PROTOTYPE
FACULTY OF ENGINEERING AND APPLIED SCIENCE
Journal of Undergraduate Engineering Research and Scholarship

PT-13: Coastal and Ocean Engineering ENGI.8751 Undergraduate Student Forum
Faculty of Engineering and Applied Science, Memorial University, St. john's, NL, Canada MARCH, 2013

Paper Code. (PT-13 - Dodd)

THE OCEAN RANGER DISASTER

JoAnne Dodd
Memorial University of Newfoundland
St. John's, NL, Canada
joanne.dodd@mun.ca

ABSTRACT

In November 1980 the Ocean Ranger was the world's largest semi-submersible oil rig of its time and it was moved to the Grand Banks of Newfoundland to commence the drilling of an exploration well in the Hibernia oil field. On February 14th, 1982 the Ocean Ranger would face and be defeated by a terrible storm at sea, resulting in the fatalities of the entire crew. It wasn't until after the disaster that it was concluded that the rig had several design flaws that contributed to the failure of the vessel to survive in the massive storm. Today these design flaws serve as lessons learned for other coastal and ocean structures.

The Ocean Ranger was constructed in 1976, in Hiroshima Japan. Weighting 25,000 tons, the oil rig was said to be built to withstand 190km/h winds and 34m waves approving the vessel for "unrestricted ocean operations."

Catastrophic events, such as the sinking of the Ocean Ranger, are nothing short of a nightmare and never are they intended by the engineers whom design these structures. Although engineers design to prevent catastrophes, it is the failures of the past that act as some of the best lessons learned for the design and safety of future builds. Highlighted in the following paper are the engineering flaws that led to the failure of the Ocean Ranger and took the lives of 84 crew.

1 INTRODUCTION

The Ocean Ranger was owned by a company stationed in New Orleans called Ocean Drilling and Exploration Company. Ltd (ODECO) and constructed in 1976 by Mitsubishi Heavy Industries, located in Hiroshima, Japan.[1]

Prior to drilling for the Hibernia oil field located in the Grand Banks, the Ocean Ranger worked in many locations such as Alaska, New Jersey and Ireland and operated successfully. It was in 1980 that the oil rig was moved to the Hibernia oilfield to drill an exploration well under contract by Mobil

Oil Canada. However, a harsh winter storm on February 14, 1982 would defeat the Ocean Ranger and take with it 84 lives.[1]

1.1 Background

The Grand Banks lay southeast of Newfoundland and consists of multiple banks such as Grand, Green and St. Pierre, totalling in a size of 282,500 km^2. As part of Canada's continental shelf, the main water source flows from the Labrador current with warm waters from the Golf stream flowing into the southern portion. When a warm air mass moves from the Gulf stream across to the cool Labrador current, it produces a heavy fog which is known to occur often in the spring. Large waves also frequent the area as the Gulf stream strikes the Grand Banks.[2] It is also known to have extreme weather conditions such as winter storms, hurricanes, as well as the threat of ice bergs, primarily in the spring. The Grand Banks of Newfoundland have an ocean depth of approximately 36.5 to 185 meters due to the geology of raised submarine plateaus and it is home to rich fishing and petroleum resources. In 1966 the hunt for petroleum within the Grand Banks began, leading to many successful discoveries such as Hibernia in 1979.[2],[3]

Figure 1: The Grand Banks of Newfoundland [2]

The Hibernia oilfield is located 315 km east-southeast of St. John's Newfoundland in the Jeanne d'Arc Basin. Due to the extreme weather conditions, a gravity base structure (GBS) was chosen as the drilling platform and it was estimated that the field would produce 522 million barrels of crude oil over the life of the wells. However, in March 2011 the number of barrels had already surpassed the anticipated amount, as 736.1 million barrels of crude oil had been recovered. Initially the lifespan of Hibernia was 20 years, today the project life is expected to last until 2040.[4]

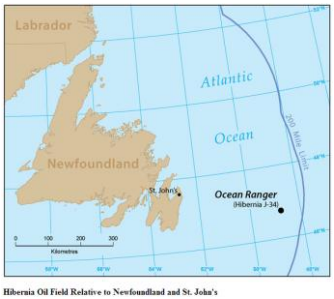

Figure 2: Hibernia Oil Field/Ocean Ranger location. The Ocean Ranger was drilling the Hibernia J-34 well on February 14, 1982 [5]

