# Risk Assessment of Bunker Occupation To Prevent Oil Spill At Jetty Propylene Refinery Unit - VI Balongan In Accordance With ISGOTT

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***Abstract*—The bunkering operation at Pertamina's Jetty Propylene Refinery Unit - VI Balongan involves the transfer of fuel oil to ships, presenting potential risks of oil spills that could have severe environmental and economic consequences. This study aims to conduct a risk assessment of bunker occupation to prevent oil spills at the refinery un it's jetty. The International Safety Guide for Oil Tankers and Terminals (ISGOTT) sixth edition serves as the framework for this assessment. The risk assessment methodology employed in this study includes hazard identification, consequence analysis, and risk evaluation. Potential hazards associated with bunker occupation activities areidentified, such as equipment failure, human error, and adverse weather conditions. Consequence analysis considers the potential impact of oil spills on the environment, including marine life, coastal ecosystems, and nearby communities. Risk evaluation involves assessing the likelihood and severity of potential oil spills based on historical data, industry standards, and expert opinions. Mitigation measures, such as safety protocols, emergency response plans, and maintenance procedures, are identified and incorporated into the risk assessment. The goal is to minimize the likelihood and severity of oil spills during bunker occupation operations.**

***Index Terms*—Risk Assessment; ISGOTT; Oil Spill**

## I. Introduction

PT Pertamina RU – VI Balongan is the sixth of the seven refineries owned by Pertamina (Persero) with its main business activity is processing crude oil into BBM (fuel oil), non-fuel and petrochemical products. Pertamina (Persero) Balongan RU-VI refinery is one of Pertamina's refineries with a total of ± 2,000 employees consisting of permanent and contract workers PT. Pertamina (Persero) RU-VI Balongan is a refinery that processes state-owned oil and gas to meet and serve theneedsof oil and other fuels for the wider community. The refinery uses modern machinery for oil and gas processing and maintenance. In the course of its business, PT. Pertamina (Persero) RU-VI Balongan alsoapplies rules andprocedures to prevent work accidents. However, in practice there are still obstacles and problems in the implementation of these regulations and procedures, among others. B. Violation of SIKA regulations (Safe Work Permit) and K3 procedures established by the company by employees, not using personal protective equipment properly. and at most on the part of the company, some workers and workers still do not understand written calls, graphics and types of malicious code, which causes workers to make mistakes in carrying out tasks related to certain codes [1].

One of the big tasks of the HSE unit is to carry out controlling and evaluation of work activities in the field so that they are in accordance with SMK – III. These efforts need to be carried out periodically to avoid work accidents caused by technology and human error. In accordance with PP No. 50 of 2012, Health and Safety Work that is abbreviated as K3, all guarantee functions andtry to protect health and safety employees. Prevention of work accidents and work-related diseases. Besides It's based Permenaker Number 5 of 2018, Security and Occupational Medicine,

called K3, applies to all ensuring activities and protects the workforce through monitoring the working environment. Bunker management is crucial for optimizing cruise speed by maintaining the use of fuel consumption [2]. Bunkering is activity of above boat Which is done from boat the boat, boat thebarge or boat theboat tanker. Bunker is activity No routine Which done by boat in accordance with need material burn it Alone. Bunker refers to material burn or oil lubricant Which brought One boat and moved the boat another for use as a material burn machine boat. In the shipping industry, the word "bunker" is used to define a place where fuel or lubricating oil used in ship engines is stored. Bunkering is the transportation or movement of fuel. There are various typesof bunkers providedby bunker ships including MFO (Marine Fuel Oil), MDO (Marine Diesel Oil), HSD (High Speed Diesel). Each type of fuel has its own advantages. This advantage must be considered for ship engines [3].

Based on the results of the analysis of the journal article "Risk Assessment of Bunker Work to Prevent Oil Spills on Ships According to ISGOTT on KM. Camara Nusantara I" in 2020 by Sholihah Irma Rif'atus, there are changes and developments to the regulations used in previous studies, but still using vulnerability matrix tables and probability the same in determining mitigation.

This research was conducted to avoid more fatal work accidents and result in material losses for the company. This is also based on events oil spill in Jetty Cargo waters. Integrated Balongan terminal. This research will also carry out matrix calculations to determine the mitigation that must be carried out by the company.

