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Hazard Identification and Assessment for Floating, Production, Storage and Offloading Unit in Offshore Oil Industry

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Abstract- Floating Production Storage and Offloading Systems (FPSO) are large vessels or ships often equipped with processing facilities and moored to the location for a shorter or longer period of time. The key feature of the ship-shaped FPSO is the mooring turret and the fluid transfer system. The vessel is anchored to the seabed via the turret which allows it to weathervane on a bearing assembly. The well fluids from the subsea wells are routed through flexible riser pipelines to the production facilities of the vessel. Safety is an important topic in the offshore industry. The main aims are to protect the health, safety and welfare of people at work, and to safeguard others. HAZID study provides a general overview of the hazards present in FPSO. HAZID study is a very important part of the formal safety assessment of a FPSO. The complex HAZID is done when the whole plan and layout of the vessel is obtained. The hazards identified are sorted out and a risk matrix is generated. Each hazard is given a risk index according to its probability and severity. The hazards are also compared with different standards which helps for the future reference of hazard associated with a FPSO.
Keywords- Complex, Hazard, Production, Safety, Ship.

I. INTRODUCTION

Crude oil is a naturally occurring mixture of hundreds of different hydrocarbon compounds trapped in subsurface rock. These hydrocarbons were created millions of years ago when plant and algae material died and settled on the bottom of streams, lakes, seas and oceans, forming a thick layer of organic material. Subsequent sedimentation covered this layer, applying heat and pressure that cooked the organic material and changed it into the petroleum we extract from the subsurface today. Crude oils are generally differentiated by the size of the hydrogen rich hydrocarbon molecules they contain. Crude oil is a complex mixture of hydrocarbons with minor proportions of other chemicals such as compounds of sulphur, nitrogen and oxygen. The different parts of the mixture must be separated, before they can be used, and this process is called refining. Crude oil from different parts of the world, or even from different depths in the same oilfield, contains different mixtures of hydrocarbons and other compounds. This is why it varies from a light-coloured volatile liquid to thick, dark, black oil, so viscous that it is difficult to pump from the subsurface. Crudes from different sources have different compositions. Some may have more of the valuable lighter hydrocarbons, and some may have more of the heavier hydrocarbons. The compositions of different crudes are measured and published in assays. This information is used by the refinery in deciding which crudes to buy to make the products that its customers need at any given time. When crude oil comes out of a well it is often mixed with gases, water and sand. It forms an emulsion with water that looks a bit like caramel. The sand suspended in the emulsion produces this caramel effect. Eventually the sand settles and the water is then removed using de-emulsifying agents. Both sand and water have to be separated from the crude oil, before it can be processed ready for transportation by tanker or pipeline. The dissolved gases are removed at the well. Once the drilling shaft makes contact with the oil, it releases the pressure in the underground reservoir and the dissolved gases fizz out of solution pushing crude oil to the surface. This is necessary as they might come out of solution and cause a build-up of pressure in a pipe or a tanker.

II. FPSO IN OFFSHORE INDUSTRY

A floating production unit is a vessel that receives oil and gas from subsea wells through flow-lines known as risers. The vessel can be either a purpose-built ship or semi-submersible, or a converted tanker. This review is limited to tanker-type systems, commonly known as floating production storage and offloading units (FPSO). The FPSO concept has been around for about three decades. Initially floating production systems were introduced for early production or marginal field development. Today, their potential for deep water development is of interest. There are now over 70 FPSOs working all over the world or under construction. Most of the applications are conversions of ocean-going oil tankers in relatively benign environmental areas such as Southeast Asia, West Africa and offshore Brazil near the Equator. Some vessels operate in the North Sea, for which the design events are winter storms. A few FPSOs are used in the tropical cyclone prone areas of the South China Sea and offshore North-Western Australia, and several are under consideration for the Gulf of Mexico. A Floating Production Storage Offloading (FPSO) unit is a marine vessel which is designed to extract Oil and Gas from an offshore well, process it, and store it for some time and offload it to a tanker or exported through a pipeline. When compared to other offshore units in deep waters an FPSO is the most cost efficient and reliable way. An FPSO can be used in any type of fierce climatic conditions that ship can withstand. Life of a FPSO ranges from 15 to 20 years i.e. it can stay in offshore location for its life time until and unless an accident occurs, in between shuttle tankers have to come and receive the products extracted.

