Unusual Decisions Set Stage for BP Disaster

Deep Trouble

By Ben Casselman
And Russell Gold

It was a difficult drill from the start.
API Well No. 60-817-44169 threw up many challenges to its principal owner, BP PLC, swallowing expensive drilling fluid and burping out dangerous gas. Those woes put the Gulf of Mexico project over budget and behind schedule by April 20, the day the well erupted, destroying the Deepwater Horizon rig and killing 11 men.

Government investigators have yet to announce conclusions about what went wrong that day. The final step in the causation chain, industry engineers have said in interviews, was most likely the failure of a crucial seal at the top of the well or a cement plug at the bottom.

But neither scenario explains the whole story. A Wall Street Journal investigation provides the most complete account so far of the fateful decisions that preceded the blast. BP made choices over the course of the project that rendered this well more vulnerable to the blowout, which unleashed a spew of crude oil that engineers are struggling to stanch.

BP, for instance, cut short a procedure involving drilling fluid that is designed to detect gas in the well and remove it before it becomes a problem, according to documents belonging to BP and to the drilling rig's owner and operator, Transocean Ltd.

BP also skipped a quality test of the cement around the pipe—another buffer against

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Some of BP's choices allowed it to minimize costly delays. "We were behind schedule already," said Tyrone Benton, a technician who operated underwater robots and worked for a subcontractor. He said that on the day before the accident, a Monday, managers "hoped well'd be finished by that Friday... But it seemed like they were pushing to finish it before Friday."

He added: "They were doing too many jobs at one time." Mr. Benton is suing BP and Transocean claiming physical injury and mental anguish.
BP acknowledges the well was running over budget but says it didn't cut corners. "Safe and reliable operations remain a priority regardless of how much a well is behind schedule or over budget," spokesman Andrew Gowers wrote in an email.

Some workers agree safety was paramount for both BP and Transocean. "Safety was their No. 1 concern. Protecting the environment was their No. 1 concern," said Darin Rupinski, a Transocean employee whose job was to help keep the rig in place.

BP was drilling to tap an oil reservoir it had identified called Macondo, the same name as the cursed town in Gabriel Garcia Marquez's novel "One Hundred Years of Solitude." As on many past projects, BP hired a drilling rig from Transocean, the largest deep-water driller. Workers from Transocean and other contractors did most of the work, under the supervision of BP employees on the rig and in Houston.

BP started working on the well in October, using a different rig. After three weeks natural gas got into the well, called a "kick." That's not uncommon. But two weeks later a hurricane damaged the rig and it had to be towed to port for repairs.

BP started again in January, this time with Transocean's Deepwater Horizon, a warhorse rig that had worked for BP for years. BP filed a new drilling permit with federal regulators.

According to a company document seen by the Journal, BP approved spending $96.2 million and about 78 days on the well. The target time was much less—about 51 days. By April 20, the well was in its 80th day, owing to delays such as one that had begun on March 8.

That day, workers discovered that gas was seeping into the well, according to drilling reports from the rig reviewed by the Journal. Workers lowered a measuring device to determine what was happening, but when they tried to pull it back up, it wouldn't budge. Engineers eventually told them to plug the last 2,000 feet of the then-13,000-foot hole with cement and continue the well by drilling off in a different direction.

The episode took days to resolve, according to drilling reports, not counting backtracking and re-drilling. Each extra day cost BP about $1 million in rig lease and contractor fees.

Other problems arose. The rock was so brittle drilling mud cracked it open and escaped. One person familiar with the matter estimates BP lost at least $15 million worth of the fluid.

Still, by mid-April the well seemed a qualified success. BP was convinced it had found a lot of oil. Until engineers in Houston could make plans to start pumping it out, the workers on the nearly complete well, in a standard practice, would plug it and temporarily abandon it.

One of the final tasks was to cement in place the steel pipe that ran into the oil reservoir. The cement would fill the space between the outside of the pipe and the rock, preventing any gas from flowing up the sides.

Halliburton, the cementing contractor, advised BP to install numerous devices to make sure the pipe was centered in the well before pumping cement, according to Halliburton documents, provided to congressional investigators and seen by the Journal. Otherwise, the cement might develop small channels that gas could squeeze through.

