National Aeronautics and Space Administration

Porthole to Failure:

The Sinking of the Ocean Ranger

Leadership ViTS Meeting

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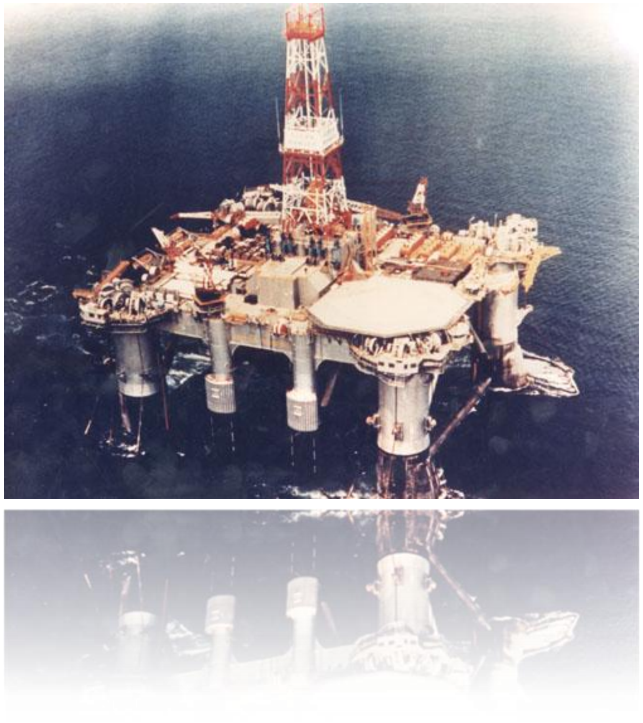

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THE MISHAP

During the winter of 1982, the world's largest mobile offshore drilling unit, the Ocean Ranger, was drilling for oil off the Newfoundland coast. An intense storm approached. Since its 1976 launch, the big rig had weathered over 50 storms in two oceans; designed for 115 mph winds and 110-foot waves, it could handle this storm too. But close to 1:00 a.m. EST on February 15, 1982, the Ocean Ranger's crew sent a desperate mayday call. Nearby vessels arrived only an hour later to find rescue impossible on the freezing, tall waves. Of the Ocean Ranger's 84 crewmembers, only 22 were ever recovered. Autopsies confirmed that these victims died from hypothermia, and the 62 missing were presumed to have met a similar fate.

Rig Configuration

•The *Ocean Ranger* was constructed with a semisubmersible design that placed its drilling platform atop eight columns fixed to two parallel pontoons.

•When operators arrived at a drilling site, they would set 12 anchors and fill ballast tanks inside the pontoons with seawater, submerging the oil rig to the appropriate drilling depth.

•The anchor chains and cables were stowed in storage spaces – called chain lockers – inside each of the rig's four corner columns.

•The tops of the columns, which were normally 80 feet above the ocean surface, remained open to weather since no gate or cover had been supplied.

•Each pontoon held pumps that transferred ballast forward or aft in a pontoon via pneumatically powered valves that were electrically controlled by a crewmember standing a 12-hour watch in the Ballast Control Room.

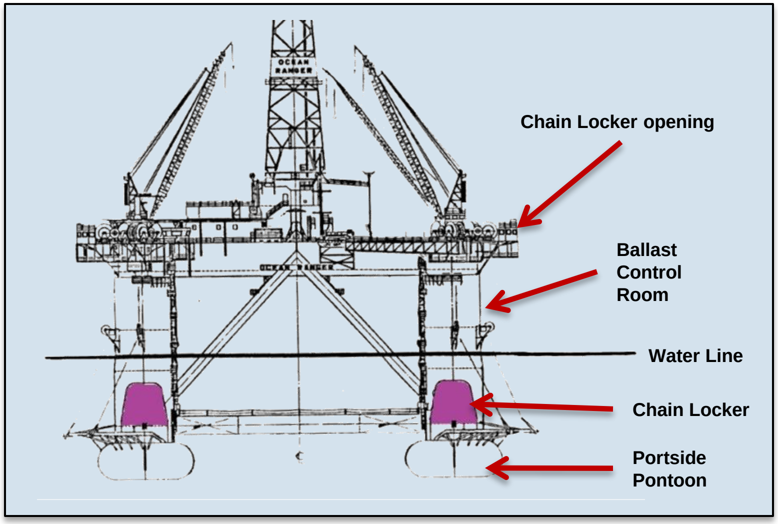


Figure 1: ***Ocean Ranger*** **schematic, as viewed when facing the bow.**

Ballast Control Room

•*Ocean Ranger* had only 2 qualified operators (one per 12-hour shift) to man the control room, which was located inside an inner column on the starboard (right) side of the rig.

