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PRESENT CONDITION OF EXISTING SINGLE POINT MOORING IN INDONESIA WATERWAYS IN VIEW OF BKI

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ABSTRACT

Single Point Mooring (SPM) is one of the most used of mooring system for vessel transfer system in oil and gas industry of Indonesia especially CALM buoy type. SPM requires a feasibility evaluation and safety guarantees during operation to minimize risk of failure such as vessel loss of position, hydrocarbon release, etc. In Indonesia, the large quantity of the out of services CALM buoys remains in their actual location now, without any supporting data and logbook regarding to history of the use, while now the operation of served oil fields has been terminated. It is difficult to conduct the feasibility evaluation process using prescriptive methods due to that condition with the aim of re-using existing SPM. In the present paper, complexity of existing SPM will be addressed and point view of BKI deal with this case will be presented as well as an alternative method which is possible for assessment of existing SPM in Indonesia waterways will be discussed briefly. It is a preliminary study for establishment of Guidance for classifying of existing SPM to be conducted by involving Stakeholders.

Keywords : *SPM, failure, risk, integrity*

1.0 INTRODUCTION

In oil and gas industry, there are several kinds of mooring system and one of them is widely used in Indonesia, namely Single Point Mooring (SPM). Single point mooring have been operating in Indonesia since 1970s [1]. There are 3 type of SPM i.e. turret mooring, CALM (Catenary Anchor Leg Mooring) Buoy, SALM (Single Anchor Leg Mooring) [2]. The SPM of CALM buoy type is commonly used in Indonesia for mooring of Floating Production, Storage and Offloading (FPSO)/Floating Storage, and Offloading (FSO) or mooring of oil tankers during offloading from shore-based oil storage facilities.

The large quantity of the out of services CALM buoys remained in their actual location is being present condition, without any supporting data and logbook regarding to history of the use, while now the operation of served oil fields has been terminated. The averaging of existing mooring systems have been outstanding for more than 10 years. Hence the owner, Indonesia Government, consider to re-use the existing buoys for mooring engaged with FPSO/FSOs. Under this circumstances, BKI propose to the SKKMIGAS as a representative of Indonesian Government in establishing an evaluation procedure to examine the condition of each CALM buoy and to categorize the existing buoys according to actual individual condition [3].

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Almost the entire FSO/FPSO in Indonesia have been classed to International Association Classification Society (IACS) members i.e ABS, BV, LR, DNV, etc. Similarly, the mooring systems (SALM, CALM, mooring tower, etc.) are also classed and supervised during construction by IACS members. By the time, the Owner/Operator do not maintain the procedure of classification such as surveys, inspection and condition assessment due to the out of planned service time. Table 1 shows some of the mooring systems data that exist in Indonesia [3].

Table 1: Existing CALM Buoy till 2006

No.	Code	Owners	Years	No.	Code	Owners	Years
1.	IM 1027	Pertamina	1970	15.	IM 1146	Liapco	1983
2.	SO 10230	Union Oil	1971	16.	SO 11450	Pertamina	1981
3.	IM 1039	Liapco	1972	17.	IM 1196	Airport Buoy	1984
4.	IM 1043	Pertamina	1972	18.	SO 11520	Pertamina	1983
5.	SO 10450	ARCO	1973	19.	SO 11770	ARCO	1985
6.	SO 10460	ARCO	1973	20.	SO 11780	ARCO	1985
7.	SO 10480	Total	1974	21.	SO 11790	ARCO	-
8.	SO 10680	Total	1976	22.	IM 1535	Conoco	1992
9.	IM 1071	Liapco	1977	23.	SO 12320	Pertamina	1993
10.	SO 10920	Pertamina	1977	24.	IM 1541	Pertamina	1993
11.	SO 10770	Total	1978	25.	IM 1559	Pertamina	1996
12.	SO 11220	Pertamina	1980	26.	IM 12900	Conoco	2003
13.	SO 11310	ARCO	1981	27.	SO 17380	BP	2005
14.	IM 1134	Maxus	1981				

