26 July 2010

Memorandum

To: Bill Ambrose

From: P. R. Roller

RE: Investigation of Negative Test and Riser Displacement Procedures (Preliminary Report)

Executive Summary

A number of key investigative topics have arisen so far during the course of the Deepwater Horizon Investigation. Two of these points are the negative test performed on incorporated into the temporary abandonment procedures and the riser displacement prior to retrieving the subsea blow out preventers.

In most subsea drilling operations these are two separate and distinct steps in the preparation to disconnect the subsea blowout preventers. During the last day of the Macondo Well on the Deepwater Horizon these, steps were linked together into more of a single step process by the introduction of a densely weighted spacer in the negative test procedures. While this process is uncommon, the weighted spacer itself was unusual in the aspect that it was formed by combining two separate, lost circulation pills that were be being stored on board the rig.

Preliminary results from fluid flow models combined with daily operations reports and witness interviews / testimony indicate the high density, LCM spacer that was pumped prior to commencing the negative test surely complicated the operation and most likely presented confusing pressure readings. Additional analysis of the actual volumes pumped indicates the spacer was under displaced leaving a significant amount below the annular preventer (and across the BOP stack). This also contributed to inaccurate pressure readings and did not achieve the required goal of testing to a sea water differential pressure prior to displacement.

The most common two methods of conducting negative tests involve 1) pumping down either the choke or kill lines with sea water and taking returns up the opposite line (choke or kill) with the blind-shear rams closed and 2) pumping down the drill pipe with the end of the pipe being between less than 500 feet below the mud line and taking returns up either the choke or kill line.

Available flow data shows that the well was in a static condition after the negative test was concluded.

Any findings and recommendations in the final version of this investigation will be forwarded to the respective operations managers for their review and consideration to be relayed to their respective rigs.

Methodology

A survey request was sent to the deepwater rig fleet in order to obtain data from each rig with respect to their negative testing procedures and their methods for displacing the riser to seawater prior to pulling the BOP stack.

The survey form was constructed for standardized questions and also provided options for additional data. Also, any rig specific negative testing and riser displacement procedure that may be employed were also requested.

Additional data was gathered from transcripts of the United States Coast Guard / Bureau of Ocean Energy Management hearings that are currently in progress.

Data and information acquired during the course of the independent Transocean investigation of the causes of the loss of the *Deepwater Horizon* have also been utilized.

It is understood that the investigations and additional USCG/BOEM hearings may provide additional data and insight to the negative testing and displacement operations on the *Deepwater Horizon* just prior to the incident. If additional information is available that would impact the findings of this study, it shall be amended and re-issued.

Summary of Fleet Data

Below is a summary of the compiled data received from the nine rigs.

- A total of nine rigs replied with data from their operations.
- The data from the nine rig covered operations on 24 wells
- Thirteen wells had negative tests conducted prior to displacing the riser and pulling the BOP stack (several of these were performed on completion operations where tubing, and tubing plugs / down-hole safety valves had been installed in the well.
- Eleven wells were listed without any negative test data. All were from operations in Brazil
- Five of the rigs responding included detailed procedures for negative tests, riser displacement and/or plug setting operations.
- A majority of the wells with negative tests had bridge plugs or cement retainers installed. One particular well had three retainers installed with cement plugs on top of each retainer.
- Common test procedures tended to be down the kill line and up the choke line with sea water.
- Displacement depths with one exception were within a few hundred feet of the mud line.

- After negative tests, riser displacement above closed ram preventer was noted from the rigs that submitted written riser displacement details

Deepwater Horizon Negative Test Methods

Previous Test Procedures

Several separate negative test procedures have been discovered in archived rig files. They are listed by last modified date and file name along with a bullet point summary of each procedure:

- 17 August 2007 (Negative Test 2)
  - Pipe across BOP stack
  - Pump base oil down drill string with rig pumps
  - Close Lower Annular preventer
  - Bleed off differential pressure to Halliburton Unit
  - Observe negative test for desired time
  - Place differential pressure back on drill string with Halliburton Unit
  - Pump down choke line and reverse out base oil up drill pipe
  - Line up returns to shale shakers via reverse out line
- 20 September 2007 (Negative Test Down Choke Line)
  - Pipe above BOP stack
  - Pump Sea Water down choke line
  - Close Blind Shear Rams
  - Bleed off through choke to mini-trip tank
  - Test for 15 minutes
  - Pump mud down kill line and take returns up choke line until sea water displaced
- 17 October 2007 (Negative Test Down Choke Line With Pipe Across)
  - Pipe across BOP stack
  - Base Oil down choke line
  - Close Upper Annular Preventer
  - Negative Test for 15 minutes
  - Pump mud down kill line and displace Base Oil out choke line
- 17 October 2008 (Negative test dn dp)
  - Pipe across BOP stack at desired depth
  - Line up Halliburton to Cement Stand pipe and pump base oil down drill pipe
  - Close Upper Annular preventer
  - Bleed off differential pressure back to Halliburton Unit
  - Test for 15 minutes
  - Re-apply differential pressure with Halliburton Unit down drill pipe (all the way to choke manifold and super choke so pressure can be monitored on choke panel)
  - Line up trip tank on riser annulus
  - Open Upper Annular preventer and allow base oil to U-tube back up drill pipe while keeping annulus full.

