BP Macondo – Deepwater Horizon

Report for the United States of America

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THE REPORT'S AUTHOR

I am a mechanical engineer with thirty three years of experience in the petroleum industry. Eight years of those are as a drilling and completion consultant specializing in remote operations. Previous experience includes fourteen years of petroleum engineering, predominantly in drilling and completions, in both a technical and a field supervisory role for an offshore drilling contractor, a major oil company and an international service company.
My experience includes work both on and offshore in the Western Canadian Sedimentary basin, the Canadian Arctic, and overseas. This report is based upon my formal education and industry experience.

SCOPE OF REPORT

A series of events and decisions resulted in the Macondo blowout. The elimination of any one of these would have eliminated, or at least reduced, the magnitude of the event, presumably with a corresponding reduction in loss of life, injury, and environmental impact. BP's Internal Investigation, the "Bly Report", identifies eight rig-based causation elements that BP asserts caused or contributed to the Deepwater Horizon blowout and its aftermath. These are graphically illustrated in Figure 1, pages 32 and 181 of the report, and reproduced below. I have been asked to provide an opinion as to whether the actions of BP and/or Transocean met the professional standard of care of the drilling industry regarding three of the elements:[1]

- Pressure Testing (particularly the negative pressure test) of the Macondo well on April 20, 2010
- Well Monitoring on April 20, 2010
- Well Control Response on April 20, 2010

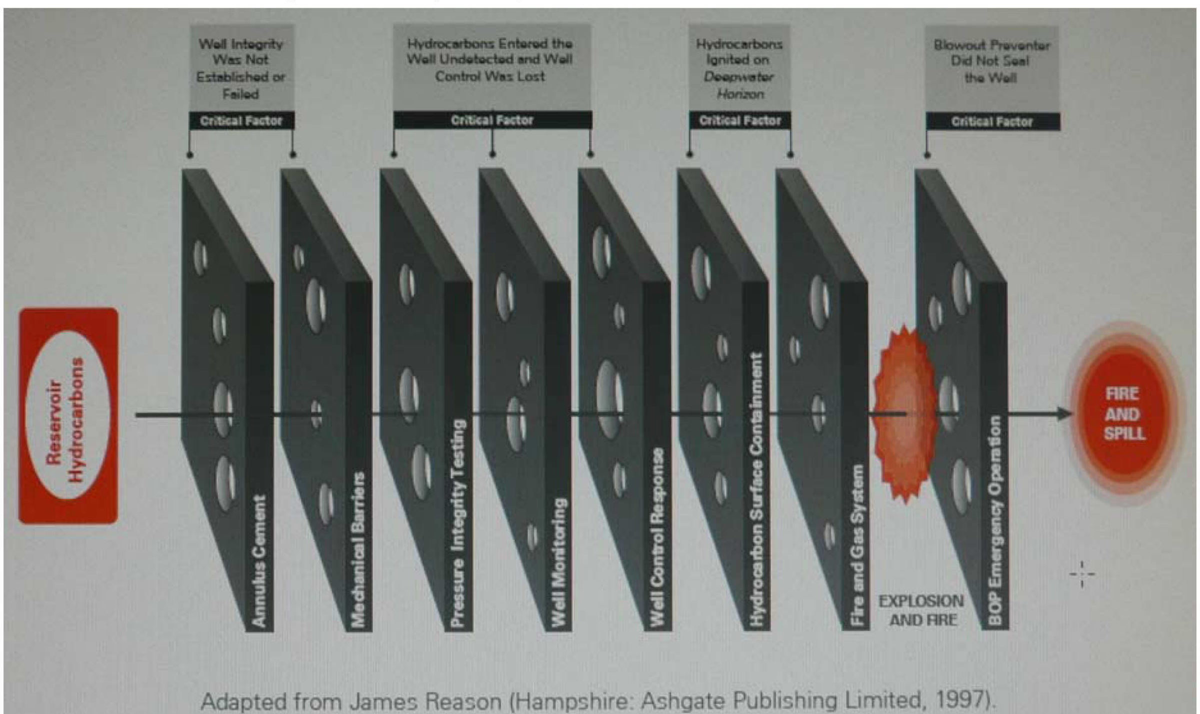

Figure 1. Barriers Breached and the Relationship of Barriers to the Critical Factors.

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[1] I have not been asked to render an opinion on potential failures relating to casing and cement issues (i.e. casing design, cement design and placement, float collar conversion), on the Deepwater Horizon's BOP system (design, maintenance, or functioning), nor on the rig's fire and gas and related systems. In addition, I have not been asked to provide an opinion as to whether the eight causation elements listed in BP's report are the sole factors that caused the Deepwater Horizon blowout. This report therefore does not discuss or make conclusions regarding other potential issues, including process safety issues that may have caused or contributed to the blowout on April 20, 2010.

EXECUTIVE SUMMARY

The standard of care commonly applied in the upstream petroleum industry is “Good Oilfield Practice”, which is generally understood in the industry as “all those things that are generally accepted as good and safe in the carrying on of exploration for petroleum, or in operations for the recovery of petroleum…”[2] or a similar understanding. The Code of Federal Regulations, 30 CFR 250.107, has similar requirements, specifically:

> *(a) You must protect health, safety, property, and the environment by:*
> *(1) Performing all operations in a safe and workmanlike manner; and…*
>
> *(c) You must use the best available and safest technology (BAST) whenever practical on all exploration, development, and production operations…*

The actions of both BP and Transocean with respect to each of the three causation elements that are the subject of this report fell below the standards of Good Oilfield Practice for either an “Operator” like BP or a “Contractor” (rig owner and/or operator) such as Transocean. These actions also failed to satisfy 30 CFR 250.401, which states:

> *You must take necessary precautions to keep wells under control at all times. You must:*
>
> *(a) Use the best available and safest drilling technology to monitor and evaluate well conditions and to minimize the potential for the well to flow or kick;…*

One of the causation modes, the negative pressure test, was a gross and extreme departure from the standards of Good Oilfield Practice. The negative pressure test was a safety critical test and the last diagnostic test of the integrity of the well prior to placing it into an underbalanced situation in which hydrocarbons could flow into the wellbore. The conclusion of both BP and Transocean personnel that the negative pressure test was successful lacked any justification based on basic principles of well control or physics. With minimal explanation, even a layperson would be able to understand how the observed data from the negative pressure test should not have been interpreted as a successful test. The rationalization by Transocean and BP personnel that the observed and contradictory data was caused by a “bladder effect” or “annular pressure” was also grossly below the standards of Good Oilfield Practice. Fundamental principles of engineering should have alerted BP and Transocean personnel that the so-called “bladder effect” theory (even if such a theory existed) could not explain the observed data. The proposal of the bladder effect, which has no technical basis, and the adoption of that theory, demonstrates the abdication of responsibility of both BP and

[2] PETROLEUM (SUBMERGED LANDS) ACT 1982 of South Australia

Transocean. Despite the vast resources committed by both companies to their investigations, neither company was able to explain or verify the existence of a bladder effect.

Finally, approximately an hour after the negative pressure test was incorrectly declared a success, and at roughly the same time that the well began to flow (approximately 20:52), a BP shoreside senior drilling engineer (Mark Hafle) was provided more than enough data by one of BP's Well Site Leaders (Donald Vidrine) to question the "success" of the test.[3] It appears the shoreside engineer did question the conclusion that the test had been a success – by pointing to a critical part of the contradictory data (a pressure differential between the drill pipe and the kill line). Nevertheless, neither he nor the WSL (or apparently any others aboard the rig) took action during the remaining time, nearly an hour before the first explosion, to re-evaluate the results of the negative test to verify the assumption that the test was successful. At that point, conflicting information called the conclusion into doubt, and basic standards of Good Oilfield Practice required that the negative pressure test not be considered a success until this was resolved. As will be shown, the actions that should, and would, have been taken to resolve the conflicting information would have inherently shut-in the well, preventing further influx of reservoir fluids into the well (and subsequently to surface), essentially eliminating the likelihood of a blowout.

BP and Transocean personnel nevertheless:

1. did not take additional action to conduct a retest of the negative pressure test;
2. did not notice, or did not act on, indications that there was the possibility of an influx into the well;
3. did not take timely action to secure (shut-in) the well once they detected further anomalies in the observed parameters.

These failures, both individually and collectively, would be considered grossly outside the accepted standards of Good Oilfield Practice under nearly any circumstances. In view of the known pressure of the formation (approximately 12,000 psi) and the risk of potential harm to the rig, the rig crew, and the environment if a blowout were to occur, these actions were incomprehensible.

In addition to failing the standard of Good Oilfield Practice, this event is eerily similar to a previous event on a Transocean rig in the North Sea. As detailed in a Trans Ocean Operations Advisory of April 14, 2010, a Transocean rig experienced a similar influx and an uncontrolled

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[3] Hafle interview notes – Exhibit 296 page 6 – BP-HZN-BLY00103037
Exhibit 3575 – BP phone log – Hafle/WSL telecom 20:52 April 20

release of wellbore fluids at surface.[4] The event had the following characteristics in common with the Macondo incident.

1. The well was being deliberately placed in an underbalanced condition where the formation pressure exceeded that of the internal hydrostatic pressure.
2. A negative pressure test had been performed and deemed acceptable.
3. The well was being displaced with an "open system" drawing seawater from a "sea chest" and taking mud returns to the mud pits, so that "the true displacement could not be monitored". (Descriptions from the Transocean Operations Advisory).
4. Indications of flow in and flow out discrepancies were not acted upon.
5. Indications of increasing flow out of the well were not acted upon.
6. No action was taken by onboard personnel to secure the well until wellbore fluid started to unload (flow violently out of the wellbore and onto the rig floor area). In other words, the influx had passed the BOPs.

There is no evidence to indicate that this information, which would have reiterated the importance of standard operating procedures, and reinforced the danger of complacency resulting from a successful pressure test, was effectively communicated beyond Transocean's North Sea operations.

[4] Trans Ocean Operations Advisory – TRN-USCG_MMW-00043222 & TRN-OIG-00258937

Assumptions:

The following assumptions have been generally accepted, appear to be consistent with observations, and supported by subsequent forensic examination of recovered equipment. To date they have not been disputed by any of the major parties of the event. For this reason, no further attempt has been made to verify them.

1. The flow path of the hydrocarbons was down the outside of the casing (through the cement sheath), up the inside of the shoe track, and up through the float shoe.
2. The formation fluid then flowed up the inside of the casing, through the BOP and up the drilling riser.
3. At some time subsequent to the first explosion on the rig, the flow also began to flow up the drillpipe.

There were two data acquisition and monitoring systems on the rig at the time of the incident. Both displayed and recorded numerous drilling parameters, including fluid circulating rates and pressures. The first was supplied by Transocean as part of the rig equipment. It is referred to as the Hitec system. Although this provided real-time data to the personnel on the rig, and was considered the "primary source of information" for the drill crew,[5] the data for the relevant time period had not been transmitted to shore and thus was lost and is not available for post analysis. The second system was supplied under contract to BP by Sperry Sun, a Halliburton subsidiary. This data was transmitted to shore on a real-time basis and thus has been preserved and used by numerous parties, including BP and Transocean, for post analysis. A graphical display of 47 parameters has been supplied as Exhibit 604 and HAL_0048974. While the scale on this display is small, the trends relevant to this report are visible. The author has accepted the values provided by BP and Transocean in their respective reports. These appear to be in general agreement with each other, and with the graphical display in Exhibit 604 and HAL_0048974. For the parameters discussed, small variations in their exact values do not materially affect the conclusions of this report.

[5] Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 118

Activities Preceding the Period of Analysis

The BP Macondo prospect was in deep water (5,067'), approximately 50 miles off the Louisiana coast. It was initially spudded (started drilling) October 6, 2009, by the semisubmersible Marianas. On November 8, 2009, drilling operations were suspended and the well was secured due to Hurricane Ida. The Marianas sustained substantial damage during the storm and had to be dry-docked for repairs. The semisubmersible Deepwater Horizon was brought on to the location to finish the well. The 5,000' water depth was deep, but not remarkable. There were, however, numerous other factors that made the Macondo well a very complex project.

1. The producing formations were highly pressured, requiring a mud weight of 14 pounds per gallon (more than that of a normally pressured formation).

2. The margin between the formation pressure and the fracture or leak-off pressure (the pressure at which drilling mud is lost to the formation, possibly resulting in a loss of well control) was very small. Several significant lost circulation events (drilling mud lost to the formation) had occurred, including one from April 4 to 7 in the section that had just been cased and cemented less than a day earlier.

3. The well had already taken a kick (a flow of formation fluids into the well) on March 8, in the same hole section, that had resulted in the bottom hole assembly being lost, and required a sidetrack of the existing hole and a revised casing plan.

At the time of the incident, the well had been drilled to a total depth of 18,360'. Casing was run to a depth of 18,304' and cemented in place with conventional & foam cement. This author will not comment on discussions about cement quality, centralizer placement, etc. as these are better discussed by experts in the field.

Actions Immediately following "Bumping the Plug"

At approximately 00:35 on April 20, personnel on the rig finished displacing the cement for the last casing string. The casing was pressured up to approximately 1,000 psi over circulating pressure (positive pressure test). The pressure was bled off and a total of 5 barrels of fluid was bled back. The casing floats were reported as "holding". In other words, no further flow was noted back up the inside of the casing/drillpipe at that time.[6] After setting the seal assembly at the top of the casing string, the casing was successfully pressure tested (positive pressure) to 250 psi and 2,500 psi (nominal).[7] The crew then ran an open ended string of pipe into the well

[6] BP, Transocean, and Halliburton reports above all agree on the volume.

[7] Transocean Daily Drilling Report 4/20/2010 - TRN-USCG_MMS-00011646

to a depth of 8,367 feet in preparation for the negative pressure test and subsequent displacement of the riser to seawater.

Negative Pressure Test

Pressure testing involves applying a specified pressure differential for a specified period of time and verifying that there is no leakage and no (or a specified small amount of) pressure loss. As mechanical systems may exhibit the ability to contain pressure in different directions (essentially a one way valve effect) it is Good Oilfield Practice to perform a pressure test in the direction of pressure. BP's internal documents reflect this, requiring "if fluid in the wellbore is below kill weight, then test shall be an integrity test from below".[8] In other words, a pressure test (specifically a negative pressure test) needs to be conducted in order to confirm the integrity of the cement outside the casing, the cement in the shoe track, and the valves in the float collar, thus determining if hydrocarbons in the "pay zone" have the ability to enter into the casing and potentially cause a blowout.

It is precisely to confirm the pressure integrity of the system in the required direction that a negative pressure test was specified in the MMS approved temporary abandonment program[9] and planned as part of BP's operations.[10] There was a significant inconsistency regarding the use of a negative pressure test, and also the procedures for the same, as it applied to this well.

1. BP's corporate requirements for zonal isolation included the option of an "inflow test", but did not require it.[11]

2. BP's program for 7" X 9 5/8" – Production Casing Operations specifies "Negative test with base oil to the wellhead – monitor for 30 minutes with no flow".[12] This instruction provides the evaluation criteria ("monitor for 30 minutes with no flow"), but gives little guidance as to the differential pressure required or the method of achieving it. (I.E. Is it intended that the well be displaced to base oil from the wellhead to surface, or something else?)

