United States District Court
Eastern District of Louisiana

In re: Oil Spill by the Oil Rig Deepwater Horizon in the Gulf of Mexico on April 20, 2010,

MDL No. 2179

REBUTTAL EXPERT REPORT OF FORREST EARL SHANKS II

November 7, 2011

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CONFIDENTIAL

TREX-40020

1. Introduction

My name is Earl Shanks. I submitted a report in this case on October 17, 2011, discussing design issues related to the *Deepwater Horizon*'s ("DWH") blowout preventer ("BOP"). I have been asked by counsel for BP to review and to provide a response where appropriate to three expert reports that discuss BOP-related issues that were submitted by Halliburton (Glen Stevick, Ph.D., P.E.) and Cameron (Cliff Knight, P.E. and David O'Donnell, P.E.). My response to certain issues raised in these reports is below.

The reports of Cameron and Halliburton have not changed the opinions I presented in my report submitted October 17. There may be opinions or analyses in the Cameron and Halliburton reports that I do not directly address in this rebuttal report, especially when they relate to issues that I have already discussed in my October 17 report. A lack of discussion of any portion of the Cameron and Halliburton reports should not be interpreted as agreement.

The opinions that I provide in this rebuttal report are based on my 37 years of experience in the offshore oil and gas industry, my education and training, and the material I have considered while working on this matter as identified in Appendix A of my October 17 report and Appendix A that is attached to this report. The opinions that I provide are my own and are made to a reasonable degree of engineering and scientific certainty.

2. The DWH BOP Had Sufficient Pressure to Shear Centered Pipe.

Halliburton's (Stevick) and Cameron's (O'Donnell) expert reports state that the DWH BOP did not have sufficient shearing capacity for the anticipated Macondo well conditions.[1] I disagree.

As an initial matter, the DWH BOP did have sufficient shearing capacity to shear the 5-1/2" drill pipe in the hole, had it been centered, under the actual conditions of April 20. An analysis that I have seen that models the pressures during the incident shows that the maximum ***actual*** pressure experienced by the DWH's BOP—which is what the Maximum Anticipated Surface Pressure ("MASP") at mudline calculation is intended to estimate—would have been approximately 8,300 psi.[2] Using Cameron's conservative calculations from EB 702D, this corresponds to a shearing pressure of 3,764 psi for the 5-1/2", S-135 drill pipe that was across the BOP stack during the incident. This conservative estimate for the shearing pressure using Cameron's EB 702D formula is within the design envelope of the DWH BOP, and within the available 4,000 psi operating pressure that the DWH BOP could provide to the high pressure shear circuit.[3] Using the shear tests that were performed with the DWH BOP, which indicated a

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[1] O'Donnell Report at 20 ("The Deepwater Horizon shearing configuration chosen by BP and Transocean was not suitable for the Macondo well . . . ."); Stevick Report, Appendix B ("BSR Capacity Calculations") at 1.

[2] BP Incident Investigation Report, Appendix W, *Report-Dynamic Simulations Deepwater Horizon Incident BP*, at p. 56.

[3] Stevick Report at 34.

closing pressure[4] of 2,700 psi for 5-1/2", S-135, 24.7 ppf drill pipe, and extrapolating this data to the actual wellbore pressures would give even lower pressures than what Cameron's EB 702D formula predicts. Thus, the BOP was sufficiently rated to shear centered pipe under the actual pressures of the Macondo well, which closely matches the anticipated pressures (under MASP) that were included with the APD.

Halliburton's (Stevick) and Cameron's (O'Donnell) expert reports apparently do not criticize the capability of the DWH BOP to shear the 5-1/2" drill pipe under ***actual*** maximum pressures encountered during the incident. In fact, Halliburton's expert report (Stevick) agrees that "[i]f the drill pipe was centered at the time of the incident (and did not become off-center until later), then activating the BSR probably would have completely sheared the drill pipe and sealed the well, preventing the blowout" even if the wellbore pressure was as high as 10,000 psi (1,600 psi higher than the MASP calculated for the Macondo well).[5] Rather than criticize the ability of the Cameron blind shear rams to shear under the maximum ***actual*** pressures of the incident, these reports criticize the shearing pressure capacity of the DWH BOP based on pressures that they claim would have been expected or anticipated. For reasons that I discuss below, I disagree with the anticipated or expected pressures that they use to assess the shearing capacity that was needed for the Macondo well.

2.1. Halliburton's Report Uses Unfounded Assumptions to Assess the Shearing Capacity Needed for the Macondo Well.

Halliburton's (Stevick) expert report criticizes the pressure rating of the BOP, and the adequacy of the blind shear rams' shearing capacity in Appendix B of the report, using a methodology that I have not seen used or discussed in evaluating BOP suitability.[6] For example, rather than use the calculated MASP of the APD that MMS approved, Halliburton's (Stevick) report suggests that BP should have used a MASP of 10,000 psi in evaluating the suitability of the DWH BOP for the Macondo well, but does not indicate why. Halliburton's (Stevick) report also factors in an additional safety factor of 1.3, but fails to take into account the safety factor that is already built into Cameron's conservative EB 702D. Specifically, EB 702D states that its formula to calculate the predicted shearing pressure is based on maximum forces recorded in real world tests:[7]

> [The] value is derived from the <u>maximum</u> recorded shear force that Cameron has experience in a test environment for a given drilling tubular size and material designation.

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[4] As I explain in my October 17 report, the shearing pressure would be lower than 2,700 psi closing pressure.

[5] Stevick Report at 34; Stevick Report Appendix B at 3.

[6] Stevick Report, Appendix B (BSR Capacity Calculations) at 1-5.

[7] MDL Ex. 3185 at CAM_CIV_0098274.

EB 702D also recommends that users "perform actual shear testing on site to confirm the shearability of the tubular in question."[8] This recommended shear testing was performed by Cameron in April 2000 for the DWH blind shear rams and yielded a closing pressure[9] of 2,700 psi, which is a lower pressure than what Cameron's EB 702D formula predicts.[10]

Finally, it is important to note that additional shearing capacity, regardless of how much was added, would not have allowed the Cameron "SBR" rams to shear drill pipe that was outside its shearing zone. Even if the DWH BOP had 8,000 psi of shearing pressure, as Halliburton's (Stevick) report urges, it would not have made a difference in the outcome of the incident. The DWH BOP failed to seal the well because the pipe was off-center and not fully within the shearing zone of Cameron's blind shear ram configuration, not because of inadequate shearing pressure.

2.2. Cameron's Report Calculates MASP Incorrectly for Evaluating Shearing Capacity.

Cameron's (O'Donnell) expert report, on the other hand, suggests that the BOP was not suitable for the Macondo well because it concludes that a MASP of 10,757 psi should have been used for evaluating the shearing capacity of the DWH BOP. This is incorrect. The MASP approved by MMS, 8,404 psi, is the appropriate of the two values for assessing the shearing capacity of the DWH BOP.

To support the conclusion that 10,757 psi should have been used for MASP and evaluating the blind shear ram's shearing capacity, Cameron's (O'Donnell) expert report looks to the APD submitted for the Macondo well and takes the MASP that was calculated under the Fracture Gradient method, and ignores the MASP calculated according to the Bottom Hole Pressure method. This, however, is incorrect and inconsistent with industry practice because the MASP calculated according to the Bottom Hole Pressure method cannot be ignored. MMS and the offshore drilling industry generally agree that MASP is calculated as the ***lesser*** of the Fracture Gradient Method or the Bottom Hole Pressure method.[11] In contrast to this, Cameron's (O'Donnell) report uses the ***greater*** of the two numbers from the March 15, 2010 Application for Bypass:[12]

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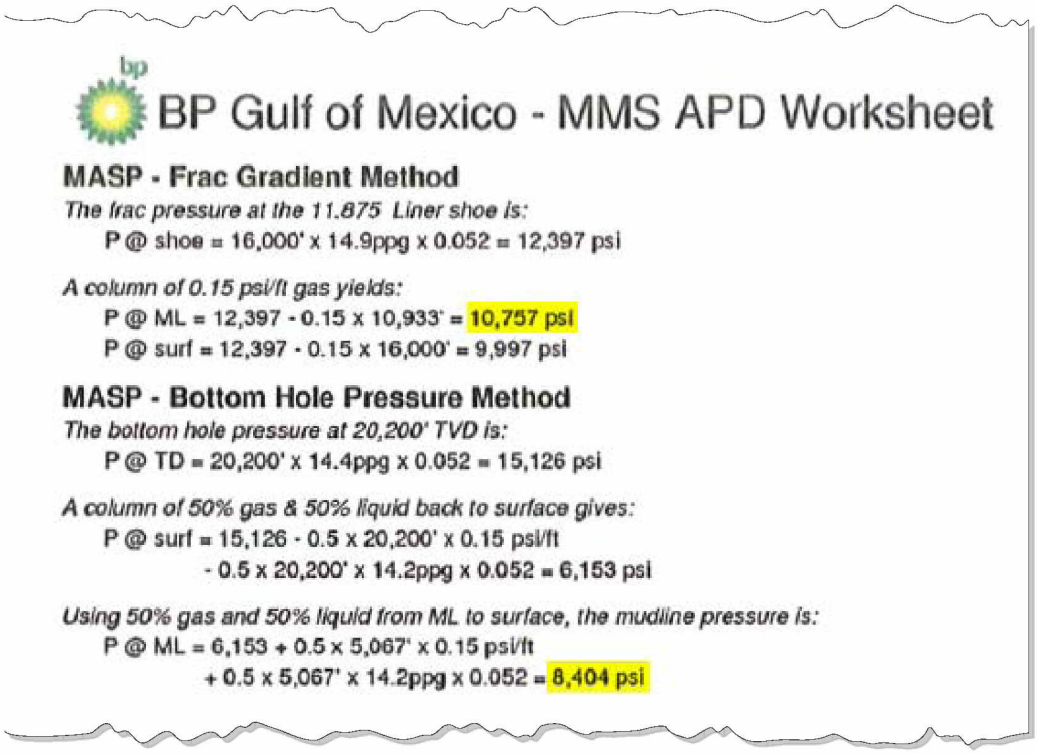
[8] MDL Ex. 3185 at CAM_CIV_0098271.

[9] As I explain in my October 17 report, the shearing pressure would be lower than 2,700 psi closing pressure.

[10] CAM_CIV_0025645-660. I also note that Halliburton's (Stevick) report bases his opinion in part on 6-5/8" drill pipe, not the 5-1/2" drill pipe that was in the hole and across the BOP stack on the day of the incident.

[11] See, for example, XRD005-000292 at XRD005-000345 (*Assess the Acceptability and Safety of Using Equipment, Particularly BOP and Wellhead Components, at Pressures in Excess of Rated Working Pressure*, West Engineering (October 10, 2006) ("For drilling applications, there are two different possible values for MASP. … ***Both must be calculated and the lesser of the two is to be used***.")

[12] MDL Ex. 1339.