## II. Literature Review

### A. *Implementation of Occupational Safety Health Management System According to SMK – III*

Occupational Safety and Health Management System, hereinafter abbreviated as SMK3 Government Regulation No. 50 of 2012 is part of the company's general management system to manage risks related to work activitiesin order to providea safe, efficient andproductive workplace. Meanwhile, according to OHSAS 18001, it is an occupational health risk management system related to organizational business, from this it can be concluded that the purpose of implementing SMK3 and OHSAS 18001 and PP No. 50 of 2012 has the same goal, namely the risks that must be managed in relation to K3 in the company [4].

PT Pertamina Kilang Internasional RU – VI Balongan K3 is of great concern in every activity which exists on site. When all employees and contractors (business partner) in the environment of PT Kilang Pertamina Internasional RU – VI Balongan at work carry out work with safe behavior, it is expected that the accident rate will be below or equal to the numberPerformance Measure (PM) has been determined. However, in reality, since the implementation of a safe work culture since the beginning of the operation of RU-VI, work accidents have continued to occur [5].

### B. *ISGOTT (International Safety Guide of Terminal and Tankers) Sixth Edition by ICS/OCIMF*

IMO (International Maritime Organization) as one of the maritime organizations of the United Nations (United Nations) because good and standardized ship management is important to avoid accidents, pollution and other maritime risks in maritimeaffairs andother aspects. Design and implementation of international work safety known as ISGOTT (International Safety Guide of Terminal Tankers) [6]. ISGOTT is one of the results of securing tankers and terminals. IMO has adopted the ISGOTT as one of its most important guidelines regarding the safe operation of tankers and terminal codes, IMO referring to it as a regulation which is referred to as the reference various rules and is recommended [7].

Oil spill prevention according to ISGOTT Sixth Edition are:

before starting the operation, hold a pre-bunker between the competent representatives of the ship and the bunker facility (barge, terminal or truck). Pre-bunker checks should be carried out [8] :

1) Designate the fuel tanks to be loaded.
2) Confirm there is enough space for the nominated loading volume.
3) Establish the maximum loadingvolume for each of the designated tanks.
4) Check that bunker system valves are correctly lined up.
5) Determine the rates for the start of loading, bulk loading and topping-off.
6) Set out the tank atmosphere control arrangements.
7) Establish the internal tank transfer arrangements.
8) Verify the operation and accuracy of the gauging system.
9) Confirm the alarm settings on overfill alarm units.
10) Agree with the bunker supplier, before starting, to establish and record:
    - The loading procedure
    - How and where to carry out quantity checks
    - How and where to carry out quality checks, including installing a sampler if used.
11) Establish safe access to and from the ship.
12) Decide how to monitor the temperature of the bunkers during loading.
13) Set out the communication procedure for the operation, includingthe emergency stop signal and the steps for emergency disconnection and unberthing.
14) Decide the personnel requirements to carry out the operation safely.
15) Monitor the bunkering operation and that it conforms to the agreed procedure.
16) Verify the procedure for changingbunker tanks during loading.
17) Confirm the spill response and containment arrangements.
18) Define weather operating limitations.

If bunker tank lids or sampling points need to be opened, personnel should remain upwind. Take the following precautions:

1) Wear the correct PPE as required by the ship's SMS and the product SDS
2) Wear a personal $H_2S$ monitor
3) Change out of any oil soaked clothing as soon as possible.
4) Keep all doors to the accommodation areas closed during bunkering and ensure the accommodation block is kept at positive pressure.
5) Restrict the movement of personnel near the bunker vents.


Fig. 1. Fire Extinguisher Used for Extinguishing

All the marine fuels are pollutants and can damage the environment. They are toxic to marine life and the heavier grades are very difficult to clean up after a spill [8]:

1) Use the appropriate bunker checklists.
2) Know the procedures for preventingand respondingto spills.
3) Ensure oil spill equipment is ready and available on both the delivering vessel and receiving ship.
4) Ensure proper lines of communication.
5) Plug all scuppers and drains on the bunker barge and the receiving ship.
6) Periodically drain off any accumulation of oil free water.
7) Report spill to the authorities.