Source : BP Migas 2006

Nowadays, the SPM in Indonesia is not maintained properly so as to have high risk condition. It is also out of remaining life of its service time as planned in the construction stage. Unavailability of its supporting documents and history bring into a difficulty to assess the condition of an existing SPM. The change of function and configuration while it is operated in the other condition (terminal upgrading to receive large offloading tanker capacity with existing mooring only or complete with riser pipeline) or relocation of its buoy to a new environment and servicing to a new FPSO/FSO lead to a necessity to have an assessment for the actual condition in each of mooring system. In the other hand, the limited research activities on the local condition drives the design of environmental condition for service mainly based on North Atlantic Ocean condition. Therefore, it is important to reassess the mooring conditions with realistic methods using the characteristics of Indonesian waters to estimate and establish the optimum extended service time from the planned design [3]. One of the available technical approaching to evaluate the feasibility and to ensure the safety of SPM during its entire life is Mooring Integrity Management (MIM) method which is an evaluation SPM based on performance criteria and failure risks. The goal of this project is to establish a procedure or guidance for classifying or certifying the existing SPM in Indonesia. Unfortunately, this work has not been executed since 5 years ago due to unaffordable financial funding.

Through this paper the authors would like to recall the importance of safety to be considered in handling the existing SPM in Indonesia as well as the importance role of the Society to deal with such case in order to provide an overview to interested stakeholders. In addition, an alternative method to assess the existing SPM will be addressed in this paper briefly.

2.0 Complexity of Existing SPM

2.1 SPM as Positioning System

A single point mooring system is mainly used to keep a vessel stationed at a fixed location. They allow the vessel to weathervane. This is necessary to minimize environmental loads on the ships shaped vessel by heading into prevailing weather. Based on duration of time within moored vessel, SPM is divided in two groups i.e. temporary and permanent moored vessels as shown in Figure 1. SPM as temporary moored is mainly used in areas where a dedicated facility for loading or unloading liquid cargo is not available. Located at a distance of several kilometers from the shore-facility and connected using sub-sea and sub-oil pipelines, these single point mooring (SPM) facilities can even handle vessels of massive capacity such as VLCC. Meanwhile, SPM as permanent moored vessel are used primarily for FSO/FPSO or any floating unit to keep their position in specific location during its service life, mostly more than five years (> 5 year).

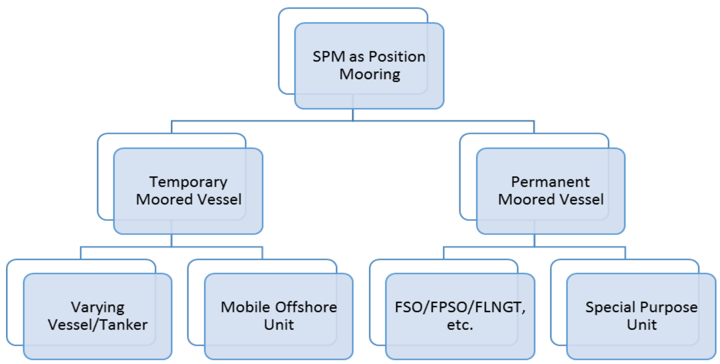

Figure 1: SPM as Position Mooring based on duration of moored vessel

BKI as classification society regulates the classification of SPM both temporary and permanent. In term of rules compliance, temporary and permanent moored vessels shown in Figure 1 have different requirements for mooring system. The design of SPM system has to consider two environmental conditions i.e. operating condition and storm condition [4]. The operating environmental condition for a SPM is defined as the maximum sea-state in which a vessel is permitted to remain moored to the SPM without exceeding the allowable loads and stresses required BKI Rules for SPM (Pt.5, Vol. IX). While, the storm condition for an SPM design is defined as the environmental condition with maximum wind, waves and associated currents based on a 100 year recurrence interval. At this condition, if the SPM is intended for temporary, no vessel is moored to the SPM system. In another hand, the permanent SPM will moore the FSO or FPSO along their service life although in storm condition. Hence, fatigue analysis becomes mandatory for permanent moored vessel.

Therefore, needless to say that SPM is a floating unit constructed to be positioned in specific location or fixed at one location which is not mobile mooring system. The mooring systems both the lines and anchor points are always specifically designed to match the vessel's requirements and local environmental conditions. Figure 2 shows a general diagram of SPM as for illustration.

2.2 SPM as transfer system

The mooring system can also be combined with a fluid transfer system that enables connection of subsea pipelines to the tanker. The fluid transfer system includes submarine hoses between the pipeline end manifold (PLEM) at the seabed and the buoy, and hoses between the buoy and the tanker. In the buoy, a swivel provides fluid transfer path between the geostatic part and the rotating part of the buoy.

