Analysis of Occupational Risk Factors of Hot Work at PT Industri Kapal Indonesia (Persero)

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Hot work in shipyards is a high-risk activity that can cause fires, explosions, injuries, and health issues due to exposure to dust and welding fumes. This study aims to describe the risk factors of hot work through the implementation of Job Safety Analysis (JSA) and safety patrol activities at PT Industri Kapal Indonesia (Persero). The research employed a qualitative descriptive approach with field observations conducted during the internship period from Agustus 2025 to October 2025. Primary data were collected through direct observation during safety patrols and analyzed using the JSA method to identify potential hazards, assess risks, and formulate appropriate control measures. The results indicate that each stage of hot work welding, cutting, and grinding has specific risks, including fires, burns, respiratory problems, injuries from metal sparks, and fall hazards. Safety patrols identified non-compliances in the field, such as inconsistent use of personal protective equipment (PPE), work areas near flammable materials, and emergency facilities that require improvement. The integration of JSA and safety patrols effectively enhances risk control and strengthens the safety culture while ensuring compliance with SMK3 regulations and hot work permit procedures.

Keywords: Hot Work, Job Safety Analysis, Safety Patrol.

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1. Introduction

Work in the construction sector involves complex interactions between human labor, building materials, and work equipment. This complexity increases the risk of accidents due to various potential hazards in the workplace. The impacts are not only physical losses but also financial losses (Karma et al., 2023). Data indicate an increasing trend in occupational accidents within the construction sector: 2,971 cases in 2023 increased to 3,566 cases by November 2024. Nationally, the Ministry of Manpower recorded 462,241 occupational accident cases throughout 2024. Entering 2025, attention has shifted to the shipyard sector, particularly hot work activities. Several major incidents, such as the explosion at PT Sumber Mandiri Shipyard (South Konawe, February 2025) and the fire at PT ASL Shipyard (Batam, June 2025), emphasize the need to strengthen occupational safety and health standards (Kemenaker, 2024).

According to the International Labour Organization (ILO), Occupational Safety and Health (OSH) is a systematic effort to maintain the physical, mental, and social well-being of workers in every type of

occupation. OSH not only functions to prevent health problems caused by work-related factors, but also protects workers from environmental risks through adjustments between workers' capabilities and job demands (Mahdiyah, 2020).

Hot work includes activities that generate flames or sparks, such as welding, cutting, and grinding using equipment such as welding transformers, cutting torches, and welding generators. These activities carry a high risk of fire and explosion, therefore requiring a Hot Work Permit (Azzahra, 2021). This permit serves as an important instrument in the OSH management system to ensure that all safety aspects, ranging from hazard identification, use of personal protective equipment (PPE), readiness of fire extinguishing equipment, to field supervision, have been fulfilled before work begins. Based on Government Regulation No. 50 of 2012 concerning the Occupational Safety and Health Management System (SMK3), companies are required to implement an OSH management system with written work permit procedures and certification for high-risk work (Kartika et al., 2024).

One strategy for preventing accidents in hot work activities is safety patrols, namely routine inspection activities conducted to ensure that hot work is carried out in accordance with work permits, compliance with PPE usage, and the readiness of emergency facilities such as fire extinguishers and hydrants. OSH violations can be addressed immediately to minimize potential accidents (Febria et al., 2025).

PT Industri Kapal Indonesia (Persero) in Makassar, established in 1963 and officially becoming a state-owned enterprise through Government Regulation No. 17 of 1977, is one of the largest shipyards in Indonesia. Since 2020, the company has focused on new shipbuilding, ship repair, and steel construction. In its operations, hot work activities constitute a crucial component that determines the quality and safety of ship construction. Therefore, PT IKI implements strict safety standards, work permit systems, and the use of PPE to ensure that work is carried out safely, efficiently, and in accordance with international maritime industry standards.

2. Method

This study employed a qualitative descriptive research design with an observational approach and a field study method. The objective of the study was to systematically describe the risk factors associated with hot work activities through safety patrol activities and Job Safety Analysis (JSA) at PT Industri Kapal Indonesia (Persero).

The research was conducted at PT Industri Kapal Indonesia (Persero) from August 2025 to October 2025. The data used in this study were primary data obtained through direct observation during the implementation of safety patrol activities. The field findings were then analyzed using the Job Safety Analysis (JSA) method to identify potential hazards, assess risk levels, and formulate appropriate control measures in accordance with the actual conditions at the worksite.

