

EXPERT REPORT

**DEEPWATER HORIZON BLOWOUT PREVENTER
EXAMINATION AND TESTING**

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TABLE OF CONTENTS

I. INTRODUCTION	3
II. EXECUTIVE SUMMARY	3
III. COMPLETE STATEMENT OF OPINIONS	5
1. Solenoid 103 Of The Yellow Pod Was Improperly Refurbished (Incorrect Coil Wiring), Preventing AMF/Deadman Functioning Of The Blind Shear Ram From The Yellow Pod ...	5
2. The 27 Volt Battery Of The Blue Pod (For Powering Solenoids) Was Inadequately Maintained And/Or Monitored, Preventing AMF/Deadman Functioning Of The Blind Shear Ram From The Blue Pod	8
3. Better And Safer Technology Was Available Since At Least 2006 That, If Implemented, Would Have Eliminated Malfunctions Associated With A Miswired Solenoid And/Or Inadequately Charged Batteries	11
4. The Blind Shear Ram Selected For This BOP Is Inadequate To Ensure Well Control In Foreseeable Conditions And Circumstances For Such Subsea Application	11
5. ROV Intervention Was Not And Could Not Have Been Successful	17
IV. BACKGROUND AND QUALIFICATIONS	17
V. REFERENCES CITED	20
VI. ATTACHMENTS	23

I. INTRODUCTION

The Deepwater Horizon Accident

Team members have been retained by the United States Department of Justice (DoJ), via Talas Engineering, Inc., to observe the Deepwater Horizon Blowout Preventer (BOP) forensic activities at the New Orleans NASA Michoud facility, and to provide opinions and findings relevant to the Deepwater Horizon accident. Observations and opinions/findings cover both Phase I (JIT ordered) and Phase 2 (BP funded) activities. The team has a diverse background focusing on failure analysis and mechanical engineering; background and qualifications of each team member are given in section V.

Other documents have extensively addressed the accident in question before, so general background will not be repeated here. The reader of this report is assumed to already be knowledgeable about the Deepwater Horizon events, and to have some knowledge of the Blowout Preventer systems.

Our opinions are specifically focused on aspects of the Blowout Preventer system, including the BOP and Lower Marine Riser Package (LMRP) and their constituent parts, associated controls, drill pipe, riser, and related ROV activities.

Opinions with sufficient data/information to be of reasonable engineering and logical certainty are given following. This report is based on the information reviewed to date, we reserve the opportunity to provide additional opinions, or augment current opinions at a later date as more information becomes available, which is anticipated.

This report is based on information gathered and witnessed during attendance at the Michoud investigation, information supplied as a result of the investigation, discussions with other members of the Working Group and representatives of the United States thereto, interrogatories, deposition testimony and other discovery produced in this litigation, and personal experience. Specific citations used to support the basis of opinions are provided in section IV, References Cited, and are referenced in brackets []. Attachment 11 is a complete listing of documents considered in preparing this report.

II. EXECUTIVE SUMMARY

At the time of the incident on April 20, 2010, rig personnel did not take sufficient measures to control the well before communications with the BOP stack were lost. Once that communication was lost, EDS function was no longer possible, so only the Automatic Mode Function or “Deadman” (AMF) remained as a last resort to place the well in a safe and controlled condition.¹ However, the AMF/Deadman failed to seal the well. Investigation was focused on this failure of the BOP to seal the well, and critical problems were found in that system. Despite being designed with redundancy to ensure functionality, multiple failures prevented sealing of the well.

Maintenance procedures, training, and quality control aboard the DWH were inadequate to ensure critical components would always function as required. BP and Transocean have a responsibility to ensure that the BOP stack and its components function properly at all times, and they failed to design, install, maintain, test, and use the BOP system and system components to ensure well control. The best available

¹Autoshear, which requires LMRP release from the BOP to activate, is not otherwise automatically triggerable.

and safest drilling technology was not implemented. BOP monitoring and maintenance was inadequate, resulting in the failure of safety critical operations to function as designed and intended. Examples of this failure to ensure the proper functioning of critical components, to maintain a safe and controlled well condition include the following:

1. Solenoid 103 of the Yellow pod was improperly refurbished (incorrect coil wiring), preventing AMF/Deadman functioning of the Blind Shear Ram from the Yellow pod.
 - a. Had Transocean followed the original equipment manufacturers procedures, or its own test procedures for repairing solenoid valves, the miswired solenoid valve would have been found to be inoperative and unsuitable for installation on the pod.
2. The 27 volt battery of the Blue pod (for powering solenoids) was inadequately maintained and/or monitored, preventing AMF/Deadman functioning of the Blind Shear Ram from the Blue pod.
 - a. Adequately charged batteries are critical to BOP emergency operation and redundancy, and should be continuously monitored.
 - b. The BOP was not maintained to ensure that the equipment would function properly.
3. Better and safer technology was available since at least 2006 that, if implemented, would have eliminated malfunctions associated with a miswired solenoid and /or inadequately charged batteries.
4. The Blind Shear Ram selected for this BOP is inadequate to ensure well control in foreseeable conditions and circumstances for such subsea application.
 - a. The BSR could not cut offset drill pipe.
 - b. The drill pipe became off-center because of rig drift.
 - c. The BSR was likely activated when the ROV operated the Autoshear function on April 22, 2010.
 - d. The Blind Shear Ram specifications are inadequate for this application and BP and Transocean failed to update the specifications with the best available and safest drilling technology. These inadequacies include inability to center pipe, blades that do not cover the full well bore, and marginal cutting capacity.
5. ROV intervention was not and could not have been successful.
 - a. ROV self-pumping flow rates are too low to close rams quickly enough in a situation where the well is flowing.
 - b. ROV intervention was also hindered by the lack of up to date schematics and plumbing diagrams of the BOP stack.

III. COMPLETE STATEMENT OF OPINIONS

1. SOLENOID 103 OF THE YELLOW POD WAS IMPROPERLY REFURBISHED (Incorrect Coil Wiring), PREVENTING AMF/DEADMAN FUNCTIONING OF THE BLIND SHEAR RAM FROM THE YELLOW POD

When the Yellow pod was raised and tested on the Q4000, technicians found the pilot valve that activates the BSR as well as the Upper Annular (UA) regulator pilot valve were inoperative. When replaced with new valves, the pod functioned correctly and was lowered back down to the stack so efforts to close in the well could continue. [1] It was discovered during investigation that the dual coils on solenoid valve 103Y, the valve that activates the blind shear ram, as well as regulator control valve 3AY, which pilots the upper annular regulator, were wired with one coil having reversed polarity in relation to the other. [2] Figure 1 is a photograph of the wiring of Solenoid 103Y as it was found during the Michoud investigation. Figure 2 is a drawing depicting the correct wiring, directly from Cameron documentation. [3] Figure 3 is an illustration combining the information from Figure 2 and showing the correct wiring. The photograph in Figure 1 shows that wiring on pins 1 and 2 are reversed (1-black, 2-white instead of 1-white, 2-black). Figure 4 is a photograph of the wiring as it was found in Solenoid 3AY, with annotations identifying the incorrect wiring.

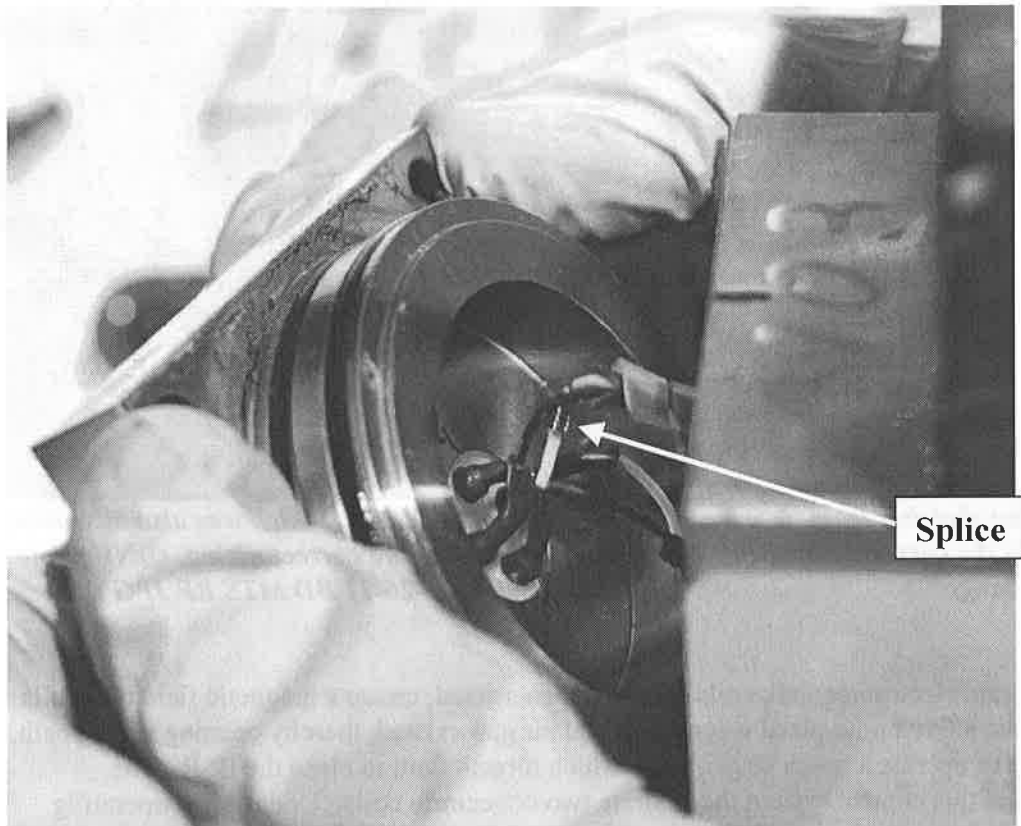


Figure 1: 103Y original solenoid, improper cable assembly flange wiring. [Pin 1 is uppermost, 4 is closest. Pins 1 and 4 are black, pins 2 and 3 are white.] Wiring connection is spliced (seen on pin 3 white wire), non-standard. (DNV photo IMG_0475.JPG, 05-27-2011 BD MTS RP JPG; additional photos in this group may also be useful to the reader).

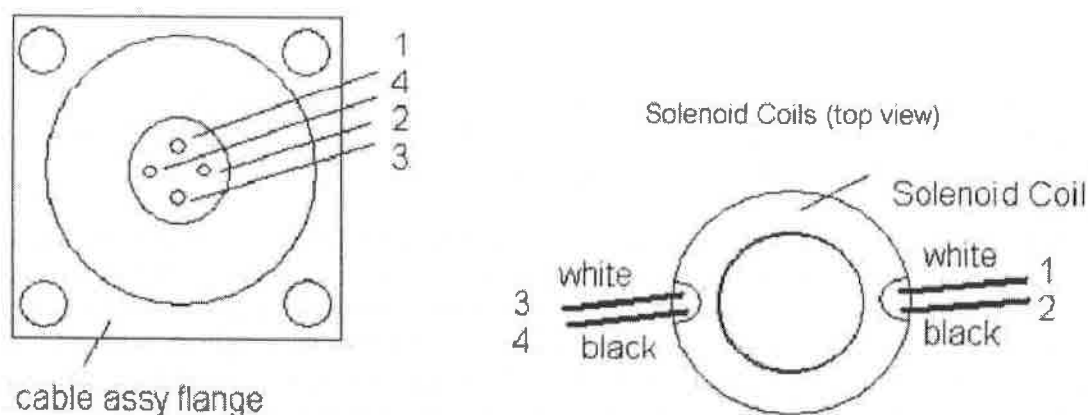


Figure 2: Sketches showing that for proper wiring, pins 1 and 3 should be white wires, and other opposing pins 2 and 4 should be black wires (excerpt from Cameron [3]). Thus, the wires on pins 1 and 2 in Figure 1 are reversed.

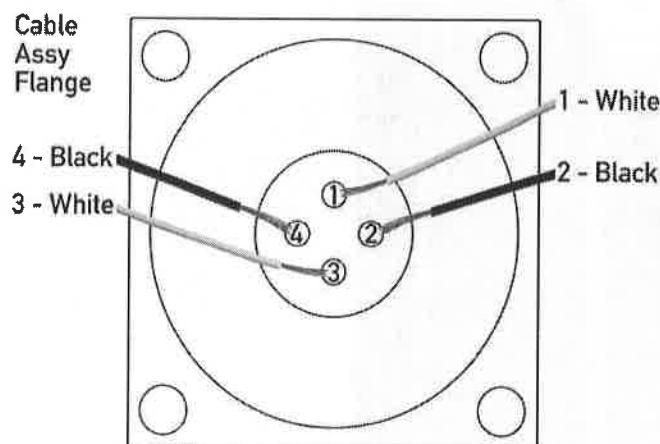


Figure 3: Combining the sketches from Figure 2, this illustrates the correct wiring on the cable assembly flange

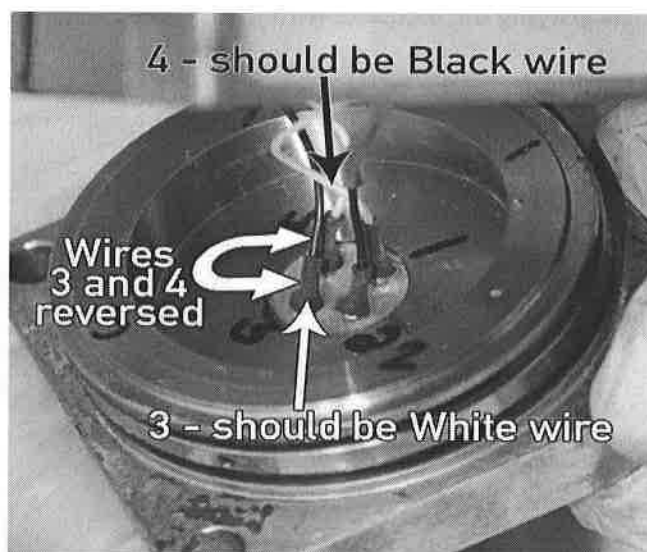


Figure 4: Solenoid 3AY, which was also miswired, with annotation of the correct wiring. (DNV photo IMG 0458.JPG, 5-26-11 BD MTS RP JPG)

Solenoid valves incorporate electromagnetic coils that, when energized, create a magnetic field that pulls a movable plunger against a fixed pole piece where an initial air gap existed, thereby opening a flow path, allowing stored pressure to operate a much larger valve which directs fluid to close the BSR. The Cameron valves used with this control system incorporate two concentric coils. Under good operating conditions, either coil should have developed adequate force to shift the valve.

The dual coil provides redundancy as well as nearly twice the pulling force to overcome stickiness due to infrequent use and possible contamination if energized correctly and simultaneously. Energizing either single coil also creates a magnetic field that draws the plunger against the pole piece. Whenever an EDS or AMF/deadman sequence is initiated, SEM A and SEM B both become operational, each relying on

power from its own 9 volt battery. Each then goes through a control sequence which includes firing its respective A or B coils. The result is that during the AMF, both coils are fired at the same time. [4 & 6] With coil polarities reversed as found, the created fields would oppose and effectively cancel each other instead of being additive, resulting in little or no shifting force. The absence of pulling force when both coils were energized resulted in the BSR not activating during AMF from the Yellow pod.

Bench testing of original solenoid 103Y, original solenoid 3AY, and contrasting these with bench testing of replacement solenoid 103Y [5] has clearly established that these two solenoids present at the time of the incident are faulty, and will not function when both coils A and B are energized.² This is one fundamental causal factor for not maintaining a safe and controlled well condition. AMF activation always energizes both coils A and B. [4 & 6]

- a. Had Transocean followed the original equipment manufacturers procedures, or its own test procedures for repairing solenoid valves, the miswired solenoid valve would have been found to be inoperative and unsuitable for installation on the pod.**

The miswired solenoid could have been avoided by actions of both 1) whomever did the refurbishment, and 2) whomever was responsible for accepting the refurbished solenoid valve, possibly using an inspection protocol. Whether repaired by an outside vendor or Transocean maintenance personnel, this was either a breach of control policy or a shortcoming in Transocean quality control policy concerning maintenance and repair of critical components.

It is apparent that neither the Cameron Factory Acceptance Test (FAT) nor the Transocean Solenoid Repair Procedure was followed during this repair, as testing at the time the solenoid was refurbished did not reveal the fact that the valve would not function if both coils were energized simultaneously. Records indicate that in February 2010, while the DWH was moving to the Macondo site, the BOP was lifted to the rig for service and solenoid 103 on the Yellow pod was replaced with a valve that had been repaired. [7] The Cameron procedures for new or refurbished solenoid valves, [3 & 8] as well as Transocean test procedures [9] call for a bench test that energizes each coil independently as well as both simultaneously. The simultaneous coil energization test would have certainly shown improper function of the solenoid valves, and the problem could have been corrected before installing on the BOP.

Transocean is explicit in its call for bench testing with both coils energized as well as each coil energized singly, and notes in the procedure that a failure to function in this test is indicative of a miswired coil. [9] It is evident Transocean was aware of the importance of proper wiring orientation of the coils in these solenoid valves.

² Initial tests of Solenoid 103Y were deemed inconclusive. The proper interpretation of this testing was severely confused by initially unknown problems with how the Portable Electronic Testing Units (PETUs) actually function. Once the PETUs were understood, the vast majority of PETU based test data made sense in light of the known miswiring of 103Y and 3AY original solenoids, along with proper wiring of 103Y replacement and 103B solenoids. Despite the eventual understanding of the PETUs' function, there were still two inconsistent individual test results reported (compared to about 18 consistent test results). Possible reasons for those results can be posited, such as human error, but the vast majority of the tests showed that the miswired 103Y solenoid could not have functioned the BSR during AMF from the Yellow pod, consistent with the certainty of the observed coil miswiring.

2. THE 27 VOLT BATTERY OF THE BLUE POD (For Powering Solenoids) WAS INADEQUATELY MAINTAINED AND/OR MONITORED, PREVENTING AMF/DEADMAN FUNCTIONING OF THE BLIND SHEAR RAM FROM THE BLUE POD

The malfunctioning of the 103 solenoid on the Yellow pod could have been overcome by the redundancy of the Blue pod, had the Blue pod been properly maintained and capable of activating the BSR. However, the 27 volt battery in the Blue pod was measured effectively dead on the Discoverer Enterprise [10] and later at Michoud [11], thus the 103B solenoid could not be sufficiently powered, and the BSR could not be closed. Although either pod was supposed to be able to activate the BSR and attempt to shut in the well, neither one of them was capable of performing that function due to different, but easily identifiable, faults in the system.

Table 1 summarizes battery no-load voltages measured at different times. [11] Testing of solenoids conducted at NASA Michoud in February of 2011 indicated that steady battery voltages of approximately 14.5 to 15 volts are required to energize solenoids. [12] No-load test results repeatedly demonstrated that the 27 volt battery in the Blue pod provided no more than 7.61 volts. All subsequent measured voltages were substantially lower than this reading. Clearly, the 27 volt Blue pod battery was effectively dead.

		Discoverer Enterprise	--- NASA Michoud ---		
	-Q4000 -				
Battery	May 6, 2010	July 5, 2010	Feb. 28, 2011	June 15, 16, 2011	June 17, 2011
Blue Pod Batteries (volts)					
SEM A 9 V		8.78	8.90	8.92	
SEM B 9 V		0.142	8.68	8.73	
27 V		7.61	1.10	2.10	
Yellow pod Batteries (volts)					
SEM A 9 V	8.85		8.67	8.58	
SEM B 9 V	8.85		8.44	8.32	
27 V	18.41		28.15	28.08	
Exemplar Batteries (volts)					
"New" 27V					28.76
"New" 9V					9.66

Table 1: No-load battery test results

As to when the Blue pod's 27 volt battery was drained, a credible mechanism of discharging the Blue pod 27 volt battery between the time of the April 20, 2010 incident and subsequent testing of the battery on

July 5, 2010 has not been identified. William LeNormand, a field service technician for Cameron International Corporation, and Jack Carter Erwin, a manager for after-market operations, and former field service technician for Cameron, both testified in depositions that they could think of no reason the batteries on the Blue pod would discharge between the date of the incident and the time of the battery tests in July 2010. [13] At the end of Phase 2 activities at Michoud, the batteries were checked for voltage and resistive load-carrying ability, at both room and subsea temperatures. [14] First, this testing showed the Blue pod 27 volt battery to be quite dead, and load testing was not even attempted on that battery.³ Second, both the Blue pod 9 volt batteries were shown to be adequately charged for AMF functions. Both of these 9 volt batteries carried the substantial resistive loads and did not drop voltage below about 6.4 volts (whereas 5 volts or more is required for AMF card functioning). [14 & 15] Thus, the conjecture⁴ that a low 9 volt battery in the Blue pod could have drained the 27 volt battery, by repeated re-boot attempts of the AMF card, is incorrect.⁵ [15]

Testing of the 9 volt batteries of the Yellow pod showed that the SEM B 9 volt battery was inadequately charged, and voltage under resistive load dropped as low as 1.5 volts. [14] However, the 27 volt battery in this Pod had not been discharged. Had a low 9 volt battery in the Blue pod drained the 27 volt battery through repeated re-booting, one would expect that the low voltage measured on the Yellow pod's SEM B 9 volt battery would have caused the same repeated re-booting, and the same drain on the Yellow pod's 27 volt battery. This was not the case. Thus the low 9 volt battery/27 volt battery discharge scenario is conclusively discounted.

Inadequacy of maintenance is self-evident, because a bad battery was not detected in an otherwise operational BOP, at a critical time when it was needed. Cameron recommends battery replacement after one year of operation, 33 actuations, or five years after date of purchase, whichever of the above events happens first. [16] The 9 volt batteries on the Blue pod were manufactured in October 2005, and the 27 volt batteries on the Blue pod were manufactured in January 2006, according to their labels. See Attachment 1, Figure A-7. [17] According to the testimony of Jim "Owen" McWhorter and Ex. 3795, the Blue pod was pod number 3 at the time of the incident on April 20, 2010. [18 & 19] According to Ex. 3792 [20], the batteries in this pod were last changed on November 4, 2007. Prior to that they were last changed on March 26, 2004. [20] This is consistent with the dates of manufacture found on the batteries in the Blue pod. If these documents are accurate, they indicate that Cameron recommendations for replacement of the batteries every year were not followed, and may explain why the Blue pod 27 volt

³ The Blue pod 27 volt battery was not tested under full load conditions as NASA personnel were reluctant to test this bank of batteries because two of the 9 volt batteries making up this 27 volt bank were so nearly depleted they reportedly feared explosion.

⁴ Transocean has posited this theory to explain the dead 27 volt battery. [15]

⁵ Erroneous measurement or reporting of battery voltages associated with Blue pod SEM B 9 volt and Yellow pod 27 volt batteries occurred on the Discoverer Enterprise and the Q4000. Subsequent measurements and tests demonstrate this to be the case. On the Discoverer Enterprise and the Q4000, indications were that the Blue pod SEM B 9 volt battery (0.142 volts indicated) and Yellow pod 27 volt battery (18.41 volts indicated) were effectively dead or excessively discharged, when they clearly were not, based on later tests at Michoud (8.73 volts and 28.08 volts respectively, almost a year later). Indications are that voltage checking methods in the field were inconsistent, improper, or affected by unknown influences.

battery was not sufficiently charged.⁶

a. Adequately charged batteries are critical to BOP emergency operation and redundancy, and should be continuously monitored.

Inadequacy of monitoring is self-evident, because a bad battery was not detected in an otherwise operational BOP, at a critical time when it was needed. This rig's monitoring and control system did not include battery voltage monitoring at the surface. This is not the best available and safest drilling technology.

In this case, the Blue pod redundancy could have overcome 103Y solenoid malfunction if all batteries were adequately charged. With charged batteries in the Blue pod the AMF/deadman would have closed the BSR while the pipe was still centered, and most probably would have sealed the well. Even if such a seal were not complete under these flow conditions, this would still have given a potential opportunity to maintain a safe and controlled well condition. Clearly, batteries being properly charged is critically important and battery charge monitoring should have been present on the BOP stack, which is the best available and safest drilling technology.

b. The BOP was not maintained to ensure that the equipment would function properly.

The miswired solenoid and inadequately charged 27 volt battery reflect inadequate maintenance and testing.

There are no records that the AMF was ever test fired as a complete system on board the vessel. [23] Indeed, witnesses have testified the AMF was never tested on board. [24] Thus, this critical BOP stack system was not checked since the BOP stack was manufactured. Additionally, as noted above, had the manufacturer recommendations for testing been followed on the miswired solenoid, the error would have been discovered. Furthermore, no procedures, checklists, or documentation have been located which reflect voltage checks of the batteries. [25] Witnesses have testified that RMS, the system used to track maintenance, did not reflect when changes to the battery system were required. [21] A review of the RMS records for the BOP pods reflects very few battery changes. [21]

Proper documentation is required to confirm and track maintenance, testing, and modifications of equipment. Failure to document certain specific items have been noted by third party inspections. [26] Transocean and BP's own audits have found problems in the lack of recorded data and poor history records, with critical checks, inspections, and whole work orders being missed. [27] Specifically, auditors have noted that "an auditable trail of maintenance performed on equipment was often not possible from an interrogation of the maintenance history". Critical checks and inspections were consequently being missed. [27]

As noted in further detail in section 5.b., up to date schematics for the BOP were never discovered, and this interfered with recovery efforts. Without proper schematics on the BOP, it is difficult to understand how complete and adequate maintenance can be performed. If proper testing had been conducted, the incorrect hosing would undoubtedly have been discovered.

⁶ There are conflicting reports as to when batteries were changed or checked and even as to which pods, (1, 2, or 3) were actually in service. Record keeping on use and service of such critical components is severely lacking or non-existent. [21]

Thus, the BOP was not maintained to ensure that the equipment would function properly and ensure the BSR and its controls could attempt to seal the well. By failing to properly use, maintain, or test the relevant solenoids and batteries on the Deepwater Horizon BOP, BP and Transocean failed to take the steps necessary to assure a safe and controlled well condition.

3. BETTER AND SAFER TECHNOLOGY WAS AVAILABLE SINCE AT LEAST 2006 THAT, IF IMPLEMENTED, WOULD HAVE ELIMINATED MALFUNCTIONS ASSOCIATED WITH A MISWIRED SOLENOID AND/OR INADEQUATELY CHARGED BATTERIES

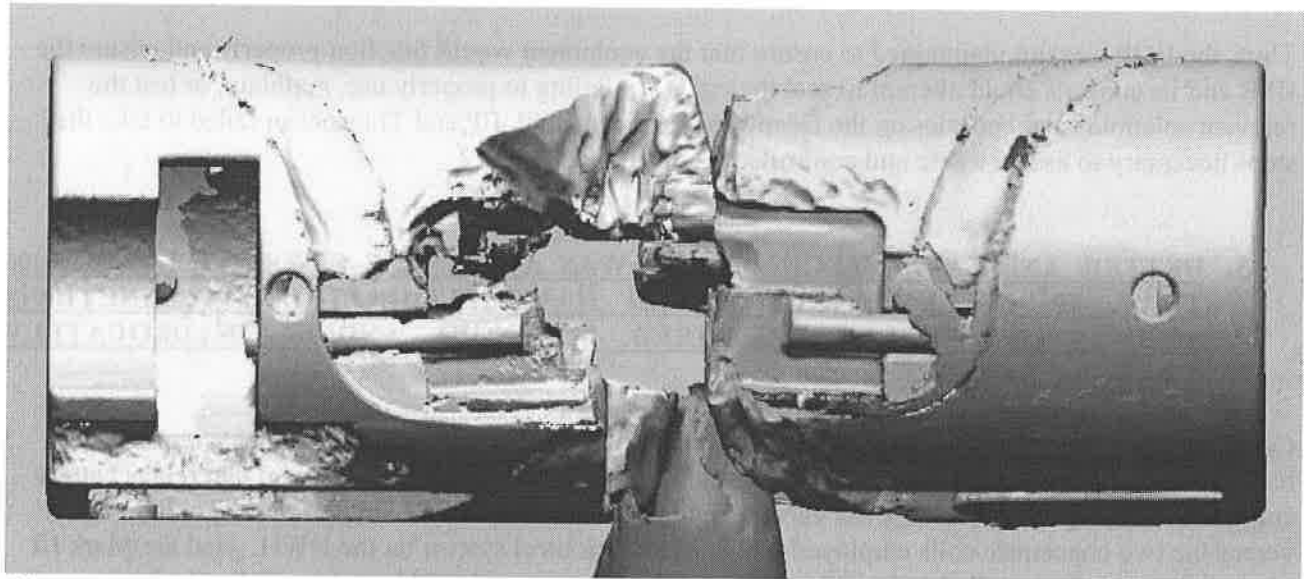
Cameron introduced their Mark III control system in 2006. [22] This system implements rechargeable batteries and continuous charging from the rig as well as a battery monitoring system that relays battery condition to the rig. In addition, pilot valves on this system incorporate a single solenoid coil design versus the two concentric coils employed on the Mark II control system on the DWH. Had the Mark III control system been installed at the time of the accident, batteries should have been fully charged, allowing the Blue pod to function. The use of a single coil also eliminates the potential for one of the dual coils to be wired incorrectly which precludes proper function. This best available and safest drilling technology should have been implemented.

4. THE BLIND SHEAR RAM SELECTED FOR THIS BOP IS INADEQUATE TO ENSURE WELL CONTROL IN FORSEEABLE CONDITIONS AND CIRCUMSTANCES FOR SUCH SUBSEA APPLICATION

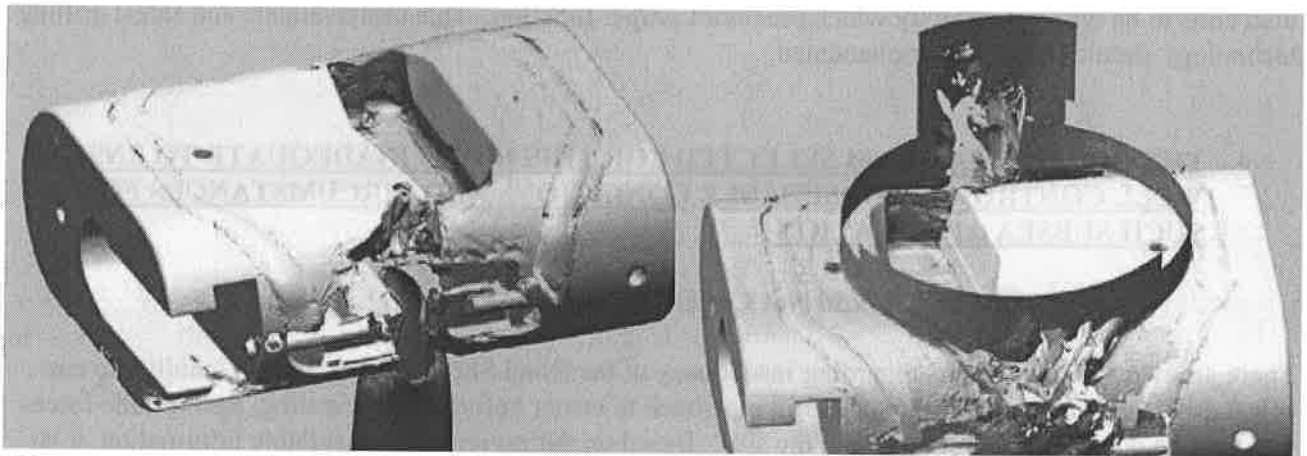
a. The BSR Could Not Cut Offset Drill Pipe

There are two technical points regarding inadequacy of the Blind Shear Ram design; 1) inability to cut offset drill pipe, or 2) inability to push drill pipe back to center before cutting/sealing, against side forces that may be present holding the pipe to the side. Based on our review of the available information, it is our opinion that the drill pipe was offset, that the offset drill pipe was the result of the rig drifting off station, and that the BSR was activated by the ROV triggering the autoshear, not by the AMF.

Inspections and geometric analysis demonstrate that the Blind Shear Ram failed to properly cut and seal the well due to an offset drill pipe. Laser scanning and CAD work [28] clearly shows how the actual drill pipe ends match the BSR jaws/blocks with drill pipe in an offset position, depicted in Figure 5.



(a)



(b)

Figure 5: Drill pipe match with BSR blocks, observed hardware geometry, by DNV scans (from revised figures 147 and 149 from DNV addendum to report, [28])

In addition, nonlinear finite element analysis (FEA) of pipe crushing/cutting [28] also shows a very good match to the actual drill pipe condition, for example Figure 6. The FEA also indicates that BSR closing force was likely normal, i.e. of sufficient pressure to cut the pipe, had the pipe been centered, because the crushed shape of the pipe is matched by the full pressure (4000+ psi) FEA response prediction. These geometric and mechanical engineering analyses corroborate observations of the hardware that there was an uncut portion of drill pipe that prevented ram block closure and sealing, and allowed upward well flow and serious washing damage within the wellbore. This is one fundamental reason for not maintaining a safe and controlled well condition.

