IN THE UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF LOUISIANA

In re: Oil Spill by the Oil Rig Deepwater Horizon in the Gulf of Mexico on April 20, 2010 (MDL No. 2179)

Before the Honorable Judge Carl J. Barbier

REBUTTAL REPORT OF GREG CHILDS

Blowout Preventer (BOP)

Submitted by Transocean Offshore Deepwater Drilling, Inc.

INTRODUCTION

This report outlines the findings and opinions of Greg Childs relating to the forensic examination of the Deepwater Horizon blowout preventer. This report presents the basis and reasoning supporting the opinions and conclusions reached on this subject and identifies the data and information considered in forming such opinions and conclusions.

TABLE OF CONTENTS

Date of Submission: November 7, 2011

TABLE OF CONTENTS

I. INTRODUCTION

This report provides rebuttal information and should be read in conjunction with my initial September 23, 2010 report. This report establishes and confirms that the BOP functioned as designed on April 20, 2010, but was unable to seal the Macondo well. Transocean and third-party testing establishes that both the yellow pod and blue pod were fully functional on April 20, 2010, and that one or both pods activated the BOP's AMF function. However, at that time, the drill pipe had been forced to the side of the wellbore by helical buckling caused by extreme dynamic flow and wellbore pressure. The buckled pipe and extreme flow prevented the blind shear rams (BSRs) from fully shearing the drill pipe and sealing the Macondo well.

In reaching these conclusions, I have relied on the information identified, my professional background, education and experience, and information provided and testing performed by other technical experts. The statement of my qualifications, my compensation and my prior testimony can be found in the appendices and text of my initial report. Additional data or information I considered since the filing of my initial report in forming my opinions is listed in the Appendix to this rebuttal. The information discussed in my initial report is not fully repeated below.

II. ON APRIL 20, 2010, BOTH THE YELLOW AND BLUE PODS WERE FULLY OPERATIONAL AND THE AMF FUNCTIONED AS DESIGNED.

Testing conducted by Transocean, DNV, and Cameron established that both the yellow pod and blue pod were functioning and able to activate the AMF on April 20, 2010. First, DNV testing on original solenoid 103Y and Transocean testing on the *Discoverer Enterprise* established that a solenoid wired in reverse polarity will fire under subsea working conditions.[1] Second, Transocean testing on a SEM removed from the *Deepwater Nautilus* spare pod demonstrated that at certain voltages a 9V SEM battery will repeatedly attempt to initiate the AMF sequence and drain the 27V battery.[2] Third, Transocean replaced AMF batteries in accordance with Cameron recommendations. These conclusions are discussed in detail below.

A. The Yellow Pod Was Able to Activate the AMF.

Transocean testing on the *Discoverer Enterprise* in August 2011 and DNV testing on original solenoid 103Y confirmed that solenoids wired in reverse polarity will function under subsea working conditions. This section first discusses these conclusions and then outlines Transocean's post-incident solenoid testing.

---

[1] The *Deepwater Enterprise* was selected because it has the identical SEM control system (Cameron Mark II) as the *Deepwater Horizon*.

[2] The *Deepwater Nautilus* was selected because it has the identical SEM control system (Cameron Mark II) as the *Deepwater Horizon*.

1. *Testing Confirms That Solenoids Wired in a Reverse Polarity Condition Function Under Subsea Working Conditions.*

Evidence from both Transocean and DNV testing establishes that a solenoid wired in reverse polarity will function under subsea working conditions. Results indicating a solenoid wired in reverse polarity will not function have been obtained solely during tests using an external power source connected directly to a solenoid. However, under actual subsea conditions, SEM power saving software causes voltage levels to pulsate out of phase.[3] When the voltage levels pulsate out of phase, the magnetic fields created by the solenoid coils do not cancel each other out as has been alleged. In other words, a solenoid wired in reverse polarity will function when utilizing SEM batteries and software even though it may not function when directly connected to an external power source.