BP Gulf of Mexico - MMS APD Worksheet

MASP - Frac Gradient Method

The frac pressure at the 11.875 Liner shoe is:

P @ shoe = 16,000' x 14.9ppg x 0.052 = 12,397 psi

A column of 0.15 psi/ft gas yields:

P @ ML = 12,397 - 0.15 x 10,933' = 10,757 psi

P @ surf = 12,397 - 0.15 x 16,000' = 9,997 psi

MASP - Bottom Hole Pressure Method

The bottom hole pressure at 20,200' TVD is:

P @ TD = 20,200' x 14.4ppg x 0.052 = 15,126 psi

A column of 50% gas & 50% liquid back to surface gives:

P @ surf = 15,126 - 0.5 x 20,200' x 0.15 psi/ft
- 0.5 x 20,200' x 14.2ppg x 0.052 = 6,153 psi

Using 50% gas and 50% liquid from ML to surface, the mudline pressure is:

P @ ML = 6,153 + 0.5 x 5,067' x 0.15 psi/ft
+ 0.5 x 5,067' x 14.2ppg x 0.052 = 8,404 psi

To be consistent with MMS requirements and industry practice, the lower MASP of the Fracture Gradient method and Bottom Hole Pressure method must be selected, which for the Macondo well was 8,404 psi. These calculations were submitted to MMS, and MMS approved the selection of 8,404 psi as the MASP for assessing the BOP test pressures for the Macondo well.

Cameron's (O'Donnell) report also cites to BP's Well Control Group Practice to support its contention that 10,757 psi is the value that should have been used for evaluating the shearing capacity of the DWH BOP. Specifically, Cameron's report states the following:

> BP's policy for calculating MASP is set forth in GP 10-10 (Depo. Ex. 215), which states: "The maximum allowable wellhead pressure shall take into account a gas column to surface for exploration . . . well." According to BP's Application for Bypass, submitted to MMS on March 15, 2010, the worst case expected conditions (100% gas column) for the Macondo well was 10,757 psi at the mud line.[13]

This conclusion, however, is wrong because Cameron's report erroneously equates two different terms: "maximum anticipated surface pressure" (MASP) and "maximum allowable working pressure" (MAWP). The BP policy that Cameron's report cites uses the phrase "maximum allowable wellhead pressure" (MAWP),[14] which is different than the term Maximum Anticipated

[13] O'Donnell Report at 21.

[14] MDL Ex. 215 at BP-HZN-2179MDL00408014; MDL Ex. 1888 at BP-HZN-BLY00145553.

Surface Pressure (MASP). BP's Tubular Design Manager, Rich Miller, testified clearly as to the important distinction between MAWP and MASP:[15]

> **Q. All right? So you said the maximum anticipated or maximum allowable is different in your opinion?**
>
> A. Yes, those are two different things.
>
> . . .
>
> **Q. Okay. And it's my understanding that what this [BP Policy on MAWP] means is that the -- when you're measuring MASP, you test it at a hundred percent column of gas to surface; is that correct?**
>
> (Objection)
>
> A. No, that's not correct.
>
> . . .
>
> **Q. Okay. Well, as to -- as to BP's understanding and what it says in these paragraphs that we read, it says the Maximum Allowable Wellhead Pressure, is that the same thing as MASP?**
>
> (Objection)
>
> A. No, it is not.
>
> **Q. It's not. How is it different?**
>
> A. Well, this is Maximum Allowable Wellhead Pressure.
>
> **Q. Well, how is that different than Maximum Allowable Surface Pressure -- or Maximum Anticipated -- I'm sorry, Maximum Anticipated Surface Pressure?**
>
> A. So "anticipated" is what do you expect. "Allowable" is -- is not "anticipated." Those are -- and that's what I said at the beginning, MASP, MAWP, there's a lot of different definitions for what that means, how to use it, it's very contextual, it -- it matters as to what the purpose of the discussion is.
>
> **Q. Well, when you -- when BP does the MASP calculation for MMS, is -- is that something different than Maximum Allowable wed -- Wellhead Pressure?**
>
> A. Yes, it is.

Cameron's (O'Donnell) report does not explain why BP's policy regarding MAWP should also govern the calculation of MASP,[16] especially since it is contrary to industry and MMS practice.

[15] R. Miller 10-13-2011 dep. tr. at 72:15 to 83:2.

I understand Cameron's (O'Donnell) report to suggest that the shearing capacity for BOPs should be evaluated using a 100% gas column to calculate MASP, which the report contends is the "worst case expected conditions."[17] This conclusion, however, ignores industry practice for calculating MASP for deepwater drilling operations. The use of a partial gas column in determining MASP, such as a 50% gas column that was used to calculate MASP of the Macondo well, is not only accepted by MMS (later BOEMRE, now BSEE), but is accepted and used by other leasehold operators operating in the Gulf of Mexico, such as Marathon, BHP Biliton, and Bois d'Arc Energy, Inc., among others.[18]

A West Engineering study commissioned by MMS in 2006 explains that it is appropriate to use a gas and fluid mixture, such as the 50% gas column MASP of the Macondo APD, and that MASP should reflect realistic conditions:[19]

> This percentage of evacuation [*i.e.*, the gas ratio] **varies from 40 to 70 percent**, depending on the operating company and/or depth of the pertinent casing string setting depth.
>
> . . .
>
> With this background, it is therefore proposed: . . .
>
> 2. For the two fluid loading, set the primary fluid as dry gas with a gradient calculated using Nagy Young Algorithm and having a fixed length of 60% of the true vertical section of the cased hole. Also consider the entire hole below casing to be gas filled. **This recommended 60% is around the median of evacuation percentages quoted in regulations, and is as technically validated as any other number.**
>
> . . .

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[16] BP's policies also state that the BOP shall have "sufficient working pressure" to "contain the maximum allowable surface pressure." MDL Ex. 215 (GP 10-10, section 6.1.2). This provision, however, relates to the pressure rating of the BOP, and its ability to hold a static pressure from below for an extended time period. F. Abbassian dep. tr. at 249-250 (testifying that this section relates to "pressure rating of the entire system"). The DWH's lower BOP was pressure rated to 15,000 psi. MDL Ex. 4271 at BP-HZN-MBI00021537-38; CAM_CIV_0018541 at 548; B. Ambrose 7-18-2011 dep. tr. at 199:4-14.

[17] O'Donnell Report at 21.

[18] MMS has produced approved APDs from other leasehold operators in the Gulf of Mexico that use similar or less conservative gas/mud gradients for calculating MASP than used in the Macondo APD. For example, see IMS065-006059 - IMS065-006079, at IMS065-006064 (Marathon Oil APD, 75/25 mud/gas) and IMS065-007465 - IMS065-007468, at IMS065-007466 (BHP Billiton, 50/50 mud/gas over 15,000ft.); IMS065-005745-IMS065-005751, at IMS065-005745 (Bois d'Arc Energy, Inc., 33/67 mud/gas); IMS084-005585 - IMS-084-005590, at IMS084-005585 (McMoRan Oil & Gas, 50/50 mud/gas over 15,999 ft.).

[19] XRD005-000292 at XRD005-000346 (*Assess the Acceptability and Safety of Using Equipment, Particularly BOP and Wellhead Components, at Pressures in Excess of Rated Working Pressure*, West Engineering (October 10, 2006) (italics in original, brackets and bold added).

10. Compare MASP 1 and MASP 2, and use the smaller of the two.

Note: The use of the smaller value might appear to be in conflict with the idea of maximizing safety, but it is not. The use of a value for MASP in design MUST make sense.

Calculating MASP using an all gas column, as suggested in Cameron's (O'Donnell) report, would have been unnecessary and less accurate. The MASP of 8,404 psi that was calculated for the Macondo APD and approved by MMS was more accurate and was still conservative. Thus, this would have been the proper MASP value for evaluating the sufficiency of the DWH BOP. Therefore, the Cameron blind shear rams had sufficient shearing capacity for the anticipated Macondo conditions.

2.3. The DWH BOP Working Pressure Rating Substantially Exceeded the Pressure Experienced During the Macondo Incident.

The DWH's ram preventers (VBRs and BSRs) are designed to seal a wellbore experiencing up to 15,000 psi of pressure, which is what their 15,000 psi working pressure means.[20] For example, the BSRs were successfully tested to 15,000 psi during the April 2000 shear test that Cameron conducted and verified:[21]

CAMERON

ENGINEERING REPORT ABSTRACT

REPORT NUMBER: 2728 DATED: May 17, 2000

TITLE: R&B Deepwater Horizon Project 18-3/4" 15M TL Super Shear Rams (SSRs) & Shear Blind Rams (SBRs) Shear Test

ABSTRACT: A set of 18-3/4" 15M TL SSRs and 18-3/4" 15M TL SBRs were shear tested in Cameron's Berwick facility in Louisiana. The SBRs sheared 5-1/2" OD, 24.7 lb/ft, S-135 drill pipe with a ram closing pressure of 2700 psi. The SBRs were pressure tested to low, 200-300 psi, and high, 15,000 psi, wellbore pressure to confirm the rams' seal integrity after shearing. The SBRs were in good condition after shearing the pipe and sealing wellbore pressure. The SSRs sheared two sizes

The calculated maximum wellbore pressure present in the BOP on the day of the incident (8,300 psi) based on the modeling analysis that I have seen appears to be slightly more than half of the lower BOP's pressure rating. As discussed above, Cameron's calculations show that the DWH BSRs could shear the drill pipe and seal a wellbore with a pressure of 8,300 psi. I have

[20] M. Whitby 7-18-2011 dep. tr. at 334:10-19 ("In the case of a blind shear ram that was for 15,000 psi working pressure, it would be required to seal 15,000 psi working pressure.")

[21] CAM_CIV_0025645-660.

not seen anything that suggests to me that the presence of the calculated 8,300 psi of pressure would damage the BSR blocks or their packers.

The BSRs would have been exposed to different conditions, depending on whether the VBRs sealed the wellbore at the time the BSRs were activated.[22] In either case, however, the BSRs would have only been exposed to erosive flow for a few seconds before they would have sealed. The presence of flow does not necessarily mean that the elastomeric elements will erode immediately, or even at all, because erosion typically requires extreme flow velocity and that is directly applied to a surface.