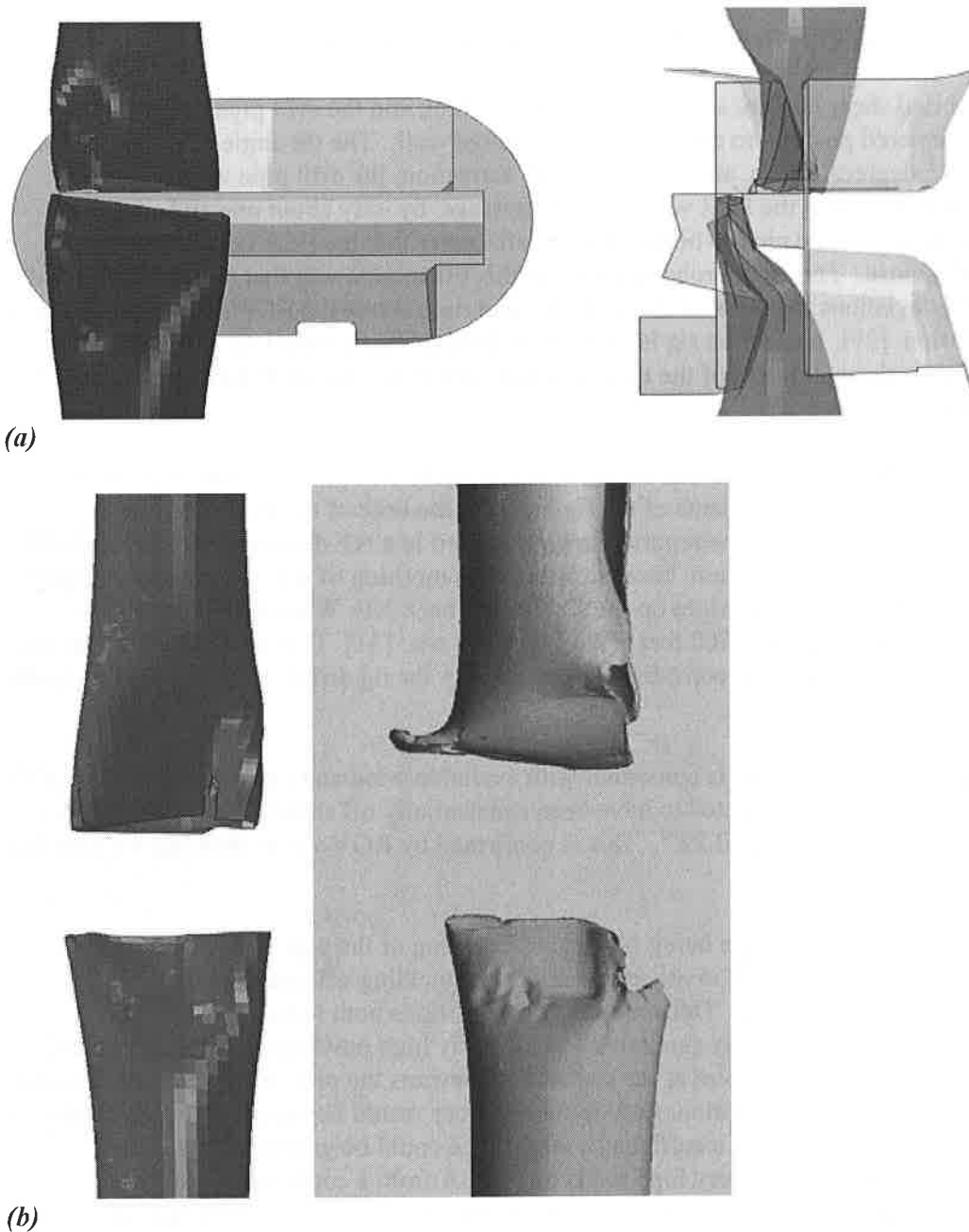


Figure 6: Drill pipe/ram block match, nonlinear FEA prediction and pipe scans, by DNV (from revised figures 144, 145, and 146 from DNV addendum to report, [28])

Offset pipe in the BOP is certainly a foreseeable and common condition, for such subsea operations. Drill pipe bending can come from several sources or their combination: 1) rig drift off the well, 2) sea currents bending the riser, 3) compression forces in the drill pipe exacerbating existing bending from other sources, 4) laterally non-uniform wellbore flow (causing lateral dynamic pressure imbalance), or 5) possible asymmetric partial closure of rams or annulars. It is certainly a very likely condition to have pipe offset in deep subsea operations, and it should be addressed in subsea BOP design and specification.

b. The Drill Pipe Became Off-Center Because of Rig Drift

The upper annular and blind shear ram are separated by about 20 feet, and the drill pipe can move about 6 inches laterally from a centered position to contacting the wellbore wall. The tilt angle associated with that geometry is about 1.5 degrees. Thus, at the time of BSR activation, the drill pipe within the BOP between the upper annular (UA) and the BSR was tilted, on average, by only about one and a half degrees. This small angle caused the pipe to be sufficiently off-center that the BSR could not cut it completely and thus fully close. The most probable cause of this offset pipe was that the rig had drifted off station. Much larger deviations than this of the drill pipe and riser above the BOP are reported to have occurred after the explosion. [29] Indeed the rig is reported to have drifted as much as 1600 feet off station at one time, which is the equivalent of the riser and drill pipe above the BOP being at an angle of around eighteen degrees.

The BOP was oriented such that the kill side was facing approximately NE. [30] To date only limited information has been located on the movements of the rig between the time of the explosion and it sinking. [29] Early on April 21st, the rig was reported to have drifted in a NE direction by 1500 or 1600 feet. Subsequently, it drifted in a SW direction, because later in the morning of the 21st it was reported to be back towards the well site. Close to midnight on the 21st, it was back NE. When the rig sank, the following morning, it was approximately 1500 feet NW of the well site. [31] Thus it is clear that the rig moved in a variety of directions, providing considerable opportunity for rig drift to push the drill pipe off-center at the BSR.

That the rig drifted significantly off station is consistent with available wind and current information. [32] Based on these data, the rig would be expected to have been substantially off station at the time of autoshear activation on the morning of April 22nd. This is confirmed by ROV video showing the riser at a marked angle at this time. [33]

The alternative explanation for the drill pipe being off-center, buckling of the pipe under load, lacks supporting evidence or credible analysis. It involves the drill pipe buckling off-center under high upwards loads applied from below the UA. This requires two conditions both to be fulfilled simultaneously: 1) that the hydrocarbon flow generates a sufficiently high upwards force on the pipe to both lift it and bow it, and 2) that the tool joint at the closed UA prevents the pipe moving upwards under very high upward forces. For the first condition, flow-induced forces would be expected, but no evidence or credible analysis has been presented that a sufficiently high force could be generated in this way. If however it were true, then there would be very high loads on the UA from a combination of forces pushing the pipe from below and those pulling the pipe from above. These would include not only the postulated high loads bowing the pipe upwards from the flow, but also the direct pressure loading on the joint itself and the high tensile forces exerted by the pipe above from this same mechanism of flow, as well as forces from rig drift off. There is no evidence or credible analysis that the UA, much of which was rubber, would have been capable of blocking the pipe movement under these severe conditions. This is particularly unlikely to be true in view of the fact that hydraulic power had been lost, likely resulting in some relaxation of the UA and it not therefore being very tightly closed. And finally, had the UA been able to hold the drill pipe so well, how could the UA also have allowed such large leakage required to generate upward force from below?

If the AMF had operated successfully at the time of loss of communication (just after the explosion) then the rig would not yet have drifted off, the pipe would not have been off-center and thus the BSR most probably would have cut the drill pipe and closed and sealed the well. Even if such a seal were not complete under these flow conditions this would still have given a potential opportunity to place the well

in a safe, controlled condition. To the extent that maintenance issues prevented AMF function, then such issues would have been a significant cause of the failure to seal the well, and ensure the safety and protection of personnel, equipment, natural resources, and the environment.

c. The BSR was likely activated when the ROV operated the autoshear function on April 22, 2010

Activation of the BSR occurred before the rig sank, but after it left station, most probably when the ROV operated the autoshear function on the morning of April 22, 2010, a few hours before the sinking. The pipe must have been cut before the rig sank to allow the remaining cut/broken portion above the BSR to rise upwards above the UA. Once the rig sank and the riser kinked, movement of the drill pipe would have been very greatly restricted. Furthermore, the BSR must have activated at some significant time after the explosion, such that the rig had now drifted off station and offset the drill pipe substantially.

The Transocean investigation report maintains that flow induced forces rather than drift caused the pipe to be off-center. [34] Even if this were true, the drill pipe would still have been centered at the time the AMF should have operated (very shortly after loss of communication with the rig). This is because, following the scenario proposed in the Transocean report, flow would have been low or zero at this time and thus the pipe would not have had enough upward force to buckle.⁷ If the AMF had functioned at this time with the pipe centered, the BSR most probably would have cut the drill pipe and closed and sealed the well. Again, to the extent that maintenance issues prevented AMF function, then such issues would have been a significant cause of the failure to seal the well, and ensure the safety and protection of personnel, equipment, natural resources, and the environment.

d. The Blind Shear Ram specifications are inadequate for this application and BP and Transocean failed to update the specifications with the best available and safest drilling technology. These inadequacies include inability to center pipe, blades that do not cover the full well bore, and marginal cutting capacity

Failure by the BSR to either center the pipe or to cut off-center pipe reflects issues with the original BSR specification and with the later failure to update to "CDVS rams". Rams with better centering characteristics and wider blades were available at the time the BOP was specified. [35] CDVS rams were available to update the BOP several years before the incident. According to Cameron testimony, CDVS rams would have been both more efficient at centering the pipe and were full width of the bore. [36] If the rams were either capable of centering the pipe or had blades the full width of the well bore, the pipe would probably have been successfully cut, providing a potential opportunity to bring the well under control, and ensure the safety and protection of personnel, equipment, natural resources, and the environment.

The only Blind Shear Ram qualification test for this BOP, undertaken in April 2000, resulted in 2,900 psi cutting pressure for the 5½ inch pipe (quoted by BP in [37]). The normal functioning available regulated

⁷ It is difficult to understand Transocean's theory, as conflicting and unclear statements appear in the Report, Appendix, and Video Presentations. Relying on Appendix M, which is the only structural analysis presented, Transocean's explanation for the pipe bowing includes the assumption that "flow stopped when the VBR closed", which is in direct contradiction with flow-induced upward forces. [34] (Appendix M, pg 6)

pressure is 3,000 psi. This is just over the required pressure obtained from testing. Furthermore, as discussed in more detail below, there are two additional factors that must be considered. The first is the natural variation in the factors involved, including the strength of the steel used in the drill pipe and its wall thickness - a single test data point of 2,900 psi is far too close to the normally available pressure for a design specification to be counted on to cut pipe reliably. The second, very important, factor is the effect of BOP wellbore pressure. When the BSR is needed to control the well, there will always be pressure in the wellbore. This factor is not taken into account in the testing, and must be added by calculation. As discussed below, it has the potential to increase the required pressure to cut and seal the BSR to well above that available. The original BSR specification was, even at best, extremely marginal for pipe cutting capacity and was substantially under-specified.

Attachment 2 includes discussion of shearing capacity calculations. It appears that full accounting of and correction for known wellbore pressure effects that tend to cancel operating pressure of the BSR were not made when the BSR was specified. The qualification test result mentioned above corroborates this omission, and in addition shows that natural variation in cut force is not being considered with the test's single cut data point.

To succinctly summarize (more details are in Attachment 2), wellbore pressure of at least 10,000 psi over seawater depth pressure must be corrected for (the lowest annular pressure rating above the BSR). By definition, the "closing ratio" of a ram (for this ram, equal to 6.7) is the ratio of wellbore pressure to additional pressure required to close the ram against that pressure. Applying the numbers for 10,000 psi wellbore pressure, we get a correction pressure of 1,493 psi. Adding this to the zero wellbore pressure (i.e. surface conditions) qualification test result of 2,900 psi required to cut the pipe indicates 4,393 psi is required to cut pipe. This greatly exceeds the normal regulated operating pressure of 3,000 psi and even substantially exceeds the emergency (AMF and Autoshear) regulated pressure of 4,000 psi. The BSR is clearly under-specified for shear capacity of the 5½ inch pipe. The mis-specification is obviously substantially worse for the upper drill string 6-5/8 inch pipe, which requires about 2,361 psi more pressure to cut. [38]

West Engineering performed a major test and analysis project in 2004, for the U.S. Minerals Management Service, concerning BSR shear force capabilities. [39] Most importantly, they reasonably and properly characterized the natural variation in pipe cut forces for the same BSR and pipe over many cuts, and established regression equations to best fit the data and to account for the natural variation observed. The standard deviation for pipe shear cut force values for S-135 pipe was found to be about 21% of the mean value. That is very large variation, clearly making reliance on a single qualification data point problematic. Design specification calculations must first include the natural variation effect, and if a single qualification data point is used for verification, a substantial test margin relative to operating pressure must be observed for a properly specified BSR. In this case, we have only 100 psi margin from 3000 psi operating pressure, or only 3.3%. If 2,900 psi is the mean pressure for cutting (which is all that can be reasonably deduced from a single sample), and we know standard deviation is about 21%, then the pipe would be cut only about 50% of the time with zero wellbore pressure. At large wellbore pressures such as 10,000 psi, which adds another 1,493 psi to the required cutting pressure, the pipe would not be reliably cut by either 3,000 or 4,000 psi regulated pressure.

5. ROV INTERVENTION WAS NOT AND COULD NOT HAVE BEEN SUCCESSFUL

a. ROV self-pumping flow rates are too low to close rams quickly enough in a situation where the well is flowing

Many futile attempts were made during the intervention to use ROV stabs to close different rams, including the Blind Shear Ram. [40] A preliminary analysis would have indicated the pumping capacity on the ROV to be woefully inadequate. The AMF was programmed to close in 20 – 30 seconds, and API specification 16D, Sec. 2.2.2.1 recommends no secondary intervention on a flowing well should require more than 45 sec to close a Blind Shear Ram. [42] Closing the BSR (displacement volume of 24.6 gal [41]) in 20 seconds requires a flow rate of around 75 gpm. A flow rate of around 33 gpm would be required to close in 45 sec. Pumps on the first ROV used were reported to have a pumping capacity of around 4.5 gpm (17 lpm). [29] At this rate, it would take about 5.5 minutes to close the BSR. All during this closing time the well flow would be eroding the exposed ram blocks and seals, making a tight closure highly unlikely. The only known practical way to expect an ROV intervention to be successful in such an operation would be to lower a charged accumulator bank to the sea bed, connect it hydraulically to the stack, and use the stored energy to operate these functions in a speedy manner. [42] Such an operation would need to have a combined capacity for stored oil and Nitrogen of about 400 gallons.

These facts were clear well before the ROVs were called upon to intervene. Indeed, Exhibit 4423 demonstrates that as of November 14, 2003 BP understood that closing the shear rams via ROV would allow them to wash out, [43] and the delays during ROV intervention in relation to this should have been avoided. In retrospect, after seeing washing damage of the BOP components, and in accordance with industry knowledge, any closures of rams or annulars should be short in time (on the order of 30 seconds or less) when the well is flowing. This requires about a 150 gpm hydraulic source, governed by the Casing Shear Ram required displacement to close in 30 seconds.

b. ROV intervention was also hindered by the lack of up to date schematics and plumbing diagrams of the BOP stack

Several attempts to close the Middle Pipe Ram (MPR) using the ROV were attempted before it was discovered the hose from the ROV hot stab that should have operated the MPR was connected to the Test Ram, which had been converted from the Lower Pipe Ram in 2004. [40] This error should have been discovered and corrected during the conversion. The fact that it wasn't indicates this function was either not tested during the conversion or, if tested, the test was done improperly, or the test results were ignored. In addition, it is apparent the ROV stab/MPR function was never tested in the 6 years since the conversion.

IV. BACKGROUND AND QUALIFICATIONS

Dr. Rory R. Davis, P.E.

I contributed to the following sections in this report: I, II (all subsections), III (all subsections), IV, V, and VI (Attachments 1,2,3,4,11).

My experience and expertise is focused most on evaluation of the BOP mechanical aspects, including mechanical design, strength and load capacities, mechanical loading, thermo-structural response of components and systems, and reliability. I am also well experienced in electro-mechanical systems.

I have B.S. (1979), M.S. (1980), and Ph.D. (1989) degrees from the University of California, Davis in Mechanical Engineering. Graduate work emphasized measurement/testing and analysis of complex mechanical dynamic systems, including rotating machinery. My Ph.D. minor subject was stochastics and probabilistics. I have over 30 years of experience in mechanical engineering, with the first 10 years spent teaching engineering at the University of California and working at Aerojet General (a rocket engine company in Sacramento, CA), and with the last 20+ years working in mechanical engineering services consulting (1990-1995 in Sacramento, CA, and in Gardnerville, NV 1995 to present). I hold current Mechanical Engineering PE licenses in the states of California and Nevada.

In those 30 years, I have become highly skilled in mechanical components and systems design and analysis, including via the Finite Element Method (FEM), involving thermo-mechanical stress, strain, deflection, life, and reliability prediction to aid accurate mechanical design. I have also been involved in many test programs to verify designs and often correlate engineering and FEM predictions, and have been operating a testing lab where material samples, components and systems are routinely tested for thermo-mechanical behavior. My consulting business also includes, as a small percentage, forensic engineering work for product liability and patent cases.

My *curriculum vitae*, which documents my publications, is presented as Attachment 3. Attachment 4 provides a list of testimony at trial/deposition in the last four (4) years. My work on this case has been compensated at a rate of \$275/hr.

Patrick R. Novak, PE

I contributed to the following sections in this report: III.1., III.5., IV, V, and VI.

I am a Mechanical Engineer, Registered in the State of Minnesota since 1973, and have worked the past 41 years in the fluid power industry. I have been involved in design, development trouble shooting, and marketing of hydraulic equipment ranging from single components to complete systems used on everything from medical devices to ore handling and processing systems for taconite and coal mines. Valves I helped develop are used in the petroleum production industry (primarily land based).

My *curriculum vitae*, which documents my publications, is presented as Attachment 5. Attachment 6 provides a list of testimony at trial/deposition in the last four (4) years. My work on this case has been compensated at a rate of \$300/hr.

Dr. J Neil Robinson

I contributed to sections III.4, IV, V, and VI of this report.

I am a materials engineer. I received a B.A. with Honors, majoring in Metallurgy, from Cambridge University in England and a Ph.D. in Materials Engineering from UCLA. I was a Principal of Failure Analysis Associates (now Exponent, Inc.), the international consulting company, where I headed the Human Factors, Risk Analysis and Materials Laboratory Groups. I was Principal Inspector at the Nuclear

Installations Inspectorate in London, responsible for evaluating materials safety issues in nuclear power plants. Over the last 40 years I have undertaken many thousands of analyses of materials failures or potential failures around the world and have testified about the results of these analyses in US Federal courts, state courts across the US, in Europe and in many arbitrations. I have authored numerous research publications in books and in national and international scientific and engineering journals.

I was asked to observe and monitor the testing performed by DNV at Michoud, LA and Dublin, OH, specifically in connection with materials-related issues and the forensic examination of the physical evidence in order to determine what happened in the accident. A copy of my CV with more details of my background is enclosed as Attachment 7. Attachment 8 is a list of my trial or deposition testimony during the last four years. My work on this case has been compensated at a rate of \$400/hr.

Raymond Merala, MS, PE

My primary contribution to this report is contained in section III.2, IV, V, and VI, and I have discussed technical aspects of the entirety of this report with each respective author.

I coordinated and lead the efforts of this multi-disciplinary team of technical experts as we observed, monitored and contributed to the forensic investigations of the Deepwater Horizon BOP stack undertaken by DNV at NASA Michoud, LA.

I obtained a Bachelor of Science degree in Agricultural Engineering and a Master of Science degree in Mechanical Engineering, from the University of California at Davis. I am a Registered Professional Mechanical Engineer in the State of California. I am a principal at Talas Engineering, Inc., an engineering firm specializing in accident analysis. I had previously been employed as a Managing Engineer at Piziali and Associates for more than 12 years. Prior to that I was employed for approximately 7½ years by Failure Analysis Associates (today known as Exponent), at that time the largest firm in the United States dedicated to studying failures of an engineering nature.

In my present position with Talas, and my previous positions at both firms mentioned, I have investigated and analyzed equipment and components and the role of these in accidents. Often a part of such an analysis has required that I evaluate design aspects of equipment and components. I have worked in the field of accident reconstruction, mechanical system design analysis, and failure analysis since 1987.

Accident reconstruction and failure analysis are both fields of applied science. An engineer working in the area of accident reconstruction and failure analysis applies laws of physics and principles of engineering to a systematic analysis of the evidence associated with a particular accident and the circumstances associated with that accident. These engineering principals and laws of physics are not bounded by industry - motor vehicles, recreational equipment, an industrial equipment component or piece of equipment, and a BOP stack all abide by the same engineering principals and laws of physics.

After obtaining my BS degree, I worked for four years as a development and test engineer at the US Department of Agriculture - Forest Service Equipment Development Center in San Dimas, CA. Here I designed, tested, and implemented various pieces of equipment and components including fluid meters, fluid power and control systems, testing instrumentation, and other field equipment.

My work on this matter has been compensated at a rate of \$325 per hour. A copy of my CV is contained in Attachment 9. A list of trial and deposition testimony I have given the past four years is included in Attachment 10.

V. REFERENCES CITED

1. LeNormand, William, *Daily Report Sheet – Subsea Pod Intervention*, Cameron Controls, May 5, 2010 (Ex. 3602) (CAM_CIV_0046703 - CAM_CIV_0046705).
2. Det Norske Veritas, *Solenoid 103 Original Wiring Connections* (DNV2011052708).
3. Cooper Cameron Corp., *Assembly and Test Procedure for Cameron Solenoid Valves – Part No. 223290-15 and Part No. 223290-63*, June 30, 2009 (CAM_CIV_0023928 - CAM_CIV_0023946).
4. Deposition of William LeNormand, June 21, 2011 at 97:8 – 98:6 (Vol. 2); Deposition of David McWhorter, July 7, 2011 at 252:1-254:25 (Vol. 1); Deposition of Carter Erwin, June 6, 2011 at 193:8-194:5 (Vol. 1).
5. TPS_BOP-10_Summary_Test_Solenoid_at_Deep_Sea_Temperature_w_Hydraulic_Pressurex.pdf, within “BOP Data Files by Test Date Initiated”, Phase 2 KPMG web site, 05-18-2011 folder (DNV2011051801).
6. Cooper Cameron Corp., *Factory Acceptance Test Procedure for Subsea Electronic Module (Horizon AMF/Deadman In Current Situation – Test Procedure)*, May 11, 2010, (CAM_CIV_0003014 - CAM_CIV_0003024).
7. Boughton, Geoff, RE: *Issue On The Horizon With Pie Connectors*, Email, May 9, 2010 (Ex. 3797) (TRN-INV-01798503 – TRN-INV- 01798507).
8. Cooper Cameron Corp., *Refurbishment Procedure for Cameron Solenoid Valves- Part No. 223290-15 and Part No. 223290-63, X-065393-03*, January 22, 2004 (CAMCG 00004025 – CAMCG 00004038).
9. Ankrom, J., *Transocean Technical Information Bulletin OPT-TIB-435-01: Instructions for Rebuilding Cameron Controls Solenoid Valve -Family 435*, September 9, 2002 (Ex. 3798) (TRN-MDL-01547899 - TRN-MDL-01547905).
10. LeNormand, William, *Daily Report Sheet – Subsea Blue Pod Intervention*, Cameron Controls, June 28, 2010. In particular, see entry for July 5, 2010 (Ex. 3619) (CAM_CIV_0151756- CAM_CIV_0151762).
11. LeNormand, William, *Daily Report Sheet – Subsea Pod Intervention*, Cameron Controls, May 5, 2010. In particular, see entry for May 6, 2010 (Ex. 3602) (CAM_CIV_0046703-46705); LeNormand, William, *Daily Report Sheet – Subsea Blue Pod Intervention*, June 28, 2010. In particular, see entry for July 5, 2010 (Ex. 3619)(CAM_CIV_0151756-1758); Dugal-Whitehead, N., *Test Preparation Sheet - Test of Deepwater Horizon Blowout Preventor Battery Voltages*, Feb. 28, 2012 (sic 2011), DNV Phase 1 Test Data; Dugal-Whitehead, N., *Test Preparation Sheet - Test of Blue SEM Batteries*, June 15, 2011, DNV Phase 1 Test Data (DNV2011061502); Dugal-Whitehead, N., *Test Preparation Sheet - Test of Yellow SEM Batteries*, June 16, 2011, DNV Phase II Test Data, (DNV2011061601); Anon., *Test Preparation Sheet- Full Load Battery Test*, June 17, 2011, DNV Phase II Test Data, (DNV2011061701).
12. Dugal- Whitehead, N., *Test Preparation Sheet - BOP Solenoid drop out and pick voltage test*, February 25, 2011, DNV Phase 1 Test Data (DNV007-000189 - DNV007-000190); Dugal Whitehead, N., *Test Preparation Sheet - BOP Solenoid drop out and pick voltage test of Yellow Pod 3A Solenoid*, February 28, 2011, DNV Phase 1 Test Data (DNV007-000191 - DNV007-000193).

13. Deposition of William LeNormand, June 20, 2011 at 334:18-335:7 (Vol. 1); Deposition of Carter Erwin, June 6, 2011 at 218:4-219:1 (Vol. 1).
14. Merala, R., Table A-2 – Summary of Full Load Battery Testing Data, June 2011. This table was compiled from DNV2011062203 – Battery Testing Summary.xls, and test data files listed under “File Name”.
15. Transocean, *Macondo Well Incident – Transocean Investigation Report, Volume 1 and Volume 2*, June 2011. In particular, see *Appendix N – AMF Testing*.
16. Cooper Cameron Corp., *Engineering Bulletin EB 891D: AMF/Deadman Battery Replacement*, September 8, 2004 (Ex. 3605) (CAM_CIV_0003275 - CAM_CIV_0003276).
17. Cooper Cameron Corp., *Battery Pack, 9VOC, 41A/HR Lithium 12 Cells in Series/Parallel w/Molex Conn. & PTC's*, September 23, 2004 (CAM_CIV_0022982).
18. Deposition of Jim (Owen) McWhorter, July 20, 2011 at 223:21-228:24 (Vol. 1).
19. Ambrose, Bill, *RE: Weekly Report from Michoud*, Email, October 26, 2010 (Ex. 3795) (TRN-INV-01523282 - TRN-INV-01523284).
20. McWhorter, J.O., DWH, SubSeaSup (Deepwater Horizon), *Batteries*, Email, February 24, 2010 (Ex. 3792) (TRN-MDL-00310821).
21. Deposition of Mark David Hay, June 29, 2011 at 72:1-24, 96:21-97:5, 148:2-151:12, 257:1-276:15, 357:14-359:7 (Vol. 1) (and referenced exhibits); Deposition of Jim (Owen) McWhorter, July 20-21, 2011 at 89:4-90:24, 94:11-95:14, 181:24-184:9, 190:22-200:5, 234:8-235:9, 337:2-25, 372:12-25, 380:10-381:24, 412:4-19, 449:4-452:8 (and referenced exhibits); Deposition of James Kent, June 21, 2011 at 379:23-380:17 (Vol. 1), June 22, 2011 at 50:13-54:14, 58:21-61:4, 90:17-99:19, 102:12-106:12, 139:21-148:9, 178:9-182:19 (Vol. 2) (and referenced exhibits); Deposition of Geoff Boughton, July 20-21, 2011 at 137:3-154:2, 157:20-158:1, 282:14-287:4, 494:8-499:9 (and referenced exhibits); Transocean, *RMS II Equipment History, Equipment: BOP Control Pod, TAG: WCS BOPP 003*, January 20, 2001 – May 20, 2010 (Ex. 4617) (TRN-INV-00034309 - TRN-INV-00034380); Transocean, *RMS II Equipment History, Equipment: BOP Control Pod, TAG: WCS BOPP 002*, January 20, 2001 – May 20, 2010 (Ex. 3299) (TRN-INV-00034227 - TRN-INV-00034306).
22. Deposition of David McWhorter, July 7, 2011 at 289:17-20 (Vol. 1); Cameron Drilling Systems, *MK III Model 80 Multiplex BOP Control Pod – Transocean Offshore Deepwaterer [sic]*, January 21, 2009 (CAM-CIV-0097590 - CAM-CIV-0097594).
23. Transocean, Investigations: What testing of the AMF was completed on board the DWH? (TRN-INV-01028932).
24. Deposition of Jim (Owen) McWhorter, July 20, 2011 at 205:3-5 (Vol. 1); Deposition of Mark Hay, June 29, 2011 at 356:5-12 (Vol. 1).
25. Deepwater Horizon Rig Move Subsea Electrical Checklist, (Ex. 3987) (TRN-MDL-00303315 – TRN-MDL-00303318) (no mention of any AMF battery check).
26. Report of Survey, Deepwater Horizon, ModuSpec USA, 17-31 October 2005 (Ex. 71) (MODUSI 01 0 000380-MODUSI 01 0 000470) see page 18.
27. Davies, K., Deepwater Horizon Technical Rig Audit, January 2005, (Ex. 3400)(TRN-MDL-00519065-TRN-MDL-00519127) see page 5-6; Davies, K., Deepwater Horizon Follow Up Rig Audit, Marine Assurance Audit and Out of Service Period, September 2009 (Ex. 275) (BP-HZN-IIT-0008871 - BP-HZN-IIT-0008930).

28. Kenney, G.D., *Forensic Examination of Deepwater Horizon Blowout Preventer – Addendum to Final Report*, Det Norske Veritas, April 30, 2011 (DNV Report #EP030842, Contract #M10PX00335).
29. Transocean, *Event Log for April 20 – 26, 2010* (TRN-USCG_MMS-00038807 - TRN-USCG_MMS-00038854).
30. BP, *Macondo Top Kill Procedures Manual for MC252-1- Re-run & Function Test Yellow Pod*, May 11, 2010 (TRN-MDL-00496148 - TRN-MDL-00496184).
31. *UPDATE 7: Unified Command Continues to Respond to Deepwater Horizon*, web site www.restorethegulf.gov, April 25, 2010.
32. Robinson, J.N., compilation from various sources and notes, including historical weather data from the National Oceanic and Atmospheric Administration for April 20-22, 2010.
33. Video from ROV Millennium 37, Oceaneering, April 22, 2010, in particular, Dive #485.
34. Transocean, *Macondo Well Incident – Transocean Investigation Report, Volume 1 and Volume 2*, June 2011.
35. Cooper Cameron Corp., *Engineering Bulletin EB 852D: Shear Ram Product Line*, October 29 -30, 1998 (CAM_CIV_0003198 - CAM_CIV_0003214).
36. Deposition of David McWhorter, July 7, 2011 at 107:11-25, 110:8-12, 112:18-16, 141:20-142:5, 144:22-25, 145:21-149:22 (Vol. 1).
37. BP, *Deepwater Horizon Accident Investigation Report*, September 8, 2010. In particular, see Section 3.5.1 (BP-HZN-BLY00144940 - BP-HZN-BLY00145180).
38. Deposition of David McWhorter, July 8, 2011 at 665:7-669:11, 685:25-686:21 (Vol. 2); Cooper Cameron Corp., *Engineering Bulletin EB 702D: Shearing Capabilities of Cameron Shear Rams*, January 21, 2008 (Ex. 3185) (CAM_CIV_0098265- CAM_CIV_0098274).
39. West Engineering Services, *Shear Ram Capabilities Study for U.S. Minerals Management Service*, September 2004, (BP-HZN-2179MDL00466042 - BP-HZN-2179MDL00466102).
40. BP, *Deepwater Horizon Accident Investigation Report*, September 8, 2010. In particular, see p. 155-156 (BP-HZN-BLY00144940 - BP-HZN-BLY00145180).
41. R&B Falcon, *DEEPWATER HORIZON TL BOP STACK Operation and Maintenance Manual*, pg. 3-42 (CAMCG 00000001 – CAMCG 00000235).
42. West Engineering Services, *Evaluation of Secondary Intervention Methods in Well Control for United States Minerals Management Service*, March 2003. In particular, see p. 73, and Section 6.10 (BP-HZN-MBI00010469 - BP-HZN-MBI00010554).
43. Byrd, M., *PREP Exercises*, Email, November 14, 2001 (Ex. 4423) (BP-HZN-2179MDL03106206- BP-HZN-2179MDL03106207).
44. Menz, W., *Factory Acceptance Test Procedure for Subsea Electronic Module (AMF Test Procedure)*, Cameron Controls X-065449-05, April 1, 2000 (TRN-HCEC-00001770 - TRN-HCEC-00001778).
45. Menz, W., *Factory Acceptance Test Procedure for Subsea Electronic Module (Deadman Test Procedure)*, Cameron Controls X-065449-05, October 14, 1998 (TRN-HCEC-00001665 - TRN-HCEC-00001679).

VI. ATTACHMENTS

ATTACHMENT 1. Battery Testing Details

ATTACHMENT 2. Blind Shear Ram Cutting Capacity Details

ATTACHMENT 3. Curriculum Vitae for Dr. Rory R. Davis, PE

ATTACHMENT 4. Testimony of Dr. Rory R. Davis, PE in last 4 years

ATTACHMENT 5. Curriculum Vitae for Patrick R. Novak, PE

ATTACHMENT 6. Testimony of Patrick R. Novak, PE in last 4 years

ATTACHMENT 7. Curriculum Vitae for J. Neil Robinson, PhD

ATTACHMENT 8. Testimony of J. Neil Robinson, PhD in last 4 years

ATTACHMENT 9. Curriculum Vitae for Raymond Meral, MS, PE

ATTACHMENT 10. Testimony of Raymond Meral, MS, PE in last 4 years

ATTACHMENT 11. List of Documents Considered

ATTACHMENT 1: BATTERY TESTING DETAILS⁸

Non-rechargeable lithium-ion batteries contained in canisters on the control pods form the basis of an emergency power supply system for the BOP stack. A Subsea Electronic Module (SEM) is present on each of the two control pods (Yellow and Blue) mounted on the LMRP. These are water-tight canisters that contain electronics, logic and computer chips, and circuit boards that control BOP stack operation. During normal operations the SEM contained equipment communicates electronically with surface operated BOP control equipment and receives signals from the surface equipment that may effect BOP stack operation. Non-rechargeable batteries are present in each SEM canister so that pre-programmed automated BOP shutdown functions may be effected in emergency situations, e.g. should power from, and communication with the drill rig be lost.

Each SEM contains a nominally 27 volt (V) battery bank and two nominally 9 volt batteries. The 9 volt batteries are intended to power redundant communication, logic and control systems within the SEM, including the AMF/Deadman function. The two systems powered by the 9 volt batteries are typically referred to as “SEM A” and “SEM B.” The 27 volt battery bank is intended to power pressure transducers and solenoid activations. The 27 volt battery bank is an assembly of three 9 volt batteries. Figure A-1 contains a photograph depicting the Yellow pod SEM with the canister cover removed, the 27 volt battery bank is identified in that photo. The two 9 volt batteries of the Blue pod SEM are shown in Fig A-2.

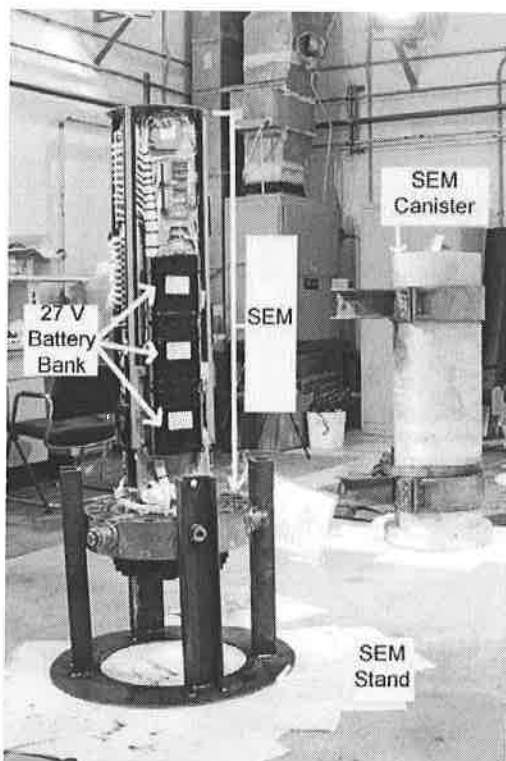


Figure A-1: Yellow pod SEM and canister.
DNV Phase II IMG_1182.JPG, June 16, 2011 BD 411 RP JPG

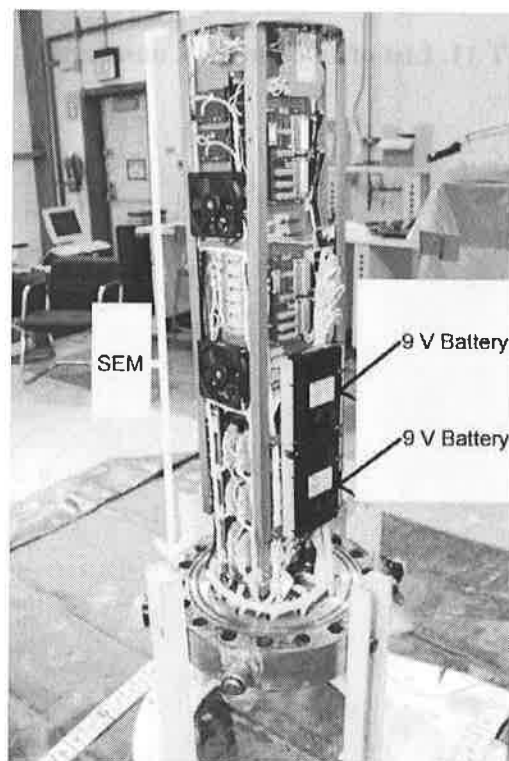


Figure A-2: Blue pod SEM and 9volt batteries.
DNV Phase II IMG_1056.JPG, June 14, 2011 BD 411 RP JPG

⁸ General References for this Appendix include [16], [44], and [45]

Since the incident of April 20, 2010, the Blue pod and Yellow pod batteries have been tested a number of times, and also, since that time, the batteries were not removed from the SEMs until June 2011. [11] The first known recorded tests of batteries contained in the Yellow pod were conducted on May 6, 2010, on the Q4000. The first known recorded tests of batteries contained in the Blue pod were conducted on July 5, 2010, on the Discoverer Enterprise. Subsequent tests were performed during the Phase 1 examination by DNV at the NASA Michoud facility on February 28, 2011 and March 1, 2011. A third major phase of testing was conducted in June of 2011 at the NASA Michoud facility as part of Phase 2 activities. Table 1, in the body of the main report, shows results of “No-Load” voltage measurements made at the times mentioned. No significant work is performed by a battery when “No-Load” tests are conducted. An exemplar “new” 9 volt battery and an exemplar “new” 27 volt battery bank were also tested in June 2011 at NASA Michoud.