3. Results

Based on the results of the safety patrol conducted at PT Industri Kapal Indonesia (Persero), it was found that hot work activities still involve several significant potential hazards. The main findings included inconsistent use of personal protective equipment (PPE), work areas located close to flammable materials, and the condition of emergency facilities (fire extinguishers, hydrants, and first aid kits) that required improvement. These potential hazards not only have direct impacts in the form of physical injuries, but may also cause occupational diseases, such as respiratory disorders resulting from repeated exposure to welding fumes.

At PT Industri Kapal Indonesia (Persero), there are three common types of hot work activities, namely:

1. Welding
   A metal joining process using high temperatures that generates sparks, welding fumes, and light radiation.
2. Cutting
   The process of separating metal materials using flames or cutting machines that produce heat, sparks, and cutting fumes.
3. Grinding
   Activities involving smoothing or cutting metal using grinding machines, which generate metal dust, sparks, noise, and the risk of grinding wheel fragments.

To analyze the risk factors in each stage of hot work activities, the Job Safety Analysis (JSA) method was applied. The JSA results showed that each stage has different hazard characteristics, ranging from equipment inspection, execution of work activities (cutting, welding, and grinding), to the cooling and cleaning stages of the work area.

Table 1. Job Safety Analysis (JSA) of Hot Work

Work Stages	Potential Hazards	Risks	L	S	R	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
Equipment inspection	Damaged cables, leaking gas cylinders	Electric shock, fire, explosion	2	3	6 (Moderate)	Replace damaged and unfit equipment.	Use heat-resistant gas hoses that comply with Indonesian National Standards (SNI).	Install gas leak detection systems and grounding on electrical equipment.	Conduct inspections and checklists before use, including gas leak testing by OSH officers.	Insulated gloves, safety shoes, and face shields.
Cutting	Sparks, cutting fumes, light radiation	Burns, fire, explosion	3	3	9 (High)	Remove all flammable materials from the cutting area.	–	–	Use a Hot Work Permit, install "Hot Work" warning signs, and provide fire extinguishers in the work area.	Welding mask, heat-resistant gloves, face shield, fire-resistant apron, and safety shoes.
Welding	Sparks, welding fumes, light radiation	Burns, fire, explosion	3	3	9 (High)	Ensure that there are no flammable materials within a 10-meter radius of the work area.	–	–	Ensure that the Hot Work Permit is active, conduct OSH briefings before work begins, and provide a fire watch during welding activities.	Welding helmet, heat-resistant gloves, face shield, respirator mask, and leather apron.
Grinding	Metal dust, grinding wheel fragments, noise	Eye injuries, respiratory disorders, hearing loss	3	2	6 (Moderate)	–	Use high-quality grinding wheels that comply with manufacturer standards.	Install guards on grinding machines.	Inspect the condition of grinding wheels before use.	Safety goggles, earplugs, mask, gloves, and face shield.
Cooling and cleaning of work area	Hot materials, scattered metal debris	Burns, tripping, slipping	2	2	4 (Low)	Dispose of hot materials or scrap metal in a safe area.	Use heat-resistant metal containers to store leftover materials.	Install barriers or warning signs for hot areas and provide adequate lighting.	Perform routine housekeeping and ensure the area is clean before leaving the location.	Heat-resistant gloves, safety shoes, and safety helmets.

R = L x S
Description:
L : Likelihood
S : Severity
R : Risk Rating
Risk Rating Formula:

Discussion

To analyze the risk factors at each stage of hot work activities, the Job Safety Analysis (JSA) method was applied. The JSA results showed that each stage has different hazard characteristics, ranging from equipment inspection, work execution (cutting, welding, and grinding), to the cooling and cleaning stages of the work area.

Based on the results of the safety patrol, it was found that hot work activities at PT Industri Kapal Indonesia (Persero) still involve significant potential hazards, particularly related to the use of personal protective equipment (PPE), work area conditions, and the readiness of emergency facilities. The fact that some workers were not consistently using complete PPE indicates a gap between OSH regulations and workers' behavior in the field. This finding is consistent with occupational safety behavior theory, which states that worker compliance is strongly influenced by routine supervision and the safety culture established within the organization.