In August 2011, Transocean confirmed through testing that a solenoid valve wired in reverse polarity will operate under subsea working conditions. Transocean purposely wired a solenoid aboard the *Discoverer Enterprise* to exhibit a reverse polarity condition. Using that solenoid, Transocean initiated the AMF from within the SEM rather than externally from a portable electronics testing unit (PETU). During Transocean's August 2011 tests, the solenoid wired in reverse polarity successfully functioned all fifteen times it was tested.[4] Transocean's testing procedures are set forth in more detail below in Section II.A.2.

DNV's testing also confirmed that a solenoid valve wired in reverse polarity will operate when powered by the AMF batteries via the SEM. In its testing, DNV functioned the AMF system three times with SEM A and SEM B armed according to normal operating conditions when the BOP is subsea.[5] The AMF functioned as designed each of the three times, firing solenoid 103Y and pressurizing the pilot line to the high pressure shear circuit. When solenoid valve 103Y correctly fires, the high pressure circuit pressurizes with hydraulic fluid, closing the blind shear rams. Importantly, these tests were conducted using the same batteries and software that would have activated the AMF on April 20, 2010. The failures observed during DNV testing only occurred during attempts to activate original solenoid 103Y manually from the PETU interface instead of from the AMF system. On April 20, 2010, original solenoid 103Y was operated by the AMF and not by a PETU.

Despite the testing results from Transocean and DNV, some experts have relied upon Cameron's September 2010 testing to suggest that solenoids wired in reverse polarity do not fire. That testing, however, was not conducted using SEM software or AMF batteries. Instead, Cameron used a non-pulsating external power supply. In its September 2010 report, Cameron acknowledged:

---

[3] CAM_CIV_0374340, at 341.

[4] TRN-MDL-02971987-1993 (TREX-50165).

[5] DNV Laboratory Notebook of Gary Kenney (TREX-03130), at 016893-96.

> [T]he power saving software installed on the SEM plays a vital role in producing the pulsation in a solenoid with reverse polarity. **It is possible this did not show up on our test stand at first pass because those solenoids are fed a constant 24V.**[6]

In other words, Cameron recognizes that the power saving software it installed in the *Deepwater Horizon* pod SEMs causes a pulsation that may allow solenoids wired in reverse polarity to work when energized by SEM batteries and software. This is consistent with Transocean's and DNV's testing results.

Original solenoid 3A on the *Deepwater Horizon* BOP provides further evidence that solenoids wired in reverse polarity properly function in subsea working conditions. Solenoid 3A was a critical, required component frequently used to adjust the upper annular pressure regulator. Without a correctly functioning solenoid 3A, the upper annular could not have functioned properly. Though DNV's post-incident testing determined that solenoid 3A on the yellow pod exhibited reverse polarity, there is no evidence to suggest that the *Deepwater Horizon*'s yellow pod upper annular regulator failed to function as designed on April 20, 2010 or during the course of the Macondo well.

2. Transocean's Independent Testing Procedure.

Transocean conducted the following testing procedures using the spare SEM and solenoids on the *Discoverer Enterprise* on August 4-5, 2011, using the same testing procedures each day.[7]

Test 1: (with properly wired solenoids)

- Connected PETU to spare SEM.
- Connected the solenoid for the upper casing shear rams, which are activated in the AMF sequence, to the SEM.
- Using the PETU, armed SEM A AMF, and subsequently armed SEM B AMF.
- Confirmed that SEM A was armed via PETU by reading the raw count value for the AMF arm/disarm. Confirmed SEM B was armed using same process.
- Turned off the power to the PETU which in turn removed the external power to the SEMs and triggered the AMF (The AMF sequence will initiate without the hydrostatic and conduit hot line pressure transducers connected because Cameron has programmed it to interpret this condition as having no transducers connected).

---

[6] CAM_CIV_0374340-41 (emphasis added).

[7] TRN-MDL-02971987-1993 (TREX-50165) (WEST Daily Report, 8/5/2011).

- Solenoid activated as part of the AMF sequence as indicated by the solenoid valve plunger shifting positions once and only shifting back off when de-energized at the end of the AMF upper casing shear ram portion of the AMF valve sequence.