2 THE OCEAN RANGER DISASTER

2.1 Design

The Ocean Ranger was the largest semi submersible drilling rig of its kind in 1976. Its vast size towered at a height of 103m, a length of121m and a width of 80m.[1] It floated upon two long pontoons that consisted of pumps, switches and valves that were used as a ballast system to adjust the oil rig's position in the ocean.[6]

Upon the completion of the Ocean Ranger, it was said to have been designed to operate in "unrestricted ocean operations" as it was built to withstand heavy winds up to 190km/h and large waves up to 34m in height. With the extreme weather conditions known to exist at the Grand Banks, such an oil rig would seem ideal to drill an exploration well for the Hibernia oil field.[1] It was often said that the rig was unsinkable, however such assumptions had been made before and ended in disaster.[1]

2.2 The Storm

8:00am February 14, 1982 a weather report was received on the Ocean Ranger stating that a large storm was approaching its location. The forecast predicted winds to hit 167km/h and waves to reach 11m. At the time, the Ocean Ranger was drilling the Hibernia well J-34 (see figure 2) and it continued to do so until 4:30pm. It was at that time that the drilling supervisor ordered that the drill pipe be disconnected and retracted (otherwise known as "Hung up") as they prepared to wait out the storm. The crew was unsuccessful in retracting the drill pipe in the severe weather and they were ordered to shear the pipe off. By 7:00pm the storm had fully reached the Hibernia oil field.[7]

Accompanying the Ocean Ranger were two other rigs, the SEDCO 706 and the Zapata Ugland along with other nearby support vessels. At 7:00pm the nearby vessels' radio picked up conversations from the Ocean Ranger about broken glass, water and switches and valves that appeared to be operating on their own. After 9:00pm, the Ocean Ranger confirmed with those nearby that a portlight had broken in the ballast room, but it was cleaned up and no immediate concerns were raised due to the incident. At 11:30pm the Ocean Ranger contacted the radio operator onshore for the routine weather report and there were no problems reported. Throughout the radio transitions it was also noted the winds had reached 190km/h and waves up to 20m. Around 1:00am on February 15, 1982 Mobil's senior manager aboard the Ocean Ranger reported that the rig was listing, following shortly after with a request for the supply vessel, Seaforth Highlander, to come closer to the Ocean Ranger as the supply vessel was on standby for emergencies. Just ten minutes later the Ocean Ranger sent out Mayday calls over the radio and sent out a final report at 1:30am that the crew was heading for the life rafts.[7]

It became clear that this was an emergency situation, as the Seaforth Highlander followed the request of the Ocean Ranger and attempted to move closer to the oil rig. However, conditions were severe and it was difficult for them to make headway. Still, they continued to try and search for survivors. At 2:21am a flare was spotted. The Seaforth Highlander followed the flare and found a lifeboat with crew members aboard. After a daring attempt to rescue the crew, the lifeline used snapped as the crewmen piled all along one side of the lifeboat causing it to tip and capsize. Ultimately the Seaforth Highlander seaman were unable to save the crewmen.[7]

Shortly after losing radar contact with the Ocean Ranger around 2:45am, the rig capsized and sank. Despite rescue efforts, there were no survivors.[7]

2.3 The Cause

When a large wave smashed a portlight in the ballast control room the protective cover was not hatched, causing water to splash over the control room equipment. Lights then started flashing and once a mop up crew arrived, they believed that the portside pontoon valves were opening and closing on their own. As a result, the crew was swift to cut the power, take out the wet switches and rinse them of the salt water. Once completed, power was restored but the salt water must have shorted the circuits, causing the platoon to open and water to rush into the ballast tanks.[6]

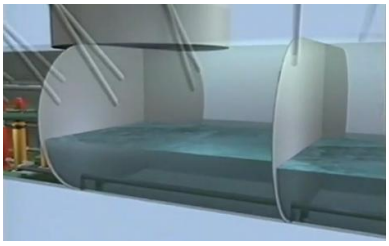

Figure 3: Simulated inllustration of water filling the ballast tanks [6]

