Chapter 4.6 | Negative Pressure Test

The negative pressure test performed at Macondo showed repeatedly over a three-hour period that the well lacked integrity and that the cement had failed to seal off the hydrocarbons in the pay zone. BP well site leaders, in consultation with Transocean rig personnel, nevertheless mistakenly concluded that the test had demonstrated well integrity and then proceeded to the next phase of temporary abandonment.

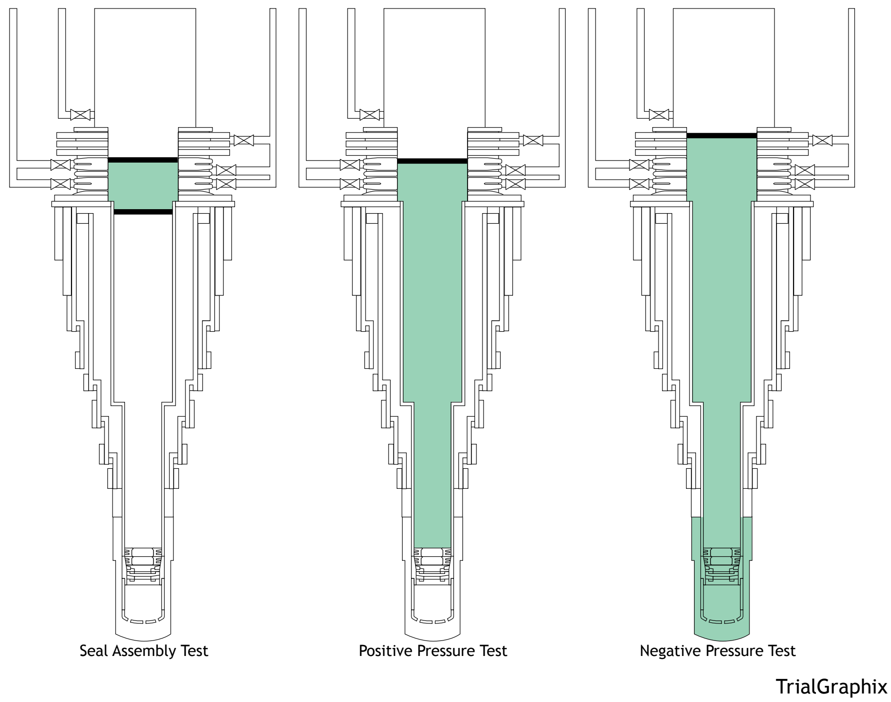
The Chief Counsel's team finds that the failure to properly conduct and interpret the negative pressure test was a major contributing factor to the blowout.

Well Integrity Tests

After cementing the production casing, BP was nearly ready to **complete** the Macondo well and turn it into a producing well. (Completion refers to the process of preparing the well for production and installing equipment to collect oil from the well.)

However, BP only planned to use *Deepwater Horizon* to drill the well, not to complete it. After installing the production casing, BP planned to have the *Deepwater Horizon* leave Macondo for a different drilling job elsewhere in the Gulf of Mexico. Another rig would perform the completion work at some undetermined time in the future.

Figure 4.6.1. Well integrity tests.



The rig crew conducted three pressure tests as part of the temporary abandonment procedure to verify the integrity of the well. From left to right: the seal assembly test, the positive pressure test, and the negative pressure test. Test regions are shown in green.

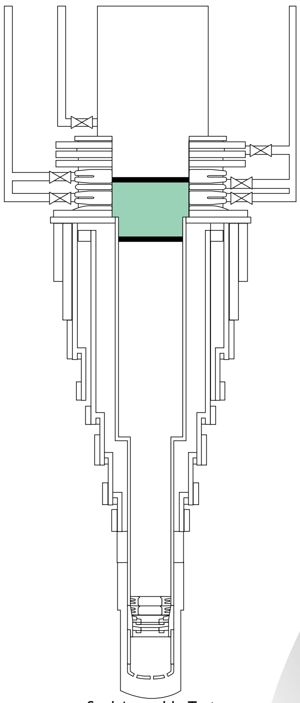
The well would be temporarily "abandoned" during the time between *Deepwater Horizon*'s departure and the completion rig's arrival. The *Deepwater Horizon* crew's last responsibility would be to secure the well to ensure that nothing could leak in or out—to confirm the **well's integrity**—during that intervening time. It was during this **temporary abandonment** process, rather than during drilling, that the blowout occurred.

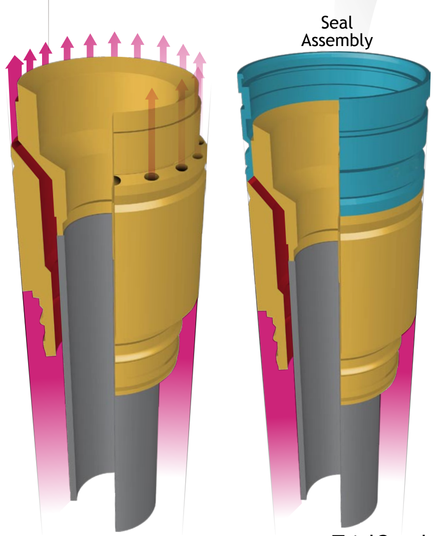
As part of the temporary abandonment procedure, the rig crew conducted tests to check the well's integrity. If there were a leak in the system of cement, casing strings, and mechanical seals that comprised the well, these tests should have revealed it. The rig crew conducted three different tests: a seal assembly test, a positive pressure test, and a negative pressure test. The tests each checked different parts of the well's integrity.

Significantly, however, the negative pressure test was the only one that tested the integrity of the cement at the bottom of the well.[1] That cement is what the rig crew would rely on to isolate hydrocarbons in the pay zone and keep them from coming up the well.

Testing this cement was thus critical to safety of everyone on the rig.

WELL INTEGRITY TESTS





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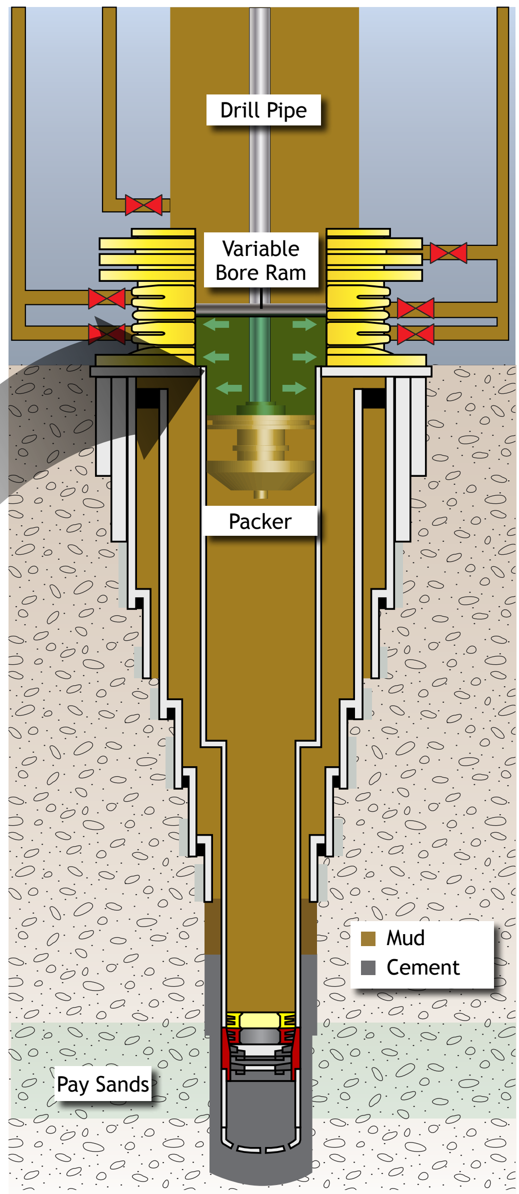
The casing hanger, as described in Chapter 4.1, has flow passages that facilitate the flow of fluids during normal drilling operations. The seal assembly (blue) is fitted atop the casing hanger to halt annular flow after the primary cement job is complete. Together, the two bind the casing to the wellhead.

Figure 4.6.2



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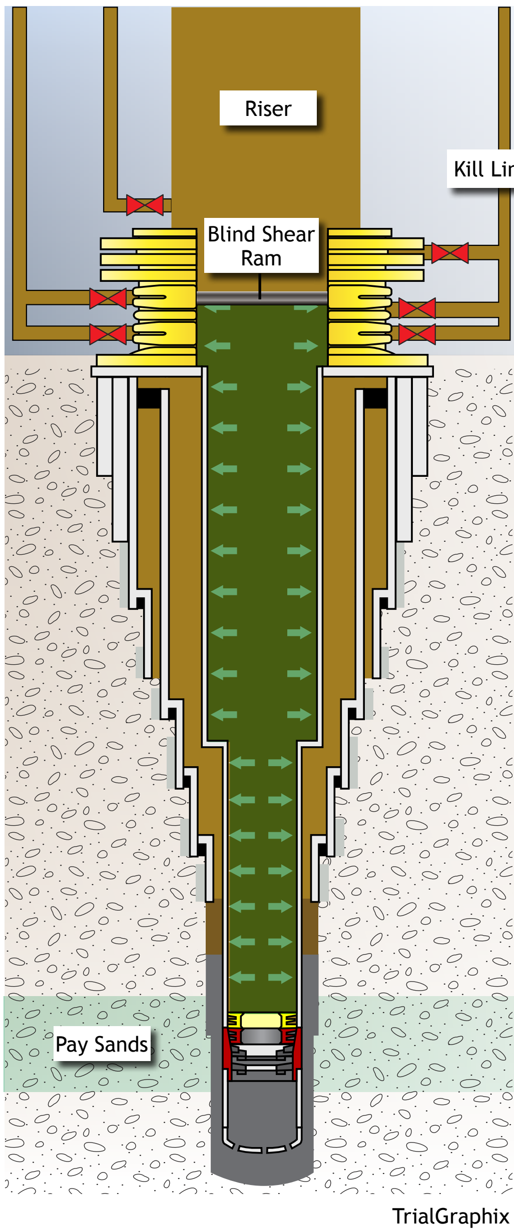
The seal assembly test checked the integrity of the interface between the casing and the wellhead. After lowering a packer into the well, the rig crew closed a variable bore ram around the BOP, sealing the space above and below the seal assembly. The rig crew then pumped fluid into this space, increasing the pressure inside it. If fluid did not leak out of the seal assembly, the pressure would remain constant.

Seal Assembly Test

The **seal assembly test**, as its name implies, tests the casing hanger seal assembly. A long string production casing hangs from a casing hanger inside the wellhead. The casing hanger both supports the casing and seals off the annular space outside the top of the casing. After installing the casing, rig personnel conduct a test to determine that the casing hanger seal does not leak. To do so, the crew installs a plug, or **packer**, on the bottom of the drill pipe and lowers it beneath the seal assembly. The crew closes a variable bore ram of the blowout preventer (BOP) (above the seal assembly) around the drill pipe. This creates a small enclosed space inside the casing at the mudline. The rig crew then pumps additional fluid into this space, increasing the pressure. They then monitor the pressure for a predetermined time period. If the pressure remains constant, it means that the casing hanger seal is capable of containing high internal pressure. If the pressure drops, fluid is escaping through a leak. In the early morning hours of April 20, the rig crew performed two separate pressure tests on the seal assembly, both of which passed.[2]

Figure 4.6.3



The positive pressure test checks the integrity of the well by testing whether the casing and wellhead seal assembly can contain higher pressure than surrounds them. The *Deepwater Horizon* crew increased the pressure in the production casing string by pumping fluid into it through the kill line. If fluid does not leak out of the casing, the pressure again remains constant.