The subject control pod batteries were also tested under “loaded” conditions on two occasions at NASA Michoud. Battery voltage and current flow measurements were made while the battery was effectively “inserted” into a circuit approximately simulating a load the batteries could be subjected to, including under emergency conditions. Such a test is different from a “No Load” test in that significant current is actually flowing from the battery as would be the case when the battery was actually doing work and providing energy. One “load” was created by inserting a 1.6 ohm resistor across the battery, for 9 volt battery tests. A 10 ohm resistor was used for a series of 27 volt battery tests. Figure A-3 below shows average voltage measurements made during 75 second long “Full Load Battery Test” of the 9 volt batteries at NASA Michoud in June 2011. These tests were conducted with the batteries at both “subsea” temperature (approximately 39° to 40°F) and ambient/room temperature (approximately 78°F). See Table A-1 – Summary of Full Load Battery Testing Data, for a summary of test results and source documents for Figures A-3 and A-4.

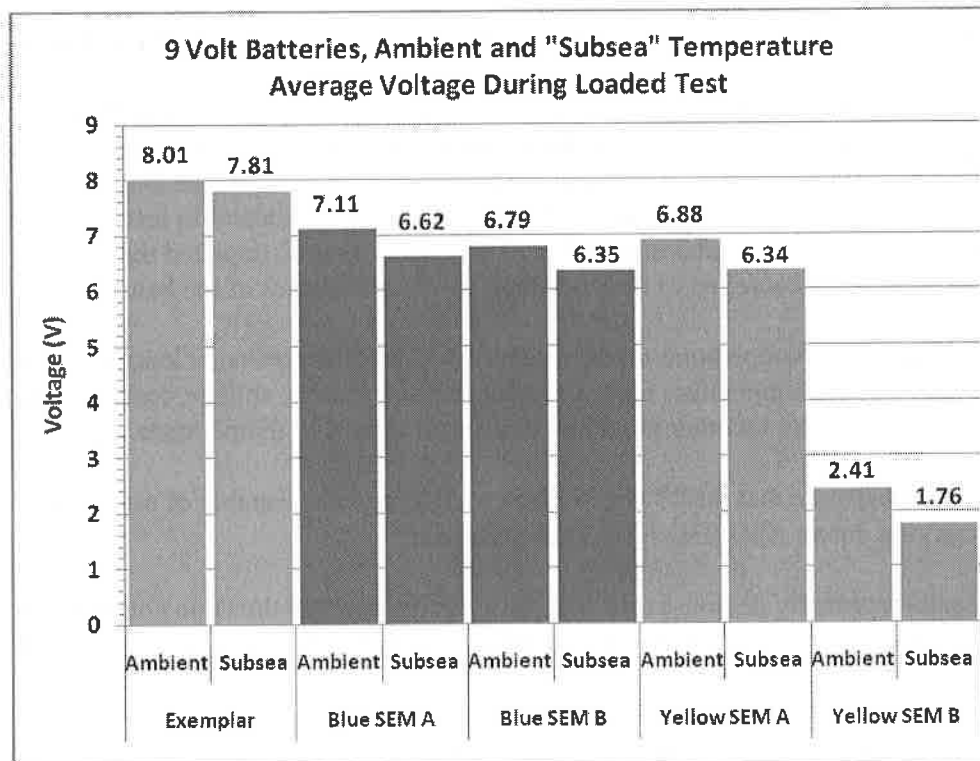


Figure A-3: Average voltage measured during “loaded” tests of 9 volt batteries

Figure A-4 below shows average voltage measurements made during 75 second long “Full Load Battery Test” of the 27 volt batteries at NASA Michoud in June 2011. These tests too were conducted with the batteries at both “subsea” and ambient room temperatures.

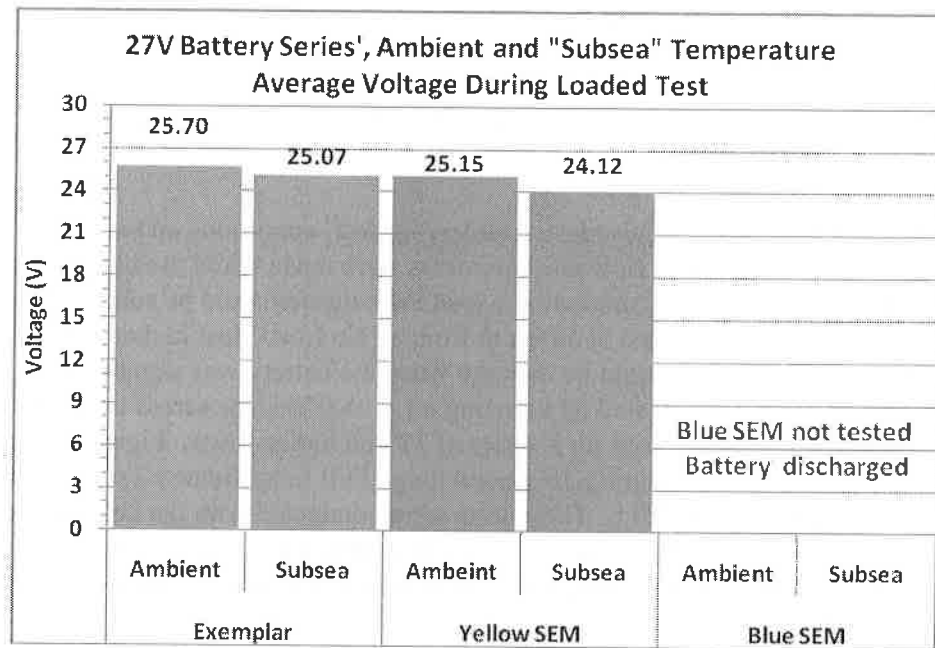


Figure A-4: Average voltage measured during “loaded” tests of 27 volt batteries

More detailed results below show voltages and currents measured during the 9 and 27 volt loaded battery tests, including voltage and current time histories for these tests. All the batteries from the Yellow pod were tested. Both 9 volt batteries removed from the Blue pod were tested. The Blue pod 27 volt battery was not tested under the full load condition; NASA personnel were reluctant to test this bank of batteries because two of the 9 volt batteries making up this 27 volt bank were so depleted they reportedly feared an explosion if current were encouraged to flow between the three batteries of the bank.

Looking at the data, subsea temperature tends to reduce 9 volt battery voltage, loaded and unloaded, by about 0.3-0.5 volts. Subsea temperature tends to reduce 27 volt battery voltage, loaded and unloaded, by about 0.7-1.0 volts. There are no other observed significant effects of temperature.

The loaded tests demonstrate that the 27 volt Yellow pod battery was capable of producing energy sufficient for carrying out an AMF/Deadman BSR command.

No-load test results repeatedly demonstrated that the 27 volt battery in the Blue pod provided no more than 7.61 volts. Clearly, insufficient power is available from that battery to activate AMF/Deadman BSR solenoid function.

The low voltage reportedly measured on July 5, 2010, for the 9 volt Blue pod SEM B battery is erroneous. All subsequent reported voltages associated with that battery exceeded 8 volts. Likewise, the Yellow pod 27 volt battery 18.41 voltage recorded on the Q4000 in May 2005 is erroneous; all subsequent reported no-load voltages exceeded 27 volts.

The Yellow pod SEM B battery has been shown to provide substantially less voltage and current than peer batteries as time passes. It may be that this battery is nearing the end of its useful life.

Individual battery data together with information shown on the labels of the various batteries, including Part Number, Contract or P. O. Number, date of manufacture code and translation of code, Serial Number, are tabulated below in Figure A-7.

Contrary to Transocean comments [15], voltage is a good indicator of battery charge here. Current load tests showed the Yellow Pod SEM B 9 volt battery to be excessively discharged, and it is also the battery with the lowest no-load voltage. Establishing an acceptable no-load battery voltage is elementary, provided one properly accounts for temperature variation, and the required useful amp-hours (current x time) desired to remain. According to voltages measured just before resistive load was switched on, an acceptable and conservative voltage criterion for these 9 volt batteries would be 8.2 volts, regardless of the temperature. This is clear from comparing Yellow pod SEM A and SEM B voltage just before load (see graphs below).

Conclusions

Insufficient voltage existed at the Blue pod 27 volt battery to energize the solenoid that would be called upon to effect an AMF/Deadman BSR activation, during all testing conducted of that battery.

A credible mechanism of discharging the Blue pod 27 volt battery between the time of the April 20, 2011 incident and subsequent testing of the battery on July 5, 2010 has not been identified to date. The Yellow pod 27 volt battery is not discharged, despite that pod's SEM B 9 volt battery being excessively discharged.

Therefore, it must be concluded that the Blue pod 27 volt battery was insufficiently charged to energize solenoids during an AMF sequence at the time of the April 20, 2011 incident.

Testing performed since the incident of the Yellow pod 27 volt battery indicates this battery contained energy sufficient to effect energizing of solenoids associated with AMF/Deadman functions.

Erroneous measurement or reporting of battery voltages associated with Blue pod SEM B and Yellow pod 27 volt batteries appears to have occurred. Subsequent measurements and tests demonstrate this to be the case.

The low voltage measured/reported on the Discoverer Enterprise associated with the Blue pod 27 volt battery is consistent with subsequent measurements of that battery's condition, as the reported voltage was low.

Additional Battery Data

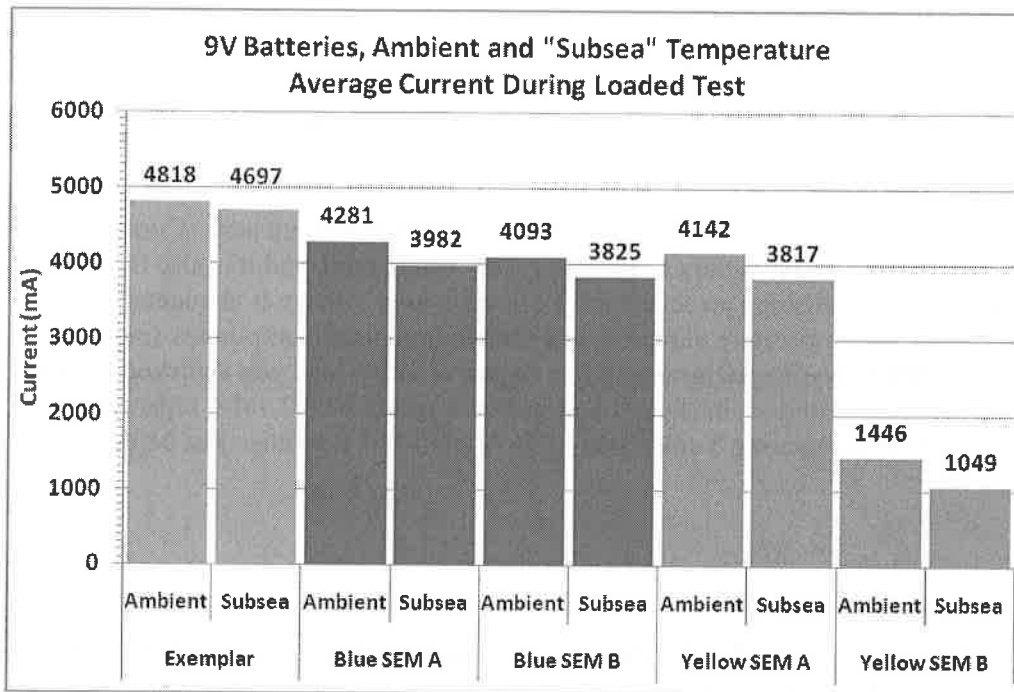


Figure A-5: Average current measured during 9 volt "loaded" battery tests⁹

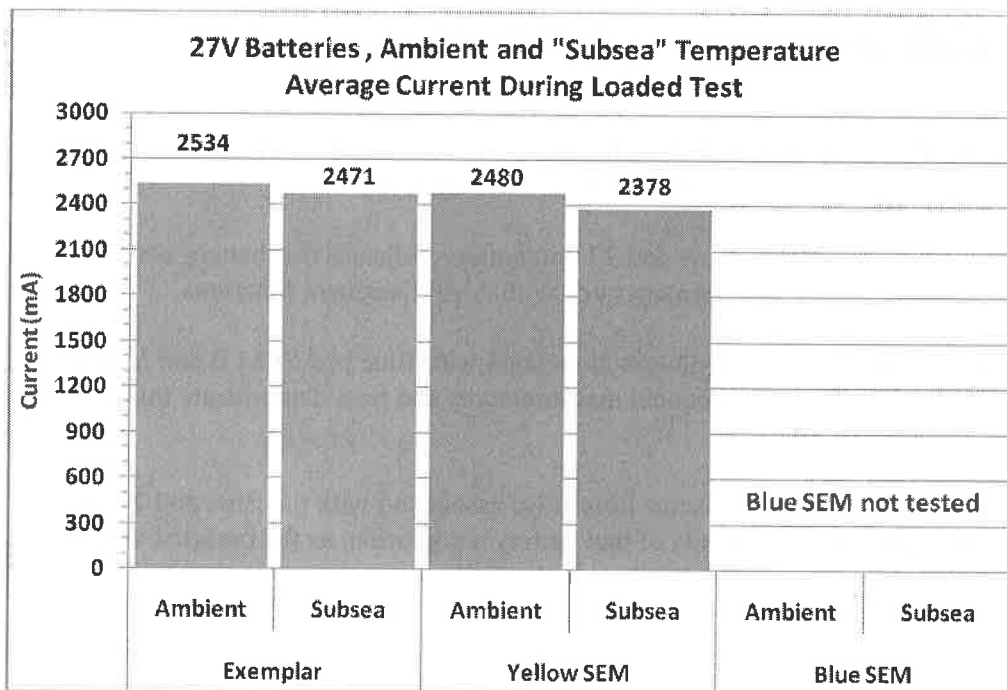


Figure A-6: Average current measured during 27 volt "loaded" battery tests.

⁹ Figures A-5, A-6, and A-8 – A-15 were created from data listed in Table A-2

Yellow Pod SEM Batteries

Location	"Two-Battery" side of SEM		"Three-Battery" side of SEM		
	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE
Cameron P/N:	223 2368-01	223 2368-01	223 2368-01	223 2368-01	223 2368-01
Contract or P.O. Number	450 192 3014	450 192 3014	450 194 3041	450 192 3014	450 192 3014
Date of Manufacture Code	0409A	0409A	0509D	0409A	0409A
Date Code Translation	April 2009, 1 st week		May 2009, 4 th week	April 2009, 1 st week	
Serial No. Assigned by QA	0000 706	0000 705	0000 743	0000 703	0000 704
Handwritten:	S/N 111 466 482-01	S/N 111 466 482-01	S/N 111 466 484-01	S/N 111 466 484-01	S/N 111 466 484-01
Use*/location	SEM B/top	SEM A/bottom	27 V top	27 V middle	27 V bottom

Blue Pod SEM Batteries

Location	"Two-Battery" side of SEM		"Three-Battery" side of SEM		
	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE	NON-RECHARGEABLE
Cameron P/N:	223 2368-01	223 2368-01	223 2368-01	223 2368-01	223 2368-01
Contract or P.O. Number	450 060 4090	450 060 4090	450 063 3612	450 063 3612	450 192 3014
Date of Manufacture Code	1005C	1005C	0106B	0106B	0106B
Date Code Translation	October 2005, 3 rd week		January 2006, 2 nd week		
Serial No. Assigned by QA	0000 269	0000 267	0000 353	0000 335	0000 333
Handwritten:					
Use*/location	SEM A/top	SEM B/bottom	27 V top	27 V middle	27 V bottom

Left side of Labels - All Batteries:

SAFT
Valdese, NC 28690
Lithium MnO₂

* as indicated by DNV Test Preparation Sheet

Battery Label Data

Batteries Tested 6-17-2011

"New" Exemplar (1)**9 V Battery**

Cameron P/N: 223 2368-01 Rev 02
Contract or P.O. Number
Date of Manufacture Code 1010A
Date Code Translation October 2010, 1st week
Serial No. Assigned by QA 000 1124

Use*/location

"New" Exemplar (1) 27 V Battery		
223 2368-01 Rev 02	223 2368-01 Rev 02	223 2368-01 Rev 02
1010A	1010A	1010A
October 2010, 1 st week		
0000 1122	0000 1119	0000 1123
27 V top	27 V middle	27 V bottom

Batteries Tested 6-19-2011

"New" Exemplar (2)**9 V Battery**

Cameron P/N: 223 2368-01 Rev 02
Contract or P.O. Number
Date of Manufacture Code 0710B
Date Code Translation July 2010, 2nd week
Serial No. Assigned by QA 000 1021

Use*/location

"New" Exemplar (2) 27 V Battery		
223 2368-01 Rev 02	223 2368-01 Rev 02	223 2368-01 Rev 02
1010A	1010A	0710A
October 2010, 1 st week		
0000 1118	0000 1117	0000 1022
27 V top	27 V middle	27 V bottom

New-Exemplar Battery Data

Figure A-7: Battery identification data- Information collected from DNV Phase II Doc. No. DNV2011061602, DNV Phase II Doc. No. DNV2011061603, DNV Phase II Doc. No. DNV2011061903, and Inspection Notes of R. Merala

"Loaded" Battery Test Results

March 1, 2011

	100 Ohm		20 Ohm	
	Initial	After 2 minutes	Initial	After 2 minutes
Yellow SEM A 9 V	8.31	8.30	8.02	7.99
Yellow SEM B 9V	8.10	8.08	7.73	7.63
Blue SEM A 9V	8.60	8.58	8.30	8.24
Blue SEM B 9V	8.35/8.40	8.39	8.11	8.02
Yellow 27 V	27.07	26.89	26.04	25.42
Blue 27 V	not tested - unloaded voltage exceedingly low			

Table A-1: Loaded battery summary data from Test Preparation Sheet, Test of Deepwater Horizon Blowout Preventor Batteries - Yellow, March 1, 2011, prepared by Norma Dugal-Whitehead, DNV Test Data, Phase I; Test Preparation Sheet, Test of Deepwater Horizon Blowout Preventor Batteries - Blue, March 1, 2011, prepared by Norma Dugal-Whitehead, DNV Test Data, Phase I

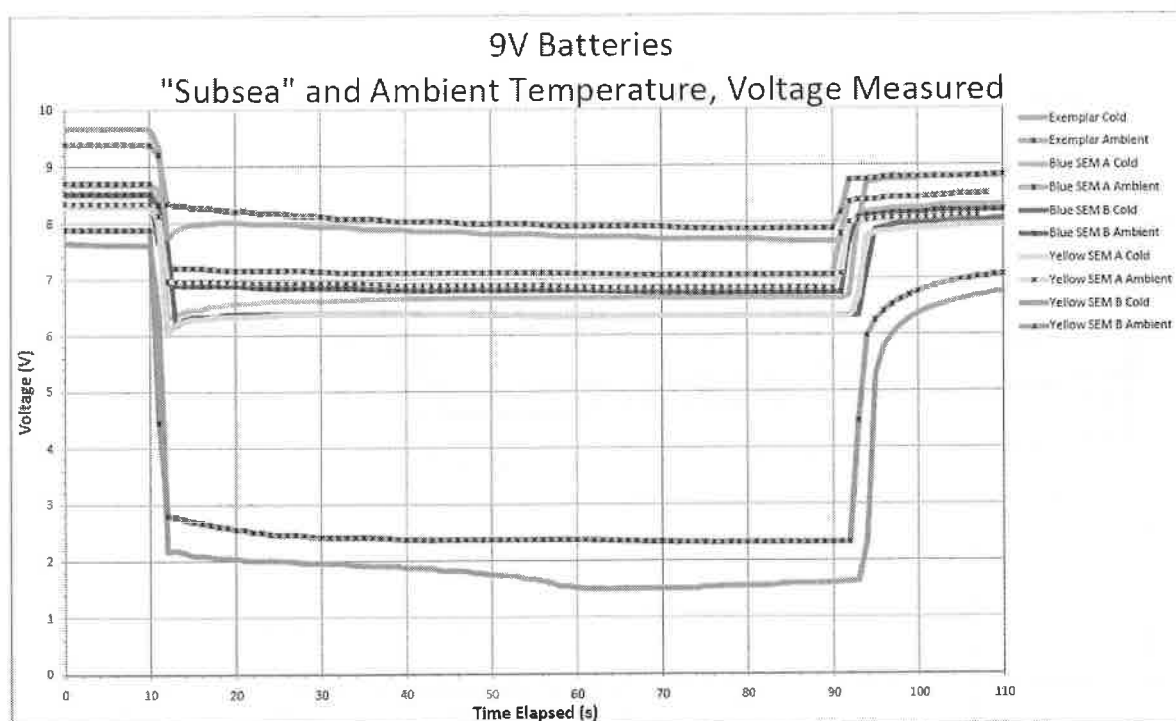


Figure A-8: Time history loaded battery voltage data, 9 volt, all data overlaid

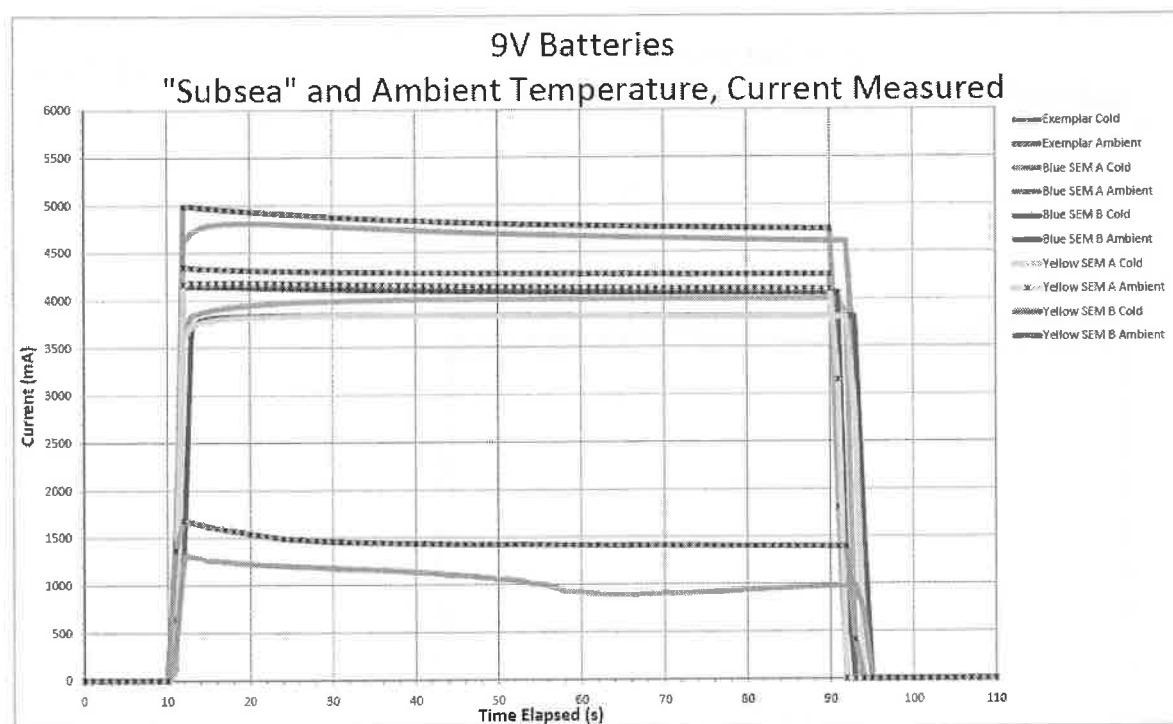


Figure A-9: Time history loaded battery current data, 9 volt, all data overlaid

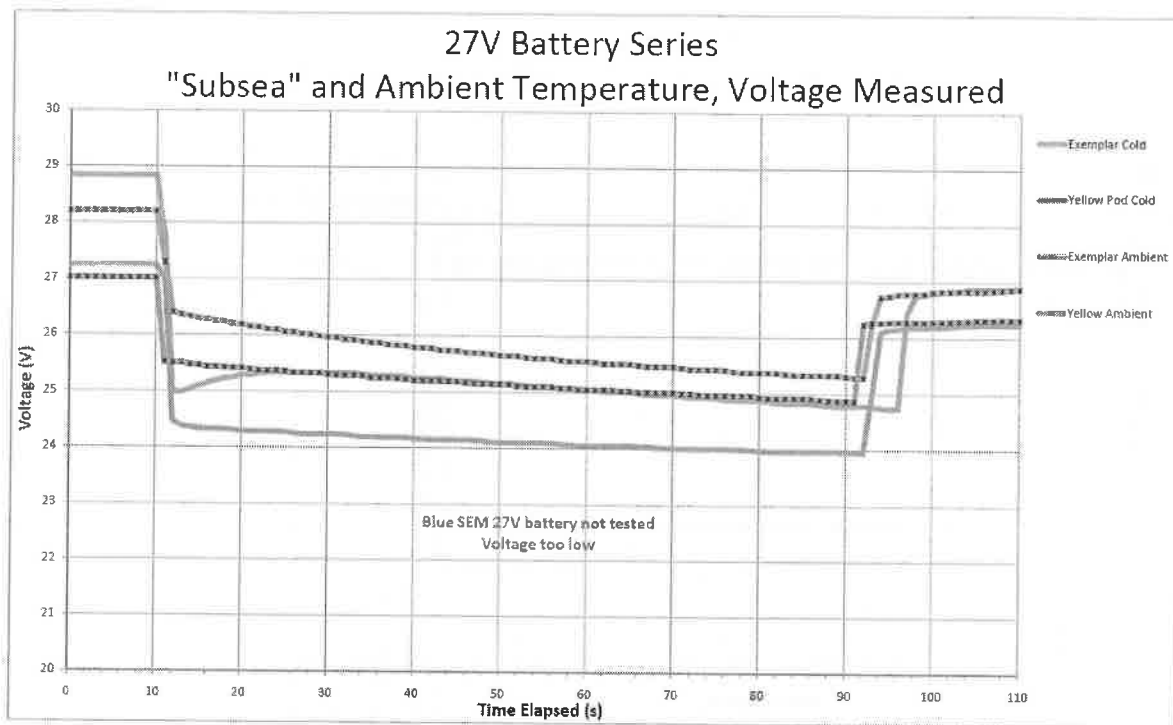


Figure A-10: Time history loaded battery voltage data, 27 volt, all data overlaid

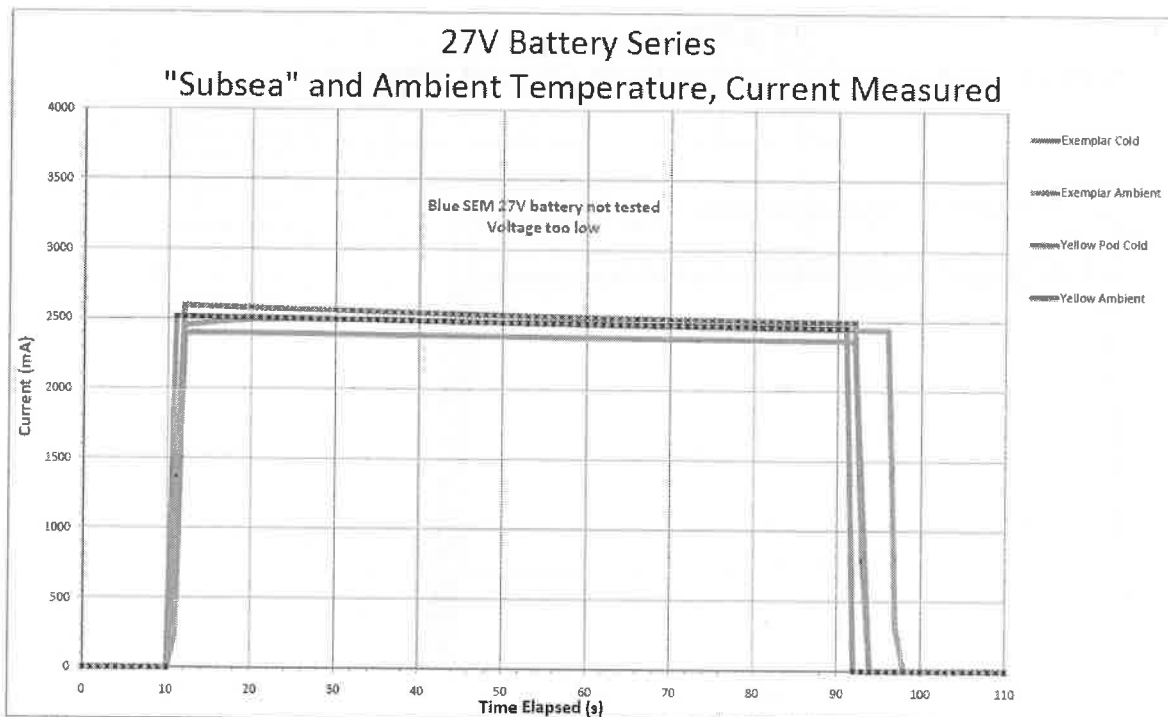


Figure A-11: Time history loaded battery current data, 27 volt, all data overlaid

