Operational Risk Assessment Of Ship To Ship Transfer In The FSRU Lampung Using Risk Matrix Method

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Abstract. Risk management is very important for companies in maintaining the sustainability of the company, especially in companies that have quite high operational risks, such as in PT PGN LNG Indonesia, which operates the FSRU terminal in Lampung. Risk management is a tool to protect the company from every possibility that harms the company. In the Ship to Ship (STS) activity, which is the process of berthing on an LNGC to the Lampung FSRU, LNGC will then move a number of LNG cargo to the tanks in the FSRU. This work is very risky, it will need comprehensive mitigation to be done, one of them is the Risk Matrix method. This research was conducted to determine the risk and level of risk in implementing STS in FSRU Terminal, using data on the results of risk mitigation contained in Hazard Identification and Risk Assessment (IBPR). Then the data is analyzed using the Job Safety Analysis (JSA) method combined with Risk Assessment for risk assessment to facilitate identification of potential hazards that might occur. From these data, 9 sources of potential hazard were obtained in STS activities, then the risk rating calculation and assessment were carried out. After the receipt rating is known, the next step is to mitigate these risks.

1. Introduction

FSRU Terminal Lampung is a floating storage and regasification facility operated by PT PGN LNG Indonesia, one of the activities that has the highest risk of operational activities is the ship to ship (STS) process, which is a berthing process between LNG Carriers (LNGC) and FSRU terminal Lampung which is assisted using 3 ASD Tug units, each of tug have machine capacity of around 4400 HP and one Crew Boat unit that also functions as a patrol boat especially during ship to ship activities.

Every marine operation has a risk that may occur, with the existence of these risks there will be obstacles in the process of activities that if it is not handled properly it can be potential to bear greater costs than those risks. The risk assessment of STS activities in Lampung FSRU Terminal that uses a tethering system in the Tower Yoke Mooring System (TYMS) needs to be carried out to identify measurement and mitigation actions so that the appropriate handling measures are the basis for building a good risk management system. Risk management on ship to ship activities needs to be completed because the impact that occurs can directly affect operational activities.

The problem that occurs is availability of Pilot / Mooring Masters in Indonesia, which is very limited, the pilot who have the qualifications for open sea scouting with the mooring system used. Another problem is the weather factor with operational areas in the open sea where uncertain weather
conditions can be a challenge in these activities and has a significant potential risk. This should be anticipated by the Pilot / Moring Master in the STS activities. According to Abdullah (2014) one of the factors that influence approaching time during the guiding process is the distance from / to the docked / detached location, the level of density of the ship, the degree of difficulty in motion, the circumference and natural factors.

Figure 1. STS first cargo, th 2014

Every work location always has risk of accidents, major or minor of the risk depends on the type of industry activity, the technology used, and the control measures undertaken. Accidents due to work are accidents related to the company's business processes. This work relationship can be interpreted as accidents occur due to work or at work. In general, accidents are caused by human actions does not meet safety (unsafe human action) and unsafe conditions of the environment (unsafe conditions).

To ensure STS activities run smoothly and safely, it is necessary to analyze the problems based on risk identification of STS activities and prioritize risks carried out using the Risk Matrix method. Risk is a probability of harmful event that occurs during a certain period of time.

According to OHSAS 18001, safety risk is a combination of the possibility of a dangerous event or exposure to the severity of an injury or health problem caused by such exposure.

Another perspective about risk management is according to AS/NZS 4360 risk management standard, risk management is the culture process and structures that are directed toward the effective management of potential opportunities and adverse effect.

Smoothness and safety of guided vessels are the main things in the implementation of scouting ships, because the consequences that can occur from a negligence on the activities of scouting ships can affect the smoothness of ship traffic in ports, even to the waters and the environment (Haryono & Setiono, 2013).

This paper focuses on how to mitigate risks from STS activities that using the TYMS mooring system, entitled "Operational Risk Assessment of Ship to Ship Activities in The FSRU Lampung Using the Risk Matrix Method" which aims to carry out appropriate mitigations to minimize all the risks that potentially occur during ship to ship operation.