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[8] BP Drilling & Well Operations Policy (BP-A-D-001) Section 24.2

[9] Exhibit 570 - MMS approved program – April 16 – BP-HZN-MBI 00127907

[10] BP program for 7" X 9 7/8" Interval – BP-HZN-CEC017628

[11] BP "Zonal Isolation Requirements…" DWGOM GP-10-60 – Section 2.2 "Suspension and Temporary Abandonment – Verification of Barriers" BP-HZN-217MDL00377057 and Section 6.3 "Suspension and Temporary Abandonment – Verification of Barriers" BP-HZN-217MDL00377064

[12] GOM Exploration Wells MC 252 #1ST00BP01 – Macondo Prospect – 7" X 9 5/8"Interval" Section 19.2.3 (15) BP-HZN-CEC017628

3. The BP April 12 plan[13] had no instructions regarding a negative pressure test. It merely instructed that the well be displaced to 6,000' with sea water followed by a 300' cement plug.

4. An April 14 email[14] outline had the cement plug set first, followed by a negative pressure test "to the wellhead" with base oil, and finally, displacement of the well to seawater at 6,000'.

5. On April 16 a different procedure was submitted to and approved by the MMS.[15] This included a negative pressure test with sea water gradient via the kill line (to the BOP at 5,000'), followed by a displacement and a negative pressure test to 8,367', and then the setting of a 300' cement plug.

6. An April 20 email[16] provided yet again a different procedure, with only one negative pressure test (with sea water to 8,367'). More detailed instructions on how to perform a negative pressure test, including the displacement fluid and depth, and also the desired pressure differential were included this time, but the procedure is silent on the duration or acceptance criteria for the test. This procedure was essentially the one used, but differs from the procedure submitted to the MMS.

The number of and variations in the procedures for pressure testing show that BP and its management did not have a clear policy on either the use of, or the procedures for, negative pressure testing. At least as significant was the deviation of the final April 20 procedure from the permitted procedure submitted to, and approved by, the MMS four days earlier.

At the time that the final email was sent to the rig, the test string had already been run into the hole and was just above the BOPs, and the DWH was pressure testing the casing (successful positive pressure test to 2,500 psi). In preparation for the displacement and negative pressure test, the choke, kill and boost lines were displaced with water. Then a spacer fluid, used to separate the oil based mud from the seawater, was pumped down the drillpipe and displaced

[13] BP Macondo TA Plan – 9.4.1 – BP-HZN-CEC009137 – Exhibit 570

[14] Email from Morel to R W Sepulvado & J N Wilson @ 2:07 PM April 14, 2010 - BP-HZN-MBI 00126982 – Exhibit 537

[15] MMS Application for Permit to Modify – April 16, 2010 - BP-HZN-MBI 00127909 – Exhibit 570

[16] Email from Morel Vidrine, Kaluza, Lambert, et al @ 10:43 AM April 20, 2010
BP-HZN-2179MDL00060995 – Exhibit 97. (also BP-HZN-CEC008574)

with seawater. The Sperrysun data shows the "U-tube effect" of the heavy mud in the annulus versus the seawater in the drillpipe and choke and kill line.[17]

The annular preventer was then closed. (This action should have isolated the hydrostatic pressure of the drilling mud in the riser from that of the drillpipe and choke/kill/boost lines). Apparently the annular did not initially seal effectively, and 20-25 bbls of mud were added to the riser.[18] It appears that the closing pressure on the annular was increased at this time to get a seal.[19]

[17] From Exhibit 604 (Sperry Sun data), the standpipe (drillpipe) pressure (SPP) at this point was just under 2,500 psi and held steady for 3 minutes (SPP reported as 2,325 psi and choke line @ 1,200 psi) At this point the annular BOP is still open. With the heavier mud in the riser (density of 14.0 ppg) versus the sea water (density of 8.5 ppg) in the drillpipe and the interface is just above the BOP at 5,000', the 1,260 psi figure is believable.

[18] Lee Lambert interview – May 17 2010 – Exhibit 6 - BP-HZN-MBI00021298

[19] Christopher Pleasant deposition – March 14, 2011 – page 405-410
Jimmy Harrel interview – May 20, 2010 - TRN-INV-00001859-60

Interpretation:

The personnel on the rig intended to perform a "negative pressure test" of the casing string, including the casing, shoe track/float equipment, and wellhead seal assembly, by partially displacing the heavy (14.17 ppg) drilling mud with seawater, putting the well in an underbalanced condition and thus confirming the well integrity.

The test sequence was as follows:

1. Run in hole with a tapered drillstring to 8,367 ft.
2. Displace boost, choke, and kill lines to sea water. (I.E. fill the lines from surface to the BOP at approximately 5,000' with sea water.)
3. Displace inside of drillstring and annular space up to BOPs with sea water (8,367 – 5,054 ft). A "spacer" of contingency lost circulation material was pumped between the sea water and the drilling mud.

   Because of the difference in hydrostatic pressure between a column of seawater (inside the drillstring) and seawater and heavy drilling mud (outside the drillstring), a static pressure of approximately 1,460 psi would have been expected on the drillpipe.
4. Close the BOPs to isolate the hydrostatic pressure of the drilling mud in the riser from the wellbore. This action should have resulted in a column of seawater from surface to 8,367 (the bottom of the drillstring) via the drillstring and/or the choke and kill lines, and a "negative pressure test" of approximately 2,350 psi.[20]

   When the annular BOP was closed, it did not seal and approximately 25 barrels of mud was "lost" and was required to refill the riser.[21] Realistically, the fluid was not "lost", but likely U-tubed (flowed due to the pressure differential) up the choke and/or kill and boost lines. Testimony is inconclusive regarding this,[22] but is it likely that, as alleged, some of the spacer may have entered the choke and/or kill line.
5. Confirm negative pressure test. Initial pressure check was 2,263 psi on the drillpipe.[23] This was bled off, but quickly returned to 1,260 psi. Initial pressure check was done at

[20] Negative Test Email – Exhibit 793 BP-HZN-CEC-0088574
(assumes 14 ppg mud - 2350 psi is reduction in hydrostatic pressure – not the underbalance)

[21] Lee Lambert – Exhibit 12 – BP-HZN-MBI00021298

[22] Kaluza - Exhibit 5 – BP-HZN-MBI00021276

[23] Kaluza - Exhibit 5– BP-HZN-MBI00021276

the drillpipe as per "Randy" (Ezell). Kaluza noted that MMS requirement was for pressure test to be done via kill the line. Seawater was pumped through the kill line to confirm that it was open.[24]

6. Pressure on kill line was noted as 30 psi and bled to zero and monitored, showing no flow for 30 minutes.[25] A discussion ensued regarding the discrepancy between the drillpipe pressure and the kill line pressure. After some discussion, the negative pressure test was considered a success.

7. In a subsequent telephone conversation at 20:52 on April 20,[26] about an hour after the negative pressure test was concluded (and coincidentally about the time that modeling suggests that the well began to flow), the discrepancy of pressure between the drillpipe & kill line was discussed between Hafle (engineer on shore) and Vidrine (WSL on the rig). Hafle expressed concern over the discrepancy, but there is no indication of any action taken to resolve it or communication beyond these two individuals. The negative pressure test was still regarded as a success, ("Mark assumed that Don has concluded that it was not a problem"), despite evidence directly challenging this assumption.[27]

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[24] 17:52 per Sperry Exhibit 604

[25] Kaluza - Exhibit 5 – BP-HZN-MBI00021276

[26] BP phone log – Exhibit 3575

[27] Hafle – BP interview – Exhibit 296 - BP-HZN-BLY00103037

Discussion:

Both flow paths (annulus and kill line vs. drillstring) should have been hydrostatically identical (completely full of sea water), i.e. they should have both read the same pressure (zero if the test was successful). Faced with two different pressures, the personnel rationalized it as the "bladder effect" or "annular compression", explaining away the 1,400 psi on the drillpipe as a transmission of pressure from the heavy drilling mud in the riser through the annular BOP element. Other than in connection with this incident, the author has not ever heard of such an effect, nor has BP, Transocean, or other investigative bodies.[28]

In addition to BP's and Transocean's inability to discover the existence of a "bladder effect," the assumption that such a phenomenon could explain the observed data was incorrect for the following reasons:

1. If there had been any such transmission of pressure across the annular BOP element, it would have been seen on both the kill line and on the drillpipe (assuming that the appropriate valves were open and the lines not plugged) as both are in hydrostatic communication (i.e. both have a seawater leg to surface). This is a basic principle of hydrostatics and one of the fundamentals of well control.

2. If the BOP element was acting as a diaphragm and causing pressure communication, the pressure that was present initially on the drillpipe would have remained at zero when bled down. It could not have built back up unless there was a leak across the annular, which would have resulted in a further loss of mud in the riser annulus. If such pressure did exist, it would have to be present on both the kill line and the drillstring – see #1 above.

3. The sealing element in the annular preventer is composed of a large block of rubber, reinforced with steel ribs and rated for 5,000 psi (or 10,000 psi). It is inconceivable that a pressure differential of 1,400 psi (14.17 ppg mud vs. 8.6 ppg sea water at 5,054 ft) could transmit a pressure of 1,260 -1,400 psi to surface without a leak. Even if this were possible, the pressure on the drillpipe would not have returned after it was bled off, as per #2 above.

It has been proposed that the LCM based spacer flowed into the kill line and partially blocked it, resulting in the erroneous readings. It is also possible that the test was not "lined up" properly (e.g. a valve was left closed). A determination as to the cause of the discrepancy is neither productive nor necessary for the purposes of the report, since the reason for the discrepancy

[28] BP - Deepwater Horizon Accident Investigation Report – Exhibit 1 – page 89
Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 102

does not change the overriding fact that the negative pressure test **could not be considered successful.**

The personnel on the rig (operator and contractor), and in town (BP engineering) were presented with two conflicting pieces of information (kill line pressure of 0 psi and drillpipe pressure of 1,400 psi). One of the explanations for this, and as it transpired, the correct one, was that the negative pressure test failed, that the well integrity had failed, and that formation fluids were trying to enter the well (or had already done so).

Good Oilfield Practice and common logic indicate that BP and Transocean should have resolved the cause of the difference, and determined the correct value(s) before proceeding. Instead, they chose to believe the result that they wanted and expected to see, and ignored the clear danger signal from the well. At the time that the rig personnel determined the negative pressure test was successful, the well was already (temporarily) underbalanced and prepared to flow (if in fact influx had not already occurred during attempts to bleed off pressure after 16:55). The failure to resolve the conflict with the data, explaining it with a non-existent phenomenon (the "bladder effect"), and finally declaring the test a "success," was a gross and extreme departure from the standards of Good Oilfield Practice by both BP and Transocean.

Ironically, if the personnel on the rig had taken the necessary action to re-run the negative pressure test at this point, or even immediately after conclusion of the 20:52 to 21:02 Hafle-Vidrine telephone call, their first actions would have been to stop the pumps and close the annular BOP (to isolate the hydrostatic head from the riser fluids). This action alone would have secured the well and prevented the situation from deteriorating while the crew were performing the necessary diagnostic procedures to resolve the discrepancy in pressure (flow checks, circulating lines, etc.). Upon determining that the well had failed the negative pressure test, the crew would have been in a position to circulate the riser and the well/drillstring back to drilling mud and perform remedial actions as required.

At the point that the test results were inconclusive, any one of the individuals involved (Wellsite Leaders, Toolpusher, and Driller) could have and should have;

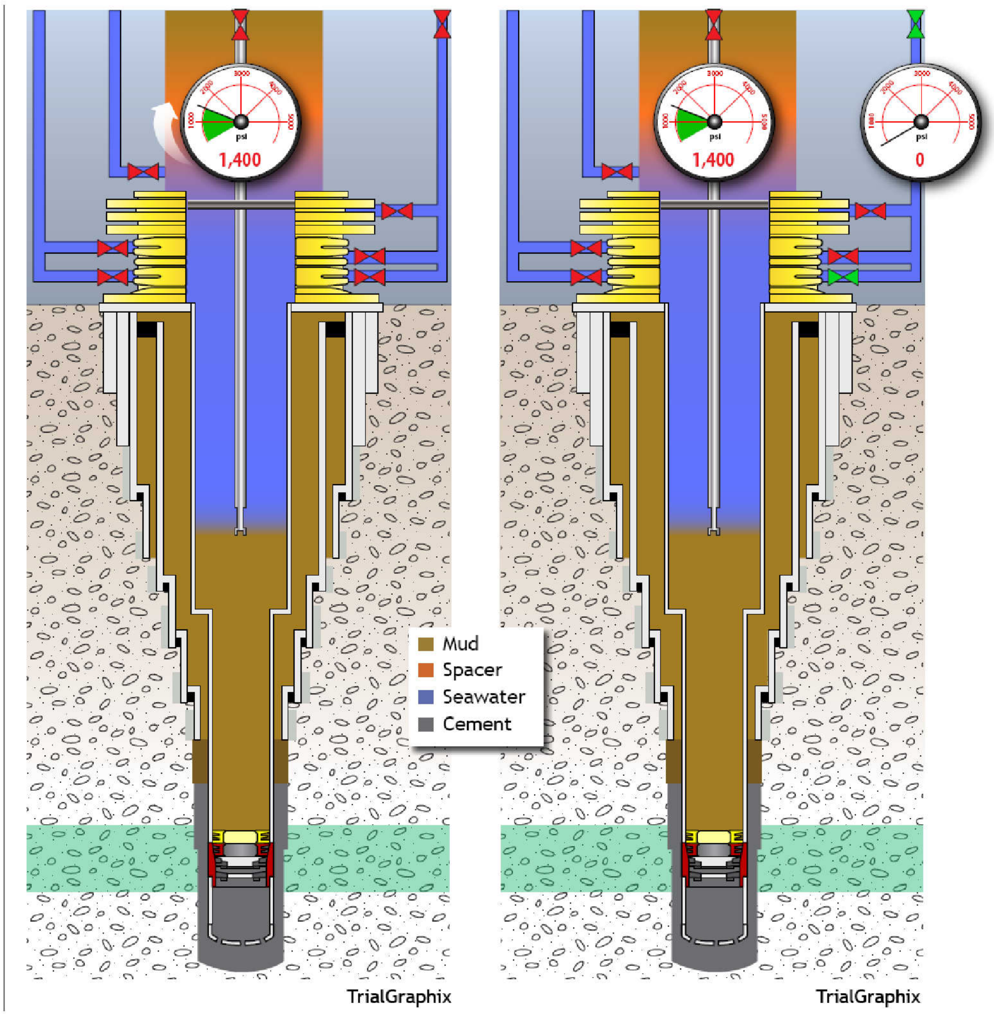
1. Recognized that the "bladder effect" did not explain the observed pressures.

2. Instituted required further investigation and/or consultation with more senior personnel to explain the conflicting data. The opportunity for such a consultation existed when WSL Vidrine spoke to shoreside-based senior engineer Hafle between 20:52 and 21:02. Despite the fact that Hafle was presented with the conflicting pressure data, and indeed stated to Vidrine that the conflicting pressure data could not indicate a

successful pressure test, Hafle accepted Vidrine's conclusion that the test was nevertheless a success.

3. Secured the well until the situation was static.

Both the operator (BP) and contractor (Transocean) should have recognized their responsibilities in the critical task of pressure testing, but there is no evidence that either of them performed any of the above actions.



