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Deepwater Horizon

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ABSTRACT

The Deepwater Horizon accident in 2010 was the largest oil spill in U.S history. The tragedy claimed the lives of 11 offshore workers and caused an estimated 4.9 million barrels of oil to leak into the ocean. To do this day the Gulf of Mexico coastline and ocean environment is extensively effected from this accident.

The Deepwater Horizon was a Mobile Offshore Drilling Unit (MODU) operating off the coast of Louisiana in the Gulf of Mexico. The vessel was drilling on the Macondo well one morning when a series of events transpired in a relatively short period of time which led to the accident.

The vessel encountered a well blowout followed by an explosion on the drill deck. The emergency disconnect system failed leaving the vessel attached to the well, releasing copious amounts of gas and hydrocarbons. After two days of unsuccessful firefighting attempts the rig finally lost stability and became submerged in the ocean. It took 87 days for the well to be successfully capped which had displaced an astonishing amount of hydrocarbons into the ocean environment

This accident became the largest oil spill in U.S history and caused severe damage to the Gulf of Mexico environment. Following this event the President of the United States put an indefinite ban on deepwater oil exploration drilling which was lifted six months later. This tragedy has been investigated by many parties and has been the main causation to many revisions to design codes, regulations, and an overall perspective on the safety culture for the offshore oil industry.

The following paper will highlight the description of the accident, the environmental & economical impacts from the accident, the risk control & regulation changes for future offshore projects, recommendations and the progress of clean up operations along the Gulf of Mexico coastline.

1 INTRODUCTION

1.1 Deepwater Horizon

The Deepwater Horizon was an ultra-deepwater, Dynamically Positioned (DP), semisubmersible MODU. The rig was constructed by Hyundai Heavy Industries in Ulsan, South Korea, with the keel laid on March 21st, 2000 with delivery on February 23rd, 2001. The vessel was commissioned by R&B Falcon and registered in Majuro, Republic of Marshall Islands (RMI). [1]

Figure 1: MODU Deepwater Horizon

Deepwater Horizon was a fifth generation MODU designed to drill subsea wells for oil exploration and production, utilizing its 476mm, 100,000kPa Blowout Preventer (BOP), and a 530mm diameter marine riser. The BOP was designed and built by Cameron International Corporation. The vessel was capable of operating in up to 2427 meters water depth and its maximum drill depth was up to 9100 meters. It was the second semisubmersible of a class of two; its predecessor Deepwater Naultius was not DP though. [1]

Table 1: Deepwater Horizon Main Particulars

Deepwater Horizon	
Overall Length	114 meters
Breadth	78 meters
Depth	41.5 meters
Gross Tonnage	32,588 GRT
Displacement	52,588 t
Propulsion	53,640 hp
Hull Material	Steel
Maximum Operating Crew Capacity	146
Estimated Market Value	$560,000,000 USD

American Bureau of Shipping (ABS) classed the Deepwater Horizon, conducting inclining test, Stability Report, & International Load Line Certificate. The International Safety Management Certificate was granted by Det Norske Veritas (DNV). The United States Coast Guard (USCG) approved the rig for the Certificate of Compliance.

1.2 Operation

Transocean was the owner and operator of the Deepwater Horizon, through its subsidiary Triton Asset Leasing GmbH. Following construction it was leased to BP for a three year contract for use in the Gulf of Mexico. This contract was renewed several times and in 2010 it was extended until 2013. During this time Deepwater Horizon operated on many oil fields including the Atlantis, Thunder Horse oil wells, Kaskida oil field, and the Tiber field. The Tiber field has a vertical depth of 10,683m below 1259m of water; which became the deepest drilled oil well in the world conducted by the Deepwater Horizon.

In early 2010 the vessel started an exploration drilling project on a well at the Macondo field (Mississippi Canyon Block 252), approximately 66 km off the coast of Louisiana at a water depth of 1522 m. The rights of the project were as follows; BP: 65%, Anadarko: 25% & MOEX Offshore 2007: 10%.

On the morning of April 20th the vessel had been drilling on the Macondo well when the final cement casing of the well had been completed with final integrity tests conducted by Halliburton. Problems started to arise after conducting negative pressure tests in the well. This consists of testing the pressure below the cement plug that was installed on the well to confirm hydrocarbons stay in the well. Eventually it was concluded by crew on the drill deck that the test was successful. During that evening the drilling crew observed abnormal pressures in the pipe leading to the well. The crew commenced the steps to shut in the well to prevent the release of hydrocarbons. This did not work and led to a well blowout with drilling mud and hydrocarbons moving up from the well. A series of events transpired in a relatively short window of time which led to the accident on the Deepwater Horizon.

2 ACCIDENT

2.1 Explosions

At 9:50pm (Central Standard Time Zone) there was a well blow out on the Deepwater Horizon. The crew attempted to divert the flow of the drilling mud and hydrocarbons to the mud gas separator (MSG), this failed and the contents of the well began discharging onto the Drill Floor. The MODU was then rocked by an explosion followed by a fire. As time went on a second more violent explosion occurred causing total power loss. After the explosions the emergency disconnect system (EDS) failed to activate therefore leaving the vessel connected to the well. [1]

The explosions were caused by the copious volume of gas (methane, ethane, propane) and hydrocarbons leaking on to the drill floor and interacting with an ignition source on the vessel. The first explosion occurred on the drill floor by the MSG and the second occurred in either one of the Engine Rooms.

