who smoke. Fire occurs because there is a reaction of three fire elements, that is, the source of the fuel, heat and oxygen [5]. These fires can cause either a loss of life or material losses. Loss of life in the form of a workers suffering burns and even dying.

The potential danger of falling ladder can occur if the worker in charge of moving the ladder is inexperienced due to the size of a ladder being high enough and the heavy weight of it. In addition, when a worker will move the ladder less than 3 people then the risk of a fall ladder also gets bigger because it would be difficult to control. The potential dangers of the fall of the ladder higher risks if at the time of the ladder was moved still there are workers who are on the ladder.

When opening a paint and thinner can, the worker opens the lid of the can by gouging on a wire so that the risk is scratched wire if the worker is not careful. Once opened, the edge of the lid cans is a sharp part that can also hurt workers. In addition, workers also have the potential to expose or inhale paints or thinners that can lead to respiratory disorders as well as eye and skin irritation.

At the time of switch on the compressor electrical, workers potentially being stung. This can happen when workers come into contact with the electrified sections or because of touching the insulation or cable that is chipped. A 100-mA current can result in death. In addition, being stung by an electric current of 30 mA for 3 seconds can cause suspended [6].

In addition, when adjusting the airless spray pressure, potential hazards that may occur are broken machine hoses or move without control, explosion and fire, which could result in minor injuries, burns and even death. Worker deaths can be caused by catapulted, exposure to explosion fragments or shards or due to severe burns. In

severe burns, decreased immune response can cause bacteremia, septic shock and death [7].

At the implementation stage, the worker performs painting on all parts of the ship's surface using either a brush, roller or airless spray. Potential dangers in this painting process includes a noisy source from the airless spray machine and the inhalation or splash of paint or thinner.

The effect of noise split into two, namely, the effect on auditory sensory (auditory effect) and not on the senses of hearing (non-auditory effect). Effect not on the auditory senses include communication, sleep, performance and body disorders, and feeling of displeasure or irritability. Whereas, the effects on the auditory senses include acoustic trauma, a temporary threshold shift and a permanent threshold shift [8].

Thinner exposure on the skin can cause redness on the skin, pain, irritation, dry skin, numbness in the fingers and arms, and dermatitis. Exposure to the eyes can cause irritation, burns, conjunctivitis and corneal ulceration. Exposure to thinner through inhalation can cause headaches, watery eyes, eye irritation, nausea, muscle twitch and depression of the central nervous system. Excessive exposure can cause severe seizures, not self-conscious even death [9]. Meanwhile, inhalation of the vapors of paint may cause headaches, feeling sleepy can even cause depression of the central nervous system (CNS) [10].

Other sources of danger at this stage are sparks from both cigarettes or welding works. These sparks can be exposed to the workers' bodies that can cause minor burns to workers and may also trigger explosions or fires that can result in severe burns to them and even casualties.

Other potential dangers at the stage of implementation are a fall from a height while painting the top side area by using a ladder and an awkward posture (bent or squatted) at the time of painting at the bottom area. According to Humantech [11], foot posture which is an ergonomic risk factor is squatting, that is, bending horizontal knees of less than 45° , standing on one leg where the weight is fixed on one foot even though the other foot is stepping on the floor, and kneeling with both feet touching the ground. In addition, abnormal posture or awkward posture can cause the onset of fatigue and discomfort [11]. Doing awkward posture in the long term can cause injuries and complaints on skeletal muscle tissue or peripheral nerves [12].

At the completion stage, painting inspection is done to ensure that the painting results are in accordance with the criteria or order specifications and the coating works optimally. Potential hazards at this stage include tripping of equipment and the rest scattered material, electrocution at the time of switching off the compressor, exposure

to or inhalation of paint or thinner when tidying up the remaining paint and cleaning the airless spray using thinner, getting pinched, squeezed or strung down the ladder and the fall of material at the time of moving the ladder, getting struck to airless spray while being transported using a crane, and getting hit by a forklift at the time of return equipment and materials to the warehouse.