2. Methodology

This paper are using Risk Matrix method, Job Safety Analysis and Hazard Identification and Risk Assessment (IBPR). There is a few sequence of the research method are described as follows:
1. Risk Identification After the problem defined, then the risk identification process is carried out in the Ship to Ship operational activities

2. Risk ranking and risk matrix at this stage are carried out after the process of identification of risk, namely by determining the risk rating, and in the risk matrix the risk severity category will be generated whether the risk is included in the low, medium, high or extreme category.

3. Analyze and calculate the impact of the risk quantitatively to do an assessment of risk and also financial impact.

4. Risk mitigation at this stage will determine the sequence that will be taken to deal with the risks that have been identified. Several choices can be made for risk control according to the Australian New Zealand Risk Management Standard (AS / NZS 4360, 1999)

5. Conclusions and Recommendations at the final stage, conclusions will be drawn based on data processed and analyzed before, whether it can answer the problems that exist in PGN LNG and provide mitigation solutions that might be done to overcome operational risks that may occur from these activities.

3. Discussion

3.1 Hazard Identification And Risk Assessment (HIRA)

According to Ramli (2010), Hazard identification is a systematic effort to find out the danger in organizational activities. Each workplace that carries out risk identification from each event and then considers the conditions in determining risk as follows:

- Normal operating condition (N): Daily work and according to procedure
- Abnormal operating conditions (A): Work outside the procedure
- Emergency (E): Circumstances that are difficult to control

While the Risk Assessment, is an effort to calculate the magnitude of a risk and determine whether the risk is acceptable or not. Risk assessment is used to determine the level of risk in terms of likelihood and severity. Hazard identification is a list of all accident scenarios that are relevant to potential causes and their consequences, in response to the statement "what mistakes might occur”.

3.2 Job Safety Analysis (JSA)

Job Safety Analysis is a method for identifying and analyzing hazards in an activity. according to Jaiswal et al., (2014), there are several stages in the implementation of Job Safety Analysis, as follows:

- Select the activity that will be identified as potential dangers.
- Divide the work into several activities.
3.3 Risk Matrix

The Risk Matrix is a table that shows the relationship of two variables between likelihood and consequence, both of which have a relationship with risk. Risk Matrix according to AS / NZS 4360 standards can be seen in the following table:

| Frekuensi risiko | Dampak Risiko |
|------------------|---------------|
| 5                | H H E E E     |
| 4                | M H E E       |
| 3                | L M H E       |
| 2                | L L M H       |
| 1                | L L M H H     |

Table 1. Risk Ranking Matrix
According to AS/NZS 4360

The risk ranking according AS/AZS 4360 as follow:

E : Extreme Risk
H : High Risk
M : Moderate Risk
L : Low Risk

Furthermore, risk ratings can be developed by companies in accordance with the conditions of each company. What needs to be underlined is that the severity viewed from various aspects, the impact on human, financial, business continuity, environment and mass media.

3.4 Quantitative Impact Analysis

Before a job is carried out, risk identification must done out in advance to be able to map all potential risks, after the potential risks are identified, a quantitative calculation of the impact of these risks is implement, so that the company has a clear point of view of the impact both commercially and technically aspect.

After the potential risks have been successfully identified and the impact of commercial risks has been calculated, mitigation must be determined - mitigation that can be done to minimize the impact of commercial risk, and then calculated how much we can save after the mitigation has been successfully carried out. In that way, the impact of risk can be reduced commercially (residual).

4. RESULT

Referring to OHSAS criteria 1800: 2007 clause 4.3.1 "hazard identification, risk assessment and risk control" that hazard identification, risk assessment and risk control activities are carried out in work operations in the company. A risk will not provide a clear meaning for management in decision making if it is not known whether the risk is significant for the continuity of the business, so it is necessary to evaluate the risk to determine the priority of the risk.
4.1 HIRA

Based on this clause, the company has carried out Hazard Identification And Risk Assessment (HIRA) for ship to ship activities in the Lampung FSRU terminal as shown in table 1 below: How to identify hazards that are good, according to Stuart Hawthorn I. Eng., M.I.Plant E, in the book Risk Management is to make observations, through these observations we actually have done an identification of hazards to an activity, but in this case the implementation is certainly not easy so it needs to be done systematically.