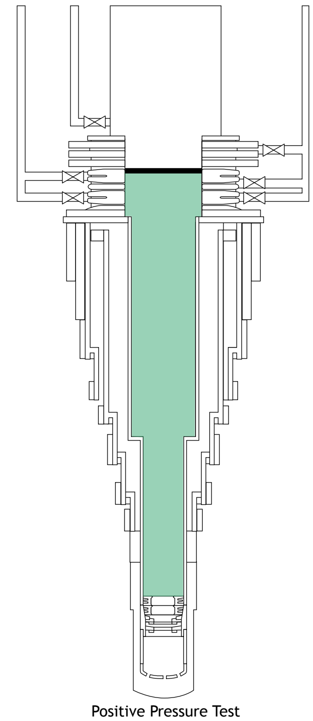
Positive Pressure Test

Later that morning, the rig crew conducted a **positive pressure test**. A positive pressure test is like a seal assembly test, but over a larger area of the well. With the drill pipe pulled out of the well, the rig crew shuts the blind shear rams on the BOP to isolate the well from the riser. The crew then pumps additional fluid into the well below the BOP and monitors the pressure. If the pressure remains constant with the pumps shut off, that means that the casing, wellhead seal assembly, and BOP are containing internal pressure and are not leaking. Between 10:30 a.m. and noon, the crew conducted a positive pressure test to 250 pounds per square inch (psi) for five minutes and then a second to 2,700 psi for 30 minutes. In both instances, pressure inside the well remained constant over the test period.[3]

Because the seal assembly and positive pressure tests at Macondo appear to have been performed and interpreted correctly, this report does not explore them further.

Neither the seal assembly test nor the positive pressure test could check the integrity of the cement in the shoe track or in the annular space at the bottom of the production casing. The seal assembly test could not test anything below the packer. Similarly, the positive pressure test does not test anything below the wiper plug on top of the float collar.

The only test that was capable of testing the bottomhole cement, which was essential to preventing a blowout, was the negative pressure test.[4]



Pressurizing the well during integrity testing requires the rig crew to seal the well at the BOP. Opening and closing valves, such as the kill line, allow the crew to manipulate pressures in the well from the rig.

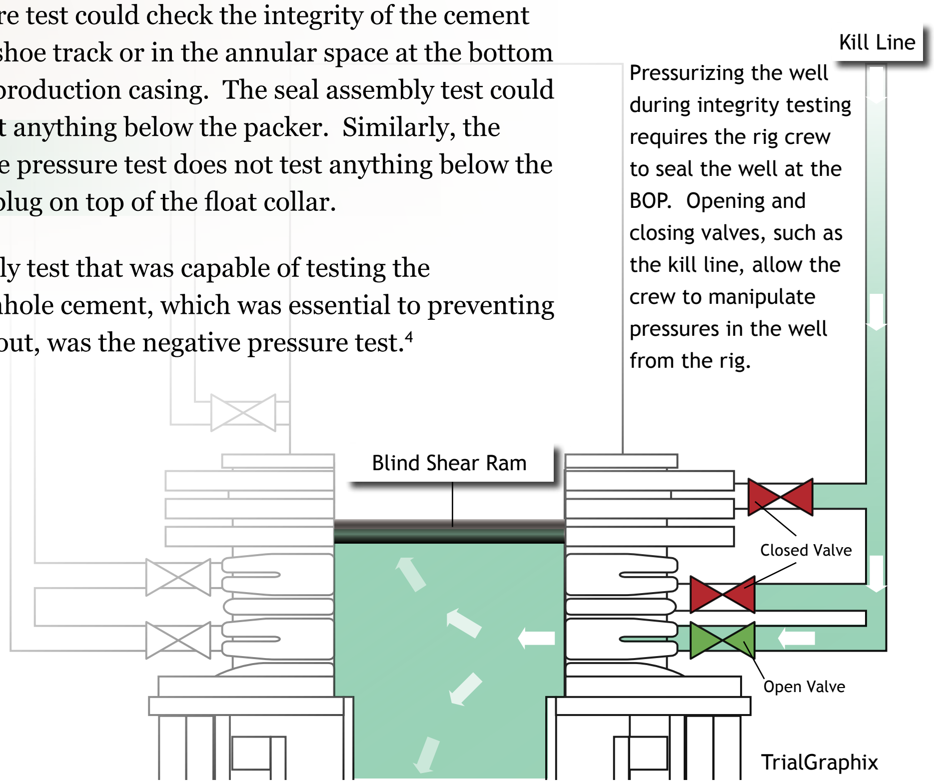
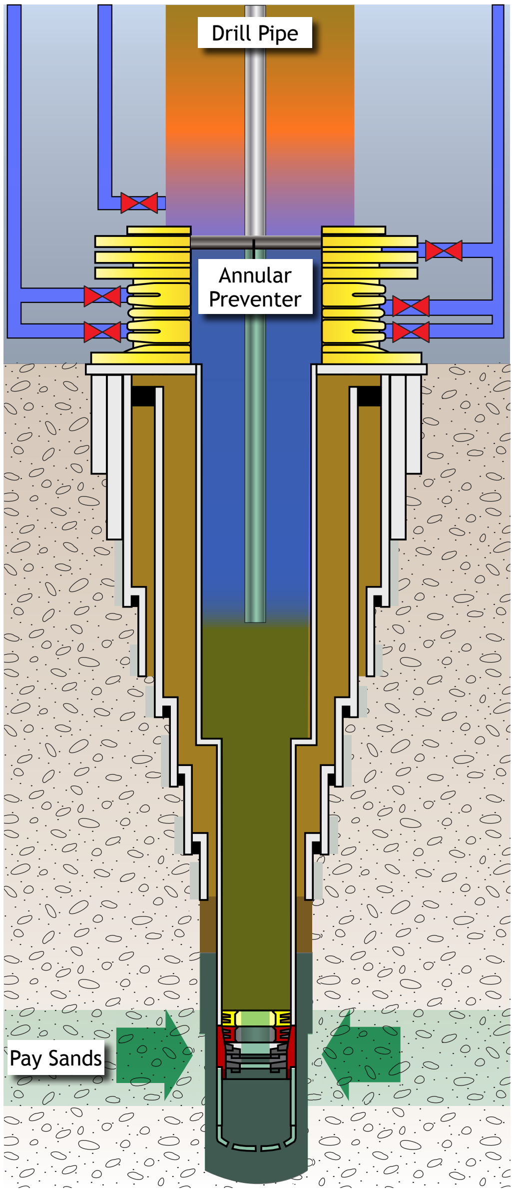


Figure 4.6.4



By moving mud from the production casing into the riser (displacement), the rig personnel reduced the pressure inside the well below the pressure outside the well (underbalancing). If there was good well integrity, the pressure inside the well would remain constant during the negative pressure test. If there was a leak of hydrocarbons into the well, the pressure in the well would rise (if the drill pipe or lines to the rig were closed) or fluid in the wellbore would be forced up and flow out at the rig (if the lines were open).

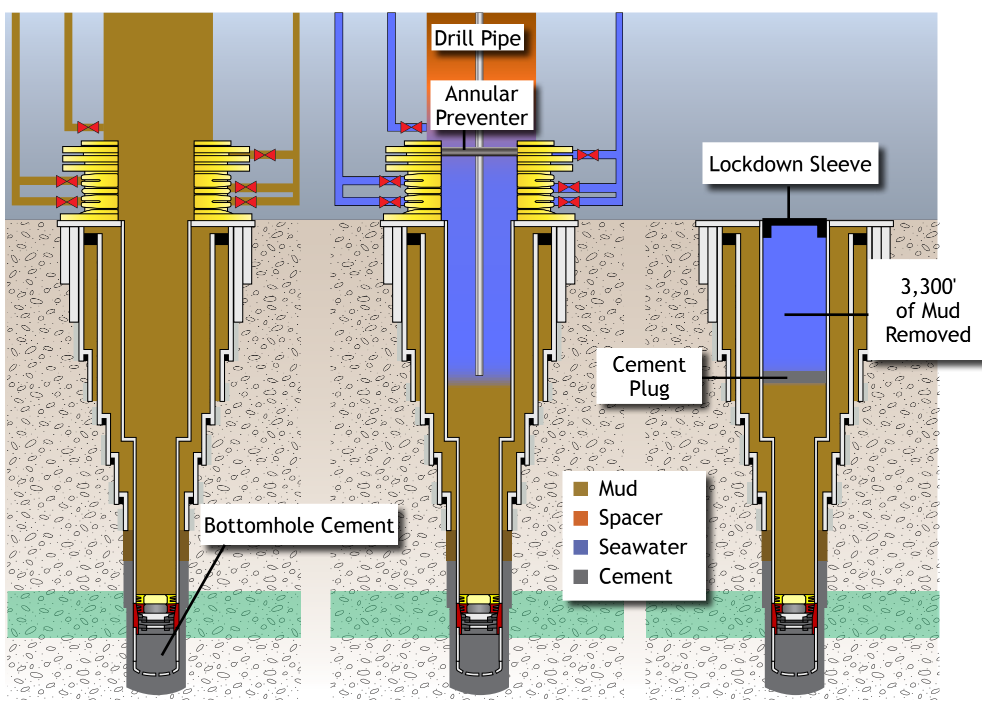
Negative Pressure Test

The **negative pressure test** is essentially the inverse of a positive pressure test. Rig personnel reduce the pressure inside the well below the pressure outside the well and then monitor the well to determine whether any hydrocarbons from the pay zones leak into the well from the formation outside it.

Whereas rig personnel identify a failed positive pressure test by observing diminishing internal pressure, they identify a failed negative pressure test when they observe *increasing* internal pressure while the well is shut in or *flow* from the well while it is open. In a successful negative pressure test, there should be no pressure increase inside the well and no flow from the well for a sustained period of time.[5] Increased pressure during this period indicates that the primary cement job at the bottom of the well has failed and hydrocarbons from the pay zone are entering the well.

The negative pressure test simulates the conditions rig personnel will create inside the well once they remove drilling mud from the riser (and from some portion of the well below the mudline) in order to temporarily abandon the well. Removing that mud removes pressure from inside the well.

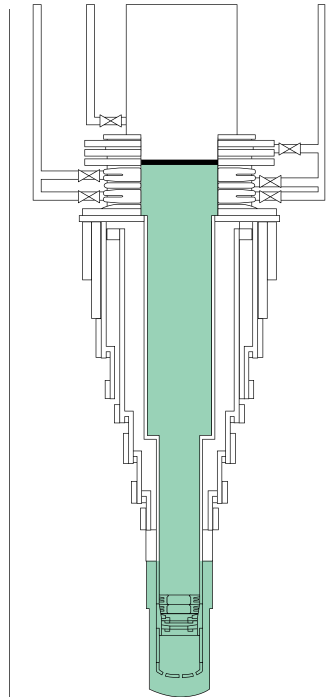
Figure 4.6.5. End of cement to temporary abandonment.



After the final casing string was cemented, heavy drilling mud filled the riser and the well (left). After the temporary abandonment planned for Macondo, the riser and its drilling mud would be removed. The drilling mud in the final casing string would be replaced with lighter seawater to a depth of over 8,000 feet below sea level (right). The removal of the hydrostatic pressure this drilling mud applied to the bottom of the well would increase the stress on the casing, seals, and cement. The negative pressure test simulated the conditions of temporary abandonment to confirm the integrity of the well in a controlled environment (middle).

The purpose of the negative pressure test is to make sure that when that pressure is removed, the casing, cement, and mechanical seals in the well will prevent high-pressure hydrocarbons or other fluids in the pay zone outside the well from leaking in. The test thus evaluates the integrity of the wellhead assembly, the casing, and the mechanical and cement seals in the well—indeed, it is the *only* pressure test that checks the integrity of the primary cement (see Figure 4.6.4).

For these reasons, both BP and Transocean have described the negative pressure test as critically important.[6]



Negative Pressure Test at Macondo

The negative pressure test at Macondo occurred in three separate phases over a five-hour period between approximately 3 and 8 p.m. on April 20.