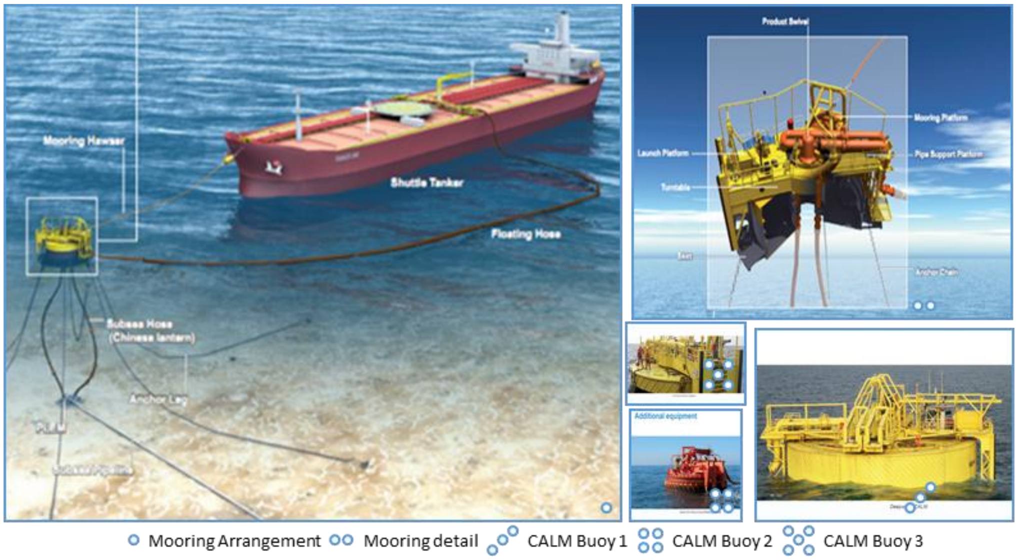

Figure 2: General SPM Diagram [1]

2.3 Possibility not compliance Class Rules

Assessment of existing SPM with an average lifetime of more than 10 years is very difficult to conduct when applying current Society Rules. The assessment criteria given by the Society Rules may not be met by the existing SPM. Some points which may not be satisfied are as follows:

- Un-available anchoring data/drawing.
- Material of chain: mostly used chain grade for marine use (grade U), while class requirement using grade R (offshore).
- Mooring system criteria: safety factor of anchor leg.

The utilization of existing SPM can be implemented partially. For instance CALM Buoy type, the hull/structure can be utilized without using existing chain and used in new location. It will be problematic if the existing SPM is lack of data and no maintenance records. As a consequence, it will be difficult to adjust to the new site environment of such SPM and it may have greater probability of failure.

3.0 POINT OF VIEW OF CLASSIFICATION SOCIETY

Single point moorings are safety critical systems in which their failure may lead to a loss of position of the floating system to which they are attached, with subsequent potential for damage to riser systems and the release of hydrocarbons. Although SPM accidents are rare in Indonesia, but considering their present condition without maintenance, they would have a greater likelihood of accidents in the future. When catastrophic failures do occur, the losses to be inflicted are huge especially in economic terms. As for example, in the past the accident of SPM owned by Pertamina Refinery Unit (RU) IV Cilacap or so-called SPM Cilacap caused the oil spill to cover the waters of the southern region of Nusakambangan Island. In that case, the SPM Cilacap suffered damage on the rubber hose, which is used to transmit crude oil from the tanker heading to the refinery. From Maulidiyah thesis report (2018) describing that the total cost of environmental damage due to oil spill in the waters off Cilacap is Rp 1.9 trillion. Most of damage to the ecosystem/habitat occurred in Donan River in which the cost of losses reaches Rp 1.8 trillion. This loss does not include compensation for social losses, thus the cost of losses may increase [5]. Based on this case it can be known that failure of SPM can cause major losses.

In a research report conducted by JIP FPS mooring integrity (2006) to the failure of mooring line in the world, both single failure and multiple failure, they conclude several important reasons that could trigger mooring line failure as follows [6]:

- Available inspection and maintenance provisions can allow periods in which single or multiple defects can remain undetected,
- Most operators can not detect if they have 'lost' a mooring line,
- The risk of SPM failure is often understimated and the majority of operators do not carry spares or have systems in place for dealing with a line failure,
- Design codes and standards give little guidance on terminations, connections, fairleads and stoppers in which the majority of failures has been seen.
- Similarly there is limited guidance on inspection, repair and maintenance.