The below picture of the DWH's lower annular illustrates this point. It was taken during the forensic examination of the DWH BOP in Port Michoud, and shows that approximately half of the packing element of the lower annular remains in good condition, despite its exposure to nearly 3 months of flow after the blowout:

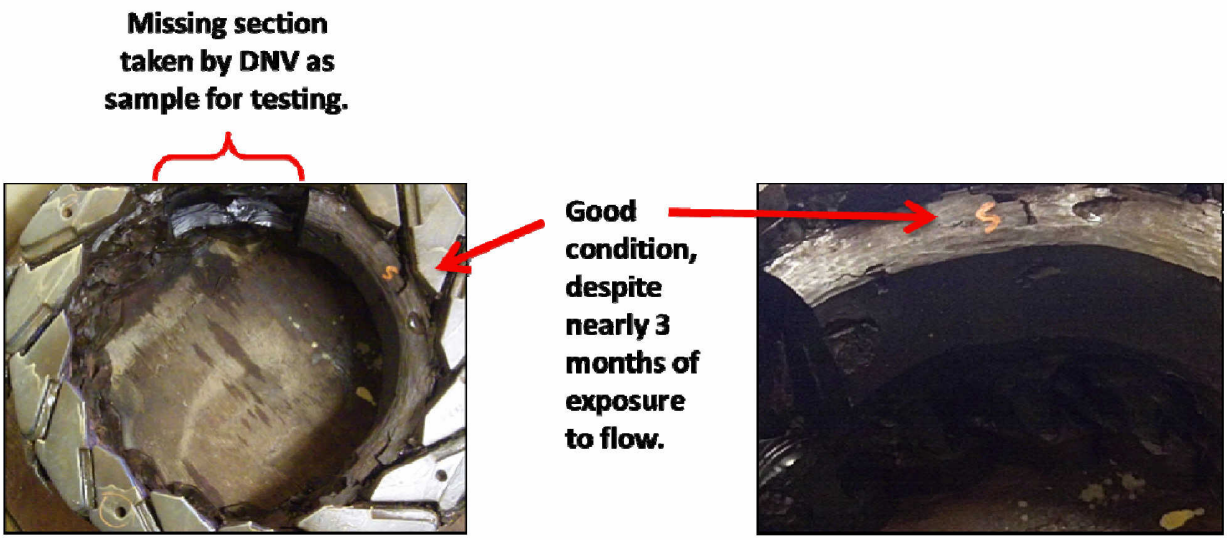

Figure 1. DWH Lower Annular

Even the BSRs, which were closed all but a few inches, sustained greatly varying levels of erosion in different areas despite months of exposure to flow:

[22] If the VBRs were sealed, there would have been low pressure and no flow in the annulus, but high pressure with flow in the drill pipe when the BSRs were activated. If the VBRs were not sealed, there would have been flow and similar pressure in the annulus and the drill pipe at the BSRs when they were activated.

Figure 2. Erosion Varies Based on Exposure to Erosive Conditions

Moreover, metal erodes more slowly than elastomeric material, and the majority of the side packer material facing the flow is designed by Cameron to be protected by metal coverings or by being inserted into the ram blocks themselves:[23]

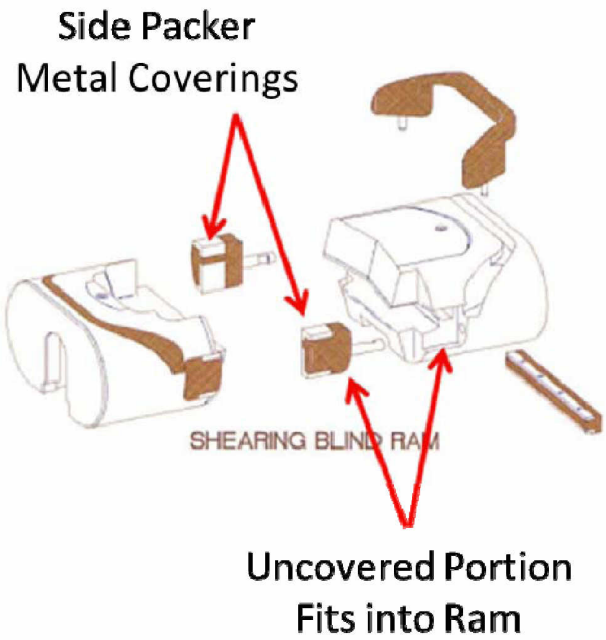

Figure 3. Cameron SBR Side Packers Have Metal Coverings

If the VBRs were sealed when the BSRs were activated, the erosive flow would only have been present, if at all, between the time that the pipe was ruptured by the shear and the time the blocks sealed. In a normal shear, the time between rupture and sealing is only a few seconds, and I have seen no evidence presented from Cameron that suggests that (1) erosive flow would have been directed to any of the elastomeric packers if the pipe had been centered, or (2) even if

[23] MDL Ex. 7001.

it were, that this short time period would have severely eroded the metal coverings and the elastomeric element to prevent the blind shear ram from sealing.[24]

If the VBRs were not sealed around the drill pipe when the BSRs were activated, the flow from below may have reached high velocities immediately before the BSR rams sealed. But even if this were the case, the exposure to a high velocity flow would have been extremely short if the pipe was centered. I have not seen any analysis or evidence suggesting how much erosion would have occurred in this time, or where the erosion would have occurred. For example, there is no analysis regarding how much erosion in various locations is required for failure to seal, or whether those levels of erosion would occur in either of these cases.[25] The side packers are protected by metal, the face packer is protected by its location, and the top packers would not be exposed to erosive flow.

Moreover, the amount of erosion depends on the length of exposure to the erosive conditions. BOP packers may remain able to form a seal even after brief exposure to erosive forces. For example, the picture below shows the section of the drill pipe that was found in the upper VBRs. It appears that the VBRs sealed on April 20 in a first location, despite being exposed to erosive forces that resulted in minor erosion to the drill pipe, which would also have caused erosion on the VBR packer. This erosion was likely caused by fluid jetting between the VBR packers and the drill pipe in the moments just before the VBR achieved its seal. It appears that the drill pipe subsequently moved down a few inches, where it remained and experienced significant erosion over time. Even in the presence of sufficient force to erode steel, the upper VBRs were still apparently able to create a seal in at least the first location.

[24] CAM_CIV_0025645 at 657.

[25] The Cameron reports (O'Donnell and Knight) point to conclusory statements by Transocean, rather than analysis of the erosive forces and exposure. Although it is not precisely clear from their reports, it appears that they believe that erosive forces applied to the side packers would have been the cause of failure. Knight report at 7 ("the pipe rupture would have resulted in significant side loading of the packers . . ."). As discussed above, this theory assumes in part that the erosive forces from the high flow velocity would have been applied directly to the side packers. I have seen no evidence, however, that indicates that this would have been the case if the drill pipe is centered.

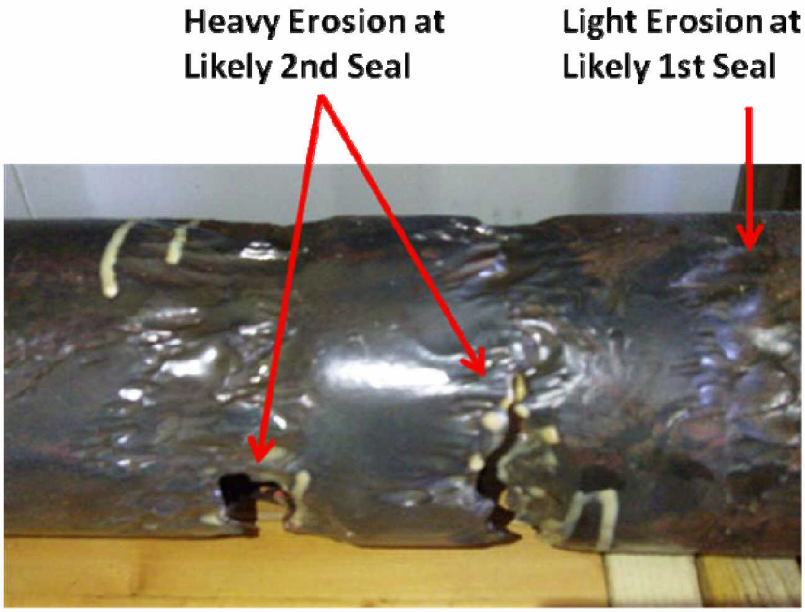

Figure 4. VBRs Appeared To Have Sealed Despite Minor Erosion.

It also appears that the Transocean rig crew believed that the BOP could stop a flowing well.[26] In fact, the rig crew's response to the realization that the well was flowing was to shut one annular, and then wait several minutes before closing the upper VBRs. Moreover, it appears that the Transocean rig crew did not attempt to activate the BSRs through the EDS until after the two explosions at 21:49.

3. <u>The DWH BOP Used the Best Available and Safest Technology (BAST).</u>

3.1. BAST Is Defined by MMS Regulations

Halliburton's (Stevick) expert report states that the DWH BOP did not use the "best available and safest technology" ("BAST"), a term from MMS regulations.[27] I disagree.[28]

[26] J. O. McWhorter 7-20-2011 dep. tr. at 270:5-8; R. Ezell 4-27-2011 dep. tr. 220:23-230:19 ("Curtis told me that Jason was shutting it in. He said 'Jason is shutting it in now' and he made a remark that 'we can't see out of our windows' . . .")

[27] Stevick Report at p. 26.

[28] I am not an expert in MMS regulations, but I am familiar with certain MMS regulations applicable to BOPs, including those discussed in this report, based on my experience in the industry.

First, MMS regulations in effect prior to the Macondo incident defined BAST as:[29]

> *Best available and safest technology (BAST)* means the best available and safest technologies that the Director determines to be economically feasible wherever failure of equipment would have a significant effect on safety, health, or the environment.

The regulations also stated that:[30]

> (c) You must use the best available and safest technology (BAST) whenever practical on all exploration, development, and production operations. In general, we consider your compliance with MMS regulations to be the use of BAST.

In my experience, BAST is not a term used in the offshore oil and gas drilling industry outside the context of MMS regulations. Because it has no common meaning in the industry, there is also no industry understanding for what amounts to BAST, and it is unlikely that an industry understanding is possible because terms like "best" and "safest" are subjective and can vary greatly depending on the situation.

As I understand the definition above, the MMS Director determines what is BAST based in part on what is "economically feasible." Furthermore, compliance with MMS regulations satisfies the BAST regulation absent other direction from the MMS Director. I am not aware of any notice or statement by the Director that the DWH's BOP did not utilize BAST.

Second, MMS approved the Application for Permit to Drill ("APD") for the Macondo well, which had a schematic of the BOP and its components.[31] MMS inspectors also visited the DWH multiple times while it was drilling the Macondo well and it is my understanding that MMS never issued a non-compliance notice regarding the use of BAST.[32]

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[29] 30 C.F.R. § 250.105.

[30] 30 C.F.R. § 250.107(c).

[31] MDL Ex. 4008.

[32] MDL Ex. 4126; MDL Ex. 4127; J. O. McWhorter 7-21-2011 dep. tr. at 355:21-356:15.

Third, Cameron's Vice President of Engineering and Quality, David McWhorter, has confirmed that the DWH BOP was designed and manufactured to API specifications,[33] and neither Transocean nor Cameron suggested any modifications to the DWH BOP were needed for it to constitute BAST. Also, as I have explained previously, the DWH BOP was suitable for the Macondo well conditions, and thus as a practical matter, was acceptable technology.

Based on my experience, the fact that MMS has never concluded that the DWH BOP was not BAST, and that the DWH BOP was suitable for the Macondo well conditions, I disagree with the conclusion that the DWH BOP was not BAST.

3.2. Two Blind Shear Rams (BSRs) Are Not Needed for BAST.

Halliburton's (Stevick) expert report states that the DWH BOP was not BAST because it did not have two BSRs.[34] I disagree.

There was no MMS regulation before the incident (nor is there one at the writing of this report) requiring that a BOP have two BSRs or that two BSRs are needed for a BOP to constitute BAST. Second, as I discussed in my original report, the use of two BSRs would not have allowed the DWH BOP to shear the drill pipe in the BOP and seal the wellbore following the blowout on April 20, 2010.[35]

Besides the DWH, I am aware of 15 offshore rigs that were being operated by Transocean in North American waters in 2010.[36] Figure 5 displays the various shearing ram configurations for the BOPs used on these 15 rigs, which are contracted to various leasehold operators, including Shell and Marathon.