Test 2: (using solenoids with coils wired in reverse polarity)

- Connected PETU to spare SEM.
- Connected the solenoid for the upper casing shear rams, which are activated in the AMF sequence, to the SEM.
- Using the PETU, armed SEM A AMF, and subsequently armed SEM B AMF.
- Confirmed that SEM A was armed via PETU by reading the raw count value for the AMF arm/disarm. Confirmed SEM B was armed using the same process.
- Turned off power to the PETU which in turn removed the external power to the SEMs and triggered the AMF (The AMF sequence will initiate without the hydrostatic and conduit hot line pressure transducers connected because Cameron has programmed it to interpret this condition as having no transducers connected).
- Solenoid activated as part of the AMF sequence as indicated by the solenoid valve plunger shifting positions once and only shifting back off when de-energized at the end of the AMF upper casing shear ram portion of the AMF valve sequence.

On August 4, 2011, Test 2 was repeated six times with completely consistent results. On August 5, 2011, Test 2 was repeated an additional nine times with completely consistent results. These fifteen tests confirmed that when coils in a solenoid wired in reverse polarity are energized by the SEM (and not by the PETU), the solenoid valve will function properly and actuate the AMF.

B. The Blue Pod Was Able to Activate the AMF.

Transocean testing from October 20, 2010 through December 13, 2010 on the *Deepwater Nautilus* spare pod indicated that low voltage on blue pod SEM B 9V battery caused the blue pod SEM to repeatedly attempt to boot the AMF processor, thereby draining the 27V battery.[8] Transocean performed several tests, the conclusions to which are detailed in both Transocean's internal report and in my initial expert report.

[8] See "Summary of SEM Testing Results" for detailed description of testing procedures on the *Nautilus* blue pod battery (starting at TRN-MDL-02996003).

Transocean conducted its testing under various scenarios, including various battery voltages - full batteries, weak batteries, and depleted batteries. At a high level, Transocean's procedure for testing the blue pod batteries is outlined below:[9]

1. Transocean selected the *Deepwater Nautilus* spare pod batteries and subsea electronic module to test the behavior of the AMF and control systems. The *Deepwater Nautilus* is the *Deepwater Horizon*'s sister rig, and its BOP control system is identically configured and functionally equivalent to the *Deepwater Horizon*'s control system. Several members of the testing team verified the configuration.

2. Transocean's team conducted tests on the *Deepwater Nautilus* equipment from October 20, 2010 to December 13, 2010 at WEST's Drilling Equipment Center in Brookshire, Texas.

3. For example, on October 20, 2010, the team conducted four tests using partially depleted 27V and 9V batteries:

- **Test 1**: The team connected the 27V and 9V batteries to SEM A. The test with SEM A using the AMF 27V and SEM A 9V batteries functioned and completed the AMF sequence as demonstrated by viewing the indicator lights on each Cameron solenoid valve.

- **Test 2:** The team conducted its testing with SEM B using the AMF 27V and 9V batteries. This set up did not complete the AMF function as evidenced by the red "halt" error condition light flashing on SEM B PLC CPU card.

- **Test 3**: The team repeated the test using SEM A powered by the SEM B 9V and the AMF 27 V test batteries. The testing team observed the AMF system would not disarm unless the SEM PLC had enough power to boot and run its programmed software. When the AMF was activated, the SEM AMF card relied on the SEM PLC to signal back to the SEM AMF card that the SEM PLC completed the correct operation of the AMF sequence. The team also observed that the AMF card de-energized and re-energized the SEM PLC every 4 minutes and 11 seconds.