In an April 18 report to BP, Halliburton warned that if BP didn't use more centering devices, the well would likely have "a SEVERE gas flow problem." Still, BP decided to install fewer of the devices than Halliburton recommended—six instead of 21.

BP said it's still investigating how cementing was done. Halliburton said that it followed BP's instructions, and that while some "were not consistent with industry best practices," they were "within acceptable industry standards."

The cement job was especially important on this well because of a BP design choice that some petroleum engineers call unusual. BP ran a single long pipe, made up of sections screwed together, all the way from the sea floor to the oil reservoir.

Companies often use two pipes, one inside another, sealed together, with the smaller one sticking into the oil reservoir. With this system, if gas tries to get up the outside of the pipe, it has to break through not just cement but also the seal connecting the pipes. So the more typical design provides an extra level of protection, but also requires another long, expensive piece of pipe.

"I couldn't understand why they would run a long string," meaning a single pipe, said David Pursell, a petroleum engineer and managing director of Tudor, Pickering, Holt & Co., an energy-focused investment bank. Oil major Royal Dutch Shell PLC, in a letter to the MMS, said it "generally does not" use a single pipe.

BP's Mr. Gowers said the well design wasn't unusual. BP engineers "evaluate various factors" to determine what design to use for each well, he said.

Despite the well design and the importance of the cement, daily drilling reports show that BP didn't run a critical, but time-consuming, procedure that might have allowed the company to detect and remove gas building up in the well.

Before doing a cement job on a well, common industry practice is to circulate the drilling mud through the well, bringing the mud at the bottom all the way up to the drilling rig.

This procedure, known as "bottoms up," lets workers check the mud to see if it is absorbing gas leaking in. If so, they can clean the gas out of the mud before putting it back down into the well to maintain the pressure. The American Petroleum Institute says it is "common cementing best practice" to circulate the mud at least once.

Circulating all the mud in a well of 18,360 feet, as this one was, takes six to 12 hours, say people who've run the procedure. But mud circulation on this well was done for just 30 min-
The mood aboard the rig on April 20 was upbeat. The work was nearly done, and workers were eager to put the troublesome well behind them.

Some saw indications that managers wanted to wrap up quickly. "Kevin Senegal, a subcontractor employee who cleaned tanks, said he was told to be ready to clean two tanks on a coming shift instead of the usual one. "To me it looked like they were trying to rush everything," he said.

A disagreement broke out on the rig on April 20 over the procedures to be followed. At 11 a.m., workers for the half-dozen contractors working on the rig gathered for a meeting. Douglas Brown, Transocean's chief mechanic on the rig, testified Wednesday at a hearing in Louisiana that a top BP official had a "skirmish" with top Transocean officials.

The Transocean workers, including offshore installation manager Jimmy Wayne Harrell, disagreed with a decision by BP's top manager about how to remove drilling mud and replace it with lighter seawater. Mr. Brown said he heard Mr. Harrell say, "I guess that is what we have those pinchers for," referring to a part of the blowout preventer that would shut off the well in case of an emergency.

BP won the argument, said Mr. Brown, who is a plaintiff in a suit against BP and Transocean. Mr. Harrell declined Journal requests for comment.

A little after 5 p.m., to check

"To me it looked like they were trying to rush everything."

The well's integrity and whether gas was seeping in, rig workers did what is called a "negative pressure test." It was supervised by a BP well-site leader, Robert Kaluza. His experience was largely in land drilling, and he told investigators he was on the rig to "learn about deep water," according to Coast Guard notes of an interview with him. BP declined to comment on his experience.

A lawyer for Mr. Kaluza said he "did no wrong on the Deepwater Horizon."
The test initially strayed from the procedure spelled out in BP's permit, approved by the MMS, according to the Coast Guard interview with Mr. Kaluza. When the first test results indicated something might be leaking, workers repeated the test, this time following the permitted procedure. The second time, pressure rose sharply, with witnesses saying that the well "continued to flow and spurted," according to notes gathered by BP's investigators that were reviewed by the Journal. BP denies violating its MMS permit.

Well-control experts say it's clear gas was leaking into the well, most likely through the seal at the top but possibly through the bottom or even through a collapsed pipe.

Earlier this month, BP lawyers told Congress the test results were "inconclusive" or "not satisfactory." On Tuesday, according to the Congressmen's memo, BP said it saw signs of "a very large abnormality."