The FPSO is becoming a very popular concept in the oil and gas industry. Configuration decisions are driven primarily by the need to meet functional and safety requirements. The functional requirements vary widely, and may involve well or reservoir testing, pilot or early production, or full field development. The principal functional requirements of the floating facility are sufficient load-carrying capacities for process and possibly work-over equipment, and maximum availability and efficiency of the production system. This implies that the unit should remain safely on location, with minimum motions, during all environmental conditions. The well work-over requires the use of rigid risers and is more sensitive to motions than production. Many marginal fields, especially where the unit is used for production testing or early production, are located far from pipeline systems. In such cases the production systems consist of an offshore loading facility and shuttle tankers. In severe sea states, storage capacity may be required in order to maintain continuous production. The primary function is to process oil and gas from wells and, in some cases, from other fixed or floating installations, using on-board production processing facilities. The processing facilities normally consist of process control and safety systems and equipment, including utilities and auxiliary systems and equipment. The differences in operations and equipment pose different hazards. Particular hazards arise in connection with topside and marine operations, such as production processing and offloading.

The processes taking place in a FPSO can be explained easily. The well streams enter the vessel through the turret which is connected to the well lines. The well streams are then sent to the topside of the FPSO. The topside is mainly divided into Main separator, Gas dehydration, Power generation, Water injection, Sea water Treatment, Oil processing and Gas compression. The well streams first enter the main separator where it is separated into oil, water and gas. The gas is sent to the gas dehydrator where it is dehydrated and sent to gas compression. The gas needed for power generation is taken and the rest is injected back to the well head for pressure inside the oil wells or exported. The water from the separators is sent to the water injection and further fed in to sea water treatment facility. A part of the water is send to the well head and the rest is dumped into the sea. The gas from the separator is send to the oil processing facility and stored. The hull of the FPSO is used for the storage of the oil. When the storage facility gets filled the shuttle tanker arrives and offloading of the oil to the tanker takes place through the oil processing facility. In addition to the significant growth of this market sector, we are witnessing today the progressive extension of the significant knowledge base of building and operating these floating facilities to provide solutions for other segments of the oil and gas industry.

III.IMPORTANCE OF SAFETY IN OFFSHORE INDUSTRY

Safety was not given much importance until accidents started to increase tremendously. Health and safety is a vital part of any industry, but particularly for offshore companies. A number of recent disasters in various parts of the world have highlighted the increasing importance of effective HSE management in the offshore sector. In addition to the immediate human, environmental and financial costs, the reported accidents and negligence have a severe impact on a company's reputation. In the wake of these high profile accidents, regulatory agencies have also taking steps to provide a strict regulatory framework along with contingency measures for all companies engaged in offshore oil and gas production. Offshore activities entail the hazard of a major accident with potentially severe consequences to the life and health of workers, pollution of the environment, direct and indirect economic losses, and deterioration of the security of energy supply. The main hazards include fire, after ignition of released hydrocarbons; explosion, after gas release, formation and ignition of an explosive cloud; and oil release on sea surface or subsea.

The consequences of accidents should be clearly distinguished from emissions and pollution during normal operation activities, even if these activities are extended through the whole life-cycle of an installation. While the latter (pollution from normal operation) results in relatively small quantities of pollutants ending in the sea during long periods, the accidental events result in release of huge quantities of hydrocarbons and pollutants discharged uncontrolled in the sea during relatively short periods. A more detailed analysis of past accidents and events has been performed based on the database WOAD (World Offshore Accident Dataset)

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of DNV. This is one of the most reliable and most complete databases of failures, incidents and accidents in the offshore oil and gas sector. The dominant event, occurring most frequently is the release of fluid or gas, especially for fixed units, followed by fires and falling objects. For Mobile Units, the occupational incidents (falling objects, crane accidents) are dominant event, followed by fatigue and releases of liquids/gases. Overall the accident analysis has shown the relevance of major accident hazards in the offshore oil and gas activities. Accidents do happen, and risks are present and need to be controlled. The events that require particular attention in this context, mainly fires, explosions and blowouts, have been reported to cause severe consequences.