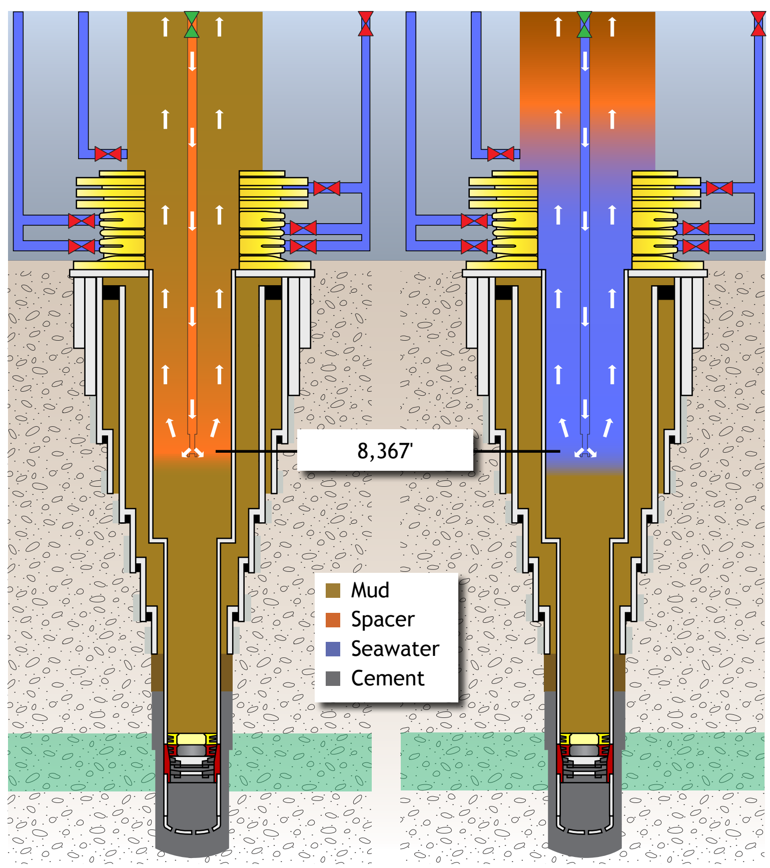
First, the crew prepared to conduct the negative pressure test. To replicate conditions after temporary abandonment, the crew needed to "remove" the column of mud to a depth of 8,367 feet below sea level. In its place, the crew would "substitute" a column of seawater (see Figure 4.6.5). The crew accomplished this by pumping seawater (preceded by a buffer fluid known as **spacer** to separate it from the mud) down through a drill pipe lowered to that depth, illustrated in Figure 4.6.6. As they exited the stinger at the end of the drill pipe, the spacer and seawater would force—or **displace**—the surrounding mud up through the casing and into the riser. Once the seawater had displaced the mud and spacer into the riser above the BOP stack, the crew would close an annular preventer on the BOP around the drill pipe.

Closing the annular preventer would isolate the well below from the hydrostatic pressure exerted by the column of heavy drilling mud and spacer in the riser. At that point, the well would instead be subject to the lower hydrostatic pressure exerted by the lighter 8,367-foot column of seawater in the drill pipe. This would simulate the reduced hydrostatic pressure inside the well after temporary abandonment.

The next step was to conduct what became the first negative pressure test (the crew originally planned to conduct only one test). The crew would open a valve on the drill pipe at the rig and **bleed off** any pent-up pressure inside the drill pipe. In other words, the crew would allow fluids to flow out of the drill pipe until the flow stopped and the pressure in the pipe fell to 0 psi. The crew would then close—or **shut in**—the drill pipe and monitor the pressure inside it to see whether it remained at 0 psi or increased. This **drill pipe pressure** reflected the internal pressure of the well.

At Macondo, the crew had unexpected difficulty in bleeding the drill pipe pressure down to 0 psi. After each attempt, the crew would shut in the well, and the pressure would build back up. The rig crew attempted three times to bleed

Figure 4.6.6. Preparations for the negative pressure test.



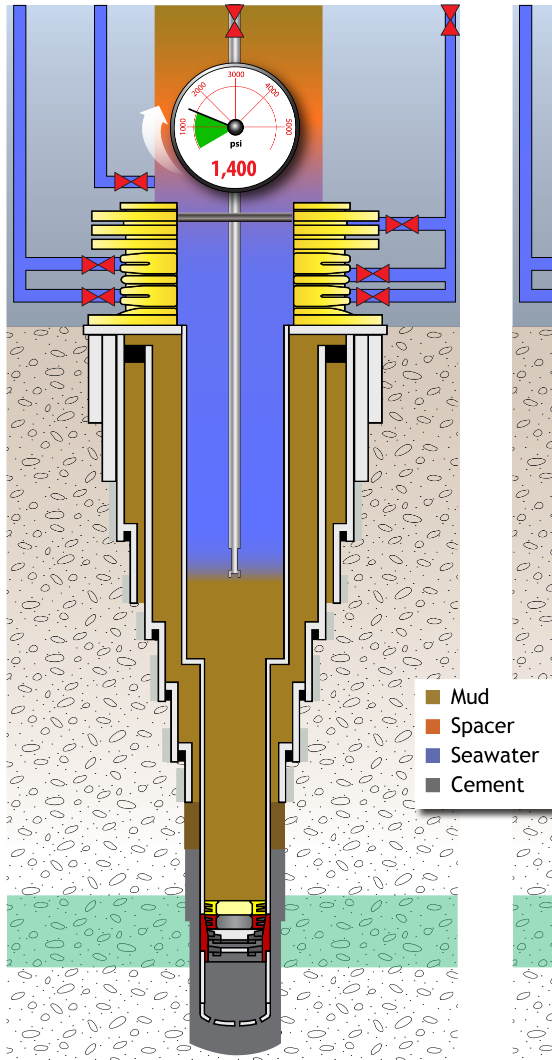
To prepare for the negative pressure test, the rig crew needed to displace the mud in the drill pipe and casing string from a depth of 8,367 feet to above the BOP. The crew did so by pumping spacer fluid (left) and then seawater (right) down the drill pipe until the mud was above the BOP.

off the drill pipe pressure, but each time, the drill pipe pressure rose after being bled off. After the third attempt, drill pipe pressure rose from 0 to 1,400 psi as shown in Figure 4.6.7.

All parties now agree that this 1,400 psi pressure reading indicated that the well had failed the negative pressure test and that the cement job would not prevent hydrocarbons in the pay zones from entering the well.[7] The 1,400 psi pressure was the pressure of the hydrocarbon-bearing pay zone that was not properly sealed off by the primary cement.

The crew did not recognize that this first negative pressure test had identified a problem with the well—or if they did, they did not act upon that fact. Instead, they conducted a second test.

Figure 4.6.7. First test failure.



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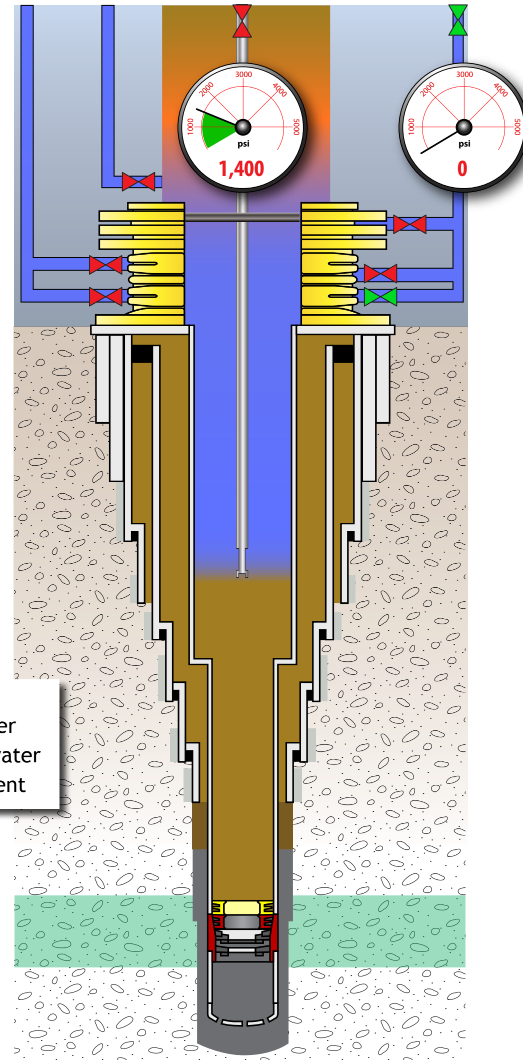
During the first negative pressure test, the crew repeatedly bled the drill pipe pressure down to 0 psi. However, more fluids bled than expected, and the drill pipe pressure repeatedly increased. After the last bleed, the drill pipe pressure rose from 0 to 1,400 psi, a clear failure.

Figure 4.6.8. Second test failure.



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During the second negative pressure test, the crew bled off the pressure in the kill line, rather than the drill pipe. The crew observed no excessive flow or pressure buildup on the kill line. The well site leaders and rig crew decided this was a successful test. But they had never accounted for the pressure on the drill pipe, which remained at 1,400 psi throughout the second test.

BP had submitted a permit modification to MMS stating that it would conduct the negative pressure test on the kill line rather than the drill pipe.[8] At least in part for this reason, BP well site leaders decided to follow up their first test on the drill pipe with a second negative pressure test in which they monitored pressure and flow on the kill line.[9] Rig personnel therefore opened the kill line, bled the pressure down to 0 psi, and monitored the line for 30 minutes. This time, there was no flow or pressure buildup in the kill line. The well site leaders and rig crew decided this was a successful negative pressure test and moved on to the next steps in the temporary abandonment procedure. But, as shown in Figure 4.6.8, although the pressure on the kill line may have stayed at 0 psi, drill pipe pressure remained at 1,400 psi.

The well site leaders and rig crew never adequately accounted for that elevated pressure in the drill pipe.

The negative pressure test at Macondo "failed" in the sense that it did not show that the well had integrity. It was successful, however, in that it repeatedly and accurately identified a serious problem. All parties have since agreed that the 1,400 psi pressure reading on the drill pipe showed that hydrocarbons from the formation were entering the well from the pay zones and that the cement had failed to isolate or block off those pay zones. The larger question is why the men on the rig floor, who depended on this test to ensure well integrity, did not interpret the results of the negative pressure test correctly.

Answering this question is difficult because of the lack of consistent and detailed witness accounts. Some of the most valuable facts will never be known because many of the men involved in the test died in the rig explosion. The well site leaders involved in the test did survive but declined to speak to investigators about what happened (one citing his medical condition and the other invoking his Fifth Amendment rights).

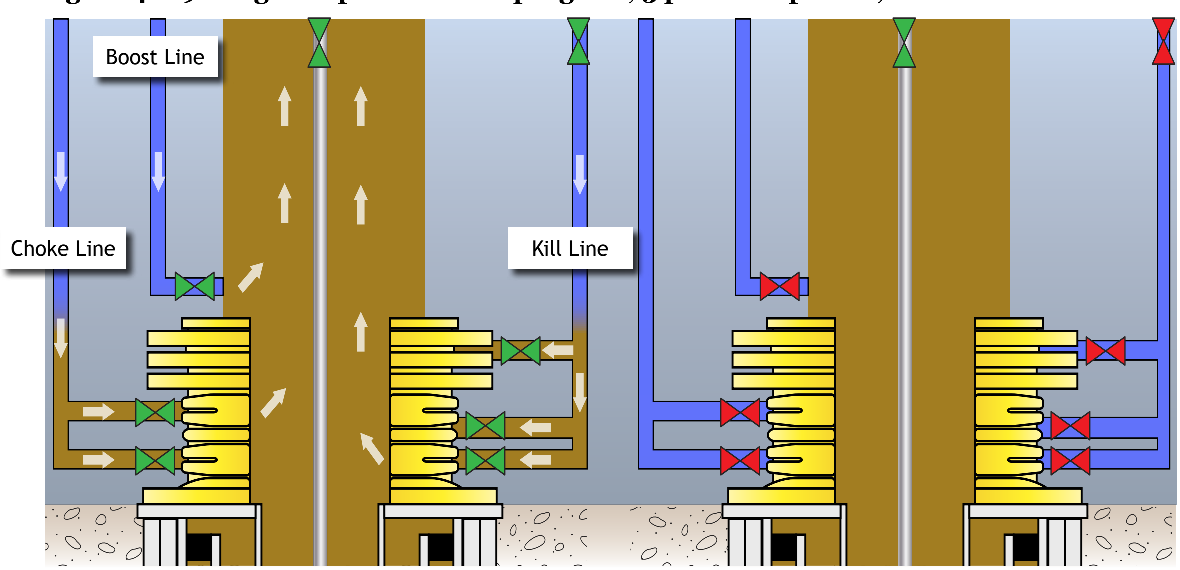
However, the Chief Counsel's team did review notes taken by BP investigators who spoke with both well site leaders soon after the blowout. The Chief Counsel's team also had access to data records showing the pressures that the rig crew observed as well as testimony from witnesses who observed certain events in the drill shack that evening. The Chief Counsel's team based the following account on these information sources.

