

**Preliminary Test Plan and Objectives**  
**Macondo 9-7/8" x 7" Production Casing Hangar & Seal Assembly**

**INTRODUCTION**

Analyses are being performed of the 9-7/8" x 7" production casing. The analyses are to simulate the condition of the casing, casing hangar, and seal assembly in the Macondo well. Casing hangar loads, casing growth due to applied internal and external pressures, and potential for lift off of the casing hangar assembly due to the conditions in the well leading up to the incident are to be evaluated analytically.

Physical testing of the components is also desired to validate the analytical findings. It is not practical to simulate the entire well conditions (over 12,000 feet of casing hung vertically from the casing hangar with varying internal and external pressures along the length). Test conditions will have to be chosen to validate the key findings of the analytical modeling and to assess what effect these might have had on the casing, casing hangar, and seal assembly.

This is a preliminary assessment of possible tests that may be of interest. These will be refined and re-evaluated as additional analytical results become available.

**PRELIMINARY ANALYSIS FINDINGS**

The lock-down ring for the 9-7/8" x 7" casing hangar was not installed when the incident occurred. Based on the information available, it appears that negative pressure conditions (more external pressure than internal pressure) existed on the casing after the cement was installed. Preliminary calculations indicate this condition was sufficient to cause significant growth in the length of the casing (due to Poisson's effect on the casing and pressure end load differences). This growth in length may have been sufficient to lift the casing hangar and seal assembly out of the approximately 6" long sealing region and thereby compromise the annulus seal.

Figure 1 shows the wellhead region with the 9-7/8" casing hangar and seal assembly. The lock-down ring shown in the figure was not installed at the time of the incident.

**PRELIMINARY TEST OBJECTIVES**

1. Tests to simulate length growth due to pressure imbalance. This will allow us to:
  - a. Simulate the calculated length change and determine whether the seal assembly lifts off.
  - b. And measure the friction force required to move the seal assembly.
2. Tests to determine seal response if lift-off occurred. Does flow of wellbore fluids compromise seal when the negative pressure conditions existed? If the external pressure was capped with nitrogen that migrated from the cement, does the seal re-seat itself after passing the nitrogen through? Was the seal affected by fluid flow during the cement job?



**EQUIPMENT REQUIRED FOR TESTS**

Item #	Description	Quantity Required
1	High Pressure Wellhead Housing	1
2	13" Casing Hangar	1
3	9-7/8" Casing Hangar	1
4	9-7/8" Hangar Seal Assembly (do we need multiple seals only, or multiple assemblies?)	10
5	Casing Running Tool (or part required for simulating setting of casing)	1
6	9-7/8" Casing (xx ' Long)	1
7	External casing (22" diameter ? – or something smaller?)	1

**TEST #1. Casing Movement / Seal Friction**

Test #1 will require a vertical test setup with a high pressure wellhead housing, 13" casing hangar, 9-7/8" casing hangar and it's seal assembly, a length of 9-7/8" casing (5', 20', one joint?), and a length of external casing below the high pressure wellhead to provide pressure containment around the 9-7/8" casing. Multiple seal assemblies should be obtained – it is expected that the tests will compromise the seal assembly enough to warrant replacement of the sealing elements between tests. It is also important that the casing hangar / seal assembly be installed in the same manner as was used in the well – this may require us to have a casing running tool (or at least part of one).

Most of the length change would be due to the long string of casing below the hangar that will not be included in the test assembly. To simulate the forces and displacements of this casing, a cylinder (and perhaps a spring assembly) will be necessary below the short length of 9-7/8" casing. The intent of the test is to simulate the conditions at the casing hangar and in the casing immediately below the hangar after it was run, during cementing, and during the events then leading up to the incident. That will require internal and external pressures and use of the cylinder / spring assembly to simulate casing load and change in length during the events.

Objectives are:

1. Simulate 9-7/8" casing hangar conditions prior to the incident, including forces, pressures, and length change effects from the casing below.
2. Measure required force to move the seal assembly in these conditions.

**TEST #2. Seal Reliability**

Test #2 will require the same high pressure wellhead housing, 13" casing hangar, 9-7/8" casing hangar and seal assembly. The objective is to simulate the flow conditions that occurred after

the casing was installed (during the cement job) and subsequent flow conditions if the seal assembly lift-off occurred.

Objectives are:

1. Evaluate the effect of possible flow conditions on the seal assembly.
2. To Be Determined – after further discussions. Are there any API standard tests for these seals that might be considered?



FIGURE 1 CASING HANGAR / SEAL ASSEMBLY