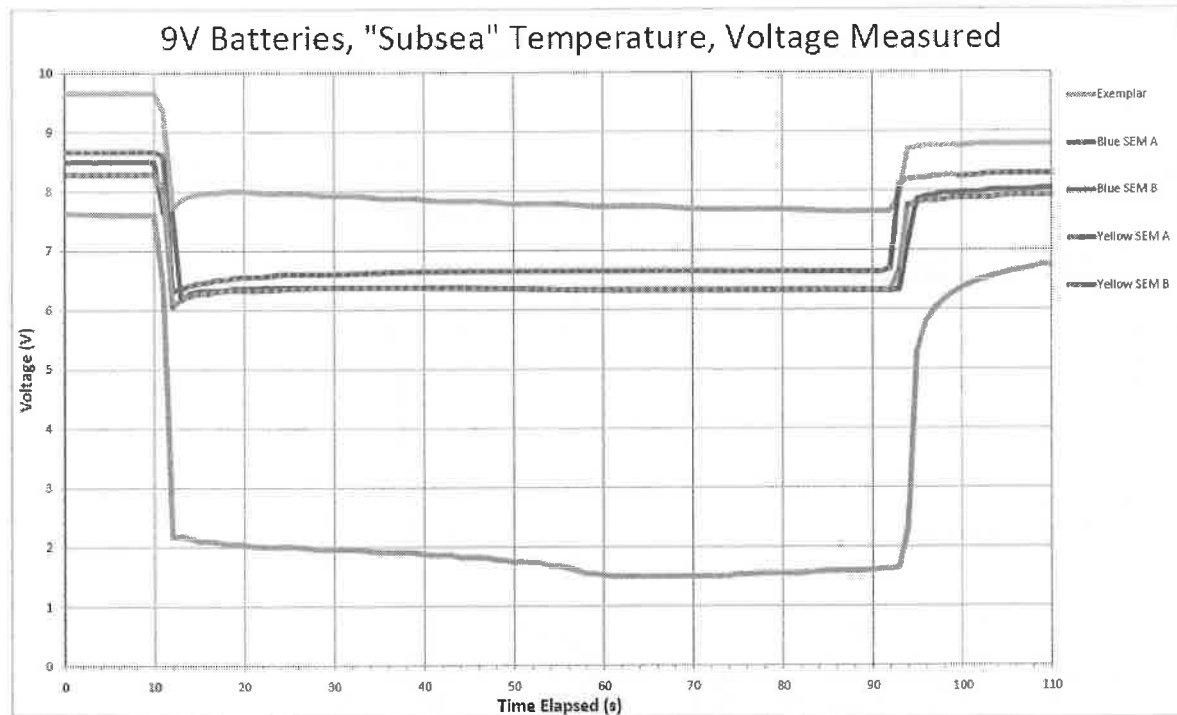


Figure A-12: Time history loaded battery voltage data, 9 volt, subsea temp only

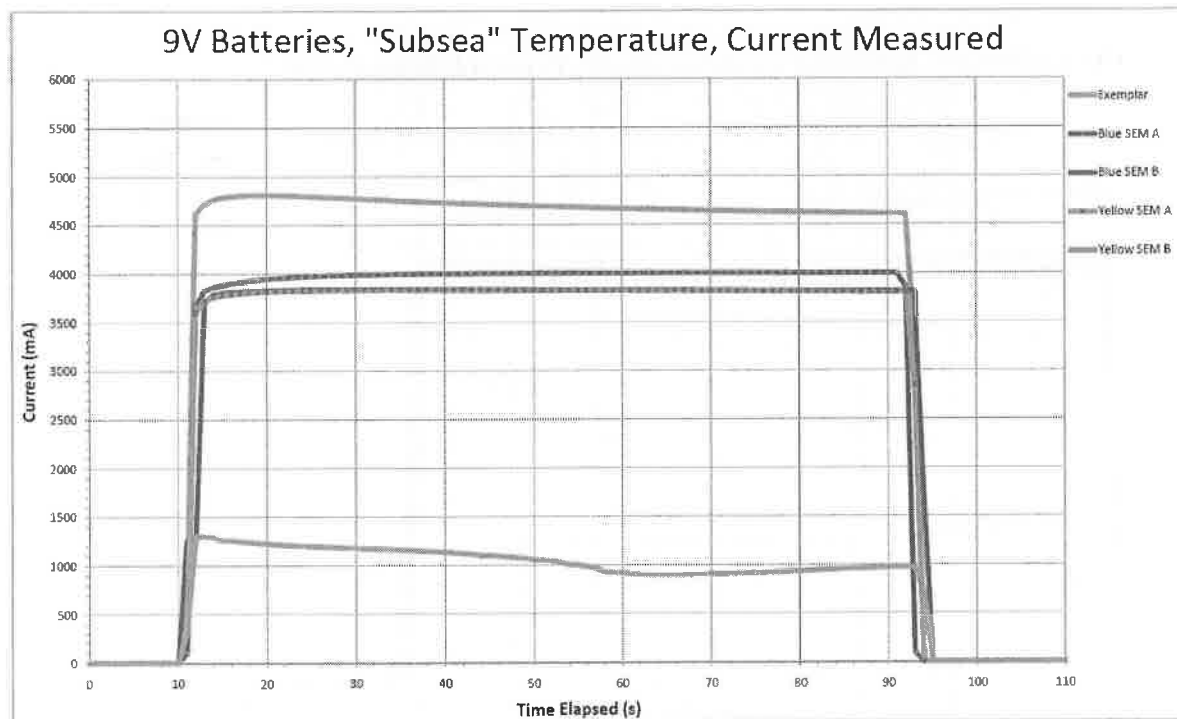


Figure A-13: Time history loaded battery current data, 9 volt, subsea temp only

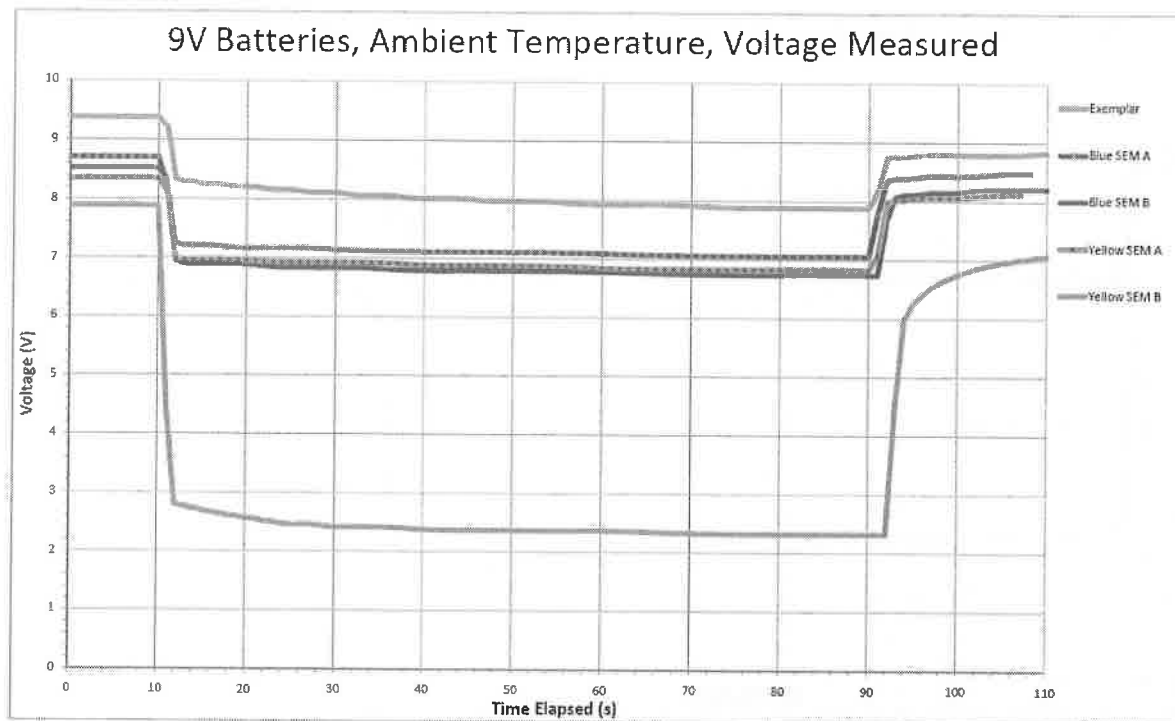


Figure A-14: Time history loaded battery voltage data, 9 volt, ambient temp only

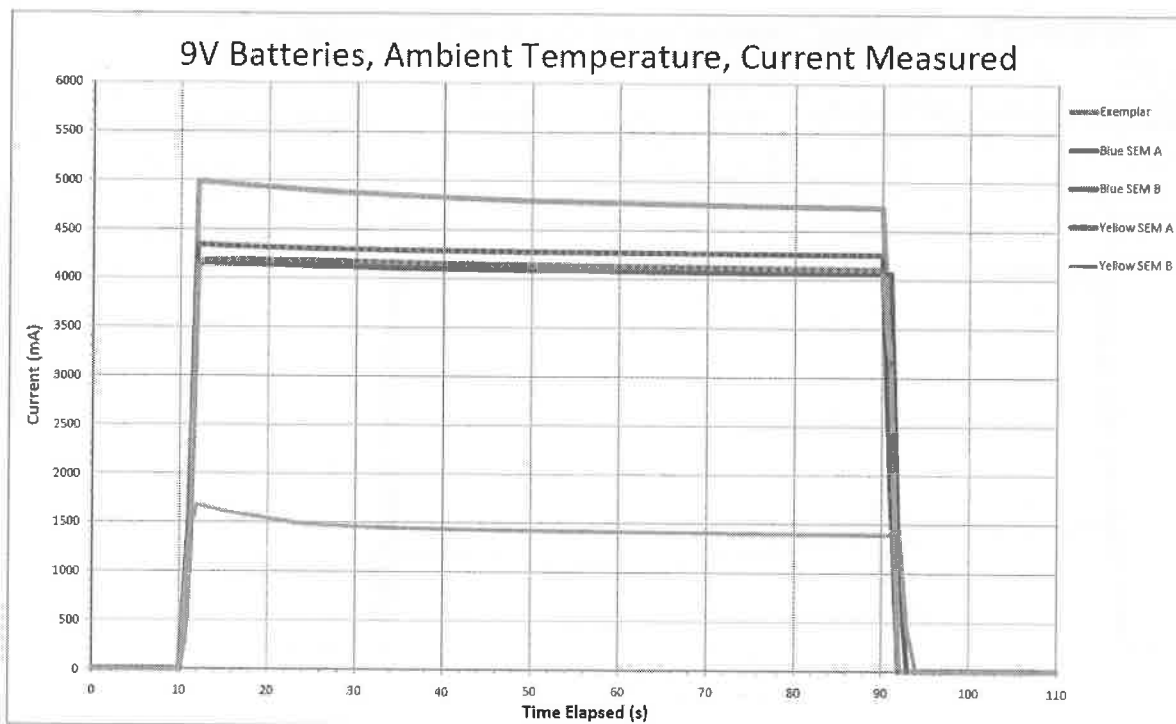


Figure A-15: Time history loaded battery current data, 9 volt, ambient temp only

Summary of Full Load Battery Testing Data, June 2011, NASA Michoud

Date	Data File	Stress Engineering Services, Inc. Comments	Corresponding NASA Testing Document	File Name
6/17/2011	Bat-1	20 Ohm test of exemplar 9-volt and 27-volt batteries at ambient temperatures: scan 400 start 9-volt battery test, scan 914 start second test	DNV2011061701 - BOP-029 Full Load Battery Test	DNV2011061716 - Bat-1
6/17/2011	Bat-2	1.6 Ohm test of exemplar 9-volt battery in refrigerator	DNV2011061702 - BOP-030 Full Load Battery Test	DNV2011061719 - Bat 2
6/17/2011	Bat-3	10 Ohm test of exemplar 27-volt battery at ambient temperature	DNV2011061702 - BOP-030 Full Load Battery Test	DNV2011061722 - Bat 3
6/18/2011	Bat-4	10 Ohm test of exemplar 27-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061804 - Bat 4
6/18/2011	Bat-5	10 Ohm test of Yellow Pod 27-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061807 - Bat 5
6/18/2011	Bat-6	1.6 Ohm test of exemplar 9-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061810 - Bat 6
6/18/2011	Bat-6a	1.6 ohm test of Yellow SEM B 9-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061813 - Bat 6a
6/18/2011	Bat-7	1.6 ohm test of Yellow SEM A 9-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061816 - Bat 7
6/18/2011	Bat-8	No Data		
6/18/2011	Bat-9	File was Skipped		
6/18/2011	Bat-10	1.6 ohm test of Blue SEM B 9-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061819 - Bat 10
6/18/2011	Bat-11	1.6 ohm test of Blue SEM A 9-volt battery at cold temperature	DNV2011061802 - BOP-032 Full Load Battery Test at Low Temperature	DNV2011061822 - Bat 11
6/19/2011	Bat-11a	10 Ohm test of exemplar 27-volt battery at ambient temperature	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061906 - Bat 11a
6/19/2011	Bat-12	10 Ohm test of 27-volt Yellow Pod battery at ambient temperature	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061909 - Bat 12
6/19/2011	Bat-13	1.6 Ohm test of exemplar 9-volt battery at ambient temperature	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061912 - Bat 13
6/19/2011	Bat-14	1.6 Ohm test of 9-volt Yellow Pod SEM B battery	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061915 - Bat 14
6/19/2011	Bat-15	1.6 Ohm test of 9-volt Yellow Pod SEM A battery	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061918 - Bat 15
6/19/2011	Bat-16	1.6 Ohm test of 9-volt Blue Pod SEM B battery	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061921 - Bat 16
6/19/2011	Bat-17	1.6 Ohm test of 9-volt Blue Pod SEM A battery	DNV2011061903 - BOP-030 Full Load Battery Test with SEM batteries	DNV2011061924 - Bat 17

Table A-2: Summary of Full Load Battery Testing Data, June 2011, compiled from DNV2011062203-Battery Testing Summary.xls, and test data files listed under "File Name"

ATTACHMENT 2. Blind Shear Ram Cutting Capacity Details

This BOP uses a Cameron TL 18.75 inch bore BSR with 15 ksi wellbore rating. This ram can provide 717,000 lbf of cutting force at 3,000 psi normal max working pressure. [39] It can also be functioned via Autoshear or AMF with 4,000 psi regulated pressure (and the cutting force would be proportionally higher by 1.33x, or 953,600 lbf).

The drill pipe located at the BSR at the time of the incident was a 5½ inch 21.9 ppf S-135 steel pipe. Above the BOP, 6-5/8 inch 40.0 ppf S-135 steel pipe was present, which should also be cuttable (blind shear rams must be capable of shearing any drill pipe in the hole under maximum anticipated pressures).

West Engineering performed a major test and analysis project in 2004, for the U.S. Minerals Management Service, concerning BSR shear force capabilities [39]. Most importantly, they reasonably and properly characterized the natural variation in pipe cut forces for the same BSR and pipe over many cuts, and established regression equations to best fit the data and to account for the natural variation observed. The regression equation for S-135 pipe was found to be

$$F_{\text{shear}} = -35.11 + 0.63F_{\text{de}} + 4.489e_u + 2 \times 76.69$$

Where F_{shear} = pipe shear force (kip)

F_{de} = Distorsion Energy Force (kip) = $0.577AS_y$

e_u = Material elongation at break (%)

A = Pipe cross section area (in²)

S_y = Material yield strength (ksi)

This equation produces about a 97.25th percentile shear force value, i.e. based on test statistics, this force level would cut the pipe 97.25 out of 100 times. The last term, “ 2×76.69 ” is added to assure this, and essentially represents two standard deviations of variation from test data. This is a quite large correction for natural variation, but is justified by the test data. The other three terms are the linear regression curve fit of actual data, using F_{de} and e_u as independent variables (see [39] for reasons why those variables are used). Without the last term to account for natural variation, the regression alone is a “mean” or average force prediction. Accordingly, when calculating the regression prediction, typical or average material properties should be used, which for standard S-135 steel are $S_y=146$ ksi and $e_u=21\%$. The pipe area is $A=5.828$ in² for the 5½ inch pipe.

Then plugging in the numbers for the 5½ inch pipe, $F_{\text{shear}} = 521.8$ kip. And by scaling to the BSR capability at 3000 psi, the required operating pressure is 2183 psi to produce this force (and at depth, this is differential pressure relative to sea water).

Note this value is based on West Engineering’s work based on actual testing, not Cameron’s shearing formula. BP quotes [37] that Cameron’s formula results in 2,840 psi cutting pressure at surface or 2410 psi at sea bed, which both would be substantially worse than the West prediction. But I prefer to use the West Engineering information for which more background is known at this time, including a large number of tests.

Now, two additional important factors come into play, possible wellbore pressure and the closing ratio of the ram. This ram has a closing ratio of 6.7:1, which is poor, in the respect that wellbore pressure has a larger effect on canceling closure force from the operating pressure. By definition, the wellbore pressure divided by the closing ratio is the additional piston pressure required to counter the wellbore pressure.

One maximum wellbore pressure reasonably assumed is the maximum working pressure rating of all annulars above the BSR, because if an annular is sealing the well at its limit, that pressure would be present at the BSR. In our case, the highest rated annular is rated for 10,000 psi (the upper annular), and this value is differential pressure across the annular element, thus assumed relative to sea water pressure at the depth in question (neglecting heavier than sea water mud above the annular). So 10,000 psi divided by the closing ratio 6.7 gives 1,493 psi additional pressure required. Note this does not account for the possible wellbore pressure increase beyond the working annular value, which is plausible, but the higher value is not known when designing the BOP. Some engineers might use the BOP wellbore rating for the maximum, which in our case would be 15,000 psi, and would be more conservative.

We then add the 2,183 psi design requirement to the 1493 psi worst case wellbore pressure effect, for a required pipe cut total pressure of 3676 psi. This exceeds the normal maximum operating pressure of 3000 psi. This indicates that just before the explosion, if the annular was holding well flow at its limit pressure, the BSR may not have been able to reliably cut the drill pipe even if the BSR was activated via normal controls or EDS.

If one was to use the 15,000 psi wellbore pressure maximum, the required extra pressure would be 2,239 psi, for a total required piston pressure of 4,421 psi to cut the pipe. This substantially exceeds the emergency regulated pressure. Although the maximum wellbore pressure to use here is arguable, the recommendation would be to conservatively use BOP wellbore rating (15,000 psi in this case), because the annular underside pressure is not absolutely limited by its working maximum pressure of 10,000 psi. The working maximum is just the value at which it is designed to hold a seal for substantial time. Leaking could take place at holding pressures above the maximum rating of the annular, before loss of annular function. It would be of interest to know how much more pressure can be held by a leaking annular above its rating, possibly allowing a design value between 10,000 and 15,000 psi to be used as a shear limit, but such data is not currently available.

In the Deepwater Horizon incident, it has not been established that the EDS or other “normal” system function from the rig was used to close the BSR, so the problem noted above with BSR shear rating exceeding the 3,000 psi working pressure likely did not come into play, THIS TIME. It is also not likely that the shear rating against the 4,000 psi emergency pressure came into play either, THIS TIME, as once rig communication was lost, the upper annular closing pressure was relieved, and later times at which the BSR could have activated would likely not have seen enough wellbore pressure to prevent closure.

However, this discussion does illustrate the need to carefully account for natural variation in pipe shear force and wellbore pressure possibilities when specifying the BSR shear capacity. In other circumstances, this BSR could have been prevented from functioning to cut drill pipe, solely due to mis-specification for reasonably expected worst case conditions. In particular, the most likely scenario of upper annular well holding at 10,000 psi would not have allowed BSR closure 97.25% of the time with 3000 psi working piston pressure. The discrepancy of 676 psi over working pressure for this case is large, and clearly not acceptable for a high reliability design of a safety critical system.

The information in West Engineering’s report [39] has been available for over five years, and should be implemented by now in all BSR sizing, whether for new applications or refits of existing BOPs. The natural variation alone is a key effect that must be covered by BSR sizing. Cameron’s formula numbers indicate it is being considered.

On the other hand, full correction for wellbore pressure and closing ratio was apparently not considered. According to CFR 250, “BOP system and system components and related well-control equipment shall be

designed, used, maintained, and tested in a manner necessary to assure well control in foreseeable conditions and circumstances...”. One must wonder, simply in the presence of the April 2000 BSR qualification result of 2900 psi cutting pressure of the 5½ inch pipe (quoted by BP in [37]), and with the knowledge that large possible wellbore pressure must additionally be compensated for (especially with a BSR with poor closing ratio), and subject to natural variation, why the BSR was not re-specified for higher capacity in the year 2000 before deployment of this BOP.

ATTACHMENT 3. Curriculum Vitae for Dr. Rory R. Davis, P.E.

DR. RORY R. DAVIS, P.E.
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Gardnerville, NV 89410
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(775) 782-7227 • (775) 782-7292 FAX

Post-Secondary Education:

B.S., Mechanical Engineering, University of California, Davis, 1979

B.S. Senior Project: Design of Aluminum Bicycle Frames

M.S., Mechanical Engineering, University of California, Davis, 1980

M.S. Thesis: Measurement of Foot-Pedal Loads During Bicycling

Ph.D., Mechanical Engineering, University of California, Davis, 1989

Ph.D. Dissertation: Practical Nonlinear Simulation of Rotating Machinery Dynamics With Application to Turbine Blade Rubbing

Positions Held:

12/90-present: Chief Engineer and Chief Executive Officer

Employer: Convergence Engineering Corp.
Gardnerville, NV

Duties: Technical leader for the company in mechanical engineering. Specific coverage in the areas of engineering applied mechanics, thermal/stress and design analysis, structural dynamics, and advanced probabilistic, optimization and statistical methods. Major tasks include 1) metallic and composite hardware thermal, stress, dynamic, and fatigue analysis, 2) composite material testing, including sample design and test planning, 3) mechanical design, concept development, prototype hardware testing and development, 4) vibration qualification test design and execution, 5) complex dynamic system analysis, including rotordynamics and nonlinear multi-energy domain systems, 5) multi-disciplinary system analysis and optimization, 6) expert witness consulting to attorneys and insurance companies.

Breadth of projects are briefly described:

- 1) Multi-disciplinary optimization of upper stage rocket engines using several existing analysis tools (power system analysis, ANSYS FEA, and pump/turbine component design) in an integrated optimization tool (Northrop Grumman, Blue Origin, AFRL).
- 2) Mechanical engineering team member on Deepwater Horizon failure forensic investigation, including on-site inspections, test observations, and analysis of Blowout Preventer equipment (U.S. Dept. of Justice)

- 3) Extensive new methodologies development and applications of FEA for taut-fabric geodesic radome design analysis, including prestretch, thermal, gravity, and wind loads (World Radomes).
- 4) Impact and load testing of spacecraft landing gear systems utilizing energy dissipating crush materials. Required buildup of novel high loading rate and large travel fixturing/actuation systems (Blue Origin).
- 5) Design and analysis of a new steam turbine for solar energy installations. Included ANSYS analysis of rotordynamics, supersonic nozzle and feed structural, and steam conducting shaft structural issues, along with automated parametric modeling in EXCEL optimization routines (Sierra, IAS).
- 6) Detailed thermo-structural design analysis of pneumatically controlled high speed hot gas sleeve valves for rocket engine turbine control (Blue Origin).
- 7) Detailed thermo-structural design analysis and testing in support of very high accuracy graphite/sandwich construction optical benches. Testing in CEC lab of laminates and sandwiches including insert pullout under multi-axial loads (AMA, Boeing SVS).
- 8) Design analysis of very large land-based antenna systems, including tracking mounts and other support structures, under thermal, earthquakes and wind loads (General Dynamics).
- 9) Development of a large 1.2MW Vertical Axis Wind Turbine (VAWT), using more flexible and non-conventional supercritical rotordynamic designs for minimum cost and maximum structural efficiency, including fiberglass airfoils and closed loop structural dynamics control. Design supported by fiberglass composite coupon characterization in CEC lab (Great Wind Enterprises).
- 10) Military space vehicle development for Air Force FAST program. Extensive use of composites and novel composite cryogenic propellant tank and propellant line application, verified by sophisticated composite loads/stress analysis via FEA, coupled with CFD for aero loads and other tools (CRC, USAF, Boeing).
- 11) High fidelity cryogenic TPA design analysis, with ANSYS, for rotordynamics, clearance/tolerance, stress/strength, and deflection evaluation. Full detailed housing simulation coupled with shaft/rotor, including main and secondary cryogenic transient flows and pressures. Transient and steady state thermal and structural analysis (Northrop Grumman).
- 12) Design and analysis (thermal and structural) of rocket engine test stand facilities for vacuum engine operation (Blue Origin).
- 13) Detailed analysis of in-space thermal, deployment/firing shock and vibration, and launch acoustic/vibe loads on space station structures with small thrusters (Sierra, Orion).
- 14) Extensive analysis/test correlation of composite structure buckling for aerospace vehicle hardware (JSF engine bypass ducts, braided and fabric construction). Complete test program, including basic coupons, flange subcomponents, and scaled size major components in CEC laboratory. Nonlinear large deflection FEA of irregular duct designs, predicting pre to post buckling deflections, and verified by test in CEC lab (AFRL, Wright Patterson AFB, SBIR Phase II, I).
- 15) Design analysis and vibration problems troubleshooting/resolution by analysis and test correlation of advanced centrifugal separator systems. Analysis includes complex coupled rotordynamic analysis of rotors with flexible housings and floor mount structures, contained fluids, and nonlinear rolling bearing stiffness (CINC, SDS). Some systems in nuclear service.
- 16) Design of composite radomes for military missiles and ground based systems. Sophisticated thermal and structural design with transient and static FE analysis, incorporating composite material characterization test results. Often, material characterization performed at CEC laboratory of monolithic and sandwich laminates (AMA, CEI, AASC, and others).

- 17) Design analysis of aircraft instrumentation/remote sensor turrets, radomes, and mounting systems (Raytheon, SDG, and others)
- 18) Extensive thermo-structural design and analysis of metallic rocket engine components (calorimeters, preburners, injectors, and thrust chambers) for life and strength, for next generation hydrocarbon fuel NASA (TR107), Air Force (IHPRT), and commercial (Sierra Engineering, Microcosm, Blue Origin, RocketPlane) launch systems.
- 19) Acoustic analysis of rocket engine systems and laboratory test systems involving characterization and enhancement of dynamic combustion stability of rocket engines (Sierra Engineering, TRW).
- 20) Innovative new rocket chamber test hardware thermo-structural design and analysis, utilizing favorable properties of graphite solids and foams (Sierra Engineering, AFRL).
- 21) Acousto-Structural coupled analysis of a new large 650,000 lb thrust cryogenic rocket engine. Analysis included combustion/acoustic stability, chug coupling, and structural response in ground test, including test stand structural dynamics. Test correlation was included (TRW).
- 22) Extensive NHRA Top Fuel drag car frame investigation, including on-track loads testing, nonlinear large deflection and plastic material FEA, full chassis lab testing for correlation with FEA, and detailed design recommendations (BME, SFI, NHRA). Now CEC is one of a few accredited laboratories performing required acceptance testing of chrome-moly tubing for chassis builders.
- 23) Development of carbon graphite rear subframe/airbox for off-road motorcycles. Nonlinear large deflection composite FEA (Yamaha Japan).
- 24) Extensive laboratory testing of a very high performance ammonia coolant heat exchanger system for laser weapons application. All system assembly, instrumentation, testing, and data acquisition/reduction in CEC lab (Sierra, Northrop Grumman).
- 25) Design by FEA of specialized titanium hardware, to minimize cost and maximize structural performance. Subjects include bicycle frames, work shoe toe boxes, electroplating equipment, and heat exchangers (Titan Mfg.).
- 26) Design by FEA, testing, and test data processing of off-road motorcycle accessory hardware, including new generation handlebars, foot pegs, and loading ramps (Tucker-Rocky, Answer Products).
- 27) Detailed FEA of complex nuclear powerplant steam dryers, for vibration response and fatigue life of welded steel structures. Nuclear industry requirements for analysis documentation and procedures (GE Nuclear).
- 28) Optimal design of electron beam etching machine vacuum chambers and handling mechanisms utilizing structural system optimization for dynamic deflection cancellation (Perkin-Elmer, AIBT).
- 29) Earthquake qualification of standby battery banks by nonlinear transient analysis, shock analysis, and testing (TYCO).
- 30) Earthquake retrofit system mechanical design, analysis, and testing including kinematic design and nonlinear inelastic structural dynamics (EiLand).
- 31) Optimal structural design of a 24 ft aircraft radome for the Navy's E2-C Hawkeye, to produce the lightest radome ever for this platform (Loral, Navy).
- 32) Mechanical and structural design of a continuously variable transmission for bicycles, emphasizing low manufacturing cost and high reliability, for a Kennewick, WA company, involving complex kinematics and linear/nonlinear stress analysis with elastomers.
- 33) Structural design of lightweight fiberglass/steel hybrid military van and municipal solid waste semitrailers, including complete road environment fatigue analysis and material

- characterization testing. Units successfully underwent qualification testing at Aberdeen Proving Grounds (Altamont Technologies).
- 34) Space station composite sandwich structure design for solar electricity system transformers (AASC, Loral).
 - 35) Design analysis of a new laminated wing heater for MD-80 aircraft. Analysis included structural and thermal FEA with composites and flexible nonlinear bonding materials (AASC, TDG).
 - 36) Proof of principle analysis and prototype testing of a new internal combustion engine/compressor/pump design (Transcove Ltd., Ireland). Convergence contributed novel kinematic design refinements to enable the concept to be more efficient than existing piston machine designs. Key performance issues were proven in subscale laboratory tests by CEC.
 - 37) A major effort in 1993-1995 was performed for FloWind Corporation, San Rafael, CA. Convergence Engineering, with technical leadership from Dr. Davis, developed a highly automated structural analysis system for Vertical Axis Wind Turbines, which reduced design iteration analysis time from 4-6 weeks to 2 days. The system was applied to development of a structurally optimized next generation high aspect ratio wind turbine, and a prototype was built, tested (at Tehachapi, CA wind farm) and correlated with analysis predictions.
 - 38) A major effort in 1990-1992 was performed for B.P. Chemicals Aerospace Composites Division. Detailed finite element analysis was performed on carbon graphite/honeycomb thrust reverser blocker door designs for the Boeing 757 and 777 aircraft. Special proof-of-principle analyses were performed to verify the accuracy of modeling approaches. Complex 3-D laminate solid models were constructed and used for static pressure and dynamic vibration loading analyses, including sophisticated layup optimization analysis. Strength and fatigue analyses of the composite and metallic components were done with model results. Fatigue testing of PR500 carbon graphite laminate coupons was performed, and complete statistical analysis was provided for B.P. materials characterization test programs. Comprehensive design review presentations were made, and expertise was provided for customer technical interface and B.P. technical planning. Convergence Engineering also provided vibration qualification testing services for the 757 and 777 blocker door programs, and supported static and fatigue qualification tests.
 - 39) More than 220 legal cases, involving product liability or patent disputes, with varied subjects ranging from furniture to heavy equipment to shaker tables for vibration testing. Plaintiff and defense, mechanical engineering analysis and testing. High technology applied to legal cases, greatly reducing cases brought to trial, instead settled based on quantitative engineering information.

7/84-11/90 : Engineering Specialist

Employer: System Analysis Department
Aerojet Propulsion Division
Sacramento, CA

Duties: Technical leader for the company in the areas of structural dynamics and advanced probabilistic and statistical methods. Led the building of most of the company's analytical capability in rotordynamics over the last five years (see Ph.D. dissertation on page 1). Planned and performed original research under company IR&D in the areas of rolling element bearings, fluid film bearings, and rotordynamic nonlinear coupled system analysis methods. Also acted as subgroup manager including task allocation, review, and project planning of structural dynamics efforts.

Performed a NASA technology contract entitled Modeling of Rolling Element Bearing Mechanics, which was a result of the IR&D work. Included detailed nonlinear static and dynamic analysis of rolling element bearings with flexible races and housing interface gaps. Applied probabilistic analysis knowledge to the Advanced Launch System project in areas of sensitivity, variability, and thrust/mixture ratio trimming of candidate engine power systems. Applications of experiment design, regression, and variance propagation methods were involved. Developed new approaches to the probabilistic description of trimming operations.

Other previous significant work includes:

- 1) Participated as a dynamics expert on Titan 34D failure analysis teams and have provided continuing support to the Titan program in areas of design loads definition, vibration analysis, and start transient structural system response. Failure analysis included comprehensive structural start transient response prediction, and support of POGO analysis. Involved in reviews at Aerospace Corp., Sheldon Rubin in charge.
- 2) Performed extensive structural random and transient dynamic response analysis of High Endoatmospheric Interceptor (HEDI) components and systems. Also have led the overall dynamic analysis effort for this project intermittently.
- 3) Provided ongoing leadership within the company in methods development and planning to address customer needs and increase productivity.
- 4) Led the development and implementation of a comprehensive dynamic system analysis computer code, RODYNE. Initially developed to perform complex time and frequency domain rotordynamic analysis in an interactive environment, it has also been useful for engine power system and other analyses. It is now a foundation computer program for the system analysis group, and was recognized by the company via an innovation award (see below).
- 5) Performed as lead dynamicist on the Space Shuttle Engine Study. Work included turbine blade and disk vibration analysis, rotordynamic analysis including structural coupling of engine mounting, and detailed ball bearing analysis.
- 6) Performed testing and troubleshooting of the TRANSTAR turbopump which had a rotor stability problem. Recommended design changes to solve the problem. Have also performed troubleshooting on high capacity firefighting pumps (Aerosafe) and bearing testers.
- 7) Provided dynamics support on various proposals to NASA, including the SSME Alternate Turbopump Development Program, Influence of Rubbing on Rotordynamics, Blade Tip Rubbing Stress Prediction, and others.
- 8) Performed extensive modeling and stress analysis of Titan pump housings for uprate applications.

9/82 - 7/84 : Mechanical Engineering Consultant

Employer: Self

Duties: Private part time business performing engineering consulting for varied clients. Jobs included farm equipment failure troubleshooting (strain gage testing and finite element analysis), dump truck failure analysis, vibrating equipment stress testing, library research and on-site investigations for liability cases, and beer can design refinement using finite element methods. Other references available upon request.

9/82 - 7/84 : Visiting Lecturer and Researcher

Employer: Mechanical Engineering Department
University of California
Davis, CA

Duties: Course preparation, instruction, and student consultation in upper division mechanical engineering subjects. Courses taught included introductory and intermediate dynamics,

introductory and intermediate mechanical design, and probabilistic design. Also developed new computer-aided design teaching methods for intermediate mechanical design courses.

7/80 - 9/82 : Project Manager, Consulting Services

Employer: Structural Dynamics Research Corporation
San Diego, CA

Duties: Solved difficult mechanical design and vibration problems on a consulting basis for various industrial clients. Sophisticated computer analysis methods were commonly used. Responsibilities included all items for the satisfaction of clients, including:

- 1) Sales calls and initial customer contacts
- 2) Research, financial planning, and preparation of contract proposals
- 3) Data collection on site, often including modal and vibration tests of existing mechanical equipment.
- 4) Comprehensive analysis of mechanical systems under study using static and dynamic techniques, most often via finite element methods with computers.
- 5) Interpretation of test and analysis data and determination of proper courses of action for the client.
- 6) Ongoing financial tracking and control.
- 7) Preparation of complete engineering reports.

Some of the subjects of study were seismic qualification of hardware, heavy truck ride studies, electron beam etching machine vibration control, train hopper car stress analysis, beer can holder design analysis, electronic equipment vibration isolation, and CNC machine tool frame design to minimize vibration.

pre-1980 : Engineering Intern and others

Employer: IBM, Weyerhaeuser, University of California

Duties: Various summer internships, teaching assistant, research assistant, and reader jobs. Highlights include:

- 1) work in UC Davis agricultural engineering dept. building forest engineering research equipment (welding, mechanic, mechanical designer)
- 2) Weyerhaeuser work on a new tree nursery cultivation implement which led to an invention report. Implement was conceived, designed, built, and tested in 3 months.

Specific Skills:

- Extensive mechanical design and analysis experience, including function, failure, and durability.
- Extensive experience in the analysis of rolling element bearing mechanics.
- Extensive knowledge in structural dynamics, including rotating machinery dynamics as a subset.
- Extensive knowledge in modal synthesis and other reduction techniques with application to real dynamic systems.
- Extensive experience in the use of finite element methods and computer programs. Experienced in porting finite element data into other codes for different analyses. Particular experience in the use of ANSYS, with some experience with NASTRAN and others.
- Extensive knowledge of probabilistic, optimization, and statistical methods and their application to engineering problems, including experiment design, regression, response surface methodology, hypothesis testing, probabilistic design methods, and advanced signal processing.
- Training in general system dynamics, including classical and modern control.
- Engineering-oriented computer coding experience, mostly with FORTRAN. Also experience with assembly language, APL, and BASIC, VISUAL BASIC, GAUSS, EXCEL, MATHCAD.
- Experience with PC computers and associated commercial software (word processors, spreadsheets, and specialty engineering analysis codes).
- Instrumentation, testing, and machinery diagnosis experience using strain gages, accelerometers, proximity probes and modern filtering and analog/digital data acquisition equipment.
- Hands on experience with design and fabrication of analog electronics.
- Welding and general mechanical proficiency. Experienced in prototype fabrication and testing.

Honors and Awards:

- R.B. Young Technical Innovation Award, Aerojet TechSystems Company, 1987, "RODYNE: Simple and Efficient Linear/Nonlinear Integrated Dynamic Analysis"
- Earl C. Anthony Fellowship, University of California, Davis, 1983-84
- Distinguished Scholar Research Award, University of California, Davis, 1979-80
- Graduate Division Fellowship, University of California, Davis, 1979-80
- B.S. Degree with highest honors and Mechanical Engineering Departmental Citation, University of California, Davis, 1979
- William Stout Award, University of California, Davis, 1977
- Cal Aggie Alumni Association Award, University of California, Davis, 1977

Affiliations and Licenses:

- American Society of Mechanical Engineers (ASME)
- Society of Automotive Engineers (SAE)
- Tau Beta Pi Engineering Honor Society
- Phi Kappa Phi Honor Society
- Registered Professional Engineer in California, Mechanical, No. 22810
- Registered Professional Engineer in Nevada, Mechanical, No. 11336

Patents:

- co-inventor, "Pedalling Efficiency Indicator", U.S. Patent No. 4,463,433, July 1984.
- co-inventor, "Force-Resisting Devices and Methods for Structures", U.S. Patent No. 7,043,879, May 2006.
- co-inventor, "Force-Resisting Devices and Methods for Structures", U.S. Patent No. 7,458,187, December 2008.

