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SUBSEA ASSET INTEGRITY MANAGEMENT FOR PROJECT EXECUTION PHASE

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ABSTRACT- Asset Integrity is the capability of an asset to perform its required function successfully and efficiently while safeguarding life and the environment.Standard petroleum topside facilities have common access from topside. Unalike topside facilities, subsea assets have no direct access and have very little human relation and intervention. Earlier the life cycle of any asset majorly focuses on frequently occurring incidents whose influence will be less but now the thinking is changed because of the recent incidents. The focus has now moved to less regularly happening incidents whose effect will be considerable sometimes destructive. The term "integrity management" is often misapprehending. In industrial language, integrity management usually refers to the program of observation during operation with typical integrity programs revolving around inspection management. Subsea systems such as jacket structure, riser-caissons, conductors, templates, risers experience highly dynamic loading due to environment combined with internal and external corrosion issues. Therefore, inspection alone cannot ensure the integrity of these structures. A suitable integrity management program should employ simulation, monitoring, mitigation, and testing in addition to regular inspection.

I. INTRODUCTION

After many incidents happened in recent time, many oil and gas companies were obligate to reconsider their provision's asset integrity to minimize their risk vulnerability. The Downstream sector for so long has focused on asset integrity but the upstream sector has only recently moved focus on asset integrity.Exploring fossil fuel is getting ever more challenging whereby the search for new sources has expanded to complex geographical locations. Among all types of field evolution,subsea developments have gained popularity. Expenditure for drilling and completing subsea wells, floating production platform and pipelines in the asian region is expected to increase by 8% from year 2011 until 2015[1].Unlike topside facilities, subsea assets do not supply the same level of direct control of asset condition and only can have very little human interaction and involvement [2].

Subsea development is evermore challenging in deeper water and therefore close attention should be given during project execution phase. Subsea facility integrity management plan can be developed during the project phase when the designer's input and information on construction-led design changes can be obtained directly and easily incorporated[3]. An asset is an entity from which the profitable owner can derive a benefit in future accounting period by holding or using the entity over a period of time. The Institute of Asset Management defines asset management as a set of systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance , risks and outlay over their life cycles for the purpose of achieving its organizational strategic plan.UK Health and Safety Executive (2009) KP3 program defined asset integrity as the ability of an asset to perform its required function effectively and efficiently whilst protecting health, safety and the environment[4].

Subsea production systems can be defined as range in complexity from a single satellite well with a flowline linked to a fixed plan, to several wells on a template producing to a floating facility. Typical subsea production systems consist of wellheads and trees, sealines and end connections, controls, control lines, single-well structures, templates and manifolds, remote operating vehicle (ROV) and completion/workover and production risers. To present sound guidance for developing or moving aim program, this document evaluated lessons learned by the process industries. It does not give just one way of managing the integrity of assets since there are many ways to approach the implementation of an integration program, and other resources will be needed to develop a full program. Company management will need to recognize which approaches best suit their facility and company needs. Having a successful AIM program is consistent with a business case for process safety. Benefits of AIM program that can provide greater value for the business include. A life cycle approach to managing asset quality considers quality from the time the asset is designed until the time it is taken out of service for retirement or reuse. Effective quality management can be powerful tool for upgrading a facility management of assets integrity.[5]

II. LITERATURE REVIEW

In a past few decades many incidents are reported which makes the asset Integrity management more important. Learning from accidents and incidents is both part of every safety professional's toolkit.

On 10 August 2011, an oil leak was reported from the Garnet F field resulting from the failure in a subsea flow line, 176 km east of Aberdeen[6]. On the initial investigation by Health and Safety Executives, they find that an audit of the safety management system was due in 2008 for the leaking pipeline and had not been accomplish before the incident. Due to causal investigation accomplish on the leak, Shell has increased awareness on reducing hydrocarbon leaks within operations and increased hugefocus on asset integrity of subsea asset[7].