Preparations for the Negative Pressure Test

The rig crew began preparations for the negative pressure test at about 3 p.m. with a pre-job safety meeting. Because the crew would have to displace drilling mud to conduct the test, Leo Lindner, M-I SWACO's mud engineer, led the meeting. Well site leader Bob Kaluza was present for the meeting, though he left soon after it ended.[10] The meeting was held in or near the drill shack.

Shortly after 3 p.m., Transocean driller Dewey Revette pumped water to displace mud from three pipes, or "lines," that ran from the rig to the BOP stack: the **boost**, **choke**, and **kill lines** (see Figure 4.6.9).

Figure 4.6.9. Negative pressure test progress, 3 p.m. on April 20, 2010.



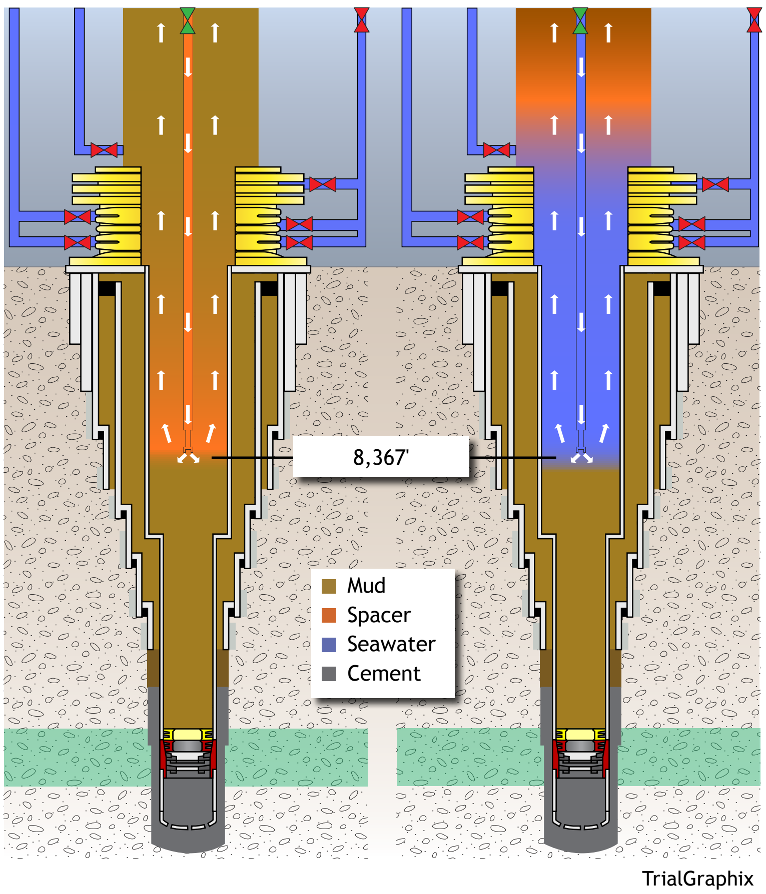
To begin preparations for the negative pressure test, the rig crew displaced the boost, choke, and kill lines with seawater. Seawater was pumped into the lines on the rig, forcing mud into and up the riser (left). After the lines were displaced, the crew closed the valves connecting them to the riser and BOP (right).

Rig personnel could use these lines to pump fluids into the well without pumping fluids through the drill pipe.[11]

The boost line was connected to the well immediately above the BOP. Rig personnel could pump fluids through it to accelerate the displacement of mud in the riser, literally "boosting" mud up toward the rig. The rig crew anticipated pumping seawater through the boost line later in the temporary abandonment process and prepared for doing so by displacing mud inside the line with seawater.

The choke and kill lines were connected to the BOP at various points on the stack. Rig personnel could use these lines to pump fluids in and out of the well even while certain BOP elements were fully sealed. These lines were therefore crucial to controlling kicks during drilling operations: After shutting the well in with the BOP, rig personnel could use them to "kill" the well (that is, overbalance it) with heavy mud and then "choke it off" by circulating hydrocarbons out. The rig crew could also use these lines instead of the drill pipe to conduct the negative pressure test. The men on the *Deepwater Horizon* eventually did use the kill line for this purpose.[12]

Figure 4.6.10. 4 p.m.



The crew displaced the mud in the drill pipe and in the casing from 8,367 feet to above the BOP. The crew first pumped a spacer fluid down the drill pipe, which forced the mud out and up the casing and the riser (left). Following the spacer, the crew pumped seawater into the drill pipe. This forced the spacer and the mud up the casing. The crew's intent was to pump enough seawater to displace the spacer and mud above the BOP (right).

Just before 4 p.m., the crew took its next preparatory step. They pumped seawater down the drill pipe to displace the drilling mud in the pipe and then continued pumping seawater until they displaced mud in the casing above 8,367 feet with seawater as shown in Figure 4.6.10.[13] Because mud is expensive and reusable, and because direct contact with seawater would contaminate it, the crew used spacer fluid as a buffer to separate the seawater from the mud. The crew's goal was to displace the heavy mud and spacer fluid entirely above the BOP.

Use of Lost Circulation Material as Spacer

Operators commonly choose to use a spacer during displacement. However, BP chose to use a somewhat unusual *type* of spacer fluid at Macondo. BP chose to use a fluid composed of leftover **lost circulation materials** stored on the rig. As previously discussed, BP engineers had been concerned about the risk of further lost returns since the lost circulation event in early April. BP had asked M-I SWACO to make up at least two different batches, or "pills," of lost circulation material for that contingency—one commercially known as Form-A-Set and the other as Form-A-Squeeze. BP decided to combine these materials for use as a spacer during displacement.

The combined spacer material that BP chose thus had two unusual characteristics. First, the material was denser than the drilling mud in the well and, at 16 pounds per gallon (ppg), much denser than 8.6 ppg seawater.[14] While using such a dense spacer would arguably assist in displacing mud down and out of the drill pipe, it could prove problematic as well. BP's plan called for the spacer to be pushed up through the wellbore and into the riser by the seawater flowing behind it. By using a spacer that was so much denser than the seawater, BP increased the risk that the spacer would instead flow downward *through* the seawater, potentially ending up *beneath* the BOP and confounding the negative pressure test.[15]

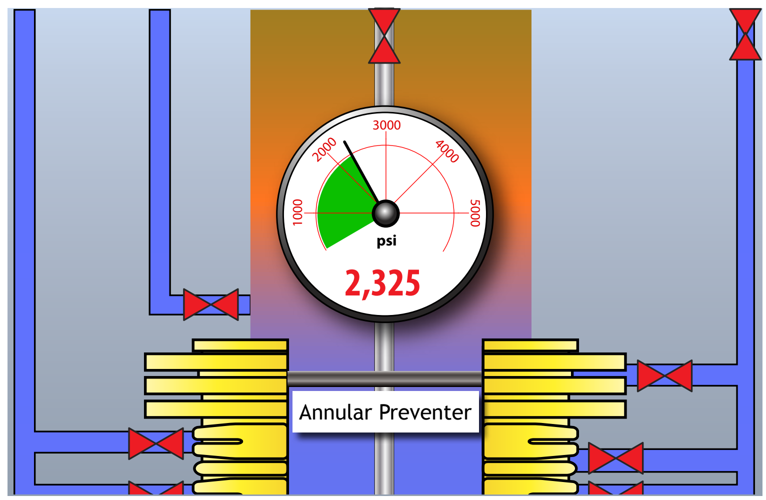
Second, the lost circulation materials that BP combined to create its spacer created a risk of clogging flow paths that could be critical to proper negative pressure testing. Much as blood clots to stop a bleeding wound, viscous lost circulation materials are designed to plug fractured formations to prevent mud from leaking out of a well. M-I SWACO therefore warned BP before the negative pressure test that spacer composed of lost circulation material could "set up" or congeal in "small restrictions" in tools on the drill pipe.[16]

The Chief Counsel's team found no evidence that anyone in the industry had ever used (or even tested) this type of spacer before, much less that anyone at BP or on the rig had done so.[17] There also appears to be no operational reason BP chose to use the lost circulation material as a spacer.[18] Rather, according to internal BP emails and the testimony of various witnesses, BP chose to use the lost circulation pills as a spacer in order to avoid having to dispose of the material as hazardous waste pursuant to the Resource Conservation and Recovery Act (RCRA).[19]

RCRA regulations would normally have required BP to treat and dispose of the two pills as hazardous waste. But BP and M-I SWACO reasoned that once the two pills had been circulated down through the well as a spacer they could be dumped overboard pursuant to RCRA's exemption for water-based drilling fluids.[20] This is what prompted BP to direct M-I SWACO to use the lost circulation material as a spacer.[21] This decision would save BP the cost of shipping the materials back to shore and disposing of them as hazardous waste.[22]

These disposal concerns also led BP to use an unusually large volume of spacer material at Macondo. Typically, 200 barrels of spacer are enough to provide an adequate buffer between mud and seawater.[23] BP chose to pump 454 barrels of its unusual combined spacer fluid at Macondo.[24]

Figure 4.6.11. 4:53 p.m.



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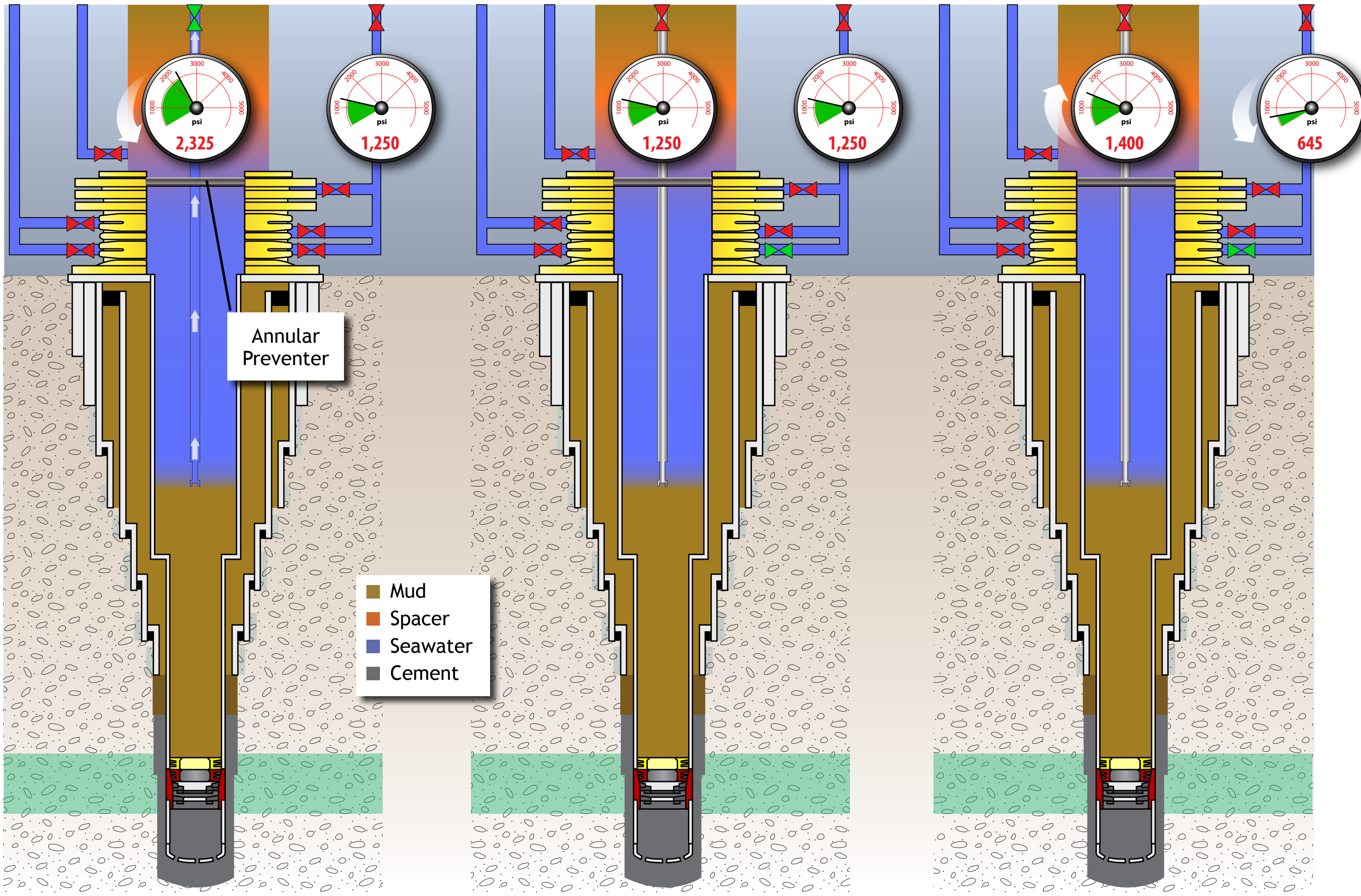
The crew closed the annular preventer around the drill pipe. The drill pipe pressure was approximately 700 psi higher than should have been expected, a sign that some spacer may have remained beneath the BOP.

