Evaluation of Casing Design Basis for

Macondo Prospect

Mississippi Canyon Block 252

OCS-G-32306 Well No.1

Revision 4

22 March 2010

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EPT Drilling

EPT

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Casing Summary

Macondo Prospect: Based on the detailed analysis the following tubulars are recommended:

Jet:	36" 552.69 ppf, 1.500" wall, Grade X80, NOV/GP XLW
Conductor:	28" 218.27 ppf, 0.750" wall, Grade X56, NOV/GP XLW
Surface:	22" 224.49 ppf, 1.000" wall, Grade X80, NOV/GP XLF
Surface Liner:	18" 116.09 ppf, 0.625" wall, Grade P110, TenarisHydril 511
Intermediate:	16" 96.00 ppf, 0.575" wall, Grade P110, TenarisHydril 511
Intermediate Liner:	13-5/8" 88.20 ppf, 0.625" wall, Grade Q125, VAM SLIJ-II
Drilling Liner:	11-7/8" 71.80 ppf, 0.582" wall, Grade Q125, VAM SLIJ-II
Production Liner:	9-7/8" 62.8 ppf, 0.625" wall, Grade Q125, VAM SLIJ-II
Production Casing:	9-7/8" 62.8 ppf, 0.625" wall, Grade Q125, VAM SLIJ-II by 7" 32.0 ppf, 0.453" wall, Grade C110, VAM SLIJ-II or 7-5/8" 39.00 ppf, 0.500" wall, Grade Q125, VAM SLIJ-II or TenarisHydril 523

Casing weights and grades were selected by; 1) the minimum required to meet the design requirements, and/or 2) standardized combinations for ease of procurement and minimization of BP OCTG stock, and/or 3) the standard tubulars for DW GOM wells. To use up BP stock other connections from the BP Approved Connection List for the are acceptable. The SF_A could change with a change in connection, but nothing significant is anticipated. Based on the above tubular recommendations, a dispensation from the BP Drilling and Well Operations Policy is required for the 22" Surface casing, and 16" Intermediate casing.

Revision 1 changes the 16" from 109.00 ppf and a full string to 96.00 ppf and a liner with the TOL in the 22" 1.500" wall X80 surface casing. Also the 11-7/8" drilling liner is changed to a 13.625" SET.

Revision 2 changes the setting depth of the 22", 18", 16", 13-5/8" and 11-7/8". PTD is changed to 20200 ft and the PP and FG were revised slightly.

Revision 3 changes the setting depth of the 16", 13-5/8", changes the SET back to 11-7/8" and changes the depth.

Revision 4 changes the setting depth of the 16", 13-5/8", 11-7/8"; changes the 9-7/8" Production casing to a liner, and adds a 9-7/8" by 7" or 7-5/8" Production tieback, see Attachment 4

This is a sub-sea well designed for production, but is not designed for any H_2S Service. Evaluation for the mitigation for APB (Annular Pressure Build-up), is required.

Introduction

The design basis for this well was evaluated using the BP Casing Design Manual (CDM) recommended loads (see Tables B.1 – B.4), the requirements of the BP Drilling

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and Well Operations Policy (DWOP), and the Advanced Guidelines for Deepwater Well Design. The evaluation was done using the Landmark StressCheck Version 2003.16 Build 1061 software.

Burst: Current suggested BP drilling design load recommendations for internal yield, or burst, are based on a gas gradient to the surface equivalent to the formation fracture pressure at the casing shoe, ***Frac @ Shoe w/Gas Gradient Above*** (FAS), internal with pore pressure in the open hole and mud and/or cement mix fluid density inside pipe external, for drilling loads. The secondary ***Gas Kick Profile*** (GKP) is based on a 100 bbl influx and a kick intensity (KI) of 2.0 ppg. The use of the Limited Kick (LK) load case, with a statistically calculated kick intensity (KI) per CDM BPA-D-003 6.5.2, has been discontinued. For development wells, where no hydrocarbons are expected before the next casing string is set, a load case based on a water gradient to surface equivalent to the formation fracture pressure at the casing shoe, ***Lost Returns with Water*** (LRW), internal with pore pressure and mud and/or cement mix fluid density external, for drilling loads, may be used. A fourth drilling load case that may be considered is based on historical data that implies that kicks generally have an influx of no more than 20 bbl and that the surface pressure is infrequently greater than 1/3 the BHP, ***Frac @ Shoe w/1/3 BHP at Surface*** (1/3 BHP). For production loads, the burst recommendation is based on a ***Tubing Leak*** at the surface plus the hydrostatic head of the packer fluid (TL) internal with pore pressure and mud and/or cement mix fluid density external. For injection applications (water injection, formation fracturing, etc.) the load cases are ***Stimulation Surface Leak*** (SSL) and ***Injection Down Casing*** (IDC) The SSL models maximum injection pressure at the surface plus the hydrostatic head of the packer fluid internal, with pore pressure and mud and/or cement mix fluid density external. The IDC models maximum injection pressure at the surface plus the hydrostatic head of the injection fluid internal, with pore pressure and mud and/or cement mix fluid density external.