During bunkering [8]:

1) Keep all bunker fuel away from naked flames, sparks or other sources of ignition.
2) Keep all bunker fuel away from heated surfaces.
3) Do not smoke on deck.
4) Supervise bunker rate at the intervals agreed by Responsible Officers for supplier and receiver.
5) Ensure that when changing over from one tank to another, excessive back pressure is not put on the hose or bunker lines.
6) Decrease the bunker rate when topping-off tanks to avoid spillage.
7) Before disconnecting hoses, all hoses and lines should be drained to the tank or, if applicable back to the bunker facility (barge or terminal) before hose disconnection.
8) Blowing lines with air into a receiving ship's bunker tanks introduces a number of safety risks and is not recommended.
9) All unused bunker manifolds and hoses connected to the bunker system should be blanked before transfer.

*C. Bunkering*

The process of refueling ships, or the process of refueling ship-to-ship and cargo-to-ship, involves a high level of risk and therefore requires proper procedures, which are regulated in SOLAS (Safety of Life At Sea) 1974, specifically SOLAS Chapter 3, what is regulated is safety equipment and one of them is life safety equipment, which includes the placement and use of safety equipment [9].

Bunkering is an activity carried out on a ship for the purpose of loading. Oil from truck to ship or from ship to ship (ship to ship). Bunkering itself is a necessity for ships. Oil as fuel for ships. Bunkers also have procedures and conditions for bunker work to be carried out safely. Bunker. This has happened in almost all major ports in Indonesia using the STS method. According to Kluijven (2015) Bunkers supply ships with fuel, such as lubricating oil, and transportable water which can be brought to port. fuel is used for ship operations including ship logistics. What fuel to distribute to the available bunker tanks. The total fuel required by the main engine when sailing serves to store the fuel needed by the engine when on the highway, the gas tank is made of thin steel. The interior is coated with the Fuel Fill system's rust inhibitor [7].

In addition, the operation of the bunker itself cannotbe separated from the measurements and calculations of bunker maintenance on board. At the same time, according to the work instructions of the Ocean Operations Region IV Sea organization (NO.B008/F24400/2011-SO) for measuring and calculating on-board bunker reserves, it is indicated that bunkers or fuel are used in operations. Ships consist of 3 types, namely [7]:

1) Marine Fuel Oil (MFO) / Heavy Fuel Oil (HFO) is a fuel oil used for direct combustion in industrial kitchens and other applications such as Marine Fuel Oil. MFO is fuel oil but not a type distillate including the type of residue that is more viscous and dark black at room temperature.

2) Marine Diesel Oil (MDO) / Marine Diesel Oil (MDF) is one of the same production lines as diesel oil and has the same advantages for several specific parameters, including; A higher cetanenumber results in better combustionin the engine and; Water and sulfur content is very low. Thereby preventing and eliminating corrosion.

3) High Speed Diesel (HSD) / Solar / Bio-Solar. Diesel is a product of the crack distillation process of used lubricating oil and has the following advantages:

   a. Higher cetane number and cetane index resulting in perfect combustion quality in the engine.

   b. Water Content and Sulfur Content are very low because the raw material goes through a dehydration stage (separation of water from used lubricating oil) before being processed to prevent and reduce the appearance of corrosion and the formation of deposits for engine combustion.

Refueling (fuel oil) is generally when the ship is docked. This is done because of the various facilities available at the port compared to by the time the ship is in anchorage area. The safety factor is much better at the port because the ship is well tied to the pier/jetty and can be refueled via a ship or tank truck [10][11].

Fig. 2. Bunkering Process

From System on Ground to Ships (Onshore to Ship) The bunkering process from land to ship is usually the right choice when the demand for bunkering is high in the area and is also planned as a long-term investment. This option also works when there are other consumers nearby that also need to be supplied. One of the drawbacksof using options. Onshore refueling for ships requires a lot of effort from the refuelingshipsto reachthe bunkerlocations. Only ships of a certain size can dock at the wharf. The land-to- ship bunkering process is very suitable for serving ships with high delivery rates and relatively high demand [12].