Unlikely Displacement of All Spacer Above the BOP

After pumping 352 barrels of seawater behind the spacer, the crew closed the upper annular preventer, believing that they had displaced all of the spacer above the BOP.[25] BP's post-incident report calculates that the crew was correct, albeit by a slim margin of just 12 feet.[26] But that calculation is optimistic. It assumes that none of the heavy spacer fell back down through the much lighter seawater that was pushing it upward through the wellbore. Given the substantial density differential between the spacer and seawater and the substantial amount of time it took to displace 454 barrels of spacer, it is likely that at least some of the spacer fell backward through, or mixed with, the seawater on its way up the casing into the riser. Even putting aside that complication, Transocean and at least one independent expert have calculated that the tail end of the spacer did not end up above the BOP.[27]

Figure 4.6.12. 4:55 p.m.



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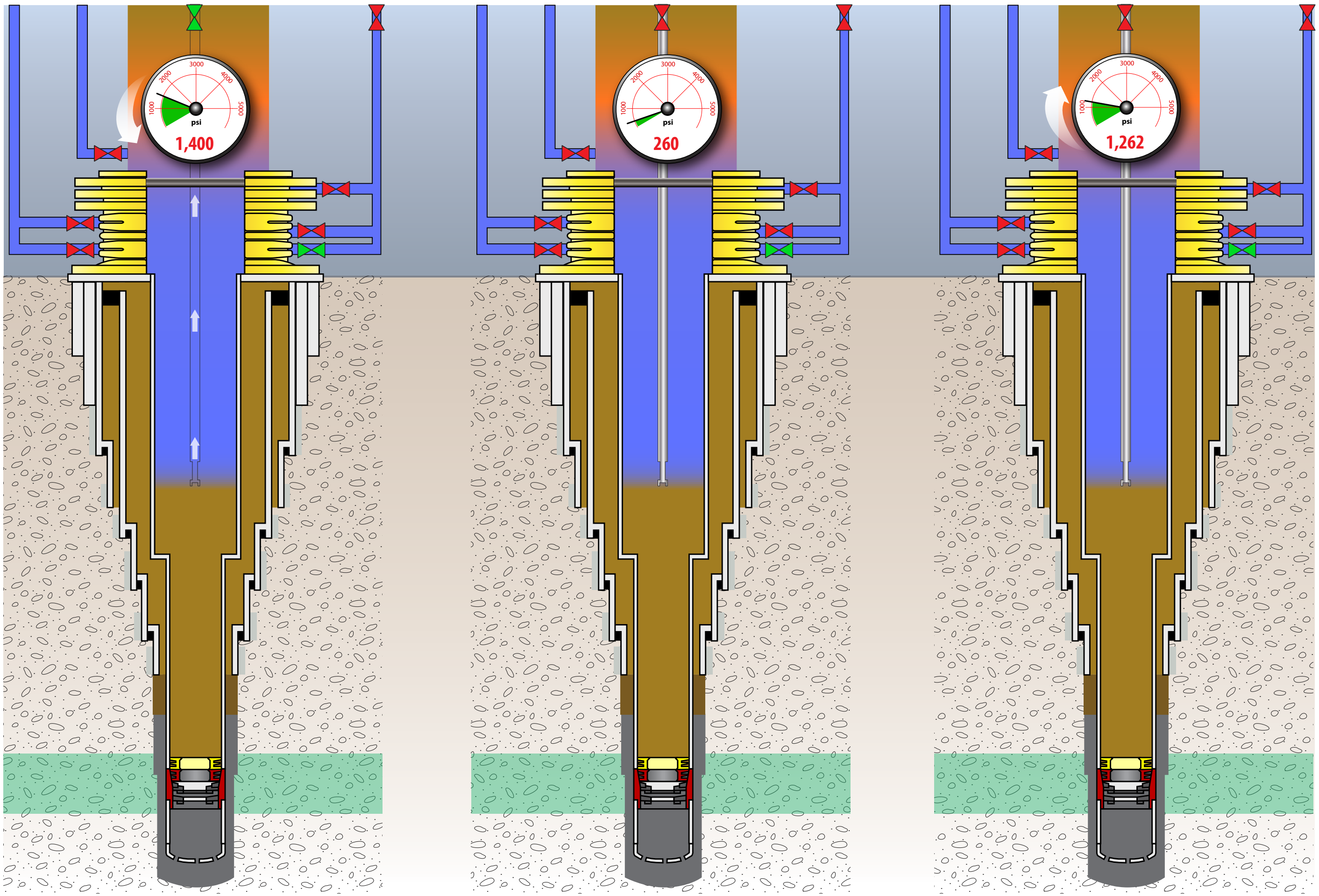
After the annular preventer was closed (left) the crew bled down the pressure in the drill pipe to equalize its pressure with the pressure in the kill line. Because both the drill pipe and the kill line go to the same vessel, when the valve connecting the kill line to the BOP is opened, the pressures should remain equal (middle). Instead, when the valve was opened, the pressures diverged (right).

Because the BOP and wellhead were a mile beneath the rig, the crew had no way of observing directly whether they had displaced all of the spacer above the annular preventer. But pressure readings on the drill pipe should have alerted them that something was amiss. When the crew first closed the annular preventer around the drill pipe (see Figure 4.6.11), the pressure on the drill pipe was approximately 700 psi higher than it should have been.[28] That anomaly should have merited further investigation because it could have indicated that spacer remained below the BOP. But it does not appear that anyone in the drill shack had ever calculated what the drill pipe pressure should have been.[29]

This higher-than-expected pressure was the first of many unrecognized and unheeded anomalous readings during the negative pressure test.

The rig crew next bled the drill pipe to 1,250 psi, in an effort to equalize pressure on the drill pipe with pressure on the kill line (which was 1,250 psi at the time, as shown in Figure 4.6.12).[30] Once the crew had bled the drill pipe pressure down to 1,250 psi, it opened a valve on the kill line at the BOP so that both the drill pipe and kill line were open to the well. At this point, the drill pipe and kill line should have behaved like two straws in the same glass of water: The pressure in both should have been a steady 1,250 psi. Instead, when rig personnel opened the valve, the drill pipe pressure jumped, and the kill line pressure dropped.[31]

Figure 4.6.13. 4:58 p.m.



The crew began the negative pressure test by attempting to bleed the drill pipe pressure to 0 psi (left). However, the crew was unable to reduce pressure to below 260 psi (middle). This bleed returned an unknown amount of water to the rig. The crew shut in the drill pipe, and the pressure built up to 1,262 psi (right). In a successful negative pressure test, pressure does not build up.

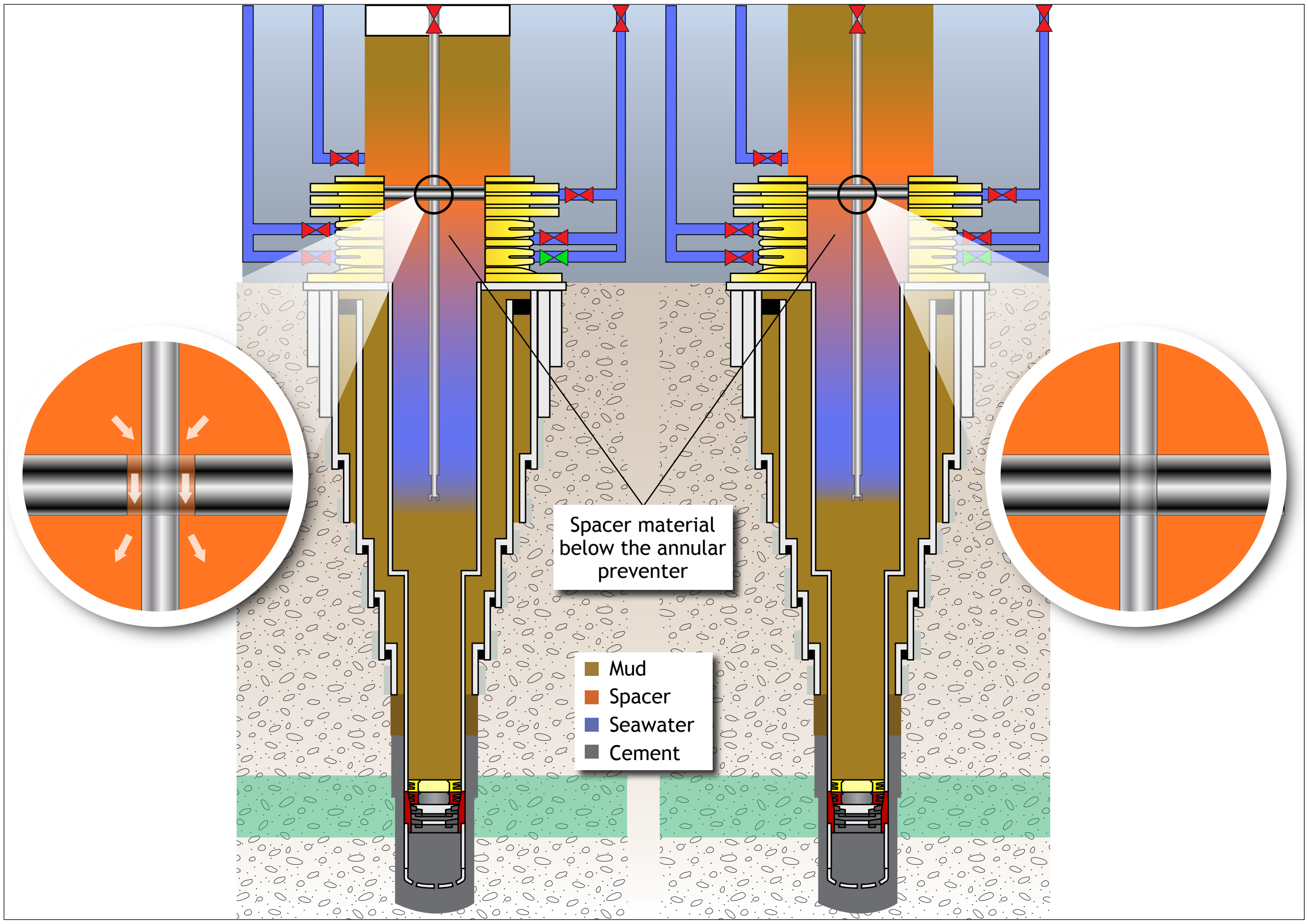
This should have been another indication that spacer might have ended up beneath the BOP or that something else was amiss.[32] There is some evidence that the crew or well site leaders may have recognized a concern, but nobody appears to have acted upon it.[33] In what became a pattern, individuals on the rig did not take a simple precaution: They could have opened up the annular preventer, pumped more seawater into the well to ensure that all spacer had been displaced above the BOP, and begun the negative pressure test anew.[34] This would have taken time but also would have ensured that misplaced spacer did not confound the test results.