The crew noticed that something was wrong so they cut the power again, but it was too late. This caused the Ocean Ranger to be 10 degrees off balance. The only course of action was to pump out the ballast tanks, but such a problem was not included in the engineering design of the rig, and therefore there was no way to drain the tanks. Instead pumps were only installed in the rear of the pontoon and they would only work if the rig was level and at this point the rig was listing forward.[6]

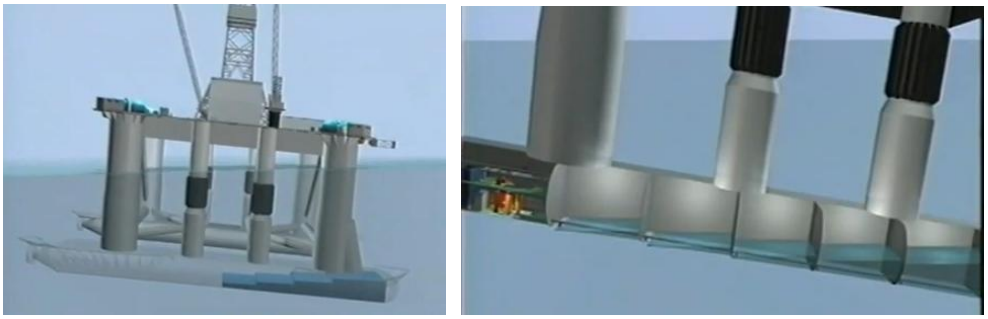

Figure 4: Simulated illustration of the Ocean Ranger 10 degrees off balance (left) and the pump at the rear of the pontoon (right) [6]

.

It is unclear exactly what may have happen in this point in time. However, there are three likely scenario's. 1) Due to the electrical malfunction, the valves remained open and the rig resumed a forward list. 2) The group in the ballast control room tried to manually override the system and get the valves to close but they had no formal training to do so and cause the valves to remain open (human error). 3) A combination of human error and equipment malfunction. It is clear however, that the Ocean Ranger somehow resumed a forward list which was increased when water filled the six foot chain lockers. These chain lockers had no cover and began to fill with water causing the rig to become more off level until it finally capsized.[6]

Figure 5: Simulated illustration of the forward list (left) and chain lockers filling with water (right) [6]

The Crew was forced to carry out an evacuation to the lifeboats which they were never properly trained for. It is probable that lack of training may have lead to panic and therefore crewman may have leapt from the Ocean Ranger into the icy waves.[6]

3 LESSONS LEARNED

The Canadian Enquiry issued 136 recommendations to prevent future events similar to the sinking of the Ocean Ranger. Among them include oil rig design changes, lifeboats for twice the number of crew, and better training. [6]

3.1 Design Flaws

Two major design flaws are that of the chain lockers and the ballast control room. It can be said that these components were not designed for failure but rather for ideal conditions. The chain lockers were designed to allow significant distance between the locker opening and the ocean surface assuming the rig had an even keel. This would have been an ideal condition. However, with 12 anchors in total, not even their weight would keep the rig stable once harsh waves and high winds created a major cyclone. A hatch over the deep pockets would have prevented this mode of failure if the designers had taken these circumstances into account.[8]

As for the ballast control room, the ideal condition would be that water was never capable of reaching/entering the ballast control room. However portlights are breakable and they were present in the ballast control room. Therefore the possibility of the portlights breaking and allowing seawater to enter should have also been considered as a mode of failure. Had the ballast room been fully waterproofed considering all modes of failure, it is plausible that the confusion with what was happening to the valves would not have happened.[8]

To finish, the ballast control console was the only method for operating the valves. The console should have been better designed with a more comprehensive method of indicating the valves position.[8]

3.2 Training Failure

There were several shortfalls in the training programs, procedures and manuals used for the operation and safety of the Ocean Ranger. The ballast control room operator was a very important and vital role for operating the Ocean Ranger. However, there was no formal training for the position.