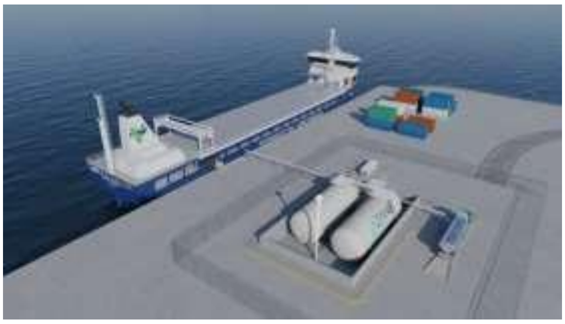

Fig. 3. Onshore to Ship Bunkering Process

Among other bunker systems, the truck-to-ship option is the most commonly used. The transport trucks are connected to the ship by flexible hoses during fuel loading and unloading. Currently, the most widely used fuel for marine fuel needs is the truck-to-ship option. Therefore, the truck-to-ship bunkering process is currently an effective method. Trucks used for bunkering can be used for other distribution purposes. However, due to capacity reasons, truck-to-ship refuelingis only suitable for ships that require fuel with a low capacity. The bunkering process with the truck-to-ship option is very flexible and easy. It doesn't have to be a special place, but loadingand unloadingis also possible, as long as there is enough space [12].


Fig. 4. Truck to Ship Bunkering Process

Refueling with the ship-to-ship option is possible at most ports. Bunkering with this option can be done at the wharf when the ship is anchored or when the ship is anchored at anchor or in the middle of the sea. Bunker ship berthing to cargo ship, even if the port authority allows it, bunkering can be done from ship to cargo ship during loading and unloading of the ship. The obstacle to implementingthe bunker option with this optionis the large investment that must be spent to buy a bunker ship and operate it. Each optionusedaffects bunker processingtime. The size and type of ship also affect fuel time. Because every ship must have fuel requirements depending on engine power and transportation routes. According to the Danish Maritime Authority, the longest time required for a refueling operation is the truck-to-ship option [8].

Fig. 5. Ship to Ship Bunkering Process

*D. Oil Spill Preparedness and Respond*

Offshore oil and gas production has greatly increased its potential since the 1990s due to increasing global oil and gas demand and declining onshore production. In parallel, oil transportation technology has developed at the same pace as the oil production industry, with super tankers and transoceanic crude and refined oil pipelines. Offshore oil production and transportation threatens marine ecosystems with spills that have significant environmental, social and financial impacts, with long-term consequences that span decades [13].

Oil spills occur after natural spills, oil transport, oil drilling, accidental collisions or sinking of oil tankers, pipeline or oil rig failures, etc. Minor oil spills can be managed more easily and effectively using existing technology. This is why size matters when it comes to oil pills and large spills. Every time an oil spill occurs, the public loses confidence in the ability of authorities and oil companies to implement preparedness and response decisions to mitigate the impact [14]. These multiple impacts typically depend on the amount and type of oil spilled, environmental conditions, and the susceptibility of organisms and their habitats to oil [15]. When crude oil enters the sea, it forms an oil slick. (on the order of tens to hundreds of meters per day), and slow, small-scale diffusion processes (on the order of centimeters to meters per day) that change the shape of the silt causing changes in pollutant concentrations. The timeframe and relative importance of the process depend on environmental factors specific to the spill, including the amount of oil spilled, the initial physicochemical properties of the oil, and weather and sea conditions[13].

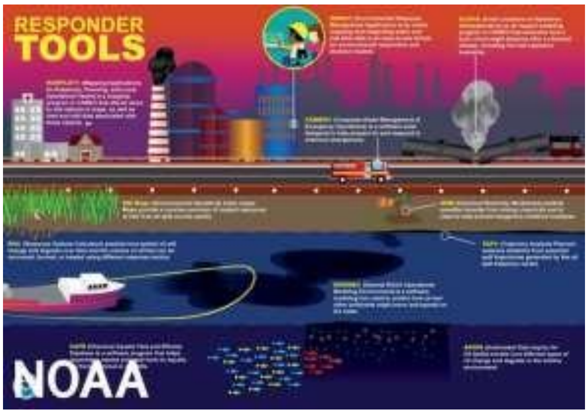


Fig. 6. Responder Tools According to NOAA


Fig. 7. Responding to Oil Spill at Sea According to NOAA


Fig. 8. Responding to Oil Spills on Shore According to NOAA

Effective marine oil spill response operations depend on rapid response from the moment a slick is detected. Given that other factors may influence oil control and prevention efforts and cause further spread of oil, as noted in oil spill-related incidents depending on the severity of the spill, it would be environmentally catastrophic [16]. A cornerstone of oil spill preparedness and response is the consideration of oil spill response itself. A study conducted by found that oil spill response can strike a good balance between physical and material properties, transportation and weathering of the spilled oil [17]. The choices that need to be made include cleaning strategies, organizing maritime safety measures, climate and sea conditions, and booking cleaning offices. It is imperative to drive the ideal planning strategy for oil spill response with the specific end goal of aligning overall costs and response capabilities [18].