First Negative Pressure Test
Annular preventer is closed to isolate hydrostatic pressure from the riser fluid.
Seawater from 8,367' to surface via drillpipe shows 1,400 psi
Kill line is closed (0 psi)

Second Negative Pressure Test
Annular preventer is closed to isolate hydrostatic pressure from the riser fluid.
Seawater from 8,367' to surface via kill line (now open) shows 0 psi, but...
drillpipe (still full of seawater) shows 1,400 psi

Well Monitoring During Displacement

After declaring the negative pressure test a success, BP and Transocean proceeded to displace the well and riser to seawater.

One of the primary indicators of a wellbore "kick" or influx of formation fluids is the measurement of flow into the well versus flow out of the well. The most reliable method of determining an influx, and standard operating practice on conventional drilling operations worldwide, is to operate a closed system (no fluid into or out of the system, except that going to/from the wellbore). Thus any change in relative flowrate results in a corresponding change in volume (which is a much more easily and accurately measured parameter). This is commonly referred to as PVT (Pit Volume - Total). The instrumentation and software on the Deepwater Horizon was easily capable of making this measurement and displaying it.

It has been reported that mud was being transferred from the rig's active mud system to the supply vessel Damon Bankston, but this transfer had ended during the negative pressure test and was not resumed.[29] Despite this, other operational procedures on the rig rendered monitoring of this critical parameter difficult to impossible. Personnel on the rig were simultaneously drawing water out of the seachest (the ocean), taking well returns to the mud tanks, and dumping the sand traps and various tanks in the active system, and transferring fluid between various tanks.

Mud logging personnel claimed to have tracked and logged fluid transfers manually,[30] but it is not practical to display or utilize this information in real-time with a calculator, pencil, and paper. The drilling fluid system on a modern offshore drilling rig such as the Deepwater Horizon could have been configured as a closed system by filling one set of tanks with seawater and having another set empty. During the first phase of displacement, the crew would have drawn seawater from one set of tanks and routed drilling mud returns to the empty set. By monitoring the combined volume of both sets, any net change (influx) would have been visible in real time and could have been shown as a trend line on the monitor screens. When one set of seawater and mud tanks was empty/full, the flow could have been switched to a second set and the first refilled with seawater and emptied of mud. This process would have been slightly slower than that selected, but would have significantly improved the accuracy of the monitoring process.

In addition to monitoring the changes in tank volume, it is possible to measure the flowrate of fluids into and out of the well. Flow into the well can be measured relatively accurately by

[29] Log of M/V Damon Bankston – April 20, 2010 13:28 – 17:17 TRN-INV-00402267 & TDR040-251364

[30] Deposition of J Keith – March 28, 2011 – Page 71-78, pages 139 -145

counting the strokes of the positive displacement mud pumps. The rate varies with the speed of the pumps, their mechanical configuration, and their efficiency. Speed of the pumps (stroke rate or rpm) is measured in real time by the data system on the rig. Mechanical configuration (liner size and stroke length) is known. Efficiency can be estimated, but can be, should be, and probably was confirmed experimentally on the rig. With these three parameters, the rate at which fluid is pumped into the well is known and can be calculated and displayed accurately in real-time. The flow out measurement is less precise. On the Deepwater Horizon it was measured by determining the height (depth) of fluid in the flow line and converting that to a "flow rate". The height parameter is sensitive to a number of variables in addition to flow rate. These include mud viscosity and vessel movement. As a result, these indicators, although frequently calibrated in "gallons per minute" or similar flow rate, are not precise, although they serve to indicate a possible change in the flow regime that should be investigated. For example, between 4:00 and 4:25 AM on April 20 the "Flow-In" curve tracks with the "#3 Pump Rate" (at about 400 gpm). The "Flow-Out" curve also generally tracks the other two, varying between 300 and 400 gpm, showing that there is enough "noise" or variability on the curves to make an instantaneous numerical comparison difficult.[31] This is best summarized by the testimony of the mud logger. "Q. Prior to the blowout, were you able to continuously and accurately monitor flow-in versus flow-out? A. No, sir."[32] Even though the personnel were not able to "continuously and accurately monitor flow-in versus flow-out," there was sufficient data available to require further investigation.

Well Displacement Operations – Hitec/Sperrysun Data

Having determined (erroneously) that the negative pressure test was successful, the crew opened the annular BOP and began to displace the well to seawater in preparation for setting an abandonment plug. This removed the hydrostatic pressure of the heavy mud, placing the well in an underbalanced condition. If the cement and casing system had been intact (as would have been proven by a successfully performed negative pressure test), it would have provided a necessary barrier for this operation.[33] This was a "routine operation", but considering the lost circulation history, downhole pressure, and anticipated flow capability of the Macondo well, there was good reason to be cautious when putting such a well in an underbalanced condition.

During the negative pressure test the well had been deliberately underbalanced, but once the annular BOP was opened the hydrostatic pressure of the drilling mud in the riser initially brought the well back into an overbalanced condition. As displacement continued, however,

[31] Sperry Sun Data - HAL_0048974

[32] Deposition of J Keith – March 28, 2011 – Pages 58 - 59

[33] A properly functioning BOP would have provided an additional barrier.

the entire riser, not just the choke/kill lines and drillpipe/tubing, were filled with seawater, reducing the pressure at the bottom of the well and putting it back in an underbalanced condition. As previously discussed, the line-up of the mud pits, combined with the operations underway (simultaneous injection of seawater, taking mud returns, and cleaning of tanks) deprived the crew members of the ability to effectively monitor "pit gain", the primary indication of wellbore influx. In addition, due to the configuration or the rig piping, sensors, and cameras, some of the monitoring devices (see below) were not usable when the flow from the well was diverted overboard. Despite these factors, there were numerous indications that should have alerted the personnel on board that something was not right with the well. Had these been noticed and properly interpreted, corrective action should have been taken, and the explosion/blowout likely been avoided.

At 20:02, displacement of the riser (from the mudline/BOP) was started and pumps #1, #3 & #4 were brought on line.[34] At this point the well was still overbalanced and could not flow.[35] At 20:50, corresponding to the arrival of the spacer at surface, the pumps were slowed to approximately half the previous speed. According to both BP and Transocean calculations the well began to flow as early as 20:38 (Transocean) or at 20:52 (BP). Whatever the exact time, the pumps were slowed at 20:52 and displacement continued as formation fluids began to enter the wellbore.[36]

From 21:01 to 21:08, circulation continued at a further reduced rate. During all this time the mud in the annulus (at approximately 14 ppg) was being replaced with 8.6 ppg seawater. If all other parameters were constant, the drillpipe or standpipe pressure (SPP1 on exhibit 604) would be expected to go down. Instead it increased. According to BP[37] the circulating pressure increased from 1,250 to 1,350 psi. Without the original digital data it is not possible to confirm the exact values. As stated by Transocean, the scales selected determine how obvious the trend is, but the increasing trend is apparent on the full screen 0-7,500 psi "Hitec" display proposed by Transocean,[38] and even on the 15 channel, 0-5,000 psi scale in Exhibit 604. It is not possible to know what the rig crew were monitoring at the time, but the rig crew (Transocean), the Sperry mudloggers, and the supervisory personnel (BP & Transocean) on the

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[34] Halliburton/Sperry Mud Log - Exhibit 604 – HAL_0048974

[35] OLGA modelling BP - Deepwater Horizon Accident Investigation Report – Exhibit 1 - page 25-26

[36] OLGA modelling indicates this @ 20:52, as pump rate is slowed
BP - Deepwater Horizon Accident Investigation Report – Exhibit 1 - page 25
Sperry Sun Data - HAL_0048974

[37] BP - Deepwater Horizon Accident Investigation Report– Exhibit 1 – page 92

[38] Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 121 & figure 4

rig could all select the scales and display modes that they considered appropriate to monitor the activity in progress. The increase in circulating (drillpipe) pressure was most likely caused by (1) an influx of wellbore fluids into the wellbore, pushing up heavy mud (14 ppg) past the bottom of the tubing and displacing the lighter seawater, or (2) displacement of the heavy 14 ppg mud with lighter reservoir fluids at the bottom of the well and a corresponding decrease in hydrostatic pressure holding back the formation pressure, or a combination of both factors.

There are other possible explanations for the pressure changes, for example, a partial plugging of the string during circulation. Whether these are correct, credible or likely is ultimately not relevant to the fundamental fact that the anomalies needed to be investigated – but tragically were not. The change in pressure was an anomaly that should have been noted, and investigated (for example by checking for flow and/or pressure). The mud logger claimed in testimony that he took a break "before that (stopping the pumps for the sheen test)" "between 8:30 and 9:00" for "approximately eight to ten minutes," but when he returned he reviewed the data and did not see any indication of a kick.[39] Considering the mud logger's experience (eighteen years),[40] this is surprising, to say the least. For whatever reason, all the personnel involved either did not notice the change, or did not realize its significance.

At 21:08 the pumps were shut-off to allow a "sheen test" to be performed on the returning fluid, prior to returns being pumped overboard. Again, from 21:08 to 21:14 the drillpipe pressure increased (from 1,017 to 1,263 psi - with the pumps off). This disturbing trend is visible, not only on the BP reconstructed data,[41] but also on the Transocean interpretation[42] and on the Sperry chart.[43] The increase of 250 psi in six minutes was very significant. With the pumps off, this was an almost certain indicator of a kick. It definitely was an anomaly to be investigated immediately. Again, this data would have been visible to the drill crew, mud logger, and also supervisory personnel, but none of them noticed the change, or did not realize its significance.

The mud logger testified that at 21:08 the pumps were shut down. He claims that he visually confirmed no flow and the gate (valve) to the gumbo buster and shale shakers was closed and visually confirmed.[44] This diverted the flow from the well to the overboard line, in preparation

[39] Testimony of J E Keith March 28 2011 – page 102-103

[40] Testimony of J E Keith March 28 2011 – page 68

[41] BP - Deepwater Horizon Accident Investigation Report – Exhibit 1 – page 94-95 & figure 9

[42] Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 121 & figure 4

[43] Ex. 604 Sperry Data HAL_0048974

[44] Testimony of J E Keith March 28 2011 – page 150-161

for pumping the spacer overboard once approval was received. From this point on, two key indicators of flow were not available. Firstly, the Sperry flow sensor was located upstream of the closed gate, but in a now closed section of pipe and thus gave no indication of flow. Secondly, once the flow was diverted overboard, the television camera that provided confirmation of flow could not provide any useful information. The crew would have had to have gone down to the gumbo box and physically looked inside to see the flow.[45] Although the crew failed to detect or act upon it, the well was flowing all the time the pumps were shut off (six minutes).

Modeling done for BP using the OLGA model suggests that the well began to flow at 20:52.[46] Transocean`s estimate is between 20:38 and 20:52.[47] The exact time is not critical. An analysis of the Sperry Sun flow data shows that at this time the pumping rate on all three active pumps was decreased (by 10-15%), but at the same time, the flow out increased (by 30%). The flow out began to fluctuate, and just before the pumps were stopped and the flow diverted (bypassing the Sperry sensor) at 21:08, the flow out peaked at 1,000 gpm, equal to the flow out at 20:50 when the pumps were being run at essentially twice that speed. This discrepancy between flow rate and pump rate should have been obvious to the personnel on the rig.

Although the Sperry data (the only data set that survived the explosion) could not display the flow from the well once the flow was switched to overboard discharge, the Transocean (Hitec) instrumentation would have shown flow (assuming it was operational and correctly configured – and there has been no evidence that it was not). This data was presumably displayed at the driller's position (using the "drill crew's primary Hitec monitors"),[48] the BP wellsite leader's office,[49] and (presumably) in the Transocean OIM/toolpusher offices.

Modeling indicates that the well was flowing for approximately one hour by the time the well flowed onto the rig floor. The flow peaked at 4,465 gpm at 21:47, just prior to shutting the annular preventer[50] or about four times the expected flow (slightly over 1,000 gpm based on displacement rates with similar pump strokes at 20:50).[51] It is impossible to understand how

[45] Testimony of M Sepulvado May 11 2011 – page 364

[46] BP - Deepwater Horizon Accident Investigation Report – Exhibit 1 – page 25

[47] Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 102

[48] Macondo Well Incident – Transocean Investigation Report – Exhibit 4248 – page 119

[49] Testimony of J E Keith March 28 2011 – page 109

[50] Stress Engineering Services – Hydraulic Analysis of Macondo #252 Well – page 144
Macondo Well Incident – Transocean Investigation Report – – Exhibit 4304 Appendix G

[51] Ex. 604 Sperry Data HAL_0048

the drill crew (and possibly the onboard supervisors) did not notice a four-fold increase in flow over a half hour period (21:08 -21:47). The mud logger had previously been instructed to use the Sperry Sun flow sensor over the Hitec one on the displayed parameters, as it was more sensitive.[52] It is unclear whether the flow parameter from the Hitec sensor was displayed on the Hitec system in the mud logging unit.

Excess flow out of the well and pit volume increase would generally be considered two of the primary indicators of a flowing well, but there are others. One of these is drillpipe pressure anomalies. While they are not certain indicators of an influx or "kick", as they may be caused by something else, they should be investigated and the cause determined. Since the record of drillpipe pressure has survived the explosion, it has taken on increased importance in the post analysis. Even though it is impossible to reconstruct the Hitec flow data records (except by modeling) or to determine the scales and displays being used by the personnel on tour, the drillpipe pressure should be viewed as an indicator of a kick.[53]

With all other parameters constant, drillpipe pressure is very sensitive to changes in flow rate. For example a 20% increase in flow rate will result in up to a 45% increase in pressure. Analysis (particularly in real-time for the rig personnel) is difficult from 21:15 to 21:30 due to changes in pump rate. For this reason, it is important to look at pressure changes during periods of constant flowrate (pump strokes). Since the pump rate is changed several times during the displacement of the spacer (21:15 to 21:30), it is necessary to look at "snapshots" of constant rates. The period between 21:08 and 21:15 where the pumps were shut down has already been discussed. From 21:26 to 21:30, all three pumps are running at a constant rate and the drillpipe pressure decreased by 400 psi.[54] It is reasonable to expect some reduction in drillpipe pressure as the last of the heavy spacer is circulated out of the annulus and replaced by sea water, but a calculation shows that the change in hydrostatic pressure caused by four minutes of circulation is less than 100 psi.[55] The decrease in circulating pressure observed is significantly greater than that. Also, even without the benefit of the calculation, one can see that the rate of change in drillpipe pressure is quite different from 21:22 to 21:24 versus 21:26 to 21:30. While there are other possible explanations for this change in pressure (e.g. a washout in drill string), the most likely is that a lighter fluid (formation oil & gas) had passed above the end of the drill

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[52] Testimony of J E Keith March 28 2011 – page 178 – 185 and 310 - 315

[53] ENFORM 2nd Line Well Control Manual 2005 – Appendix IV-1
Transocean Well control Handbook – Section 5 Subsection 1 paragraph 2.4
– TRN_USCG_MMS-00043886 & TRN-MDL-00286843

[54] Ex. 604 Sperry Data HAL_0048

[55] In the 4 minute period, flow-in is about 750 gpm or 70 bbls (from Sperry chart)
70 bbl spacer @ 0.37 bbl/ft = 190 ft & 16 ppg spacer Vs 8.6 ppg seawater = 73 psi

string, decreasing the U-tube effect and thus reducing the drillpipe pressure. This is slightly inconsistent with numbers suggested by the OLGA post incident modeling, which suggests that at 21:38 (twelve minutes later) wellbore fluids had just passed the BOP and entered the riser. Whatever the cause, it appears that at this point (21:31) the crew recognized some kind of anomaly as they shut down the pumps and shortly thereafter the toolpusher and driller were observed discussing "differential pressure".[56] A flow check is considered the "gold standard" as verification as to whether the well is flowing or not, and one should have been performed at this point. As per the Transocean Well Control Handbook "Flowchecks must be performed at the following times……Anytime the driller (…) has any concerns regarding the well status."[57] Although the pumps were shut down for approximately 10 minutes, there is no indication that a flow check was done.