Collapse: The collapse recommendation for drilling loads is based on ***Lost Returns with Mud Drop*** (LRMD) until the hydrostatic head equalizes with the loss formation pore pressure. The default is maximum exposed drilling mud density internal below the fluid level and the mud density pipe was set in external. More extreme could be the ***Partial/Full Evacuation*** (P/F Evac) load case depending on the fluid level and internal fluid density selected. For production loads the mud density the casing was set in is external with full evacuation internal below the packer and packer fluid density above the packer internal, ***Above/Below Packer*** (A/B Pkr).

Abbreviations

1/3 BHP: Burst load case for fracture at shoe w/1/3 BHP at Surface
A/B Pkr: Collapse load case for Above/Below Packer
APB: Annular Pressure Build-up due to thermal effects and trapped annuli
bbl: Barrel/barrels of fluid
BML: Below mud line
BU: Back-up, external fluid
CDM: BP Casing Design Manual, BPA-D-003
CMTG: Collapse load case for cementing operations
DWOP: BP Drilling and Well Operations Policy, BPA-D-001

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IDC: Burst load case for Injection Down Casing
FAS: Burst load case for Frac @ Shoe w/Gas Gradient Above
KI: Kick intensity
GKP: Burst load case for Gas Kick Profile
LRMD: Collapse load case for Lost Returns with Mud Drop
LRW: Burst load case for Lost Returns with Water
m: meters
MD: Measured depth
MIY: Minimum Internal Yield
PP: Pore pressure
P/F Evac: Collapse load case for Partial/Full Evacuation
ppf: Pounds per foot, mass of steel tubes
ppg: pounds per gallon, density of fluid
PT: Pressure test
PTD: Proposed total depth
SF_X: Safety factors; $_B$-burst, $_C$-collapse, $_A$-axial $_{VME}$-triaxial
sg: Specific gravity
SSC: Sulfide Stress Cracking
SSL: Burst load case for Stimulation Surface Leak
TL: Burst load case for Tubing leak
TOC: Top of cement
TOL: Top of liner
TVD: True vertical depth

Macondo Prospect Description

This evaluation is for a medium pressured, average temperature, 18250 ft TVD/MD development well with an anticipated maximum PP of 13.9 ppg (13190 psi) at PTD. The bottom hole temperature is estimated at 267°F. The well will be drilled as a subsea well in 4992 ft of water. Pore pressures, fracture gradients, temperatures, casing sizes, and setting depths were supplied by the Macondo Prospect drilling team based on geophysical, geological, and offset information, see attachments 1, 2, and 3.

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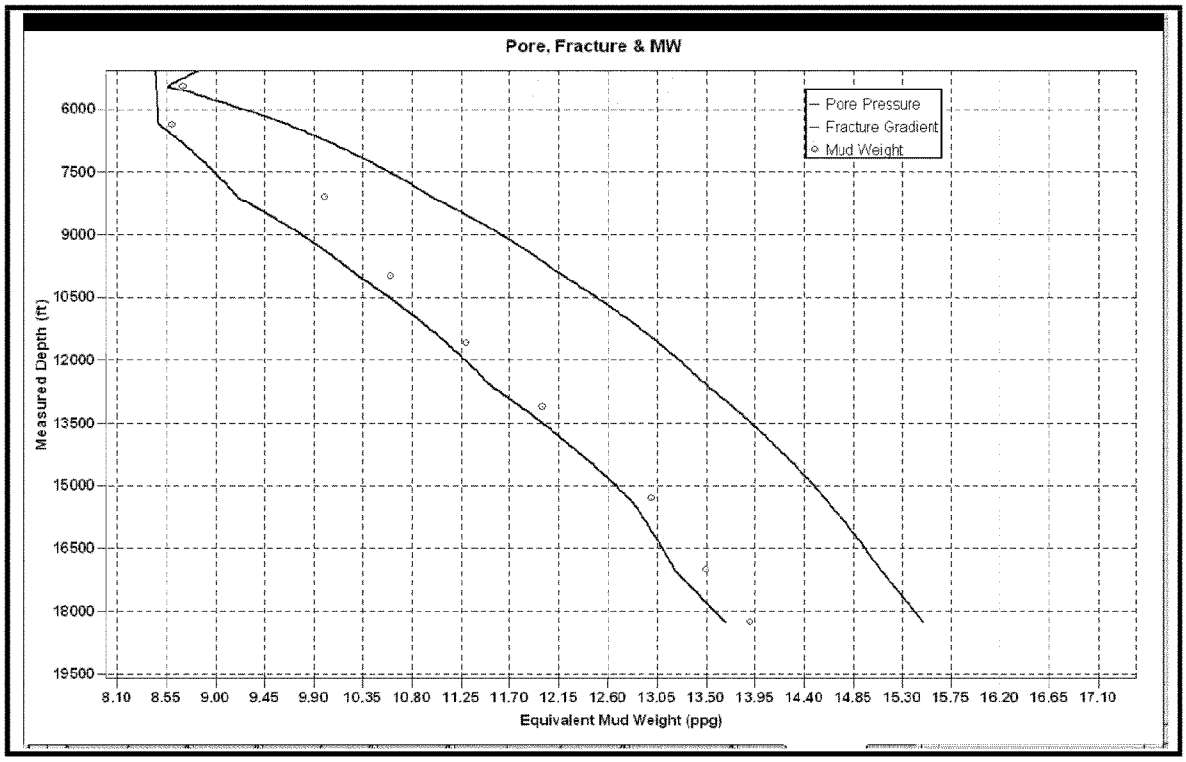
Figure 1: Macondo Prospect MC252 Proposed Formation Pressure Profiles R4



