From: Merrill, Robert C
Sent: Fri Jul 02 19:08:47 2010
To: William Burch
Cc: Baker, Kate H (Swift); Wulf, Gary T; Willson, Stephen SM; Mason, Mike C
Subject: Macondo Technical Note - Depletion for Relief Well vA.doc
Importance: Normal
Attachments: Macondo Technical Note - Depletion for Relief Well vA.ZIP

Bill:
Thank you for reminding that I "owed you" this note. These are the revised number which I promised the other day. They are consistent with the values of reservoir pressure which we shared with the authorities yesterday.
Let me know if you'd would like more information.
Bob
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Macondo Technical Note

Title:	Depleted Pressure for Relief Well Planning
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Issued by:	Bob Merrill
Date:	July 2, 2010
Version:	A – DRAFT

Question Addressed in this Technical Note:

The team planning the relief well has requested an estimate of the pressures which they may encounter at the reservoir interval.

Key Conclusions

The likely maximum pressure in the M56E (main oil sand) is 11,260 psia. The likely minimum pressure is 9,360 psia. This range is due to the uncertainty in aquifer support and flowrate.

Simulated Reservoir Pressures on 1-July

		4x Aquifer		No Aquifer	
	Initial P	35 mbd	70 mbd	35 mbd	70 mbd
M57B	12,850	11,570	10,900	11,380	10,610
M57C	13,020	12,870	12,800	12,860	12,770
M56A	12,040	9,890	8,130	9,170	6,960
M56B	12,040	10,880	9,900	10,400	9,150
M56C	12,040	11,770	10,340	10,630	9,560
M56D	11,840	11,540	11,240	11,210	10,620
M57E	11,860	11,260	10,670	10,550	9,360
M57F	11,880	11,520	11,180	11,110	10,400

The main oil sand is highlighted.

- A large aquifer would be associated with higher pressures ("large" referring to the geologist's largest mapped aquifer extent of 4x the oil column). The aquifer's effectiveness leads to an uncertainty of 1,000 psia in the reservoir pressure.

- The depletion is directly proportional to the flowrate. These cases were run at fixed rates of 35, 40, 50 and 70mbd. This range of flowrates leads to an uncertainty of between 600 and 1200 psia in the M56E (depending on aquifer size).

- The M56A sand, a permeable, 3 ft sand which is 300 ft above the main sand, is likely to see the largest depletion of any reservoir sand. It's depletion could be as large as 5,000 psi, and average values yield depletions of 2,000 psi.

Assumptions / Discussion

1. The calculation was performed using a VIP simulation model with the following parameters:
   - Oil B_{oi}: 2.345 rb/stb
   - c_f: 6 x 10-6 $psia^{-1}$
   - c_w: 3 x 10-6 $psia^{-1}$
   - GOR: 2993 SCF/stb
   - OOIP: 109.9 mmstb
   - Reservoir Volumes: Oil: 257.8 mmrb, S_{wc}: 9.7% (in M56E, varies in other zones), Aquifer: 991.6 mmrb (excludes connate water, 3.8x oil volume)
2. The model is a stylized representation of the reservoir, with each layer homogeneous, and no dip.
   - The model includes the M57(B, C) and M56(B, C, D, E, F) sands, and was originally created to address whether the wellbore could become gas filled during shut-in at the "topkill."
   - The M57 gas sands have a higher initial pressure than the main oil sands; they are modelled with a limited areal extent. These sands contribute some flow for the first 10 days of production, during which time the predicted GOR drops from 4,600 SCF/stb to 3030 SCF/stb.
3. Reservoir sands' properties and depths were modelled per spreadsheet "MC252 – 1 Sand Description v2.xls", (24-May, email Kelly McAughan, attached). The sands without permeability but calculated porosity were assigned a nominal permeability (see table).

Reservoir Properties

Top of Sand MD Depth Feet	Bottom of Sand MD Depth Feet	Top of Sand TVDSS Depth Feet	Bottom of Sand TVDSS Depth Feet	Fluid Content	Expected to flow Used in Modeling	Sand Name	Gross Sand Feet	Net Sand Feet	Pay Sand Feet	Average Gross Porosity %	Average Net Porosity %	Average Pay Porosity %	Average Net Sw %	Average Pay Sw %	Arithmetic Air Perm MD	Geometric Air Perm MD	Geometric Term converted to Oil (85%) MD	Perm Used in Model MD	Temperature Degrees F	Pressure psia
12301.0	12346.0	11945.0	12161.0	Gas	Yes if Liner Leak	S203	7	7	7								1600	N/A	167	7991 psia (based on 11.1 pp
12227.2	13230.2	13141.6	13144.6	Gas	Yes if Liner Leak	S026	3	3	3								1600	N/A	178	8405 psia (based on 12.3 pp
17467.0	17469.0	17381.1	17383.1	Gas	Yes	M57B	2	2	2	17.96	17.96	17.96	51.58	51.58	15.08	7.5	7.50	7.5	234	12847 psia (based on pos: w
17703.0	17708.5	17614.1	17622.6	Uncertain	No	M57C	8.5	0	0	8.36								0.1	237	13017 psia (Geo tap @ 177
17904.0	17906.5	17718.1	17720.6	Oil or Gas	Yes	M55A	2.5	2.5	2.5	22.48	22.46	22.48	24	24	1702.07	467.39	397.28	397.3	239	12038 psia (one MDT press
17973.5	17989.5	17886.5	17902.5	Brine	No	M56B	5	3	0	14.18	16.96		57.55		7.43	3.12		3.0	241	
18030.0	18032.0	17944.1	17946.1	Brine	No	M56C	2	2	0	17.28	17.28		64.2		4.73	4.05		4.0	241	
18067.0	18089.0	17981.1	18003.1	Oil	Yes	M56D	22	22	22	20.67	20.67	20.67	17.17	17.17	257.67	101.8	86.53	86.5	242	11838 psia (MDT & Geotap)
18120.0	18191.0	18034.1	18105.0	Oil	Yes	M56E	69.5	64.5	64.5	21.42	22.08	22.08	9.7	9.7	514.04	328.79	275.22	275.2	243	11856 psia (MDT)
18217.5	18238.5	18131.5	18152.5	Oil	Yes	M56F	6.5	6.5	6.5	21.38	21.08	21.08	21.85	21.85	1440.59	129.67	110.89	110.4	244	11875 psia (based on fluid g
							Vsh<0.4	Poro>0.14	Sw<0.5	Vsh<0.4	Poro>0.14	Sw<0.5								
If Density log is not corrected to match core porosity																				
18067.0	18089.0	17981.1	18003.1	Oil	No Use Other	M56D	22	22	22	18.32	18.32	18.32	18.55	18.55	26.96	18.46	26.96			

1. From core in M56D and M56E K (Klinkenberg air core at net confining stress = 2000 psi) is a function of core porosity at net confining stress
2. Log porosity is calibrated to core porosity at net confining stress in M56D & M56E
3. Log perm is calculated from core derived equation (from #1)

Gross has Vshale cut off Vsh<0.4
Net has a Porosity cut off Poro>0.14
Pay has a Sw cut off Sw<0.5

Water Depth = 4992 feet