[56] BP Deepwater Horizon Accident Investigation Report – Exhibit 1 – page 27
Transocean investigation Report – Exhibit 4248 – page 128

[57] Transocean Well Control Handbook – Section 4 Subsection 4 paragraph 1.5.1
– TRN_USCG_MMS-00043878-79 & TRN-MDL-00286835-36

Well Control Response

Most of the events after 21:31 are pieced together from witness observations and correlated to logged data[58] where possible. For this reason, the exact timing of these events, and possibly the order may be considered somewhat uncertain, but this would not materially change the conclusion that well control response fell below the standards of Good Oilfield Practice. From 21:31 onward the pumps were shut down, but it appears that the well flowed unchecked during this period. The drillpipe pressure climbs and then falls again (it should have been static and close to zero). The rise is likely due to the displacement of heavy mud in the lower part of the wellbore by lighter wellbore fluids, thus reducing the hydrostatic head holding back the formation pressure. The drillpipe pressure then starts to drop, likely as the wellbore above the bottom of the drillpipe starts to fill with lower density oil (and gas) displacing the original mud and sea water, thus decreasing the hydrostatic head above the bottom of the drillpipe. In addition, there are some short term variations in the drillpipe pressure during this time. This may have been caused by the drill crew attempting to bleed down the drillpipe pressure. At 21:42 the character of the drillpipe pressure again starts to trend upward, either due to the closure of the diverter, or as more lighter reservoir fluid enters the wellbore and/or the gas in the wellbore continues to expand, or a combination of these factors. (Since gas arrives at surface less than six minutes later, it can be assumed that by this time the wellbore and riser contained a significant amount of reservoir fluid.)

At approximately this time (21:42 - 21:44), mud was observed blowing out of the well and up to the crown.[59] The mud flow then stopped temporarily and it is therefore believed that the crew closed the diverter (and probably the annular preventer) at this point to control flow out of the well and onto the rig floor, as would be standard procedure. This is consistent with both the change in drillpipe pressure and the expected actions of the drill crew. Also at 21:42, there is an almost instantaneous increase of 15 barrels in the trip tank. It is not clear from the available data which trip tank level is increasing, but it is likely due to the combination of increased flow and/or diversion of wellbore fluid during the diverter closing process. At 21:47 the drillpipe pressure takes a sudden spike upwards, rising from about 1,200 psi to 6,000 psi in 2 minutes, until the end of data transmission (presumably the generator overspeed and blackout). At the same time (21:47) the “flow out” reading rises sharply. This indicates an increase in fluid level in the main flow line. It is unclear why this reading appears. With the flowline set to bypass to the overboard line, the flowline signal went to 0 at 21:09 and would have been expected to stay at that point, even when the diverter was actuated.

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[58] Ex. 604 Sperry Data HAL_0048

[59] See, for example, Lee Lambert deposition – May 10, 2011 – page 585

Various witnesses describe mud shooting all the way up the derrick and coming out of the degasser, and subsequently flames shooting over the derrick. Based on these accounts, it appears that when the diverter was closed, the flow from the well was diverted to the mud gas separator, rather than to the port or starboard overboard diverter line. The accounts of "mud flowing up to the crown"[60] and "we had like a 240 foot derrick and it (fire) was coming out of the top of it as well. Massive fire. Extremely hot",[61] suggest that the diverter either did not close fully, or perhaps more likely, could not withstand the forces of the blowout and/or explosion and failed, opening a path to the drill floor and derrick. The diverter, like other pieces of well control equipment, is rated for static pressure, not the impact of fluid flowing out of the well at a high rate.

It is axiomatic and taught in all well control training, that the sooner an influx into the wellbore is detected and addressed, the smaller it will be and thus easier to control. Put another way, "The objective is to limit the size of the kick".[62] If the personnel on the rig had identified any of the kick indicators, the appropriate action would have been to run a flow check, followed by shutting in the well (assuming that flow was detected). Early detection would have greatly increased the chances of successfully shutting in the well.

If the personnel on the rig had re-run the negative pressure test at any point, their first actions would have been to stop the pumps and close the annular BOP. The purpose of this would have been to isolate the hydrostatic head of the riser fluid(s) from the well to allow a negative pressure test. It would have shown, at minimum, a lack of wellbore integrity, but it also would likely have indicated the presence of lighter formation fluid(s) in the hole. Much more importantly, closing the BOPs would have secured the well and prevented the situation from deteriorating while the crew performed the necessary diagnostic procedures to resolve the discrepancy in pressure (flow checks, circulating lines, etc.). The crew would then have been in a position to circulate the riser and the well/drillstring back to drilling mud and perform remedial actions as required.

Ironically, at 20:52 Vidrine (WSL) called Hafle (BP shoreside engineer) to discuss testing of the upcoming surface cement plug. When they discussed the negative pressure test during that call, Hafle was told "the crew had zero pressure on the kill line, but that they still had pressure on the drillpipe". His reply was "you can't have pressure on the drill pipe and zero pressure on the kill line in a test that is properly lined up".[63] Coincidentally, according to modeling[64] this was approximately the point where the well began to flow on its own. If either Hafle or Vidrine

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[60] Lee Lambert deposition – May 10, 2011 – page 585

[61] Miles (Randy) Ezell deposition April 27, 2011 – page 234 - 235

[62] Advanced Blowout and Well Control – Robert D. Grace et al – page 33

[63] Hafle interview notes – Exhibit 296 page 6 – BP-HZN-BLY00103037

[64] BP Deepwater Horizon Accident Investigation Report – Exhibit 1 – page 25

had appreciated the significance of the observed data at that time and rerun the pressure test, they would have inherently secured the well and presumably detected the problem before it became a disaster. Unfortunately, they took no action with regard to the negative pressure test or well control response.

Final Conclusion

The tragic incident on the Deepwater Horizon appears to be rooted in complacency and an expectation that since the well was cased and cemented there was no further need for a high level of vigilance. This is not consistent with Good Oilfield Practice, particularly for a well of this nature. The risks associated with displacing a cased hole to an underbalanced condition, despite having successfully performed a negative pressure test, had been graphically highlighted in the Transocean "Operation Advisory" referenced at the beginning of this document.

From the time the production (last) casing string was cemented, until the first explosion, numerous decisions were made by operator and contractor personnel that failed to anticipate, detect, and react appropriately to the influx of reservoir fluids into the wellbore.

During the negative pressure test and subsequent displacement, several warning signs were available to the personnel onboard (and also onshore) that indicated there was a problem with the well. These were either not noticed, or explained away.

These include:

1. The initial negative pressure test gave conflicting results, showing pressure readings of 1,400 psi and subsequently 1,240 psi where they should have been zero. The personnel on board accepted the test as successful, when it was clearly apparent that it was not. There are other possible explanations for the pressure, but it is incomprehensible that experienced personnel, both operator and contractor, should have accepted this test as "good" without determining the cause of the discrepancy. There has been discussion about the lack of "acceptance criteria" for a negative pressure test. Notwithstanding the lack of "acceptance criteria", this does not explain the actions on the rig. Common logic and Good Oilfield Practice should have determined that the results were not acceptable. Furthermore, when these results were relayed to BP's onshore management, they were recognized as inconsistent, but no action appears to have been taken to determine the cause of the discrepancy, or re-evaluate the negative pressure test.[65]

2. A "closed system" was not used to displace the well to facilitate accurate monitoring of the well, while displacing it to an underbalanced condition. This could have been done relatively easily with the equipment on board the DWH and would have provided early

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[65] M Hafle Interview notes - Exhibit 296 – page 6 – BP_HZN_BLY00103037

warning of an influx into the wellbore. This is standard procedure during regular drilling operations and should have been implemented in this case.

3. During the displacement of the riser to seawater there were a number of anomalies in the drillpipe pressure that either went un-noticed or were ignored. Drillpipe pressure variations are typically considered a secondary, rather than a primary indicator of a kick. Drillpipe pressure variations are more commonly caused by other factors such as plugged drill string or a "washout" (hole) in the drillstring. Despite this, a variation, if detected, should be examined and its cause determined before the situation deteriorates. It is not possible to be certain exactly what parameters and what scales the rig crew and mud loggers were watching on their monitors, but it is realistic to assume that the personnel would/should have been monitoring the drillpipe pressure (among other parameters). It appears that the anomalies were not identified or interpreted until very near the end, by which time it was too late.

4. A primary indicator of flow into the wellbore is an increase in flow out of the well. During the displacement there were additional anomalies that should have been visible to the personnel on location. These anomalies provided other indicators that there were problems with the well.

5. Once the spacer arrived at surface and the personnel performed the sheen test and prepared to divert flow overboard, the Sperrysun flow sensor was bypassed. Thus there is no permanent record of the flow from the well in the last 40 minutes. Despite this lack of data for post analysis, there was a second ("primary") flow sensor on the rig as part of the Hitec system.[66] There has been no testimony that this system was not operational on the evening of the event, and thus we can assume the "flow" information from this system was available to the personnel onboard (contractor, operator, and possibly mud logger). For some inexplicable reason, this information was not noticed or acted upon by anyone onboard, as the first positive action to control the influx was to close the diverter after fluid had flowed out of the well and over the drill floor. There is simply no logical explanation as to how this information was not observed by the above personnel. By the time attempts were made to shut in the well, it is estimated to have been flowing at about 4,000 gpm (four times the displacement rate).[67]

[66] Macondo Well Incident – Transocean Investigation Report– Exhibit 4248 – p 118

[67] Stress Engineering Services – Hydraulic Analysis of Macondo #252 Well – page 144
Macondo Well Incident – Transocean Investigation Report – Exhibit 4304 – Appendix G

The foregoing actions failed to satisfy 30 CFR 250.401, which states:

> *You must take necessary precautions to keep wells under control at all times. You must:*
>
> *(a) Use the best available and safest drilling technology to monitor and evaluate well conditions and to minimize the potential for the well to flow or kick;...*

The actions of both BP and Transocean with respect to each of the three causation elements discussed in this report (Negative Pressure Test, Well Monitoring, and Well Control Response) fell below the standards of Good Oilfield Practice for either an "Operator" like BP or a "Contractor" (rig owner and/or operator) such as Transocean.

One of the causation modes, the negative pressure test, was a gross and extreme departure from the standards of Good Oilfield Practice. The negative pressure test was a safety critical test and the last diagnostic test of the integrity of the well prior to placing it into an underbalanced situation where hydrocarbons could flow into the wellbore. The conclusion of both BP and Transocean personnel that the negative pressure test was successful lacked any justification based on basic principles of well control or physics.

If appears almost certain that if even one of these decisions had been made differently, or the parameters been observed, interpreted correctly, and acted upon, the events of April 20 would have been avoided, or at least mitigated.

Appendix 1: Materials Provided for this Report

Exhibit No.	Document Title/Description	Producing Party Bates Range
0003	Typewritten Notes	BP-HZN-CEC020351 - BP-HZN-CEC020354
0003-A	Typewritten Notes	BP-HZN-CEC020351 - BP-HZN-CEC020354
0004	Handwritten Notes - [Steve Robinson Notebook]	BP-HZN-CEC020334 - BP-HZN-CEC020340
0004-A	Handwritten Notes - [Steve Robinson Notebook]	BP-HZN-CEC020334 - BP-HZN-CEC020340
0005	Typewritten Notes	BP-HZN-MBI00021275 - BP-HZN-MBI00021282
0006	Handwritten Notes - [Steve Robinson Notebook]	BP-HZN-MBI00021406 - BP-HZN-MBI00021433
0007	Transcription of Brian Morel Interview Notes - commenced 1040 hrs 27-Apr-2010	BP-HZN-MBI00021304 - BP-HZN-MBI00021347
0012	Typewritten Notes	BP-HZN-MBI00021298 - BP-HZN-MBI00021297
0054	Section 4. Overview of Deepwater Horizon Accident Analyses	
0096	E-Mail - From: Corser, Kent Sent: Tue Jun 22 21:33:30 2010 - To: Brock, Tony; Robinson, Steve W (Alaska) Subject: FW: John Guide Email Capture	BP-HZN-BLY00097030 - BP-HZN-BLY00097033
0097	E-Mail - From: Morel, Brian P Sent: Monday, April 26, 2010 6:40 AM - To: Holik, Cynthia M Subject: FW: Ops Note	BP-HZN-2179MDL00060995
0102	Boots/Coots - Incident Investigation of Well MC252#1 - Review of 9-7/8" x 7" Casing Negative Test	BP-HZN-BLY00094096 - BP-HZN-BLY00094143
0114	Handwritten Notes - Interviewer: James Wetherbee (dated 3 May 10)	BP-HZN-BLY00061711 - BP-HZN-BLY00061714
0120-A	Minerals Management Service, Interior - Page 281	
0145	Onshore Organizational Chart & Rig Crew Organizational Chart	
0151	E-Mail - From: Lucari, James L Sent: Sat Jul 10 18:17:34 2010 - Subject: Final BP Incident Investigation Summary Notes for Sims and Guide Interviews	BP-HZN-BLY00124205 - BP-HZN-BLY00124216
0153	BP Incident Investigation Team - Notes of Interview with John Guide - July 1, 2010 at BP Westlake 1 at 10:30am CDT	BP-HZN-BLY00124217 - BP-HZN-BLY00124231
0184	GP 10-60 - Zonal Isolations Requirements during Drilling Operations and Well Abandonment and Suspension: Group Practice - BP Group Engineering Technical Practices	BP-HZ-2179MDL00269659 - BP-HZ-2179MDL00269673
0192	Don Vidrene Interview - Tuesday 27th April	BP-HZN-CEC020346 - BP-HZN-CEC020350
0193	Handwritten Notes	BP-HZN-MBI00139555 - BP-HZN-MBI00139559
0194	Handwritten Notes	BP-HZN-BLY00061459 - BP-HZN-BLY00061467
0195	Handwritten Notes - John Guide Interview 5/12/10	BP-HZN-BLY00104243 - BP-HZN-BLY00104239
0197	HORIZON INCIDENT, FLOAT COLLAR STUDY - ANALYSIS: Report PN 1101198	WFT-MDL-00003610 - WFT-MDL-00003629
0198	Engineering Report on Testing of Weatherford M45AP Float Collar: Report PN 1751225	WFT-MDL-00003370 - WFT-MDL-00003609
0214	E-Mail - From: Bodek, Robert Sent: Thu 18 16:13:49 2010 - Subject: FW: Lesson Learned - Plan Forward: Macondo	BP-HZN-BLY00015694 - BP-HZN-BLY00015694698
0218	Weatherford - Drilling & Intervention Systems: Float Equipment - Mid-Bore Auto-Fill Float Collar Model M47A0	BP-HZN-BLY00143883 - BP-HZN-BLY00143891
0219	Transcription of Brian Morel Interview Notes - commenced 1040 hrs 27-Apr-2010	
0220	Transcription of John LeBleu Interview Notes (Per Warren Winters) - conducted 29 Apr 2010	
0221	Transcription of Brad Tippets Interview Notes - conducted 27 Apr 2010	
0222	Transcription of Shane Albers Interview Notes - conducted 28 Apr 2010	
0224	BP Incident Investigation Team - Notes of Interview with Erick Cunningham - July 16, 2010 at BP Westlake 1 at 10:00am CDT	BP-HZN-BLY00061269- BP-HZN-BLY00061272
0229	A Probabilistic Approach to Risk Assessment of Managed Pressure Drilling in Offshore Applications: Technology Assessment and Research Study 582 Contract 0106CT39728 31-October-2008 Final Report	