4.2. Risk assessment

Based on the observations and interviews, it was found that in all the hull painting work steps, there were 22 types of risks consisting of 6 risks (27%) with high category, 12 risks (55%) with medium category and 4 risks (18%) with low category.

High risk consists of the risk of dying and experiencing hearing loss. The risk of death is caused by various things, namely, the fall of the airless spray being transported using a crane, getting hit by a forklift, or by a ladder, falling from a height, and explosions and fires. These risks have the likely value of 5, that is highly unlikely or nearly impossible, because:

1. The cranes are operated by experienced operators, the use of alarm sounds, and there are direction officers.
2. The use of an alarm sound in the operation of forklifts that became the signal for the other workers that there are forklifts that are running or will pass.
3. Supervision of work during work at a height and provision of body safety harness.
4. Care and maintenance of the airless spray machine and its equipment at regular intervals, the smoking ban and the hot work (welding) in all phases of the painting, as well as providing APAR in the work area.

The value of the consequences of the risk of death due to the fall of the airless spray, getting hit by a forklift, a fall from a height, or explosion and fire is 1, that is, catastrophic because it results in the victim's death. Based on the value of the likelihood and consequence of the risk, the value is 5.

Other high risk is the risk of hearing loss due to noise from airless spray machine. These risks have the likely value of 3, that is, sometimes in accordance with the average hull painting work of PT. X, which is once a month. While the value of the consequences is 2, which is major because it can lead to defects in the organ of hearing so that risk value is 6.

4.3. Risk control

Based on the results of the risk evaluation, it can be noted that out of a total 22 hazards in the hull painting process, there are 27 percent risk that is not acceptable (high risk), 55 percent risk can be tolerated (moderate risk) and 18 percent of the risk is acceptable (low risk). According to Pareto's theory, the risk of which is included in the category of the unacceptable needs to get attention and treatment immediately so that these risks do not cause negative effects that can harm workers or the company because the percentage is over 20 percent [13].

Based on the results of the risk assessment and evaluation, it can be seen that controlling already exists in PT. X. Here are the controls that have been applied in PT. X on the potential hazards that fall into the category of unacceptable (high risk).

1. Died due to stricken or the fall of the ladder

Risk control due to the fall of the ladder that has been done by PT. X is with the application of ladder safety lock, the use of complete PPE and the supervision during the work process. Based on observation in the field, it is known that almost all portable ladders are used in the process of hull painting, safety locks are damaged or not working properly. In addition, the use of the PPE also has yet to be implemented with maximum because there are still many workers who do not use PPE or its not standard.

Supervision during the work done by each of the concerned division workers on duty to oversee the work that is the responsibility of its divisions. For the process of hull painting, supervision is especially done by outfitting section. Surveillance is also done by a safety officer for each type of work. This supervision aims to ensure that workers are safely lifting the ladder. However, supervision is also not yet effective because even though the supervisor knows that the move is wrong or the worker's APD is incomplete, there is no reprimand against the worker. Even if there is reprimand, workers will only respond with not serious because there is no follow-up or sanctions for workers who violate the regulation.

2. Died from getting hit by a forklift

Risk control that has been done by PT. X is to have signaled pedestrian path. However, on its application in the field, no worker adheres to the pedestrian pathways.

3. Died due to a fall from a height

Risk control that has been done by PT. X is by the supervision of work and the provision of PPE for work at height, that is, safety body harness. However, in its application in the field, none of the workers use the safety body harness when working at height.

4. Died from stricken or the fall of the machine being transported using a crane

The control done by PT. X is providing full PPE for workers, the use of a siren on a crane that is operating, and there is a worker in charge to set the direction. However, for the operators of the crane, it is only an operator who is experienced but not yet certified.