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[33] D. McWhorter 7-8-2011 dep. tr. at 443:4-11; D. McWhorter 7-7-2011 dep. tr. at 191:22-192:18.

[34] Stevick Report at 26.

[35] Expert Report of Forrest Earl Shanks II (10/17/2011) at 59-61.

[36] MDL Ex. 4793.

Shear Ram Configuration	1 BSR & 0 CSR	1 BSR & 1 CSR	2 BSR & 0 CSR	2 BSR & 1 CSR
Rigs	Marianas; DWN; AMI	Deepwater Horizon; Petrobas 10000	Discoverer Clear Leader; Discoverer Americas; DIN; Discoverer Deep Seas; DSP	Discoverer Enterprise; C.R. Luigs; Deepwater Pathfinder; Development Driller I; Development Driller II; Development Driller III

Figure 5. Shear Ram Configuration of Transocean North American Off-Shore Rigs in 2010

As shown in Figure 5, nine of Transocean's 15 other North American rigs had two, or fewer, shear rams: *i.e.*, only 1 BSR and no CSR, 2 BSRs and no CSR, or 1 BSR and 1 CSR.[37] Moreover, even with a two BSR configuration, the DWH AMF/Deadman system only had the accumulator capacity to supply one set of BSRs with the pressure needed to shear the pipe and seal the well.

Also, internal Cameron communications indicate that of the 38 BOPs it sold from 2005 to 2010, 36 contained only a single BSR.[38] Therefore, the DWH's blind shear ram configuration was consistent with the industry as of April 20, 2010. Additionally, given the greater shearing capabilities of CSRs over BSRs, the shear ram configuration for the DWH's BOP was technologically acceptable and reflected sound engineering judgment.

3.3. Cameron's DVS Blind Shear Ram Is Not BAST.

Halliburton's expert report (Stevick) states that the DWH BOP was not BAST because it did not use Cameron's DVS double "V" BSR design.[39] I disagree.

First, MMS regulations, either before the incident or today, do not require that BOPs operating in North American waters have a specific BSR design, such as Cameron's DVS double "V" design. The only MMS (later BOEMRE, now BSEE) regulation that I am aware of that

[37] MDL Ex. 4793.

[38] Expert Report of Forrest Earl Shanks II (10/17/2011) at 60; CAM_CIV_0311314 at 317.

[39] Stevick Report at 26-28.

goes to this issue states that a subsea BOP must have a blind shear ram, without any reference to a specific blind shear ram design.[40]

Second, Cameron also indicates that its SBR design was much more widely used as of April 20, 2010 than any of its double "V" BSR designs, such as the DVS.[41] Accordingly, Cameron's SBR design, which was used on the *Deepwater Horizon*, is still widely used in the industry.

Third, the use of Cameron's DVS design would not have allowed the DWH's BSR to shear the drill pipe in the BOP during the blowout on the Macondo well. The DWH's BSR failed to shear the drill pipe in the BOP and seal the wellbore because the drill pipe was outside the shearing zone of the BSR's blades,[42] not because the BSR lacked sufficient shearing capacity.[43] To the extent Halliburton's expert report (Stevick) suggests that the BOP should have implemented Cameron's CDVS design, which does extend across the wellbore, this design had been downgraded from a 15,000 psi to a 10,000 psi working pressure before April 20, 2010.[44] Therefore, based on knowledge available before April 20, the CDVS was not a better or safer alternative design than the Cameron's 15,000 psi-rated SBR rams as used on the DWH BOP.

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[40] 30 C.F.R. § 250.442(b) ("Your subsea BOP stack must include at least four remote-controlled hydraulically operated BOPs consisting of an annular BOP, two BOPs equipped with pipe rams, and ***one BOP equipped with blind-shear rams***.").

[41] Expert Report of Forrest Earl Shanks II (10/17/2011) at 60; CAM_CIV_0311314 at 317. Halliburton's report's (Stevick) makes reference to Cameron employee Jack Carter Erwin's deposition testimony about the prevalence of the DVS design in 2010, but the reference does not include Mr. Erwin's complete testimony on the issue, which minimizes its value. Mr. Erwin testimony in full on this issue is, "I don't know the specifics, if they were DVS RAMs. I would assume by 2009, 2010 from my understanding, DVS was a much more used RAM than the SBR." J.C. Carter 6-6-2011 dep. tr. at 19-22. Cameron's Director of Engineering Technology, Melvin Whitby, also stated that the SBR design is still being offered and is still requested by Cameron's customers. M. Whitby 7-18-2011 dep. tr. at 340:17-22.

[42] Expert Report of Forrest Earl Shanks II (10/17/2011) at 29-57.

[43] Cameron's report (Knight) criticizes the various theories of the PSC, U.S, and Transocean regarding the off-center drill pipe, as "flawed." It remains my opinion that the drill pipe was off-center at the BSRs when the BSRs were activated. In addition to the comparison of laser scans discussed in my October 17 report, I have also inspected the drill pipe, BSR blocks and other BOP physical evidence in person at Port Michoud. The deformation and markings on the drill pipe strongly suggest that the pipe was off-center. In addition, the pipe segment that was located above the BOP, which is described in the DNV forensic report as segment 1-A-1, is deformed inconsistently with the bend in the riser. This further supports the discussion in my October 17 report that the drill pipe was off-center due to plastic deformation of the drill pipe in and above the BOP.

[44] CAM_CIV_0012644 at 46.

3.4. Use of Tandem Boosters Is Not BAST.

Halliburton's (Stevick) expert report states that the DWH's BOP did not use BAST because it did not have tandem boosters.[45] I disagree.

First, MMS regulations did not (and still do not) require the use of tandem boosters. Second, the purpose of tandem boosters is to increase the available shearing force of BSRs, but based on Cameron's shearing formula and the shearing tests that it conducted, Cameron's blind shear rams as used on the DWH BOP already had sufficient capacity to shear the drill pipe in the BOP during the incident under both the actual conditions experienced and the MASP calculated before the incident. Therefore, tandem boosters were not needed, and in any event would not have made a difference on the day of the incident because even if the BSRs had been able to shear the off-center drill pipe they would not have been able to seal the wellbore.[46] Third, Transocean had investigated implementing tandem boosters on the DWH's sister rig, the *Deepwater Nautilus*, and discovered that the addition of tandem boosters to the DWH's BSR was not practical.[47] Fourth, use of tandem boosters is not widely accepted in the industry, as demonstrated by the fact that Transocean had not implemented any tandem boosters on any other deepwater drilling rigs that it operated in the Gulf of Mexico as of April 20, 2010.[48]

3.5. Use of Cameron's Mark III BOP Control System Is Not BAST.

Halliburton's (Stevick) expert report states that the DWH's BOP was not BAST because it did not use Cameron's Mark III control system, which used single coil solenoids, rechargeable batteries, and could monitor the charge of the batteries.[49] I disagree.

First, I am not aware of any MMS regulation either today or before the incident requiring the use of single coil solenoids in BOP control pods in order to be BAST. Cameron does not take this position. For example, Cameron's corporate representative David McWhorter has stated:[50]

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[45] Stevick Report at 26-28.

[46] Expert Report of Forrest Earl Shanks II (10/17/2011) at 29-57.

[47] Expert Report of Forrest Earl Shanks II (10/17/2011) at 61-62; G. Boughton 7-20-2011 dep. tr. at 120:19-122:2, 225:8-23.

[48] G. Boughton 7-20-2011 dep. tr. at 122:3-5.

[49] Stevick Report at 29-30.

[50] D. McWhorter 7-7-2011 dep. tr. at 96:15-21.

> **Q. Well, speaking for Cameron today, does Cameron take the position that their Mark III solenoid system is better or not?**
>
> A. We -- we don't have an official position on -- on solenoids from our -- our Mark II versus our Mark III.

Second, I am not aware of any MMS regulation either today or before the incident requiring the use of rechargeable batteries or requiring the ability to monitor the charge of the batteries while the control pods are deployed in order for a BOP to be BAST. Regarding the use of non-rechargeable batteries in BOP control pods, Mr. McWhorter stated:[51]

> **Q. Did people at Cameron say, "We have a control system where the batteries are not rechargeable, and that's a problem." Did that discussion ever take place at Cameron?**
>
> A. No. Not -- in -- in general, that -- that system is highly redundant, and at the time it was developed was state-of-the-art, is still a -- a fantastic system. And has – has recommendations for battery changeout and replacement that are, by any measure, extremely conservative. So it -- it was not our feeling that that was a problem.

Mr. McWhorter further stated:[52]

> **Q. Okay. That -- and as you sit here today, you don't think that's a problem? If I've understood your testimony correctly, Cameron does not think that's a problem that they have a battery system that can't be charged and can't be monitored subsea?**
>
> A. If -- if properly maintained, it -- it is not a problem at all.

Third, the Mark III was known to have reliability issues, suggesting that it may not have been considered a better and safer technology as of April 2010. For example, in 2009, Cameron issued a Safety Alert regarding a problem with the Mark III system that "could result in failure of the BOP to perform its intended function."[53] Transocean's Subject Matter Expert for Subsea Equipment also considered the Mark III system to be less redundant than the Mark II system.[54]

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[51] D. McWhorter 7-7-2011 dep. tr. at 99:8-20.

[52] D. McWhorter 7-7-2011 dep. tr. at 103:20-104:2.

[53] MDL Ex. 3626 at CAM_CIV_0012634.

[54] G. Boughton 7-20-2011 dep. tr. at 233:23-234:21.

Fourth, as of 2009, at least a dozen Transocean rigs employing Cameron control systems were using the earlier generation Mark I or Mark II systems, and as of at least July 2011 no Transocean rigs have implemented a Mark III system.[55] Thus, Cameron's Mark III system, as of April 2010, was not widely used in the industry, and the older generation control systems (Mark I and II) were still predominantly used. In early 2009, there were at least 36 rigs, which were owned by many different drilling contractors and contracted to numerous leasehold operators, using Cameron control systems that had not switched to the Mark III system.[56]

3.6. Use of an Acoustic Back-Up System Is Not BAST.

Halliburton's (Stevick) expert report states that the DWH's BOP was not BAST because it did not use an acoustic back-up system or an acoustic control system.[57] I disagree.

First, I am not aware of any MMS regulation either today or before the incident requiring the use of acoustic back-up systems for a BOP. Second, acoustic back-up systems are uncommon in the Gulf of Mexico because they have known reliability issues. As of at least April 20, 2010, none of Transocean's rigs in the Gulf of Mexico had acoustic back-up systems.[58] Third, an acoustic back-up system was not needed as an alternative means of communicating with the control pods if the MUX cables were damaged because the AMF/Deadman system was designed for this situation. The ROV intervention panel also provided a redundant means of disconnecting the LMRP from the lower BOP should disconnect be desired. In other words, the DWH BOP had sufficient backup systems in case of an emergency, and the addition of an acoustic back up system would have potentially added unnecessary complexity to the BOP control systems.