Exhibit No.	Document Title/Description	Producing Party Bates Range
0240	Analysis of Cementing Operations on the Deepwater Horizon and Possible Contributing Factors to Loss of Well Control - Prepared for: Warren Winters, Date: June 17, 2010	BP-HZN-2179MDL00324053 - BP-HZN-2179MDL00324106
0241	E-Mail - From: McKay, Jim Sent: Tuesday, June 29, 2010 5:14 PM - Subject: Updates to CSI models	BP-HZN-2179MDL00323666 - BP-HZN-2179MDL00323667
0251	RIG CONDITION ASSESSMENT - DEEPWATER HORIZON (Prepared for Transocean USA, Inc., Houston, Texas)	MODUSA 000078 - MODUSA 000189
0261	Report on Subsea Equipment Condition: Deepwater Horizon - Prepared by Gary Eastveld for Transocean - WEST Job #001C - 30 November 2005	TRN-HCEC-00063738 - TRN-HCEC-00063777
0275	Deepwater Horizon Follow Up Rig Audit, Marine Assurance Audit and Out of Service Period September 2009	BP-HZN-IIT-0008871 - BP-HZN-IIT-0008930
0278	getting HSE right - a guide for BP managers, March 2001	
0281	Letter from BP: September 14, 2009 - Attn: Rules Processing Team (Comments) MS 4024, Re: Proposed Rule - Safety and Environmental Management Systems Outer Continental Shelf Oil and Gas Operations, 1010-AD15, FR Vo. 74, No. 15 6-17-09	
0284	Draft: BP Incident Investigation Team - Notes of Interview with Greg Waltz, July 29, 2010 10:00am CDT (Telephonic Interview from Washington, D.C.).	BP-HZN-BLY00111497 - BP-HZN-BLY00111507
0294	Analysis of Cementing Operations on the Deepwater Horizon and Possible Contributing Factors to Loss of Well Control - Prepared for: Warren Winters, Date: June 17, 2010	BP-HZN-BLY00139698 - BP-HZN-BLY00139805
0296	BP Incident Investigation Team - Notes of Interview with Mark Hafle - July 8, 2010 at BP Westlake 1 offices - 2:00pm CDT.	BP-HZN-BLY00103032- BP-HZN-BLY00103038
0300	E-Mail - From: Martin, Brian J Sent: Mon May 03 19:20:16 2010 - Subject: Mark Hafley Interview Notes	BP-HZN-BLY00085685 - BP-HZN-BLY00085686
0318	Integrating Human Factors into High Frequency/Low Severity Incident Investigations	
0320	Typewritten Notes: John Guide - May 12 2010 - Cowie, Martin, Wetherbee, Corser, Pere	
0324	Typewritten Notes: John Guide - May 12 2010 - Cowie, Martin, Wetherbee, Corser, Pere	
0362	SPE 110388 - A Standard Real-Time Information Architecture for Drilling and Completions	
0363	SPE 123208 - WITSML Real-Time Inter-operability testing	
0364	IADC/SPE 111757 - Development and testing of a Rig-Based Quick Event Detection System to Mitigate Drilling Risks	
0506	BP Incident Investigation Team - Notes of Interview with David Sims - June 24, 2010 at BP Westlake 1 at 8:30am CDT	BP-HZN-BLY00125436 - BP-HZN-BLY00125446
0537	E-Mail - From: Morel, Brian P Sent: Wed Apr 14 19:24:50 2010 - Subject: RE: Forward Ops	BP-HZN-MBI00126982
0539	E-Mail - From: Morel, Brian P Sent: Fri Apr 16 02:42:42 2010 - Subject: FW: Modification of Permit to Bypass at Location Surface Lease: G32306 Surface Area: MC Surface Block: 252 Bottom Lease: G32306 Bottom Area: MC Bottom Block: 252 Well Name: 001 Assigned Api Number: 608174116901 has been approved	BP-HZN-CEC043219 - BP-HZN-CEC043229
0545	E-Mail - From: Morel, Brian P Sent: Fri Apr 16 04:38:03 2010 - Subject: Updated Procedure	BP-HZN-2179MDL00249965 - BP-HZN-2179MDL00249987
0547	E-Mail - From: Morel, Brian P Sent: Tue Apr 20 15:36:07 2010 - Subject: Ops Note	BP-HZN-MBI00129108
0555	DAILY PPFG REPORT - Date and Time: Oct. 22, 2009 6:00AM	BP-HZN-MBI00073351
0556	DAILY GEOLOGICAL REPORT - Date: 02/10/2010	
0562	E-Mail - From: Morel, Brian P Sent: Mon Apr 12 17:57:25 2010 - Subject: Rev 1 Procedure	BP-HZN-2179MDL00272297 - BP-HZN-2179MDL00272317

Exhibit No.	Document Title/Description	Producing Party Bates Range
0566	E-Mail - From: Morel, Brian P Sent: Tuesday, April 20, 2010 10:43 AM - Subject: Ops Note	BP-HZN-2179MDL00161670
0570	Form MMS-124 - Electronic Version: Application for Permit to Modify	BP-HZN-MBI00127907 - BP-HZN-MBI00127910
0589	Operation Event Report	TRN-USCG-MMS-00044226- TRN-USCG-MMS-000227, TRN-MDL-00287183- TRN-MDL-00287184
0590	Well Control Handbook	TRN-USCG-MMS-00043810 - TRN-USCG-MMS-00044107, TRN-MDL-00286767- TRN-MDL-00287064
0596	Well Control Handbook	BP-HZN-2179MDL00330768 - BP-HZN-2179MDL00331163
0597	DEEPWATER HORIZON EMERGENCY RESPONSE MANUAL - Volume 1 of 2	BP-HZN-IIT-0002370 - BP-HZN-IIT-0002741 BP-HZN-MBI00131953 - BP-HZN-MBI00132325
0605	Chief Counsel's Report - Chapter 4.7: Kick Detection	
0606	Sperry sensors used on the horizon	HAL_0216292
0607	Deepwater Horizon - Flow Diagram (Return flow to pits)	HAL_0266303
0612	April 2000 - HES INSITE User Manual, Halliburton Energy Services	HAL_0408233 - HAL_0408384
0614	INSITE Anywhere Access Log	HAL_0050546 - HAL_0050563
0617	Document Produced Natively - Rigsite for SDL, Lesson 1: SDL Services and Job Responabilities Overview	HAL_0463296
0639	GoM Tandem Spacer Recommendation - Business/Technical Case (June 15, 2009)	
0667	Well Control Handbook (Revision Date: March 31, 2009)	TRN-USCG-MMS-00043810 - TRN-USCG-MMS-00043818 TRN-MDL-00286767- TRN-MDL-00287075
0671	DEEPWATER HORIZON - OPERATIONS MANUAL - VOLUME 1 of 2	BP-HZN-2179MDL00141787 - BP-HZN-2179MDL00142399
0673	Transocean - OPERATIONS POLICIES AND PROCEDURES MANUAL (Revision Date: NOVEMBER 1, 2004)	TRN-HCEC-00004639 - TRN-HCEC-00004726
0674	Well Control Handbook (Revision Date: March 31, 2009)	TRN-HCEC-00005402 - TRN-HCEC-00005797
0675	E-Mail - From: Johnson, Paul (Houston) Sent: Wednesday, May 12 2010 2:04 PM - Subject: RE: Negative test Procedure	TRN-MDL-00398758 - TRN-MDL-00398759
0706	Emergency Disconnect Procedure	TRN-USCG-MMS-00013698 - TRN-USCG-MMS-00013699 TRN-MDL-00013572- TRN-MDL-00013573
0741	E-Mail - From: Deepwater Horizon, Foreman Sent: Tue Apr 20 11:36:55 2010 - Subject: FW: Updated Info for Prod Casing job	BP-HZN-2179MDL00015356 - BP-HZN-2179MDL00015404
0768	Initial Exploration Plan - Mississippi Canyon Block 252 - OCS-G - 32306	BP-HZN-2179MDL00001095 - BP-HZN-2179MDL00001218
0792	Macondo Relief Well MC252#3 - Operational File Note 22	
0793	E-Mail - From: Morel, Brian P Sent: Monday, April 26, 2010 6:40 AM - Subject: FW: Ops Note	BP-HZN-CEC008574
0794	E-Mail - From: Morel, Brian P Sent: Tue Apr 20 15:36:07 2010 - Subject: Ops Note	BP-HZN-MBI00129108
0806	National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling Cement Testing Results	HAL_0502206 - HAL_05022062
0826	Gullion's Method of Pressure Testing (6 Jan 2010)	BP-HZN-2179MDL00750812- BP-HZN-2179MDL00750835
0827	Pressure Testing (January 6, 2010)	BP-HZN-2179MDL00750446- BP-HZN-2179MDL00750460
0831	E-Mail - From: Morel, Brian P Sent: Thu Nov 12 21:33:45 2009 - Subject: FW: Drill Collars: Type and Quantity?	BP-HZN-MBI00076083/DHCIT_ASX-7188235 BP-HZN-MBI00076085/DHCIT_ASX-7188237
0850	E-Mail - From: Morel, Brian P Sent: Thu Nov 12 21:33:45 2009 - Subject: FW: Drill Collars: Type and Quantity?	BP-HZN-2179MDL00214099 - BP-HZN-2179MDL00214101
0858	E-Mail - From: Morel, Brian P Sent: Mon Apr 19 15:33:04 2010 - Subject: RE: 6 5/8" Drill Pipe ppf?	BP-HZN-MBI00128875
0863	bp - GP-48-04, Inherently Safer Design (ISD)	BP-HZN-2179MDL00408143 - BP-HZN-2179MDL00408172
0864	bp - GP-48-03, Layer of Protection Analysis (LOPA)	BP-HZN-2179MDL00408202 - BP-HZN-2179MDL00408242
0866	GulfofMexicoSPU - Operating Plan (OMS Handbook)	BP-HZN-2179MDL00333155 - BP-HZN-2179MDL00333195
0902	DWGOM - GP 10-60-1 - Zonal Isolation Requirements during Drilling Operations and Well Abandonment and Suspension (Supersedes GP 10-60)	BP-HZN-2179MDL00664466- BP-HZN-2179MDL00664480

Exhibit No.	Document Title/Description	Producing Party Bates Range
0907	BP Incident Investigation Team - Notes of Interview with John Sprague - July 7, 2010 at BP Westlake 1 Offices - 1:00pm CDT	BP-HZN-BLY00125462 - BP-HZN-BLY00125462
0910	GOM - D&C, Major Hazard and Risk Management - Leadership Action	BP-HZN-2179MDL00665965- BP-HZN-2179MDL00666037
0925	Transocean - COMPANY MANGEMENT SYSTEM	TRN-USCG-MMS-00032700 - TRN-USCG-MMS-00033035 TRN-MDL-00032700 - TRN-MDL-00033035
0926	Transocean - OPERATIONS ADVISORY - LOSS OF WELL CONTROL UPPER COMPLETION	TRN-USCG-MMS-00043222 - TRN-USCG-MMS-00043225 TRN-MDL-00273897 - TRN-MDL-00273900
0927	Transocean - PERFORMANCE MONITORING AUDIT AND ASSESSMENT PROCEDURES	TRN-USCG-MMS-00039487 - TRN-USCG-MMS-00039568 TRN-MDL-00039463 - TRN-MDL-00039544
0933	RMS II Morning Report, Rig: Deepwater Horizon, 19 Apr 2010	TRN-HCEC-00035561 - TRN-HCEC-00035588 TRN-MDL-00077298 - TRN-MDL-00077325
0944	Transocean - MARINE COMPLIANCE PROCEDURES (Revision Date: JULY 28, 2010)	TRN-USCG-MMS-00042630 - TRN-USCG-MMS-00042957 TRN-MDL-00273305 - TRN-MDL-00273632
0948	HSE Management System Bridging Document	BP-HZN-BLY00076260 - BP-HZN-BLY00076264
0949	E&P Segment - Recommended Practice, Applying Control of Work On Drilling & Completion Operational Sites	BP-HZN-2179MDL00293151 - BP-HZN-2179MDL00293165
0986	Chief Counsel's Report_2011: National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling	
1022	bp - DAILY GEOLOGICAL REPORT	
1023	bp - DAILY PPFG REPORT	BP-HZN-MBI00073421 - BP-HZN-MBI00073422 BPD107_161822 - BPD107_161823
1024	bp - DAILY PPFG REPORT	BP-HZN-MBI00104053 - BP-HZN-MBI00104055 BPD107_192454 - BPD107_206456
1048	E-Mail - From: Bodek, Robert Sent: Wed Oct 21 20:48:02 2009 - Subject: RE: Macondo well flow event	BP-HZN-2179MDL00891525 - BP-HZN-2179MDL00891526
1049	E-Mail - From: LeBleu, John Sent: Tue May 04 18:28:39 2010 - Subject: Macondo Information	BP-HZN-2179MDL00762245 - BP-HZN-2179MDL00762253
1050	E-Mail - From: Bodek, Robert Sent: Mon Oct 26 18:23:04 2009 - Subject: FW: BP Request For MC 252 / MC 292 Drilling Information	BP-HZN-2179MDL00884634 - BP-HZN-2179MDL00884636
1051	E-Mail - From: Bodek, Robert Sent: Thu Oct 29 15:20:26 2009 - Subject: RE: Macondo	BP-HZN-2179MDL00884296
1055	E-Mail - From: Bodek, Robert Sent: Wed Dec 02 16:17:16 2009 - Subject: RE: Hey	BP-HZN-2179MDL00894881 - BP-HZN-2179MDL00894882
1056	E-Mail - From: Bodek, Robert Sent: Fri Feb 12 20:28:43 2010 - Subject: RE: Macondo Update 2pm	BP-HZN-2179MDL00888541
1057	E-Mail - From: Bodek, Robert Sent: Sat Feb 13 17:53:47 2010 - Subject: RE: Macondo LOT #4	BP-HZN-2179MDL00270472
1059	E-Mail - From: Bodek, Robert Sent: Wed Feb 24 16:53:54 2010 - Subject: RE: Macondo	BP-HZN-2179MDL00002974 - BP-HZN-2179MDL00002975
1060	E-Mail - From: Bodek, Robert Sent: Thu Feb 25 01:16:31 2010 - Subject: RE: LWD memory data	BP-HZN-2179MDL00003391 - BP-HZN-2179MDL00003392
1061	E-Mail - From: LeBleu, John Sent: Thu Feb 25 23:59:25 2010 - Subject: FW: LWD memory data from Macondo trip out / loss zone	BP-HZN-2179MDL00006206 - BP-HZN-2179MDL00006216
1064	E-Mail - From: Bodek, Robert Sent: Sat Mar 06 23:05:21 2010 - Subject: RE: 14 3/4" x 16" hole-section preview	BP-HZN-2179MDL00001935 - BP-HZN-2179MDL00001937
1065	E-Mail - From: Bodek, Robert Sent: Sun Mar 07 23:11:39 2010 - Subject: RE: Macondo daily update	BP-HZN-2179MDL00001898 - BP-HZN-2179MDL00001904
1067	E-Mail - From: Albertin, Martin L. Sent: Tue Mar 09 07:11:31 2010 - Subject: RE: Macondo kick	BP-HZN-2179MDL00005606 - BP-HZN-2179MDL00005607
1069	E-Mail - From: Albertin, Martin L. Sent: Wed Mar 10 16:10:32 2010 - Subject: RE: Remainder of Macondo	BP-HZN-2179MDL00039111 - BP-HZN-2179MDL00039112
1070	E-Mail - From: Bellow, Jonathan M Sent: Mon Mar 15 14:29:57 2010 - Subject: FW: Some Thoughts and Help Requested, PP detection, Macando	BP-HZN-2179MDL00044180 - BP-HZN-2179MDL00044182