Safety Patrol

Safety patrol is a routine patrol activity carried out with the aim of monitoring and supervising all ongoing activities in the work area. In addition, safety patrols are necessary to monitor the work environment in order to create a safe environment that complies with Occupational Safety and Health (OSH) standards. Safety patrols are conducted by authorized personnel who have received proper training (Priyatna et al., 2024).

Safety patrol functions as a form of direct control to ensure that workers comply with OSH standards in the field, while JSA serves as a planning tool that comprehensively maps risks before work is carried out. Therefore, the findings from safety patrols identifying non-compliance can be used as feedback to improve and strengthen the implementation of JSA. For example, when incomplete PPE usage is identified, the control recommendations in the JSA should be reinforced through safety patrol activities to ensure consistent implementation.

This finding is in line with the study by Yuamita et al. (2022), which stated that the implementation of JSA in hot work activities within the shipyard industry is effective in identifying specific hazards at each stage of work and providing more contextual control recommendations. The study emphasized that JSA not only functions as a formal document but also as a practical guideline that must be continuously updated based on field findings, one of which is through safety patrol activities. This demonstrates that the combination of JSA and safety patrols can strengthen the occupational safety culture and reduce the risk of occupational accidents and diseases in hot work activities.

Job Safety Analysis (JSA)

JSA is a systematic method used to identify hazards that arise at each stage of a job, analyze the associated risks, and determine appropriate control measures to reduce or eliminate those risks (Pranoto et al., 2024). Based on the results of the Job Safety Analysis (JSA) presented in Table 1, each stage of hot work activities, including welding, cutting, and grinding, has specific risks, ranging from fire hazards, burns, respiratory

disorders, to injuries caused by metal sparks. Hazard identification through JSA provides a systematic overview that risks do not only arise during the execution stage, but also during preparation (equipment inspection) and final stages (cooling and cleaning the work area). This proves that OSH implementation cannot focus solely on work execution, but must encompass the entire work cycle.

This finding is consistent with the study by Purnamawat et al. (2021), which showed that the application of JSA in ship repair activities was able to identify risks at every work stage, where most activities were categorized as high or even extreme risk. The study emphasized that JSA not only serves as a hazard control tool but also plays an important role in building a safety culture within shipyard environments.

Equipment Inspection

Inspection of hot work equipment (such as welding, cutting, and grinding tools) is necessary to ensure that activities can be carried out safely. These inspections are conducted before, during, and after work to prevent accidents caused by equipment failure or unsafe working conditions.

Based on the JSA results, the equipment inspection stage is a crucial initial step before carrying out hot work activities. The identified hazards at this stage include damaged electrical cables and leaking gas cylinders. These hazards may lead to serious risks such as electric shock, fire, and explosions if the equipment is used without prior inspection. Therefore, the recommended control measures include routine inspections, periodic maintenance, and leak testing of gas cylinders before work activities begin. Thus, equipment inspection is not merely a standard procedure, but also a critical preventive control measure to avoid workplace accidents from the outset.

Welding

Welding is a metal joining process that uses high temperatures and produces sparks, welding fumes, and light radiation. Welding is defined as a process of joining metals or non-metals through material heating, with or without pressure and filler materials (Rosadah et al., 2024).

Based on the JSA results, welding activities have complex hazard characteristics. The primary hazards identified were sparks, welding fumes, and exposure to light radiation. These factors may result in burns, fires, or explosions if appropriate controls are not implemented. Therefore, the use of complete PPE, such as masks, heat-resistant gloves, face shields, and aprons, is mandatory in every welding activity. In addition, strict supervision of the work environment is required, particularly to ensure that no flammable materials are present that could increase the likelihood of accidents. Consequently, hazard control in welding activities should focus not only on worker protection but also on environmental controls to prevent serious accidents.

Cutting

Cutting is the process of separating metal materials using flames or cutting machines that generate heat, sparks, and cutting fumes. In this process, the metal is heated until it becomes red-hot or nearly reaches its melting point, then oxygen under specific pressure is applied according to the thickness of the metal, resulting in oxidation reactions that remove the metal and complete the cutting process (Subastian et al., 2020).