### *E. Oil Spill Effect*

An early study by [19] indicated that many of the impacts were due to oil spills, as they occurred at production sites and during the delivery of goods to their destinations by sea transport. The inadvertent spillage of petroleum hydrocarbons, such as crude oil, into marine areas causes marine pollution, particularly affecting the nation's marine life, people and economic resources, and is one of the most feared known adverse effects on communities, especially the oceans. become one. It has serious impacts on fishermen, farms, health and the immediate environment, poses serious threats to economic activity and has a huge impact on society, such as the temporary closure of shipping routes and the evacuation of tourists, which are the most serious causes of marine pollution. It causes economic loss and affects society. The marine environment leads to damage to the ecological balance agreed upon by mutual agreement [18].

## III. RESEARCH METHOD

### *A. Problem statement*

The problem is the beginning in making this research, the goal is to find solutions that need to be done in the research process. In this case, the observed problem is the process bunkering at the Pertamina Internasional RU – VI Balongan Refinery was not optimal, therefore a new method was needed for the process bunkering. This is because the bunkering checklist system still uses manual systems.

### *B. Literature Study*

In the process of this final project using several journals and research that has been done previously to be processed into raw materials and discussion of this final project.

### *C. Data Collection and Analysis*

At the data collection stage, the data obtained will be used as a template for manufacturing page scenarios. The data taken relates to the fundamental business of the bunkering process itself. This data collection is done based on information obtained at PT. Pertamina International Refinery RU – VI Balongan. Data analysis is done after processing identification to the risk of the operational process carried out. This stage aims to determine the workflow and separate major risks and minor risks, prepare data and prepare for the next stage, namely evaluating and handling risks. Analysis can be in the form of qualitative, semi-quantitative and quantitative or a combination of the three.

### *D. Qualitative Analysis*

At the data collection stage, the data obtained will be used as a template for manufacturing page scenarios. The data taken relates to the fundamental business of the bunkering process itself. This data collection is done based on information obtained at PT. Pertamina International Refinery RU – VI Balongan. Data analysis is done after processing identification to the risk of the operational process carried out. This stage aims to determine the workflow and separate major risks and minor risks, prepare data and prepare for the next stage, namely evaluating and handling risks. Analysis can be in the form of qualitative, semi-quantitative and quantitative or a combination of the three.

### *E. Semi Quantitative Analysis*

Semi-quantitative analysis in this study is in the form of risk analysis using a numerical scale in calculating the management matrix risk. Where the data is qualitative which is then converted into quantitative data based on the weighting that has been provided in the matrix.

### *F. Quantitative Analysis*

Quantitative analysis in this study is based on ISGOTT Sixth Edition, matrix data in the form of numbers, mitigation that must be carried out if work errors occur, probability vulnerability matrix and risk management tables.

### *G. Data Collection*

At the data collection stage it was carried out at the Pertamina RU – VI Balongan Propylene Jetty. By using several methods such as; field survey by being directly involved in the tank soundingprocess, tank truck sounding, and the refueling process as well as interviews obtained of the workers in the company.

## IV. Data Collection

At the data collection stage it was carried out at the Pertamina RU – VI Balongan Propylene Jetty. By using several methods such as; field survey by being directly involved in the tank sounding process, tank truck sounding, and the refueling process as well as interviews obtained of the workers in this company.

### *A. Field Study*

The field survey was carried out in the form of participation in the pre-bunkering-post implementation, in which the pre-bunkering stage was carrying out request list or administration of correspondence that will be brought to be valid evidence, calculating the ship's tank with interpolation calculations, then bunkering where sounding The tanker then matches the clearance certificate for the car, the process of transferring fuel from the tanker to the ship supervised by bunker agency and crew commissioned ship (Chief Engineer). And the last post – bunker namely by filling the bunker checklist and other supporting documents.

### *B. Structured Interview*

At this stage, interviews were conducted with several respondents, namely; Senior Supervisor I, Agency Bunker, Chief Engineer, and Captain. Where senior supervisor I take care of the legality of documents for the implementation of bunkering. Bunker agency in charge directly on the pre-bunkering-post.