Fourth, had an acoustic back-up system been used, it would not have been able to close the CSR or a second BSR. Once hydraulic connection to the rig was lost, the BOP relied on subsea accumulators for needed hydraulic pressure and fluid. Approximately 28 gallons of hydraulic fluid was needed to close the DWH's BSR and then activate the ST-Lock.[59] As designed, there were eight 80-gallon accumulator bottles mounted on the lower BOP to provide adequate hydraulic fluid and pressure to the AMF/Deadman system.[60] However, the CSR required approximately 69 gallons of hydraulic fluid to close and shear,[61] and had a second BSR been included on the BOP it would have required approximately 28 gallons of hydraulic fluid to close and lock. The accumulators available on the BOP could not have provided the additional

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[55] MDL Ex. 3344; G. Boughton 7-20-2011 dep. tr. at 233:16-22.

[56] MDL Ex. 7026; CAM_CIV_0078871.

[57] Stevick Report at 30-31.

[58] D. McWhorter 7-7-2011 dep. tr. at 125:14-126:10; G. Boughton 7-20-2011 dep. tr. at 230:23-231:6.

[59] BP-HZN-2179MDL01155528 at 5723, 5986.

[60] BP-HZN-2179MDL01155528 at 56143-44.

[61] BP-HZN-2179MDL01155528 at 5723.

hydraulic pressure and fluid needed for these functions. Thus it was not practical to add closure of additional rams to the AMF/Deadman sequence and an acoustic back-up system, if present, would not have been able to close more than a single BSR.

3.7. Implementation and Use of an EDS-2 System Is Not BAST.

Halliburton's (Stevick) expert report states that the DWH's BOP was not BAST because EDS-1, not EDS-2, was the primary EDS sequence that was used on the DWH.[62] I disagree.

First, it is important to clarify that the DWH had two pre-programmed EDS sequences available. EDS-1 activated the BSRs before disconnecting the LMRP, while EDS-2 activated the CSRs then the BSRs before disconnecting the LMRP. Therefore, to be clear, the Transocean drill crew had EDS-2 available to it. The desired EDS sequence could be selected at any time on the BOP control panel simply by selecting EDS-1 or EDS-2.[63]

Second, I am not aware of any MMS regulation either today or before the incident requiring the use of an EDS sequence that includes closure of a CSR. Third, the DWH's two EDS sequences were designed for different scenarios and neither is better or safer than the other because they each have advantages and disadvantages. Although EDS-2 provided greater shearing capabilities, it also took longer to function.[64] Thus in an emergency situation where time could be critical and the DWH's BSRs had adequate shearing capacity, EDS-1 may be preferable. Fourth, the selection of either EDS-1 or EDS-2, was an operations decision that would depend on the circumstances. Also, regardless of which EDS sequence was preferable in a given situation, this was Transocean's choice to make as the drilling contractor. As Mark Hay, a Transocean Senior Subsea Supervisor on the DWH, stated:[65]

> **Q. Who makes the decision as to which EDS program to use at a given time?**
>
> A. Transocean does.
>
> **Q. What individual would be the one that would be responsible for that?**
>
> A. Senior subsea and OIM.
>
> **Q. So that would be your position?**
>
> A. Yes.

[62] Stevick Report at 31.

[63] W. LeNormand 6-21-2011 dep. tr. at 611:1-13.

[64] BP-HZN-2179MDL00086090 at 6159.

[65] M. Hay 6-29-2011 dep. tr. at 48:13-20.

Fifth, because the EDS was not activated until after the explosions on the rig severed the MUX cables, the EDS signal was not able to reach the BOP. Therefore, the choice of EDS sequence had no effect on the failure of the BOP to secure the wellbore.

Appendix A:

Materials Considered

Beginning Bates number	Ending Bates number	Description
		Access to all depositions and exhibits
BP-HZN-2179MDL00086090	BP-HZN-2179MDL00086167	Incident Report, Drift Off and Emergency Disconnect, Transocean Horizon, June 30, 2003
BP-HZN-2179MDL00088245	BP-HZN-2179MDL00088413	Vastar Resources, Inc. Deepwater Horizon Rig Files, 6.0 BOP Equipment, Volume 3
BP-HZN-2179MDL00251251	BP-HZN-2179MDL00251255	DWH-IADC-2010-04-17.pdf
BP-HZN-2179MDL00251256	BP-HZN-2179MDL00251259	DWH-IADC-2010-04-18.pdf
BP-HZN-2179MDL00251260	BP-HZN-2179MDL00251265	DWH-IADC-2010-04-19.pdf
BP-HZN-2179MDL00251266	BP-HZN-2179MDL00251270	DWH-IADC-2010-04-20.pdf
BP-HZN-2179MDL00408005	BP-HZN-2179MDL00408026	GP 10-10 Well Control Group Practice
BP-HZN-2179MDL00871315	BP-HZN-2179MDL00871360	KC102 #1 Application for Permit to Drill a New Well
BP-HZN-2179MDL00912924	BP-HZN-2179MDL00913033	Tubular Bells Drilling Program.doc
BP-HZN-2179MDL01009020	BP-HZN-2179MDL01009074	Well Control.pdf
BP-HZN-2179MDL01155049	BP-HZN-2179MDL01155346	Vastar Resources, Inc. Deepwater Horizon Rig Files, 6.0 BOP Equipment, Volume 2
BP-HZN-2179MDL01155528	BP-HZN-2179MDL01156159	Vastar Resources, Inc. Deepwater Horizon Rig Files, 6.0 BOP Equipment, Volume 1
BP-HZN-2179MDL01819480	BP-HZN-2179MDL01819529	Handwritten notes
BP-HZN-2179MDL02172464	BP-HZN-2179MDL02172464	DW Horizon IMT ROV Ops Notes_September 19.xls
BP-HZN-2179MDL03547166	BP-HZN-2179MDL03547210	Appendix B: Application for Permit to Drill (APD)
BP-HZN-2179MDL03547166	BP-HZN-2179MDL03547379	MC 727 #2 Application for Permit to Drill
BP-HZN-2179MDL03772302	BP-HZN-2179MDL03772302	Oceaneering Millennium 37 ROV video from April 22, 2010
BP-HZN-2179MDL03772304	BP-HZN-2179MDL03772304	C-Innovation video from April 22, 2010
BP-HZN-BLY00000001	BP-HZN-BLY00000193	Deepwater Horizon Accident Investigation Report
BP-HZN-BLY00061169	BP-HZN-BLY00061169	Sperry Sun data from 4/5/2010 through 4/20/2010
BP-HZN-BLY00063669	BP-HZN-BLY00063683	Approval.pdf
BP-HZN-MBI00137274	BP-HZN-MBI00137304	Responder Logbook
BP-HZN-MBI00167826	BP-HZN-MBI00167826	ROV footage
BP-HZN-MBI00171007	BP-HZN-MBI00171038	Responder Logbook
CAM_CIV_0003123	CAM_CIV_0003130	Shearing Blind Rams -- Operations, Care, and Maintenance / Drilling Engineering EB 538 D / Revision C1
CAM_CIV_0012632	CAM_CIV_0012634	Safety Alert # 4058 - Mark III Modular Drilling Control Pod SEM (Subsea Electronics Module) Indication Faults
CAM_CIV_0012644	CAM_CIV_0012646	Safety Alert 22258 / Reduced Fatigue Life of Packer for 18-3/4 15K Type

		T/TL BOP CDVS Ram & 18-3/4 10/15K Type UII BOP CDVS Ram
CAM_CIV_0012830	CAM_CIV_0012831	Cameron Ram BOP Cavity in Service Acceptance Criteria / Engineering Bulletin EB 905 D / Revision A1
CAM_CIV_0018541	CAM_CIV_0018584	Multiplex BOP Control System Budgetary Proposal for Reading & Bates "Vastar Project"
CAM_CIV_0025645	CAM_CIV_0025660	Engineering Report Abstract / Report Number: 2728 / R&B Deepwater Horizon Project 18-3/4" 15M TL Super Shear Rams (SSRs) & Shear Blind Rams (SBRs) Shear Test
CAM_CIV_0070269	CAM_CIV_0070270	Design File Cover Sheet & Table of Content / Design File No. DF-005108 / Rev A01
CAM_CIV_0070271	CAM_CIV_0070271	Design Input
CAM_CIV_0070272	CAM_CIV_0070287	Sales Order Acknowledgement / Sale Order: 50/V25/60198329
CAM_CIV_0070288	CAM_CIV_0070288	Design Output
CAM_CIV_0070289	CAM_CIV_0070292	Cameron - Houston, Texas / Product Engineering Part/Document Audit Report / Entry Number: 2113587-10
CAM_CIV_0070293	CAM_CIV_0070297	Cameron - Houston, Texas / Product Engineering Part/Document Audit Report / Entry Number: 2113587-07
CAM_CIV_0070298	CAM_CIV_0070298	Assembly 18.3/4" 15M BOP Double "TL" with ST-Lock W/SEQ VLV / SK-120036-05
CAM_CIV_0070299	CAM_CIV_0070299	Assembly 18-3/4" 15,000 'TL', Double BOP W/ST-Lock and Seq. Valve / SK-013970-02
CAM_CIV_0070300	CAM_CIV_0070300	Body
CAM_CIV_0070301	CAM_CIV_0070313	18 3/4" 15M TL BOP Body Analysis Standard
CAM_CIV_0070314	CAM_CIV_0070314	DIM. Drawing - Body, 18-3/4" 15M# 'TL' W/Special NPT and Sae Flange Prep on Open & Close Port
CAM_CIV_0070315	CAM_CIV_0070315	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011729-01
CAM_CIV_0070316	CAM_CIV_0070316	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011727-01
CAM_CIV_0070317	CAM_CIV_0070318	Machine Detail - Body, 18-3/4" 15M# 'TL' BOP, W/Special Flange Prep, on Open & Close Port / X-103151-02
CAM_CIV_0070319	CAM_CIV_0070320	Machine Detail - Body, 18-3/4" 15M# 'TL' BOP, W/Special NPT and Sae Flange Prep on Open & Close Port / X-103151-03
CAM_CIV_0070321	CAM_CIV_0070321	Bonnet