IV. HAZARD ASSESSMENT IN OFFSHORE INDUSTRY

A key part of the Formal Safety Assessment (FSA) require a number of detailed Safety Studies to be undertaken, which identifies the hazards, assess the potential consequences and then determine the adequacy of the design and operational controls which are intended to manage these hazards. The main parts include Identification of the Hazards (HAZID), Hazards & Operability Study for the Marine Systems (HAZOP), Fire and & Explosion Risk Analysis (FERA), Escape, Temporary Refuge, Evacuation and Rescue Assessment (ETRERA), Emergency Systems Survivability Assessment (ESSA), Hazards & Effects Management Process (HEMP), and ALARP workshop (Risk Reduction Measures and Cost Benefit Analysis)

The FERA is used to identify the flammable and combustible inventories across the FPSO unit and will analyse the fire consequences and likelihood of these consequences occurring. A direct input into the FERA is the HAZID, and the results of the FERA will be used in the Hazards & Effects Management Process to help develop confidence that the Hazards are being adequately managed and responsibilities assigned to specific positions for the various Safety Critical Activities/Tasks required to maintain the integrity of Safety Critical Systems/Equipment. The relevant fire events will be identified for each inventory, and the FERA will assess the overall risk associated with all of these inventories. The FERA will identify and consider in the analysis, the various detection and mitigation controls and will use Event Tree Analysis to summate the risk associated with all the likely events resulting from a release from each inventory, considering the likelihood and impact of failure of these mitigation controls. Relevant recommendations will be made within the FERA to help to reduce the likelihood of a flammable/combustible MAH being released and to help mitigate the overall consequences, which can be used to reduce the overall fire and explosion Risk.

The intent behind an ETRERA is to determine if the escape routes, evacuation and rescue system and the Temporary Refuge are suitable for the facilities, whether they will remain available during all credible events, and whether they can be improved. The objectives of the ETRERA are to analyse the frequency of impairment of the escape routes; analyse the frequency of impairment of the TR routes; analyse potential impairment of the TR; analyse the suitability of evacuation systems; provide a general description of ETRER systems; and compare the ETRER systems to the Goals and Performance Standards.

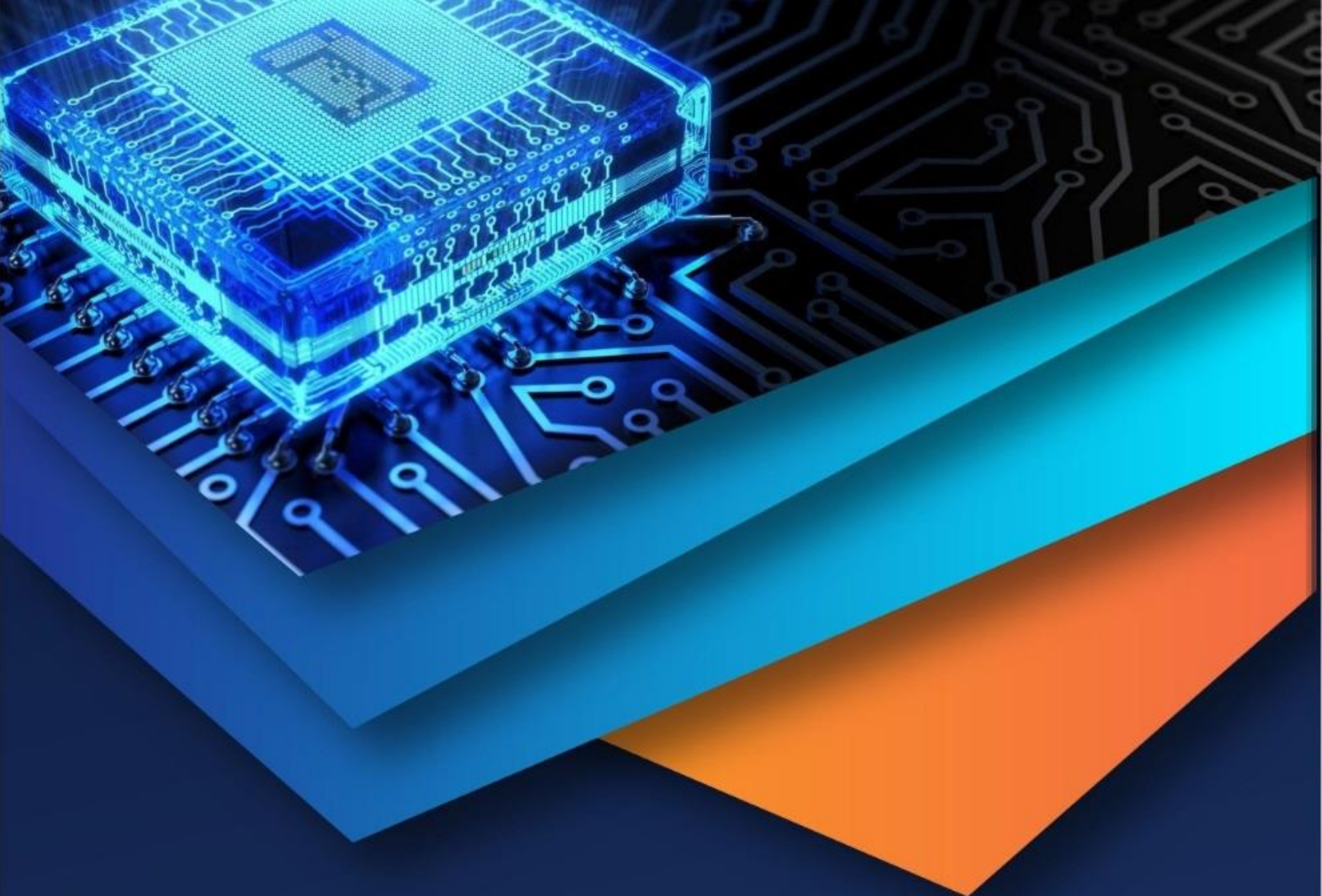
The aim of the HEMP is to demonstrate completeness in the management of each hazard applicable for the FPSO Unit and to highlight any deficiencies that may exist. The HEMP can be used to provide a structured approach to the analysis of hazards throughout the life cycle of the unit. A number of risk identification and assessment tools are used in the process and these are applied in a logical and rigorous manner. The arrangements identified as necessary to manage assessed threats, and potential consequences and effects, are then incorporated in the design phase or, for existing facilities, accounted for in their operations. It is necessary to verify that the threat barriers, recovery preparedness and mitigation measures in place are suitable and sufficient. If they are not, then remedial action must be taken and all necessary procedures are incorporated into the HSE Management System. It is not just a one-off activity undertaken during the design stage of projects; it continues throughout the operating lifecycle of the FPSO and is an integral part of the overall HSE Management System. It is thus live and active document which requires constant review and updating as required.