2.2 Fire

The fire on the vessel after the explosions was fuelled with endless amounts of hydrocarbons from the blown out well. The fire pumps could not be operated to supply water to the fire main and sprinkler system because of the total electrical power loss from the second explosion. With the fire being endlessly fuelled and the firefighting systems onboard not functioning, the firefighting team decided it was futile to attempt to fight the fire. The Master of the Deepwater Horizon decided to abandon ship. [1]

Figure 2: Deepwater Horizon engulfed in flames

2.3 Evacuation

Crew members assembled towards two liferafts at the bow of the Deepwater Horizon when the Master gave the order to abandon ship. Lack of training for crew members for evacuation procedures caused panic and confusion. There was no head count taken and some crew jumped overboard instead of utilizing the liferafts. The liferafts were under such intense heat and smoke the master elected to launch them as quickly as possible, although they were not to capacity. The remaining crew left on deck after the liferafts disembarked (including the master) jumped overboard.

The offshore supply vessel, Damon B. Bankston, was alongside the Deepwater Horizon during these events to receive drilling mud from the rig. This would be a major factor in saving the overboard crew. The supply vessel launched a fast rescue craft to tow the liferafts away from the burning vessel & the men overboard. A headcount was completed on board the supply vessel and found that 115 crew members made it off safely while 11 crew members were missing. [2]

2.4 Sinking of the Deepwater Horizon

Eleven different vessels arrived to the scene following two days after the explosions to fight the fire, using fire monitors, as seen in figure 4. SMIT Salvage Americas, a contractor with Transocean, eventually took charge of the firefight. Deepwater Horizon lost stability and became submerged in the ocean most likely because of the abundant volume of water being applied to the fire. The vessel finally sank at 10:26am on April 22nd, 2010.

Figure 3: Supply ships attempting to firefight the blaze of Deepwater Horizon

The exact cause of the vessel's loss of stability and sinking cannot be determined but it has been concluded to be caused by or a combination of the following factors:

- Damage to the MODU from the explosions and fire
- Accumulation of water from firefighting efforts in downflooding points on the vessel
- Migration of water within the MODU watertight barriers that were damaged, poorly maintained, or left open by crew at the time of evacuation

3 COST

3.1 Human Life

Eleven crew members on the Deepwater Horizon were missing at the time of evacuation and were never found and presumed dead after a search and rescue effort from the U.S. Coast Guard. The deceased crew members were last seen around the drill floor and are believed to have suffered fatal injuries from the explosions and fire. Sixteen crew members were injured from the explosions, fire and/or evacuation.

3.2 Environmental

An astonishingly amount of hydrocarbons leaked into the Gulf of Mexico for over 87 days from the well until it was successfully capped. It is estimated that over 4.9 million barrels of crude oil were displaced into the ocean. Figure 5 shows the area of the Gulf that was covered by the oil spill. It is considered the worst environmental disaster in U.S. History.

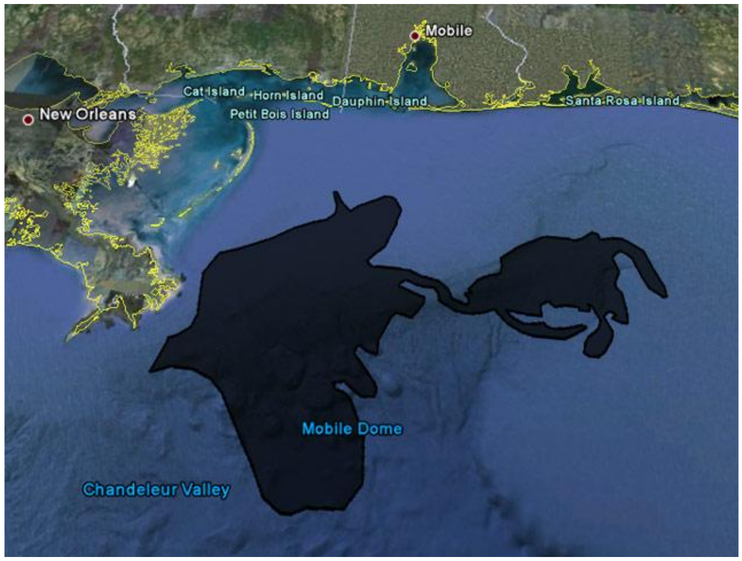

Figure 4: The Estimated Oil Spill Area

3.3 Economical

Due to attempts to seal the leak, clean up costs, legal fees, fines and the loss of assets, BP, the principal leaser of the rig and field, has been estimated to spend $40 Billion but the figure could increase by a significant amount. BP currently has lawsuits against Transocean, Halliburton and Cameron mainly for their alleged contribution in the accident. The President of the United States put a moratorium on deepwater oil drilling after the disaster that lasted about 6 months. [1]