Table 2. Hazard Identification and Risk Assessment

Furthermore, the solution development is with the Job Safety Analysis (JSA) method in order to obtain a more objective solution and in accordance with existing activities and agreed by all parties. Work accident risks that have been identified by the Job Safety Analysis (JSA) method are then re-analyzed using risk assessment, so that these risks can be assessed and scored with the aim of knowing which risks must first be prioritized in order to be able to do mitigation.

4.2 Job Safety Analysis (JSA) in Ship to Ship Activity

The results of the identification of hazards in the ship to ship process were identified from the shipment of Notice of Readiness (NOR) to the transfer of personnel for the closing meeting of the CTM, then an assessment of the potential hazards was conducted. Assessment using the criteria of
likelihood (likelihood), severity (severity), and the value of risk control, but because of the many activities that must be identified in ship to ship activities, to identify hazards in these activities is carried out using the Job Safety Analysis (JSA) method, namely by identify hazards and describe the stages/activities carried out in a job in order to find out the potential hazards associated with the ship to ship process. The results of the JSA discussion process ship to ship as shown in table 2 below. Furthermore, the results of developing solutions with the Work Safety Analysis (JSA) method can find out the risk of work accidents that have been identified and then analyzed using risk assessments, so that these risks can be discussed and scored with predictable goals which ones need to be prioritized for mitigation.

Furthermore, the results of developing solutions with the Work Safety Analysis (JSA) method, we can find out the risk of work accidents that have been identified and then analyzed again using risk assessment, so that the risk can be assessed and scored with the aim of knowing which risks are prioritized for mitigation.

### Table 3. Risk Impact Criteria

| Sequence of Basic Job Steps | Machine/Equipment/Tool Involved in each step | Potential Accidents or Hazards | Recommendations to Eliminate or Reduce Potential Hazards | Date of Issued: Sept 3rd, 2016 | Signature of Supervisor: Capt. Afriy D. |
|-----------------------------|-------------------------------------------|-------------------------------|--------------------------------------------------------|-------------------------------|------------------------------------------|
| PREPARATION:                |                                           |                               | Work closely with LNS. Shipping Coordinator & Team.     |                               |                                          |
| Check the condition of LNS |                                           |                               |                                                        |                               |                                          |
| Prepare risk analysis       |                                           |                               |                                                        |                               |                                          |
| JSA DESCRIPTION:            |                                           |                               |                                                        |                               |                                          |
| 1. Transfer/ Lifting of Personnel/STS Equipment to/from LNS | Crane, personal basket (P), sash, etc. | INJURY | Following STS Transfer, LNS Handling Principles.        |                               |                                          |
| 2. Guiding LNS to the Pier Boarding ground | VHF Marine band |             |                                                        |                               |                                          |
| 3. Embarking / disembarking | Pilot ladder with combination going way as per regulation required | Full down | See SOP (Embarking/Disembarking LNS)                   |                               |                                          |

Furthermore, the results of developing solutions with the Job Safety Analysis (JSA) method, we can find out the risk of work accidents that have been identified and then analyzed again using risk assessment, so that the risk can be assessed and scored with the aim of knowing which risks are prioritized for mitigation.

#### 4.3 Risk Matrix

Based on the results of observations and interviews conducted with several workers involved in STS activities, 9 STS activities that were potentially hazardous were obtained, which included maneuvering and unberthing activities. Furthermore, based on the IBPR and JSA that have been made, then a risk list can be made to illustrate the overall level of risk and its handling related to the STS activities. This stage is based on procedure number P-005 / 0.20 regarding Risk Management, as follows:
4.3.1 Determination of risk impact criteria

Risk criteria is used based on the impact and likelihood of occurrence of risk which then produces a level of risk that can be used to determine the priority of treatment. Risk criteria are set as in the following table:

| Index | Details | Probability of Occurrence  | Probability of Impact | Probability of Consequence  | Probability of Action  | Probability of Recovery  |
|-------|---------|----------------------------|------------------------|----------------------------|------------------------|--------------------------|
| 5     | Catastrophic  | Very high         | High                  | High                       | Low                    | Moderate               |
| 4     | Major      | High             | High                  | High                       | Medium                 | Moderate               |
| 3     | Moderate   | Medium           | High                  | Medium                     | Low                    | Low                    |
| 2     | Minor      | Low              | High                  | Low                        | Low                    | Low                    |
| 1     | Negligible | Very Low         | Very Low              | Very Low                   | Very Low               | Very Low               |

Table 4. Risk Impact Criteria

4.3.2 Risk Possibility

The risk probability criterion is used as a qualitative description of an opportunity or frequency, the likelihood of a specific event or outcome, measured by the ratio of a specific event or outcome to the number of possible events or outcomes.