On 20th April 2010, an uncontrolled flow of water, oil mud, oil, gas and other materials rushed out of the drilling riser and drilling pipe on a dynamically positioned drilling vessel at approximately at 5000ft of water in the Northern Gulf of Mexico, offshore the coast of Louisiana. Methane gas from the well under high pressure shoot upward inthe drill column, expanded onto the platform, then ignited and exploded. This explosion caused the deaths of 11 workers and serious injuries to more other and the release of crude to sea. The leak continued for 87 days with spills of 4 million barrels and caused huge environmental destruction[8]. A series of incident investigations were accomplish to determine cause of the incident. Investigation of the available evidence indicates thatwhen given the opportunity to save time and money, tradeoffs were made for the certain things such as production because it was indentified that there are no downsides associated with the unpredictability. The importance of asset integrity was neglected and it caused the downfall of Deepwater Horizon.[9].

Every single incident provides valuable lessons learned for us to avoid similar situations from recurring. The Ekofish Bravo accident that occurred on 22 April 1977 during an involvement to pull out tubing string in a production well recorded the largest oil spill in the North Sea. The production Christmas tree valve was removed and a Blowout preventer was not installed; the well kicked and an incorrectly installed down hole safety valve failed[10]. The failed safety valve resulted in an oil and gas liberate. The blowout resulted in a continuous discharge of crude oil through an open pipe 20 meters above the sea surface with approximate rate of 1170 barrels per hour, approximately 202,380 barrels of oil flee before the well was finally capped 7 days later[11].

The blowout determined that human error was a major factor which led to the mechanical failure of the safety valve including faults in the installation documentation and equipment identification and misjudgments, improper planning and improper well control. Based on the investigation finding, apparently there were a series of asset integrity requirement which were neglected and caused the accident.[12].

Asset integrity can be divided into design integrity, technical integrity and operation integrity as illustrated in Fig.1. Asset integrity can be divided into design integrity, technical integrity and operation integrity as illustrated in figure 1. Design integrity provides assurance that facilities are designed in accordance to governing standards and meet specified operating requirements without compromising on safety, accessibility, operability and maintainability. Any facility asset integrity must evolve from the design phase and the integrity management plan is developed with incorporating hardware barriers. Technical integrity is defined as the development of a design that is carried out by well trained personnel, who have been assessed to be competent in accordance with recognized, soundpractices and procedures with adequate provision for reviews and audits to ensure the design intent is unimpaired in any way that could cause undue risk or harm to people or damage to the environment. Asset technical integrity refers to a condition where the technical state of assets incorporates all related operations and business processes as one process to ensure that there will be no harm done to people, property or the environment.

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Figure 1: Sub groups of asset integrity

Operational integrity addresses operating within an asset's operating envelope, as defined by technical barriers. Suitable knowledge, required experience, adequate manning, ability manpower and reliable data for decision making are essential to operate the plant as intended throughout asset lifecycle. Oil and gas companies have to manage assets without any incidents by managing the governance and integrity of its assets. The objectives of asset integrity are to acquiescent to all national requirement, regulatory, company policies and standards; adapted to industry requirement and international standard and regulation; stay fit for purpose safe and operational under all circumstances; ensure all assets operate in safe manner, reliable within design parameter and efficient in its operation mode; ensure all suitable check, process and review in place to safeguard the asset ;ensure the asset design, construct, install, operate and maintain to a risk level tolerable to the ALARP concept; protect company reputation; achieve planned production forecast and follow operating and maintenance philosophy [13].

Most oil and gas companies use asset integrity management to manage asset integrity activities in various stage of an asset's lifecycle. Department of Mines and Petroleum refer to asset integrity as fitness for purpose (FFP) and used Figure 2 to illustrate asset integrity management[14]. The asset lifecycle can be divided into five phases; design, installation, commissioning, operation and decommissioning. The asset integrity strategies, policies, procedure and scheme are developed in early stage of assets when the failure frequencies are decreasing. During operation phase the asset design requires reappraisal and for the design life extension additional measure should be taken place. After the initial design life, asset failure frequency will increase.