•The operator needed to observe current sea conditions to properly adjust ballast in the pontoon tanks, so four circular glass portlights (windows) were provided in the control room. Each portlight had a steel cover known as a deadlight that could be fastened from the inside to prevent wave damage to the windows in storm conditions.

•The ballast control operator used lighted pushbutton switches which were arranged in line diagrams on a 'mimic' type control board to operate valves and ballast pumps. This electrically powered mimic board was the only way the crew could view valve position.

•If electric power to the control valves was lost, their fail-safe design was to close (pneumatic pressure powered valve movement).

WHAT HAPPENED?

Control Room Flood and Power Restoration

•On February 14, 1982, *Ocean Ranger* was battered by a North Atlantic cyclone. The crew prepared for high winds and heavy seas, but because the rig had withstood so many major storms already, they remained confident it would weather this one as well.

•The crew's focus remained on drilling until platform motion exceeded 15 feet of vertical travel. Then, they sheared off the drill pipe to protect the wellhead and took whatever self-protective measures they recalled from past experience; their operations manual lacked detail on what to secure aboard the rig itself.

•At approximately 7:45 p.m., a large wave impacted *Ocean Ranger* and shattered windows in the Ballast Control Room. Salt water soaked the ballast control console, and power to the control panel was lost, either short-circuited by water or secured by the crew to prevent shock.

•Operators then observed lights on the mimic board flashing from red to green and back, leading them to believe that the valves in the portside pontoon were opening and closing on their own. Such a circumstance would fill the portside tanks with seawater and result in a dangerous list (tilt). Close to 9:00 p.m., the crew cut electrical power to the console to force the valves to close.

•With power to the console cut off and the pontoon valves closed, it is likely the *Ocean Ranger* would have weathered the storm. But for unknown reasons, the men on the *Ocean Ranger* restored power to the console approximately four hours later. After the crew restored power, short circuits or inadvertent operator commands caused valves in the bow to open, allowing water to flood the forward ballast tanks and causing the rig to list toward the bow.

Chain Locker Flood and Evacuation

•Neither the rig master nor the ballast control operator understood the pump system well enough to employ the only technique that would effectively pump water from the ballast tanks at the degree at which *Ocean Ranger* was now tilted.

•Someone on board had one last suggestion not listed in the operations manual: a set of brass actuating rods, if threaded into the control console, would force the valves to close while electrical power was shut down. He was mistaken, but none of the crewmembers understood the system well enough to refute the erroneous suggestion.

•The brass rods had actually been used in tests while the rig was still under construction and should not have remained on board. Inserting the rods into the console forced valves to open – not to close. When the crew threaded the rods through the panel, they allowed even more water to enter the ballast tanks, causing the rig to list even further.

•The forward list brought the tops of the corner columns within range of the tallest waves, and water entered the chain lockers' exposed openings.

•When the crew realized its efforts were to no avail, it sent a mayday and boarded the lifeboats. By the time help could arrive, it would be too late.

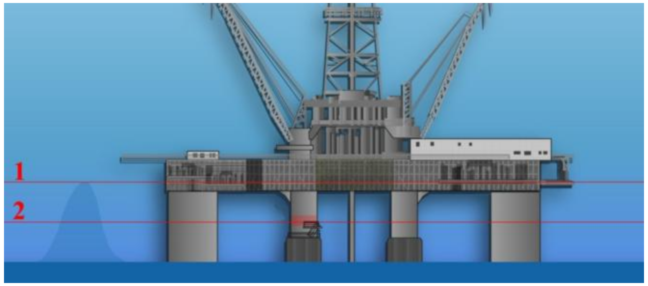
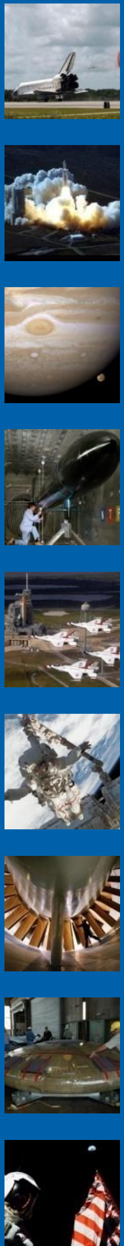