The risk probability category is divided into 5 types as follow:
- **Index 1**: Rare, the possibility for risk occur is nearly small
- **Index 2**: Unlikely, rarely happening
- **Index 3**: Moderate, possible to occur
- **Index 4**: Likely, more possible to occur
- **Index 5**: Almost Certain

Table 5. Criteria of Risk Probability

| KRITERIA PROBABILITAS RISIKO | KATEGORI RISIKO |
|-----------------------------|-----------------|
| Index | Probabilitas | KATEGORI RISIKO |
| 5     | Almost Certain | Governance Risk |
| 4     | Likely | Strategy and Planning Risk |
| 3     | Moderate | Finance Risk |
| 2     | Unlikely | Operational/Infrastructure Risk |
| 1     | Rare | Compliance Risk |
4.3.3 Inherent Risk Map

Based on the impact and likelihood of the risk occurring, the level of risk can be divided into "high", "Moderate to High", "Moderate", "Low to Moderate", "and" Low", furthermore the risk level criteria can be seen on the inherent risk map. An inherent risk map is used to map the number of impacts and probabilities of the total risks identified at the outset. In this paper, there are 9 potential risks to the STS FSRU and LNGC activities with the distribution of probability and impact figures as follows:

Table 6. Risk Map

| Impact Probability | Low   | Medium | High  | Extreme |
|--------------------|-------|--------|-------|---------|
| Probability        | 0     | 1      | 2     | 3       |
| Probability Class   | Rare  | Unlikely | Likely | Almost Certain |

4.3.4 Priority Level Of Risk Management

Based on the risk level matrix above, risk management priorities are set as follows:

Table 7. Risk Level Criteria

| Risk Level | Action |
|------------|--------|
| 1 - 2      | **Low Risk**: Acceptable risks do not require additional control measures, existing control actions are continued and monitored |
| 3 – 6      | **Moderate Risk**: Existing control measures must be monitored and if necessary, add a new control system so that the risk level is at a low risk level |
| 8 – 9      | **High Risk**: Activities should not be carried out until the risk has been reduced, it is necessary to consider adding resources to reduce the risk |
| 12 – 16    | **Extreme Risk**: Risk is not acceptable, additional control is required before work is carried out. |
## Table 8: Ship To Ship Risk Matrix

| No. | Strategic Objective | Risk Event | Preventive Actions (Risk Agent) | Qualitative Impact | Quantitative Impact | Mitigation Plan | Cost/Benefit Impact | Frequency | Probability | Impact | Score |
|-----|---------------------|------------|---------------------------------|--------------------|---------------------|-------------------|-------------------|-----------|-------------|--------|-------|
| 1   | 1                  | Ship to Ship | 1. Increase ETD on the plan 2. | High                | $100,000 (Low)      | Increase ETD      | +++               | 5         | 2           | 40     | 100   |
|     |                    | Risk       | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 3         | 3           | 90     | 180   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 4         | 4           | 160    | 320   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 5         | 5           | 250    | 500   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 6         | 6           | 300    | 600   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 7         | 7           | 350    | 700   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 8         | 8           | 400    | 800   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 9         | 9           | 450    | 900   |
|     |                    |            | 1. Increase ETD on the plan 2. |                    |                     |                  |                  | 10        | 10          | 500    | 1000  |