The casing pressure test (PT) loads were selected to provide results at or near the worst case burst load and have not been checked for compliance with any government requirements. The final design factors do not include any allowance for casing wear.

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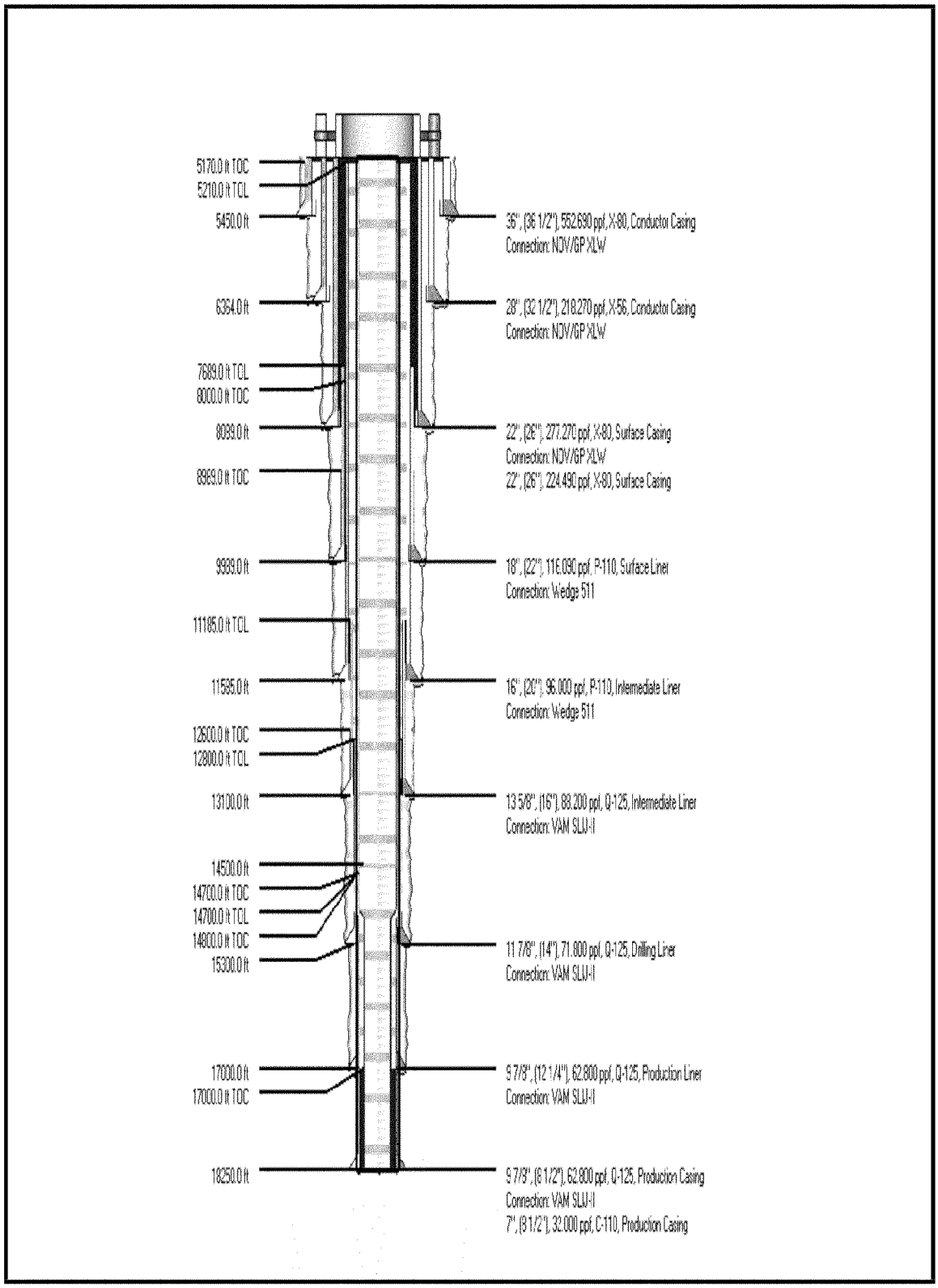
Figure 2: Macondo Prospect MC252Proposed Casing R4