CAM_CIV_0070322	CAM_CIV_0070328	Table 26 Formulas for Maximum Deflection and Maximum Stress in Flat Plates with Straight Boundaries and Constant Thickness
CAM_CIV_0070329	CAM_CIV_0070329	Operating Piston
CAM_CIV_0070330	CAM_CIV_0070332	18 3/4" 15M TL BOP Operating Piston Analysis Standard
CAM_CIV_0070333	CAM_CIV_0070333	Sub-Assembly, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# 'TL' BOP
CAM_CIV_0070334	CAM_CIV_0070334	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2010388-05
CAM_CIV_0070335	CAM_CIV_0070335	DAP234IFS.mcd
CAM_CIV_0070336	CAM_CIV_0070336	Machine Detail, Operating Piston for Housing Locking Screw 18.3/4" 15M "TL" BOP / X-102270-05
CAM_CIV_0070337	CAM_CIV_0070337	Mach. Detail, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# "TL" BOP / X-102270-03
CAM_CIV_0070338	CAM_CIV_0070338	Bonnet Bolt
CAM_CIV_0070339	CAM_CIV_0070342	18 3/4" 15M TL BOP Bonnet Bolt Analysis Standard
CAM_CIV_0070343	CAM_CIV_0070343	Bonnet Bolt F/18-3/4" 15M# 'TL' BOP
CAM_CIV_0070344	CAM_CIV_0070344	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2010401-02
CAM_CIV_0070345	CAM_CIV_0070345	Piston Ram Change
CAM_CIV_0070346	CAM_CIV_0070348	18 3/4" 15M TL BOP Ram Change Piston Analysis Standard
CAM_CIV_0070349	CAM_CIV_0070349	Piston, RAM Change, 18-3/4"-15M# 'TL' BOP
CAM_CIV_0070350	CAM_CIV_0070350	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2010391-02
CAM_CIV_0070351	CAM_CIV_0070351	Cylinder Ram Change
CAM_CIV_0070352	CAM_CIV_0070355	18 3/4" 15M TL BOP Ram Change Cylinder Analysis Standard
CAM_CIV_0070356	CAM_CIV_0070356	Cylinder, RAM Change, 18-3/4"-15M# 'TL' BOP
CAM_CIV_0070357	CAM_CIV_0070357	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2010393-02
CAM_CIV_0070358	CAM_CIV_0070358	Cylinder Head
CAM_CIV_0070359	CAM_CIV_0070361	18 3/4" 15M TL BOP Cylinder Head Analysis Standard
CAM_CIV_0070362	CAM_CIV_0070362	Operating Cylinder
CAM_CIV_0070363	CAM_CIV_0070366	18 3/4" 15M TL BOP Operating Cylinder Analysis Standard
CAM_CIV_0070367	CAM_CIV_0070367	Cylinder, Operating Piston, 18-3/4" 15M# 'TL' BOP
CAM_CIV_0070368	CAM_CIV_0070368	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2010389-02

CAM_CIV_0070369	CAM_CIV_0070369	Design Review / Design Fiel #: DF-005108-01
CAM_CIV_0070370	CAM_CIV_0070370	Stud DBL Ended
CAM_CIV_0070371	CAM_CIV_0070373	18 3/4" 15M TL BOP Operator Cylinder Studs Analysis Standard
CAM_CIV_0070374	CAM_CIV_0070374	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 22011346-26-01
CAM_CIV_0070375	CAM_CIV_0070375	Tandem Booster
CAM_CIV_0070376	CAM_CIV_0070448	Cameron Design Approval Package / Package Number: 5024-279-001
CAM_CIV_0070449	CAM_CIV_0070449	Super Shear
CAM_CIV_0070450	CAM_CIV_0070450	DAP268-HSG-SS.mcd
CAM_CIV_0070451	CAM_CIV_0070458	DAP237HSG-SS.mcd
CAM_CIV_0070459	CAM_CIV_0070465	Working.rpt
CAM_CIV_0070466	CAM_CIV_0070471	Test.rpt
CAM_CIV_0070472	CAM_CIV_0070472	DAP268-BON-SS.mcd
CAM_CIV_0070473	CAM_CIV_0070475	DAP245BON-SS.mcd
CAM_CIV_0070476	CAM_CIV_0070476	DAP268-OP-SS.mcd
CAM_CIV_0070477	CAM_CIV_0070478	DAP245OP-SS.mcd
CAM_CIV_0070479	CAM_CIV_0070479	DAP268-CH-SS.mcd
CAM_CIV_0070480	CAM_CIV_0070481	DAP245CH-SS.mcd
CAM_CIV_0070482	CAM_CIV_0070482	DAP268-CS-SS.mcd
CAM_CIV_0070483	CAM_CIV_0070484	DAP245CS-SS.mcd
CAM_CIV_0070485	CAM_CIV_0070485	DAP268-SS-SS.mcd
CAM_CIV_0070486	CAM_CIV_0070487	DAP245SS-SS.mcd
CAM_CIV_0070488	CAM_CIV_0070489	Sub-Assembly, Bonnet 28", Externally Ported Super Shear Ram, End Cap W/ Polypak GRV, 18-3/4 15M, 'TL' BOP / SK-019369-02
CAM_CIV_0070490	CAM_CIV_0070490	DIM. DWG-Super Shear Housing 18-3/4" TL BOP
CAM_CIV_0070491	CAM_CIV_0070491	DIM. DWG-Super Shear Bonnet 18-3/4" TL BOP
CAM_CIV_0070492	CAM_CIV_0070492	DIM. DWG-Super Shear Piston 18-3/4" TL BOP
CAM_CIV_0070493	CAM_CIV_0070493	DIM. DWG-Super Shear End Cap 18-3/4" TL BOP
CAM_CIV_0070494	CAM_CIV_0070494	Section III Bills of Materials
CAM_CIV_0070495	CAM_CIV_0070495	DAP268-PIS.mcd
CAM_CIV_0070496	CAM_CIV_0070497	DAP245OP.mcd
CAM_CIV_0070498	CAM_CIV_0070498	DAP268-RCC.mcd
CAM_CIV_0070499	CAM_CIV_0070500	DAP245RCC.mcd
CAM_CIV_0070501	CAM_CIV_0070501	DAP268-OC.mcd
CAM_CIV_0070502	CAM_CIV_0070504	DAP245OC

CAM_CIV_0070505	CAM_CIV_0070505	Rams
CAM_CIV_0070506	CAM_CIV_0070517	18-3/4" 15M BOP SBR Rams Analysis Standard
CAM_CIV_0070518	CAM_CIV_0070531	18-3/4" 15M BOP 5.0" Pipe Rams Analysis Standard
CAM_CIV_0070532	CAM_CIV_0070533	Product Engineering Part/Document Audit Report / Entry Number: 2163089-07
CAM_CIV_0070534	CAM_CIV_0070535	Product Engineering Part/Document Audit Report / Entry Number: 2010407-01
CAM_CIV_0070536	CAM_CIV_0070537	Product Engineering Part/Document Audit Report / Entry Number: 2163582-01
CAM_CIV_0070538	CAM_CIV_0070539	Product Engineering Part/Document Audit Report / Entry Number: 2010374-03
CAM_CIV_0070540	CAM_CIV_0070540	Machining Detail, Pipe Ram Charted Drawings -01 thru -23 18.75"-10/15M Type-T-B.O.P. / X-24153
CAM_CIV_0070541	CAM_CIV_0070541	Mach. Det. Conn. Rod Slot, 18-3/4" 15M# 'T' & 'TL' BOP Ram Body / X-023806-01
CAM_CIV_0070542	CAM_CIV_0070542	Mach. Detail, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# "TL' BOP / X-102270-03
CAM_CIV_0070543	CAM_CIV_0070543	Machine Detail, Button, 18-3/4 10M-15M, T BOP / X-23985-01
CAM_CIV_0070544	CAM_CIV_0070557	18-3/4" 15M TL BOP 6-5/8" Pipe Hangoff Ram Analysis Standard
CAM_CIV_0070558	CAM_CIV_0070570	18-3/4" 15M TL BOP 7-5/8" to 3-1/2" VBR Ram Analysis Standard
CAM_CIV_0070571	CAM_CIV_0070572	Product Engineering Part/Document Audit Report / Entry Number: 644575-01-00-01
CAM_CIV_0070573	CAM_CIV_0070574	Product Engineering Part/Document Audit Report / Entry Number: 2010407-01
CAM_CIV_0070575	CAM_CIV_0070576	Product Engineering Part/Document Audit Report / Entry Number: 2163091-01
CAM_CIV_0070577	CAM_CIV_0070578	Product Engineering Part/Document Audit Report / Entry Number: 644575-01
CAM_CIV_0070579	CAM_CIV_0070580	Product Engineering Part/Document Audit Report / Entry Number: 644575-01-00-02
CAM_CIV_0070581	CAM_CIV_0070594	18-3/4" 15M TL BOP 6-5/8" x 5" Flexpacker NR Ram Analysis Standard
CAM_CIV_0070595	CAM_CIV_0070595	Machine Detail-Hangoff Ram Body 18-3/4 15M 'T' and 'TL' BOP 6-5/8X5 Flexpacker NR / X-208738-01
CAM_CIV_0070596	CAM_CIV_0070596	Mach. Detail, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# "TL' BOP / X-102270-03

CAM_CIV_0070597	CAM_CIV_0070597	Mach. Det. Conn. Rod Slot, 18-3/4" 15M# 'T' & 'TL' BOP Ram Body / X-023806-01
CAM_CIV_0070598	CAM_CIV_0070598	Machine Detail, Button, 18-3/4 10M-15M, T BOP / X-23985-01
CAM_CIV_0070599	CAM_CIV_0070599	Molding Detail - Flexpacker 18-3/4" 10/15M UII BOP Double Plate for 6-5/8" to 5" Pipe OD / X-103945-01
CAM_CIV_0070600	CAM_CIV_0070601	Product Engineering Part/Document Audit Report / Entry Number: 2163767-01
CAM_CIV_0070602	CAM_CIV_0070602	Product Engineering Part/Document Audit Report / Entry Number: 2163768-01
CAM_CIV_0070603	CAM_CIV_0070603	18 3/4" 15M TL BOP DVS Shear Ram Analysis Standard
CAM_CIV_0070604	CAM_CIV_0070614	18-3/4" 15M TL BOP DVS Shear Ram Analysis Standard
CAM_CIV_0070615	CAM_CIV_0070615	Machine Detail - Ram Body, Lower Double V-Shear (DVS) 18-3/4 15M 'T' and 'TL' BOP / X-208167-01
CAM_CIV_0070616	CAM_CIV_0070616	Machine Detail - Ram Body, Upper Double V-Shear (DVS) 18-3/4 15M 'T' and 'TL' BOP / X-208166-01
CAM_CIV_0070617	CAM_CIV_0070617	Mach. Detail, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# "TL" BOP / X-102270-03
CAM_CIV_0070618	CAM_CIV_0070618	Mach. Det. Conn. Rod Slot, 18-3/4" 15M# 'T' & 'TL' BOP Ram Body / X-023806-01
CAM_CIV_0070619	CAM_CIV_0070619	Machine Detail, Button, 18-3/4 10M-15M, T BOP / X-23985-01
CAM_CIV_0070620	CAM_CIV_0070621	Cameron - Houston, Texas / Product Engineering Part/Document Audit Report / Entry Number: 2232813-02
CAM_CIV_0070622	CAM_CIV_0070623	Cameron - Houston, Texas / Product Engineering Part/Document Audit Report / Entry Number: 2232813-01
CAM_CIV_0070624	CAM_CIV_0070637	18-3/4" 15M TL BOP 5-1/2" Pipe Rams Analysis Standard
CAM_CIV_0070638	CAM_CIV_0070640	18-3/4" 15M TL BOP 4-1/2" Pipe Rams Analysis Standard
CAM_CIV_0070641	CAM_CIV_0070641	Machining Detail, Pipe Ram 18-3/4 10/15M "T" BOP / X-24153
CAM_CIV_0070642	CAM_CIV_0070642	Inspection Ref. Data, Ram Body, 18-3/4"-5M# "TL" BOP (All Pipe Sizes) / X-102427-01
CAM_CIV_0070643	CAM_CIV_0070643	Machining Detail, Pipe Ram Charted Drawings -01 thru -23 18.75"-10/15M Type -T- B.O.P. / X-24153
CAM_CIV_0070644	CAM_CIV_0070644	Mach. Det. Conn. Rod Slot, 18-3/4" 15M# 'T' & 'TL' BOP Ram Body / X-023806-01
CAM_CIV_0070645	CAM_CIV_0070645	Mach. Detail, Operating Piston to Function W/Sequence Valve 18-3/4" 15M# "TL' BOP / X-102270-03