The First Negative Pressure Test

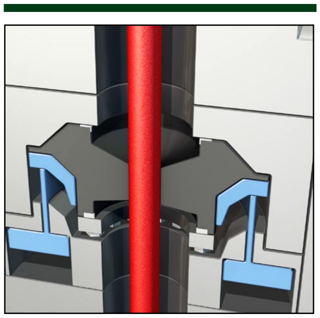
Just before 5 p.m., the crew opened a valve at the top of the drill pipe on the rig and attempted to bleed the drill pipe pressure down to 0 psi, as shown in Figure 4.6.13. The crew was unable to do so and could only reduce pressure to 260 psi.[35] It is not clear how many barrels of fluid the crew bled off at this point. Three witnesses have testified that 23 to 25 barrels were bled off; other accounts suggest it may have been more or less.[36]

The uncertainty over how much fluid flowed from the well during the bleed-off suggests that the well site leaders and crew failed to monitor the bleed-off volumes with requisite rigor. It does not appear that anyone had calculated ahead of time how many barrels should have flowed from the

Figure 4.6.14. 5:10 p.m.



The rig crew noticed that the fluid level in the riser was falling. Because the annular preventer was not sufficiently tight around the drill pipe, spacer fell beneath the BOP (left). In response, the rig crew tightened the seal of the annular preventer and refilled the riser (right), but did not circulate the spacer back above the BOP.



Annular Preventer. The annular preventer is a hard rubber donut that surrounds the drill pipe; when activated it expands and fills the space around the drill pipe, sealing the well below (see also Figure 2.9).

well during the bleed, even though such calculations would have been relatively straightforward.[37] After failing to bleed the pressure down to 0 psi, the crew closed the valve on the drill pipe, and the pressure built back up to 1,262 psi.[38]

These events indicated that the well was not behaving as a closed system. Something was entering the well, although the source of the material entering the well was indeterminate. If the well had been a closed system, the crew would have had no difficulty bleeding the drill pipe pressure down to 0 psi, and the well would have returned far less than 23 barrels of fluid during the bleed-off.[39] Also, the drill pipe pressure would not have increased.

As one independent expert has pointed out, this series of events actually constituted a failed negative pressure test, although the crew did not recognize that fact.[40]

At 5:10 p.m., the rig crew apparently noticed that the level of fluid in the riser was falling.[41] Spacer in the riser was leaking down through the annular preventer and into the well below the BOP.[42] Unlike many other indications, the crew could observe the fluid levels in the riser with their own eyes. When one rig crew member arrived on the rig floor, he saw others standing around the rotary table and using a flashlight to peer down into the riser to see how much fluid was missing.[43]

Around this time, the night crew began to gather at the drill shack in anticipation of the 6 p.m.

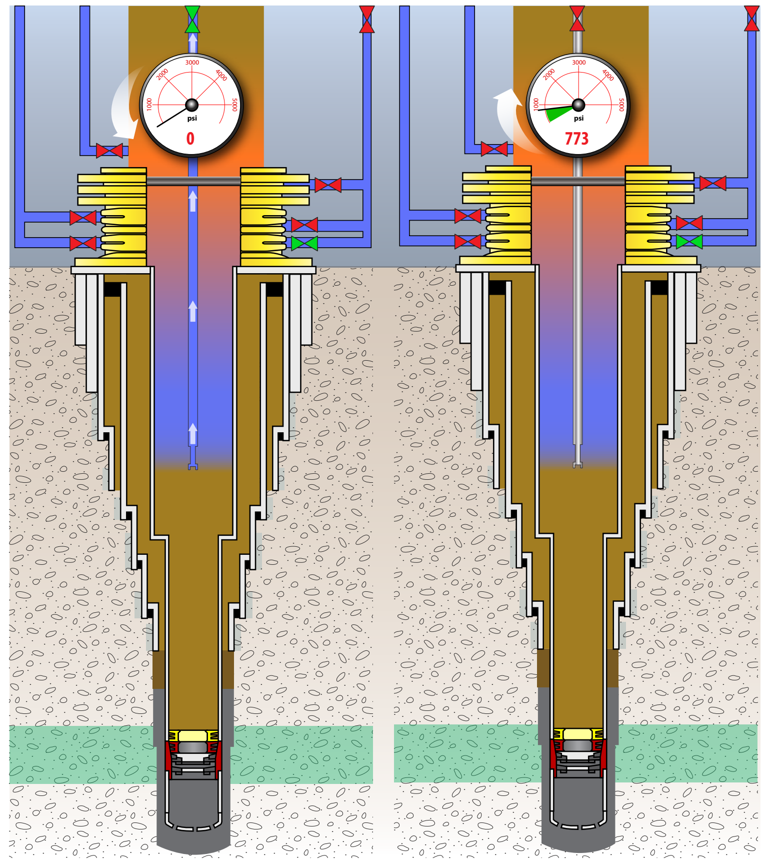
shift change. The night crew would include Transocean toolpusher Jason Anderson and M-I SWACO mud engineer Gordon Jones.

A group of visiting BP and Transocean executives also entered the drill shack as a part of a rig tour. They were escorted by Transocean offshore installation manager Jimmy Harrell and senior toolpusher Randy Ezell. The drill shack was so crowded with the shift relief and tour group that it was "standing room only,"[44] Transocean executive Daun Winslow recognized that the drilling team was confused about something. When the tour group left the drill shack, Winslow asked Harrell and Ezell to remain behind to assist.[45]

In response to the dropping levels of fluid in the riser, Harrell instructed the rig crew to tighten the seal of the annular preventer against the drill pipe as shown in Figure 4.6.14. Wyman Wheeler, the Transocean toolpusher on duty at the time, then topped off the riser with 20 to 25 barrels of mud, and the fluid level in the riser stayed steady.[46] The crew had thus identified and eliminated a leak in the well system that could have explained the anomalous pressure readings they had seen and their inability to bleed the drill pipe pressure to 0 psi.[47] By this time Kaluza returned to the rig floor.[48]

Despite clear evidence that spacer had probably leaked below the BOP, rig personnel again did nothing to ensure that they had fully displaced the spacer above the BOP and instead proceeded with the test.[49]

Figure 4.6.15. 5:26 p.m.



The rig crew attempted again, this time successfully, to bleed the drill pipe pressure down to 0 psi. Fifteen barrels of seawater were returned during this bleed (left). The drill pipe was shut in, but the drill pipe pressure rose to 773 psi. Fifteen barrels is a higher return than should have been expected, and the drill pipe pressure should not have built back up.

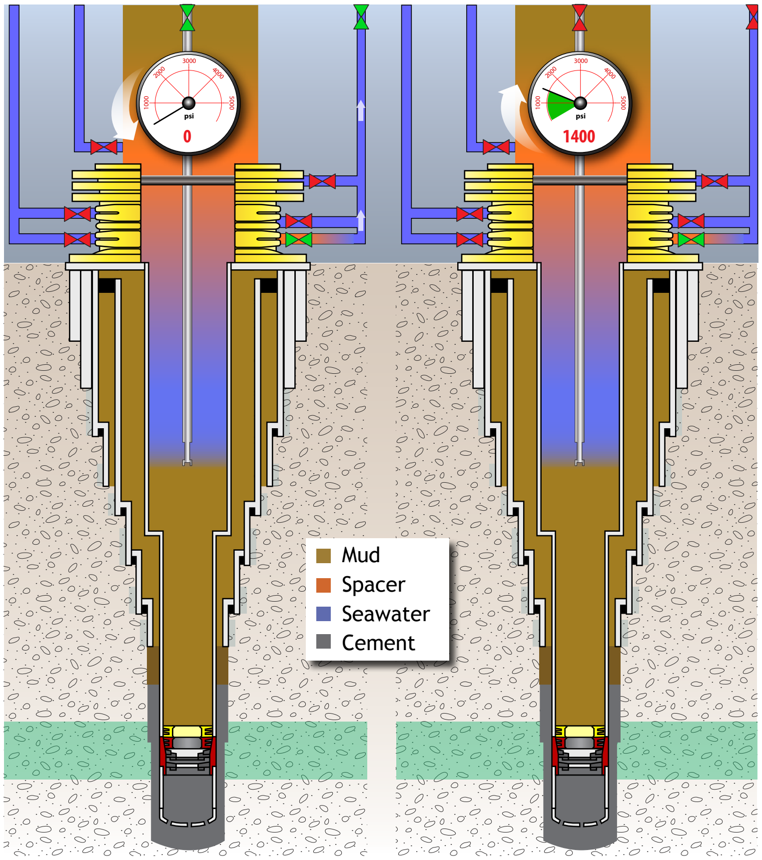
Having tightened the annular preventer, the crew once again tried to bleed the pressure in the drill pipe to 0 psi as shown in Figure 4.6.15. This time they were successful. According to witness accounts, 15 barrels of fluid were bled off from the drill pipe in the process.[50] Again, nobody had done any calculations to predict the returns. Those calculations would have predicted only three to five barrels of returns; the bleed-off process had produced more fluids than it should have.[51]

The crew shut in the drill pipe, but the pressure again built back up.[52] In this case, the pressure reached 773 psi and most likely would have gone higher had the crew not begun immediately bleeding it off.[53]

This second series of bleed-offs, excessive flows, and pressure buildups constituted another failed "negative pressure test" that the crew again did not recognize as such. With the annular preventer fully closed and sealed, the only explanation for the excessive returns and pressure increase would be that the primary cement job had failed to seal off the pay zone. Hydrocarbons were leaking from the formation into the well. Individuals involved in the test at this point should have recognized that the well lacked integrity.

According to at least one witness, shortly before 6 p.m. Kaluza directed the crew to bleed down

Figure 4.6.16. 5:53 p.m.



TrialGraphix

The rig crew bled drill pipe pressure down for a third time, this time through the kill line. Witnesses reported that three to 15 barrels were returned as the drill pipe reached 0 psi (left). When the drill pipe was shut, the drill pipe pressure rose to 1,400 psi. According to BP witnesses, the Transocean rig crew attributed this rise to a "bladder effect." A 15-barrel return would have been excessive, and the rise of drill pipe pressure to 1,400 psi was a clear sign that the negative pressure test had failed (right).

the drill pipe pressure by opening the kill line rather than the drill pipe. Because the kill line and drill pipe both led to the same place (again, like two straws in the same glass of water), bleeding pressure from the kill line would also cause drill pipe pressure to drop to 0 psi. It is not clear why Kaluza directed the crew to bleed down the drill pipe pressure by opening the kill line. The switch may be significant, however, as it suggests uncertainty about the pressure readings and flow observations. "Let's open the kill line and see what happens," Kaluza reportedly said.[54] Shortly afterward, Kaluza left the rig floor to speak with the Don Vidrine, the other BP well site leader whose shift was about to begin.[55]

Witnesses have provided differing estimates of the amount of seawater the crew bled from the kill line, ranging from three to 15 barrels.[56] Flows in the upper end of this range would have been more than expected—but once again, nobody calculated ahead of time what flows to expect. As the pressure on the drill pipe dropped almost to 0 psi,[57] the kill line continued to flow and spurt water until the crew closed the line's upper valve on the rig.[58] Over the next 30 to 40 minutes, the drill pipe pressure rose to 1,400 psi as shown in Figure 4.6.16.[59]

This was the clearest indication yet that the well lacked integrity. The 1,400 psi pressure buildup can only have been caused by hydrocarbons leaking into the well from the reservoir formation.

One expert described this test result as a "conclusive failure."[60] Later analysis has shown that 1,400 psi is approximately the reading that one would have expected reservoir hydrocarbon pressure to produce at the surface if there had been *no cement* at the bottom of the well during the negative pressure test.[61]

Kaluza returned to the rig floor with Vidrine, who would soon be relieving him.[62] While personnel at the rig had not treated earlier pressure readings and flow observations as problematic indications, the two well site leaders and other rig personnel did recognize that the rise in drill pipe pressure to 1,400 psi was a cause for concern.[63] According to witness accounts, Kaluza and Vidrine discussed the test in the drill shack together with Anderson, Revette, assistant driller Steve Curtis, and BP well site leader trainee Lee Lambert.[64] Because Kaluza's and Vidrine's accounts are only known through BP internal investigation notes, and the Transocean personnel principally involved did not survive (Ezell has stated that he did not take part in any such conversation and that he left the drill shack before the drill pipe pressure reached 1,400 psi), the details of the discussion are unclear. Transocean has challenged the accounts of the three BP witnesses, but those three accounts are consistent with each other, and at this point the Chief Counsel's team has no testimonial or documentary evidence that conflicts with them.