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Macondo Prospect Design Detail

Jet: 36" 552.69 ppf, 1.500" wall, Grade X80, NOV/GP XLW set 5081-5450 ft.
Meets the BP DWOP requirements. No dispensation required.

Conductor: 28" 218.27 ppf, 0.750" wall, Grade X56, NOV/GP XLW set 5081-6364 ft.
Meets the BP DWOP requirements. No dispensation required.

Surface: 22" 277.27 ppf, 1.250" wall Grade X80 DQ S90 set 5081-5264; 22" 224.49 ppf, 1.000" wall, Grade X80, NOV/GP XLF set 5264-8089 ft.
Does not meet the BP DWOP requirements.

a) FAS: SF_B 0.97, SF_{VME} 1.15 w/7.6 ppg BU

Changing the load to a GKP load case, based on a 100 bbl influx with a KI of 2.0 ppg, results in acceptable design factors.

b) GKP: SF_B 2.20, SF_{VME} 2.46 w/7.6 ppg BU

Note: The above factors are based on top of the 16" liner being hung in the supplemental adapter in the 1.250" wall section. If the 1.000" wall pipe is exposed the factors will be lower, but still acceptable.

A dispensation is required to use the BP GKP load case for the burst load case.

Surface Liner: 18" 116.09 ppf, 0.625" wall, Grade P110, TenarisHydril 511 set 7689-9989 ft
Meets the BP DWOP requirements. No dispensation required.

a) FAS: SF_B 2.24, SF_{VME} 2.80 w/7.6 ppg BU

Intermediate Casing: 16" 96.00 ppf, 0.575" wall, Grade P110, TenarisHydril 511 set 5210-11585 ft
Does not meet the BP DWOP burst design requirements.

a) FAS: SF_B 0.74, SF_{VME} 0.93 w/7.6 ppg BU

Changing the load to a GKP load case, based on a 100 bbl influx with a KI of 2.0 ppg, results in acceptable design factors.

b) GKP: SF_B 1.06, SF_{VME} 1.32 w/7.6 ppg BU

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This result is close enough with the very conservative 7.6 ppg external fluid density, an increase of less than 1.0 ppg increases the SF_B and SF_{VME} factors to greater than the recommended minimum of 1.10 and 1.25 respectively.

A dispensation is required to use the BP GKP load case for the burst load case.

Intermediate Liner: 13-5/8" 88.20 ppf, 0.625" wall, Grade Q125, VAM SLIJ-II set 11285-13100 ft

Meets the BP DWOP requirements. No dispensation required.

a) FAS: SF_B 1.25, SF_{VME} 1.56 w/7.6 ppg BU

Drilling Liner: 11-7/8" 71.80 ppf, 0.582" wall, Grade Q125, VAM SLIJ-II set 12800-15000 ft

Meets the BP DWOP requirements. No dispensation required.

a) FAS: SF_B 1.40, SF_{VME} 1.75 w/7.6 ppg BU

Drilling or Production Liner: 9-7/8" 62.80 ppf, 0.625" wall, Grade Q125, VAM SLIJ-II set 14700-17000 ft

Meets the BP DWOP drilling and production burst and collapse design requirements.