This disaster ruined local economies and livelihoods around the coastlines of the Gulf of Mexico near the spill. The fishing industry was destroyed from the effect of the spill on marine life and will take many years to recover to original stocks. BP has compensated up to $5 Billion to those affected from the disaster. Litigation for the disaster is being discussed in a 20 year time scale. [3]

4 RISK CONTROL

4.1 Role of Risk Control Strategies & Equipment in Mitigation

Deepwater Horizon had all the required valid statutory safety certificates to date preceding the explosion. The MODU possessed the required liferafts and lifeboats on board, leading to a somewhat successful evacuation. The firefighting equipment on board was up to standard too. Although it is not required, having a supply vessel with a fast rescue craft in the proximity of a MODU in case of an emergency ended up being a major factor for 115 crew members surviving after evacuation.

4.2 Failure of Risk Control Strategies & Equipment

The MODU, its owner (Transocean) and its leaser (BP) had serious safety management failures and poor safety culture manifested in continued maintenance deficiencies, training and emergency preparedness weaknesses as shown in evidence, which culminated in the casualty at the Macondo well on April 20, 2010. [1] It was not ensured that crew were trained and ready for emergencies. Adequate maintenance of safety equipment was not regularly completed and there was no proper risk assessment completed for this particular situation. The flag state, the Republic of Marshall Islands failed to meet its responsibility to ensure safety and to properly monitor the activities of ABS and DNV for the MODU.

In regards to failure of risk control and equipment for the explosions, the electrical equipment on the MODU may not have been capable to prevent the ignition of flammable hydrocarbons. A previous audit of the vessel found that there was a lack of control over maintenance and repair of this equipment. Fire and gas detectors were not installed to automatically activate the EDS system if hydrocarbons were detected in critical areas. The system had to be activated by crew members which were improperly trained to clarify crew members' roles in the event of a well blow out. Therefore the EDS were not activated in time and the engine room was not notified to shut down all generators. It was found that many fire and gas detectors were bypassed. The A-class bulkheads which separate the drill floor from the occupied areas were insufficient to provide a blast protection for the crew members. The exact cause of the two explosions is still unknown. [1]

The firefighting team showed signs of lack of proper training. The fire main system was unable to work without electrical power, which was knocked out from the second explosion. The IMO MODU code doesn't not provide adequate fire protection when considering the magnitude of fires experienced on the Deepwater Horizon.

The boundaries established at the bow where the liferafts were located was not a suitable shield for personnel evacuating from the exposure of intense radiant heat coming from the hull of the vessel. The emergency lighting that came on when power went out was not sufficient enough for safe evacuation at launching areas and muster areas.

The exact cause of the loss of stability and sinking of the Deepwater Horizon will never be determined with the limited evidence available. The overall firefighting plan was uncoordinated, therefore leading to large volumes of water being directed towards the MODU without consideration of the stability of the vessel. Transocean did not follow its operations manual with respect to watertight integrity and never conducted deadweight surveys every five years, as required in the IMO MODU code.

5 CONCLUSION

A number of parties investigated the accident of the Deepwater Horizon and mostly came to the same conclusion, it could have been prevented. With MODUs drilling in more extreme environments and deeper in the ocean the hazards are exponentially increased. Therefore codes and regulations for these MODUs need to be revised such as the 1989 IMO MODU Code, which have had many recommendations of improvement from this disaster.

The safety culture in the offshore oil industry needs to be revitalized. Crew members need to be aware of the numerous amounts of risks they are induced to and they must respect the procedures to minimize the risk. BP and Transocean were almost entirely to blame for this disaster as found in court, they are still compensating victims and cleaning up the Gulf. Classification societies and flag states must produce more due diligence in the safety of their vessels.

A major recommendation from parties such as the United States Coast Guard is the need of explosion protection for workers and safety equipment. A risk assessment for explosions on the drill floor and other areas of the MODU must be completed. Revisions to the IMO code must be put into place for providing explosion design loads to bulkheads and barriers separating crew.

Gas and fire detectors must be fully functional and coordinated logically with the EDS, air intakes and power sources. Fire pump systems must be self contained for a certain amount of time if electrical power is lost they are able to function. A more elaborate fire risk analysis should be completed with more focus on training crew to fight it.

It would be a safe recommendation that a supply vessel be in the vicinity of the MODU at all times. It may not be realistic and economical but maybe the time near MODUs could be increased.

It is essential to maintain watertight integrity on the MODU if it is to be saved during a firefighting mission. There must be a coordinated plan among vessels fighting the fire to make sure water is not injected into downflooding points or areas on deck which will decrease the stability. The stability of the vessel should be given in real time to an observer(s) on shore thus weights on the vessel are known when fighting a fire.

Overall it is seen that this disaster was caused by a lack of due diligence on a number of parties and person(s) in the matter of safety. All that can be done now is to learn from this accident so this doesn`t happen again. This can be done by revising practises, training, codes, and regulations to further provide safety in the offshore oil industry.

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