



Engineering Ethics: The Deepwater Horizon Disaster

An Online Continuing Education Course for Engineers

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Engineering Ethics: The Deepwater Horizon Disaster

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In 2008, the energy company BP received a permit to drill a subsurface oil well in the Gulf of Mexico called the Macondo well. For this project, BP chartered the 10-year-old rig Deepwater Horizon from its owner, Transocean, which had enjoyed a “strong overall” safety record with no major incidents for 7 years. Halliburton was responsible for cementing work.

The Deepwater Horizon was celebrated as one of the safest drilling rigs in the world. In 2009, the Minerals Management Service identified the rig as a “model for safety.” The Associated Press noted that “its record was so exemplary, according to MMS officials, that the rig was never on inspectors’ informal ‘watch list’ for problem rigs.”

However, there were signs of a potential blowout in the days prior to the April 20, 2010 explosion, particularly gas bubbling from the oil dome into the well itself. The rig was using heavy drilling mud, which helped keep the gas down during drilling operations. But, on the day of the explosion, a BP official—aboard to celebrate seven years without a safety incident—directed the crew to replace the drilling mud with light seawater despite objections from the chief driller.

At 9:56 p.m., the crew of the Deepwater Horizon noted that the lights flickered and there were two strong vibrations. According to BP’s subsequent investigation, the explosion and fire occurred when a bubble of methane gas escaped the well (a textbook blowout) and traveled up the marine riser (the subsurface pipe to the surface), igniting when it was sucked into the air intakes of the diesel generators. The explosion started a fire on the platform that was beyond the capacity of the Deepwater Horizon’s firefighting capacity.

The worst of the explosions gutted the Deepwater Horizon stem to stern. Crew members were cut down by shrapnel, hurled across rooms and buried under smoking wreckage. Some were swallowed by fireballs that raced through the oil rig’s shattered interior. Dazed and battered survivors, half-naked and dripping in highly-combustible fluids, crawled inch by inch in pitch darkness, willing themselves to the lifeboat deck. It was no better there. That same explosion had ignited a firestorm that enveloped the rig’s derrick. Searing heat baked the lifeboat deck. Crew members, certain they were about to be cooked alive, scrambled into enclosed lifeboats for

shelter, only to find them like smoke-filled ovens. Several said their prayers and jumped into the oily seas 60 feet below. An overwhelmed young crew member, Andrea Fleytas, finally screamed what so many were thinking: “We’re going to die!”

Rescue attempts began immediately, with 17 workers being airlifted to hospitals in nearby Mobile, AL for injury and 98 workers being evacuated by lifeboat. Overall, 11 workers were never recovered and are presumed to have died in the explosion. The still-burning Deepwater Horizon sank a day later.

Over the next 87 days, the uncapped well leaked more than 300 Olympic-sized swimming pools of oil into the Gulf’s waters (4 million barrels) before it was finally capped on July 15, 2010, making it the biggest oil spill in United States history. The leak polluted the water with 12 times more oil than the Exxon Valdez spill of 1989.

Once the oil left the well, it spread throughout the water column. Some floated to the ocean’s surface to form oil slicks, which can spread quickly by being pushed by winds. Some hovered suspended in the midwater, forming several layers of oil, dispersant and seawater mixtures drifting down-current; during the spill, a 22-mile long oil plume was reported. This plume formed because chemical dispersants, released into the water to break up the oil so it could wash away, allowed the oil to mix with seawater and stay suspended below the surface. And some oil sunk to the seafloor by adhering to falling particles in the water such as bacteria and phytoplankton to form marine snow. As much as 20 percent of the spilled oil may have ended up on top of and in the seafloor, damaging deep sea corals and potentially damaging other ecosystems that are unseen at the surface. Over 8,000 animals (birds, turtles, mammals) were reported dead just 6 months after the spill, including many that were already on the endangered species list.

Oil continued to sink to the ocean floor for more than a year. It changed the amounts of sediment collecting on the bottom of the sea for years afterward and choked them of oxygen. Immediately after the spill, the 1,300 miles of contaminated coasts saw oil concentrations 100 times higher than background levels, and even eight years later, concentrations were 10 times higher than before the spill. Over 1,000 miles of shoreline on the Gulf of Mexico, from Texas to Florida, was impacted by oil from the Deepwater Horizon blowout. Much of this area has been cleaned, but eroded shorelines are taking longer to recover and erosion rates have accelerated in these areas.

Scientists are still figuring out exactly how the oil impacted the biology of the Gulf, but the immediate effect was to turn the seafloor near the well site into a “toxic waste dump,” one study said. Studies are also showing that reef fish changed drastically after the spill; that fish absorbed some of the oil-sourced contaminants; and that ecological communities throughout the water column, from tiny bacteria to deep sea corals to arthropods, could take decades to recover.

Sixteen-thousand total miles of the Gulf have been affected by the BP oil spill, including the coasts of Texas, Louisiana, Mississippi, Alabama, and Florida. And when oil spills into the ocean, it is difficult to clean up. Part of the difficulty is that no two spills are alike. The amount and type of oil (whether crude or refined) affects how it spreads, and a spill in seawater spreads differently than freshwater. Local environmental conditions also play a huge role: currents, tides, weather, wind speed and direction, air temperature, water temperature, and presence of ice all affect how the oil spreads and how well cleanup workers can access the spill area. This variability makes it difficult to plan for spills ahead of time.