### *C. Documentation*

He implementation of research activities is supported by the existence of documents which are valid evidence of this research, where the documents are given during internship activities industry going on. Documents are carried out by collectingand requestingdata, namely K3LL policies, SOPs bunker along with forms and other documents as research supporting data.

## V. Data Analysis

Data analysis is done after processing identification to the risk of the operational process carried out. This stage aims to determine the workflow and separate major risks and minor risks, prepare data and preparefor the next stage, namely evaluating and handling risks as shown in Tabel 1. Analysis can be in the form of qualitative, semi-quantitative and quantitative or a combination of the three [20]. From this research, the following mitigation can be produced asshown in Tabel 2.

TABLE I. Comparison of ISGOTT Sixth Edition with The Incident at KPI RU – VI Balongan

| ***Checks*** | ***In The Field*** |
|---|---|
| Isolation electricity effective | Electrical isolation in the field has met the standards, namely the minimum occurrence of technical errors such as electrical short circuits. |
| Bunker transfer equipment<br>- Is in good condition<br>- Already appropriate<br>- The line is checked | Bunkering support equipment in good condition |
| Fire fighting equipment ready to use | There are firefighters in the bunkering process area. |
| Scuppers and saveall installed | Scuppers and saveall are installed fine |
| The portable drip tray is positioned correctly | The fence has been positioned properly and correctly |
| Unused bunker joints emptied and fully bolted | Unused bunker connections are blanked and well bolted |
| Overcharge and high level alarm units operate | Alarms operated |
| The bunker operation emergency stop is operating | There is a special emergency operation team around the bunkering area |
| The bunker tank openings were closed. | The tank cover is closed properly |
| Oil spill cleaning agents are available. | Availability of oil spill separator in around area bunker |
| Medium/high frequency radio antenna isolated. | Radio isolation has been carried out during the bunkering process. |
| Ultra high and ultra high frequency transceivers are set to low power mode. | High frequency shutdown is done. |
| Bunker hoses, fixed pipelines and manifolds are drained. | Bunker hoses, pipelines and manifolds are well drained. |
| Remote and manually controlled valves are closed. | The cover is well handled. |
| Effective fenders | The fenders on the jetty are properly installed and the fender maintenance is good enough. |
| Effective tethering | The mooring lines used are in good condition and the mooring process of the ship is going well. |
| Access between ships and facilities is secure | There is easy boat and jetty access. |

TABLE II. Mitigation Planning

| ***Source of Risk*** | ***Category*** | ***Mitigation*** |
|---|---|---|
| Licensing delays | Very low | Prepared letters long before the bunker process |
| Delay in mooring alley | Very low | Prepared mooring gang team to arrive earlier before the ship arrives |
| The mooring rope broke | Moderate | Tools and equipment are inspected before use & damaged tools are replaced or repaired |
| Crash between the fender and the ship | Height | Coordination between ships, both bunker ships and jetties |

| Source of Risk | Category | Mitigation |
|---|---|---|
| Damaged fender on the jetty | Low | Carry out routine maintenance and monitoring of the fenders on the jetty |
| There was an error with the job on the jetty | Low | Coordinate with related parties that there is work and can separate the bunkering process from other work |
| Electrical short | Moderate | Perform regular monitoring |
| Fire | Height | • Perform appropriate loading<br>• Maintain radio contact to control center |
| Work on the jetty that causes sparks | Moderate | Coordinate with related parties that there is work and can separate |
| Oil spill on deck | Height | Carry out appropriate loading |
| Hose leak | Moderate | Securing |
| Bad weather | Very low | Look at the weather guide from BMKG regarding sea water waves around the waters where the bunkers are located |
| Ship ran aground | Height | See tide guides for the area around the bunker's waters |
| Limited movement | Very low | Calculation of proper maneuvering navigation according to the size of the ship |
| The tanker overturned in the bunker | Height | Coordinate |
| There was a leak in the pipe at the jetty | Height | Carry out routine maintenance and monitoring of pipes in the jetty |
| Unprepared guard in the area | Very low | Coordinate at |
| Equipment unavailability | Low | Tools and equipment are inspected before use & damaged tools are replaced or repaired |
| Damage to equipment | Low | Tools and equipment are inspected before use & damaged tools are replaced or repaired |
| The drain hole is not completely closed | Moderate | Make sure all drain holes are closed or re-check |
| Valve that is not closed completely | Moderate | Make sure all valves are closed or re-check |