Exhibit No.	Document Title/Description	Producing Party Bates Range
1071	E-Mail - From: Johnson, Paul (Houston) Sent: Fri Mar 12 16:11:51 2010 - Subject: FW: Some Thoughts and Help Requested, PP detection, Macando	BP-HZN-2179MDL00004927 - BP-HZN-2179MDL00004928
1074	E-Mail - From: Bodek, Robert Sent: Tue Mar 16 19:13:30 2010 - Subject: For your review…	BP-HZN-2179MDL00006076 - BP-HZN-2179MDL00006078
1078	E-Mail - From: Bodek, Robert Sent: Thu Mar 18 18:49:07 2010 - Subject: RE: Lessons learned - plan forward: Macondo	BP-HZN-2179MDL00021267 - BP-HZN-2179MDL00021268
1079	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Fri Mar 19 01:44:47 2010 - Subject: RE: Lesson Learned - Plan Forward: Macondo	BP-HZN-2179MDL00025882 - BP-HZN-2179MDL00025884
1080	E-Mail - From: Bodek, Robert Sent: Fri Mar 19 03:08:07 2010 - Subject: RE: Macondo Update 8pm	BP-HZN-2179MDL00022579 - BP-HZN-2179MDL00022580
1083	E-Mail - From: Bodek, Robert Sent: Wed Mar 24 19:47:26 2010 - Subject: RE: Macondo Casing Plan & Pore Pressure Update	BP-HZN-2179MDL00002160 - BP-HZN-2179MDL00002161
1089	E-Mail - From: Bodek, Robert Sent: Mon Mar 29 11:54:15 2010 - Subject: RE:	BP-HZN-2179MDL00881160
1091	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Sat Apr 03 21:50:06 2010 - Subject: PP update Macondo BP01 17835MD	BP-HZN-2179MDL00247819 - BP-HZN-2179MDL00247820
1092	E-Mail - From: Morel, Brian P Sent: Mon Mar 29 16:24:49 2010 - Subject: RE: Macondo bp1 Mar 29 model	BP-HZN-2179MDL00246940 - BP-HZN-2179MDL00246941
1093	E-Mail - From: Albertin, Martin L. Sent: Fri Apr 02 16:34:40 2010 - Subject: RE: Macondo 9-78 LOT FIT Worksheet .xls	BP-HZN-2179MDL00006046
1095	E-Mail - From: Albertin, Martin L. Sent: Mon Apr 05 20:10:44 2010 - Subject: RE: Macondo Sand pressures	BP-HZN-2179MDL00004909
1096	E-Mail - From: Bodek, Robert Sent: Mon Apr 05 14:00:07 2010 - Subject: RE: Macondo Reservoir Section	BP-HZN-2179MDL00002081 - BP-HZN-2179MDL00002083
1097	E-Mail - From: Morel, Brian P Sent: Mon Apr 05 14:00:07 2010 - Subject: RE: Macondo Sand pressures	BP-HZN-2179MDL00034106 - BP-HZN-2179MDL000341069
1098	E-Mail - From: Beirne, Michael Sent: Wed Apr 14 19:38:24 2010 - Subject: FW: Macondo	BP-HZN-2179MDL00015683- BP-HZN-2179MDL00015685
1099	E-Mail - From: Bodek, Robert Sent: Fri Apr 09 12:15:59 2010 - Subject: Macondo	BP-HZN-2179MDL00028569
1127	E-Mail - To: Guide Subject: RE: call	BP-HZN-MBI00222540 - BP-HZN-MBI00222541
1128	E-Mail - From: Corser, Kent Sent: Tue Jun 22 21:33:30 2010 - Subject: FW: John Guide Email Capture	BP-HZN-BLY00097030 - BP-HZN-BLY00097033, BP-HZN-BLY0006943 & BP-HZN-BLY00069435
1129	E-Mail - From: Guide, John Sent: Thu Apr 15 02:48:20 2010 - Subject: Re: Meeting	BP-HZN-2179MDL00311590
1130	E-Mail - From: Guide, John Sent: Mon Apr 26 01:03:49 2010 - Subject: Tomorrow	BP-HZN-2179MDL00443866
1131	E-Mail - From: Bodek, Robert [robert.bodek@bp.com] Sent: Thursday, April 15, 2010 2:19 PM - Subject: Evaluation complete at macondo	DWRM0000184 BP-HZN-MBI00126345 - BP-HZN-MBI00126346
1134	Drilling & Completions MOC Initiate (date initiated 4/15/2010)	BP-HZN-2179MDL00081508 - BP-HZN-2179MDL00081510
1136	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Fri Mar 19 01:44:47 2010 - Subject: RE: Lesson Learned - Plan Forward: Macondo	BP-HZN-2179MDL00025882 - BP-HZN-2179MDL00025884
1142	E-Mail - From: Vinson, Graham (Pinky) Sent: Wed Mar 10 15:08:58 2010 - Subject: Macondo	BP-HZN-2179MDL00834528
1149	E-Mail - From: Hafle, Mark E Sent: Mon Mar 15 03:07:10 2010 - Subject: RE: IMPORTANT: Enforced Change for BP1Password Users	BP-HZN-2179MDL0028710
1150	E-Mail - From: Guide, John Sent: Tue Apr 13 01:06:46 2010 - Subject: Tomorrow	BP-HZN-2179MDL00309921
1151	E-Mail - From: Guide, John Sent: Fri Apr 16 12:33:01 2010 - Subject: RE: Meeting	BP-HZN-2179MDL00312926

Exhibit No.	Document Title/Description	Producing Party Bates Range
1154	Transcription of Brian Morel interview notes - commenced 1040 hrs 27-Apr 2010	BP-HZN-MBI00021304 - BP-HZN-MBI00021343
1163	MACONDO - Containment & Disposal Project for MC252-1	TRN-MDL-00494098 - TRN-MDL-00494142
1220	E-Mail - From: Beirne, Michael Sent: Tue Apr 13 14:11:43 2010 - Subject: FW: Macondo TD	BP-HZN-2179MDL00044347 - BP-HZN-2179MDL00044348 BPD109-044347 - BPD109-044348
1221	E-Mail - From: Beirne, Michael Sent: Tue Apr 20 13:13:19 2010 - Subject: RE: Macondo Forward Plan	BP-HZN-MBI00129063 - BP-HZN-MBI00129064
1228	E-Mail - From: Lacy, Stuart C (QO Inc.) Sent: Sat Apr 10 22:44:55 2010 - Subject: FW: BP Macondo MDT	BP-HZN-2179MDL00884444
1234	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Fri Mar 19 05:06:10 2010 - Subject: FW: Lesson learned - Plan forward: Macondo	BP-HZN-2179MDL00011120 - BP-HZN-2179MDL00011122
1235	E-Mail - From: Bodek, Robert Sent: Fri Feb 12 20:28:43 2010 - Subject: RE: Macondo Update 2pm	BP-HZN-2179MDL00888541
1239	E-Mail - From: Johnson, Paul (Houston) Sent: Fri Mar 19 03:55:05 2010 - Subject: RE: Macondo Update 8pm	BP-HZN-2179MDL00004529 - BP-HZN-2179MDL00004530
1255	E-Mail - From: Quitzau, Robert Sent: Fri 4/9/2010 6:39:00 PM - Subject: Macondo TD Reached	ANA_MDL-000002456
1256	E-Mail - From: Huch, Nick Sent: Wed Apr 14 18:54:22 2010 - Subject: RE: Macondo TD & Draft Sub. Op. AFE	BP-HZN-MBI00178357 - BP-HZN-MBI00178358
1300	SHEAR RAM CAPABILITTIES STUDY (September 2004)	
1307	WESTLAW - Code of Federal Regulations Correctness	
1311	E-Mail - From: Morel, Brian P Sent: Tue Mar 23 12:04:27 2010 - Subject: RE: Open hole lot?	BP-HZN-MBI 00114048
1313	National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling - Pore Pressure and Fracture Gradients	
1314	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Tue Sep 08 16:53:33 2009 - Subject: PP monitoring on the Marianas	BP-HZN-2179MDL00891636
1315	Chief Counsel's Report - Chapter 4.2: Well Design, Page 59	
1316	E-Mail - From: Bodek, Robert Sent: Sat Oct 10 10:53:08 2009 - Subject: RE: Stalling on the Macondo morning report	BP-HZN-2179MDL00894793
1317	E-Mail - From: Albertin, Martin L. Sent: Wed Oct 21 20:43:35 2009 - Subject: RE: Macondo well flow event	BP-HZN-2179MDL00884793 - BP-HZN-2179MDL00884794
1321	E-Mail - From: Bodek, Robert Sent: Tue Mar 09 05:10:27 2010 - Subject: FW: Macondo kick	BP-HZN-2179MDL00028746 - BP-HZN-2179MDL00028747
1322	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Tue Mar 09 10:15:44 2010 - Subject: PP Report Macondo 13305 MD	BP-HZN-MBI 00109564 - BP-HZN-MBI 00109567
1323	E-Mail - From: Bodek, Robert Sent: Thu Mar 18 16:11:47 2010 - Subject: Lesson learned - Plan forward: Macondo	BP-HZN-2179MDL00040392 - BP-HZN-2179MDL00040396
1324	E-Mail - From: Morel, Brian P Sent: Thu Mar 18 23:26:15 2010 - Subject: MW Increase	BP-HZN-MBI 00113109
1326	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Fri Mar 19 04:44:47 2010 - Subject: RE: Lesson learned - Plan forward: Macondo	BP-HZN-2179MDL00025882 - BP-HZN-2179MDL00025884
1328	**Gulf of Mexico SPU** - Recommended Practice for Cement Design and Operations in DW GoM	BP-HZN-2179MDL00347509 - BP-HZN-2179MDL00347550 BPD008-007864 - BPD008-007905
1329	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Fri Mar 19 20:47:01 2010 - Subject: RE: 11-7/8" Procedure	BP-HZN-2179MDL00290043 - BP-HZN-2179MDL00290045
1330	**Gulf of Mexico SPU** - Technical Memorandum	BP-HZN-BLY00164099 - BP-HZN-BLY00164136
1331	bp - DAILY PPFG REPORT	BP-HZN-MBI00104053 - BP-HZN-MBI00104055 BPD107_192454 - BPD107_206456
1332	bp - DAILY GEOLOGICAL REPORT	
1333	bp - DAILY PPFG REPORT	BP-HZN-MBI00073292 - BP-HZN-MBI00073292
1334	bp - DAILY PPFG REPORT	BP-HZN-MBI00073421 - BP-HZN-MBI00073422
1335	bp - DAILY PPFG REPORT	BP-HZN-MBI00074995 - BP-HZN-MBI00074997
1336	Application for Revised New Well	
1337	bp - MC 252 #1 (Macondo): 18 1/8" x 22" hole-section review (18" CSG section)	BP-HZN-MBI00099622 - BP-HZN-MBI00099632

Exhibit No.	Document Title/Description	Producing Party Bates Range
1341	E-Mail - From: Hafle, Mark E Sent: Thu Mar 18 23:12:40 2010 - Subject: Re: PP at TD	BP-HZN-MBI000113108 BPD107_201509
1342	E-Mail - From: Bodek, Robert Sent: Mon Mar 29 16:18:01 2010 - Subject: RE: Macondo bp1 Mar 29 model	BP-HZN-MBI000116545 - BP-HZN-MBI000116546 BPD107_204956 - BPD107_204957
1343	E-Mail - From: Albertin, Martin L. Sent: Fri Apr 02 16:34:40 2010 - Subject: RE: Macondo 9-78 LOT FIT Worksheet .xls	BP-HZN-2179MDL00006046 BPD109_006046
1344	bp - DAILY PPFG REPORT	BP-HZN-MBI00117997 - BP-HZN-MBI00117998
1345	E-Mail - From: Vinson, Graham (Pinky) Sent: Fri Apr 02 23:47:49 2010 - Subject: Re: PP Update Macondo BP01 17321 MD	BP-HZN-2179MDL00015170 - BP-HZN-2179MDL00015171 BPD109-015170 - BPD109-015171
1348	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Tue Feb 16 11:00:48 2010 - Subject: PP Report Macondo 11010MD	BP-HZN-MBI00103113
1349	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Wed Feb 17 10:45:22 2010 - Subject: PP Report Macondo 11887MD	BP-HZN-MBI00103882
1350	E-Mail - From: Paine, Kate (QuaDril Energy LT) Sent: Tue Mar 09 08:11:57 2010 - Subject: RE: Macondo kick	BP-HZN-2179MDL00044464 - BP-HZN-2179MDL00044466
1390	E-Mail - From: Morel, Brian P Sent: Sun Apr 18 13:42:56 2010 - Subject: RE: Lab Tests	BP-HZN-MBI00128655 - BP-HZN-MBI00128657
1396	E-Mail - From: Cocales, Brett W Sent: Sun Apr 18 15:25:06 2010 - Subject: RE: Lab Tests	BP-HZN-2179MDL00315411 - BP-HZN-2179MDL00315411
1454	Transocean - Well Control Handbook	TRN-USCG-MMS-00043810 - TRN-USCG-MMS-00044205 TRN-MDL-00286767 - TRN-MDL-00287162
1469	Transocean - SUBSEA SYSTEMS - FAMILY 400 Subsea Maintenance Philosophy	TRN-MDL-00616518 - TRN-MDL-00616528
1620	E-Mail - From: Sepulvado, Ronald W Sent: Fri Apr 16 09:57:31 2010	BP-HZN-MBI 00129442/ BPD107-217843 BP-HZN-MBI 00192877 - BP-HZN-MBI 00192878 BPD108-024951 - BPD108-024952
1649	BP Response to Presidential Commission's Preliminary Technical Conclusions	BP-HZN-2179MDL00972787 - BP-HZN-2179MDL00972795
	Macondo Report (Chief's Counsel Report)	
	Exhibit Log updated as of 05-11-11	
	Deepwater Horizon Accident Investigation Report (Bly Report)	
	Deepwater Horizon Accident Investigation Report Appendices A to AA (Bly Report Appendices)	
Ex. 2386	BP GoM Deepwater SPU - Well Control Response Guide January 2010	BP-HZN-2179MDL00368642 - BP-HZN-2179MDL00368768
Ex. 2389	Well Control Manual Volume 1 Procedures and Guidelines December 2000 Issue 3	BP-HZN-2179MDL00335948 - BP-HZN-2179MDL00336409
Ex. 2390	Well Control Manual Volume 2 Fundamentals of Well Control December 2000 Issue 3	BP-HZN-2179MDL00336410 - BP-HZN-2179MDL00336757
Ex. 2391	Well Control Manual Volume 3 HPHT Guidelines December 2000 Issue 3	BP-HZN-2179MDL00336758 - BP-HZN-2179MDL00336889
	Email from Kenneth Armgost to John LeBleu regarding Deepwater Horizon Pit Diagram	BP-HZN-MBI 00053002
	Macondo BP_Pits_04-21-2010	
	Chapter 4.7 - Kick Detection from Chief Counsel's Report p. 165-190; Endnotes p. 307-390	
	Deepwater Horizon Mud Pit Diagrams	BP-HZN-MBI 00053003 - BP-HZN-MBI 00053005
	Operations Manual - Deepwater Horizon Section 7 March 2001	ABSDWH000302 - ABSDWH000362
	Operations Simulation Test March 2001	
607	Deepwater Horizon Flow Diagram	HAL_0266303
	Flow Diagrams Final Assembly	TRN-USCG_MMS-00014355 - TRN-USCG_MMS-00014358 TRN-OIG-00221388 - TRN-OIG-00221391
	Flow Diagrams Shear Ram Kit	TRN-USCG_MMS-00013703 TRN-OIG-00220736