According to notes from BP's post-incident interviews of Kaluza and Vidrine, as well as testimony from Lambert, Anderson explained that the 1,400 psi pressure on the drill pipe was being caused by a "bladder effect" or "annular compressibility."[65] According to Lambert, Anderson explained that "heavier mud in the riser would push against the annular and transmit pressure into the wellbore, which in turn you would expect to see up the drill pipe," as illustrated in Figure 4.6.17.[66]

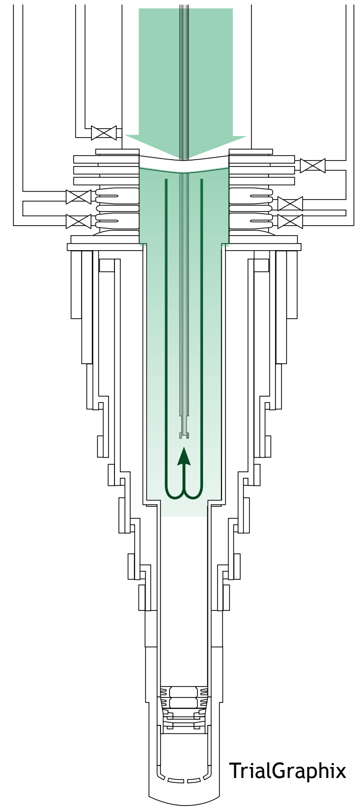
The Chief Counsel's team found no evidence to support this theory. Indeed, every industry expert that the Chief Counsel's team spoke with agreed that no such phenomenon exists. Even if it did exist, any pressure caused by this "bladder effect" would have disappeared after the rig crew bled off the drill pipe and kill line.[67]

Any "bladder effect" could not explain the 1,400 psi on the drill pipe.

Although there was a long discussion about the drill pipe pressure, it does not appear as though anyone in the discussion seriously challenged the bladder effect. According to BP witness accounts, Anderson explained that the pressure buildup after bleeding was not unusual. He told the well site leaders, "Bob and Don, this happens all the time."[68] Revette, the driller, apparently agreed that he had seen the bladder effect before.[69] Lambert testified that he asked about the phenomenon but accepted Anderson's explanation. On later reflection after the blowout, however, Lambert agreed that the explanation did not make sense.[70]

The conversation apparently turned to conducting another negative pressure test, this time on the kill line instead of the drill pipe. According to witness accounts, Vidrine insisted that the crew perform a new negative pressure test on the kill line because the latest permit that BP had submitted to MMS stated that BP would conduct the test on the kill line.[71] But it is unlikely that Vidrine made this decision solely because of the permit language; the rig crew had conducted the first test on the drill pipe without regard to the permit. Moreover, the BP team had already consciously deviated from the permit when it instructed the crew to conduct a combined displacement and negative pressure test–the permitted procedure did not specify such a step.[72] It appears instead that Vidrine insisted on a kill line test at least in part out of concern over the results of the negative pressure test on the drill pipe.[73] But again, neither Vidrine, Kaluza, nor the rig crew treated the test on the drill pipe as a failure. Instead, they chose to disregard it in favor of a new test on the kill line.

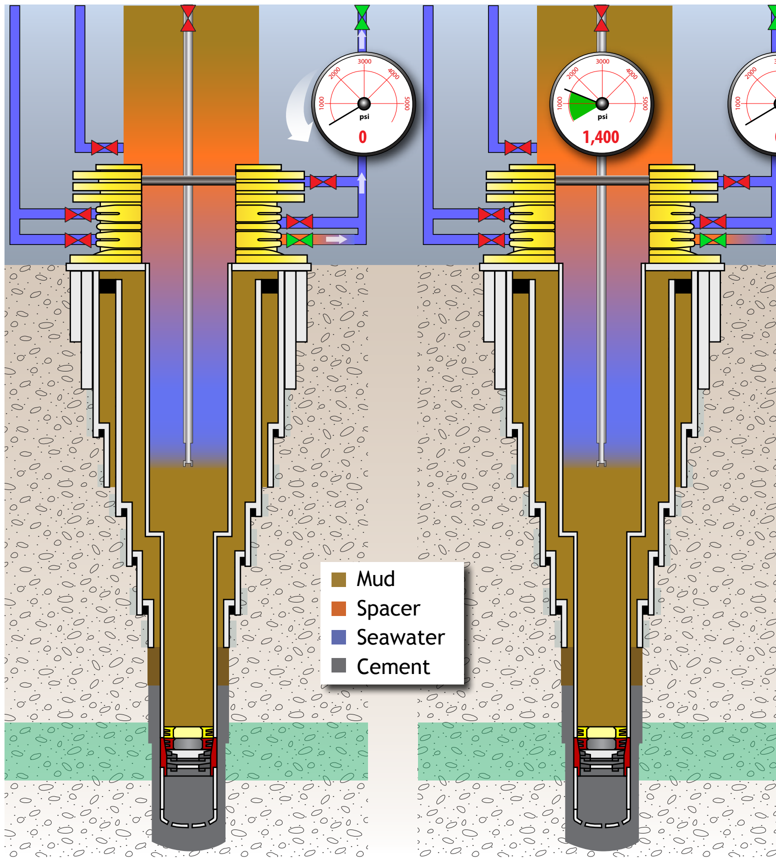
Figure 4.6.17



Bladder Effect. This figure represents the Chief Counsel's team's understanding of the "bladder effect" theory that supposedly explained the elevated pressure on the drill pipe. The "bladder effect" explanation contends that heavy fluids (mud and spacer) displaced to the riser were exerting force on the annular preventer from above, which in turn communicated pressure into the well. The Chief Counsel's team found no evidence to support this theory.

The Second Negative Pressure Test

Figure 4.6.18. 6:40 p.m.



TrialGraphix

The rig crew conducted a negative pressure test on the kill line. The rig crew reduced the pressure on the kill line to 0 psi, bleeding an insignificant amount of water (left). No flow or pressure buildup was observed on the kill line, which on its own would have been a successful negative pressure test. However, the 1,400 psi on the drill pipe remained and was never properly accounted for (right).

Sometime after 6:40 p.m. on April 20, while the group in the drill shack continued to discuss the test, the crew moved the negative pressure test to the kill line at Vidrine's behest. The crew pumped a small amount of fluid into the kill line from the rig to ensure the kill line was full. They plumbed the kill line so that fluids could be bled off into the "mini trip tank" near the drill shack and then bled the pressure on the kill line down to 0 psi as shown in Figure 4.6.18. According to witness accounts, less than one barrel of seawater flowed from the kill line, an insignificant amount. Once that flow stopped, beginning at about 7:15 p.m., the crew monitored the kill line for 30 minutes and observed no additional flow or pressure buildup.[74]

The lack of pressure or flow on the kill line, on its own, would have meant a successful negative pressure test. *But the 1,400 psi on the drill pipe had never disappeared.*

The well site leaders and rig crew carried on their discussion about the test and whether the 1,400 psi on the drill pipe was acceptable. Vidrine later told BP interviewers that he continued talking about the 1,400 psi reading for so long that the rig crew found it "humorous."[75] Anderson and Revette apparently continued to explain the pressure as a "bladder effect." Kaluza's statements to BP investigators suggest that he was present for the discussion as well and that he too accepted the Transocean explanation. He justified his acceptance to the investigators by saying that if Anderson had seen this phenomenon so many times before it must be real.[76] In an email written after the blowout, Kaluza explained to BP management:

> Please consider this suggestion in the analysis about how this happened. I believe there is a bladder effect on the mud below an annular preventer as we discussed.... Due to a bladder effect, pressure can and will build below the annular bladder due to the differential pressure but can not flow – the bladder prevents flow, but we see differential pressure on the other side of the bladder.[77]

In the end, everyone apparently accepted that the negative pressure test on the kill line established that the primary cement job had successfully sealed off hydrocarbons in the pay zone.[78]

Transocean and BP have each contested their relative involvement in the negative pressure test and their relative legal responsibilities for interpreting it. The determination of legal responsibility is beyond the scope of this Report. However, experts and witnesses alike agree that industry practice requires the well site leader to make the final decision regarding whether the test has passed or failed.[79] There is also widespread agreement that the rig crew plays some role in interpreting tests, given their experience in running them and their authority to stop work if they recognize a safety concern.[80]

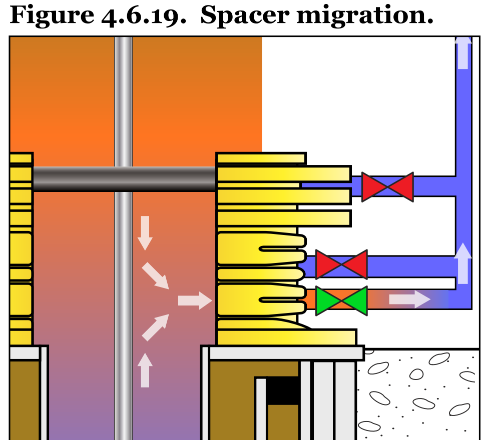
The Chief Counsel's team believes that the group of personnel involved in the Macondo negative pressure test—including Transocean drilling personnel and the two BP well site leaders—decided as a group that the test had succeeded.[81] It appears that the highly experienced Transocean crew[82] affirmatively advocated the view that the first and second negative pressure tests were acceptable once the "bladder effect" was considered, and the well site leaders eventually agreed. The long time spent conducting and discussing the tests shows a desire for consensus. It is possible, even likely, that this desire obscured the parties' responsibilities.

It does not at this time appear that either the BP well site leaders or the Transocean drilling crew ever sought guidance from others on the rig or onshore. For instance, based on available evidence, it does not appear that the BP well site leaders ever called the shoreside BP engineering team to ask for advice on interpreting or conducting the negative pressure test (Ezell also stated that nobody spoke with him regarding the test results).[83] BP did not require its well site leaders to obtain shoreside approval before directing the rig crew to begin temporary abandonment operations.[84] But the shoreside team had valuable expertise and experience. They could have answered questions about the test results, just as they often did regarding other drilling operations.[85] John Guide, BP's Houston-based wells team leader, later stated that given the pressure readings, he would have expected a call from the rig.[86]

Instead, Vidrine apparently deemed the test successful. No one disagreed,[87] and the rig crew moved on to begin displacing the remaining mud from the riser. Vidrine did speak to BP senior drilling engineer Mark Hafle by telephone shortly before 9 p.m., roughly an hour after the negative pressure test was finished. Hafle had called from Houston to see how operations were proceeding. Hafle had the transmitted Macondo drilling data up on his monitor. Vidrine told Hafle that there had been issues with the negative pressure test. He may specifically have told Hafle about the 1,400 psi seen on the drill pipe, and Hafle would have been able to see on his computer the recorded pressures from the test. But Vidrine explained that the test issues had been resolved.[88] The Chief Counsel's team has not seen any evidence of any further discussion of the test with BP personnel onshore.[89]

The second negative pressure test showed again that the well lacked integrity. The 1,400 psi reading from the drill pipe indicated that hydrocarbons were leaking into the well. The fact that the kill line pressure was 0 psi at this time suggests that something may have been blocking fluids from flowing through the kill line and transmitting pressure to the gauges on the rig. One possibility, alluded to earlier, is that the spacer below the BOP had migrated into the 3¹⁄₁₆-inch

Figure 4.6.19. Spacer migration.



Leftover lost circulation material used as spacer for the negative pressure test could have migrated into the kill line during bleeds.

TrialGraphix

diameter kill line and clogged it.[90] It is also possible that rig crews accidentally closed a valve that should have been open. The kill line could also have been clogged by undisplaced mud in the kill line or by gas hydrates that solidified during the test (the same type of hydrates that complicated containment operations).[91] The exact reason may never be known.

Technical Findings

The Negative Pressure Test Showed That the Cement Failed

The pressure readings and flow indications during the negative pressure test were not ambiguous. In retrospect, BP, Transocean, independent experts, and other investigations all agree that this critical test showed that the cement had failed and there was a leak in the well.[92]

There were three instances in which pressure built up after being bled off, including the buildup experts have deemed a "conclusive failure" wherein pressure inside the drill pipe rose from 0 to 1,400 psi.[93] On at least one occasion, bleed-off procedures produced more flow than should have been expected. And while the rig crew observed no flow from the kill line during the second negative pressure test, the drill pipe pressure remained at 1,400 psi.