From the above reasons, it can be understood that although the existing SPM has maintenance data, it does not guarantee the safety of its mooring system moreover to the existing SPM which has no data and maintenance records. The chance of failure would be greater. This shows the importance of classification for existing SPM.

As the classification agency and a service provider, Society conducts the evaluation in compliance with the Rules & Regulation in an objective, professional and independent manner. Any SPM classed in Society will be given a notation of class. Either the SPM is built under supervision of Society or not (existing), they will be maintained based on rules requirements. They will undergo interval survey consist of annual, intermediate and renewal survey. Class renewal survey are to be carried out at 5 year intervals to renew the classification certificate.

Unfortunately, as explained in point 2.3 above, the existing SPM have possibility to not comply with Society rules. Consequently, the existing SPM may not be able to have a class. However, the existing SPM may be maintened with another scheme of certification process. To cope with this problem, the Society, besides classifying SPM, may carry out certification of service life of existing SPM based on recognized standard or guidance as independent certification body.

Therefore, the existing SPM may be maintained by Society. In this case, a guidance for assessment of existing SPM is necessary to establish. The guidance or any other instruction will give the benefits to owner/operator, society and also to government.

- For the owner/operator , the technical judgments for each condition of SPM will improve the safety and continuity of service as the guaranties in fulfilling the established guidance. Also operator/owner will benefit from the acquired technical reasons to use in safe and secure buoys. In terms of economical point of view, it will help to guarantee economical operation
- For society, the guidance will enrich the ability and service level for all of stake holders, and also it will expand the business scope of Society.
- For the government, i.e SKKMigas, this guidance will determine the ability of all of mooring systems in supporting of the service for further exploration in the oil and gas business.
- For insurance companies/financial institutions, the evaluation result by Society may be used as an objective reference for technical conditions of SPM as a basis for determining insurance premiums and credit extension approvals by financial institute.

3.1 Alternative method

Since the existing SPM is lack of data with no maintenance records, a method to evaluate the feasibility of such SPM is required. So far, failures of SPM have been occured due to overload, fatigue, manufacturing defects, excessive wear, corrosion, etc. It generally occurs on fairlead, hawse pipe, touchdown area on seafloor, mooring lines connections, and connection of transfer equipments. Therefore an alternative method is needed to solve the problems. One of which is Mooring Integrity Management (MIM) method which is an evaluation method of mooring system based on system performance criteria and failure risk to be encountered by SPM over its entire life.

System performance measurement criteria in order to meet the regulation is represented in a performance standard. The performance is derived based on agreed criteria satisfying class rules & regulation, recognized codes & standards, or company own technical specifications. It is derived based on risk assessment providing relaxed requirements for existing SPM under Company own operational specifications. It is used as a reference in identifying failures and analyzing the consequences when failure occurs to obtain the least effect, so as to determine the strategy for inspection and monitoring. By utilizing the Failure Modes and Effect Analysis (FMEA) the probability of failure will be analyzed according to the impacts in which the risk analysis is carried out using semi-quantitative methods. Furthermore, the risk matrix is used to the present risks in order to determine the classified acceptance criteria, whether the risk is acceptable, As Low As Reasonably Practicable (ALARP) or unacceptable.

These guidance would serve as a fundamental for future work for risk-based inspection planning for SPM. By making use of inspection guidances with risk-based SPM, operators would then have a tool to improve inspection planning and scheduling at the component level. In addition, operators would also be able to use the resources appropriately and to improve the risk profile of their assets, both individually and collectively. Furthermore, government i.e SKKMigas would have a tool to assist the existing SPM in evaluating inspection programs against of internal risk profile.

4.0 CONCLUSIONS AND SUGESTION

The present condition and complexity of exiting SPM in Indonesia waterways has been discussed in this paper. Needless to say that the SPM (both new and existing ones) should be maintened by Society for minimizing the failures which may occurs. Therefore, they will have data and maintenance records during its service life in the future. For further work, the authors will focus in developing the alternative method i.e MIM to provide procedure for assessment of existing SPM based on performance criteria and failure risk which is the final goal of this study.

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