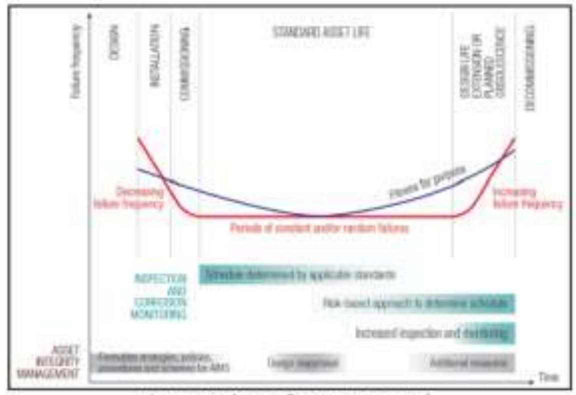

Figure 2: Fitness for Purpose graph

Asset lifecycle begins when a project opportunity enters the project funnel process. Careful consideration should be given between short term and long term benefits, between risks and reward profiles and associated costs when dealing with all stages of the asset life cycle to ensure the best value for money is achieved with asset integrity management. Phased project management processes, also known as stage and gate management processes (SGMP), is commonly used in macro and micro projects from early evaluation, to sanction the project and close it out[15]. At each project phase, the project team shall meet the requirements to move the project from current phase to next phase. In general, the SGMP aims to improve the decision making process by helping to manage the level of uncertainty and increase the quality of projects [16]. Table 1 shows the project phases associated with asset lifecycle.

Scholar	Project Phases (Based on stage and gate management processes)				
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Walkup Jr & Ligon (2006)	Feasibility Identify	Identify (broader development plan)	Definition (detailed development plan)	Execution	Operation
Alsayari, Lauritzen, & Alqurtas (2011)	Concept Investigation	Strategic consensus	Strategic implementation	Installation & Evaluation	Closure
Adibhatla & Wattenbarger (2009)	Screen candidate processes	Evaluate in depth	Field test on uncertainties	Commercial evaluation	Implementation, surveillance, operation

Asset integrity management is a continuous process throughout the project lifecycle. On average there are five phases in an asset's lifecycle including identify, evaluate, concept definition, execute, and operate as illustrated in Figure3. Heavy emphasis on design integrity should be made at the concept selection and concept definition phases to establish asset integrity. Upon starting the project execute phase, the focus will be on technical integrity. The process will be continued even after project has been handed over to the operation team in the operate phase. In the operate phase, the asset definitely needs to be maintained in order to maintain the integrity of the asset.

Fig. 3. Illustration of asset integrity during asset lifecycle in project phases

It is very challenging to achieve asset integrity at any stage of asset life cycle. There are mainly visible and invisible parameters that may delay the delivery of asset integrity. Many scholars conducted studies or compiled lessons learnt about asset integrity mainly during the asset's operation lifecycle. Bale & Edwards (2008) reported non-user-friendly procedures, poor handling of management of change, lack of experience, incompetent engineers, human error, improper training and lack of design review during the design phase can challenge the execution of effective asset integrity management. Rahim, Refsdal & Kenett (2010) acknowledged that generally in projects, lack of compliance, incompetent engineering, communication breakdown, lack of collaboration within teams are key challenges to asset integrity. Pirie & Østby (2007) further highlighted that poor data and knowledge transfer from construction to operation, varying quality of risk management, inadequate maintenance and safety work practice and lack of continuous process improvement can impact asset integrity of facilities. In subsea field applications Suyanto (2011) stressed new technologies, harsher environments, complex technical issue, high cost for inspection and intervention, limited inspection intervals and longer lead time for repair are impacting the subsea asset integrity.