V. CONCLUSION

In general, a primary safety measure is to design to avoid situations associated with human errors and technical faults that can escalate into progressive failures with catastrophic consequences. This implies ensuring the damage tolerance of structure, safety barriers and equipments. This issue can be dealt with in a semi-probabilistic manner by the ALS approach. In this approach initial accidental conditions corresponding to a given probability for different hazards are identified, and the survival of the damaged system is checked by a conventional design check. It is important to take a systems view of risk. At the same time the challenge is to control the risk to be within an acceptable level. An important measure to avoid catastrophic accidents is to design the subsystems to survive certain design accidental events. This is already implemented for Norwegian codes for offshore structures, and was also introduced for passive safety equipment. The objective of a quantitative risk analysis is usually to determine the level of risk in terms of probability versus magnitude of the consequences for fatalities, pollution and property loss. The consequences can be expressed in specific units, such as lives lost or gallons spilled, or they can be in terms of general economic consequences, assuming values can be placed on human life or degradation of the environment. This may be done for an industry as a whole basis and be compared with the risk level in other industries. The risk picture for different regions or countries may also be estimated. Historical data in WOAD (1996) provides a basis for such estimates for major geographical areas, such as Europe, Gulf of Mexico etc. For other areas, theoretical analyses are necessary.

REFERENCES

[1] CMPT (1999) “A Guide to Quantitative Risk Assessment for Offshore Installations”.
[2] CEC (1987) “Risk Analysis for Offshore Structures and Equipment”, The Commission of the European Communities, Graham and Trotman, London.
[3] HSE (2000) “Operational Safety of FPSOs: Initial Summary Report”. Report OTR 2000/086, Health and Safety Executive, London.
[4] Karsan, D.I., Aggarwal, R.K., Nesje, J.D., Bhattacherjee, S., Arney, C., Haire, B., Balleiso, J. (1999) “Risk Assessment of a Tanker Based Floating Production storage and Offloading (FPSO) System in Deepwater Gulf of Mexico”, Paper at OTC, Houston.
[5] Moan, T., (1995) “Safety levels across different types of structural forms and materials – Implicit in Codes for Offshore Structures”, SINTEF, issued as a background document for workshop conducted by ISO TC67/SC7.
[6] Safetec AS (1996/97) “Development of a UK Shipping Database (COAST)” Final Report to the Health and Safety Executive, UK Offshore Operators Association and Department of Transport.
[7] Terpstra, T., d’Hautefeuille, B., Macmillan, A. (2001), “FPSO Design and Conversion: A Designer’s Approach”, Paper OTC 13210, OTC Conf., Houston, Tx.
[8] WOAD (1996): “Worldwide Offshore Accident Databank”, Det Norske Veritas, Oslo.



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