- 18 October 2008 (Negative Test Using Base Oil)
  - Pipe across BOP Stack
  - Base Oil down Drill Pipe
  - Close Upper Annular Preventer
  - Bleed off drill pipe pressure
  - Test for 15 minutes
  - Re-apply differential pressure
  - Open Upper Annular and fill riser with trip tank to U-tube base oil back to surface
  - NOTE: to never apply differential pressure in excess of 33% of rated subsea working pressure on annular preventer
- 28 January 2010 (Negative Test While Displacing)
  - Pipe across BOP Stack at desired depth
  - Displace choke, kill and boost lines with sea water
  - Pump 16.7 ppg water base spacer down drill pipe
  - Displace down drill pipe and up above BOP stack with sea water
  - Close Upper Annular preventer
  - Bleed off differential pressure to Halliburton Unit and record volume of bleed
  - Test for 15 minutes
  - Re-apply differential pressure with Halliburton Unit
  - Open Upper Annular preventer
  - Continue with riser displacement

Pending Data Required To Complete Investigation

Pressure / Flow Models For Latest Test

A detailed flow model has also been prepared by Stress Engineering, Inc. – Houston, Texas. This model utilizes the actually pit volume, pump pressure and flow data from the *Deepwater Horizon*. A number of preliminary model runs have been completed. The final data from the models will be analyzed and incorporated into the finding findings.

Detailed Drilling Fluid Analysis

A detailed fluid analysis of the drilling mud and the Forma-set / Forma-squeeze pills are required. In order to proceed with the analysis, detailed daily drilling fluid reports have been requested (on several occasions).

Once the exact content of the mud and spacer is known, pilot testing will begin and the results will be used for the detailed analysis.

Preliminary Conclusions

Negative tests have normally been performed by displacing the drilling mud in the well at a depth that is no more than a few hundred feet below the mud line.

The mean differential pressure of this data sample is approximately 1600 psi.

The maximum differential pressure of all negative tests was 2800 psi. This was due to water depth as the test was conducted just below the mud line in this particular case.

The two most common methods of obtaining a negative differential test was 1) pumping down the kill line and up the choke line with seawater under a closed set of blind-shear rams and 2) pumping down the drill pipe with seawater and taking returns up the choke or kill line with a pipe ram or annular preventer closed.

Weighted spacers were noted to be used in a couple of examples for riser displacement *but were not incorporated into the negative test procedure*. The use of weighted spacers in the actual negative test procedure can, and has been observed to complicate the test results.

APPENDIX 1
NEGATIVE TEST
STATISTICS

Number of Rigs	9		(5 Brazil / 4GoM)
Total number of wells	24		Three of the 24 wells were completions with DHSVs
Number of wells with Neg test:	13		(4 in Brazil / 9 in GoM)
Number of wells w/o Neg test	11		All of these wells were in Brazil - 3 had DHSVs installed
Number of wells with Retainer	8		One well had three retainers installed with cement plugs on top. 7 of 13 wells that performed negative tests had bridge plugs or retainers installed. Two others were completions with plugs in the tubing hanger.
Lowest Differential	163	psi	(9.2 ppg brine in hole prior to test)
Average Differential	1609	psi	
Tests with Base Oil	3		
Tests with Sea Water	9		
Test Down Drill Pipe	3		
Test Down C/K line	8		
Test Down Both	1		
Spacer Utilized	1		
No Spacer	12		
Maximum Depth BML	1191	feet	Some of the data was missing and depth BML was interpolated from the test differential pressure
Minimum Depth BML	-138	feet	Some of the data was missing and depth BML was interpolated from the test differential pressure
Average Depth BML	156	feet	Some of the data was missing and depth BML was interpolated from the test differential pressure

REFERENCES

Transocean Fleet Rig Survey Information

1) DIN Negative Test Information.xls
2) DIN Negative Test Information ver PRR.xls
3) Displace Riser with Closed BOP.pdf
4) POA 31 - T&A Displacement.doc
5) Notes from TOI Fleet Response.doc

DWH Investigation Team Analysis

1) Composite Negative Test Information ver PRR.xls
2) MI-Swaco Riser Displacement Procedures – BP-HZN-MBI00133083, BP-HZN-MBI00170827
3) Stress Engineering Preliminary Findings
4) Transocean -- Memo BP Internal Investigation (2).pdf (*should have number already*)
5) John Rogers Smith, P.E., MMS Order No. M10PX00294: *Review of Operational Data Preceding Explosion on Deepwater Horizon in MC252*, Final Report July 1, 2010
6) E-mail 20April2010 and preceding emails , Hoggan, James L. to Lindner, Leo T.; BP-HZN-MBI00129043

DWH Archived Files

1) NEGATIVE TEST.doc
2) NEGATIVE TEST 2.doc
3) Negative test dn dp.doc
4) NEGATIVE TEST DOWN CHOKE LINE.doc
5) NEGATIVE TEST DOWN CHOKE LINE WITH PIPE ACROSS.doc
6) NEGATIVE TEST DOWN CHOKE LINE WITH PIPE ACROSS ver2.doc
7) NEGATIVE TEST USING BASE OIL.doc
8) NEGATIVE TEST WHILE DISPLACING.doc

Witness Interviews

1) Lee Lambert – BP-HZN-MBI00021283
2) Robert Kaluza – BP-HZN-MBI00021237,1238,1272,1273,1276
3) Brian Morel – BP-HZN-MBI00021304

Witness Testimony USCG/BOEM Hearings

1) Leo Lindner –
2) John R. Smith, P.E.-