a) FAS: SF_B 1.90, SF_{VME} 2.35 w/7.6 ppg BU

The FAS drilling load case is based on the liner set above PTD at 17000 ft MD. The production load cases are based on the 9-7/8" liner set at PTD of 18250 ft MD. If the 9-7/8" is set as a liner it will be a drilling liner and eventually covered by the 7" or 7-5/8" Production casing

b) TL: SF_B 2.00, SF_{VME} 2.33 w/7.6 ppg BU

c) A/B Pkr: SF_C 0.83, SF_{VME} 1.24 w/a 0 ppg fluid density below the packer

To improve these results we can increase the collapse resistance of the pipe or decrease the collapse load requirements. The A/B Pkr load case default is a design with PP external and zero (0) pressure internal, this would simulate a well that would not flow and was jetted of all fluid to below the perforations. This would certainly be a worst case scenario; however I have seen it happen so know it can occur. If we assume that we will not jet the well dry, the minimum internal load is from a column of dry gas at the abandonment pressure, and the external load is original PP the collapse load is acceptable. I assumed an abandonment pressure of 4955 psi at the perforations or about 3130 psi (assuming 0.1 psi/ft) at the wellhead, which is equivalent to about 5.2 ppg fluid density.

d) A/B Pkr: SF_C 1.25, SF_{VME} 1.99 w/a 5.2 ppg fluid density below the packer

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Production Casing: 9-7/8" 62.80 ppf, 0.625" wall, Grade Q125, SLIJ-II set 5081-14500 ft and 7" 32.00 ppf, 0.453" wall, Grade C110 VAM SLIJ-II or 7-5/8" 39.00 ppf 0.500" wall Grade Q125, VAM SLIJ-II set 14500-18250 ft

Meets the BP DWOP production burst design requirements.

9-7/8" a) TL: SF_B 1.47, SF_{VME} 1.65 w/7.6 ppg BU

7" b) TL: SF_B 1.86, SF_{VME} 1.31 w/7.6 ppg BU

7-5/8" c) TL: SF_B 2.15, SF_{VME} 1.72 w/7.6 ppg BU

The 7" and 7-5/8" do not meet the production collapse design requirements

9-7/8" d) A/B Pkr: SF_C 1.06, SF_{VME} 1.63 w/a 0 ppg fluid density below the packer

7" e) A/B Pkr: SF_C 0.82, SF_{VME} 1.14 w/a 0 ppg fluid density below the packer

7-5/8" f) A/B Pkr: SF_C 0.91, SF_{VME} 1.32 w/a 0 ppg fluid density below the packer

To improve these results we can increase the collapse resistance of the pipe or decrease the collapse load requirements. The A/B Pkr load case default is a design with PP external and zero (0) pressure internal, this would simulate a well that would not flow and was jetted of all fluid to below the perforations. This would certainly be a worst case scenario; however I have seen it happen so know it can occur. If we assume that we will not jet the well dry, the minimum internal load is from a column of dry gas at the abandonment pressure, and the external load is original PP the collapse load is acceptable. I assumed an abandonment pressure of 4955 psi at the perforations or about 3130 psi (assuming 0.1 psi/ft) at the wellhead, which is equivalent to about 5.2 ppg fluid density.

7" g) A/B Pkr: SF_C 1.21, SF_{VME} 1.82 w/a 5.2 ppg fluid density below the packer

7-5/8" h) A/B Pkr: SF_C 1.35, SF_{VME} 1.72 w/a 5.2 ppg fluid density below the packer

This Production casing design does not have tapered string for any potential large SSSV in the tubing string.

It should also be noted that this production casing is not designed for any H2S service.

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Well Summary

The well summary table below, from StressCheck, is from the file that has the acceptable design/load case options discussed above for each casing string.

StressCheck Well Summary for the Macondo Prospect MC252 R4

String	OD/Weight/Grade	Connection	MD Interval (m)	Drift Dia. (in)	Minimum Safety Factors			
					Burst	Collapse	Axial	Triaxial
Conductor Casing	36", 552.690 ppf, X-80	NOV/GP XLW	5081.0-5450.0	32.813	9.73 C	1.30	5.60 C	2.73
Conductor Casing	28", 218.270 ppf, X-56	NOV/GP XLW	5081.0-6364.0	26.313	2.63	1.59	3.67	2.91
Surface Casing	22", 277.270 ppf, X-80	NOV/GP XLW	5081.0-5264.0	19.313	2.08 C	7.98	4.63	2.36
	22", 224.490 ppf, X-80	N/A	5264.0-8089.0	19.813	1.59	3.07	4.37	1.87
Surface Liner	18", 116.090 ppf, P-110	Wedge 511	7689.0-9989.0	16.563	2.46	3.23	3.91 C	2.81
Intermediate Liner	16", 96.000 ppf, P-110	Wedge 511	5210.0-11585.0	14.75	* 1.06	1.77	2.27 C	1.32
Intermediate Liner	13 5/8", 88.200 ppf, Q-125	VAM SLIJ-II	11185.0-13100.(	12.250 A	1.25	5.63	3.21 C	1.56
Drilling Liner	11 7/8", 71.800 ppf, Q-125	VAM SLIJ-II	12800.0-15300.(	10.625 A	1.39	5.13	3.18 C	1.74
Production Liner	9 7/8", 62.800 ppf, Q-125	VAM SLIJ-II	14700.0-17000.(	8.500 A	2.00	1.35	(2.03) C	2.18
Production Casing	9 7/8", 62.800 ppf, Q-125	VAM SLIJ-II	5081.0-14500.0	8.500 A	2.92 C	1.58	2.38 C	2.58
	7 5/8", 39.000 ppf, Q-125	VAM SLIJ-II	14500.0-18250.(	6.5	2.58 C	1.35	(1.29) C	2.09