Exhibit No.	Document Title/Description	Producing Party Bates Range
	Flow Diagrams Stack Flow Diagram	TRN-USCG_MMS-00013704 TRN-OIG-00220737
	Flow Out Sensor Calibration, Confirguration and Correlation Instruction Manual (by Halliburton Sperry Drilling Services Surface Data Logging)	HAL_0309944 - HAL_0309951
	Stack Flow Diagram - Cameron	BP-HZN-MBI 00010427
	RBS-8D P&ID (REV.3) 2000-02-21	ABSDWH004320 - ABSDWH004422
	Piping & Instrument Diagram Sea Water Service System Main & 2nd Decks	TRN-HCEC-00027522 TRN-OIG-00027522
	Piping & Instrument Diagram Sea Water Service System 3rd Deck - Starboard	TRN-HCEC-00027523 TRN-OIG-00027523
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port AFT	TRN-HCEC-00027527 TRN-OIG-00027527
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port AFT	TRN-HCEC-00060414 TRN-OIG-00060414
	Piping & Instrument Diagram Sea Water Service System Main & 2nd Decks	TRN-HCJ-00027522 TRN-OIG-00105817
	Piping & Instrument Diagram Sea Water Service System 3rd Deck - Starboard	TRN-HCJ-00027523 TRN-OIG-00105818
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port AFT	TRN-HCJ-00027527 TRN-OIG-00105822
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port FWD	TRN-HCEC-00110521 TRN-OIG-00252593
	Deepwater Horizon Operations Manual Vol. 1 of 2 October 27, 2000 (Marine Operation Manual for RBS-8D Project Vol. 1 of 2)	TRN-HCEC-00060137 - TRN-HCEC-00060726 TRN-OIG-00060137 - TRN-OIG-00060726
	Hull Inspection	TRN-HCEC-00027412 - TRN-HCEC-00027535 TRN-OIG-3704773 - TRN-OIG-00027535
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port FWD	BP-HZN-BLY00004740 - BP-HZN-BLY00004741
	Piping & Instrument Diagram Sea Water Service System Lower Hull - Port FWD (OE-603 Fuel Oil Centrifuge Report of Survey - Deepwater Horizon)	MODUSI 01 2 009568
	Deepwater Horizon Operations Manual (Rev. 0 March 2001)	TRN-HCEC-00018328 - TRN-HCEC-00018995 TRN-MDL-00101874 - TN-MDL-00102463
	Deepwater Horizon Operations Manual (Rev. 0 March 2001) Transocean Offshore Deepwater Drilling Inc	TRN-HCEC-00018328 - TRN-HCEC-00018995 TRN-MDL-00162849 - TN-MDL-00163516
	RBS8D Specification for the Construction and Outfitting of the RBS8D Dynamically Positioned Semi-Submersible Deepwater Drilling Vessel for R&B Falcon Drilling Company	TRN-HCJ-00124047 - TRN-HCJ-00124912 TRN-MDL-00268549 - TRN-MDL-00269414
	Macondo BP_Pits_04-21-2010 (1834 pages)	
	Data on 4-20-2010 at 9:45:00 to 21:49:10 (725 pages)	BP-HZN-2179MDL00417997 - BP-HZN-2179MDL00418721
604	Plot Range: 4-18-10 23:50 to 4-20-10 22:10 (color)	HAL_0048973 - HAL_0048974
620	Plot Range: 4-18-10 23:50 to 4-20-10 22:10 (color)	HAL_0048974
	Draft Plot Range: 4-20-10 14:28 to 4-20-10 21:52 (black & white) Plot time: 9-27-10 09:30	HAL_020710
	Plot Range: 4-20-10 16:50 to 4-20-10 21:52 Plot time: 10-06-10 23:40	HAL_0431027
	Pit Volume Data (Note pad format)	HAL_0051652
	Subsea and Choke Manifold testings on 2-09-10	BP-HZN-MBI00002458 - BP-HZN-MBI00002468
	Macondo BP_Cementing_4-21-2010 (04-20-10 9:45:00 to 4-20-10 21:49:16) (690 pages)	
	Macondo BP - Surface Time Log 1 inch = 30 min (paint format)	
	Macondo BP - Surface Time Log 1 inch = 60 min (paint format)	
	Data on 4-19-10 0:00:00 to 4-19-10 14:48:20 (107 pages)	
	Graph - 1 hr prior to event 20:58 - 21:49 (Flow Indication #1, #2, and #3)	

Exhibit No.	Document Title/Description	Producing Party Bates Range
	Tab 01 - Gulf of Mexico SPU Risk Management SEEAC Brief	BP-HZN-2179MDL00620074 - BP-HZN-2179MDL00620081
	Tab 02 - Gulf of Mexico SPU - OMS Handbook dated 12-3-08	BP-HZN-2179MDL00984858 - BP-HZN-2179MDL00984925
	Tab 03 - Drilling and Well Operations Documentation	
765	Tab 04 - Group Defined Operating Practice Assessment, prioritization and management of risk Document No. GDP3.1 - 0001 (formerly GDP 31-00-01) Implementation Draft.	BP-HZN-MBI-00195280 - BP-HZN-MBI00195301
	Tab 05 - Email from Jonathan Sprague to David Rich regarding FW: Risk Management Recommended Practice for GoM D&C; Drilling & Completions Recommended Practice for Risk Managmeent Implementation Draft	BP-HZN-2179MDL00619987 - BP-HZN-2179MDL00620044
	Tab 06 - Gulf of Mexico SPU GoM Drilling & Completions GoM D&C Operatin Plan/Local OMS Manual (73 pages)	BP-HZN-MBI00193448 - BP-HZN-MBI00193520
215	Tab 07 - Well Control Group Practice	BP-HZN-2179MDL00408005 - BP-HZN-2179MDL00408026
	Tab 08 - Pore Pressure Detection During Well Operations	BP-HZN-2179MDL00408027 - BP-HZN-2179MDL00408043
94	Tab 09 - Well Operations	BP-HZN-2179MDL00373833 - BP-HZN-2179MDL00373852
95	Tab 10 - Working w/Pressure (Supersedes GP 10-45)	BP-HZN-2179MDL00353757 - BP-HZN-2179MDL00353773
	Tab 11 - Email from Jake Skelton regarding GP 10-60 Zonal Isolation; Zonal Isolation Requirements during Drilling Operations and Well Abandonment and Suspension dated 4-16-09	BP-HZN-2179MDL00377054 - BP-HZN-2179MDL0037706
	Tab 12 - Hazard Identification (HAZID) Study	BP-HZN-2179MDL00408099 - BP-HZN-2179MDL00408123
	Tab 13 - Guidance on Practice for Hazard Identification (HAZID) Study DWGoM GP 48-005 (dated Rev. 1 10-Dec-08)	BP-HZN-2179MDL01115685 - BP-HZN-2179MDL01115724
862	Tab 14 - Hazard and Operability (HAZOP) Study	BP-HZN-2179MDL00407776 - BP-HZN-2179MDL00407832
864	Tab 15 - Layer of Protection Analysis (LOPA)	BP-HZN-2179MDL00408202 - BP-HZN-2179MDL00408242
	Tab 16 - Major Accident Risk (MAR) Process	BP-HZN-2179MDL00407937 - BP-HZN-2179MDL00408004
	Tab 17 - GoM of Drilling and Completions D&C Recommended Practice for Management of Change	BP-HZN-2179MDL00339799 - BP-HZN-2179MDL00339820
	Tab 18 - Email from Jonathan Sprague to Patrick O'Bryan regarding BtB Deliverables; Gulf of Mexico SPU D&C Guidance Document Drilling Engineering BtB Stage Gate Process (Well Level) (dated 11-30-09)	BP-HZN-2179MDL00284914 - BP-HZN-2179MDL00284934
	Tab 19 - HSE & Operations 2009-2010 Plan Getting the basics right Version 8.0	BP-HZN-CEC022823 - BP-HZN-CEC022833
	Tab 20 - Gulf of Mexioc SPU Annual Engineering Plan 2009	BP-HZN-2179MDL00620082 - BP-HZN-2179MDL00620121
	Tab 21 - Safety & Operations - Major Accident Risk	BP-HZN-BLY00145504
	Tab 22 - GoM HSSE QPR Top SPU Risk Management	BP-HZN-CEC078145 - BP-HZN-CEC078153
	Tab 23 - Risk Register for Project: Macondo; Last Updated: 20-June-09	BP-HZN-2179MDL00670193
	Tab 24 - Risk Register for Project: Macondo; Last Updated: 20-June-09	BP-HZN-2179MDL00670193
	Tab 25 - Pre-Drill Data Package OCS-G G32306 No. 1 60-817-411690000	BP-HZN-2179MDL00351800 - BP-HZN-2179MDL00351838
	Tab 26 - Evaluation of Casing Design Basis for Macondo Prospect Mississippi Canyon Block 252 OCS-G-32306 Well No. 1 Revision 2	BP-HZN-CEC008333 - BP-HZN-CEC008346
	Tab 27 - Evaluation of Casing Design Basis for Macondo Project	BP-HZN-2179MDL00060971 - BP-HZN-2179MDL00060982
	Tab 28 - Evaluation of Casing Design Basis for Macondo Project	BP-HZN-2179MDL00060983 - BP-HZN-2179MDL00060994
	Tab 29 - Evaluation of Casing Design Basis fo Macondo Project Revision 4	BP-HZN-CEC008347 - BP-HZN-CEC008361
	Tab 30 - Appendix N. Mississippi Canyon 252 No. 1 (Macondo) Basis of Design Review	BP-HZN-BLY001155382 - BP-HZN-BLY00155448
	Tab 31 - Evaluation of Casing Design Basis for Macondo Prospect Relief Wells No. 1 & 2	BP-HZN-BLY00072764 - BP-HZN-BLY00072774
	Tab 32 - Evaluation of Casing Design Basis for Macondo Prospect Relief Wells No. 1 & 2	BP-HZN-BLY00074203 - BP-HZN-BLY00074215

Exhibit No.	Document Title/Description	Producing Party Bates Range
	Tab 33 - Email from Stephen Morey regarding RE: Macondo Relief Wells; Evaluation of Casing Design Basis for Macondo Prospect Relief Wells No. 1 & 2 (dated 5-18-10)	BP-HZN-2179MDL00999366 - BP-HZN-2179MDL0099939_
	Stress Engineering Services Inc - Summary Report Global Analysis of Macondo 9 7/8 - in x 7-in Production Casing 4992 Ft Water Depth, GOM (For Macondo Well Investigation) PN1101197	
	Stress Engineering Services Inc - Horizon Incident Float Collar Study - Analysis Report PN 1101198	
181	BP orgranization chart	
1519	TO/Halliburton rig crew organizational chart (color) used in the Presidential Commission's Report	
	Deposition of Chris Pleasant	
	Deposition of Joseph Keith	
	Deposition of Paul Johnson	
	Deposition of David Sims	
	Deposition of Samuel Defranco	
	Deposition of Kent Wells	
	Deposition of Daun Winslow	
	Deposition of Greg Walz	
	Deposition of Adrian Rose	
	Depoisition of Brett Cocales	
	Deposition of Randy Ezell	
	Depoisition of Douglas Brown	
	Deposition of John Guide	
	Deposition of Lee Lambert	
	Deposition of Murry Sepulvado	
	Deposition of Kevin Lacy	
	Deposition of Vincent Tabler	
1645	BP Gulf of Mexico (GoM) Transocean Offshore Deepwater Drilling Inc North America (TODDI NAM) HSE Management System Bridging Document / Also known as Bridging Document	BP-HZN-2179MDL00899905 - BP-HZN-2179MDL00899909
	BP Group Recommended Practice for Working with Contractors GRP 2.5-0001 (BP ISNET and Qualifications)	BP-HZN-2179MDL02389810 - BP-HZN-2179MDL02389835
	Gulf of Mexico Business Units Shelf and Deepwater Contractor Handbook Revised January 2008 (20080100 Chevron Contractor Handbook)	TRN-HCEC-00074475 - TRN-HCEC-00074458 TRN-MDL-00116295 - TRN-MDL-00116295
	Gulf of Mexico GoM Development H-2 HSSE Management Plan Define/Execute (Draft) BP Doc No: NKHR2-10-HS-PR-000001	BP-HZN-2179MDL00398727 - BP-HZN-2179MLD00398770
	Index of BP Manuals (excel format)	BP-HZN-BLY00124774
	Harrell USCG Statement (U.S. Coast Guard Witness Statement Investigation - Jimmy Wayne Harrell	
	Harrell Interview - 1 (Interview Form)	TRN-INV-00001856 - TRN-INV-00001860
	Harrell Interview - 2 (Confidential Interviewing Form)	TRN-INV-00001861 - TRN-INV-00001864
	Harrell Interview - 3 (Drawing Indicating Movement)	TRN-INV-00001865 - TRN-INV-00001876
	TO Personnel on Board for 4/20/2010	TRN-USCG_MMS-00030428 - TRN-USCG_MMS-00030434
	JIT Testimony of David Young	
	Deposition Exhibits uploaded through July 22, 2011 and David Hackney depo exhibits 4600 - 4609	
	USCG Audio file - Donald Vidrine Audio from MMS	
	USCG Audio file - Donald Vidrine Interview	
	USCG Audio file - Miles R Ezell from MMS	
	USCG Audio file - Miles Randall Ezell	
	USCG Audio file - Robert Kaluza Audio from MMS	
	Diverter_Squence (animation clip)	
	Drilling_a_Deepwater_Well_3D (animation clip)	