Just two things then stood between the rig and an explosive mixture of gas and oil. One was the heavy drilling mud. The other was the blowout preventer near the sea floor. But the BOP had various problems, among them some leaking hydraulics.

By 8 p.m., BP was satisfied with the test and had enough confidence to proceed. It was this that may have been "a fundamental mistake," a BP official told congressional staffers Tuesday, according to the memo from two members of Congress.

Following BP's instruction, Transocean workers turned to replacing the mud with seawater, according to Coast Guard interviews with Mr. Kaluza and Donald Vidrine, the top BP official on the rig. Removing the mud keeps it from polluting the sea but also means there's less weight to hold down any gas.

BP's plans for the well, approved by the MMS on April 16, called for workers to remove the mud before performing two procedures designed to make sure gas couldn't get into the well.

The first called for installing a giant spring to lock the seal at the top of the well in place after removal of the mud. There's no evidence in rig-activity logs the spring was ever installed. If gas was coming up the sides of the well, pushing against the seal, this spring would have helped prevent leakage.

Second, BP opted to remove the mud before placing a final cement plug inside the well.

In documents presented to Congress, BP has hypothesized that gas could have gotten into the inside of the pipe through a failure of the cement at the bottom of the well. BP was planning to set a second, backup cement plug in the well before declaring its work done.

But workers began removing mud before setting this plug, leaving little to prevent any gas inside the pipe from rising to the rig. That plan was approved by the MMS on April 16, according to the permit reviewed by the Journal.

A spokeswoman for the Interior Department, of which the MMS is a part, said it was "looking at everything, from what happened on the rig that night and the equipment that was being used to the safety, testing and backup procedures."

About 9:45, the seawater and remaining mud began to head back up the pipe. Witnesses say they saw mud shooting out of the derrick like water from a firehose. A worker on the rig floor made a frantic call to BP's Mr. Vidrine, who had gone to his office, according to his interview with the Coast Guard.

Transocean workers raced to tame the well. Nothing worked. This was no ordinary gas kick. It was far more ferocious.

Workers rushed to hit the emergency button to activate the blowout preventer's clamps and detach the rig from the well, according to witness accounts. They were too late. Gas flowing out found an ignition source, and an explosion rocked the rig.

Well No. 60-817-44169 was beyond control and on its way to becoming infamous.

—Vanessa O'Connell, Jeffrey Bell, Douglas A. Blackmon, Ana Campey, Miguel Bustillo and Jennifer Levitz contributed to this article.
Recipe for Disaster?

Investigators are still trying to figure out exactly what caused the Deepwater Horizon to blow up on April 20. But based on what is known, experts have worked out the most likely scenario. This diagram of the well's lining is vastly foreshortened to emphasize the well's layers.

1. Oil and gas

Engineers constructed the well out of telescoping segments of metal casing that became narrower as they reached deeper below the surface.

2. Natural gas was locked in a high-pressure reservoir, trying to get to the surface.

3. Heavy drilling fluid, known as mud, helped keep the gas under control. But as the mud sat in the well, some gas may have been able to leak in.

4. Workers pumped cement to seal off the sides of the well. But they didn't flush out the mud-filled gas first. Instead, the cement pushed any gas further up the well.

5. Oil and gas also might have gotten into the inside of the casing through a cement plug at the bottom.

6. Any gas rising up the side of the well would have expanded, pushing against both the inner pipe within the well and a seal at the top.

7. Due to the design of the well, the gas had a straight shot to the top of the well.

Source: Transocean testimony and WSJ research
Ben Casselman and Joe Shoulak/The Wall Street Journal
8. Gas got into the inside of the pipe, either by pushing through a seal at the top, or through the cement on the bottom, or else by collapsing the pipe.

9. A final cement plug would have stopped gas inside the well from reaching the surface, but workers didn’t set a plug before removing heavy drilling fluid.

10. With gas in the well, heavy drilling fluid was the only thing stopping it from coming to the surface.

On April 20, workers began removing the drilling fluid and replacing it with seawater, allowing gas to shoot to the surface, where it caught fire.

Drilling "mud," perhaps mixed with oil, appeared to spew from BP's crippled well Wednesday, the company said, after workers began trying to plug it. CEO Tony Hayward said success wouldn't be clear until Thursday.