* S.F. Below D.F.
C Conn Critical
A Alternate Drift
( ) Compression

Attachment 1: Schematic and Well Data R2

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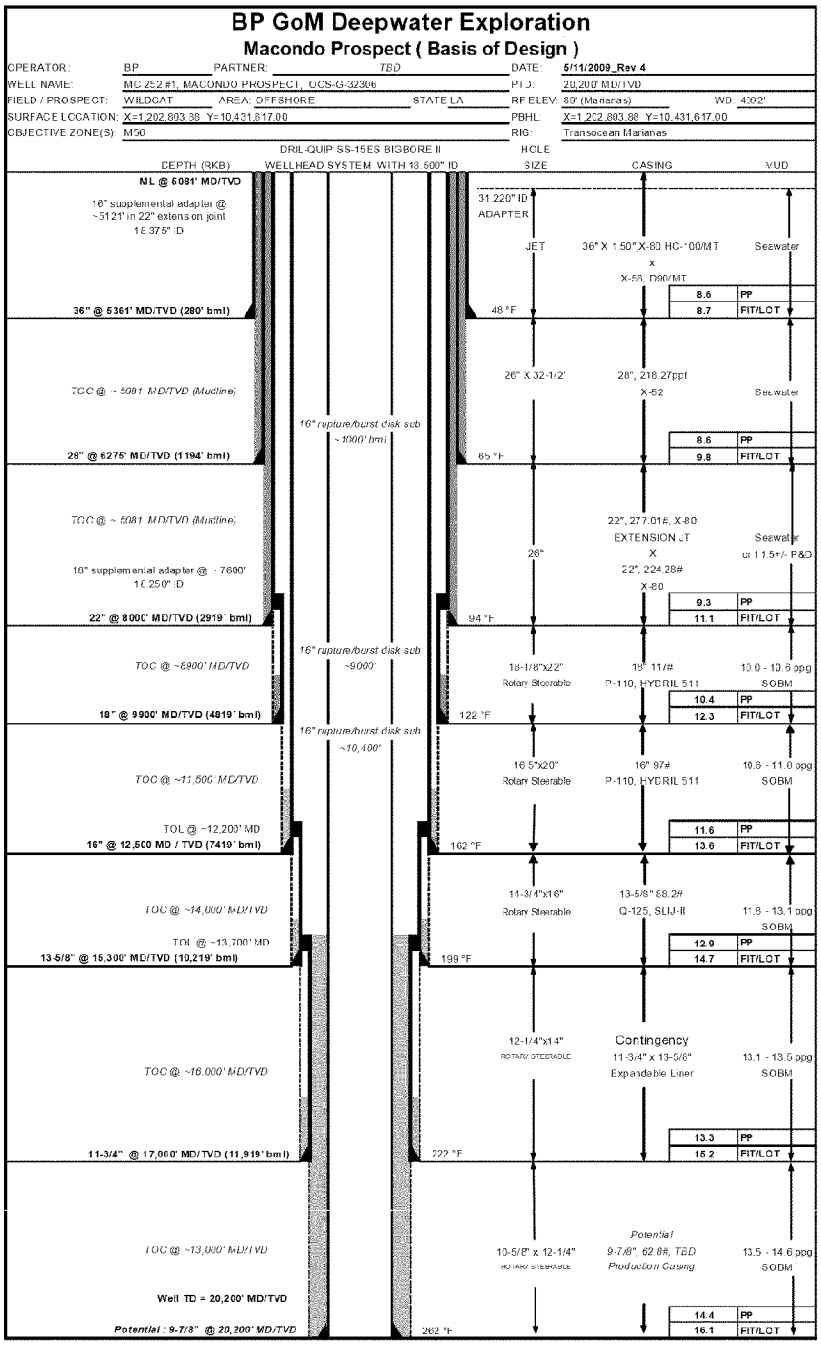