5. Died due to fires or explosions

The control done by PT. X is to perform maintenance and inspection both visually at the time the equipment will be used or periodically. In addition, it has installed warning signs of smoking ban when entering the territory of PT. X and prohibition of doing hot work during the process of painting using airless spray and installation of APAR. However, there are still many workers who smoke in area PT. X and doing hot work when painting process is done.

6. Hearing disorders due to exposure to noise

The control done by PT. X is working with supervision and provision of earplug. However, these earplugs are not socialized to workers, so there is no worker who uses an earplug even when working in areas with high noise. In addition, there is no socialization of the dangers of noise exposure. Based on the results of periodic checks conducted by company clinics, it is known that there are workers who have increased threshold of hearing.

4.4. Recommended high hazard risk control

Control measures are a process, regulation, instrument, implementation or action that serves to minimize negative effects or increase the chances of positive [13]. Risk control can follow a hierarchy of controls approach. The risk control hierarchy is a sequence in the prevention and control of risks that may arise consisting of several levels in sequence starting from the technical control (elimination, substitution, engineering), administrative control to the control through the PPE (Personal Protective Equipment) [14]. The high-risk control recommended by the authors include:

1. Died due to stricken or the fall of the ladder

Died due to the fall of the ladder has a likelihood value of 5 and a consequence value of 1. Because of the high consequence values, the control should be done to reduce the consequences. Risk management against impacts or consequences do with mitigation strategies. A mitigation strategy is a risk management strategy intended to minimize the impact of risk [15].

Therefore, the control that can be done to reduce the risk of death due to falling down the ladder is by forming a first aid team to deliver first aid quickly and precisely, so that the victim from being hit by the ladder can still be saved.

Another control is by providing PPE. Based on the discussion in the previous section, it's known that PT. X has provided PPE for each type of work. However, there is less control, so many workers do not use the complete APD or standard APD. Therefore, strict supervision and imminent employment of unsuitable workers are required. In addition, the company also had to do an examination of PPE periodically to ensure the feasibility of the PPE and to provide PPE in accordance with the size, needs and work environment of workers.

Risk control with risk transfer has been conducted by PT. X by registering the entire workers on BPJS Ketenagakerjaan.

Besides controls to suppress the consequences, controls to suppress the likelihood can be done with a technical approach (engineering control) that includes elimination, substitution, isolation and controlling the distance, as well as the administrative approach through the control of exposure and human approach (human control) [16].

Technical control can be done to lower the risk of death due to the fall of the ladder with the procurement of a new ladder or repairing the damage safety lock of ladder so that at the time of moving the ladder, it is in a position that is sturdy. Other technical controls that can be done is to move the ladder using tools such as lifting crane, so that the potential hazards of being struck down the ladder by manual hauling can be removed.

The administrative control that can be done is the care and examination of the ladder on a regular basis so that the damage on the ladder can be known beforehand. In addition, the socialization of ways of lifting the stairs for safe manually so you can escape either from the risk of accident or health risks.

Based on the results of observation, it is known that supervision has been done on the work process of hull painting. But this oversight needs to be improved by giving a firm warning on workers who do not use PPE and work unsafe.

2. Died from getting hit by forklift

Died from getting hit by forklift has a likelihood value of 5 and a consequence value of 1. Because of the high consequence values, the control should be done to reduce the consequences. Control that can be done to reduce the risk of death after being hit by a forklift is by forming a first aid team.

Based on the results of observation, it is known that control that has been done by PT. X to prevent the potential danger of getting hit by a forklift is making special routes for pedestrians. However, no worker complies with the pedestrian-specific path. In order for workers to be willing to comply with the special path, it is necessary to formulate a policy or regulation on pedestrian obligations to walk on a pedestrian-specific path along with strict sanctions for infringing workers.

To support the policy, it is necessary to place warning signs and socialization of the policy and the importance of walking on a pedestrian-specific path to prevent workplace accidents.