CAM_CIV_0070646	CAM_CIV_0070646	Machine Detail, Button, 18-3/4 10M-15M, T BOP / X-23985-01
CAM_CIV_0070647	CAM_CIV_0070647	Design Validation
CAM_CIV_0070648	CAM_CIV_0070648	Certificate of Conformance New Manufacture
CAM_CIV_0070649	CAM_CIV_0070649	Test Report BOP Type
CAM_CIV_0070650	CAM_CIV_0070650	Certificat De Test
CAM_CIV_0070651	CAM_CIV_0070651	Certificat De Test
CAM_CIV_0070652	CAM_CIV_0070663	Bonnet Test Report
CAM_CIV_0070664	CAM_CIV_0070665	Test Report BOP Type
CAM_CIV_0070666	CAM_CIV_0070674	Bonnet Test Report
CAM_CIV_0070675	CAM_CIV_0070675	Engineering Report Abstract / Report Number: 3548 / DVS Ram for 18-3/4"-15M TL BOP Temperature Qualification
CAM_CIV_0070676	CAM_CIV_0070676	Engineering Report Abstract / Report Number: 3549 / SBR Ram for 18-3/4"-15M TL BOP Temperature Qualification
CAM_CIV_0070677	CAM_CIV_0070686	Appendix I / Sealing Characteristics
CAM_CIV_0070687	CAM_CIV_0070687	Engineering Report Abstract / Report Number: 3629 / 18-15M TL SBR Fatigue Test
CAM_CIV_0070688	CAM_CIV_0070688	Engineering Report Abstract / Report Number: 2728 / R&B Deepwater Horizon Project 18-3/4" 15M TL Super Rams (SSRs) & Shear Blind Rams (SBRs) Shear Test
CAM_CIV_0070689	CAM_CIV_0070689	Engineering Report Abstract / Report Number: 3628 / 18-15M TL DVS Shear Ram Fatigue & Shear Test
CAM_CIV_0070690	CAM_CIV_0070690	Engineering Report Abstract / Report Number: 3702 / 5 to 3-1/2 VBR for 18-3/4-15K TL BOP API 16A Fatigue Test
CAM_CIV_0070691	CAM_CIV_0070691	Engineering Report Abstract / Report Number: 3119 / 183/4"-15M TL BOP CDVS Rams Fatigue Testing
CAM_CIV_0070692	CAM_CIV_0070692	Engineering Report / E.R.No. 1784 / Fatigue Test of 5" Fixed Bore Ram Packers in an 18-3/4"-15,000 Psi T BOP on 5" Diameter Pipe
CAM_CIV_0070693	CAM_CIV_0070693	Engineering Report / E.R.No. 1729 / Stripping Life of 5" Pipe Ram 18-3/4" T Ram Assemblies -- 3000 Psi Well Bore Pressure -- 1500 Psi Closing Pressure
CAM_CIV_0070694	CAM_CIV_0070695	Hangoff Test of 5" Fixed Bore Pipe Rams for 18-3/4"-15M T BOP / Revision A1 / Engineering Test Report Summary TR-1060 D
CAM_CIV_0070696	CAM_CIV_0070696	Engineering Report Abstract / Report Number: 2148 / Hangoff Test, 5" Diameter Pipe, 18-3/4" 15M T BOP 7-5/8" to 3-1/2" VBRs
CAM_CIV_0070697	CAM_CIV_0070697	Engineering Report Abstract / Report Number: 1899 / API 16A Ram Access Test on the Cameron 18-3/4"-15M T BOP

CAM_CIV_0070698	CAM_CIV_0070698	Engineering Report Abstract / Report Number: 2088 / Scaled BOP Operational Characteristics Test Data Per API SPEC 16A, First Edition, November 1, 1986
CAM_CIV_0070699	CAM_CIV_0070699	Engineering Report Abstract / Report Number: 3558 / VBR Ram for 18-3/4" - 15M TL BOP Temperature Qualification
CAM_CIV_0070700	CAM_CIV_0070700	Design Verification
CAM_CIV_0070701	CAM_CIV_0070701	18 3/4"-15,000 PSI TL BOP
CAM_CIV_0070702	CAM_CIV_0070705	Type Approval Certificate No. D-3062
CAM_CIV_0070706	CAM_CIV_0070709	Addendum to TAC D-3062
CAM_CIV_0070710	CAM_CIV_0070713	Type Approval Certificate No. D-3160
CAM_CIV_0070714	CAM_CIV_0070714	Facility Type: Self Elevating Unit / Facility Names: West Juno (Cameron SO#1227952) / Shipyard,Hull Numbers: Keppel Fels Ltd. Singapore, B312 / Review Activity: Extension of Approval of BOP & RAM Assemblies
CAM_CIV_0070715	CAM_CIV_0070716	Independent Review Certificate No.: HOE-569769A/2010
CAM_CIV_0070717	CAM_CIV_0070718	Independent Review Certificate No.: HOE-569769B/2010
CAM_CIV_0070719	CAM_CIV_0070719	Design Changes
CAM_CIV_0070720	CAM_CIV_0070720	Engineering Report Abstract / Report Number: 3558 / VBR Ram for 18-3/4" - 15M TL BOP Temperature Qualification
CAM_CIV_0070721	CAM_CIV_0070721	Engineering Report Abstract / Report Number: 3549 / SBR Ram for 18-3/4" - 15M TL BOP Temperature Qualification
CAM_CIV_0070722	CAM_CIV_0070722	Engineering Report Abstract / Report Number: 3548 / DVS Ram for 18-3/4" - 15M TL BOP Temperature Qualification
CAM_CIV_0070723	CAM_CIV_0070723	Engineering Report Abstract / Report Number: 3629 / 18-15M TL SBR Fatigue Test
CAM_CIV_0070724	CAM_CIV_0070724	Engineering Report Abstract / Report Number: 3628 / 18-15M TL DVS Shear Ram Fatigue & Shear Test
CAM_CIV_0070725	CAM_CIV_0070728	Design Improvement to 18-3/4"-15M TL BOP Operating Piston Buttons
CAM_CIV_0070729	CAM_CIV_0070730	Design File Cover Sheet & Table of Content / Design File No. DF-005052-01 / Rev A1
CAM_CIV_0070731	CAM_CIV_0070731	Design Input
CAM_CIV_0070732	CAM_CIV_0070733	Drilling Engineering Design and Development Planning / DF-005052-01
CAM_CIV_0070734	CAM_CIV_0070734	Design Output
CAM_CIV_0070735	CAM_CIV_0070740	Cameron - Houston, Texas / Product Engineering Part/Document Audit Report / Entry Number: 2163588-09
CAM_CIV_0070741	CAM_CIV_0070741	Assembly 18-3/4" 10/15M 'DL' Annular BOP W/ Anti-Rotation Key / SK-013908-03

CAM_CIV_0070742	CAM_CIV_0070750	Calculations for the "DL" BOP Body
CAM_CIV_0070751	CAM_CIV_0070751	DIM. Drawing Body, 18-3/4" 10M# PSI WP 'DL' Annular BOP
CAM_CIV_0070752	CAM_CIV_0070752	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011702-01
CAM_CIV_0070753	CAM_CIV_0070753	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011689-01
CAM_CIV_0070754	CAM_CIV_0070754	18 3/4" - 10M 'D' BOP' Body Analysis w/3 1/16" Dia. Horizontal Hole through Bottom Plate
CAM_CIV_0070755	CAM_CIV_0070755	Post1 Linearized Stress Listing
CAM_CIV_0070756	CAM_CIV_0070756	Post1 Linearized Stress Listing
CAM_CIV_0070757	CAM_CIV_0070757	Post1 Linearized Stress Listing
CAM_CIV_0070758	CAM_CIV_0070758	Post1 Linearized Stress Listing
CAM_CIV_0070759	CAM_CIV_0070762	18 3/4"-10M DBOP Body W/ 10 ksi Bore, 931 Kip Tens & 2,014 Ft-Kip BM
CAM_CIV_0070763	CAM_CIV_0070763	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011698-01
CAM_CIV_0070764	CAM_CIV_0070764	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011695-01
CAM_CIV_0070765	CAM_CIV_0070766	Calculations for the "DL" BOP Piston
CAM_CIV_0070767	CAM_CIV_0070767	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011655-01
CAM_CIV_0070768	CAM_CIV_0070769	Calculations for the "DL" BOP Outer Cylinder Head
CAM_CIV_0070770	CAM_CIV_0070770	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 2011653-01
CAM_CIV_0070771	CAM_CIV_0070771	Calculations for "Lock Ring Teeth", 18-3/4" 10M DL Annular BOP
CAM_CIV_0070772	CAM_CIV_0070772	Dimensional Drawing Lock Ring, 18-3/4" 10M# 'DL' Annular BOP
CAM_CIV_0070773	CAM_CIV_0070773	Cooper Cameron Corporation Houston, Texas / Engineering Bill of Material / Entry Number: 699337-21
CAM_CIV_0070774	CAM_CIV_0070774	18 3/4-10M WP DBOP Body W/Hub 8' Floor
CAM_CIV_0070775	CAM_CIV_0070777	18-3/4 10M DBOP Piston
CAM_CIV_0070778	CAM_CIV_0070778	'D' BOP / Packer Volume Studies
CAM_CIV_0070779	CAM_CIV_0070781	18" -10M # Type 'DL' BOP
CAM_CIV_0070782	CAM_CIV_0070786	Insert 18 3/4-10M DL Packer
CAM_CIV_0070787	CAM_CIV_0070787	Engineering Bill of Material Explosion / Entry Number: 644853-01-10-01
CAM_CIV_0070788	CAM_CIV_0070788	Engineering Bill of Material Explosion / Entry Number: 644853-01-10-01