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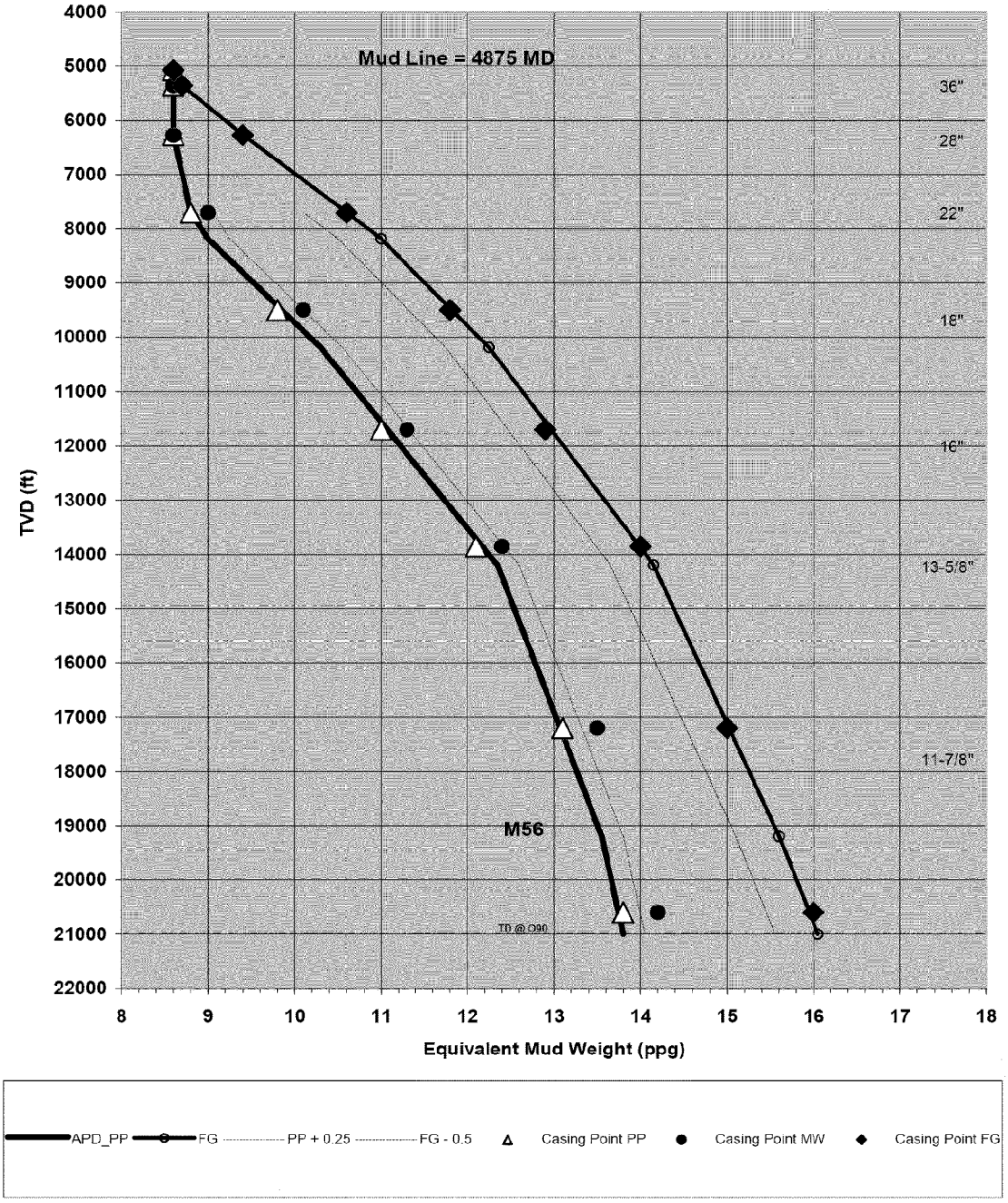
Attachment 2: PP/MW/FG Pressure Prediction

MC 252 - Macondo Prospect , PP/MW/FG Pressure Prediction



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Attachment 3: Well Data

Data for MMS PP/MW/FG chart - MC 252 Macondo - revB: 2/4/09

Feb 4, 2009 updated WD to 4992' from shallow hazard work

New casing depths: PP/MW/FG curves updated

added 192' for WD increase over original Draft Casing plan

Depth	PP	FG	PP + 0.25	FG - 0.5
5081	8.6	8.6		
5361	8.6	8.7		
6267	8.6	9.4		
7692	8.8	10.6	**9.05**	**10.1**
8192	**9**	11	**9.25**	**10.5**
10192	10.3	12.25	**10.55**	**11.75**
14192	**12.35**	**14.15**	**12.6**	**13.65**
19192	13.55	15.6	**13.8**	**15.1**
21000	13.8	16.05	**14.05**	**15.55**