The test failure should have been clear even though the well site leaders and rig crew had complicated matters by using an untested spacer and by allowing the spacer to leak below the BOP during the test. The well site leaders and rig crew never should have accepted the test as a success or continued with displacement operations.

BP's Spacer Choice Complicated the Negative Pressure Test

BP's decision to use 454 barrels of a highly viscous spacer may have confounded the negative pressure test. All parties agree that at some point during the negative pressure test the spacer had leaked beneath the BOP and that the rig crew never circulated it out. That spacer may have migrated into and clogged the open kill line. If there had been a clear path through the kill line down to the wellhead, the rig crew would have observed the same 1,400 psi pressure inside the kill line that they saw on the drill pipe.[94] If that had happened, the crew might have recognized that the second negative pressure test had failed.

The Chief Counsel's team did not examine the legal significance of BP's decision to use lost circulation materials as spacer and then discharge them directly into the Gulf of Mexico. But the Chief Counsel's team does conclude that greater care should have been taken first in testing and then in monitoring the placement of this unusual spacer.

BP's own investigative report states that its team used the spacer because of a "perceived expediency."[95] Although BP had never used this material as a spacer before or tested it for such use, and although BP used twice as much spacer at Macondo as it had used at other similar jobs, the company did not undertake a risk analysis to consider the consequences of its decision.

BP thus did not consider the risk that a dense spacer made of lost circulation materials could be left beneath the BOP, potentially clogging crucial piping paths.

Rig Personnel Should Have Displaced All Spacer Above the BOP

Personnel involved in the test may have further confounded the negative pressure test by failing to set up the test as intended. They knew for at least two reasons that heavy spacer fluid had leaked beneath the BOP where it could potentially confuse test results. First, they observed that the pressure inside the drill pipe was 2,325 psi when the annular was closed at 5 p.m. Second, when they opened the kill line, they observed a drop in pressure on the kill line and a simultaneous jump in pressure on the drill pipe.

Despite these indicators, the individuals conducting the test did not try to correct the problem even after they decided to run a second negative pressure test. They could easily have circulated the spacer out of the wellbore to ensure that the test was set up as planned. They should have done so.[96]

Management Findings

Given the risk factors attending the bottomhole cement, individuals on the rig should have been particularly attentive to anomalous pressure readings. Instead, it appears they began with the assumption that the cement job had been successful and kept running tests and proposing explanations until they convinced themselves that their assumption was correct. The fact that experienced well site leaders and members of the rig crew believed that the Macondo negative pressure test established well integrity demonstrates serious management failures.

There Were No Established Procedures or Training for Conducting or Interpreting the Negative Pressure Test

Lack of Standard Procedures

Neither BP nor Transocean had pre-established standard procedures for conducting a negative pressure test.[97] While BP required negative pressure tests under certain conditions, one of its employees admitted that the tests "could be different on every single rig depending on what the [well] team agreed to."[98] Transocean likewise required negative pressure tests but did not have set procedures.[99] For example, the crew of the *Marianas* had done the immediately preceding negative pressure test at Macondo in a different way than the *Deepwater Horizon* crew did the April 20 test.[100] Partly because Transocean rigs conducted tests differently (in part because different rigs have different equipment), Kaluza and BP drilling engineer Brian Morel both spoke with an M-I SWACO engineer on April 20 to ask how the rig had previously conducted the negative pressure test.[101]

Unfortunately, the lack of standard test procedures is unsurprising. In April 2010, MMS regulators did not require operators even to conduct negative pressure tests, let alone spell out how such tests were to be performed.[102] (The Chief Counsel's team notes that some wells need not be negative tested.[103]) Nor had the oil and gas industry developed standard practices for negative pressure tests.[104] An independent expert admitted that he had to consult an academic text to find a description of a negative pressure test procedure.[105]

The recent regulatory proposal to require negative pressure test information in permit applications to MMS may trigger companies and the industry to establish standard negative pressure test procedures[106] (discussed further in Chapter 6). A negative pressure test procedure ought to include the depth of mud displacement, the volumes of fluids to be pumped into the well, the pressures and fluid returns to be expected during the test, and criteria for determining whether the negative pressure test passes or fails. The procedure should also include explicit instructions for diagnosing and addressing problematic or anomalous test readings.

Lack of Training at Macondo

BP well site leaders displayed troubling unfamiliarities with negative pressure test theory and practice. Neither Kaluza nor Vidrine calculated expected pressures or volumes before running the negative pressure test even though other BP well site leaders routinely do so.[107] Vidrine, Kaluza, and Morel all described the criteria for a successful test in terms of "flow or no-flow," which ignores the importance of monitoring pressures in the well.[108] Both well site leaders apparently accepted the "bladder effect" explanation, and Kaluza continued defending the theory and describing the Macondo test results as "rock solid" a week after the blowout.[109] These are clear signs that BP needs to train its personnel better.

Transocean has acknowledged that it does not train its personnel in the conduct or interpretation of negative pressure tests and that its Well Control Handbook does not describe a negative pressure test. Instead, Transocean states that its rig crews learn how to conduct a negative pressure test through general work experience.[110]

Partly because of this, Transocean has been unable to conclude whether its *Deepwater Horizon* rig crew had enough experience to conduct and interpret the negative pressure test on April 20.[111] Transocean is not unique in omitting training for the negative pressure test. Experts have stated that academic training on the negative pressure test may only be included in coursework as time allows.[112]

Transocean has argued that the members of its rig crew were tradesmen, not engineers, and could not have been expected to interpret the complex results of the Macondo negative pressure test. Transocean's training approach certainly supports that view.

However, a negative pressure test essentially consists of underbalancing a well and then watching to see if a hydrocarbon kick enters the well as a result. Transocean expected its rig crew to recognize signs of a kick during complex drilling operations. It appears inconsistent for Transocean to claim that its crew is trained in and skilled in recognizing kick indicators during drilling but is unable to recognize the same kick indicators during controlled testing.

Inadequate Procedures for Macondo

The most conspicuous problem with the negative pressure test procedures at Macondo is that there were almost no written procedures at all. As described in Chapter 4.5, although BP eventually developed temporary abandonment procedures that included a negative pressure test, the procedures stated only when the test would be done in relation to other operations. BP did not explain to the crew or its well site leaders how they should perform or interpret the test. The final M-I SWACO procedure, for instance, said simply, "[c]onduct negative test." After the incident, BP engineering managers opined that the Transocean crew knew how to conduct a negative test, and that these limited instructions should have been adequate.[113] Whether justified or not, the events of April 20 prove that BP's expectation was incorrect.

BP's early plans for abandonment repeatedly failed to mention a negative pressure test at all.[114] On April 12, Morel circulated a draft temporary abandonment plan that did not include a negative pressure test.[115] Morel's omission may have been a mere oversight, but it may also have signaled his unfamiliarity with the test.

Ronnie Sepulvado, one of BP's *Deepwater Horizon* well site leaders who was not on the rig for the negative pressure test, needed to tell Morel that he should include one.[116] Similarly, Kaluza's pre-tour briefing to the rig crew described temporary abandonment procedures that did not include a negative pressure test. This prompted Harrell to state that Kaluza needed to add a negative pressure test.[117] Kaluza's omission, like Morel's, may have signaled unfamiliarity with the test and its importance.

Although Morel and other BP engineers continually refined their temporary abandonment procedures, they never expanded their negative pressure test procedures to explain what pressures or flow volumes the crew should expect to see.[118] Even more importantly, they did not add criteria for determining if the test had passed, nor contingency procedures in case the test failed. Kaluza admitted "[w]e didn't talk about what if the negative test fails."[119] Moreover, several of the BP Macondo team's early descriptions of the negative pressure test (including the one approved by MMS) were written so imprecisely that team members disagree even today about what they mean (as described in Chapter 4.5). Nor were the later descriptions passed along in "Ops Notes" or telephone calls necessarily better. When Hafle called Kaluza to discuss the test on the afternoon of April 20, he "had [the] impression that Kaluza wasn't really clear on neg[ative pressure] test procedure."[120] Unfortunately, neither Hafle nor Kaluza seemed to think this uncertainty was a problem, because they appear to have ended the call without resolving it.

Lindner eventually wrote a displacement procedure for BP that contained the most detailed procedure for running the negative pressure test. Lindner's document spelled out how much spacer and seawater the rig crew should pump into the well before conducting the test. His was the first procedure that reflected BP's decision to use a large combined spacer fluid to help displace mud from the well.[121] But it told rig personnel nothing about expected bleed-off volumes, how to interpret the negative pressure test, or what to do about anomalous pressure readings. It may also have included errors. For example, Lindner's calculations directed rig personnel to pump a volume of seawater that may have been too small to fully displace spacer above the blowout preventer. In retrospect, it is inexcusable that the most detailed written procedures for the negative pressure test were written by a mud engineer in the course of specifying fluid volumes to be displaced prior to the test.

Finally, the men on the rig did not always follow the few clearly written procedures that they had. Beginning April 14, the procedures directed that the negative pressure test would be conducted on the kill line. But rig personnel did not follow this instruction during the first negative pressure test. Instead, they conducted the initial negative pressure test on the drill pipe. This may suggest that in addition to creating better test procedures, BP and Transocean need to ensure that those procedures are followed.

BP Failed to Recognize and Alert Rig Personnel to the Exclusive Reliance on the Negative Pressure Test at Macondo

Both the Macondo well plan and the challenges surrounding the Macondo cement job put a premium on the negative pressure test. BP's temporary abandonment procedures required the crew to severely underbalance the well and to rely solely on the high-risk bottomhole cement as the exclusive barrier in the wellbore to flow while they displaced mud from the riser.

Despite these facts, BP never emphasized to rig personnel the particular importance of the Macondo negative pressure test. BP personnel forgot even to mention the test during relevant communications on at least two occasions. (See "Inadequate Procedures for Macondo" section, above). Had BP properly emphasized the importance of the test and the need for special scrutiny of its results, BP and Transocean personnel on the rig may have reacted more appropriately to the anomalous pressure readings and flows they observed.

Leadership and Communication

Even in the absence of detailed procedures, BP well site leaders should have exercised better judgment and initiative. When they confronted a 1,400 psi pressure reading from the drill pipe and a 0 psi reading from kill line, they should have insisted on probing and fully resolving the issue. Instead, interview notes suggest that they deferred to a toolpusher's explanation without fully understanding, questioning, or testing it.

Kaluza was not on the rig floor during most of the preparations for the test and may have missed the first part of the attempted negative pressure test on the drill pipe. He was in the well site leader's office doing calculations for the planned cement plug.[122] Had he been on the rig floor and participating in the test the entire time, Kaluza would have been in a better position to observe several anomalies, including:

- the excessive pressure (2,325 psi) at the end of the pre-test fluid displacement;
- the pressure changes in the drill pipe and kill line when the rig crew opened the kill line valve at the BOP;
- the rig crew's inability to bleed the drill pipe below 260 psi and the abnormally large volume of fluid flow during that bleed; and
- the drop in the fluid level in the riser.[123]

One BP well site leader who was not on the rig on April 20 stated that his practice during negative pressure tests is to remain on the rig floor from the beginning of preparations until he signs off on the test.[124] Independent experts have stated that well site leaders should certainly be present as seawater is pumped out of the drill pipe during displacement and before the crew begins any bleeds.[125]

Kaluza also apparently never personally analyzed the unusual spacer that the rig crew used during his shift.[126] And notes of his statements to BP investigators suggest that he did not recognize that such a spacer could confound the negative pressure test.[127] One independent expert has stated that it would have been standard industry practice for the well site leader to "personally confirm[] the properties of the final blend."[128]

Most significantly, it appears that neither the BP well site leaders nor the Transocean drilling team ever called shore-based personnel to ask for assistance, to report the anomalous pressure readings, or to check the "bladder effect" explanation. Neither company had specific policies in place that required their personnel to report the results of the test to shore.[129] But both BP and Transocean expected rig personnel to call if they needed help or were uncomfortable.[130] Indeed, BP personnel called to shore on April 19 to discuss the problems the rig crew was experiencing while trying to convert the float collar.[131] Instead, the well site leaders and drilling team relied solely on their own limited experience and training to wrongly interpret the test results as a success.