| Source of Risk | Category | Mitigation |
|---|---|---|
| Faults in manifolds both on board and on land | Moderate | Do a double check on the manifold |
| Detachment of the hose from the manifold | Moderate | Check again on the manifold |
| Imperfect cargo lid | Moderate | Check again |
| Fire if not closed | Height | Check again to close the tank after the bunker |
| The occurrence of human error such as; fell, slip, stumbled, fell into the sea | Moderate | Use |
| Crushed material | Moderate | Use |
| No preparedness of equipment for oil spills | Low | Tools and equipment are inspected before use & damaged tools are replaced or repaired |
| Damage to antenna transmitter or radar | Low | Tools and equipment are inspected before use & damaged tools are replaced or repaired |
| VHF/UHF is not turned off | Very low | Check again |
| There was a crew who smoked during his journey bunker | Height | He was warned not to smoke during the bunkering process or while working |
| Unprepared for naked light | Low | Installation of signs and barriers in the bunker area |
| Imperfectly all accommodation doors and windows are closed | Low | Check again |
| A data error has occurred | Very low | Check again |
| Fire and explosion | Height | Perform appropriate loading |
| Chemical poisoning | Height | Use |

# VI. RESULT AND DISCUSSION

## A. *Result*

Based on data and review directly on Jetty RU – VI Balongan obtained several events, namely:

1) Delay in tanker because it does not serve only marine bunkers (tank car service for all RU – VI function)
2) The extension of the bunker time is due to the length of time the permit letter number goes down.

Management risk is a response to risk that has been assessed. The following shows the choice of way management risk.

TABLE III. MANAGEMENT OPTION RISK

| ***Risk Rating*** | ***Management Risk*** |
|---|---|
| Very High (E) | Transfer risk |
| Height (H) | Reducing the consequences of risk |
| Moderates (M) | Reducing the possibility of that happening |
| Low (L) | Avoid activity |
| Very Low (VL) | Accept the risk |

Small risks have different levels. Highly recommended to reduce the risk greatly as high (E) and high (H) as possible. Both levels of risk are within the intolerable range. Moderate risk (M) can be considered acceptable or reduced as far as possible. Low (L) and very low (VL) risks are generally accepted.

From the table of probability and effect levels, the risk index level for each event is determined by using a formula obtained by combining the risk event classifications. The following formula is used to measure the risk of an event [21].

## *B. Discussion*

So that the final result of the risk index will be mapped according to the following matrix map, which is a risk matrix map 5 × 5 can be seen in the following table :

TABLE IV. RISK MATRIX 5X5

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Likelihood rating*** | ***5*** | Moderat | 7 High (H) | 8 High (H) | 9 Very High (E) | 10 Very High (E) |
| | ***4*** | 5 Low (L) | Moderat | 7 High (H) | 8 High (H) | 9 Very High (E) |
| | ***3*** | 4 Low (L) | 5 Low (L) | Moderat | 7 High (H) | 8 High (H) |
| | ***2*** | 3 Very Low (VL) | 4 Low (L) | 5 Low (L) | Moderat | 7 High (H) |
| | ***1*** | 2 Low (L) | 3 Very Low (VL) | 4 Low (L) | 5 Low (L) | Moderat |
| | | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
| | ***Consequence / Consequence Rate Rating*** | | | | | |

According to Ben-Azher (2008), which is found in the journal [22], explains that *Risk = probability of risk occurrence × consequence of risk occurrence.* Ben-Azher also explained factor The main elements of a risk level are influenced by three factors among them: factor maturity or so-called maturity factor (Pm) which reflects the potential risks associated with new technological developments.

Complexity factor or complexity factor (Pc) which reflects the probability of risk due to development system. Factor dependency or dependency factor (Pd) reflects the potential risk of dependence such as facilities and contractors. The outcome of risk exposure is also affected by three factors: performance (i.e. poor job performance), cost (i.e. increased costs) and scheduling (i.e. deviation from the established schedule) [22].

Based on the results of research that occurred in the field, it was concluded that the risk assessment score is a method used to evaluate and measure risk based on various factors. The specific scoring system used may vary depending on the industry or context, but can provide an overview of how risk assessments are generally carried out such as:

1) Identify and define risk factors: Start by identifying the specific risks associated with the activity, project, or situation. These risks can be categorized based on different factors such as likelihood, impact, severity, or any other relevant criteria.