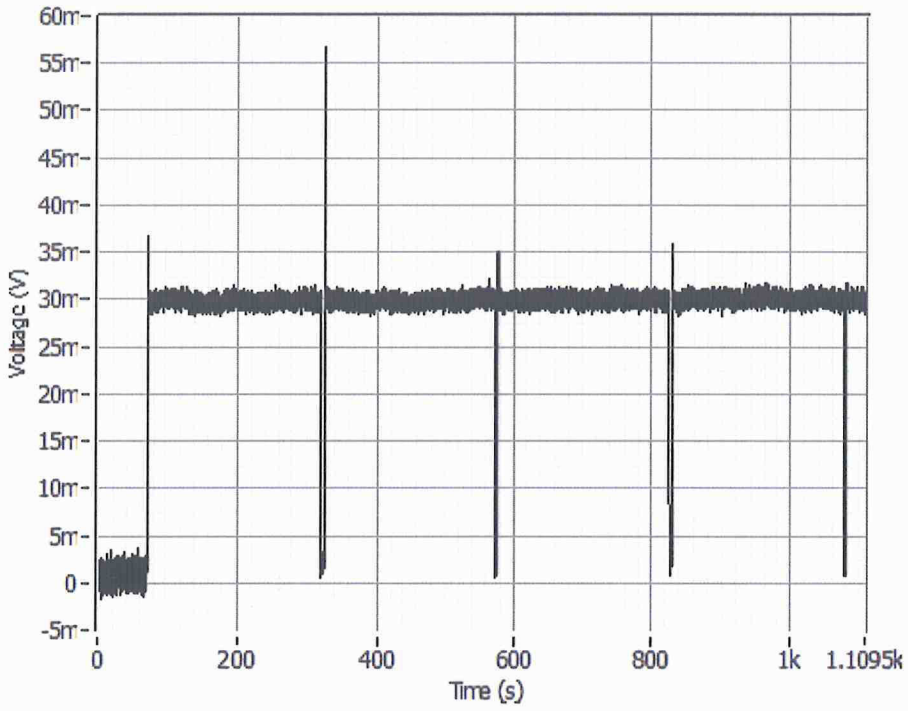
- **Test 4**: The team connected SEM B to the AMF 27V and SEM A 9V batteries. In other words, the testing team switched the batteries with each other and confirmed that the red flashing "halt" error light followed the SEM B 9V battery. This was evidence of the 9V battery having sufficient charge for the AMF to activate but not enough to fully boot and run the software on the SEM's PLC. This demonstrates the AMF card's rebooting cycle described in Transocean's internal investigation report and my initial expert report.

---

[9] Id.

Similar tests were conducted through December 13, 2010, changing different variables on the power supplies to reflect battery conditions that may have been present on April 20, 2010 (adequate, weak, and/or inadequate). On December 13, 2010, the test results were recorded using a device that reads currents and voltages and from which a graph of the testing data was created. The figure below shows the December 13, 2010 test results. The vertical lines depicted approximately every 4 minutes and 11 seconds indicate that the rebooting cycle has started over.

GRAPH 1



December 13, 2010 Test Results Showing that Approximately Every 4 Minutes and 11 Seconds the Rebooting Cycle Started Over.

C. *Deepwater Horizon* AMF Battery Replacement Was Consistent with Cameron Recommendations.

Transocean replaced AMF batteries in accordance with Cameron recommendations. Engineering Bulletin 891D recommends replacing AMF batteries after:

- One year of on-time operation;
- Or when the number of actuations exceeds 33 in a 12-month period;
- Or five years after the date of purchase;

- Whichever of the above events happens first. [10]

The batteries for all three *Deepwater Horizon* SEM pods were replaced in accordance with the recommendations outlined in EB 891D above.

- On April 20, 2010, the #1 SEM was in the yellow pod position. Cameron replaced the batteries in June 2009, and the SEM was put into service in October 2009. [11]

- The #2 SEM was in the spare pod position in the moon pool. Cameron replaced the batteries in February 2010. [12]

- The #3 SEM was in the blue pod position. The #3 SEM batteries were put into service in April 2009. [13]

As indicated above, the blue pod batteries were replaced in accordance with Cameron's recommendations. The batteries were still within the one-year window of operation and within the five-year window from the date of purchase when first put into service.

