



## Macondo Technical Note

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Title:	Shut-in Pressures: Range and Likelihood
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### Question Addressed in this Technical Note:

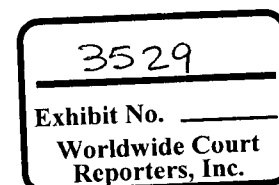
As BP is currently evaluating kill options for the Macondo well, this technical report addresses the following questions:

- What is the likely range of shut-in pressures at the well head (SIWHP)?
- What probability of occurrence can be assigned to each of the calculation methods.
- Is it likely to change over time?

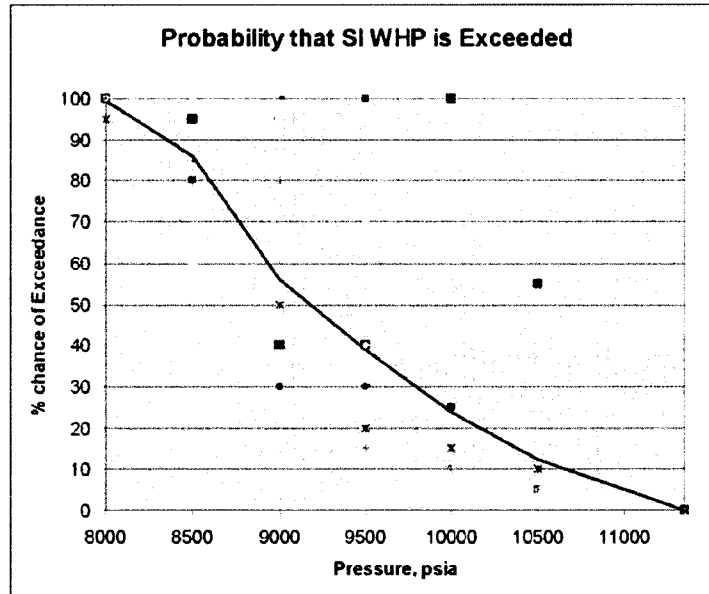
This note expands upon earlier work documented in a draft technical note dated 17-May. We are not able answer the third question at this time; there was insufficient time to obtain the results from transient wellbore simulation.

### Key Conclusions

1. The SIWHP is expected to be between ~8,100 psia and 11,350 psia. This range considers the impact of shallower high pressure gas zones, which are found at depths between 17,467 – 17,806 ftMD-RKB.
  - There was consensus that these gas zones were likely to be open, but the contribution and depletion of these zones was an area of uncertainty.
  - The shallower gas zones at 12,030 – 13,320 ftMD-RKB are behind the 13 5/8 inch liner and are not likely to increase the stated range of SIWHP.



2. The team was requested to estimate the likelihood of SIWHP exceeding a number of values. The following figure provides that estimate:



It is clear that the team believes that there is a 20% probability that the SIWHP will exceed 10,000 psia. The team also believes that the SIWHP is only 15% likely to be less than 8,500 psia.

3. The Enterprise has reported considerable variation in the gas-oil ratio of the recovered oil. These GORs range from an initial 2,850 SCF/stb, consistent with the oil's PVT data, to almost 7,500 SCF/stb. The GORs show an increasing trend.
- The 7,500 SCF/stb value is consistent with a calculated SIWHP of ~9,500 psia.
  - The trend of GOR with time influenced the presented cumulative probability chart.

#### Attachments

1. Pressure Ranges and Calculation Methods
2. Method for Establishing probabilities
3. Table of Formation Properties
4. Thermal Gradient

## Model Results of Shut-In Pressure for Macondo Well

Modelled Sand(s)	SI WHP	Tool	Correlation	Gradient
M56E Oil	8,164	Pipesim	EoS Tables	Geothermal
M56F Oil	8,169	Pipesim	EoS Tables	Geothermal
M56D Oil	8,181	Pipesim	EoS Tables	Geothermal
M56e,d,f	8,351	Prosper	Al-Marhoun	Geothermal
M56A Oil	8,481	Pipesim	EoS Tables	Geothermal
Lower Oil Sands + Gas Zone	8,503	Prosper	Al-Marhoun	Geothermal
Lower Oil Sands + Gas Zone	8,605	Prosper	Vasquez-Beggs	Geothermal
M56E Oil	8,232 - 8,860	Excel	Incompressible	none
M56E Gas	10,200	Excel	Hall-Yarborough	linear
M56A (2nd sand @17804) Gas	10,372	Prosper	Al-Marhoun	Geothermal
M56A (as gas-filled)	10,569	Pipesim	EoS Tables	Geothermal
M56A+M57B Gas	10,797	Prosper	Al-Marhoun	Geothermal
M57B Gas	11,184	Prosper	Al-Marhoun	Geothermal
M57B Gas	11,327	Pipesim	EoS Tables	Geothermal
M57B Gas	11,368	Excel	Hall-Yarborough	linear
Oil, GOR = 7500	9,450	Pipesim	Al-Marhoun	Geothermal
Oil, GOR = 7500	9,600	Pipesim	EoS Tables	Geothermal

Draft for Discussion

## Method Used to Develop Cumulative Probabilities

The cumulative probabilities were determined through a polling process. The petroleum and reservoir engineers were presented the model results, the modelling assumptions, and the other considerations / constraints.

Each engineer was asked to consider a range of values (8000, 8500, 9000, 9500, 10000, 10500, and 11350 psia) and estimate in their own best judgement the probability that the SIWHP would exceed that value. As the models predicted a pressure range of 8,100 psia to 11,350 psia, the probability of exceeding 8,000 psia was almost 100% and that of exceeding 11,350 psia was 0%.

After each engineer wrote down their values, they were polled in a random order for their estimated probability. These were then averaged to create a cumulative permeability curve for each pressure.

This was then followed by a discussion of the technical reasons behind the estimates. At the conclusion of this discussion the group consensus was to increase the probabilities of exceedance for 10,000 and 10,500 psia by 5%.

The resulting curve was plotted. The statistics associated with each point (after the 5% shift) are provided in the following table:

Draft for Discussion

Pressure	Mean Probability to Exceed	Min Probability	Max Probability
8,000	99%	95%	100%
8,500	86%	60%	100%
9,000	56%	30%	100%
9,500	39%	5%	100%
10,000	24%	10%	100%
10,500	12%	5%	55%
11,350	0%	0%	0%

# Instructions for Data

	Val=0.4	Poro=0.14	Sw=0.5	Val=0.4	Poro=0.14	Sw=0.5
if Density log is not corrected to match core porosity						
10067.0	10059.0	17681.1	18303.1	1048	2893	23.66
No Use Other	MS62	22	22	22	18.32	18.55

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 calculated from core porosity at net confining stress in M56D & M56E
3. Log perm is calculated from core derived equation (from #1)

Water Depth = 4982 feet

# Thermal Gradient

$$y = 0.0795x^2 + 42.102x + 3152$$

Macondo Temperatures