For achieving the goal of securing assets meet its full lifecycle usage, a framework for asset integrity will be handy. Subsea asset integrity framework requires the methodical and continuous monitoring of activities from concept selection, detail engineering, procurement, manufacturing, construction, installation, commissioning, operation, inspection and maintenance to meet asset integrity aim as reported. The ultimate aim of the framework is for asset owner to reveal that the assets are safe and to prove that to various stakeholders. This section will focus on the asset integrity framework reported by various scholars, mostly from oil and gas applications. Based on an earlier studyand shown in Table 2, it can be concluded that there is lack of standard on asset integrity framework[17].

Table 2. Asset integrity framework that reported by various scholars

	International Association of Oil & Gas Producers (2008)	Rahim, Refsdal, & Kenett, (2010)	Rocher, Perrollet, & Muir (2011)	Sri-amornthum, Chinpongpan, & Chunsakran (2012)	Wenman & Dim. (2012)	Dutta & Madi, (2014)	Refsdal & Ostby, (2014)
Asset phase	Operation	operation	operation	operation	operation	operation	operation
Design	X		X		X	X	
People	X		X	X	X		X
Plants	X		X	X	X	X	
Community				X		X	
Processes	X			X	X		X
Competence		X	X			X	X
Compliance		X			X		
Communication		X	X			X	
Collaboration		X					
Control		X	X		X	X	
Data collection			X		X	X	

When contrast to other development options the subsea developments in shallow, deep and ultra deep water have become a foundation. However subsea developments have its distinctive nature. According to the DNV GL survey, 52% of respondents expect subsea technologies to absorb the strongest investment in coming years (DNV GL, 2014). The subsea development in deeper water depth presents increasing challenges in higher development cost. Operational cost with subsea installation, involvement subsea wells are increasing at a higher rate than the cost the hardware. Ratio of installation or intervention cost of hardware has increased from 1:1 for shallow water to 3:1 for deeper water. Poor asset integrity management resulting in intervention or repair work would tremendously increase costs for an asset throughout its lifecycle. To avoid heavier costs during the operation phase and lower profit margins, the asset integrity should be managed effectively from the project phase. It is believed that the right combination of people, processes and technology can safeguard asset integrity and maximize profitability. Accidents in the oil and gas industry highlighted how important it is to have suitable asset integrity management in place to anticipate such disasters and hopefully prevent them before they become a reality. According to Suyanto (2011) subsea asset integrity management is defined as the management of subsea system or asset to ensure that it delivers the design requirements and do not harm life, health or the environment throughout the required life. Subsea facilities are unique and require special attention because the equipment doesn't have direct and manual access like topside equipment. Specific precautions have to be taken at the design stage to ensure that the adopted design solutions will not compromise the long term safe operation and also to develop monitoring techniques that will allow indirect conditions to be followed up, repay for the lack of direct access for traditional inspection means.

III. CONCLUSION

The first objective of a subsea asset management framework is to detail out strategies to direct the risks associated with assets in a very methodical manner with regards to retaining asset integrity throughout its life. Based on the literature review, it is disclose that many companies deployed and focused asset integrity management only during an asset's operation stage or for life extension projects. Asset integrity only focused on operating assets is not ideal and should be revisited for system effectiveness from the start of an asset's life cycle. Current operation phase asset integrity execution poses many challenges as reported in Table 3 are requisite for the development of subsea asset integrity framework during project phase. The suggested study will focus subsea projects at evaluate, concept definition and execute phases as shown in Fig. 4. Asset integrity assurance processes will be intensively focused on concept selection, pre-FEED, FEED, detailed design, manufacturing, installation and commissioning activities. The obstacles that can influence the successful execution of subsea asset integrity will be studied. Based on the outcome of obstacles, the weakness and best practices of asset integrity will be evaluated for subsea asset integrity strategy. The identified strategy will be integrated to develop a subsea asset integrity framework for project phase. Robust and rigorous subsea asset integrity framework will safeguard subsea asset and provide affirmation that subsea asset to perform its required function effectively and efficiently whilst protecting health, safety and the environment.

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