CAM_CIV_0070789	CAM_CIV_0070790	Index / Design Approval Package / DAP Number: DAP-246-01 / 18-10M DL Annular BOP
CAM_CIV_0070791	CAM_CIV_0070791	DAP246-BDY.mcd
CAM_CIV_0070792	CAM_CIV_0070800	Calculations for the "DL" BOP Body
CAM_CIV_0070801	CAM_CIV_0070801	18 3/4" - 10M 'D' BOP' Body Analysis w/3 1/16" Dia. Horizontal Hole through Bottom Plate
CAM_CIV_0070802	CAM_CIV_0070802	Post1 Linearized Stress Listing
CAM_CIV_0070803	CAM_CIV_0070803	Post1 Linearized Stress Listing
CAM_CIV_0070804	CAM_CIV_0070804	Post1 Linearized Stress Listing
CAM_CIV_0070805	CAM_CIV_0070805	Post1 Linearized Stress Listing
CAM_CIV_0070806	CAM_CIV_0070809	18 3/4"-10M DBOP Body W/ 10 ksi Bore, 931 Kip Tens & 2,014 Ft-Kip BM
CAM_CIV_0070810	CAM_CIV_0070810	DAP246-TOP.mcd
CAM_CIV_0070811	CAM_CIV_0070822	Calculations for the "DL" BOP top Plate
CAM_CIV_0070823	CAM_CIV_0070823	DAP246-PIS.mcd
CAM_CIV_0070824	CAM_CIV_0070825	Calculations for the "DL" BOP Piston
CAM_CIV_0070826	CAM_CIV_0070826	DAP246-OCH.mcd
CAM_CIV_0070827	CAM_CIV_0070828	Calculations for the "DL" BOP Outer Cylinder Head
CAM_CIV_0070829	CAM_CIV_0070829	DAP246-LR.mcd
CAM_CIV_0070830	CAM_CIV_0070831	Calculations for "Lock Ring Teeth", 18-3/4" 10M DL Annular BOP
CAM_CIV_0070832	CAM_CIV_0070832	18-3/4" 10M# 'DL' Annular BOP W/Anti-Rotation Key / SK-013908-03
CAM_CIV_0070833	CAM_CIV_0070833	DIM. Drawing Body, 18-3/4" 10M# PSI WP 'DL' Annular BOP
CAM_CIV_0070834	CAM_CIV_0070834	DIM. DWG-Top 18-3/4" -10M DL Flgd Btm X Stdd Top
CAM_CIV_0070835	CAM_CIV_0070835	DIM. DWG-Piston 18-3/4" -10M DL
CAM_CIV_0070836	CAM_CIV_0070836	DIM. DWG-Outer Cylinder Head 18-3/4" -10M DL
CAM_CIV_0070837	CAM_CIV_0070837	Dimensional Drawing Lock Ring, 18-3/4" 10M# 'DL' Annular BOP
CAM_CIV_0070838	CAM_CIV_0070838	Closing Pressure Required by 18-10 D/DL Annular
CAM_CIV_0070839	CAM_CIV_0070839	Design Validation
CAM_CIV_0070840	CAM_CIV_0070841	Engineering Test Specification
CAM_CIV_0070842	CAM_CIV_0070842	Strain - Gauge Tests (1st Run) / 18 3/4" - 10,000# W.P. Studded X Studded Type D BOP
CAM_CIV_0070843	CAM_CIV_0070844	18 3/4 10 KSI 'D' BOP
CAM_CIV_0070845	CAM_CIV_0070846	18 3/4 - 10M 'D' BOP at 15000 PSI Finite Element / Strains in (Illegible), Stress in KPSI
CAM_CIV_0070847	CAM_CIV_0070856	Untitled
CAM_CIV_0070857	CAM_CIV_0070860	Untitled

CAM_CIV_0070861	CAM_CIV_0070869	18 3/4 - 10000 D BOP Strain Gage Test Top Bore Hoop Strain CH-18, 19
CAM_CIV_0070870	CAM_CIV_0070871	Untitled
CAM_CIV_0070872	CAM_CIV_0070872	Engineering Report Abstract / Report Number: 1955 / Stripping Life Test - Standard 18-3/4" - 10M Annular Packer
CAM_CIV_0070873	CAM_CIV_0070873	Engineering Report Abstract / Report Number: 3600 / 18-3/4: 10M Annular, Cold Temperature Test
CAM_CIV_0070874	CAM_CIV_0070874	Engineering Report Abstract / Report Number: 3311 / Sealing Performance Test, 18-3/4" 10M DL Annular for BP Paul B Loyd Junior Flat Packs at Cold Temperature
CAM_CIV_0070875	CAM_CIV_0070875	Engineering Report Abstract / Report Number: 3221 / 18-3/4" 10M DL Annular High Temperature Test
CAM_CIV_0070876	CAM_CIV_0070876	Engineering Report Abstract / Report Number: 3043 / 18-3/4"-10M D/DL Annular Packer/Donut Assembly Fatigue Testing
CAM_CIV_0070877	CAM_CIV_0070877	Engineering Report Abstract / Report Number: 3221 / 18-3/4" 10M DL Annular High Temperature Test
CAM_CIV_0070878	CAM_CIV_0070878	Engineering Report Abstract / Report Number: 3320 / 18-3/4" 10M Type' D/DL' Annular Assembly with M1-84 Compound with no Post Cure Qualification Fatigue Test
CAM_CIV_0070879	CAM_CIV_0070879	Engineering Report Abstract / Report Number: 3311 / Sealing Performance Test, 18-3/4" 10M DL Annular for BP Paul B Loyd Junior Flat Packs at Cold Temperature
CAM_CIV_0070880	CAM_CIV_0070880	Engineering Report Abstract / Report Number: ER-3653 / Fatigue Test on 18 3/4"-10M Annular Assembly with Molded Bore
CAM_CIV_0070881	CAM_CIV_0070881	Engineering Report Abstract / Report Number: 3600 / 18 3/4"-10M DL Annular, Cold Temperature Test
CAM_CIV_0070882	CAM_CIV_0070882	Engineering Report Abstract / Report Number: ER-3769 / Fatigue Test on 18 3/4"-10M D/DL Annular Assembly Manufactured with Compound M1-85 Mixed by Gold Key
CAM_CIV_0070883	CAM_CIV_0070883	Design Review & Verification
CAM_CIV_0070884	CAM_CIV_0070884	18 3/4" -10,000 D/DL Annular BOP Product Requirements
CAM_CIV_0070885	CAM_CIV_0070887	Type Approval Certificate No. D-2999
CAM_CIV_0070888	CAM_CIV_0070889	Independent Review Certificate No: HOE-318920/2008
CAM_CIV_0070890	CAM_CIV_0070890	Design Changes
CAM_CIV_0070891	CAM_CIV_0070891	Engineering Report Abstract / Report Number: 3043 / 18 3/4"-10M D/DL Annular Packer/Donut Assembly Fatigue Testing

CAM_CIV_0070892	CAM_CIV_0070892	Engineering Report Abstract / Report Number: 3320 / 18 3/4"-10M Type 'D/DL' Annular Assembly with M1-84 Compound with no Post Cure Qualification Fatigue Test
CAM_CIV_0070893	CAM_CIV_0070893	Engineering Report Abstract / Report Number: ER-3653 / Fatigue Test 18 3/4"-10M Annular Assembly with Molded Bore
CAM_CIV_0070894	CAM_CIV_0070894	Engineering Report Abstract / Report Number: ER-3769 / Fatigue Test on 18 3/4"-10M D/DL Annular Assembly Manufactured with Compound M1-85 Mixed by Gold Key
CAM_CIV_0078870	CAM_CIV_0078870	Email from C. Erwin to D. McWhorter re: Upgrade oppurtunities.xlsx Attachments: Upgrade oppurtunities .xlsx
CAM_CIV_0078871	CAM_CIV_0078871	Native of produced spreadsheet
CAM_CIV_0270293	CAM_CIV_0270299	Cameron Engineering Bulletin 859
CAM_CIV_0311314	CAM_CIV_0311318	R: Rigs w/Cameron BOP stack with 2 shear ram cavities
CAM_CIV_0334582	CAM_CIV_0334767	02_TLBOP with ST-Locks.pdf
CAM_CIV_0335363	CAM_CIV_0335363	CC-TLBOP-ST-06 Accessories and Options.ppt
CAM_CIV_0357411	CAM_CIV_0357474	Engineering Report Abstract / Report Number: 3815 / 18-3/4 15K TL cDVS Ram Fatigue Test
CAM_CIV_0375738	CAM_CIV_0375741	Field Performance Reports - FPR Number 221870.pdf
CAM_CIV_0375743	CAM_CIV_0375746	Field Performance Reports - FPR Number 221928.pdf
IMS065-005745	IMS065-005751	Casing Design Worksheet: Drilling Casing (Well #A6)
IMS065-006059	IMS065-006079	Marathon Oil Company Drilling Program, South Pass 87 #6BP1, OCS-G-07799, Aquarius Prospect
IMS065-006496	IMS065-006502	Casing Design Calculations
IMS065-007465	IMS065-007468	bhpbilliton, Green Canyon 654, OCS-G-20085 #2, Shenzi Prospect
IMS084-005585	IMS084-005590	Casing Design Summary
N/A	N/A	Joint Cover Memo and BOEM Report
N/A	N/A	Republic of the Marshall Islands Investigation Report
N/A	N/A	Expert Report of Gregg Perkin (PSC)
N/A	N/A	Expert Report of Rory Davis (US)
N/A	N/A	30 CFR 250.442 and 30 CFR 250.443
N/A	N/A	30 C.F.R. 250.442(b)
N/A	N/A	2011-09-23 Expert Report of Greg Childs (Transocean).pdf
N/A	N/A	30 CFR 250.413
N/A	N/A	FEA drill pipe buckling and shearing models and associated files

N/A	N/A	Macondo Well Incident, Cameron 18-3/4" - 15,000 TL-BOP, Calculation of vertical friction of 5-1/2" Drill Pipe in 6-5/8" - 3-1/2" Variable Bore Pipe Rams (VBRs)
N/A	N/A	Expert Report of David L. O'Donnell (Cameron)
N/A	N/A	Expert Report of Glen Stevick, Ph.D., P.E. (Halliburton)
N/A	N/A	Expert Report of Knight Hawk (Cameron)
N/A	N/A	30 CFR 250.105
N/A	N/A	30 CFR 250.107
N/A	N/A	30 CFR 250.132
N/A	N/A	30 CFR 250.1503
N/A	N/A	30 CFR 250.401
N/A	N/A	30 CFR 250.416
N/A	N/A	30 CFR 250.417
N/A	N/A	30 CFR 250.440
N/A	N/A	30 CFR 250.446
N/A	N/A	Photographs of DWH BOP, riser, pipe segments
PSC-MDL2179-005060	PSC-MDL2179-005259	DNV Report Vol. I
PSC-MDL2179-005260	PSC-MDL2179-005610	DNV Report Vol. II
TRN-INV-00032368	TRN-INV-00032372	DOC-00008012 HQS_OPS_EAL_BOPR_005.pdf
TRN-INV-01747442	TRN-INV-01747659	Transocean Investigation Report Vol. 1.pdf
TRN-INV-01747660	TRN-INV-01748295	Transocean Investigation Report Vol. 2.pdf
TRN-MDL-00001641	TRN-MDL-00001680	
TRN-MDL-00049105	TRN-MDL-00049519	RBS 8D - Multiplex BOP Control System Volume 1 - System Manual, Maintenance Valves & Regulators
TRN-MDL-00069825	TRN-MDL-00069837	
TRN-MDL-00272700	TRN-MDL-00272832	SINTEF Report
TRN-MDL-00501351	TRN-MDL-00501374	Technical Information Bulletin
TRN-MDL-00505381	TRN-MDL-00505418	Transocean DP Incident Summary and Analysis
TRN-MDL-01622406	TRN-MDL-01622529	bp Omission Profile 042902_.doc
TRN-MDL-02170944	TRN-MDL-02170945	SK-019490-04.DWG
XRD005-000292	XRD005-000347	Assess the Acceptability and Safety of Using Equipment, Particularly BOP and Wellhead Components, at Pressures in Excess of Rated Working Pressure