III. THE MAJORITY OF EXPERTS BELIEVE THAT THE DRILL PIPE WAS FORCED OFF-CENTER BY A FORCE FROM BELOW.

As depicted in the table below, all parties, with the exception of Cameron, support the scenario that the blind shear rams did not shear and seal the wellbore because the drill pipe was forced to the side of the well and partially outside the shearing surface, preventing the rams from fully closing. One of Cameron's experts rejects the off-center drill pipe scenario and the other states that it is irrelevant whether the drill pipe was off center or not. Instead, both of Cameron's experts argue that excessive flow eroded the ram sealing elements and prevented the blind shear rams from sealing, regardless of the drill pipe position and regardless as to whether the blind shear ram was activated by the AMF or the Autoshear.

---

[10] Cameron Engineering Bulletin 891D, AMF/Deadman Battery Replacement, CAM_CIV_0003275 (TREX-03605).

[11] See Summary Document of AMF Battery Replacement and Pods, TRN-MDL-02996001-02.

[12] Id.

[13] Id.

Table 1: Theories on Why the Blind Shear Rams Failed to Seal the Well

Report	Client	Off-Center	Theory	Analysis Supporting Theory
Childs	Transocean	Yes	Force from Below	Stress Engineering/DNV Testing Data
Perkin	Plaintiffs' Steering Committee	Yes	Force from Below	DNV Testing Data
DNV	BOEMRE	Yes	Force from Below	Forensic testing performed by DNV at Michoud
Davis	DOJ	Yes	Rig Drift	None
Shanks	BP	Yes	Force from Above	DNV Testing
Knight	Cameron	No	N/A	Finite Element Analysis
O'Donnell	Cameron	Irrelevant	N/A	N/A

A. Excessive Flow From Below (the Force-from-Below Theory) Caused the Drill Pipe to Buckle.

The force-from-below theory is the only theory that plausibly addresses all evidence discovered during post-incident analyses. Under this theory, flow from the well created lift, which buckled the section of drill pipe within the BOP stack and into the riser. This lift also moved the tool joint into the upper annular and accounts for the erosion patterns DNV observed on the recovered portion of the drill pipe. The two minority theories indicated above fail to adequately explain the drill pipe position as proven by the DNV investigation.[14]

[14] For example, the Department of Justice's expert theorizes that the drill pipe was buckled due to rig drift off. However, he has no information or evidence to determine where the rig was located when the Autoshear pin was cut. Instead, he states that the rig "would be expected to have been substantially off station at the time of Autoshear activation on the morning of April 22nd." (Talas Engineering Report at 14). DNV, on the other hand,

Just prior to the VBR closure at 9:47 p.m., the velocity of the fluid around the tool joints inside the casing was determined by Stress Engineering to be approximately 120 ft/sec or 75 mph,[15] creating an average[16] upward lift of 125,000 lbs.[17] This is sufficient force to remove drill pipe stretch and compress the 5.5-inch drill pipe from below.[18] With the weight of the drill string above restricting the 5.5-inch drill pipe's upward movement, flow from the well compressed and ultimately helically buckled the drill pipe inside the BOP stack and into the riser. When the AMF activated, the helical buckling had forced the drill pipe off-center, and the BSR was unable to shear the 5.5-inch drill pipe and seal the well.

In addition to buckling the drill pipe, flow from the well pushed the tool joint into the upper annular. Prior to displacement, a driller typically positions the drill pipe tool joint in the BOP to ensure that a continuous length of uniform drill pipe runs through the rams. This practice also ensures that a tool joint is not placed within one of the annular elements. There is no evidence to suggest this practice was not followed by the *Deepwater Horizon* drill crew. As such, it is highly unlikely the crew purposefully placed the tool joint in the upper annular as some experts contend. Rather, it is more likely the tool joint was pushed into the annular by the reduction in drill pipe stretch caused by the lift created by flow from the well. Once the tool joint was partially in the upper annular, it was centered by the annular packer and restricted from further upward movement by the weight of the drill string above. Though the tool joint was centered by the annular packer, the 5.5-inch drill pipe remained buckled within the BOP stack. As a result, the BSR closed on an off-centered portion of the drill pipe and was unable to seal the well.