Publications:

1. Brinkley, A.L., and Davis, R.R., "Response Surface Modeling of a Closed-Cycle Split-Expander Liquid Rocket Engine" 6th JANNAF Modeling and Simulation Subcommittee Meeting, Orlando, FL, December, 2008.
2. Raymer, D.P., Doupe, C., Zweber, J., Fry, T., Munro, B., Davis, R., Crockett, D., Mallick, K., and Weatherly, H., "An Affordable Flight Demonstrator for Fully-Reusable Access to Space Technologies", paper presented in Session 3C at the 54th JANNAF Joint Propulsion Meeting (JPM 2007), Denver, CO, May 14, 2007.
3. Cheng, G.C., Davis, R.R., Johnson, C.W., Muss, J.A., Greisen, D.A., and Cohn, R.K., "Development of GOX/Kerosene Swirl-Coaxial Injector Technology", paper AIAA 2003-4751, presented at the 39th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Huntsville, AL, July 20, 2003.
4. Johnson, C.W., Palmer, S.M., and Davis, R.R., "Improvements to ROCETS (ROcket Engine Transient Simulation)", presented at JANNAF Conference, JANNAF Interagency Propulsion Committee, 3rd Modeling and Simulation Subcommittee, Colorado Springs, CO, December 1-5, 2003 (limited distribution, Critical Technology).
5. Davis, R.R., "The Ball Piston Engine – A New Concept in High Efficiency Power Machines", SAE Paper #970066, presented at the SAE International Congress and Exposition, Detroit, Michigan, February 24, 1997.
6. Davis, R.R., "Practical Nonlinear Simulation of Rotating Machinery Dynamics With Application to Turbine Blade Rubbing", Ph.D. Dissertation, University of California, Davis, 701 pg, May 1989.
7. Davis, R.R., "Enhanced Rotor Modeling Tailored for Rub Dynamic Stability Analysis and Simulation", *Rotordynamic Instability Problems in High Performance Turbomachinery 1988*, Proceedings of a workshop held at Texas A&M University, College Station, Texas, pp. 431-444, May 16-18 1988.
8. Davis, R.R. and Vallance, C.S., "Incorporating General Race and Housing Flexibility and Deadband in Rolling Element Bearing Analysis", *Rotordynamic Instability Problems in High Performance Turbomachinery 1988*, Proceedings of a workshop held at Texas A&M University, College Station, Texas, pp. 373-387, May 16-18 1988.
9. Davis, R.R., "Enhanced Rotor Modeling Tailored for Dynamic Stability Analysis and Nonlinear Simulation", presented at the Second International Symposium on Transport Phenomena, Dynamics, and Design of Rotating Machinery, Honolulu, Hawaii, *Proceedings Preprints, Vol. 2: Dynamics*, pp. 182-193, April 3-6 1988.
10. Davis, R.R. and Vallance, C.S., "Incorporating General Race and Housing Flexibility and Deadband in Rolling Element Bearing Analysis", presented at the Second International Symposium on Transport Phenomena, Dynamics, and Design of Rotating Machinery, Honolulu, Hawaii, *Proceedings Preprints, Vol. 2: Dynamics*, pp. 241-254, April 3-6 1988.
11. Davis, R.R. and Hull, M.L., "Design of Aluminum Bicycle Frames", *ASME J. of Mechanical Design*, vol. 103, no. 4, pp. 901-907, October 1981.

12. Hull, M.L. and Davis, R.R., "Measurement of Pedal Loading in Bicycling: I. Instrumentation", *J. of Biomechanics*, vol. 14, no. 12, pp. 843-856, 1981.
13. Davis, R.R. and Hull, M.L., "Measurement of Pedal Loading in Bicycling: II. Analysis and Results", *J. of Biomechanics*, vol. 14, no. 12, pp. 857-872, 1981.
14. Davis, R.R. and Hull, M.L., "Performance Analysis of Bicycle Pedalling", *1981 Biomechanics Symposium*, ASME Publication AMD-Vol. 43, no. G00201, pp. 109-112, June 1981.
15. Hull, M.L. and Davis, R.R., "Biomechanics of Overuse Injuries in Bicycling: Instrumentation", *1980 Advances in Bioengineering*, ASME Publication no. G00176, pp. 129-132, November 1980.
16. Davis, R.R. and Hull, M.L., "Pedalling Efficiency in Bicycling", *1980 Advances in Bioengineering*, ASME Publication no. G00176, pp. 133-136, November 1980.
17. Hull, M.L. and Davis, R.R., "A Six-Axis Bicycle Pedal Load Measurement System", presented at the ISA/80 International Conference and Exhibit, Houston, Texas, Instrument Society of America Publication no. C.I. 80-698, pp. 677-689, October 1980.
18. Davis, R.R., "Measurement of Foot-Pedal Loads During Bicycling", M.S. Thesis, University of California, Davis, 49 pg, October 1980.
19. Davis, R.R. and Hull, M.L., "Design of Aluminum Bicycle Frames", *California Engineer*, vol. 58, no. 4, pp. 10-15, Spring 1980.

ATTACHMENT 4. Testimony* of Dr. Rory R. Davis, P.E. in last 4 years

List as of 06/13/2011 first reporting date:

Valencia v. Portola Pizza Factory - Deposition

Wooden bench failure in restaurant, representing plaintiff
Deposition testimony as expert: October, 2007

Kindice v. Corabel, et al - Deposition

Building roof access ladder failure, representing plaintiff
Deposition testimony as expert: May, 2008

Additional since 06/13/2011 first reporting date:

EiLand v. Simpon StrongWall , et al - Deposition

Patent infringement action, earthquake resistance structural systems, representing plaintiff
Deposition testimony as facts witness (inventor): June, 2011

*Testimony includes depositions, trials, and arbitrations, but does not include inspections, investigations, analysis, testing, and reports to clients

ATTACHMENT 5. Curriculum Vitae for Patrick R. Novak, P.E.

PATRICK R. NOVAK, P.E.

SUMMARY

Over 44 years of experience in design, development, administration and sales. Proven ability to take a project from inception through completion within time requirements while maintaining budgetary controls. Broad-based knowledge of all facets of business operations through positions of increased responsibility.

ENGINEERING/PRODUCT DEVELOPMENT

- Developed and brought to market an electro-hydraulic control valve utilizing PMDC motors. This valve is applied successfully by OEM's in Ag, Construction, Mining, Transportation, Petroleum, & Marine industry.
- Led a team that developed and brought to market a low-cost electro-mechanical servo system for off-road and industrial applications.
- Developed or supervised development of over 2000 custom hydraulic valves and integrated packages.
- Applied hydrostatic drive systems ranging in size from 10 -1500 HP, including HST drives for tour trams at Universal Studios.
- Developed air and hydraulic systems for applications ranging from small medical tables to 1000T wafer board presses and hydraulically operated pellet load out systems for moving trains.
- Designed and specified hydraulic drive and material handling systems for mining, metal making, steel, marine and petroleum processing industries.
- Led team that specified and purchased CAD system for design department.
- Awarded patent for closed circuit television system monitoring secured areas.
- Engineered production equipment, including high speed assembly machines, tools and dies for manufacturing electrical and communication connectors.
- Developed systems (including layout and sizing calculations) for hydraulic dredging projects ranging from small industrial settling ponds to municipal projects requiring miles of pipeline.
- Served as expert witness in lawsuits involving engineering and fluid power issues.
- Served as arbitrator in disputes involving fluid power related issues.

MANAGEMENT AND ADMINISTRATION

- Established and manage independent sales representatives to market Motorized Flow Control Valves, custom hydraulic manifolds and components world wide.
- Set up and manage distributor organization to support same manufacturer.
- Developed and implemented marketing and promotional plans for six product lines
- Managed set up and operation of all aspects of manufacturing division of large fluid power distributor.
- Managed group responsible for importing and reselling imported hydraulic components.
- Prepared and monitored annual operating budgets.
- Formulated long range (3 to 5 years) plans for manufacturing operation.
- Hired and managed staff of up to 18.

- Actively participated in startup and operation of a dredging contracting business.

SALES BACKGROUND

- Built sales of newly developed electro hydraulic flow control to over 7000 units per year
- Worked with Reps, distributors, and large OEM accounts to apply prototype electro-mechanical actuator and fluid power systems and components, manage production issues.
- Increased sales of Industrial Products Group by 45% in two years.
- As GM and Chief Engineer, worked with nationwide sales staff selling hydraulic cartridge valves, manifolds, and components to OEM's and industrial manufacturers.
- As distributor salesman, sold fluid power systems and components in Upper Midwest territory.

EMPLOYMENT HISTORY

Independent Sales Rep Representing Source Fluid Power, Power Engineering & Mfg, Inc / Private Consulting practice	1995 to present
ADDCO Manufacturing Company, Inc, St Paul, MN Director of Sales-Industrial Products Group	1991 to 1994
Fauver Co., Minneapolis, MN	1973 to 1991
Chief Engineer, Mobile Group	1990 – 1991
General Manager, Mobile Engineering Center	1981 – 1990
Application Engineer, Mobile Engineering Center	1979 – 1981
Sales Engineer	1973 – 1979
Mini Dredge, Inc. (MDI) President, (concurrently with Fauver Co.)	1974 – 1986
Air Hydraulic Systems, Minneapolis, MN Sales Engineer	1972 to 1973
Industrial Hydraulic Co., Milwaukee, WI Sales Engineer	1970 to 1972
3M Company, St Paul, MN Project Engineer	1967 to 1970

EDUCATION

Bachelor of Science, Mechanical Engineering University of North Dakota, Grand Forks, ND	1967
Licensed Professional Engineer, State of MN	1973
Continuing Education (required to keep license current), including: Legal Issues for MN Professional Engineers	

Product Liability for the MN Professional Engineer
TQM—SPC, Process Improvement, Team Building and Leadership
Increasing Sales through the use of sales Reps
Strategic Planning
Engineering Management
Sales, Time and Territory Management
Computer Programming (Basic)
Value Engineering
Numerous Seminars

ADDITIONAL INFORMATION

Professional development:

Authored and presented papers at SAE Off Highway Conferences

Packaged Hydraulics for Productivity Improvement – Case History, ASV Inc. All Terrain Vehicle

Improving Hydraulic System efficiency Using Cartridges and valve Packages

Energy Consideration in Hydraulic System Design Served as judge for National Design Contests sponsored by Hydraulics and Pneumatics Magazine

Provided articles on use of cartridge valves and packages to Hydraulics and Pneumatics, Diesel Progress magazines.

Served as Arbitrator in dispute between machine shop and industrial customer.

Affiliations:

Member, Society of Automotive Engineers (SAE)\

Have been listed as “expert” in fluid power by Teltech Resource Network, now Intota, since 1984. In this capacity, have provided short term consulting services, including acting as expert witness in several lawsuits.

ATTACHMENT 6. Testimony of Patrick R. Novak, P.E. in last 4 years

1. **HWH Corporation vs. Deltrol Corporation**
James P. Craig
Lederer Weston Craig, PLC
118 Third Ave. SE, Suite 700
P. O. Box 1927
Cedar Rapids, IA 52406-1927
Phone: 319-365-1184
2. **Deal vs. Highway Preservation Systems, et al.**
Joseph L. Dilts, Esq.
Koehnen & Patton LLP
PNC Center, Suite 800
201 East Fifth Street
Cincinnati, OH 45202
Phone: 513-381-0656
3. **Ackerman and Pacific Boring vs. Hydratech**
Donald R. Franson Jr.
Sagaser, Hansen, & Franson
2445 Capitol Street, Second Floor
Fresno, CA 93721
Phone: 209-233-4800
4. **Theo. H Davies & Co. dba Pacific Machinery vs. Brothers Industries**
Michael R. Marsh, Esq.
Case, Myrdal, Bigelow, & Lombardi
Grosvenor Center
Mauka Tower, Suite 2500
Honolulu, HI 96813
Phone: 808-547-5400
5. **Martinez v. CNH America**
Mark Oium
Oium Reyen & Pryor
220 Montgomery Street, Suite 910
San Francisco, CA 94104
Phone: 415-392-8300
6. **Tompkins v. Houghton, et al**
Andrew Liebowitz
The Berry Firm
1412 Main Street, Ste 230
Dallas, TX 75202
Phone: 214-915-9801
(Deposed, November, 2010)

ATTACHMENT 7. Curriculum Vitae for J. Neil Robinson, PhD

SUMMARY

Dr. Robinson received a B.A. with Honors, majoring in Metallurgy, from Cambridge University in England and a Ph.D. in Materials Engineering from UCLA. He was a Principal of Failure Analysis Associates (now Exponent, Inc.), the international consulting company, where he headed the Human Factors, Risk Analysis and Materials Laboratory Groups. He was Principal Inspector at the Nuclear Installations Inspectorate in London, responsible for evaluating materials safety issues in nuclear power plants. Over the last 40 years he has undertaken many thousands of analyses of materials failures or potential failures around the world and has testified about the results of these analyses in US Federal courts, state courts across the US, in Europe and in many arbitrations. He has authored numerous research publications in books and in national and international scientific and engineering journals. This research has included not only materials engineering and failure issues but also issues of safety and of human factors engineering.

SPECIALIZED PROFESSIONAL COMPETENCE

Failure analysis; accident investigation; metallurgy and materials engineering for metals, polymers (including plastics, rubbers and composite materials) and glass; corrosion and environmental effects on failure; testing methods; human factors engineering.

EXAMPLE INVESTIGATIONS

- 2010 Deepwater Horizon (BP) oil spill in the Gulf of Mexico (investigation ongoing)
- Loss of a chemical tanker off San Francisco
- Failure of LNG tanks in Abu Dhabi
- Explosion of a power plant in Kansas City
- Failure assessment of ore processing equipment in Chile

EDUCATION

Ph.D. (Engineering, Major in Materials, Minor in Education), University of California, Los Angeles (1973)

M.A., Cambridge University (1972)

B.A. (Natural Sciences, Major in Metallurgy), Cambridge University, with Honors (1968)

BACKGROUND

Talas Engineering, Inc., Consultant, Materials Engineering (2010 to Present)

Independent Engineering Consultant, materials engineering and failure analysis (1994 to Present)

Failure Analysis Associates, Inc. (now Exponent, Inc.), Menlo Park, CA

- Principal Engineer (most senior engineering level in the company) (1987 to 1994)

Headed Human Factors, Risk Analysis and Materials Laboratory Groups

- Managing Engineer (1983 to 1986)

- Senior Engineer (1981 to 1982)

Khonkaen University, Thailand

- Visiting Expert Lecturer, Materials Engineering (1979 to 1980)

Nuclear Installations Inspectorate, London

- Principal Inspector (1978 to 1979)

Responsible for evaluating potential material failure modes and safety issues in nuclear power plants

- Inspector (1975 to 1978)

Imperial College, University of London

- Post-Doctoral Research Scientist (1973 to 1975)

Failure Analysis Associates

- Consultant (1971 to 1974)

University of California, Los Angeles

- Post-Graduate Research Engineer (1971 to 1973)

GKN Group Technological Center, Birmingham, England

- Assistant Metallurgist (1968 to 1970)

Chairman, Failure Analysis Sessions, American Society of Mechanical Engineers National Pressure Vessel and Piping Congresses.

National Aeronautics and Space Administration Certificate of Recognition.

American Society for Testing and Materials Student Award.

Distinguished Student Scholarship, University of California, Los Angeles.

Previously peer reviewer for: Metals Handbook, American Society for Metals; American Society for Testing and Materials publications; American Society of Mechanical Engineers publications; Engineering Fracture Mechanics; International Journal of Fracture; Safety Technical Group, Human Factors and Ergonomics Society.

Listed: Who's Who in America; Who's Who in Science and Engineering.

Formerly Full Member of: American Society for Metals; Human Factors and Ergonomics Society; American Society of Mechanical Engineers; Society for Risk Analysis, Ergonomics Society.

SELECTED PUBLICATIONS AND INVITED LECTURES – MATERIALS ENGINEERING & FAILURE ANALYSIS

1. "Tensile Test Apparatus for Brittle Materials," *Journal of Physics E: Scientific Instruments*, Vol. 5, p. 171, 1972.
2. "The Relationship Between Microstructure and Fracture Toughness for a Low Alloy Steel," *Engineering Fracture Mechanics*, Vol. 4, p. 377 (with C.W. Tuck), 1972.
3. "The Determination of K_{Ic} Values from Measurements of the Critical Crack Tip Opening Displacement at Fracture Initiation," 3rd International Conference on Fracture, Munich, West Germany (with A.S. Tetelman), 1973.
4. "The Use of Small Specimens in Fracture Toughness Testing," 18th National Society for Advancement of Material and Process Engineering Symposium and Exhibition, Anaheim, California (with A.S. Tetelman), 1973.
5. "The Determination of the Relationship Between Strain and Microhardness Using a Visioplasticity Technique," *Metallurgical Transactions*, Vol. 4, p. 2091 (with A.H. Shabaik), 1973.
6. "The Critical Crack-Tip Opening Displacement and Microscopic and Macroscopic Fracture Criteria for Metals," Ph.D. Dissertation, University of California, Los Angeles, 1973.
7. "The Measurement of K_{Ic} on Small Specimens Using Critical Crack Tip Opening Displacement," 7th National Symposium on Fracture Mechanics, University of Maryland, in *American Society for Testing and Materials Special Technical Publication 559, Fracture Toughness and Slow-Stable Cracking* (with A.S. Tetelman), 1974.
8. "The Use of Small, Pre-Cracked Specimens for Quality Control Purposes," in *Proceedings, Conference on Prospects of Fracture Mechanics*, published by Noordhoff (with A.S. Tetelman and I. Roman), 1974.
9. "The Relationship Between Crack Tip Opening Displacement, Strain and Specimen Geometry," *International Journal of Fracture*, Vol. 11, p. 453 (with A.S. Tetelman), 1975.
10. "The Measurement of Crack Growth Resistance Curves (R-Curves) Using the J-Integral," *International Journal of Fracture*, Vol. 11, p. 528 (with S.J. Garwood and C.E. Turner), 1975.
11. "Comparison of Various Methods of Measuring K_{Ic} on Small Pre-Cracked Specimens After General Yield," *Engineering Fracture Mechanics*, Vol. 8, p. 301 (with A.S. Tetelman), 1976.
12. "An Experimental Investigation of the Effect of Specimen Type on the Crack Tip Opening Displacement and J-Integral Fracture Criteria," *International Journal of Fracture*, Vol. 12, p. 723, 1976.
13. "The Application of Elastic-Plastic Fracture Mechanics Parameters in Fracture Safe Design," *Nuclear Engineering and Design*, Vol. 45, p. 133 (with G.R. Egan), 1978.
14. "The Application of Elasto-Plastic Fracture Mechanics to the Safety Assessment of Nuclear Power Station Components," OECD Nuclear Energy Agency Specialist Meeting on Elasto-Plastic Fracture Mechanics, Daresbury, England (with N.J.I. Adams and S.J. Garwood), 1978.
15. "Elasto-Plastic Fracture Mechanics Applied to the Safety Assessment of Nuclear Power Stations," 5th International Conference on Structural Mechanics in Reactor Technology, Berlin, (with N.J.I. Adams and S.J. Garwood), 1979.
16. "Marine Failure Analysis," presented to Society of Naval Architects and Marine Engineers, Northern California Section, San Francisco (with R.K. Taylor), 1983.

17. "Application of the Failure Assessment Diagram in the Analysis of a Pressure Vessel Failure," American Society of Mechanical Engineers, 4th National Congress on Pressure Vessel and Piping Technology, Portland, Oregon (with G.J. Fowler), 1983.
18. "Failure Analysis Methodology," American Society of Mechanical Engineers, 4th National Congress on Pressure Vessel and Piping Technology, Portland, Oregon (with D.O. Cox), 1983.
19. "Prediction of Structural Failure Using the Failure Assessment Diagram," in *Proceedings, International Symposium for Testing and Failure Analysis*, Los Angeles, California (with G. Fowler), 1983.
20. "Analyzing Failures - Some Advice and Examples," Invited Paper, *Mechanical Engineering*, American Society of Mechanical Engineers, Vol. 106 (with C.A. Rau, Jr.), July 1984.
21. "A Review of Fracture Mechanics Life Technology," National Aeronautics and Space Administration Report, sections on Nonlinear Fracture Mechanics (with G. Derbalian) and Weld Cracks, 1986.
22. "Use and Presentation of Technical Evidence," Invited Presentation, International Symposium on Pacific Basin Dispute Resolution, San Francisco, California, 1987.
23. "Learning from Failure," *Professional Engineering*, Vol. 5 (5), p.15 (with B.V. Brickle, et al.), 1992.

SELECTED PUBLICATIONS AND INVITED LECTURES – HUMAN FACTORS & SAFETY AND RISK ANALYSIS

1. "Warnings on Consumer Products - Objective Criteria for Their Use," in *Proceedings, Human Factors Society Annual Meeting* (with R.L. McCarthy, J.P. Finnegan, and R.K. Taylor), 1982, and reprinted in *Human Factors Perspectives on Warnings*, Human Factors and Ergonomics Society, 1994.
2. "Cost/Risk Analysis for Disk Retirement," U.S. Air Force, Wright Aeronautical Laboratories Report, AFWAL-TR-83-4089, Vol. 1 (with D.E. Allison, et al.), 1984.
3. "Spa and Pool Safety: A Quantitative Risk Analysis," Failure Analysis Associates Report to National Spa and Pool Institute (with G.E. McCarthy), 1985.
4. "Quantitative Safety Comparison of Three Hay Baling Technologies," American Society of Agricultural Engineers, Winter Meeting, Chicago, Illinois (with R.L. McCarthy and I. Brand), 1985.
5. "Safety Information Presentation: Factors Influencing the Potential for Changing Behavior," in *Proceedings, Human Factors Society Annual Meeting* (with D.P. Horst, et al.), 1986, and reprinted in *Human Factors Perspectives on Warnings*, Human Factors and Ergonomics Society, 1994.
6. "Product Life and its Relationship to Product Safety," American Society of Mechanical Engineers, Spring Design Show and Conference, Chicago, Illinois (with R.L. McCarthy, et al.), 1987.
7. "Measured Impact of a Mandated Warning on User Behavior," in *Proceedings, Human Factors Society Annual Meeting* (with G.E. McCarthy, et al.), 1987.
8. "Test of a Reversible Feed Drive on a Large Round Baler," American Society of Agricultural Engineers, Summer Meeting, Rapid City, South Dakota (with I. Brand and R.L. McCarthy), 1988.
9. "What is a Warning and When Will it Work?," in *Proceedings, Human Factors Society Annual Meeting* (with T.J. Ayres, et al.), 1989, and reprinted in *Human Factors Perspectives on Warnings*, Human Factors and Ergonomics Society, 1994.
10. "A Comparative Analysis of Industrial Lift Truck (Forklift) Accidents," American Society of Mechanical Engineers, Winter Annual Meeting, Dallas, Texas (with R.L. McCarthy, et al.), 1990.
11. "Accident Mode Risk Analysis of Agricultural Tractors," in *Engineering Applications of Risk Analysis*, American Society of Mechanical Engineers, (with J.A. Weiss, et al.), 1991.

12. "Warning Labels: Science and the Law," *New Law Journal*, Vol 142(6536), p. 83 (with B.V. Brickle), 1992.
13. "A Methodological Taxonomy for Warnings Research," in *Proceedings, Human Factors Society Annual Meeting* (with T.J. Ayres, et al.), 1992.
14. "Risk Analyses for Agricultural Vehicles," presented at the American Society of Agricultural Engineers, International Winter Meeting (with T.J. Ayres, et al.), 1992.
15. "A Comparative Analysis of the Annual Injury Risk for Motorized Vehicular Recreation," in *Safety Engineering and Risk Analysis*, American Society of Mechanical Engineers (with C.T. Wood, et al.), 1993.
16. "Behavioral Effectiveness of a Truck-Tire Warning Label," presented at the Human Factors and Ergonomics Society Annual Meeting (with T.J. Ayres, et al.), 1993.
17. "Risk-Based Warning Design," in *Product Warnings, Instructions and User Information*, American Bar Association (with R.L. McCarthy, et al.), 1994.
18. "Risk and Effectiveness Criteria for Using On-Product Warnings," *Ergonomics*, Vol. 38, p. 2164 (with R.L. McCarthy, et al.), 1995

ATTACHMENT 8. Testimony of J. Neil Robinson, PhD. in last 4 years

1. Kevin E. Turner v. Northern Indiana Brass Co. dba NIBCO Inc., Superior Court of the State of California, Placer County, Case No. S CV 9387.

Trial testimony: March 10, 2009

2. Arthur Newby, et al. v. Safeworks LLC, et al., Superior Court of the State of California, Sacramento County, Case No. 03AS01668 consolidated with Case Nos. 03AS01359 and 03AS00831.

Deposition testimony: January 15, 2008

Trial testimony: February 27, 2008

ATTACHMENT 9. Curriculum Vitae for Raymond Merala, M.S., PE

SPECIALIZED PROFESSIONAL COMPETENCE

Motor vehicle, recreational equipment, and industrial equipment accident reconstruction. Vehicle dynamics, occupant dynamics. Mechanical system and component failure analysis. Human injury biomechanics. Static and dynamic test design, digital data acquisition and analysis. Design, testing, and failure analysis of recreational, agricultural, forestry, industrial, and construction equipment. Risk analysis. Analysis and design of dynamic systems.

BACKGROUND AND PROFESSIONAL HONORS

B.S. (Agricultural Engineering), University of California, Davis (June 1980)

M.S. (Mechanical Engineering), University of California, Davis (March 1987)

Principal

Talas Engineering, Inc. (May 2007 - present)

Managing Engineer

Piziali and Associates, Inc. (Jan. 1995 - April 2007)

Managing Engineer

Failure Analysis Associates, Inc. (June 1987 - December 1994)

Research Assistant

Mikuni Corporation (1986, 1987)

Project Leader/Agricultural Engineer

Equipment Development Center, USDA Forest Service (Jan 1981 - Sept. 1984, Summer 1985)

Engineering Aide

Agricultural Engineering Department, University of California, Davis (\approx 1979, 1980)

Registered Professional Mechanical Engineer, California #M026171

Member, American Society of Mechanical Engineers

Member, Society of Automotive Engineers

Member, American Society for Testing and Materials, Committee F-27 on Snow Skiing

Member, International Society for Skiing Safety

Member, American Society of Agricultural and Biological Engineers

SELECTED PUBLICATIONS AND PRESENTATIONS

"Tractor Semitrailer Left Turns and Lane Changes," SAE Technical Paper 2010-01-0049, SAE International 2010 World Congress, Detroit, Michigan, April 12, 2010 (with K. White).

"Driver Perception of a Loose Rear Wheel," SAE Technical Paper 2010-01-0050, SAE International 2010 World Congress, Detroit, Michigan, April 12, 2010 (with K. White and D. Desautels).

"Injury Causation in Rollover Accidents and the Biofidelity of Hybrid III Data in Rollover Tests," SAE Technical Paper 980362, Society of Automotive Engineers, International Congress and Exposition, Detroit, Michigan, February 23-26, 1998 (with R.L. Piziali, et al.).

"The Biomechanics of Head and Neck Injuries in Skiing," 12th International Symposium on Ski Trauma and Skiing Safety, International Society for Skiing Safety, Whistler, British Columbia, Canada, May 1997 (with R.L. Piziali, and R.H. Hopper).

- “Foot Injuries and Foot Protection on All-Terrain Vehicles,” in Safety Engineering and Risk Analysis, 1994, D.W. Pyatt, Editor, American Society of Mechanical Engineers, 1994 International Mechanical Engineering Congress and Exposition, Chicago, Illinois, November 1994 (with T.J. Ayres, et al.).
- “Evaluation of a Proposed ATV Design Modification,” SAE Technical Paper 940276, Society of Automotive Engineers, International Congress and Exposition, Detroit, Michigan, February/March 1994 (with R.L. Piziali, et al.).
- “Water Ski Binding Release Loads; Test Method and Results,” Proceedings, International Symposium on Ski Trauma and Skiing Safety, International Society for Skiing Safety, Kaprun/Zell am See, Austria, May 1993 (with R.L. Piziali).
- “Risk Analyses for Agricultural Vehicles,” American Society of Agricultural Engineers, International Winter Meeting, Nashville, Tennessee, December 1992 (with T.J. Ayres, et al.).
- “Evaluation of an Occupant Protection System for All-Terrain Vehicles,” American Society of Mechanical Engineers, Winter Annual Meeting, Anaheim, CA, November 1992 (with R.L. Piziali, et al.).
- “The Application of Biomechanics to the Analysis of Automotive and Skiing Accident Injuries,” Proceedings, 4th International Conference on Structural Failure, Product Liability and Technical Insurance, Vienna, Austria, July 1992 (with R.L. Piziali and T.P. Khatua).
- “Accident Mode Risk Analysis of Agricultural Tractors,” American Society of Mechanical Engineers, Winter Annual Meeting, Atlanta, Georgia, December 1991 (with J.M. Weiss, et al.).
- “The Biomechanics of Lower Extremity Snow Ski Injuries,” Ninth International Symposium on Ski Trauma and Skiing Safety, International Society for Skiing Safety, Thredbo, NSW, Australia, June 1991.
- “Modeling and Simulation of a Supercharger,” Journal of Dynamic Systems, Measurement and Control, American Society of Mechanical Engineers, Vol. 110, Sept. 1988 (with M. Hubbard, and T. Miyano).
- “Guidelines for Evaluating Mechanical Tree Planters,” USDA Forest Service Project Record 8624-1207, November 1986 (with D.W. McKenzie).
- “Retardant Measurement System-Operational and Laboratory Evaluation of Mass Flowmeter,” USDA Forest Service Project Record 8651-1206, August 1986 (with L. Pope).
- “User and Procurement Manual for Retardant Measurement System - Mass Flowmeter,” USDA Forest Service, February 1986 (with R.T. Harrison).
- “Engineering Field Evaluation of Intermittent Tree Planters,” American Society of Agricultural Engineers, Paper #85-2804, 1985 (with J.A. Miles and J.E. Burk).
- “Evaluation of an Intermittent Furrow Tree Planting Machine,” USDA Forest Service Project Record 8224-1201, July 1984 (with D.W. McKenzie and A. Alsobrook).

ATTACHMENT 10. Testimony of Raymond Meral, M.S., PE. in last 4 years

Approximate Date	Case Caption	Venue
8-22-2011	Interstate v Cleveland Wrecking Depo	Superior Court, CA, San Francisco Co.
7-19-2011	Clark v Lopez Depo	Superior Court, CA, Shasta Co.
5-27-2011	Yeo v Chu Depo	Superior Court, CA, San Francisco Co.
3-25-2011	Greer v Narconon Depo	Superior Court, CA, Santa Cruz Co.
1-28-2011	Banac v Hepworth et al. Trial	Superior Court, CA, Alameda Co.
1-25-2011	Banac v Hepworth et al. Depo	Superior Court, CA, Alameda Co.
1-20-2011	Young v Mercury Depo	U. S. District Court - Dist. of Nevada
1-19-2011	Banac v Hepworth et al. Depo	Superior Court, CA, Alameda Co.
11-30-2010	Huey et al. v Sanmo Intl. Co. Depo	Superior Court, CA, San Francisco Co.
4-9-10	Zukerkorn v Peninsula Trail	Superior Court, CA, Alameda Co.
3-30-10	Golf & Country Club, et al. Depo	Superior Court, CA, Alameda Co.
1-22-10	Martinez v CNH America Depo	U. S. District Court - Dist. of Nevada
1-13-10	Fahringer v Snow Summit Depo	Superior Court, CA, San Bernardino Co.
10-22-09	Tackett v Johnson Depo	Superior Court, CA, Santa Clara Co.
10-6-09	Cardoza v Coniston Products Trial	Superior Court, CA, Alameda Co.
9-8, 18-09	Cardoza v Coniston Products Depo	Superior Court, CA, Alameda Co.
8-28-09	Mumford v Hoffman Depo	Superior Court, CA, San Mateo Co.
8-21-09	Martinez v City of Atwater Depo	Superior Court, CA, Stanislaus Co.
6-11-09	Thomas v Buchanan Depo	Superior Court, CA, Alameda Co.
6-3-09	Mazzurco v Gano Depo	Superior Court, CA, Monterey Co.
5-22-09	Silva v Greyhound Depo	Superior Court, CA, Alameda Co.
5-5-09	Mazzurco v Gano Depo	Superior Court, CA, Monterey Co.
3-31-09	Lu v Indian Valley Golf Club Depo	Superior Court, CA, Marin Co.
3-9-09	Turner v NIBCO Trial	Superior Court, CA, Placer Co.
3-3-09	Rianda v Granite Construction Depo	Superior Court, CA, Monterey Co.
2-27-09	Rader v Co. of Tulare, Armstrong Depo	Superior Court, CA, Tulare Co.
2-2-09	Herman v Leale's RV et al. Depo	Superior Court, CA, Santa Clara Co.
10/17/08	Harlan v Ostrander Trial	Superior Court, CA, San Joaquin Co.
8/29/08	Neil v Lifetime Products, Inc. Depo	Superior Court, CA, Sacramento Co.
8/25/08	People v M. Johnstone Trial	Superior Court, CA, San Mateo Co.
8/6/08	LaBarge v Metro Cab Depo	Superior Court, CA, San Francisco Co.
7/2/08	Mulhern v Bourget's et al. Depo	Superior Court, CA, Sacramento Co.
6/17/08	Gregg v Andrighetto Produce Depo	Superior Court, CA, San Mateo Co.
3/21/08	Gonzales v Castro Depo	Superior Court, CA, Tulare Co.
3/3/08	Glenn v Six Flags Trial	Superior Court, CA, Sacramento Co.
2/5/08	Chan v City of Hanford Depo	Superior Court, CA, Kings Co.
1/18/08	Concepcion v Bethany Center Depo	Superior Court, CA, San Francisco Co.
1/10/08	Morehouse v Clary Corp. Depo	Superior Court, CA, Sacramento Co.
11/7/07	Glenn v Six Flags Depo	Superior Court, CA, Sacramento Co.
10/31/07	Brosius v Bayer Depo	Superior Court, CA, Contra Costa Co.

8/23/07

Thor v Kerr

Trail Superior Court, CA, Tulare Co.

ATTACHMENT 11. List of Documents Received and/or Considered.