Casing Point Data

Size	MD	PP	MW	FG	Top of Casing	Footage Req'd	Csg Wt./ft	Air String Wt. Klbs
ML	5081	8.6	8.6	8.6	-	-	-	-
36	5361	8.6	8.6	8.7	4865	496		
28	6275	8.6	8.6	9.4	4870	1405	218	306
22	7700	8.8	9.0	10.6	4865	2835	224	635
18	9500	9.8	10.1	11.8	7100	2400	117	281
16	11700	11.0	11.3	12.9	4905	6795	97	659
13.625	13850	12.1	12.4	14.0	11200	2650	88.2	234
11.875	17200	13.1	13.5	15.0	13150	4050	71.8	291
9.875	20600	13.8	14.2	16.0	4865	15735	62.3	980

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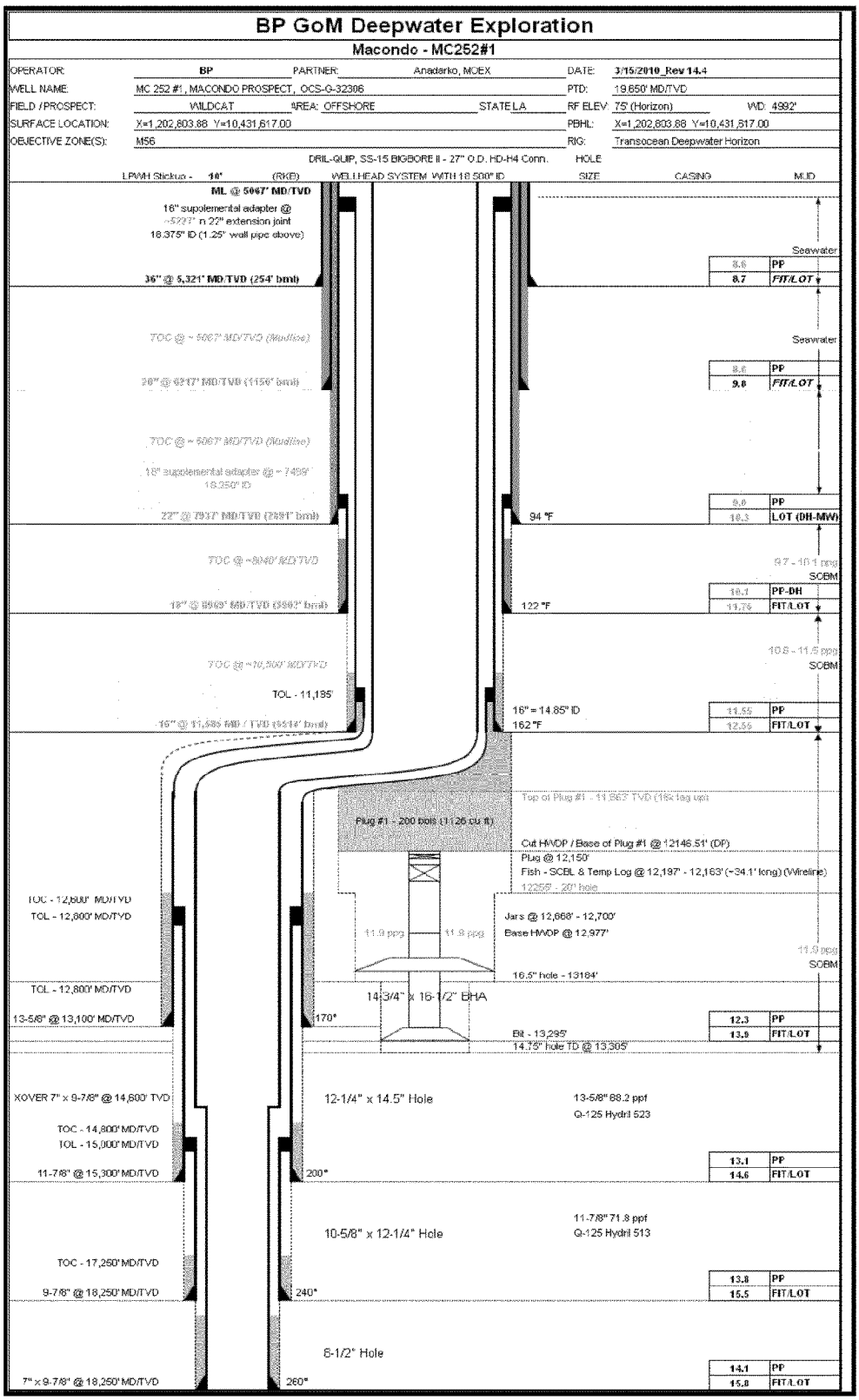
Attachment 4: Proposed Wellbore Drawing March 2010



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