Other administrative controls that can be done are forklift inspection periodically to ensure all safety equipment works, and the operators of forklifts must be certified.

3. Died due to falling from a height

Died due to falling from height has a likelihood value of 5 and a consequence value of 1. Based on those values, the control should be done to suppress the consequences. Control that can be done to reduce the risk of dying from falling from a height is by forming a first aid team.

PPE for work at height (safety body harness) has been provided by PT. X. However, in practice in the field, no worker uses a safety body harness when working at height. Therefore, the company should improve surveillance as well as firmness in the use of PPE and conduct socialization about the dangers of working at height so that workers are motivated to use safety harness body.

In addition, the control of potential hazard of falling from a height can be done administratively. The first administrative control is with increased supervision on the process of the work at the height. This supervision aims to ensure that workers do work safely and use complete PPE.

The second administrative control is done by checking ladder or scaffolding and PPE periodically to ensure that the equipment and PPE are still eligible for use and there is no damage.

Further administrative control can be done by socializing and implementing Work Instructions (WI) at each stage of the hull painting process. Based on the results of interviews and observations, it is known that there have been WI for all stages of hull painting. However, WI is not socialized at workers so that its implementation does not exist.

4. Died due to stricken or the fall of the machine being transported using a crane
Died due to the fall of the machine has a likelihood value of 5 and a consequence value of 1. Based on those values, the control to be done is to suppress the consequences. Control that can be done to reduce the risk of death due to the fall of the machines is to form a first aid team.

Based on the observations, it is known that the area around the crane is the path that is usually used by workers from the office to the dock or vice versa, either when the crane is operated or not. Therefore, the worker is potentially crushed by a machine being transported using a crane when the machine falls.

Control of the potential hazard of falling or crashing of a machine being transported using a crane can be done by drawing up a policy or regulation that governs that at the time of crane operation, the area around crane must be sterile. To support this policy, it is necessary to install signs that indicate the boundaries of areas that workers cannot pass while cranes are operating.

Another policy to be drawn is a policy that requires that crane operators be certified. The certification of the operator ensures that the operator has the ability to operate a crane well, and in the event of an accident the company parties will make it easy to define who should be responsible.

Another control that can be done is to do maintenance and inspection of the crane and equipment regularly so that if there is damage to the crane, it can be known immediately, and control measures can be determined.

5. Died due to fires or explosions
Died due to fires or explosions have a likelihood value of 5 and a consequence value of 1. Therefore, the control must be made to reduce the consequences of risk. Control that can be done to reduce the risk of death due to explosion or fire is by forming a team of emergency response and first aid teams also so that in the event of an explosion or fire, the loss against property and casualty can be minimized.

Based on the results of observation and interviews, it is known that a potential fire or explosion can occur when there is an electrical current or engine pressure is

released and the existence of constituent elements of fire reaction. Control that can be done is to carry out surveillance on any job related to electric current, working pressure (machine), heat and combustible gas. Furthermore, it can be done by socializing and implementing WI to each stage of hull painting.

6. Hearing disorders due to exposure to noise

Hearing disorders due to exposure to noise has a likelihood value of 3 and a consequence value of 2, so the risk value is 6. Based on the risk value, the control must be made to reduce the likelihood and consequences. Control to suppress the consequences of hearing health disorders resulting from exposure to noise is by the provision of PPE.

Based on the results of the interview, it is known PT. X has provided the earplug. However, this earplug is not socialized to workers, so no worker uses earplug although working on areas with high noise. In addition, no socialization of the dangers of noise exposure. Therefore, PT. X must actively socialize the use of earplugs in work with high noise and the dangers of noise exposure. This earplug should always be maintained and inspected at regular intervals.

Control of noise exposure can technically be done by building a closed room or a house specifically for the machines that produce noise to reduce noise exposure to the work environment as well as to the workers.

Administrative noise exposure control can be done by performing maintenance and inspection of the machines periodically so that the noise exposure can be minimized.