	Offshore Emergency Response Manual		Manual	Transocean	
	Analysis of Incident in Which Mechanical Barrier Failed			Transocean	
BP-HZN-BLY00031145 - BP-HZN-BLY00031435	Service Manual For ABB Vetco Gray Capital Drilling Equipment Consisting of a Nominal 21" HMF-H Marine Riser System and Wellhead Connector With sections for BOP Stack Equipment, Riser Equipment and Telescopic Joint. (Initial certification of parts)	06/00/2000	Manual	ABB Vetco Gray	Reading & Bates Drilling Co. (RBS8D) (Deepwater Horizon)
BP-HZN-BLY00032857 - BP-HZN-BLY00032864	Inspection Reports, Stress Test Report, Design Specifications, Inspection Reports for 1000K Traveling Block Assembly/ 78" Sheave	08/04/2000	Paper		
BP-HZN-BLY00054088 - BP-HZN-BLY00054648	Multiplex BOP Control System Manual/Certification (Volume I) (Data Book)	10/11/2000	Manual	Cameron Controls	TO/BP
BP-HZN-BLY00049914 - BP-HZN-BLY00050312	Multiplex BOP Control System Manual/Certification (Volume Two) Sections 5 - 10 Contains Factory Acceptance Tests, Drawings and Documentation. (Data Book)	10/11/2000	Manual	Cameron Controls	RBS8D/ Transocean
BP-HZN-BLY00050313 - BP-HZN-BLY00050902	Multiplex BOP Control System Manual/Certification (Volume Three) Sections 12 (Blue/Yellow & Spare Control Pod Contains Factory Acceptance Tests, Drawings and Documentation. (Data Book)	10/11/2000	Manual	Cameron Controls	RBS8D/ Transocean

BP-HZN-BLY00050903 - BP-HZN-BLY00051413	Multiplex BOP Control System Manual/Certification (Volume Four) Sections 13-18 Contains Factory Acceptance Tests, Drawings and Documentation. (Data Book)	10/11/2000	Manual	Cameron Controls	RBS8D/ Transocean
BP-HZN-BLY00051414 - BP-HZN-BLY00051880	Multiplex BOP Control System Manual/Certification (Volume Five) Sections 19-29 Contains Factory Acceptance Tests, Drawings and Documentation. (Data Book)	10/11/2000	Manual	Cameron Controls	RBS8D/ Transocean
BP-HZN-BLY00049679 - BP-HZN-BLY00050913	Deepwater Horizon TL BOP Stack Operation and Maintenance Manual	10/20/2000	Manual	Cameron Controls	RBS8D/ Transocean
Various	Multiplex BOP Control System Manual Volumes 1-8	06/00/2000	Manual	Cameron Controls	RBS8D/ Transocean

BP-HZN-2179MDL00377702	Email from Guide to Sepulvado R. and M., Lockwood and Dendy	04/14/2009	E_Mail	Guide	Sepulvado R., Sepulvado M., Lockwood, Dendy
BP-HZN-2179MDL00397439 - BP-HZN2179MDL00397440	Email from Winfree to Guide, Powell and Grant B19	04/14/2009	E_Mail	Winfree	Guide, Powell, Grant
APC-SHS2A-0000001144	Email from Bodek (BP) to Kamm (Anadarko)	02/10/2010	E_Mail	Bodek	Kamm
ANA-MDL-0000005126 - ANA-MDL0000005127	Email Chain(top email is from Roque to Talley)	04/10/2010	E_Mail	Roque	Talley

ANA-MDL-000019858	Email from Burton	04/21/2010	E_Mail	Burton	Trautman, Allbritton, Mulder, Folger
BP-HZN-2179MDL00002754	Email chain From Sims to Hafle	03/14/2010	E_Mail	Sims	Hafle
BP-HZN-2179MDL00003765 - BP-HZN-2179MDL00003772	Email from Charles Bondurant	04/20/2010	E_Mail	Bondurant	Rainey, Thorseth, Ritchie, Vinson, Graham, Zwart, Yeilding, Liu.
BP-HZN-2179MDL00021218	Email from Bennett	03/26/2010	E_Mail	Bennett (QO Inc.)	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocales, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev
BP-HZN-2179MDL00021420	Email chain.	2/25/2010	E_Mail	LeBleu	Zhang, Diaz, Sant, Chester
BP-HZN-2179MDL00032196	Email-	03/22/2010	E_Mail	Bennett (QO Inc.)	Bodek

BP-HZN-2179MDL00033771	Email:		03/10/2010	E_Mail	Sims	Rich, Sprague, Walz
BP-HZN-2179MDL00039364	Status update email		03/27/2010	E_Mail	Bennett (QO Inc.)	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev
BP-HZN-2179MDL00044390	Email: Macondo Update Question		04/10/2010	E_Mail	Boesiger	Lacy (QO inc.)
BP-HZN-2179MDL00239154	Email		02/10/2010	E_Mail	Bennett (QO Inc.)	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev

BP-HZN-2179MDL00242045	Email: Well status is function testing BOP	02/18/2010	E_Mail	Bennett (QO Inc.)	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev
BP-HZN-2179MDL00243976	Email: Macondo Update. Status Testing BOP's	03/15/2010	E_Mail	Lacy	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev
BP-HZN-2179MDL00248954	Status update email:	04/09/2010	E_Mail	Lacy	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev

BP-HZN-2179MDL00272284	Email Status Update	04/10/2010	E-Mail	Lacy	Albertin, Arca, Bellow, Bodek, Boesiger, Bondurant Cocalles, Decalf, Depret, Guide, Hafle, Johnston, Lacy, LeBleu, Lundquist, McAughan, Morel, Nguyen, Paine, Piccoli, Reiter, Ritchie, Scherschel, Simpson, Sims, Skripnikova, Vinson, Zamorouev
TRN-HCEC-00063352 - TRN-HCEC-00063390	Incident Investigation Report: Bardolino Well Control Incident 12/23/2009.	02/17/2010	Report	Flaherty (Shell U.K)	
TRN-USCG_MMS-00043226	Email	04/05/2010	E-Mail	Braniff	Sannan, Legrand, Wainwright, Walls, Berthou, Nuttall, Strachan, Leach, Polderman, Polhamus, Rudd, Erlandsen, Rushton, McMahan, Hand, Clyne, Coull
TRN-USCG_MMS-00043227 - TRN-USCG_MMS-00043228	Transocean Well Operations Group Advisory "Monitoring Well Control Integrity of Mechanical Barriers"	04/05/2010	Advisory	TO	All Rigs
TRN-USCG_MMS-00043222 - TRN-USCG_MMS-00043225	Transocean Operations Advisory "Loss of Well Control During Upper Completion"	04/14/2010	Advisory	TO	All Rigs
MODUSI 01 2 009903	Memorandum	04/08/2005	Memorandum	Spencer	Shoemaker, Bryant
MODUSI 01 2 010353 - MODUSI 01 2 010391	Report Survey BHP Safety Critical Equipment Semi-Sub Deepwater Horizon.	03/15/2005	Report	Moduspe c	BHP Billiton

TRN-HCEC-00090686 - TRN-HCEC-00090797	Rig Condition Assessment Deepwater Horizon:	04/12/2010	Report	Moduspe c	TO
BP-HZN-MBI00000943- BP-HZN-MBI00001315	Deepwater Horizon Emergency Response Manual Volume 1 of 2	02/15/2008	Manual	TO	
BP-HZN-MBI00001316- BP-HZN-MBI00001577	Deepwater Horizon Emergency Response Manual Volume 2 of 2	02/15/2008	Manual	TO	
ABSDWH003335 - ABSDWH003381	ABS Statutory Inspection Report of Deepwater Horizon	02/27/2003	Report	ABS	
TRN-HCJ-00063579 - TRN-HCJ-63894	Deepwater Horizon Rig Assessment (Revision 1)	11/04/2005	Report	TO	
MODUSI 01 2 009309 - MODUSI 01 2 009411	Report Survey of Deepwater Horizon	10/31/2005	Report	Moduspe c	TO
BP-HZN-MBI000022705	Well Control Handbook	03/31/2009	Manual	TO	
CAM-GR-000000253	Low Temperature and Ambient Temperature Testing of Shearing Blind Rams	09/27/2005	Advisory	Cameron	
MSU 03 0 001502 - MSU 03 0 001622	Equipment History Maintenance For Crane #1 Port from March 16th 2009-March 16th 2010	03/16/2010	Report	TO	
MSU 03 0 001884 - MSU 03 0 001913	Equipment History Maintenance For Drawworks Active Heave	03/16/2010	Report	TO	
MSU 03 0 001946 - MSU 03 0 002000	Equipment History Maintenance For DP Process Control & NDU Units	03/16/2010	Report	TO	
MSU 03 0 001122 - MSU 03 0 001126	Equipment History Maintenance For 18-3/4" BOP Lower Annular	03/16/2010	Report	TO	
MSU 03 0 002320 - MSU 03 0 002345	Equipment History Maintenance For BOP Mounted Control Valves	03/16/2010	Report	TO	

BP-HZN-CEC044459 - BP-HZN-CEC044576	Final Report Blow-Out Prevention Equipment Reliability joint Industry Project (Phase I - Subsea)	05/12/2009	Report	West Engineering Services	
DHCIT_TP-1121984 - DHCIT_TP-1122102	Final Report Blow-Out Prevention Equipment Reliability joint Industry Project (Phase I - Subsea)	01/15/2010	Report	West Engineering Services	
DHCIT_TP-1377615- DHCIT_TP-1377618	High Temperature Packers and Seals for Cameron 18-3/4" 15K TL Ram BOPs and 18-3/4" 10K DL Annular BOP	05/13/2005	Report	West Engineering Services	
DHCIT_TP-1360845 - DHCIT_TP-1360869	High Temperature Elastomer Study for MMS	03/06/2009	Report	West Engineering Services	MMS
TRN-HCEC-00016648 - TRN-HCEC-00016794	RB Falcon Deepwater Horizon BOP Assurance Analysis	03/00/2001	Report	WS Atkins Inc	
CAM-DOI 000000078	Safety Alert	11/11/2009	Safety Alert	Cameron	
TRN-HCJ-00036308- TRN-HCJ-36427	Equipment History Jan 1 2010 - May 5th 2010 for DWH BOP HPU Accum Bank #1	05/05/2010	Report	TO	
Various	BP Daily Operation Reports for the DWH at the Macondo Well from 1/31/2010 - 4/19/2010 (No report for 4/20/2010)	Various	Report	BP	BP
Various	Macondo Well Applications, Amended Applications, Bypasses, Revised Bypasses to MMS from May 2009-April 15th 2010	Various	Application	BP	MMS

MSU 03 0 003186 - MSU 03 0 00333	11KV Main Switch Board #1 (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001102- MSU 03 0 001121	18-3.4-15000-TL-BOP (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001122- MSU 03 0 001126	18-3.4-BOP Lower Annular (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001202- MSU 03 0 001211	18-3.4-BOP Middle Single Rams (3/16/09-3/16/10)	03/16/2010	Report	TO	
TRN-USCG_MMS-00013654 - TRN-USCG_MMS-00013683	18-3.4-BOP Upper Annular (12/5/08-5/5/10)	05/05/2010	Report	TO	
TRN-HCEC-00035589 - TEN-HCEC00035	Administration (1/1/10-5/6/10)	05/06/2010	Report	TO	
MSU 03 0 001184- MSU 03 0 001193	Blue BOP MUX Cable (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 002823 - MSU 03 0 002832	Blue BOP Mux Cable Reel (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001141 - MSU 03 0 001168	BOP Blue Mux Control Pod (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001127 - MSU 03 0 001140	BOP Bridge Crane #1 (3/16/09-3/16/10)	03/16/2010	Report	TO	
TRN-HCJ-00040251 - TRN-HCJ-00040693	BOP HPU Accum Bank #1 (1/1/09-12/31/09)	05/07/2010	Report	TO	
TRN-HCEC-00039811 - TRN-HCEC-00039930	BOP HPU Accum Bank #1 (1/1/10-5/6/10)	05/06/2010	Report	TO	
TRN-HCEC-00078401 - TRN-HCEC-00079047	BOP HPU Accum Bank #1 (11/1/08-5/5/2010)	05/05/2010	Report	TO	
TRN-HCEC-00046325 - TRN-HCEC-00047083	BOP HPU Accum Bank #3 (1/1/09-12/31/09)	05/07/2010	Report	TO	
MSU 03 0 001260 - MSU 03 0 001261	BOP HPU Pipework (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001194 - MSU 03 0 001201	BOP HPU Pump #1 (3/16/09-3/16/10)	03/16/2010	Report	TO	

MSU 03 0 002320 - MSU 03 0 002345	BOP Mounted Control Valves (3/16/09-3/16/10)	03/16/2010	Report	TO	
MSU 03 0 001262 - MSU 03 0 001278	BOP Stack LMRP Connector (3/16/09-3/16/10)	03/16/2010	Report	TO	
TRN-HCEC-00040161 - TRN-HCEC-0040217	BOP Sub-sea Accumulator Bank (1/1/10-5/5/10)	05/05/2010	Report	TO	
TRN-HCJ-00039351 - TRN-HCJ-00039408	BOP Sub-sea Accumulator Bank (1/1/10-5/6/10)	05/06/2010	Report	TO	
TRN-HCEC-00036070 - TRN-HCEC-00036071	BOP Transporter (1/1/10-5/6/10)	05/06/2010	Report	TO	
TRN-HCEC-00036072 - TRN-HCEC-00036077	Cement System Instrumentation (1/1/10-5/6/2010)	05/06/2010	Report	TO	
MSU 03 0 001228 - MSU 03 0 001235	Choke Manifold (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 001701 - MSU 03 0 001824	Derrick (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-USCG_MMS-00017613 - TRN-USCG_MMS-00017903	Derrick Drops Area #1 (5/1/2005-5/7/2010)	05/07/2010	Report	TO	
MSU 03 0 001825 - MSU 03 0 001831	Diverter (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 001169 - MSU 03 0 001183	Drillers BOP Control Panel (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-HCJ-00079053 - TRN-HCJ-0079089	Emergency Shutdown Device (5/1/05-5/7/10)	05/07/2010	Report	TO	
MSU 03 0 001236 - MSU 03 0 001247	Houston Digital Instrument (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-HCEC-00037236 - TRN-HCEC-00037247	Main Engines ESD (1/1/2010-5/6/2010)	05/06/2010	Report	TO	
TRN-USCG_MMS-00014359 - TRN-USCG_MMS-00014395	Main Engines ESD (5/1/05-5/7/2010)	05/07/2010	Report	TO	
MSU 03 0 002299 - MSU 03 0 002314	Main Engines ESD (3/16/09-3/16/2010)	03/16/2010	Report	TO	

MSU 03 0 002026 - MSU 03 0 002297	Main Lighting Center #1 (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 011327 - MSU 03 0 011366	Man Riding Winch #5 White Rig Floor Port Aft (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 010625 - MSU 03 0 010704	Riser Joint DWH002 IK Tan (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 011043 - MSU 03 0 011045	Riser Tensioner Ring (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-HCEC-00037505 - TRN-HCEC 00037645	ROT Cement Booster Hose (1/1/2010-5/6/2010)	05/06/2010	Report	TO	
MSU 03 0 001248 - MSU 03 0 001257	Stack Mounted Hose Fitting (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 011166 - MSU 03 0 011189	Top Drive (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-HCEC-00036298 - TRN-HCEC 00036307	Top Drive Upper BOP (1/1/2010-5/6/2010)	05/06/2010	Report	TO	
MSU 03 0 003674 - MSU 03 0 003679	Top Drive Upper IBOP (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 011367 - MSU 03 0 011429	Utility Winch #8 Brown Moonpool Port Aft (3/16/09-3/16/2010)	03/16/2010	Report	TO	
MSU 03 0 002916 - MSU 03 0 003185	Waste Oil Holding Tank Port (3/16/09-3/16/2010)	03/16/2010	Report	TO	
TRN-HCJ-00087885 - TRN-HCJ-00088538	Watertight Door HPU Accum (5/7/05-5/7/2010)	05/07/2010	Report	TO	
MSU 03 0 011277 - MSU 03 0 011326	Watertight Door HPU Accum (5/7/05-5/7/2010)	05/07/2010	Report	TO	
CAM-DOI 000000001	BOP Variable Bore Ram Assembly	02/03/2000	Report	Cameron	
CAM-DOI 0000000034	Cooling Kits for Drillers Control Panel	03/00/2000	Report	Cameron	
CAM-DOI 000000003	ST-Lock OP and Preventative Maintenance	03/07/2000	Report	Cameron	

CAM-DOI 0000000002	Product Advisory #6020	03/09/2000	Report	Cameron	
CAM-DOI 0000000004	Sequence Valve ST-Lock	03/30/2000	Report	Cameron	
CAM-DOI 0000000005	Bearing, Overhauling Nut ST-Lock	06/15/2000	Report	Cameron	
CAM-DOI 0000000444-CAM-DOI 0000000045	ST-Lock Brake Hub	03/13/2002	Report	Cameron	
CAM-DOI 0000000050	ST-Lock Overhauling Nut	03/14/2002	Report	Cameron	
CAM-DOI 0000000061	Supershear Ram Retainer Pin	04/02/2002	Report	Cameron	
CAM-DOI 0000000033	Fuses in Subsea Architecture	05/00/2002	Report	Cameron	
CAM-DOI 0000000035	BOP VBE Packer Range Change	09/20/2002	Report	Cameron	
CAM-DOI 0000000037	Top Seals	09/02/2005	Report	Cameron	
CAM-DOI 0000000041-CAM-DOI 0000000042	Safety Alert TL-BOP RAM Lock	01/11/2006	Report	Cameron	
CAM-DOI 0000000064	Update Shearing Capability of Cameron Shear Ram	06/21/2007	Report	Cameron	
CAM-DOI 0000000065	Mod Control Pod Mark I Stack and Riser Multi Port Stinger Segment Inspection	04/02/2008	Report	Cameron	
CAM-DOI 0000000069	St-Locks	02/24/2009	Report	Cameron	
CAM-DOI 0000000083	Bonnet Bolts and Bonnet Studs	01/20/2010	Report	Cameron	
CAM-DOI 0000000026	LMRO & Wellhead Connector Function Lock Out		Report	Cameron	
CAM-DOI 0000000030	Product Advisory #18040		Report	Cameron	

CAM-DOI 000000007	Shuttle Valves		Report	Cameron	
CAM-DOI 000000127-CAM-DOI 000000140	Type A Lib Seals Update for D and DL Annular BOP	06/21/1985	Report	Cameron	
CAM-DOI 000000151-CAM-DOI 000000152	Shearing Limitations Due to increased Pipe Strength	09/13/1990	Report	Cameron	
CAM-DOI 000000121-CAM-DOI 000000126	Cameron Collet Connector Self Locking Design	06/15/1991	Report	Cameron	
CAM-DOI 000005984-CAM-DOI 000005990	Shearing Capabilities of Cameron Shear Rams	08/19/1991	Report	Cameron	
CAM-DOI 000000109-CAM-DOI 000000113	Recommendations for Field Testing Cameron D Annular BOP	10/31/1991	Report	Cameron	
CAM-DOI 000000154-CAM-DOI 000000156	D Shaped Seal used as Optional Replacement for Standard Lip Seal in Annular BOPs	02/08/1992	Report	Cameron	
CAM-DOI 000000167-CAM-DOI 000000171	Inspection and servicing Mod BOP Control Pod Stingers and Receptacles	03/22/1992	Report	Cameron	
CAM-DOI 000000172	Low Temperature Testing of Variable Bore Rams	11/29/1993	Report	Cameron	
CAM-DOI 000000142-CAM-DOI 000000145	ST-Lock Sequencing Valve for T BOP	05/06/1994	Report	Cameron	
CAM-DOI 000000114-CAM-DOI 000000119	Variable Bore Ram Engineering Data	11/30/1994	Report	Cameron	
CAM-DOI 000000752-CAM-DOI 000000758	Factory Acceptance Test Procedure for 18.75 15 M T and TL BOP with 4000psi Op Pressure & ST-Locks	02/20/1998	Report	Cameron	
CAM-DOI 000000174-CAM-DOI 000000190	Shear Ram Product Line	10/30/1998	Report	Cameron	
CAM-DOI 000000191	TL BOP Op Cylinder to Bonnet Seal	02/12/1999	Report	Cameron	

CAM-DOI 000000192-CAM-DOI 00000194	Sequence Valve on-site Inspection Procedure	05/20/1999	Report	Cameron	
CAM-DOI 000000195-CAM-DOI 00000198	Long Term Storage of T & TL BOPs	06/12/1999	Report	Cameron	
CAM-DOI 000013871-CAM-DOI 000013889	Partial engineering report (Pages 14-30)	06/22/1999	Report	Cameron	
CAM-DOI 000000208	Ceramic Seal Plates	09/27/1999	Report	Cameron	
CAM-DOI 000005991-CAM-DOI 000005997	Variable Bore Ram Sealing	11/19/1999	Report	Cameron	
CAM-DOI 000011358-CAM-DOI 000011364	Factory Acceptance Test procedure for 40 Gallon Accumulator Bottle Rack	01/20/2000	Report	Cameron	
CAM-DOI 000010185-CAM-DOI 000010215	Factory Acceptance Test Procedure for Hydraulic Power Unit and Control Panel	02/14/2000	Report	Cameron	
CAM-DOI 000013899-CAM-DOI 000013904	Procedure for Nitrogen Purged Subsea Equipment	04/04/2000	Report	Cameron	
CAM-DOI 000009364-CAM-DOI 000009415	Factory Acceptance Test Blue Pod (DWH)	04/26/2000	Report	Cameron	
CAM-DOI 000009355-CAM-DOI 000009587	Factory Acceptance Test Yellow Pod (DWH)	04/26/2000	Report	Cameron	
CAM-DOI 000000210-CAM-DOI 000000211	Long Term Storage of D & DL Annular BOPs	06/06/2000	Report	Cameron	
CAM-DOI 000009711-CAM-DOI 000009763	Factory Acceptance Test Procedure (Spare Pod)	06/27/2000	Report	Cameron	
CAM-DOI 000013687-CAM-DOI 000013739	Factory Acceptance Test Procedure	06/27/2000	Report	Cameron	
CAM-DOI 000009990-CAM-DOI 000009992	Subsea BOP Control Pods Survey Report	09/22/2000	Report	Cameron	
CAM-DOI 000000212-CAM-DOI 000000214	Existing Diverter Packer Circuits	09/29/2000	Report	Cameron	
CAM-DOI 000000247	BOP Super Shear Ram Bonnets	09/04/2001	Report	Cameron	

CAM-DOI 000000248	BOP Super Shear Ram Retainer Pin	09/04/2001	Report	Cameron	
CAM-DOI 000000150	Continuous Latch Pressure Control For Collet Collectors	07/11/2002	Report	Cameron	
CAM-DOI 000000215-CAM-DOI 000000246	BOP Control System Recommendation for Efficient Operation of Cameron BOPs with ST or Ramlock Operating Systems	01/23/2003	Report	Cameron	
CAM-DOI 000000251-CAM-DOI 000000252	AMF-Deadman Battery Replacement	09/08/2004	Report	Cameron	
CAM-DOI 000000092-CAM-DOI 000000098	Stripping Recommendations Cameron D Annular BOP	06/02/2006	Report	Cameron	
CAM-DOI 000015076-CAM-DOI 000015077	API 16A Shear test Procedure	10/08/2007	Report	Cameron	
CAM-DOI 000000157-CAM-DOI 000000166	Shearing Capabilities of Cameron Shear Rams	01/21/2008	Report	Cameron	
CAM-DOI 000014514-CAM-DOI 000014526	Mux Control Pod Hyperbaric Functional Test	04/24/2008	Report	Cameron	
CAM-DOI 000014499-CAM-DOI 000014511	Mux Control Pod Hyperbaric Functional Test (Yellow Pod)	04/24/2008	Report	Cameron	
CAM-DOI 000013907-CAM-DOI 000013914	Seal test Procedure	10/15/2008	Report	Cameron	
CAM-DOI 000014529-CAM-DOI 000014540	Mux Control Pod Hyperbaric Functional Test (Blue Pod)	02/19/2009	Report	Cameron	
CAM-DOI 000014546-CAM-DOI 000014558	Mux Control Pod Hyperbaric Functional Test (Yellow Pod)	02/19/2009	Report	Cameron	
CAM-DOI 000000200-CAM-DOI 000000207	Variable Bore Ram and Flexpacker- Sealing and Hangoff	07/30/2009	Report	Cameron	
CAM-DOI 000015221-CAM-DOI 000015227	18.75 15K TL Seadrill Shear Test	08/06/2009	Report	Cameron	
CAM-DOI 000015289-CAM-DOI 000015292	Shear Test (E.R. No 3785)	12/16/2009	Report	Cameron	

CAM-DOI 000000264-CAM-DOI 000000265	Cameron Ram BOP Cavity - In Service Acceptance Criteria	12/28/2009	Report	Cameron	
Various	Field Service Reports on DWH 1/25/2001 - 2/13/2001, 3/2/2001-3/11/2001, 7/26/2001, 11/08/2003, 12/22/2004 - 1/5/2004 (1 Doc), 5/4/2007-5/7/2007 (1 doc), 4/20/2008 - 4/27/2008	Various	Report	Cameron	
CAM-DOI 000009994 - CAM- DOI000010028	Purchase Order BOP System and Accumulator	08/04/1999	Purchase Order	Cameron	TO
CAM-DOI 000014316 - CAM-DOI 000014348	Purchase Order BOP Stack, Test System 18.75	09/20/1999	Purchase Order	Cameron	TO
CAM-DOI 000010181	Engineeering Bill of Material	07/22/2000	Purchase Order	Cameron	TO
CAM-DOI 000007487 - CAM-DOI 000007489	Purchase Order GMNOCCLK 0	08/11/2008	Purchase Order	Cameron	TO
CAM-DOI 000007503 - CAM-DOI 000007505	Purchase Order GMNO23	03/02/2009	Purchase Order	Cameron	TO
CAM-DOI 000007515 - CAM-DOI 000007517	Purchase Order GMNOSAS	09/14/2009	Purchase Order	Cameron	TO
TRN-HCEC-00063738 - TRNHCEC- 00063777	West Report on Subsea Equipment Condition Prepared by Gary Eastveld	11/30/2005	Report	West Engineeri ng Services	TO
CAM-DOI 000008050	Certificate No: HOE-2155/2001 18 3/4" 15M 'TL' BOP Stack Guidelineless System	01/09/2001	Certificatio n	ABS	Cameron
TRN-HCJ-00058438	Certificate NO: 00MS14039-Den-X Sub Assembly Bonnet Left Hand With ST Lock and Sequencing Valve for 18 3/4" 15M "TL" BOP	01/21/2000	Certificatio n	ABS	

CAM-DOI 000001812	Certificate No: 00MS14042-Den-X BOP Cameron Type "DL" Annular 18 3/4" 10K, With 18 3/4" 10K 18 Flanged Bottom, 18 3/4" 10K CX-18 Studded Top, with anti rotation key, with one 3 1/16" 15K AX Clamp Hub Outlet	01/22/2000	Certification	ABS	
CAM-DOI 000001845	Certificate No: 00MS14125-Den-X BOP Cameron Type "DL" Annular 18 3/4" 10K, With 18 3/4" 10K CX-18 Flanged Bottom, 18 3/4" 10K CX-18 Studded Top, with anti rotation key, with one 3 1/16" 15K AX Clamp Hub Outlet	01/27/2000	Certification	ABS	
CAM-DOI 000001615	Certificate No: 00MS14130-Den-X Two(2) Sub Assembly Bonnet Right Hand With ST Lock and Sequencing Valve For 18 3/4" 15 M "TL" BOP	01/28/2000	Certification	ABS	
CAM-DOI 000008051	ABS Independent Review Certificate Attachment for #HOE -2155/2001	02/12/2001	Certification	ABS/Cameron	
CAM-DOI 000008049	Certificate No: 01BT8636-HSE 18 3/4" 15M "TL" Guidelineless System	03/21/2001	Certification	ABS	
TRN-HCEC-00058839	Certificate NO: HOE-1979/2000 Type BVR Inside BOP Valve w/ HT 55-375 (7 1/4" OD & NC 50 (6 1/2" OD) Connections	05/03/2000	Certification	ABS	
TRN-HCEC-00058840	Certificate NO: HOE-1979/2000 Type BVR Inside BOP Valve w/ HT 55-375 (7 1/4" OD & NC 50 (6 1/2" OD) Connections (Independent Review	05/03/2000	Certification	ABS	

TRN-HCEC-00058833	Certificate NO: 00MS14305-A-Den-X SMFI inside bop Valve W/HT 55-375 (7 1/4" OD) & NC 50 (6 1/2" OD connections)	06/06/2000	Certification	ABS	
CAM-DOI 000001232	Independent Review Certificate NO: 97LD373	07/14/1997	Certification	ABS	
CAM-DOI 000001233	Independent Review Certificate NO: 97LD373 (Page 2)	07/14/1997	Certification	ABS	
CAM-DOI 000001215	Certificate No. 98 MS 11 923-Den-X Seven Ram Sub Assy 18 3/4" 10-15M BOP Type 'T' 5" OD Pipe	09/25/1998	Certification	ABS	
CAM-DOI 000000468	Independent Review Certificate No: HOE-2100/2000 Super Shear Ram Body, Upper & Lower 18 3/4" 15 M "T" & "TL" BOP	10/04/2000	Certification	ABS	
CAM-DOI 000000469	Independent Review Certificate No: HOE-2100/2000 Super Shear Ram Body, Upper & Lower 18 3/4" 15 M "T" & "TL" BOP	10/04/2000	Certification	ABS	
CAM-DOI 000000693	Certificate NO: HOE 2094/2000 18 3/4" 15 M "TL" Ram BOP with St-Locks & Seq. Valves, Flanged Top x Studded Bottom, CX-18 Groove Prep. With Two 3 1/16" 15M 625 AX Hub Outlets	10/04/2000	Certification	ABS	
CAM-DOI 000001219	Certificate NO: HOE 2097/2000 Ram Sub-Assembly, Hang-Off Ram 18 3/4" 15M "T" & "TL" BOP, 5" OD Pipe	10/04/2000	Certification	ABS	
CAM-DOI 000001220	Certificate NO: HOE 2097/2000 Ram Sub-Assembly, Hang-Off Ram 18 3/4" 15M "T" & "TL" BOP, 5" OD Pipe Attachment	10/04/2000	Certification	ABS	

CAM-DOI 000001306	Independent Certificate HOE 2099/2000 Attachment	10/04/2000	Certification	ABS	
CAM-DOI 000001332	Independent Certificate HOE 2092/2000 Attachment	10/04/2000	Certification	ABS	
CAM-DOI 000001951	Independent Certificate HOE 2093/2000 Attachment	10/04/2000	Certification	ABS	
CAM-DOI 000001242	Certificate NO: HOE 2098/2000 Ram Sub-Assembly, Hang-Off Ram 18 3/4" 15M "T" & "TL" BOP, 5 1/2" OD Pipe Attachment	10/04/2000	Certification	ABS	
TRN-HCJ-00058437	Independent Certificate No 99LD1018 Cameron Bonnet Sub Assembly Left Hand With St-Lock W/Sequ. Valve 18 3/4" 15K 'TL' BOP	11/29/1999	Certification	ABS	
CAM-DOI 000002269	Independent Certificate No 99LD1019 Cameron Bonnet Sub Assembly Right Hand With St-Lock W/Sequ. Valve 18 3/4" 15K 'TL' BOP	11/30/1999	Certification	ABS	
CAM-DOI 000001814	Independent Review Certificate NO 99LD1016 BOP 'DL' 18 3/4" 10M With 18 3/4" 10M Flange Bottom X 18 3/4" 10M Studded Top	12/1/1999	Certification	ABS	
CAM-DOI 000001815	Independent Review Certificate NO 99LD1016 BOP 'DL' 18 3/4" 10M With 18 3/4" 10M Flange Bottom X 18 3/4" 10M Studded Top	12/1/2000	Certification	ABS	

CAM-DOI 000000467	Certificate No 00BT7764-B4-HSE Super Shear Ram Body Upper & Lower 18-3/4" 15 M "T" and "TL" BOP	12/13/2000	Certification	ABS	
CAM-DOI 000001241	Certificate NO: 00BT7764-B1-HSE Ram Sub-Assembly, Hang-Off Ram 18-3/4" 15M "T" & "TL" BOP, 5-1/2" OD Pipe	12/13/2000	Certification	ABS	
TRN-HCEC-00055905	Certificate NO: 00BT7764-A3-HSE 18-3/4" 15M Double "TL" Ram BOP with 18-3/4" 15M CX-18 Flanged Top x Studded Bottom with High Bending Moment Inserts & High Strength Studs & Nuts with (4) 3 1/16" 15M 625 AX Hub Outlets with Dual SAE/NPT Open & Close Ports with Spacer to Provide 32.16" Clearance Between Ram Cavities & Upper Cavity with ST-Locs with Manual Feature & Lower Cavity with Externally Ported Super Shears All CX and AX Ring Grooves inlaid with Nickle Based Alloy 625	12/13/2000	Certification	ABS	
TRN-HCEC-00058246	Certificate NO: 00BT7764-A1-HSE 18-3/4" 15M Single "TL" Ram BOP with St-Locs and Sequence Valves, Flanged Top X Studded Bottom, CX-18 Groove Prep. With Two 3-1/16" 15M 625 AX Hub Outlets	12/13/2000	Certification	ABS	
CAM-DOI 000001280	Certificate NO: 00BT7764-B2-HSE Ram Sub-Assembly, Upper SBR 18-3/4" 15M "T" & "TL" BOP	12/13/2000	Certification	ABS	

TRN-HCEC-00057861	Certificate NO: 00BT7764-A2-HSE 18-3/4" 15M Double "TL" RAM BOP with ST-Locks and Sequence Valves, Flanged Top X Studded Bottom, CX-18 Groove Prep with Four 3-1/16" 15M 625 AX Hub Outlets with 32.16" Between Rams	12/13/2000	Certification	ABS	
N/A	Blow Out Preventer Hot Stab Assembly Certificate	03/21/2010	Certification	ABS	Hydril USA
N/A	Blow Out Prevention System BOP Assy. Certificate	09/08/2009	Certification	ABS	Hydril USA
N/A	Blow Out Preventor 18-15 LW Dual Ram BOP Assy. Certificate	09/08/2009	Certification	ABS	Hydril USA
N/A	Blowout Preventor BOP Assy	09/08/2009	Certification	ABS	Hydril USA
N/A	Blow Out Preventor 1 Certificate	09/09/2001	Certification	ABS	Hydril USA
ABSDWH002413 - ABSDWH002418	Miscellaneous Survey Report BOP Crane Deepwater Horizon	03/09/2001	Certification	ABS	
N/A	Cameron Information Sheet 18-3/4" Annular Stripper Packer for the Cameron 18-3/4"-10,000 psi Annular BOP		Information Sheet	Cameron	
N/A	Certification for 18-15M 22" MPL Bonnet Assembly 4K 4500 PSI Ext Pressure	03/06/2007	Certification	ABS	Hydril USA
N/A	Certificate of Conformance 18-10M GX Annular BOP Assembly, 3-15M Outlet, 10K Top Sud, X 15K Bottom Flange	12/08/2003	Certification	ABS	Hydril USA

N/A	Databook Body DRBOP TransOcean Discoverer Enterprise		Report	Hydril USA	TO
CAM-DOI 000001229	Design Verification Report Independent Review Certificate	08/09/2000	Certification	Det Norske Veritas	Cameron
CAM-DOI 000001274	Design Verification Report Independent Review Certificate	02/18/2000	Certification	Det Norske Veritas	Cameron
CAM-DOI 000001296	Design Verification Report Independent Review Certificate		Certification	Det Norske Veritas	Cameron
TRN-HCEC-00056281 - TRN-HCEC 0056282	Email from Whitby to Llorca Requesting an Independent Review Certificate for an assembly BOP with super shear bonners 28"	01/19/2000	E-Mail	Whitby	Llorca
N/A	Assess The Acceptability and Safety of Using Equipment Particularly BOP and Wellhead Components, at Pressures in Excess of Rated Working Pressure	10/10/2006	Report	West Engineering Services	Ms. Buffington
N/A	Guide for the Certification of Drilling Systems	07/00/2009	Certification	ABS	
TRN-HCEC-00063858	Inspection Reports and Testing of BOP	11/3/2005	Report		TO
ABSDWH001898 - ABSDWH001918	Survey Of One Pod Lifting Ling Weldment	01/18/2001	Report	ABS	
ABSDWH002419 - ABSDWH002422	Survey of BOP Trolley	03/09/2001	Report	ABS	
ABSDWH002397 - ABSDWH002400	Survey of BOP Bulkhead Guide	03/09/2001	Report	ABS	
ABSDWH001657 - ABSDWH001670	Survey of 18-3/4" 10M BOP, Double Ram, Cameron Type "U"	03/22/2000	Report	ABS	