2) Assign scores: Once the risk factors are defined, assign scores or values to each factor based on its significance or impact. This can be done using a numerical scale (e.g., 1 to 10) or a qualitative scale (e.g., low, medium, high).

3) Weight the scores: Some risk factors may be more critical than others. Assign weights or importance factors to each risk factor based on its relative significance. This step helps prioritize risks based on their potential impact on the overall objective.

4) Calculate the risk score: Multiply the score assigned to each risk factor by its corresponding weight and sum up the values. This calculation provides a quantitative measure of the overall risk level associated with a specific scenario.

5) Interpretation and decision-making: Analyze the risk scores obtained and interpret them in the context of the situation. Higher risk scores indicate greater potential impact or likelihood of an adverse event. Based on the risk scores, decisions can be made regarding risk mitigation strategies, resource allocation, or further analysis.

In this study, to calculate the risk using the addition method which aims to find out more specific results. Because the results of the method study obtained is not too far away so that appropriate mitigation planning can be carried out. Being able to measure and determine the magnitude of the consequences/consequences of losses in relation to goals/targets and the size of the opportunity level (frequency/probability level of events by using the Risk Level Matrix Diagram (5x5) improves. Danger level of a risk that has been identified or identified can be determined using the formula: *Risk Index (R) = Probability Index (K) + Impact Index (Consequences) (A)* [21], giving the results described in the table below: *Risk Index (R) = Likelihood Index (K) + Result Index (Consequence)(A)* then the results described in table 5.

TABLE V. MANAGEMENT OPTION RISK

| *Bunkering* | *Possible Sources Risks That Occu r* | *Likeli h ood Index* | *Inde x Con sequ ence* | *Ratin g Risk* | *Sco re* |
|---|---|---|---|---|---|
| The barge has obtained the necessary permissions to go alongside receiving ship. | Licensing delays<br>Delay in mooring alley<br>The mooring rope broke | 1<br>1<br>3 | 1<br>1<br>3 | Very Low<br>Very Low<br>Mode rate | 2<br>2<br>6 |
| Adequate electrical insulating means are in place in the barge – to – ship connection | Electr ical short<br>Fire<br>Work on the jetty that causes sparks | 2<br>2<br>2 | 4<br>5<br>4 | Mode rate<br>High<br>Mode rate | 6<br>7<br>6 |
| Effective communic ations have been established between Responsible Officers. | Unprepared guard in the area<br>There is a leak in the pipe at the Jetty | 1<br>2 | 1<br>5 | Very Low<br>High | 2<br>7 |
| Fire hoses and fire – fighting equipment on board the barge and ship are ready for immediate use. | Equipment un-availability<br>Damage to equipme nt | 1<br>2 | 3<br>3 | Low<br>Low | 4<br>5 |
| All scuppers are effectively plugged. Temporari ly removed scupper plugs will be monitored at all times. Drip trays are in position on decks around connection and bunker tank vents. | The drain hole is not completely closed<br>Oil spill on deck<br>Hose leak | 2<br>2<br>2 | 4<br>4<br>4 | Mode rate<br>Mode rate<br>Mode rate | 6<br>6<br>6 |

## VII. CONCLUSION

Based on an analysis of the risk assessment on the bunker procedure checklist at Jetty Propylene RU – VI Balongan, 52 possibilities were obtained; very low risk index 9, low risk index 9, moderate risk index 16, high risk index 18, and very high risk index 0. Very mild or mild risk must still be considered and controlled to prevent it from happening, while big risks can be controlled from the table risk mitigation. The risk obtained must be handled or mitigated, namely conducting supervision on the equipment bunker, equipment installation bunker, and implementation bunker according to ISGOTT (International Safety Guide for Oil Tankers and Terminals) which prioritizes safety from all areas. The conclusion can also be as follows:

1) Based on this research, the bunkering process at the Pertamina Internasional RU – VI Balongan Refinery has compatibility in several aspects of the ISGOTT bunker checklist Sixth Edition.

2) Based on the matrix calculations in this study based on opinions and realities in the field, the risk processing table is also a benchmark and also produces mitigation which will later become input if a work error occurs.

3) Based on ISGOTT Sixth Edition the appropriate bunkering process, namely having a process that is close to or the same as ISGOTT itself, a process that pays attention to every step of the process and also prioritizes work safety

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