Chapter 4 | Technical Findings

The Chief Counsel's team's overall technical findings are straightforward. The Macondo well blew out because the cement that BP and Halliburton pumped down to the bottom of the production casing on April 19 failed to seal off, or "isolate," hydrocarbons in the formation. As rig personnel replaced heavy drilling mud in the well and riser with seawater on April 20, they steadily reduced the pressure inside the well. At approximately 8:50 p.m., the drilling fluid pressure no longer balanced the pressure of hydrocarbons in the pay zone at the bottom of the well. At this point, the well became "underbalanced."

Once the well was underbalanced, hydrocarbons began to flow into the annular space around the production casing. In oil field terms, the Macondo well was "taking a kick." Those hydrocarbons flowed down through the annular space to the bottom of the well, into the production casing through the "shoe track," then up the well and into the riser. As they traveled up the well, the hydrocarbons expanded at an ever-increasing rate and the kick escalated into a full-scale blowout. Transocean's rig crew did not respond to the kick before hydrocarbons had entered the riser, and perhaps not until mud began flowing out of the riser onto the rig floor. Within 10 minutes of the rig crew's first response, hydrocarbon gas from the well ignited, triggering the first explosion.

Underlying Technical Causes

Behind this simple story is a complex web of human errors, engineering misjudgments, missed opportunities, and outright mistakes. Chapter 4 of the Chief Counsel's Report divides technical analysis of the blowout into 10 subchapters. Each subchapter presents the Chief Counsel's team's findings on specific technical issues.

- Chapter 4.1 presents the basis for the Chief Counsel's team's conclusions regarding the precise flow path of hydrocarbons during the blowout.
- Chapter 4.2 explains a number of the well design decisions that BP's engineering team made at Macondo and presents several findings regarding the impact of those decisions. The Chief Counsel's team finds that BP's decision to use a long string production casing increased the difficulty of achieving zonal isolation during the cement job. While the decision did not directly cause the blowout, it increased the risk of cementing failure. The Chief Counsel's team also finds that BP's decisions to include rupture disks and omit a protective casing from its well design complicated post-blowout containment efforts.
- Chapter 4.3 presents findings regarding the final cement job at Macondo. The cement job failed to isolate hydrocarbons. While it may never be possible to determine precisely why, the Chief Counsel's team identified a number of risk factors and other issues that

could have contributed to cement failure. The rig crew, cement contractors, and engineering team do not appear to have fully appreciated these risk factors.

- Chapter 4.4 presents findings regarding pre- and post-blowout testing of the foamed cement slurry design used at Macondo. The Chief Counsel's team finds that the foamed cement used at the well was very likely unstable and that this could have been a major contributing factor to overall cement failure.
- Chapter 4.5 presents findings regarding the temporary abandonment procedures that BP developed and employed at the Macondo well. The Chief Counsel's team finds that those procedures reduced the number of barriers that would be present in the well when it became underbalanced, and significantly and unnecessarily increased the risk of a blowout.
- Chapter 4.6 presents findings regarding the negative pressure test conducted on April 20. The Chief Counsel's team finds that the test clearly showed that the cement had failed to isolate hydrocarbons. BP and Transocean rig personnel both failed to interpret the test properly and instead reached a consensus that the test had demonstrated well integrity.
- Chapter 4.7 explains that the Transocean crew and Sperry-Sun mudloggers missed warning signs of a kick on the evening of April 20. The Chief Counsel's team finds that data from the rig show signs of an anomaly as early as 9:01 p.m. Some of the signs went unnoticed; others the crew detected. But even after rig personnel detected the anomaly, they did not identify it as a kick until after hydrocarbons had entered the riser. If rig personnel had identified the kick earlier, they could have prevented the Macondo blowout.
- Chapter 4.8 presents findings regarding the crew's response to the blowout after it occurred. The Chief Counsel's team finds that the crew might have mitigated the size and impact of the fires and explosions on April 20 if they had immediately diverted flow during the blowout overboard rather than to a mud gas separator system that was incapable of handling that extreme flow volume.
- Chapter 4.9 presents findings regarding the rig's blowout preventer, or BOP. Hydrocarbons had entered the riser well before the crew attempted to activate the BOP, and even a perfectly functioning BOP could not have prevented the explosions that killed 11 men on April 20. Nevertheless, BOP failures may have contributed to the magnitude of the oil spill. While BOP forensic testing is ongoing, the Chief Counsel's team presents findings regarding maintenance history and certain BOP failure theories.
- Chapter 4.10 presents findings regarding the role of rig maintenance in the blowout. The Chief Counsel's team finds that Transocean did not maintain its BOP according to manufacturer recommendations. And the Chief Counsel's team cannot rule out that this may have contributed to BOP failures. While the Chief Counsel's team found some

indications of other maintenance problems on the *Deepwater Horizon*, it does not find that any of these contributed to the blowout.

Underlying Management Causes

Each of these chapters also presents management findings that relate specifically to the technical findings in the chapter. The Chief Counsel's team finds that management failures lay at the root of all of the technical failures discussed in this Report. Chapter 5 discusses management failures in detail.