On December 15, 2010, the United States filed a complaint in District Court against BP Exploration & Production and several other defendants alleged to be responsible for the spill. The Macondo oil well leak created one of the worst environmental disasters in US history.

The spill opened many people’s eyes to the risks of drilling for oil in one of the most ecologically rich, culturally important, and economically valuable parts of the world. But 10 years and billions of dollars in cleanup efforts later, many of the same risks that allowed the disaster to occur remain.

“It took the better part of six to seven years [after the disaster] to get in place the inspection of blowout preventers and rules about making drilling plans safer and putting commonsense regulations in place, but those have been rescinded,” says Ian MacDonald, a scientist at Florida State University. “So, basically, we’re back to where we were in 2010, in terms of regulatory environment.”

Causal Factors of the Disaster

Based on interviews with 21 Horizon crew members and sworn testimony and written statements from nearly all of the other 94 people who escaped the rig along with thousands of documents obtained by *The New York Times* that describe the rig’s maintenance and operations, it finally became possible to piece together the Horizon’s last hours. What emerged was a stark

and singular fact: crew members died and suffered terrible injuries because every one of the Horizon's defenses failed on April 20, 2010. Some were deployed but did not work. Some were activated too late after they had almost certainly been damaged by fire or explosions. Some were never deployed at all. At critical moments that night, members of the crew hesitated and did not take the decisive steps needed. Communications fell apart, warning signs were missed, and crew members in critical areas failed to coordinate a response.

The paralysis had two main sources. The first was a failure to train for the worst. The Horizon was like a Gulf Coast town that regularly rehearsed for Category 1 hurricanes but never contemplated the hundred-year storm. The crew members, though expert in responding to the usual range of well problems, were unprepared for a major blowout followed by explosions, fires, and a total loss of power. They were also frozen by the sheer complexity of the Horizon's defenses and by the policies that explained when those defenses were to be deployed. One emergency system alone was controlled by 30 buttons.

The drilling crew had trained for blowouts. Floorhands were the crucial first responders. A driller would call "Blowout!" and time the floorhands' response. This usually involved quickly installing a special valve on the drill pipe to end the imagined blowout. Their training sessions had contemplated a blowout coming up through only the drilling pipe. But on April 20, 2010, it seemed that the blowout was erupting from the whole well opening. "I had no idea it could do what it did," Caleb Holloway said.

On that fateful day, when confronted with the real thing for the first time, Mr. Holloway, a lanky 28-year-old floorhand, realized that there were no floorhands on the drilling floor to respond.

The Horizon's owner, Transocean, had provided the crew with a detailed handbook on how to respond to signs of a blowout. Yet, its emergency protocols often urged rapid action while at the same time warning against overreaction. Fred Bartlit, chief counsel for the presidential commission that looked into the Horizon disaster, said Transocean's handbook was "a safety expert's dream," and yet, after reading it cover to cover, he struggled to answer a basic question: "How do you know it's bad enough to act fast?"

After the Deepwater Horizon disaster, the commission created by the Obama administration to investigate the spill reached stark, damning conclusions. Many lapses in safety had contributed to the disaster, many of which traced back to a culture both within BP and the

industry at large that did not value safety enough. A new agency, the Bureau of Safety and Environmental Enforcement (BSEE) was created to track and enforce offshore drilling safety issues, something that had previously been handled by the same agency that approved leases to oil companies, which created a potential conflict of interest.

Several factors contributed to the Deepwater Horizon disaster:

- 1. Lack of safety preparations / Poor safety culture.** Deregulation permitted BP to file their request to drill the Macondo well without providing a blowout plan (detailed procedures for responding to a sudden unintended release of gas or oil from the newly drilled well). An internal survey of workers prior to the explosion indicated significant concerns “about poor equipment reliability, which they believed was a result of cost-cutting and priorities taking precedence over safety.” Workers entered fake data to bypass safety checks, and safety on the rig was distorted.”
- 2. Flawed blowout preventer (BOP).** The BOP installed at Macondo lacked either remote or automatic shut-in capability. It should activate in case of an emergency. The BOP was not tested properly and was not sealed. Transocean had modified the BOP design, which was not approved. Also, the BOP was not properly maintained, which increased the risk of failure.
- 3. The gas alarm failed.** The BOP should have sounded the alarm and prevented the gas from reaching the engines. This system failed. Additionally, some alarms had been deliberately placed in “inhibited” mode months prior to the disaster due to nuisance alarms waking up the crew in the middle of the night. As a result, a control panel would detect an alarm and indicate the alert, but general alarms that would sound loudly across the rig would not go off.
- 4. Valve failure.** About 8 minutes before the explosion, a mixture of mud and gas began pouring onto the floor of the rig. The crew immediately attempted to close a valve in the blowout preventer, which sits on the ocean floor over the top of the well borehole. It did not work properly.

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