Exhibit No.	Document Title/Description	Producing Party Bates Range
	Kick_Detection (animation clip)	
	Negative_Pressure_Test_Generally (animation clip)	
	Negative_Pressure_Test_Specifically (animation clip)	
	USCG Witness Statement of Cathleenia Willis	
	USCG Witness Statement of Chris Pleasant	
	USCG Witness Statement of Christopher Haire	
	USCG Witness Statement of Donald Vidrine	
	USCG Witness Statement of Douglas Brown	
	USCG Witness Statement of Jimmy W. Harrell	
	USCG Witness Statement of Joseph E. Keith	
	USCG Witness Statement of Lee Lambert	
	USCG Witness Statement of Leo Lindner	
	USCG Witness Statement of Miles Rnadall Ezell	
	USCG Witness Statement of Robert Kaluza	
	USCG Witness Statement of Wyman W. Wheeler	
	Deposition of Robert Kaluza pages 1 -3	
759	Email from Patrick O'Bryan to Mike Zanghi regarding RE: Bladder effect	BP-HZN-2179MDL0032187
3576	Handwritten notes	BP-HZN-BLY00045995 - BP-HZN-BLY00045999
3574	Interview of Robert Kaluza (DRAFT - Transcription)	
	Deposition of Keith Daigle pages 1, 311-320	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	OSC TrialGraphix	
	2004 BP Integrated Audit Team Executive Summary	BP-HZN-CEC033261 - BP-HZN-CEC033400
	2004 Deep Water Horizon Rig Assurance Plan	BP-HZN-CEC033254 - BP-HZN-CEC033256
	20091117 Audit Work List BPC004-8792-8843	N/A
	20091202 Audit Work List	N/A
	20091202 CMID Audit work list Sept 2009	N/A
	20091229 CMID Audit work list Sept 2009	N/A
	20100120 CMID Audit work list Sept 2009	TRN-MDL-00304156 - TRN-MDL-00304187
	20100217 Audit Work List	N/A
	20100217 CMID Audit work list Sept 2009	N/A
	20100306 CMID Audit work list Sept 2009	TRN-USCG_MMS-00052025 - TRN-USCG_MMS-00052059 TRN-MDL-00294982 - TRN-MDL-00295016
	20100329 CMID Audit work list Sept 2009	TRN-MDL-00286568 - TRN-MDL-00286599
	Appendix Y to Bly Report	N/A
	Aug-Sept 2001	BP-HZN-CEC043461 - BP-HZN-CEC043570
	January 2005	BP-HZN-CEC043823 - BP-HZN-CEC043884
	January 2008	BP-HZN-CEC043318 - BP-HZN-CEC043399
	May 2007	BP-HZN-CEC035261 - BP-HZN-CEC035316
	September 2009	BP-HZN-IIT-0008871- BP-HZN-IIT-0008930 BP-HZN-MBI00136211- BP-HZN-MBI00136270
	CMID Annex July 2006	BP-HZN-CEC035380 - BP-HZN-CEC035422
	CMID Annex July 2009	BP-HZN-MBI00170553 - BP-HZN-MBI00170611
	IMCA Issue 5	BP-HZN-CEC035317 - BP-HZN-CEC035379
	IMCA Issue 7	BP-HZN-CEC041095 - BP-HZN-CEC041153
	BP Incident Report Drift Off & Energy Riser Disconnect Transocean Horizon July 30, 2003	BP-HZN-CEC029558 - BP-HZN-CEC029635
	BP Executive Summary Subsea Winch Incident Transocean Marianas	BP-HZN-CEC055636 - BP-HZN-CEC055654
	BP Offshore-Gulf of Mexico Incident Investigation & Root Cause Analysis Report	BP-HZN-CEC058820 - BP-HZN-CEC058843

Exhibit No.	Document Title/Description	Producing Party Bates Range
	BP America Office of the Ombudsman Confidential Investigation Final Report Case 2009-005	BP-OMB-CEC 000036 -BP-OMB-CEC 000373
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011873 - BP-HZN-CEC011878
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011879 - BP-HZN-CEC011885
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011886 - BP-HZN-CEC011893
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011894 - BP-HZN-CEC011899
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012371 - BP-HZN-CEC012375
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012376 - BP-HZN-CEC012380
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012381 - BP-HZN-CEC012385
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012386 - BP-HZN-CEC012394
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012395 - BP-HZN-CEC012400
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012401 - BP-HZN-CEC012406
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012407 - BP-HZN-CEC012410
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012411 - BP-HZN-CEC012414
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012415 - BP-HZN-CEC012419
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012420 - BP-HZN-CEC012424
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012425 - BP-HZN-CEC012429
	North America-North America Exploration-BP Daily Operations Report-Partners (Completion)	BP-HZN-CEC011954 - BP-HZN-CEC011958
	North America-North America Exploration-BP Daily Operations Report-Partners (Completion)	BP-HZN-CEC011964 - BP-HZN-CEC011968
	North America-North America Exploration-BP Daily Operations Report-Partners (Completion)	BP-HZN-CEC011969 - BP-HZN-CEC011974
	North America-North America Exploration-BP Daily Operations Report-Partners (Completion)	BP-HZN-CEC011975 - BP-HZN-CEC011979
	North America-North America Exploration-BP Daily Operations Report-Partners (Completion)	BP-HZN-CEC011574 - BP-HZN-CEC011580
	North America-North America Exploration-BP Daily Operations Report-Partners (Mobilization)	BP-HZN-CEC011585 - BP-HZN-CEC011587
	North America-North America Exploration-BP Daily Operations Report-Partners (Mobilization)	BP-HZN-CEC011610 - BP-HZN-CEC011613
	North America-North America Exploration-BP Daily Operations Report-Partners (Mobilization)	BP-HZN-CEC011588 - BP-HZN-CEC011591
	North America-North America Exploration-BP Daily Operations Report-Partners (Mobilization)	BP-HZN-CEC011606 - BP-HZN-CEC011609
	North America-North America Exploration-BP Daily Operations Report-Partners (Mobilization)	BP-HZN-2179MDL00357010 - BP-HZN-2179MDL00357012
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011980 - BP-HZN-CEC011983
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011596 - BP-HZN-CEC011599
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011592 - BP-HZN-CEC011595

Exhibit No.	Document Title/Description	Producing Party Bates Range
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011600 - BP-HZN-CEC011605
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011614 - BP-HZN-CEC011618
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011619 - BP-HZN-CEC011624
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011625 - BP-HZN-CEC011631
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011632 - BP-HZN-CEC011637
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011638 - BP-HZN-CEC011643
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011644 - BP-HZN-CEC011649
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011650 - BP-HZN-CEC011654
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011655 - BP-HZN-CEC011661
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011662 - BP-HZN-CEC011668
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011669 - BP-HZN-CEC011675
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011676 - BP-HZN-CEC011682
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011683 - BP-HZN-CEC011688
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011689 - BP-HZN-CEC011695
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011984 - BP-HZN-CEC011990
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011696 - BP-HZN-CEC011702
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011703 - BP-HZN-CEC011709
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011991 - BP-HZN-CEC011995
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011996 - BP-HZN-CEC012001
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012002 - BP-HZN-CEC012007
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-MBI100178699 - BP-HZN-MBI100178707
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011710 - BP-HZN-CEC011716
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012008 - BP-HZN-CEC012013
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011717 - BP-HZN-CEC011723
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011724 - BP-HZN-CEC011729
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011730 - BP-HZN-CEC011735
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011736 - BP-HZN-CEC011741
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011742 - BP-HZN-CEC011747
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011748 - BP-HZN-CEC011752

Exhibit No.	Document Title/Description	Producing Party Bates Range
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011753 - BP-HZN-CEC011758
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC012014 - BP-HZN-CEC012019
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011759 - BP-HZN-CEC011765
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011766 - BP-HZN-CEC011770
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011771 - BP-HZN-CEC011775
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011776 - BP-HZN-CEC011781
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011782 - BP-HZN-CEC011784
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011785 - BP-HZN-CEC011791
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011792 - BP-HZN-CEC011797
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011798 - BP-HZN-CEC011803
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011804 - BP-HZN-CEC011809
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011810 - BP-HZN-CEC011815
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011816 - BP-HZN-CEC011822
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011823 - BP-HZN-CEC011827
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011828 - BP-HZN-CEC011832
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011833 - BP-HZN-CEC011838
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011839 - BP-HZN-CEC011844
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011845 - BP-HZN-CEC011851
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011852 - BP-HZN-CEC011856
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011857 - BP-HZN-CEC011862
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011863 - BP-HZN-CEC011867
	North America-North America Exploration-BP Daily Operations Report-Partners (Drilling)	BP-HZN-CEC011868 - BP-HZN-CEC011872
	Deposition Transcript of Brandon Burgess	
	Deposition transcript of John Gisclair	
604	BP - OCS-G32306 001 ST00BP01, Mississippi Canyon Blk. 252, Macondo Bypass, Deepwater Horizon (Graph) *oversized*	HAL_0048974
606	Sperry sensors used on the horizon	HAL_0216292
607	Deepwater Horizon - Flow Diagram (Return flow to pits)	HAL_0266303
608	Preventative Maintenance	HAL_0233342 - HAL_0233347
609	SDL Field Procedures	HAL_0468825 - HAL_0468846
610	HALLIBIRTON, Sperry Drilling Services - Gulf of Mexico (GoM), Surface Data Logging: FLOW OUT SENSOR CALIBRATION, CONFIGURATION, AND CORRELATION INSTRUCTION MANUAL	HAL_0309944 - HAL_0309951
611	HALLIBIRTON, Sperry Drilling Services - BP Exploration & Production OCS-G32306 001 ST00BP00 & BP01, Mississippi Canyon Blk. 252 - RIG: Transocean Deepwater Horizon	BP-HZN-2179MDL00338238 - BP-HZN-2179MDL00338319

Exhibit No.	Document Title/Description	Producing Party Bates Range
612	April 2000 - HES INSITE User Manual, Halliburton Energy Services	HAL_0408233 - HAL_0408384
617	Document Produced Natively - Rigsite for SDL, Lesson 1: SDL Services and Job Responabilities Overview	HAL_0463296
620	(Graph) *oversized*	HAL_0048974
621	HALLIBURTON - BP Deepwater Horizon Investigation: Preliminary Insights (dated September 26, 2010	BP-HZN-BLY00170202 - BP-HZN-BLY001070218
	Deposition of Kelly Gray	
1270	Photograph	HAL_0073870
1271	FE BOX - 6'L x 3'W x 5'H (Photograph)	HAL_0073871
1272	Photograph	HAL_0073872
1273	Photograph	HAL_0073877
1607	E-Mail - From: Greg Navarette Sent: Mon Feb 22 20:55:03 2010 - Subject: FW: Subsea Pressures	BP-HZN-2179MDL00005449 - BP-HZN-2179MDL00005450
	Deposition of Cathleenia Willis	
	Deposition of Ronald Sepulvado	

Appendix 2 – Curriculum Vitae – Richard Heenan

Mechanical Engineer with thirty three years of experience in the petroleum industry. Eight years as a drilling and completion consultant specializing in remote operations. Previous experience includes eleven years in business development, marketing, and management positions (all in the upstream oilfield), and fourteen years of petroleum engineering, predominantly in drilling and completions, in both a technical and a field supervisory role for an offshore drilling contractor, a major oil company and an international service company.

Experience includes work both on and offshore, and in the Western Canadian Sedimentary basin, the Canadian Arctic, and overseas. A variety of positions with a multinational petroleum production company, an international service company, an offshore drilling contractor, and a Canadian based, international manufacturing and oilfield service company.

SKILLS

DRILLING, COMPLETIONS AND EXPLOITATION

- Drilling Manager (consultant) for an independent exploration company in the Canadian Arctic.
- Planning, permitting, and supervision of remote drilling, completion, abandonment, and restoration operations from 1200 to 4200m in the Northwest Territories of Canada, including helicopter, barge, and ice road supported operations.
- Supervised onsite drilling, completion, workover operations, and lease construction and remediation for oil and gas wells on oil, gas and injection wells from 600 to 5000 meters in Western Alberta for a multinational oil company. Projects included oil wells to critical sour gas wells. Operations included conventional drilling and workover operations, as well as snubbing, coiled tubing, and tubing conveyed perforating.
- Prepared well plans, cost estimates, drilling programs, and permit applications as above.
- Managed resource exploitation planning (drilling, facilities, gas gathering) to maximize profit in West Central Alberta.
- Project Superintendent for a drillship in Australia and Southeast Asia
- Subcontracted to NRGEconomics as Drilling Technical Expert for the development of the "Framework Regulations" (Revised and combined Drilling and Production, Geophysical, Diving, and Offshore Installation Regulations for National Energy Board - Canada
- Member of CAPP Drilling and Production Regulations Task Group, reviewing new "goal-based" regulations of the Canadian frontiers (representing Paramount Resources and MGM Energy)
- Provided engineering support (onsite and in office) during the well control efforts at the Brazeau 13-12 (Lodgepole) blowout (Alberta 1982). Co-authored the subsequent report and testified as expert witness at the ERCB (now AEUB) hearing. Served on two sub-committees that developed the Alberta Recommended Practices for Drilling Critical Sour Wells (ARPs).

- On site engineer for the drilling of a relief well at Amoco et al Steep Creek 7-28 (Alberta 1981)
- Designed and managed installation of drilling equipment upgrades to CANMAR vessels.
- Supervised preparation of documentation and testified as expert witness at US Department of Justice Anti-Trust hearing regarding CANMAR purchase of Beaudrill. Completed within six week deadline, allowing collection of $10 MM USD mobilization payment.
- Managed technical and business evaluation of market entry in Gulf of Mexico deep-water drilling market.

EXPERIENCE

Canadian Petroleum Engineering **2006 – present**
Principal in petroleum consulting company

Heenan Energy Services Ltd **2003 --- present**
Planning, permitting, and supervision of remote drilling and completion operations from 1200 to 4200m in the Northwest Territories of Canada, including helicopter, barge, and ice road supported operations to various Canadian Arctic operators.
Instruction of introductory drilling courses through PIECE International, HOT Engineering and Heenan Energy Services.

Tesco Corporation **1997 - 2003**
Sales, Marketing, and Operations Management positions – domestic and international (including Drilling Operations Manager and acting VP)

CANMAR (Canadian Marine Drilling) **1988 - 1997**
Various Business Development, Operations Management and technical positions with an offshore drilling contractor (North American Arctic & SE Asia)

Amoco Canada **1979 - 1988**
Drilling and Completions Engineering, Wellsite Supervision, and Resource Exploitation for major oil company in the Western Canadian Sedimentary Basin

Schlumberger **1978 - 1979**
Wireline Logging Engineer – offshore West Africa.

EDUCATION

Bachelor of Mechanical Engineering, McGill University, Montreal, Quebec

Registered as a Professional Engineer with APEGGA - # M31821

PRESENTIONS AND TECHNICAL COMMITTEE MEMBERSHIPS

- Member of CAPP Drilling and Production Regulations Task Group, reviewing new "goal-based" regulations of the Canadian frontiers (2006-2008)
- Technical Committee and Session Chairman - IADC-SPE Annual Drilling Conference (1998 – 2004)
- Guest Presenter – Canadian Association of Drilling Engineers 2003 – "Casing Drilling Rigs"
- Plenary Speaker – Canadian International Petroleum Conference – May 2000 – "Doing Business Internationally"
- Co-Author SPE 35092 – "The Planning and Drilling of a Wildcat Well in the Republic of Seychelles by an Operator/Contractor/Integrated Services Alliance" - 1996 IADC/SPE Drilling Conference. Peer reviewed and published in SPE Drilling Magazine - Dec 1999 as SPE 59730
- Session Co-chairman - Towards 2000 - CIM General Meeting June 1994
- Author - "Sour Service Shear Blind Rams" - 1987 CADE Spring Drilling Conference.
- Member of ERCB - Industry "Blowout Prevention Review Committee" (BPRC) Subcommittees on BOP's and on Drillpipe (1984-1986) – Developed first Alberta Recommended Practices (ARPs – now retitled IRPs - Industry Recommended Practices) for drill critical sour wells.

Appendix 3: Compensation Rate:

Compensation for this report was at $350USD/hr, plus expenses and disbursements where applicable.