The force-from-below theory outlined above is consistent with DNV's post-incident analysis of drill string erosion patterns and pipe locations.[19] The drill pipe location established by the DNV investigation is not disputed. The distance between the upper and lower fingers of the annular element is 18 inches, which corresponds to the erosion patterns found during DNV's post-incident analysis. As explained in Transocean's internal report, the drill pipe contact with the lower fingers can be clearly identified on the tool joint.[20] The erosion on the upper section of the drill pipe aligns with the area of upper fingers of the annular element. The force-from-below theory is the only theory that plausibly explains these erosions patterns.

---

ruled out rig drift off as a plausible scenario based on the physical evidence and actual position of the *Deepwater Horizon*.

[15] Hydraulic Analysis of Macondo #252 Well Prior to Incident of April 20, 2010 (TREX-50150), at 144.

[16] Variation is due to the range of possible fluid properties in the well bore.

[17] Calculation based on Hydraulic Analysis of Macondo #252 Well Prior to Incident of April 20, 2010 (TREX-50150), at 144.

[18] A compressive load above 53,343 lbs is sufficient to buckle drill pipe in a pinned-to-pinned condition. Structural Analysis of the Macondo #252 Work String (by Stress) on Table B.1 (TREX-50151), at 21. In a pinned-to-pinned condition each end of the pipe is not rigidly held and is free to rotate but not free to move vertically.

[19] DNV Final Report Related to Forensic Examination of Deepwater Horizon Blowout Preventer (TREX-01164), at 80-95.

[20] Transocean Investigation Report (TREX-03808), at 154.

B. The Falling Traveling Block (the Force-from-Above Theory) Could Not Have Caused the Drill Pipe to Buckle.

The theory that the traveling block falling (or force-from-above theory) pushed the drill pipe off center is incorrect because the VBRs could not provide the vertical friction force needed for the drill pipe to buckle due to a force from above. In addition, the force-from-above theory fails to plausibly explain the drill pipe position as established by the DNV investigation.

1. At the Time the Traveling Block Fell, the BOP had Already Lost Power and the VBRs Lacked the Closing Force Needed to Resist the Resulting Downward Force.

Under the force-from-above theory, the VBRs must exert enough vertical friction force to resist the downward force on the drill pipe caused by the falling traveling block. Without enough resistance to this downward force, the drill pipe will not buckle. Rather, it will be pushed through the VBRs toward the bottom of the well.

At the time the traveling block fell on April 20, 2010, the BOP stack had already lost power. Once the BOP stack lost power, the VBRs would also lose their control system hydraulic closing force. When presented with a dominant downward force as suggested by the force-from-above theory, it is reasonable to assume that the drill pipe would have been pushed down and out of the annular packer, possibly until the tool joint contacted the packers on the upper VBR. In such a circumstance, the drill pipe would not buckle as indicated by the DNV post-incident analysis.

2. The Force-from-Above Theory Relies on an Incorrect Vertical Friction Calculation.

Even if the BOP had not lost power by the time the traveling block fell on April 20, 2010, the VBRs still could not have provided enough vertical frictional force to resist the falling traveling block's downward force on the drill pipe. Mr. Shanks's contrary opinion is based on an inaccurately calculated vertical frictional force of 359,000 lbs. This calculation does not represent the true VBR geometry or function.

To accurately calculate the true vertical frictional force of the VBRs, new calculations were performed with the following adjustments:

- VBR packer anti-extrusion plate thickness equals 1.0 inch – not 0.5 inch;
- Anti-extrusion plates do not contact the drill pipe;
- Because anti-extrusion plates do not contact the drill pipe, only forces from the packer rubber contacting drill pipe should be considered; and
- Wellbore pressure effects were included twice and should have been included only once.