ABSDWH001812 - ABSDWH001820	Survey of BOP Assembly 18-15M, DBL, NXT, For Lower BOP Stack, Volume 7	06/30/2000	Report	ABS	
ABSDWH001821 - ABSDWH001829	Survey of BOP Assembly 18-15M, Triple, NXT, For Lower BOP Stack, Volume 8	06/30/2000	Report	ABS	
ABSDWH001869 - ABSDWH001890	Survey of Two BOP Lifting Lings	08/15/2000	Report	ABS	
CAM-DOI 000001270	Report on Drilling Systems and Offshore Equipment Body Ram, VBR 18-3/4" 15 M T AND TL BOP 6-5/8" To 3-1/2" OD PIPE	11/10/1999	Report	ABS	Cameron
ABSDWH002405 - ABSDWH002405	Survey BOP Storage Frame	11/22/2000	Report	ABS	
TRN-HCJ-00025298	Change Proposal for 18-3/4" Annular Stripper Packer so that 6-5/8" drill pipe can be stripped with Annular Closed. Changes Pressure Limits from 10000psl to 5000 PSI for the lower annular	03/09/2006	Purchase Order	TO	
CAM-DOI 000012937	Liquid Penetrant Inspection PT on 18 3/4 15M Model DWHC	08/11/2009	Report	Owensby & Kritikos	Cameron
CAM-DOI 000012948	Open Body Test Report On 18 3/4" 15K D.W.H.C. body center section	09/16/2009	Report		
CAM-DOI 000012938	Operation Control Ticket	09/17/2009	Report		
CAM-DOI 000012944	Operation Control Ticket	09/17/2009			
CAM-DOI 000012940 - CAM-DOI 000012943	Operation Control Ticket Inspect DWH 18-3/4-15M Model 'DWHC'	09/24/2009	Report		

CAM-DOI 000012945	Operation Control Ticket Inspect DWH 18-3/4-15M Model 'DWHC'	09/24/2009	Report		
CAM-DOI 000012946	Operation Control Ticket Inspect DWH 18-3/4-15M Model 'DWHC'	09/24/2009	Report		
CAM-DOI 000012947	Operation Control Ticket Inspect DWH 18-3/4-15M Model 'DWHC'	09/24/2009	Report		
CAM-DOI 000002804	Test Record 3 1/16" Act. Assembly	02/09/2000	Report		
CAM-DOI 000002988	Test Record MCS Choke & Kill	02/22/2000	Report		
CAM-DOI 000003225	Test Record MCS Choke & Kill Bottom Master Hydro	02/24/2000	Report		
CAM-DOI 000003221	Test Record MCS Choke & Kill Top Master Hydro	02/24/2000	Report		
CAM-DOI 000003794 - CAM-DOI 000003796	Test Record Actuator Assy	03/09/2000	Report		
CAM-DOI 000003717	Test Record Choke & Kill Bottom Master Lower Valve	03/13/2000	Report		
CAM-DOI 000003731	Test Record Choke & Kill Valve Lower Master	03/14/2000	Report		
CAM-DOI 000003730	Test Record Choke & Kill Valve Upper Master	03/14/2000	Report		
CAM-DOI 000004552	Rotary Product Test Record	11/08/1999	Report		
CAM-DOI 000005824	BOP Stack Schematic		Schematic	Cameron	
CAM-DOI 000005905	ST-Lock Schematic		Schematic	Cameron	
CAM-DOI 000013898	Email RE: Analog Value Variance Approval	06/30/2009	E_Mail	Burkett	Davis, Chirayil

00016597 MMS-NOLA-B2-0058 (186 Pages)	Development Driller III Emergency Disconnect System (EDS) Test Procedure		Manual		
CAM-DOI 000000259 - CAM-DOI 000000264	Cameron Bulleton 902D Well Control Equipment Periodic Inspection/Recertification	2/25/2009	Report	Cameron	
BP-HZN-BLY00265786	Schematic of BOP Version 15 (Created 4/22/2010)	4/22/2010	Schematic		
TRN-HCEC-00077322 - TRN-HCEC-00077326	Schematic of DWH BOP with Test Ram (See Page 5)	1/17/2006	Schematic		
BP-HZN-BLY00251007 - BP-HZN-BLY00251012	Proposal to convert lower most ram cavity on the Deepwater Horizon to an inverted Test Ram	11/21/2004	Proposal	TO	BP
TRN-HCEC-00077510 - TRN-HCEC-00077511	Email	01/10/2005	E-Mail	BP DWH Foreman	DWH Driller, OIM, Safety, Subsea, Toolpusher
OI835500027- OI83550053	Email	08/27/2004	E-Mail	Young, Chris	jacksonw at bp.com Jerry (Randy) Rhodes)
BP-HZN-BLY00166219- BP-HZN-BLY00166225	MMS Application for Revise New Well	11/10/2004	Application	Approved by McCarroll, John	
BP-HZN-BLY00145663 - BP-HZN-BLY00145666	Technical Note file of Risks and Benefits of conversion of VBR to Test Ram	08/04/2004	Memorandum	Ward, Marty	
BP-HZN-BLY00166232- BP-HZN-BLY00166233	TO Letter Agreement for Conversion of VBR to Test Ram	11/11/2004	Letter	Young, Chris	Rhodes, Randy
N/A*	BOP Interventions and Modifications Mark-Ups		Schematic	Det Norske Veritas	

BP-HZN-BLY00266110	Cameron Elastomer Temperature Ratings	11/11/2002	Table	Variable Bore Rams Inc.	
N/A	Hydril Elastomer Temperature Ratings	11/11/2002	Table	Variable Bore Rams Inc.	
00016597 MMS-NOLA-B2-00004-0058	DDIII Emergency Disconnect System Test Procedure and DDIII parts certificates		Certification/Testing Procedure		
BP-HZN-2179MDL00664295	Statement of Requirements for Capping Stack	06/30/2010	Report		
BP-HZN-2179MDL00667373 - BP-HZN-2179MDL00667419	Permanent Abandonment Basis of Design for Macondo Well	08/20/2010	Report	Bruce Rogers/Patt O'Bryan	
BP-HZN-2179MDL00457300 - BP-HZN-2179MDL00457528	Application for Permit to Drill - (For Drilling Macondo Relief Well)	04/28/2010	Application		
BP-HZN-2179MDL00900407 - BP-HZN-2179MDL00900491	IADC Equipment Listing for DDIII (See Page 38)		Report		
BP-HZN-2179MDL00551889 - BP-HZN-2179MDL00552011	MC252 #3 Relief Well Early Intercept Recovery Plan (Draft D)	06/10/2010	Report	Kurt Mix/Patt O'Bryan	
BP-HZN-2179MDL00836670 - BP-HZN-2179MDL00836673	Email about BOP Certifications for DDII and DDIII	08/06/2010	Email	Robert O Sanders	Harder, Sims, Frazelle, Chester, Taylor, Kidd, DD3 Wellsite Leader

BP-HZN-2179MDL00667870 - BP-HZN-2179MDL00667878	Operational Note 1 Capping Stack Plugging Procedures For Macondo Relief Well	07/27/2010	Report	Pusch and Hoskins	
BP-HZN-2179MDL00667806 - BP-HZN-2179MDL00667809	Operational Note 2 with Capping Stack Schematic	07/30/2010	Report	Hupp	Signed off by Braun, Domang???, Bryan, Odom. Bromer
BP-HZN-MBI00171284 - BP-HZN-MBI00171358	Development Driller III Integrated Acceptance Test Interim Report September 2009	09/15/2009	Report	Davies, Wong	
BP-HZN-2179MDL00572477 - BP-HZN-2179MDL00572579	DDII Macondo Relief Halliburton Sperry Drilling Services Report		Report	Halliburton	BP
BP-HZN-CEC031349 - BP-HZN-CEC031980	Vastar Resources Inc. Deepwater Horizon Rig Files 6.0 BOP Equipment, Volume 1		Report		
BP-HZN-MBI00134537 - BP-HZN-MBI00134834	Vastar Resources Inc. Deepwater Horizon Rig Files 6.0 BOP Equipment, Volume 2		Report		
BP-HZN-CEC031982 - BP-HZN-CEC032150	Vastar Resources Inc. Deepwater Horizon Rig Files 6.0 BOP Equipment, Volume 3		Report		
	Deposition Transcript - William Stringfellow		Transcript & Exhibits (Except 1191)		
	Deposition Transcript - Miles Ezell		Transcript		
	Deposition Transcript - Christopher Pleasant		Transcript		
	Deposition Transcript - Ronald Sepulvado		Transcript and Attached Exhibits		

	Deposition Transcript - Murry Sepulvado		Transcript		
	Deposition Transcript - Micah Burgess		Transcript		
	Deposition Transcript - Carter Erwin (Vol. 1)	6/6/2011 - 6/7/11	Transcript & Exhibits (Except 1488)		
TRN-USCG_MMS-00038807	Transocean Logs of Response (pdf and excel)		Log		
BP-HZN-MBI00133120	BOP Updates timeline (pdf and excel)		Log		
TRN-MDL-00303029	Email re: Issue on the Horizon with pie connectors	02/01/2010	Email	Fry, Michael	Guidry, Boughton, DWH, SubSeaSup, Chapman, Deems
TRN-MDL-00302302	DAR Consolidation report		Report		
CAM_CIV_0029724 - CAM_CIV_0029744	Cameron Daily Report Sheet	05/05/2010	Report	LeNormand, William	
	Basic Operations Manual Book				
	Deposition Transcript & Exhibits - David McWhorter	7/7/2011 - 7/8/2011	Transcripts & Exhibits		
	Deposition transcript of William LeNormand with Exhibits	6/20/2011 & 6/21/2011	Transcript & Exhibits		
TRN-HCEC-00064683	Deepwater Horizon BOP Subsea Test (exhibit 700)	02/10/10	Exhibit		
CAM_CIV_0022982	Illustration from DARFT explaining battery label	9/23/2004	Schematic		
DNV-SUPPL-000327 - 000332	Component Identification Matrix - Mark II Yellow Pod		Log		

	Deposition Transcript and Exhibits - Melvyn Whitby, Jim Owen McWhorter, & Geoff Boughton	7/18 - 7/19/2011; 7/20/2011 - 7/21/2011	Transcript & Exhibits		
BP-HZN-MB100021016	Map & NOAA Buoy #42040 data		Map; table		
	Digital Forensic Findings DVDs: Oceanneering BOA Sub-C Mill36 Video (and dive log) Oceanneering BOA Sub-C Mill37 Video (and dive log) C-Innovation Cexpress UHD05 Video Part I C-Innovation Cexpress UHD05 Video Part II	4/22/11			
	Deposition Transcript and Exhibits - DNV 30(b)(6)		Except 3133, 3143, 3146, 3152-60		
	Deposition Transcript and Exhibit 4276-Bill Ambrose				
	Exhibit 7001: Cameron Engineering Bulletin (EB852D) (17 pages)	10/30/1998	Report	B.C. Williams/Melvin Whitby	
BP-HZN-2179MDL03106208 - BP-HZN-2179MDL03106207	Exhibit 4423: Email from Byrd to Jackson & Weisinger Re: PREP Exercise	11/14/2001	Email	Michael Byrd	Curtis Jackson, Don Weisinger

BP-HZN-BLY00124705-BP-HZN-BLY00124707 TRN-INV-00034227-TRN-INV-00034306 TRN-INV-00034309-TRN-INV-00034380 TRN-INV-00077110-TRN-INV-00078633 TRN-MDL-00013581-TRN-MDL-00014228 TRN-MDL-00078165-TRN-MDL-00078221 TRN-MDL-00081088-TRN-MDL-00081145	RMS Entries				
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RMS Entries					
TRN-MDL-00081898-TRN-MDL-00081954					
TRN-MDL-00081988-TRN-MDL-00082504					
TRN-MDL-00082673-TRN-MDL-00084534					
TRN-MDL-00084535-TRN-MDL-00085406					
TRN-MDL-00085407-TRN-MDL-00085750					
TRN-MDL-00085751-TRN-MDL-00087272					
TRN-MDL-00087273-TRN-MDL-00088061					
TRN-MDL-00092653-TRN-MDL-00093118					
TRN-MDL-00588053-TRN-MDL-00588055					
TRN-MDL-01076105-TRN-MDL-01076106					
TRN-MDL-01076109-TRN-MDL-01076110					
TRN-MDL-01101682-TRN-MDL-01102135					

TRN-MDL-00272337-TRN-MDL-00272454	Various				
TRN-MDL-00310821-TRN-MDL-00310821					
TRN-MDL-00364257-TRN-MDL-00364422					
TRN-MDL-00496198-TRN-MDL-00496367					
TRN-MDL-00968117-TRN-MDL-00968117					
TRN-MDL-00979589-TRN-MDL-00979589					
TRN-MDL-01022863-TRN-MDL-01022865					
TRN-MDL-01060089-TRN-MDL-01060090					
TRN-INV-00209202-TRN-INV-00209204					
TRN-INV-00211175-TRN-INV-00211175					

TRN-MDL-00302875-TRN-MDL-00302877	Various D&D documents				
TRN-MDL-00303095-TRN-MDL-00303096					
TRN-MDL-00304316-TRN-MDL-00304317					
TRN-MDL-00304318-TRN-MDL-00304319					
TRN-MDL-00304320-TRN-MDL-00304321					
TRN-MDL-01022722-TRN-MDL-01022723					
TRN-INV-00443796-TRN-INV-00443799					
TRN-INV-00446729-TRN-INV-00446730					

DHCIT_AS-1306230-DHCIT_AS-1306254	Test Data from Q4000				
DHCIT_AS-4404644-DHCIT_AS-4404644					
DHCIT_AS-4404645-DHCIT_AS-4404648					
DHCIT_AS-4404678-DHCIT_AS-4404678					
DHCIT_AS-4404679-DHCIT_AS-4404698					
DHCIT_AS-4404733-DHCIT_AS-4404735					
DHCIT_AS-4404773-DHCIT_AS-4404773					
DHCIT_AS-4404774-DHCIT_AS-4404777					
DHCIT_AS-4404787-DHCIT_AS-4404787					
DHCIT_AS-4404788-DHCIT_AS-4404791					
DHCIT_AS-4405087-DHCIT_AS-4405090					
DHCIT_AS-4405091-DHCIT_AS-4405091					
DHCIT_AS-4405317-DHCIT_AS-4405321					
DHCIT_AS-4405441-DHCIT_AS-4405443					

DHCIT_AS-4405444-DHCIT_AS-4405446	Test Data from Q4000				
DHCIT_AS-4405574-DHCIT_AS-4405574					
DHCIT_AS-4405575-DHCIT_AS-4405575					
DHCIT_AS-4405635-DHCIT_AS-4405635					
DHCIT_AS-4405636-DHCIT_AS-4405649					
DHCIT_AS-4405772-DHCIT_AS-4405773					
DHCIT_AS-4405774-DHCIT_AS-4405792					
DHCIT_AS-4405826-DHCIT_AS-4405826					

DHCIT_AS-4405828-DHCIT_AS-4405828	Test Data from Q4000				
DHCIT_AS-4405829-DHCIT_AS-4405842					
DHCIT_AS-4405970-DHCIT_AS-4405970					
DHCIT_AS-4405971-DHCIT_AS-4405977					
DHCIT_AS-4406026-DHCIT_AS-4406027					
DHCIT_AS-4406193-DHCIT_AS-4406205					
DHCIT_AS-4406224-DHCIT_AS-4406227					
DHCIT_AS-4406260-DHCIT_AS-4406279					
DHCIT_AS-4406280-DHCIT_AS-4406294					
DHCIT_AS-4406424-DHCIT_AS-4406460					
DHCIT_AS-4406490-DHCIT_AS-4406490					
DHCIT_AS-4406491-DHCIT_AS-4406525					
TRN-INV-01838626 - TRN-INV-01838634	Email from Redd, Eddy to Hebert, Carl and Farr, Dan Re: FW: Yellow POD1	07/27/2010	Email & attachment	Redd, Eddy	Herbert, Carl; Farr, Dan
TRN-INV-01838619 - TRN-INV-01838625	Email from Redd, Eddy to Hebert, Carl and Farr, Dan Re: FW: Yellow Pod 2	07/27/2010	Email & attachment	Redd, Eddy	Herbert, Carl; Farr, Dan
TRN-INV-01838479 -TRN-INV-01838546	Transocean Manual: Deepwater Horizon Bridge Procedures Guide	(no date)	Guidebook	Captain	Bridge Team

TRN-INV-00031263 - TRN-INV-00031265	Flow Diagram, Mark 2 Contol Pod	10/29/04	diagram		
TRN-MDL-00059516 - TRN-MDL-00059517	Subsea Electronic Module, Mark II Contol Pod	1/23/02 & 11/3/02	diagram		
	Cameron Basic Operation Manual: RBS 8D - Multiplex BOP System (Vol 1)	6/00/2000	Manual	Cameron	
TRN-MDL-00369979 - TRN-MDL-00369996 TRN-MDL-00370002 - TRN-MDL-00370004 TRN-MDL-00369977 - TRN-MDL-00369975 TRN-INV-01875173 - TRN-INV-01163972 TRN-INV-01163890 - TRN-INV-01163893 TRN-INV-01838626 - TRN-INV-01838627 TRN-INV-01838619 - TRN-INV-01838621 TRN-INV-01838624 - TRN-INV-01838477 TRN-INV-01838479 - TRN-INV-01855045		12/10/1999 - 05/05/2011	Emails		

TRN-INV-01837672 - TRN-INV-01843229 TRN-INV-01843231 - TRN-INV-01837115 TRN-INV-01837116 - TRN-INV-01836495 TRN-INV-01836496 - TRN-INV-01163086 TRN-INV-01163087 - TRN-INV-01836266 TRN-INV-01836267 - TRN-INV-01835931 TRN-INV-01835821 - TRN-INV-01835822 TRN-INV-01293467 - TRN-INV-01835620 TRN-INV-01835595 - TRN-INV-01835596 TRN-INV-01835590 - TRN-INV-01262375 TRN-INV-01840865 - TRN-INV-01262147		12/10/1999 - 05/05/2011	Emails		
TRN-INV-01169380 - TRN-INV-01169382 TRN-INV-01840862 - TRN-INV-01802103 TRN-INV-01463154 - TRN-INV-01299389 TRN-INV-01834172 - TRN-INV-01175411 TRN-INV-01175408 TRN-INV-01175410 - TRN-INV-01840852 TRN-INV-01175403 - TRN-INV-01175404 TRN-INV-01175407 - TRN-INV-01802102 TRN-INV-01172009 - TRN-INV-01172011 TRN-INV-01297561 - TRN-INV-01297559		12/10/1999 - 05/05/2011	Emails		

TRN-INV-01850603 - TRN-INV-01850610 TRN-INV-01850613 - TRN-INV-01849344 TRN-INV-01849346 - TRN-INV-01304725 TRN-INV-01875166 - TRN-INV-01875170 TRN-INV-01875185		12/10/1999 - 05/05/2011	Emails		
TRN-INV-02675045 - TRN-INV-02675046 TRN-INV-02675041 - TRN-INV-02675042 TRN-INV-02675043 - TRN-INV-02675044 TRN-INV-02675052 - TRN-INV-02675056 TRN-INV-02675060 - TRN-INV-02675064 TRN-INV-02675067 - TRN-INV-00975890 TRN-INV-01026609 - TRN-INV-01028915 TRN-INV-01028932 - TRN-INV-01029278 TRN-INV-01030784 - TRN-INV-01175404 TRN-INV-01826764 - TRN-INV-01826776 TRN-INV-02500716 - TRN-INV-02500718		02/01/2009 - 03/23/2011	Various docs		
TRN-INV-02500728 - TRN-INV-02500748 TRN-INV-02501508 - TRN-INV-02505861 TRN-INV-02547435 - TRN-INV-02672587 TRN-INV-02672590 - TRN-INV-02673642 TRN-INV-02675045 - TRN-INV-02808310 TRN-INV-02808311 - TRN-INV-02808493 TRN-INV-02809336 - TRN-INV-02810023		02/01/2009 - 03/23/2011	Various docs		

	Exhibit 71: Report of Survey - Deepwater Horizon; Exhibit 80: Report of Survey - Semi-submersible Rig Deepwater Horizon; Exhibit 81: Report of Survey BHP Safety Critical Equipment - Semi-sub Deepwater Horizon; Exhibit 88: Rig Condition Assessment - Deepwater Horizon; Exhibit 673: Operations Policies and Procedures Manual; Exhibit 1158: Email from George Coltrin with attachments, Proposal BP DW RAS Cortez Bank; Exhibit 3171: Image of SAFT Lithium Mn02 Battery with serial number; Exhibit 3400: Deepwater Horizon Technical Rig Audit; Exhibit 3405: Deepwater Horizon Follow Up Rig Audit, Marine Assurance Audit and Out of Service Period; Exhibit 3419: Email from Buddy Trahan		Various docs	
	Exhibit 3420: Email from Buddy Trahan regarding Horizon BOP leak; Exhibit 3421: Email from DWH SubSeaSup regarding Batteries; Exhibit 3435: Transocean chart; Exhibit 3780: DAR Consolidation Report; Exhibit 3796: Email from DWH SubSeaSup regarding Solenoid Repair; Exhibit 3797: Email from Ronald Guidry regarding Issue on the Horizon with Pie Connectors; Exhibit 3798: Instructions for Rebuilding Cameron Controls Solenoid Valve Family 435		Various docs	

	Deposition of Mark David Hay regarding Oil Spill (1 of 2); Exhibit _ : Deposition of Mark David Hay regarding Oil Spill (2 of 2); Exhibit _ : Deposition of James Kent regarding Oil Spill (1 of 2); Exhibit _ : Deposition of James Kent regarding Oil Spill (2 of 2); Exhibit _ : Deposition of MODUSPEC through its rep Alan Schneider regarding Oil Spill					
CAMCG 00000236 - CAMCG 00000645	Cameron Basic Operation Manual: RBS 8D - Multiplex BOP System	6/00/2000	Manual			
	DNV Phase I data		Various docs			
	DNV Phase II data		Various docs			
	DNV Report for Boemre Volume I and References	3/23/11	Report			
	DNV Report for Boemre Volume II	3/23/11	Report			
	Addendum to DNV Report	5/2/11	Report			
	Revised Appendix F to DNV Final report		report			

	Report of Investigation into the Circumstances Surrounding the Explosion, Fire, Sinking and Loss of Eleven Crew Members Aboard the MOBILE OFFSHORE DRILLING UNIT DEEPWATER HORIZON In the GULF OF MEXICO, April 20-22, 2010", Volume I, United States Coast Guard, MISLE Activity Number 37215032		report		
	Oceannering BOA Sub-C Mill36 Video	4/22/10 1:00 am- 7:36 AM	Video		
	Oceannering BOA Sub-C Mill37 Video	4/22/10 1:00 am- 7:36 AM	Video		
	C-Innovation Cexpress UH05	4/22/10 1:00 am- 7:36 AM	Video		
	List of Depositions Taken as of 5/31/11		List		
	Station 42872 & 42894- Deepwater Horizon Current Data	4/20/2010 - 4/21/2010	Data		
	Weather Data from NOAA Buoy 42040	4/15/2010 - 5/1/2010	Data		
BP-HZN-MB100021016	Seafloor & Subsurface Features Chart Sheet 7 of 8	5/4/2010	Map; table		
	Transocean Deepwater Horizon Rig General Arrangements A-AA 1000-1011	12/7/01 / 7/10/02	Drawings	Dennis Waddell	

BP-HZN-2179MDL00644976 - BP-HZN-2179MDL00644995	NAX - DW Gulf of Mexico Deepwater Well Control Guidelines		Report	John Shaughnessy	
TRN-MDL-00618951-	Email FW: Deck Test Procedure	5/8/10	Email	Eddy Redd	Adrian Rose; Larry McMahan
TRN-MDL-00618974	Cameron Controls pg. 6 of 22 re Cameron Deck procedure, handwritten notes	5/4/10	Report		
TRN-MDL-00618975	Cameron Controls pg. 10 of 22 re Cameron Deck procedure, handwritten notes	5/4/10	Report		
TRN-MDL-00618952 - TRN-MDL-00618973	Cameron Controls Deck Test Procedure for Mark-II Control Pod Cameron P/N 2020708 -21 Deepwater Horizon with handwritten notes	5/4/10	Report		
TRN-MDL-00618976	Single Unit Test Certificate for PBOF Cable Part 2185879-22-05	5/7/10	Certificate	Efray Martinez / Tim Williams	
TRN-OIG-00556837 - TRN-OIG-00556870	Cameron Controls Deck Test Procedure for Mark-II Control Pod Cameron P/N 2020708 -21 Deepwater Horizon with handwritten notes	5/4/10	Report		
BP-HZN-BLY00296563 - BP-HZN-BLY00296584	Cameron Controls Deck Test Procedure for Mark-II Control Pod Cameron P/N 2020708 -21 Deepwater Horizon with handwritten notes	5/4/10	Report		

ANA-MDL-000002164 - ANA-MDL-000002185	Pencor On Site Sampling Summary for Macondo	4/14/10	report		
BP-HZN-2179MDL00062844 - BP-HZN-2179MDL00062893	Schlumberger Fluid Analysis of Macondo Samples, BP, Mississippi Canyon 252	5/19/2010	Report	S. George Mathews	K. McAughan; Y. Wang
BP-HZN-BLY00090633- BP-HZN-BLY00090646	Email String, FW: AMF test Procedure signed copy	5/13/10	email	Ray Fleming	D. Guillot; W. Judice; Ted P; MC252_email_Retention; McNeillie, Graham; K. Szafron; J. Wetherbee; N. Wong; M. Worsley
BP-HZN-CEC017697	GoM Exploration Wells, MC 252- Macondo Prospect Subsurface Information, Estimated Temperature Plot	9/09			
TRN-MDL-00427057- TRN-MDL-00427067	Transocean Subsea Maintenance Philosophy, Ref: HQS-OPS-EST-SMP-01	5/16/07	Manual	Subsea Group	Les Smiles, Milke Hall
CAM_CIV_00362862- CAM_CIV_0362865	Cooper Cmeron Corporation, Product Engineering Part/Document Audit Report Entry Number: 223290-63	10/13/04	report		
CAM_CIV_0362866- CAM_CIV_0362867	Cameron Assembly Drawing, Solenoid Valve 3/2 Way	6/27/03	Drawings		
CAM_CIV_0037650	Cameron Control, Assembly Drawing, Solenoid Valve 3/2 Way	3/8/99	Drawings		
CAMCG 00000331	Cameron Controls, Flow Diagram Mark 2 Control Pod, SK-1221-8-21-05	5/00	Drawings		

TRN-USCG_MMS-00042585 - TRN-USCG_MMS-00042590	Cameron Controls Stack Flow Diagram, SK-122124-21-05	9/04	Drawings		
TRN-MDL - 00059516 - TRN-MDL-00059517	Cameron Controls, Subsea Eleconronic Module, Mark II Control Pod, SK-122178-14	1/02			
CAM-DOJ-CIV-00031609 - CAM-DOJ-CIV-00031611	Instructions for Using Checkme		notepad		
CAM_CIV_0003275 - CAM_CIV_0003276	Exhibit 3605				
TRN-INV-02861650- TRN-INV-02861653	Exhibit 4794				
CAM_CIV_0018112 - CAM_CIV_0018140	Desk Test Procedure for Mark-II Control Pod	5/10/10			
BPD122-4684.exl	Horizon BOP Intervention, Diagnostic Pumping,	6/15/10			
BP-HZN-CEC 018930 - BP-HZN-CEC 018951	Deepwater Horizon Update	5/6/10			
CAM_CIV_0015830 - CAM_CIV_0015833	Cameron Engineering Report Abstract, Report No. 3661, Transocean Shear Test	11/24/08			
CAM_CIV_0031648 - CAM_CIV_0031663	Daily Report Sheet	5/5/10		W. LeNormand	
BP-HZN-2179MDL00377133 - BP-HZN-2179MDL00377149	West Engineering Services, BP Kasinda Well Test, Failure Modes and Criticality Analysis, BOP and Controls	2/29/08			
	Thermal Expansion Calculation			DNV	
	Flow and Force Calculation			DNV	
	Deepwater Horizon Accident Investigation Report	9/8/10		BP	

	Macondo Well Incident: Transocean Investigation Report			TO	
	Transcript of the Testimony of the Joint United States Coast Guard/Bureau of Ocean Energy Management Investigation	4/8/11, am session			
TRN-USCG_MMS-00013703	Flow Diagrams Shear Ram Kit		diagram		
TRN-USCG_MMS-00013704	Flow Diagrams Stack Flow Diagram		diagram		
TRN-USCG_MMS-00013705	Flow Diagrams Stack Flow Diagram		diagram		
TRN-USCG_MMS-00013706	Flow Diagrams Stack Flow Diagram		diagram		
TRN-USCG_MMS-00014355 - 00014358	Flow Diagrams Final Assembly		diagram		
CAM_CIV_0012567	Variable Bore Ram Assembly - Product Advisory #1005				
CAM_CIV_0003115 - CAM_CIV_0003122	Engineering Bulletin Errata Sheet		Bulletin		
CAMCG 00003216 - 00003217	Sequence Valve Onsite Inspection Procedure				
CAMCG 00000001- 00000235	DWH TL BOP Stack Operation and Maintenance Manual		Manual		
CAMCG 00000236- 00000645	Cameron Subpoena Files Multiplex BOP Control System - Vol. 1		Manual		
CAMCG 00000646- 00000919	Cameron Subpoena Files Multiplex BOP Control System - Vol. 2		Manual		
CAMCG 00000920- 00001123	Cameron Subpoena Files Multiplex BOP Control System - Vol. 3		Manual		

CAMCG 00001124- 00001427	Cameron Subpoena Files Multiplex BOP Control System - Vol. 4		Manual		
CAMCG 00001428- 00001620	Cameron Subpoena Files Multiplex BOP Control System - Vol. 5		Manual		
CAMCG 00001621- 00001761	Cameron Subpoena Files Multiplex BOP Control System - Vol. 6		Manual		
CAMCG 00001762- 000002174	Cameron Subpoena Files Multiplex BOP Control System - Vol. 7		Manual		
CAMCG 00002175- 000002842	Cameron Subpoena Files Multiplex BOP Control System - Vol. 8		Manual		
CAMCG 00002843- 00002989	Cameron Subpoena Files R&B Falcon Drilling Co PO BOP Stack Test System				
CAMCG 00003025- 00003070	Cameron Subpoena Files Assembly Drawing Driller Control Panel				
TRN-USCG_MMS-0039812-0039813	Amended Response to June 25, 2010				
N/A	API RP 53 Recommended Practices for BOP Equipment Systems for Drilling Wells, Third Edition, March 1997				
N/A	30 CFR 250, Subpart D				
	Secondary Control Info: Notice to Leasees & Operators-Accidental Disconnect of marine Drilling Risers				

	Secondary Control Info: Blowout Preventer Back-Up Control Systems					
	Secondary Control Info: MMS Safety Alert-Marine Riser Failure 20030407					
TRN-USCG_MMS 00013684	EDS Emergency Disconnect Activation General Considerations					
TRN-USCG_MMS 00013685	EDS Cementing					
TRN-USCG_MMS 00013687	EDS Emergency Disconnect Activation Tripping					
TRN-USCG_MMS 00013689	EDS Logging with Wireline					
TRN-USCG_MMS 00013690	EDS Procedure General					
TRN-USCG_MMS 00013695	EDS Sequences					
TRN-USCG_MMS 00013696	EDS Cementing (Setting Plugs)					
TRN-USCG_MMS 00013698	EDS Well Control					
TRN-USCG_MMS 00013700	EDS Well Testing					
TRN-USCG_MMS 00013701	EDS Activation Drilling					
TRN-HCEC-00031874 - 32092	Daily Operation Report 1					
TRN-HCEC-00034580- 34588 & TRN-USCG-MMS-00012251-00014354	RMS II Equipment list					

TRN-HCEC-00039351 - 00039408	Equipment History & RMS - RMS II					
TRN-HCEC-00036308 - 00036484	RMS II Equipment History					
TRN-USCG_MMS-00013703	Shear Ram Kit					
TRN-USCG_MMS-00013704 - 00013706	Stack Flow					
TRN-USCG_MMS-00014355 - 00014358	Final Assembly Schematic					
(Producing Party Bates Unavailable)	Horizon Inspection 1-30-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-29-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 4-22-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 5-16-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 6-4-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 6-5-2002			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-24-2003			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 4-21-2003			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 5-13-2003			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 6-16-2003			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 7-7-2003			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 7-19-2003			Form		

(Producing Party Bates Unavailable)	Horizon inspection 8-6-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 8-8-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 8-18-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 9-17-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 10-20-2003		Form		
(Producing Party Bates Unavailable)	Horizon Insepction 11-5-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 12-11-2003		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 1-20-2004		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 2-20-2004		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-17-2004		Form		
(Producing Party Bates Unavailable)	Horizon inspection 6-21-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 7-21-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 8-17-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 10-18-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 11-22-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 11-29-2005		Form		
(Producing Party Bates Unavailable)	Horizon Inspection 1-3-2006		Form		

(Producing Party Bates Unavailable)	Horizon Inspection 6-12-2006			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 7-18-2006			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-20-2007			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 4-6-2007			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 10-29-2007			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 11-9-2007			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 1-11-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 2-8-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-12-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 8-15-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 10-28-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 11-18-2008			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 9-28-2009			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 10-20-2009			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 11-12-2009			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 2-17-2010			Form		
(Producing Party Bates Unavailable)	Horizon Inspection 3-3-2010			Form		

(Producing Party Bates Unavailable)	Horizon Inspection 4-1-2010		Form		
BP-HZN-OIG00039358 - BP-HZN-OIG00039416	Deepwater Horizon Follow Up Rig Audit, Marine Assurance Audit and Out of Service Period September 2009		Report		
TRN-HCEC-00007783 - 00007820	DWH Acceptance of Well Control Equipment for TO Job #1668				
TRN-HCEC-00016648 - 00016794	RB Falcon Deepwater Horizon BOP Assurance Analysis				
TRN-HCEC-00063449 - 00063578	DWH Subsea Equipment Condition Audit for TO Job #001C				
TRN-USCG_MMS-00038609 - 00038695	Moduspec Rig Condition Assessment				
Cameron Deck Test Procedure for Mark-II Control Pod	Cameron Deck Test Procedure for Mark II Control Pod				
	BP Daily Operations Report for 2/24/2010		Report		
	BP Daily Operations Report for 3/13/2010		Report		
BP-HZN-MBI00020455	Piping & Instrument Diagram Choke and Kill System Rev. 3-2		Diagram		
BP-HZN-MBI00020456	Choke/Kill Manifold Diagram		Diagram		
BP-HZN-MBI00020457	Piping & Instrument Diagram Choke and Kill System Rev. 3-1		Diagram		
BP-HZN-MBI00137274 - 00137304	Responder Logbook (Thierens)				
BP-HZN-CEC 018939 - 018950	BP Update Schematics		Schematic		