Instead, crew members who wished to learn this position were anticipated to shadow other ballast control room operators during their off duty hours. Once a new ballast control operator was needed, senior managers of the oil rig chose a crew member to begin shadowing the current operator. A policy set out by ODECO indicated that employees needed to have a minimum of 80 weeks of general oil rig experience before they could begin "training". Experience on other oil rigs performing a different task than the one a worker was currently assigned also counted as experience for the policy. However at the time of the Ocean Ranger disaster, both ballast control room operators had 40 and 12 weeks of experience working on the oil rig. This was considered significant preparation as there was no training or procedures specific to the Ocean Range created by ODECO.[8]

After an interview with ODECO, conducted by the U.S Coast Guard, it was concluded that there was a midships pumping technique known by the design engineers that would have reduced the list bringing the rig back to level position. This technique was never written in the ballast control operations manual. Therefore operators must have learned this technique from studying the equipment and implementing the stability theory. It was concluded that lack of training resulted in a lack of knowledge for those operating the ballast control room. This unfortunately enabled to the Ocean Ranger to continue a forward list causing the rig to eventually capsize . There was also no procedure to outline how to go about a ballast control console failure.[8]

An Emergency Procedures manual was located on the Ocean Ranger, but there was vital information missing. There was no information on the time it would take for the U.S Coast Guard to perform a rescue operation, hence the crew would not have known that a helicopter or standby vessel rescue would take 40 minutes and 2 hours respectively. If this information was provided to the crew, a mayday call may have been sent out earlier.[8]

As for the Booklet of Operating Conditions for the Ocean Ranger found onboard the oil rig, it was argued by former crew members that the manual was merely useless for onboard applications. They felt it was written as a regulatory requirement that was difficult to read and understand.[8]

4 CONCLUSION

All tragedies come from a series of failures/mistakes. As highlighted in this paper a flaw in the design was having portlights in the ballast control room which allowed the possibility of water to enter the room. The portlight broke letting water splash onto the ballast control console and causing the system to malfunction. Lack of training and indistinct valve labelling led to confusion of those operating the ballast control system. This likely allowed the Ocean Ranger to enter and resume a forward list. Another design flaw then assisted in the failure of the capsizing oil rig. The chain lockers had no cover and dug deep into the columns, and as the rig overturned, it allowed more weight to assist the motion by filling the chain lockers with water.

One must think and expect the unthinkable that a series of bad decisions and failures can happen and individuals must take all measures possible to create a safe, sustainable design for multiple environments and to ensure employees are trained and competent in carrying out all practices and procedures.

REFERENCES

[1] "Ocean Ranger oil platform disaster" *The Energy Library*, 2004-2009. [Online], Available: http://www.theenergylibrary.com/node/13089 [Accessed March 06, 2013]

[2] "Grand Banks" *The Canadian Encyclopedia*, 2012. [Online], Available: http://www.thecanadianencyclopedia.com/articles/grand-banks [Accessed March 3, 2013]

[3] "The Grand Banks" *Government of Newfoundland and Labrador.* [Online], Available: http://www.exec.gov.nl.ca/exec/premier/gbanks.htm [Accessed March 3, 2013]

[4] Ashley A. Clarke "Atlantic Canada's Offshore Fields" [Online], Available: http://www.atlanticbusinessmagazine.ca/mobile/issues/NR_v14n1/cover.php [Accessed March 3, 2013]

[5] Mark Kirby "Hibernia Oil Field Relative to Newfoundland and St. John's" *Memorial University of Newfoundland*, 2010. [Online], Available: http://www.heritage.nf.ca/society/hibernia_map.html [Accessed March 3, 2013]

[6] Produced by Cinenova Productions for CTV and National Geographic US. Directed by Christopher Rowely. Written and researched by Mick Gzowski. "Ocean Ranger Disaster." [Online], Available: http://www.youtube.com/watch?v=Zc-gEtByAV4 [Accessed on March 3, 2013]

[7] Keith Collier "The Loss of the Ocean Ranger, 15 February 1982" *Newfoundland and Labrador Heritage Website."* [Online], Available: http://www.heritage.nf.ca/society/ocean_ranger.html [Accessed March 3, 2012].

[8] Steve Lilley "System Failure Case Studies - Porthole to Failure" *National Aeronautics and Space Administration(NASA*), December 2011 Volume 5 Issue 12.[Online], Available: http://pbma.nasa.gov [Accessed March 6, 2012]