*Note: The above table is a simplified representation of the ship-to-ship risk matrix, focusing on the key aspects of strategic objectives, risk events, preventive actions, qualitative and quantitative impacts, mitigation plans, and cost/benefit analysis.*
| No | Strategic Objective | Risk Event | Penalties (Risk Agent) | Positive Factor (Cost) | Qualitative Impact | Quantitative Impact | Non-Operational Impacts | Operational Impacts | All Impact | Mitigation Plan | Quantitative Impact | Qualitative Impact | Risk Reduction | Residual Impacts |
|----|---------------------|------------|------------------------|------------------------|--------------------|--------------------|---------------------|---------------------|-----------|------------------|--------------------|--------------------|---------------|-----------------|
| 1  | Environmental Pollution | Oil Spill at Sea (BMC) | Oil spill caused by inappropriate or negligence of personnel | Capacity limited OIL Formulae regarding spill at sea | Impacts in the ecosystem in the water around the spill | 6.0 | 6.0 | 1. Ensure the implementation of BMC Formulae regarding the pollution 2. The availability of necessary equipment and tools safety analysis in BMC Formulae in future 3. Carry out awareness training related to handling spills at sea 4. Ensuring the availability of oil spill equipment |
| 2  | Supporting Process (BMC) | The 375 process cannot become operational | Supporting fault not available (BMC, Tug) | - | - | 1. Establish cooperation in the allocation of tug and barge with Pelindo Banten (AV) 2. Establish cooperation in the allocation of tug and barge with PT PNS |
| 3  | Planning | The 375 process was late, resulting in damages | No permission available regarding 375 activities | - | - | 1. Establish cooperation in the allocation of tug and barge with Pelindo Banten (AV) 2. Establish cooperation in the allocation of tug and barge with PT PNS |
| 4  | Operating Condition | LACK control transfer to FSRU, potentially damage | Pressure limits at the FSRU exceed the operating limits in the FSRU re-ventilated for a long period | - | - | 1. Coordinate with community service and MO 2. Contact for servicing LACK |

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4.3.5 Cost and Benefit Assessment

The output of quantitative analysis calculations will give an idea of the size of the risk of an activity or danger. This quantitative calculation uses operational data and information and is based on policies issued by the company in this case from the oil and gas holding company, Pertamina. This calculation is done to calculate the extra costs that must be incurred by the company.

Table 8. Cost Range Risk Index

| Index | Range Dampak (USD) |
|-------|-------------------|
| 1     | 0 <x≤ 431.369     |
| 2     | 431.369 <x≤ 862.738 |
| 3     | 862.738 <x≤ 1.294.108 |
| 4     | 1.294.108 <x≤ 1.725.477 |
| 5     | x> 1.725.477      |

Based on a directive from Pertamina Holding that the value of the Risk Tolerance Limit (BTR) is equal to 2.1 million USD. The BTR value is then determined by the magnitude of the risk impact based on the index value, while the magnitude of the impact is determined according to the index value, as follows:

- Index 1 : 20% BTR
- Index 2 : 40% BTR
- Index 3 : 60% BTR
- Index 4 : 80% BTR
- Index 5 : 80% BTR

Based on the BTR value set by Pertamina Holding, an assessment of the impact of the company's financial risk on STS FSRU activities can be carried out. The assessment is done by calculating the magnitude of the potential impact of financial risks that may impact on the company, for example, demurrage risk that occurs due to the STS process that exceeds the specified time, then the company can be affected by financial risk of 140,000 USD assuming the time delay of the STS process for 2 day. To be able to reduce the impact of demurrage risk, control and mitigation of these risks must be carried out, namely by ensuring the availability of supporting fleets, as well as collaborating with BMKG to be able to get updates on weather conditions at the time the STS process is carried out.

5. Conclusion

Based on the results of the analysis with the risk matrix method in ship to ship activities in the FSRU Lampung terminal, it can be concluded the following reasons:

1. Potential hazards in Ship to Ship activities in the Lampung FSRU terminal can be identified using IBPR (Identifikasi Bahaya dan Penilaian Resiko) and JSA (Job Safety Analysis) and sharpened again with the Risk Matrix, with the highest potential hazard in ship maneuvering, personnel transfer and demurage activities.
2. Some precautionary steps that can be taken on the risk matrix include complying with ship to ship transfer procedures (cargo and personnel transfer), using the appropriate PPE, and make sure we are ready for a safe and correct transfer process.
3. Review Procedures / JSA / IBPR periodically or after each Ship to Ship activity on the situation, the reliability of the equipment, Scope of work crew / Person In Charge STS Operation is carried out to measure the performance of the success of operations related to Laytime-Laycan and avoid Demurage this has benefits for all parties concern related to Business contingency plans from the operational and commercial sides.

4. There is a strong relationship between risk management and the process, where the process can be success and work well if it involves risk management inside it.

5. The results of risk management must be communicated so that it can be known and understood by all parties.

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