BP-HZN-MBI00133120 - 00133126	BOP Updates Timeline					
BP-HZN-MBI00010455	Rig Worklist January (Excel Spreadsheet)			Spreadsheet		
BP-HZN-MBI00018251 - 00018268	Photos of BOP			Photos		
BP-HZN-MBI00021125 - 00021137	CR on DWH East Blind Shear Bonnet: Radiography-L 5/20/2010					
BP-HZN-MBI00021138 - 00021145	Tracerco Daignostics FMI Field Report for Choke and Kill Line Density Measurement 5/12/2010					
BP-HZN-MBI00021146 - 00021154	Tracerco Daignostics FMI Field Report for BOP Ram Closure 5/12/2011					
BP-HZN-MBI00021155 - 00021157	Tracerco Pipe on Pipe Tests					
BP-HZN-MBI00021158 - 00021160	Tracerco East-Side-Locking Cylinder Scans					
BP-HZN-MBI00021161 - 00021164	Tracerco West-Side-Locking Cylinder Scans 5/9/2010					
BP-HZN-MBI00021165 - 00021167	Tracerco West-Side-Locking Cylinder Scans 5/12/2010					
BP-HZN-MBI00021168 - 00021170	Tracerco Choke/Kill Line-Pipe Scan May 12, 2010					
BP-HZN-MBI00021171	Photo			Photo		

BP-HZN-MBI00021172	Photo Dive No 14		Photo		
BP-HZN-MBI00021175	Photo Dive No 17		Photo		
BP-HZN-MBI00021176	Photo Dive No 17		Photo		
BP-HZN-MBI00002676	Cameron BOP Stack Components				
BP-HZN-MBI00010426	Untitled Schematic		Schematic		
BP-HZN-MBI00010427	Stack Flow Diagram		Diagram		
BP-HZN-MBI00010428	Cameron TL, BOP Stack Control Equipment, Stack Mounted 18 3/4", 15,000 psi WP Schematic				
BP-HZN-MBI00010438	Cameron Schematic		Schematic		
BP-HZN-MBI00017194	Foundation of Hot Line Hose Reel (1/2) Schematic				
BP-HZN-MBI00017216 -00017217	Foundation of BOP Storage W/Test Stump (1/3)				
BP-HZN-MBI00017218 -00017219	Foundation of BOP Storage W/Test Stump (2/3)				
BP-HZN-MBI00017220 -00017221	Foundation of BOP Storage W/Test Stump (3/3)				
BP-HZN-MBI00017230 -00017231	Foundation of Remote Control Stand for Blue Reel and Yellow Reel				
BP-HZN-MBI00017274 – BP-HZN-MBI00017275	Arrangement of BOP Control Room				

BP-HZN-MBI00017278 – BP-HZN-MBI00017279	Foundation of BOP Control Main HPU					
BP-HZN-MBI00017284 – BP-HZN-MBI00017285	Foundation of BOP Accumulator Rack					
BP-HZN-MBI00017286 – BP-HZN-MBI00017287	Foundation of BOP Bottle Rack					
BP-HZN-MBI00017346 – BP-HZN-MBI00017347	Detail of Padeye For Maintenance (1/4) BOP Control Unit Room					
BP-HZN-MBI00017354 – BP-HZN-MBI00017355	Machinery Arrangement on MUX Reel Platform					
BP-HZN-MBI00017458 – BP-HZN-MBI00017459	Foundation of LMRP Storage W/Test Stump (1/2)					
BP-HZN-MBI00017460 – BP-HZN-MBI00017461	Foundation of LMRP Storage W/Test Stump (2/2)					
BP-HZN-MBI00017622 – BP-HZN-MBI00017623	Foundation of Hot Line & MUX Hose Turndown Sheaves (2/3)					
BP-HZN-MBI00017688 – BP-HZN-MBI00017689	Foundation of LMRP Bulkhead Guide (2/4)					
BP-HZN-MBI00018239 – BP-HZNMBI0001824	Cameron TL, BOP Stack Control Equipment, Stack Mounted, 18-3/4” 15,000 psi WP					
BP-HZN-MBI00018254 – BP-HZNMBI00018263	Cameron TL, BOP Stack Control Equipment, Stack Mounted, 18-3/4” 15,000 psi WP					

BP-HZN-MBI00010469 – BP-HZN-MBI00010554)	Evaluation of Secondary Intervention Methods in Well Control (by West Eng. For MMS: March 2003)					
BP-HZN-MBI00002458 – BP-HZN-MBI00002463	Subsea Pressure Test-Feb. 9-10, 2010					
BP-HZN-MBI00002454 – BP-HZN-MBI00002468	Choke Manifold Pressure Test-Feb. 9-10, 2010					
BP-HZN-MBI00002469 – BP-HZN-MBI00002473	Subsea Pressure Test-Feb. 24, 2010					
BP-HZN-MBI00002474 – BP-HZN-MBI00002478	Choke Manifold Pressure Test-Feb. 24, 2010					
BP-HZN-MBI00002479 – BP-HZN-MBI00002483	Subsea Pressure Test-March 15, 2010					
BP-HZN-MBI00002484 – BP-HZN-MBI00002488	Choke Manifold Pressure Test-March 15, 2010					
BP-HZN-MBI00002489 – BP-HZN-MBI00002493	Subsea Pressure Test-March 26, 2010					
BP-HZN-MBI00002494 – BP-HZN-MBI00002498	Choke Manifold Pressure Test, March 26, 2010					
BP-HZN-MBI00002499 – BP-HZN-MBI00002503	Subsea Pressure Test-April 9, 2010					
BP-HZN-MBI00002504 – BP-HZN-MBI00002508	Choke Manifold Pressure Test-April 9, 2010					

BP-HZN-MBI00010411	Cameron 18-3/4" 15M TL BOP Sheer Pressures (Xcel)				
BP-HZNMBI00010453	BP Xcel Workbook 1) From Cameron Rig Book; 2) Stump; 3) BOP Stack Test Space Out Measurements				
BP-HZN-MBI00021460 – BP-HZN-MBI00021999	Drilling Contract: RBS-8D Semisubmersible Drilling Unit Vastar Resources, Inc. and R&B Falcon Drilling Co. – December 9, 1998	Contract			
TRN-USCG_MMS-00038807 – TRN-USCG_MMS-00038854	Transocean's Logs of Response				
TRN-USCG_MMS-00039812 – TRN-USCG_MMS-00039813	ransocean's Amended Response to June 25, 2010 Subpoena				
TRN-HCEC-00064131 – TRNHCEC-00064132	Transocean's Letter Agreement for Conversation of VBR to a Test Ram-October 11, 2004	Letter			
BP-HZNMBI00179081 – BP-HZN-MBI00179360	Drilling Contract RBS-8D Semisubmersible Drilling Unit Vastar Resources, Inc. and R&B Falcon Drilling Co.				
BP-HZN-MBI00179361 – BP-HZN-MBI00179363	7-24-2001 Transocean letter re: Deepwater Horizon Contract Amendment – Additional Personnel	Letter			
BP-HZN-MBI00179364 – BP-HZNMBI000179366	11-5-2001 Transocean letter to BP re: Late Delivery Charge & Change Order Summary	Letter			

BP-HZN-MBI00179367 – BP-HZN-MBI00179375	12-12-2001 Transocean letter to BP re: Letter of Agreement for Cost Escalation and Naming Convention Adjustments	Letter		
BP-HZN-MBI00179376 – BP-HZN-MBI-00179378	1-16-2002 Transocean letter to BP re: Riser Removal, Transportation & Storage TSF-5121-2002-001	Letter		
BP-HZN-MBI00179379 – BP-HZN-MBI00179381	4-23-2002 Transocean letter to Vastar re: Additional Personnel for Mad Dog Project CONTRACTOR-5121-2002-005	Letter		
BP-HZN-MBI00179382 – BP-HZN-MBI00179384	6-3-2002 Transocean letter to BP re: Additional Personnel for Deepwater Horizon CONTRACTOR-5121-2002-006	Letter		
BP-HZN-MBI00179385 – BP-HZN-MBI00179387	8-26-2002 Transocean letter to BP re: Cost of re-drilling 60743#4 well as a result of recent “lost hole” incident	Letter		
BP-HZN-MBI00179388 – BP-HZN-MBI00179389	10-14-2002 Transocean letter to BP re: Contract No. 980249 re-assigned to BP, successor-in-interest to Vastar	Letter		
BP-HZN-MBI00179390 – BP-HZNMBI00179392	11-1-2002 Transocean letter to BP re: Letter of Agreement for 6 5/8” Drill pipe Rental	Letter		
BP-HZN-MBI00179393 – BPHZN-MBI00179395	1-6-2003 Transocean letter to BP re: Letter of Agreement for adding Offshore Safety Assistant	Letter		
BP-HZN-MBI00179396 – BP-HZNMBI00179399	1-7-2003 Transocean letter to BP re: Letter of Agreement for Recycling Program	Letter		

BP-HZN-MBI00179400 – BP-HZN-MBI00179401	1-9-2003 Transocean letter to BP re: Insurance Cost Adjustments		Letter		
BP-HZN-MBI00179402 – BP-HZN-MBI00179409	2-28-2003 Transocean letter to BP re: Letter of Agreement for Cost Escalation 2003		Letter		
BP-HZN-MBI00179410 – BP-HZN-MBI00179415	2-28-2003 Transocean letter to BP re: Letter of Agreement for Cost Escalation 2004		Letter		
BP-HZN-MBI00179416 – BP-HZN-MBI00179417	3-3-2003 Transocean letter to BP re: Letter of Agreement for Rental of 6 5/8" HWDP		Letter		
BP-HZN-MBI0017918 – BP-HZN-MBI00179419	3-20-2003 Transocean letter to BP re: actual cost & daily rental rate of 6 5/8" drill pipe		Letter		
BP-HZN-MBI00179420 – BP-HZN-MBI00179422	11-12-2003 Transocean letter to BP re: adding tool pusher in BP's office		Letter		
BP-HZN-MBI00179423 – BP-HZN-MBI00179430	4-19-2004 Transocean letter to BP re: Contract Extension Agreement		Letter		
BP-HZN-MBI00179431 – BP-HZN-MBI00179433	6-25-2004 Transocean letter to BP re: Cap Rock Communication Equipment		Letter		
BP-HZN-MBI00179434 – BP-HZN-MBI00179436	10-11-2004 Transocean letter to BP re: Conversion of VBR to a Test Run		Letter		
BP-HZN-MBI00179437 – BP-HZN-MBI00179439	1-7-2005 Transocean letter to BP re: Additional Personnel (Performance Engagement Coordinator)		Letter		
BP-HZN-MBI00179443 – BP-HZN-MBI00179445	2-20-2005 Transocean letter to BP re: Adding Deck Pushers		Letter		

BP-HZN-MBI00179443 – BP-HZN-MBI00179445	3-31-2005 Transocean letter to BP re: Cost Escalation 2005				
BP-HZN-MBI00179446 – BP-HZN-MBI00179455	Assignment Agreement between BP & BHP Billiton Petroleum (GOM)				
BP-HZN-MBI00179456 – BP-HZN-MBI00179458	Amendment No. 26 to Drilling Contract to reflect amended day rates				
BP-HZN-MBI-00179459 – BP-HZN-MBI00179463	Basis for Cost Escalations; Adjusted Labor; Annual Premiums				
BP-HZN-MBI00179464 – BP-HZN-MBI00179474	Amendment No. 27 to Drilling Contract to reflect day rates				
BP-HZN-MBI00179475 – BP-HZN-MBI00179476	Amendment No. 28 to Drilling Contract to reflect six (6) pup joints				
BP-HZN-MBI00179477 – BP-HZN-MBI00179480	Notice No. 29 to Drilling Contract to reflect operating rates				
BP-HZN-MBI00179481 – BP-HZNMBI00179486	Amendment No. 30 to Drilling Contract to reflect personnel labor rates: Article 3				
BP-HZN-MBI00179487 – BP-HZN-MBI00179489	Amendment No. 31 to Drilling Contract to reflect day rates				
BP-HZN-MBI00179490 – BP-HZNMBI00179611	Amendment No. 38 to Drilling Contract to reflect additional 3 years on contract				
BP-HZN-MBI00179612 – BP-HZN-MBI00179613	Exhibit A: Day Rates for 3 & 5 year options				

BP-HZN-MBI00179614 – BP-HZN-MBI00179616	10-11-2004 Transocean letter to Bp re: Conversion of VBR to Test Run				
BP-HZN-MBI00179617 – BP-HZN-MBI00179619	6-12-2002 Transocean letter to BP re: Cameron Variable Bore Rams				
BP-HZN-MBI00179620 – BP-HZN-MBI00180159	Drilling Contract (December 9, 1998		Contract		
BP-HZN-MBI00192562 – BP-HZN-MBI00192626	GoM Drilling, Completions and Interventions Riser Kink – Post-Recovery Survey Results				
TRN-HCEC-00031890 – TRN-HCEC-00031898	Transocean Daily Operation Report I: Feb. 13 – 17, 2010		Report		
TRN-HCEC-00031934 – TRN-HCEC-00031937	Transocean Morning Report: Feb. 24, 2010		Report		
TRN-HCEC-00032011 – TRN-HCEC-00032013	Transocean Morning Report: March 18, 2010		Report		
TRN-HCEC-00036061 – TRN-HCEC-00036069	Transocean Equipment History: Jan. 1, 2010 to May 6, 2010				
TRN-HCEC-00036070 – TRN-HCEC-00036071	Transocean Equipment History: Jan. 1, 2010 to May 6, 2010				
TRN-HCEC-00039351 – TRN-HCEC-00039408	Transocean Equipment History: Jan. 1, 2010 to May 6, 2010				
TRN-HCEC-00039811 – TRN-HCEC-00039930	Transocean Equipment History: Jan. 1, 2010 to May 6, 2010				

TRN-HCEC-00040041 – TRN-HCEC-00040160	Transocean Equipment History: Jan. 1, 2010 to May 5, 2010					
TRN-HCEC-00040161 – TRN-HCEC-00040217	Transocean Equipment History: Jan. 1, 2010 to May 5, 2010					
TRN-USCG_MMS-00041066 – TRN-USCG_MMS-00041152	Transocean Rig Hardware Assessment					
TRN-USCG_MMS-00041973 – TRN-USCG_MMS-00041988	Transocean Change Proposal: 8/28/2004 to reduce components on BOP (hoses, valves, etc.					
TRN-USCG_MMS-00041989 – TRN-USCG_MMS-00042012	Transocean Change Proposal: 1/5/2004 to install new rigid conduit manifold and removal of RMJBs					
TRN-USCG_MMS-00042013 – TRN-USCG_MMS-00042042	Transocean Departmental Activity Report: May 20, 2004					
TRN-USCG_MMS-00042043 – TRN-USCG_MMS-00042068	Transocean Change Proposal: 3/5/2007 re: software changes to be made to correctly display EDS selection between panels, erroneous coil faults					
TRN-USCG_MMS-00042069 – TRN-USCG_MMS-00042085	Transocean Change Proposal: 11/10/2002 re: install high shock flowmeters inside pods 3 each					
TRN-USCG_MMS-00042086 – TRN-USCG_MMS-00042087	Transocean Change Proposal: 11/13/2002 re: go with non-retrievable pods to make system more reliable and reduce failure points					

TRN-USCG_MMS-00042088 – TRNUSCG_MMS-00042098	Transocean Change Proposal: 11/21/2004 re: enhance rig with test ram capability					
TRN-USCG_MMS-00042099 – TRN- USCG_MMS-00042108	Transocean Change Proposal: 3/9/2006 re: BP requests installation of 18-3/4” annular stripper packet					
TRN-USCG_MMS-00042099 – TRN- USCG_MMS-00042108	Transocean Change Proposal: 3/9/2006 re: BP requests installation of 18-3/4” annular stripper packet					
TRN-USCG_MMS-00042109 – TRN- USCG_MMS-00042119)	Transocean Change Proposal: 8/27/2008 re: flex joint in LMRP in need of overhaul					
TRN-USCG_MMS-00042142 – TRN- USCG_MMS-00042150	Transocean Senior Subsea Supervisor Job Description					
BP-HZN-BLY00060675 – BP-HZN- BLY00060682	Cameron Daily Report Sheet: May 5, 2010					
BP-HZN-BLY00060946 – BP-HZN- BLY00061076	Blue Pod Recovery Log June 29, 2010 TO July 5, 2010					
TRN-HCEC-00063352 - TRN-HCEC- 00063390	Investigation of Well Control Incident on Transocean S711, Well 22/13a-8 (Bardolino) December 23, 2009					
BP-HZN-MBI00168122	Chain of Custody					
BP-HZN-MBI00167827	Chain of Custody					

BP-HZN-MBI00167826 -(BP-HZN-MBI00192753 through BP-HZN-MBI00192766)	(CD of various Materials Reviewed)				
BP-HZN-MBI00002469	Subsea Savings Estimate Chart		Chart		
BP-HZN-MBI00002474	Subsea Savings Estimate Chart		Chart		
TRN-HCEC-00031934	Morning Report				
TRN-HCEC-00032011	Morning Report				
MMS-NOLA-B3-00001-0067	Horizon Drilling Inspection 3/3/2010				
(Producing Party Bates Unavailable)	Maconda BP Cementing 4/21/2010				
(Producing Party Bates Unavailable)	Macondo BP1_SurfaceParameters_RT_4-22-10				
(Producing Party Bates Unavailable)	Macondo BP1_SurfaceParameters_Time_RT				
(Producing Party Bates Unavailable)	Macondo BP_Pits_4-21-2010.txt		Chart		
(Producing Party Bates Unavailable)	Macondo BP_Time SDL_4-21-2010.txt		Chart		
BP-HZN-MBI00021405.xls	Chart of Event		Chart		
TRN-USCG_MMS-00059571.pdf	Drill Pipe Performance Characteristics				
TRN-USCG_MMS-00044226.pdf	Operation Event Report				
TRN-USCG_MMS-00013703.pdf	R&B Falcon Shear Ram Kit				

TRN-USCG_MMS-00013704.pdf	R&B Falcon Stack Flow Diagram		Diagram		
TRN-USCG_MMS-00013705.pdf	R&B Falcon Stack Flow Diagram		Diagram		
TRN-USCG_MMS-00013706.pdf	R&B Falcon Stack Flow Diagram		Diagram		
TRN-USCG_MMS-00014355.pdf	CAD Diagram		Diagram		
TRN-USCG_MMS-00042585.pdf	Stack Flow Diagram		Diagram		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing May 26		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing May 27		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing May 28		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing May 29		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing July 19		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing July 20		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing July 22		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing July 23		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing August 23		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing August 24		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing August 25		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing August 26		Transcript		

(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing August 27		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing October 4		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing October 5		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing October 6		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing October 7		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing October 8		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing December 8		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Joint Investigation Hearing December 9		Transcript		
(Producing Party Bates Unavailable)	Deepwater Horizon Accident Investigation Report, September 8, 2010		Report		
HAL_0010699 - HAL_0010720	Exhibit Production Casing Design Report April 15		Report		
HAL_0010988 - HAL_0011020	Exhibit Production Casing Design Report April 18		Report		
(Not available on Native File Version Sent)	Exhibit April 20 Logging Data – July 23				
(Not available on Native File Version Sent)	Exhibit 20 Well Anomalies of Investigative Interest – July 22				
BP-HZN-OIG0009104 - BP-HZN-OIG0009132	Exhibit GOM Exploration & Appraisal Communication Plan Chart 1.pdf – October 7				

BP-HZN-OIG0009104 - BP-HZN-OIG0009132	Exhibit GOM Exploration & Appraisal Communication Plan Chart 2.pdf – October 7					
BP-HZN-OIG0009104 - BP-HZN-OIG0009132	Exhibit GOM Exploration & Appraisal Communication Plan Chart 3.pdf – October 7					
BP-HZN-OIG0009104 - BP-HZN-OIG0009132	Exhibit GOM Exploration & Appraisal Communication Plan Chart 4.pdf – October 7					
BP-HZN-OIG0009104 - BP-HZN-OIG0009132	Exhibit GOM Exploration & Appraisal Communication Plan Chart 5.pdf – October 7					
HAL_0048973	Log Graph of Sperry Sun Data					
(Not available on Native File Version Sent)	Macondo BP Surface Parameters Time Data					
(Not available on Native File Version Sent)	Macondo BP Pits Data					
(Not available on Native File Version Sent)	Macondo BP Time SDL 4-21-2010					
(Not available on Native File Version Sent)	WEST Shear Ram Capabilities Study, September 2004			Report		
(Not available on Native File Version Sent)	WEST Evaluation of Secondary Intervention Methods in Well Control, March 2033			Report		
(Not available on Native File Version Sent)	Report to the President: National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling					

(Not available on Native File Version Sent)	Refurbishment Procedure for Cameron Solenoid Valves				
TRN-USCG_MMS-00038805	Shear Pressure				
(Not available on Native File Version Sent)	Shear Rams Capabilities Study from September 2004 (Requisition No. 3-4025-1001)				
(Not available on Native File Version Sent)	Macondo Plug and Abandonment Plan Contingency to Recover BOPs with DP Inside				
(Not available on Native File Version Sent)	R&B Falcon Deepwater Horizon TL BOP Stack Operation and Maintenance				
(Not available on Native File Version Sent)	Basic Operations Manual RBS8d (DWH) Volume I	Manual			
	"Specification for Wellhead and Christmas Tree Equipment", API Specification 6A, Seventeenth Edition, November 1999, Reissued December 20, 2002				
	Davis, R.R., Finite Element model of drill string in DWH BOP/LMRP, ANSYS Finite Element program model and run files and pipe load spreadsheet in R.R. Davis engineering file system		12-Aug-11		

	Smith, J.R., "Review of Operational Data Preceding Explosion on Deepwater Horizon in MC252", Final Report to MMS, Order No. M10PX00294	1-Jul-10				
	"High Temperature Elastomer Study for MMS – MMS HPHT WEST Job #2934", West Engineering Services, Brookshire, TX	6-Mar-09				
	Drilling & Production Systems – Products and Services Overview", Cameron Brochure, November 2006					
	Parsons, Paul The Macondo Well - 3 Part series about the Macondo Well (Deepwater Horizon Blowout), Energy and Training Resources	5/17/10; 6/29/10; 7/15/10	http://energytrainingresources.com/component/zoo/item/macondo-well-blowout	article		
	Chesney, Garcia; Load and Stability Analysis of Tubular Strings, ASME 1969 - provided by DNV during phase I of investigation					
	ST lock schematic scans, West Engineering Services, Brookshire, TX, April 17, 2011					

	National Commission on the BP Deepwater Horizon oil Spill and Offshore Drilling, DEEPWATER - The Gulf Oil Disaster and the Future of Offshore Drilling - Report to the President	Jan 2011	http://www.oilspillcommission.gov/sites/default/files/documents/DEEPWATER_Report_to_the_President_FINAL.pdf		
	Holand, Per; Skall, Pal, Deepwater Kicks and BOP Performance, Unrestricted Version, for MMS, SINTEF Industrial Management, Report No. STF38 A01419	7/24/2001	http://www.boemre.gov/tarprojects/383/383%20AB%20Final%20report%20Deepwater%20Kicks%20and%20BOP%20Performance.pdf		
	Holand, Per; Reliability of Subsea BOP Systems for Deepwater Applications, Phase IIDW, Unrestricted Version, for MMS, SINTEF Industrial Management, Report No. STF38 A99426	11/7/1999	http://www.boemre.gov/tarprojects/319/319aa.pdf		

	McCrae, Hugh; <u>Marine Riser Systems and Subsea Blowout Prevention, First Edition, Unit V Lesson 10</u> . Austin, Texas: The University of Texas at Austin, Petroleum Extension Services, and Houston, Texas: International Association of Drilling Contractors	2003	http://www.amazon.com/Marine-Systems-Subsea-Blowout-Preventers/dp/0886981883		
	Bell, Timothy, Daniel Eby, Jace Larrison, and Bhavesh Ranka; <u>Blowout Prevention, Fourth Edition, Unit III Lesson 3</u> . Austin, Texas: The University of Texas at Austin, Petroleum Extension Services, and Houston, Texas: International Association of Drilling Contractors	2009	http://www.amazon.com/Blowout-Prevention-Timothy-Bell/dp/0886982421		
	Bommer, Paul; <u>A Primer of Oilwell Drilling, A Basic Text of Oil and Gas Drilling, Seventh Edition</u> . Austin, Texas: The University of Texas at Austin, Petroleum Extension Services, and Houston, Texas: International Association of Drilling Contractors	2008	http://www.amazon.com/Primer-Oilwell-Drilling-7th-Ed/dp/0886982278		

	FINAL REPORT Blow-out Prevention Equipment Reliability, Joint Industry Project (Phase I – Subsea)	5/12/2009	http://calmap.gisc.berkeley.edu/dwh/doc_link/Technical_Background/2009MMSW_ESTbopreliabilityMay_09_r1a.pdf		
	JipTrifoldr3.pdf - BOP Equipment Reliability Joint Industry Project At A Glance - from West Engineering Website		http://www.westengineering.com/pdfs/JipTrifoldr3.pdf		
	MINI SHEAR STUDY For U.S. Minerals Management Service, Requisition No. 2-1011-1003	12/2/2002	http://www.boemre.gov/tarprojects/455/Final%20Report.pdf		
	West Engineering Oct 2006 BOP and Pressures paper566AA.pdf - Assess the Acceptability and Safety of Using Equipment, Particularly BOP and Wellhead Components, at Pressures in Excess of Rated Working Pressure	10/10/2006	http://www.boemre.gov/tarprojects/566/566aa.pdf		

	SHEAR RAMCAPABILITIES STUDY, For U.S. Minerals Management Service, Requisition No. 3-4025-1001	09/2/04	http://www.boemre.gov/tarprojects/463/(463)%20West%20Engineering%20Final%20Report.pdf		
	Evaluation of Secondary Intervention Methods in Well Control, 24-April-2002, 00017139 BOEM-WDC-B20-00001-0012 -19 pages, <i>BOEM-WDC-B20-00001-0012[1].pdf</i>				
	BP Presentation Slides - Washington Briefing, Deepwater Horizon Interim Incident Investigation,	5/24/2010	http://demo.crats.energycommerce.house.gov/documents/20100527/BP.Presentation.pdf		
	Animations - Transocean AMF Video.wmv; Transocean BOP Video.wmv				

	Cameron - Shear Ram Product Line literature		http://www.scribd.com/doc/45238497/Shear-Ram-Product-Line-Cameron			
	Cameron Overview - Eight Page Brochure from Website					
	one page patent application drawing of annular preventer, from USPTO Patent Application Publication US 2008/0023917 A1, Jan 31, 2008					
	one page of sketches of Cameron Ram Packers					
	one page of sketches of Cameron Collet Connectors, page 12 f					
	Bazoune, A.A., "Lecture 34 - 8-2 The Mechanics of Power Screws", school unknown, December 2007					
	Cameron General Catalog 2005-2006		http://www.scribd.com/doc/46623080/Cameron-Catalog			

	Ram-type Blowout Preventers, four pages from a catalog, pps. 922-925, 1986 CAMERON IRON WORKS, INC, WORLD HEADQUARTERS/P.O. BOX 1212, HOUSTON. TEXAS		http://quipbase.com/quipbase/edir.nsf/docid/E1F7C6BFE3FC5B94C12577C8005F3B3A/\$file/Cameron-U2BOP-DataSheet.pdf		
	Oceanengineering - BOP and Control Pod Literature				
	Grant Prideco. All rights reserved. December 2003, DRILL pipe data tables		http://oilproduction.net/files/casing_drilling/GrantPrideco_Drill_Pipe_Data_Table_s.pdf		
	Lobkowicz, F. and Melissinos, A.C., <i>Physics for Scientists and Engineers, Volume 2</i> , W.B. Saunders, Philadelphia, 1975. In particular, Chapter 10-Magnetic Field, Chapter 11-Magnetic Fields in Matter, and Chapter 12-Faraday's Law, 140 total pages.		http://www.abebooks.com/9780721662671/Physics-Scientists-Engineers-Melissinos-Adrian-0721662676/plp		

	Bourne, G. D., "Accumulator Storage On Deepwater BOP Stacks", Petroleum Engineer International, May 1978, 4 pp.					
	Anon, "Specific Volume of Nitrogen at P and T", table of data, 6 pp.					
	Anon., "Drill Pipe Data Tables", Grant Prideco, pages 44-67 of a seminal document unknown	Dec-03	http://oilproduction.net/files/casing_drilling/GrantPrideco_Drill_Pipe_Data_Table.s.pdf			
	Christman, S., "Function Testing of BOP: Precharge Discussion", produced by Stan Christman of CSB at Michoud Phase 1, Jan 23, 2011, 5 pp.					
	Chesney, A.J.Jr. and Garcia, J., "Load and Stability Analysis of Tubular Strings", American Society of Mechanical Engineers, ASME Petroleum Mechanical Engineering Conference, Tulsa, OK, publication no. illegible, Sept 21, 1969, 8 pp.					
	Anon., "Specification for Drill Through Equipment", American Petroleum Institute, API specification 16A, 2 nd Edition, December 1997, 72 pp.					

	Anon., "Specification for Control Systems for Drilling Well Control Equipment", American Petroleum Institute, API specification 16D, 1st Edition, March 1, 1993, 44 pp.				
	Hills, P., "Solenoids and Actuators, V2.01", web page address http://homepages.which.net/~paul.hills/Solenoids/SolenoidsBody.html , March 18, 2003	http://homepages.which.net/~paul.hills/Solenoids/SolenoidsBody.html			
	Anon., "600W Programmable DC Electronic Load, Model 8510", web page address http://www.bkprecision.com/products/model/8510/600w-programmable-dc-electronic-load.html , on or about June 10, 2011, 1 pp.	http://www.bkprecision.com/products/model/8510/600w-programmable-dc-electronic-load.html			
	Anon., "Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension", ASTM D 412-98a, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, August 1998, 13 pp.	http://www.astm.org/DATABASE/CART/HISTORICAL/D412-98A.htm			

	Anon., "Standard Test Methods for Rubber Property – Compression Set", ASTM D 395-01, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, July 2001, 6 pp.		http://www.astm.org/DATABASE/CART/HISTORICAL/D395-01.htm		
	notes for Michoud Phase 2, March 3 & 4, 2011, 3 pp				
	Anon., "Deepwater Challenges Seminar", West Engineering Services, Brookshire, TX, Rev 1, Complete seminar charts, Sections 00-12, March 30, 2010, 12 pp.				
	Hoffman, C. and Coburn, D., "How The Blowout Happened", Popular Mechanics, October, 2010, 14 pp.		http://www.popularmechanics.com/science/energy/coal-oil-gas/how-the-bp-oil-rig-blowout-happened		
	Anon., misc. Cameron web pages and catalog sheets, numerous dates, 6 pp.				

	Whitby, M.F., "Design Evolution of a Subsea BOP", Drilling Contractor, May/June 2007	http://www.drillingcontractor.org/dc-cpi/dc-mayjune07/DC_May07_BOP.pdf		
	Christman, S., "BOP Accumulators", produced by Stan Christman of CSB at Michoud Phase 1, Jan 19, 2011, 1 pp.			
	Anon., "Standard Practice for Examining and Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation", ASTM E 860-07, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, June 2007, 2 pp.	http://www.astm.org/Standards/E860.htm		
	Anon., "Standard Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator", ASTM E 1188-05, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, May 2005, 2 pp.	http://www.astm.org/Standards/E1188.htm		

	Anon., "Standard Guide for Physical Evidence Labeling and Related Documentation", ASTM E 1459-92, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, September 2005, 2 pp.		http://www.astm.org/Standards/E1459.htm		
	Anon., "Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory", ASTM E 1492-05, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, August 2005, 2 pp.		http://www.techstreet.com/cgi-bin/detail?doc_no=astm%7Ce149205;product_id=1236724 (lists July 15, 2005 date and replaced by E1495-11)		
	Labeled photographs of the DWH BOP and LMRP from gcaptain.com		http://cfs1.gcaptain.com/cfs/images/BOP%20Stack.jpg http://cfs1.gcaptain.com/cfs/images/LMRP.jpg		

	A. J. Chesney, Jr. and Juan Garcia, "Load and Stability Analysis of Tubular Strings", ASME Petroleum Mechanical Engineering Conference, Tulsa, OK	Sept 1969			
	API Specification 5D, "Specification for Drill Pipe", 5th edition	Oct-01	www.scottishcamping.com/images/links/19-big-l-1236556466.pdf		
	API Recommended Practice 16ST, "Coiled Tubing Well Control Equipment Systems", 1 st edition	Mar-09	www.api.org/Standards/new/upload/16ST_e1_P_A.pdf		
	ASTM, "Standard Test Methods for Rubber Property---Compression Set", D395-01	July 2001	http://www.astm.org/DATABASE.CART/HISTORICAL/D395-01.htm		
	ASTM, "Standard Test Method for Rubber Property---Durometer Hardness", D2240-02	Mar-02	http://www.astm.org/DATABASE.CART/HISTORICAL/D2240-02.htm		

ASTM, "Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers---Tension", D412-98a	Aug-98	http://www.astm.org/DATABASE/CART/HISTORICAL/D412-98A.htm		
Drill Pipe Tables by Grant Prideco, Copyright Dec. 2003		oilproduction.net/files/..drilling/GrantPrideco_Drill_Pipe_Data_Table_s.pdf		
Deepwater Horizon's Final Hours		http://www.nytimes.com/2010/12/26/us/26spoil.html?_r=1&h		
Deepwater Horizon BOP secrets Pt. 2 YouTube, http://www.youtube.com/watch?v=0VZcC2GQK7Y		http://www.youtube.com/watch?v=0VZcC2GQK7Y		
http://cgvi.uscg.mil/media/main.php?g2_itemId=997046		photo		
http://cgvi.uscg.mil/media/main.php?g2_itemId=997145		photo		
http://cgvi.uscg.mil/media/main.php?g2_itemId=997145		photo		
http://cfs1.gcaptain.com/cfs/images/BOP%20Stack.jpg		photo		

	http://cfs1.gcaptain.com/cfs/images/LMR_P.jpg			photo		
	http://abcnews.go.com/meta/search/imageDetail?format=plain&source=http%3A%2F%2Fabcnews.go.com%2Fimages%2FBusiness%2F335d14b801f4d97927bd8d4bdf39ab8			photo		
	personal photos on 11-15-10 and 12-21-10					
	<p>Redmond G. Corbett: Mr. Corbett was also a representative of the United States to the Working Group at Michoud. During testing at Michoud, and in preparation for this report, Mr. Corbett was consulted regarding ongoing testing, test procedures, test results and his experience with rig operations, as well as other members of the Working Group. Mr. Corbett is a Subsea consultant, and former subsea engineer, with more than 20 years experience in offshore drilling.</p>					