Other administrative control is the implementation of the inspection of the audiometry periodically, especially on workers who are exposed to high noise. This examination aims to know the disorders of the senses of hearing of workers due to work early so that steps could be determined, or curative and rehabilitative programs can be done.

The control that also needs to be done is to conduct socialization and implementation of work permit in the entire stage of hull painting, so hazards including the risk of hearing loss due to noise exposure can be reduced.

5. Conclusions

Based on the results of risk assessment on the process of hull painting, it can be concluded that:

1. In the hull painting process, there are 22 hazard risks consisting of 6 high risk, 12 moderate risk and 4 low risk.
2. High risk consists of dying from being hit by a forklift, the fall of the machine being transported using a crane, getting hit by a ladder, a fire and explosion, a fall from a height and a hearing loss.
3. High-hazard risk control that has been done by PT. X is technical, administrative and PPE control.
4. Recommendations for controlling the high-hazard risk includes the establishment of emergency response teams and first aid teams, socialization, supervision and maintenance of PPE, the formulation of policies or regulation regarding the control of which has been done, putting up signs that support policy and conducting policy socialization.

References

- [1] Ariany, Z. (2014). Kajian Reparasi Pengecatan pada Lambung Kapal (Studi Kasus KM. Kirana 3). *Teknik*, vol. 35, no. 1, pp. 27-32.
- [2] The WorkSafe Western Australia Commission. (2009). *Code of Practice Spray Painting*. Perth: Chamber of Commerce and Industry of Western Australia.
- [3] Health and Safety Executive. (2011). *Five Steps to Risk Assessment*. Retrieved from <http://www.hse.gov.uk/risk/fivesteps/htm>
- [4] Division of Occupational Safety and Health. (2007). *Forklift Safety Guard*. Washington: Department of Labor and Industry.
- [5] Ramli, S. (2010). *Petunjuk Praktis Manajemen Kebakaran (Fire Management)*. Jakarta: Dian Rakyat.
- [6] Wiryosumarto, H. (2010). *Teknologi Pengelasan Logam*. Bandung: Pradyna Paramita.
- [7] Sjamsuhidajat, R. de Jong. (2004). *Buku Ajar Ilmu Bedah Edisi 2*. Jakarta: EGC.
- [8] Gempur, S. (2004). *Manajemen Keselamatan dan Kesehatan Kerja*. Jakarta: Prestasi Pustaka Publisher.
- [9] W. M. Barr and Company. (2008). *Material Safety Data Sheet Paint Thinner*. Memphis: W.M. Barr and Company.
- [10] Hempel. (16 June 2016). *Safety Data Sheet: Hempalin Enamel 52140*. Retrieved from <http://www.hempel.com/product-list/SDS-Download?download=1&quality=52140&market=Europe&lang=en-US&pid=5214011480&fileName={%}22HEMPALIN{%}20ENAMEL{%}205214011480{%}20en-US.pdf{%}22>.

- [11] Humantech Inc. (1995). *Applied Ergonomics Training Manual* (2nd edition). Australia: Barkeley Vale.
- [12] Levy, P. E. (2006). *Industrial Organizational Psychology*. USA: Houghton Mifflin Company.
- [13] Tualeka, A. R. (2013). *Analisis Risiko*. Surabaya: Graha Ilmu Mulia.
- [14] Tarwaka. (2008). *Keselamatan dan Kesehatan Kerja: Manajemen dan Implementasi K3 di Tempat Kerja*. Surakarta: Harapan Press.
- [15] Tualeka, A. R. (2015). *Analisis Risiko: Risk Assessment, Risk Management, & Risk Communication di Lingkungan Kerja*. Surabaya: CV. Bumi Lestari.
- [16] Ramli, S. (2011). *Pedoman Praktis Manajemen Risiko dalam Perspektif K3 OHS Risk Management*. Jakarta: Dian Rakyat.