Based on the JSA results, cutting activities involve hazards similar to welding, namely sparks, cutting fumes, and light radiation. These three factors may cause burns, fires, and explosions, especially if the cutting process is conducted without proper safety procedures. The JSA results indicated that the use of complete PPE, such as masks, heat-resistant gloves, face shields, and aprons, is the primary control measure that must be implemented. PPE functions to protect workers from direct exposure to heat, fumes, and metal sparks generated during the cutting process. Therefore, although cutting activities have a risk level relatively

similar to welding, strict implementation of control measures remains essential to minimize workplace accidents.

Grinding

Grinding is the process of smoothing or cutting metal using grinding machines, which produce metal dust, sparks, noise, and the risk of grinding wheel fragments. Grinding is performed to obtain smooth, angled, or contoured surfaces by placing the workpiece on a magnetic table while the grinding wheel cuts the workpiece surface to achieve the desired smoothness (Rinanto et al., 2020).

Based on the JSA results, grinding activities have hazard characteristics different from welding and cutting. The primary hazards identified include metal dust, grinding wheel fragments, and exposure to high noise levels. These hazards may result in respiratory disorders, eye injuries caused by metal particles, and hearing loss if workers are exposed to noise over prolonged periods. Therefore, the use of appropriate PPE, such as safety goggles, masks, and earplugs or earmuffs, is mandatory. In addition, installing guards on grinding machines is important to minimize the risk of grinding wheel fragments injuring workers. Thus, hazard control in grinding activities emphasizes not only individual safety but also the prevention of occupational diseases related to dust and noise exposure.

Cooling and Cleaning of the Work Area

This stage ensures that the work area is in a safe condition through final inspections covering equipment, materials, and the work environment. The process involves supervisors, safety supervisors, and workers to ensure that no residual hazards remain (Febria et al., 2025).

Based on the JSA results, the cooling and cleaning stage still contains potential hazards that should not be overlooked. Hot materials and scattered metal debris in the work area may cause burns, tripping, or slipping accidents. Therefore, control measures such as marking hot areas, using heat-resistant gloves, and thoroughly cleaning the work area after work completion are necessary. Thus, controls at the cooling and cleaning stage not only serve as follow-up actions after work completion but also form an essential part of creating a safe and organized work environment while preventing secondary accidents.

Advantages

The implementation of Job Safety Analysis (JSA) and safety patrols in hot work activities at PT Industri Kapal Indonesia (Persero) has several significant advantages. JSA has proven effective in systematically identifying hazards at every stage of work, from preparation and execution to final stages. This provides a strong basis for the company to establish appropriate and measurable control measures. Furthermore, routine safety patrols encourage workers to comply more consistently with PPE usage and OSH procedures. Safety patrol findings can also function as rapid feedback to update JSA control recommendations, making risk controls more contextual to actual field conditions. The combination of JSA and safety patrols not only reduces the potential for workplace accidents but also supports the development of a stronger safety culture within the shipyard environment while ensuring compliance with the Occupational Safety and Health Management System (SMK3) regulations under Government Regulation No. 50 of 2012 and applicable hot work permit requirements.

Challenges

The implementation of JSA and safety patrols also faces several challenges. One of the main obstacles is the inconsistency of worker compliance, particularly in the use of complete PPE, which is often considered uncomfortable or time-consuming. In addition, some emergency facilities such as fire extinguishers, hydrants, and first aid kits are not yet fully optimal, reducing the company's readiness to respond to

emergencies. Another challenge is the limited number of OSH supervisors, which prevents safety patrols from comprehensively covering all work areas. A safety culture that has not yet been fully internalized also poses difficulties, as workers' awareness of the importance of OSH still varies despite the availability of procedures. Furthermore, the dynamic nature of shipyard activities means that hazards may change at any time, requiring JSA to be continuously updated to remain relevant to field conditions.

4. Conclusion

Based on the research findings, it can be concluded that hot work activities at PT Industri Kapal Indonesia (Persero) involve significant hazards at every stage of work, from preparation and execution to final stages. Through the implementation of Job Safety Analysis (JSA), a systematic overview of various specific risks was obtained, including fire hazards, burns, respiratory disorders, injuries caused by metal sparks, and even risks of falls from height. The safety patrol results also revealed several non-conformities in the field, particularly related to PPE usage, work area conditions, and the readiness of emergency facilities.