Figure 2: Diagram showing approximate levels of the chain locker openings (1) and the Ballast Control Room (2)



PROXIMATE CAUSE

The U.S. Coast Guard Investigation cited failure of the ballast control room portlight as the proximate cause of the tragedy since it led to uncertainty as to the configuration and position of ballast valves. Based on available evidence, investigators identified three possible scenarios after the crew restored power: a) the list occurred entirely because of an electrical malfunction in the ballast control panel (i.e. short circuits in the control panel admitted water to the forward ballast tanks); b) the list occurred entirely because of a personnel error (i.e. crew members assumed a control panel malfunction when a malfunction did not actually occur, and in their attempts to rectify the perceived situation, they inadvertently directed water into the forward ballast tanks); or c) the list occurred because of a combination of an electrical malfunction and a personnel error.

UNDERLYING ISSUES

Insufficient Experience

•Despite the importance of the ballast control operator position, no formal training program for this post existed. Crewmembers interested in the position were expected to shadow the current operator during off-duty hours, and officials would choose a candidate to begin on-the-job training based on this initiative.

•There was a policy requiring employees to have 80 weeks of general offshore experience before on-the-job training for the ballast control operator position could begin, but records showed that one ballast control operator at the time of the accident had begun his training after only 40 weeks of offshore experience, and the other had begun after just 12 weeks.

•No training for procedures specific to *Ocean Ranger* existed – experience on other drilling vessels was considered sufficient preparation for joining the crew.

•The Coast Guard Investigation concluded that because of insufficient experience, the crew failed to correct the forward list while the ballast control system still allowed such correction.

Absence of Written Casualty Control Procedures

•Ballast control console malfunctions could have been addressed if the crew had possessed a detailed casualty control procedure, and per Coast Guard Investigators, the use of such a procedure would have prevented insertion of the brass rods to manually operate the ballast control system.

•Although *Ocean Ranger* had an Emergency Procedures manual that included steps for evacuation, it did not discuss lead times necessary for helicopters (2 hours) and standby vessels (40 minutes) to conduct rescue.

•Coast Guard investigators also deemed *Ocean Ranger*'s Booklet of Operating Conditions to be of little use, and former crewmembers attested that it had been produced with the primary goal of meeting a regulatory requirement.

Design Flaws

•Although *Ocean Ranger* was the most advanced oil rig of its day, some of its components, such as the chain lockers and the ballast control console, were designed not for failure, but for ideal conditions.

•The control console served as the sole interface through which controllers could ascertain which valves were open and which were closed. If designers had included a redundant or more robust means of indicating valve position, the crew could have responded better.

FOR FUTURE NASA MISSIONS

•Since 2009, NASA has adopted all five aspects of so-called ‘safety culture’ espoused by Dr. James Reason:

- •Reporting Culture (we report our concerns without fear)
- •Just Culture (there’s a sense of fairness)
- •Flexible Culture (we change to meet new demands)
- •Learning Culture (we learn from failures and mistakes)
- •Engaged Culture (everyone does their part)

Ocean Ranger

•From *Ocean Ranger*, we can learn from at least 2 shortfalls:

- •The crew onboard seemed to lack a flexible culture once the porthole was shattered and water damaged the control console.
- •The company operating the rig for hire did not demonstrate a learning culture in that little formal evidence existed to convey how the stability system was designed and operated or how lifesaving gear should be used in actual extreme conditions.

•Each day brings a new opportunity to verify and validate our engineering and loss-prevention practice – not just in reference to the norm or ideal – but especially out at the ‘design limits’ we face in terms of technical risk to people, property, and mission.

•Do we behave as our five safety culture norms prescribe?