Using these corrected values, the actual vertical frictional force from the VBRs is 131,570 lbs.[21] As noted by Mr. Shanks, the traveling block weighed approximately 190,000 lbs. As such, even if the BOP had not lost power, the VBRs could not provide enough vertical frictional force to resist the falling traveling block. Rather than buckling drill pipe inside the BOP stack, the falling traveling block would have pushed the 5.5-inch drill pipe through the VBRs toward the bottom of the Macondo well.

The force-from-above theory also fails to plausibly explain DNV's post-incident analysis. First, and as indicated above, it is highly unlikely the drill crew purposely placed a tool joint within the upper annular. As such, the force-from-above theory struggles to explain the erosion patterns discovered during DNV's analysis. More importantly, the force-from-above theory ignores the elastic deformation of the drill pipe inside the BOP – namely, between the VBRs and CSRs, the CSRs and BSRs, and the BSRs and the upper annular element.[22] As such, the force-from-above theory does not provide a plausible explanation for all evidence discovered during DNV's post-incident analysis.

IV. CONCLUSION

The post-incident testing discussed in this report confirms that the BOP functioned as designed but was unable to seal the Macondo well. Transocean and third-parties have demonstrated that both the yellow pod and blue pod were fully functional on April 20, 2010, and as such, one or both pods initiated the BOP's AMF function. At that time, however, the drill pipe was forced to the side of the well bore by helical buckling caused by extreme dynamic flow and wellbore pressure. The buckled pipe and extreme flow prevented the BSRs from fully shearing the drill pipe and sealing the Macondo well.

E.G. (Greg) Childs, P.E.

[21] Revised Calculation of Vertical Friction Force on 5.5-inch Drill Pipe, TRN-MDL-02995997-299600.

[22] DNV Final Report Related to Forensic Examination of Deepwater Horizon Blowout Preventer (TREX-01164), at 82-86. These drill pipe sections are straight establishing that there was no plastic deformation as suggested by force-from-above theory.

Documents Considered by Greg Childs in Preparation of Rebuttal Report

EXHIBIT NO.	DESCRIPTION	BATES RANGE
	Expert Report of Paul Dias	
	Expert Report of Cliff Knight	
	Expert Report of David O'Donnell	
	Expert Report of Chuck Schoennagel	
	Expert Report of Forrest Earl Shanks II	
	Expert Report of Glen Stevick, Ph.D., P.E.	
	Expert Report of Arthur Zatarain, P.E.	
	Talas Engineering Report	
	Cameron Report, September 15, 2010	CAM_CIV_0374340 – 374349
TREX-01164	DNV Final Report Related to Forensic Examination of Deepwater Horizon Blowout Preventer, Volume I, March 20, 2011	
TREX-01165	DNV Final Report Related to Forensic Examination of Deepwater Horizon Blowout Preventer, Volume II Appendices, March 20, 2011	
TREX-03130	DNV Laboratory Notebook of Gary Kenney	016862 – 16902
TREX-03605	Cameron Engineering Bulletin EB 891 D AMF/Deadman Battery Replacement, September 8, 2004	CAM_CIV_0003275 - 3276
TREX-03808	Transocean Investigation Report, June 2011	
TREX-50150	Stress Engineering Services Inc. Hydraulic Analysis of Macondo #252 Well Prior to Incident of April 20, 2010, Revision 1, April 27, 2011	
TREX-50151	Stress Engineering Services Inc. Structural Analysis of the Macondo #252 Work String, May 2011	
TREX-50165	West Daily Activity Report Testing Notes, August 5, 2011	TRN-MDL-02971987 – 2971993
	Revised Calculation of Vertical Friction Force on 5.5" Drill Pipe	TRN-MDL-02995997 – 2996000
	Summary Document of AMF Battery Replacement and Pods	TRN-MDL-02996001 – 2996002
	Summary of SEM Testing Results on the Nautilus, October –December 2010	Beginning at TRN-MDL-02996003
	Cameron Report, 18-3/4" 15M TL BOP 7-5/8" to 3-1/2" VBR RAM, April 27, 2000	CAM_CIV_0070558 – 70570
	SEM Testing at West Drilling Equipment Center, November 3, 2010	TRN-INV-01130032 – 1130041