These findings indicate that the implementation of JSA combined with safety patrols can improve the effectiveness of risk control while strengthening the occupational safety culture within the shipyard environment. The combination of these two methods not only reduces the likelihood of occupational accidents and diseases but also supports compliance with SMK3 regulations and international maritime industry standards. Therefore, this study emphasizes the importance of integrating safety planning (JSA) with field supervision (safety patrol) as a comprehensive strategy for maintaining occupational safety and health in hot work activities.

Recommendations

1. Strengthen supervision of OSH implementation to ensure workers consistently use PPE and follow safety procedures.
2. Conduct regular training on hazard identification and risk control, particularly for hot work activities.
3. Provide adequate safety facilities, such as periodic equipment inspections, additional fire extinguishers, and improvements to emergency facilities.
4. Integrate JSA findings into company SOPs so that every hot work activity has clear safety standards that must be followed.
5. Continue conducting regular safety patrols to further strengthen the OSH culture among all workers.

5. Refrences

Azzahra, F. (2021). *Gambaran Pelaksanaan Overhaul Berbasis K3 Dan 5s Unit 3 Pltu Tarahan Di Area Turbin Dan Generator Tahun 2021* (Doctoral dissertation, Poltekkes Tanjungkarang).

Balili, S., & Yuamita, F. (2022). Analisis Pengendalian Risiko Kecelakaan Kerja Bagian Mekanik Pada Proyek PLTU Ampana (2x3 MW) Menggunakan Metode Job Safety Analysis (JSA). *Jurnal Teknologi dan Manajemen Industri Terapan, 1*(2), 61-69.

Febria, A. H., Sartika, I., Ani, N., & Wartini, W. (2025). Implementasi Hot Work Permit sebagai Upaya Pencegahan Kecelakaan di Proyek Jaringan Distribusi Utama SPAM Wosusokas Segmen 3. *Sehat Rakyat: Jurnal Kesehatan Masyarakat*, *4*(3), 765-780.

Kartika, W., Maharani, Y. N., Prasetya, J. D., Cahyadi, T. A., & Prastistho, W. (2024). Implementasi Sistem Manajemen Hot Work ke dalam Sistem Manajemen Keselamatan dan Kesehatan Kerja. *JURAL RISET RUMPUN ILMU TEKNIK,* 3(1), 84-96.

Mahdiyah, R. (2020). Penerapan Konsep Dasar K3 dalam Memberikan Asuhan Keperawatan di Rumah Sakit.

Priyatna, B. S., Latif, I., & Rahayu, D. H. (2024). PENGARUH PENERAPAN SAFETY PATROL TERHADAP KEPATUHAN PEMAKAIAN ALAT PELINDUNG DIRI (APD) DI PT X. HOSPITAL MAJAPAHIT: *JURNAL ILMIAH KESEHATAN POLITEKNIK KESEHATAN MOJOKERTO, 16*(1), 76-83.

Pranoto, & Yuamita, F. (2024). Analisis pengendalian risiko kecelakaan kerja menggunakan metode Job Safety Analysis (JSA): Studi kasus PT Madubaru PG-PS Madukismo. Jurnal REPIT (Research in Engineering and Project Industrial Technology), 3(1), 11–19.

Faizah, N., & Purnamawati, E. (2021). analisis risiko k3 pada kegiatan reparasi kapal dengan menggunakan metode Hazard Identification, Risk Assessment and Determining Control (HIRADC) dan metode Job Safety Analysis (JSA) pada PT. NF. *JUMINTEN*, *2*(5), 74-85.

Rosadah, S. A., Lailiyah, S., Ardyanto, D., & Taufiq, D. N. (2024). Manajemen Risiko Pekerjaan Welding Block pada Proyek Barge Mounted Power Plant. *INSOLOGI: Jurnal Sains Dan Teknologi, 3*(1), 98-108.

Subastian, R., Basuki, H. A., & Sanata, A. (2020). Pengaruh Variasi Parameter Kecepatan Torch, Tekanan Oksigen Dan Jarak Nozzle Terhadap Material Removal Rate Pada Proses Otomasi Gas Cutting. *Rotor*, *12*(2), 17-21.

Febria, A. H., Sartika, I., Ani, N., & Wartini, W. (2025). Implementasi Hot Work Permit sebagai Upaya Pencegahan Kecelakaan di Proyek Jaringan Distribusi Utama SPAM Wosusokas Segmen 3. *Sehat Rakyat: Jurnal Kesehatan Masyarakat*, *4*(3), 765-780.