

## Monitoring Well Control Integrity of Mechanical Barriers

### Advisory:

The following will be added to the next revision of the Well Control Handbook to clarify the requirements for monitoring and maintaining at least two barriers when displacing to an under-balanced fluid during completion operations. This clarification is as a result of a recent well control event on a Transocean installation which occurred due to a failure of a tested mechanical barrier.

### Refer to Section 8, Subsection 9, 1 "Completions"

### Existing text:

*When installing completion hardware (tailpipe, packer, extension joint, safety valve, etc.) into any of the above types of well, it is necessary to adhere to the Transocean procedure and maintain a minimum of two independent tested barriers at all times. This can be achieved by utilizing the Drilling BOP, a known monitored column of fluid\*, cemented and tested casing / liner, or tested mechanical barriers (plugs, packers, etc.).*

*The preferred method of testing barriers is in the direction of flow from the well. This cannot always be achieved (i.e. open hole below barrier) and therefore, depending on the type of equipment installed, a test from above may be accepted.*

### Additional text (to be inserted below above text)

***\*When preparing to displace to a completion fluid which will put the well under-balanced, a displacement pumping schedule must be developed and then followed. Monitoring the displaced volume alone is inadequate and does not satisfy the requirement for "a known monitored column of fluid". The pumping schedule must identify; (1) the volumes to be pumped, (2) the planned displacement rate(s), (3) the position of the fluid interface(s) at all times, (4) the resultant U-tube pressures in the well at all times and, (5) most importantly the point at which the completion fluid will become under-balanced with respect to formation pressure. During this process the integrity of existing mechanical barriers must be monitored at all times. Any increase in return flow will indicate that a barrier may have failed and the well must be immediately shut-in. There have been situations in the past where a tested mechanical barrier has failed during completion operations.***

***Do not be complacent because the reservoir has been isolated and inflow tested. Remain focused on well control and maintain good well control procedures.***

**Refer to the Well Operations group website for examples of displacement charts.**

**[http://www.rigcentral.com/hqs/pt/well\\_operations\\_group/Well\\_Control.asp](http://www.rigcentral.com/hqs/pt/well_operations_group/Well_Control.asp)**

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**Application: (All Operations / Installations)**

The Advisory applies to all installations.

**Responsible Person (Actions to be taken):**

1. Operations Manager Performance to ensure all relevant personnel understand this clarification
2. Rig Manager Performance to ensure all relevant personnel understand this clarification
3. OIM / Toolpusher to ensure compliance during applicable completion operations.

**Reference to Management System documentation:**

Well Control Handbook, HQS-OPS-HB-01, Section 8, Subsection 9

## Displacing to an under-balanced fluid during completion operations

Some completions may require the use of a light completion/packer fluid; i.e. when screens are run in a lower completion where a heavier completion/packer fluid would cause reservoir damage.

This procedure has risks that must be identified and controls put in place to avoid a Well Control Event.

In the lower completion there will typically be two barriers;

1. Liner Top Packer isolating the casing / liner annulus, lower completion externally.
2. Formation Isolation Valve (FIV) isolating the lower completion internally.

The lower completion will typically be set in place with a weighted mud system that will overbalance the reservoir and the Liner Top Packer set, when the inner string is pulled from the lower completion the FIV is closed with a shifting tool, the FIV is +/-100ft below the top of the liner.

Both barriers will be pressure tested from above and inflow tested from below. The two barriers are classed as one barrier as they isolate different flow paths.

During the clean up program and then the displacement to the completion / packer fluid the well may be under-balanced during the displacement of the lighter fluids. If possible the displacements should be done on a closed system for accurate pit volume monitoring.

There have been well control incidents during this phase due to the FIV or the Liner Top Packer failing, this could result in seeing very high shut-in pressures; the reservoir pressure minus the hydrostatic pressure above the Liner Top Packer / FIV will dictate the pressure seen.

- If the well has to be shut-in be aware that the shut-in pressures may exceed the mud pump safety valves (pop-offs).
- Do not be complacent because the reservoir has been isolated and inflow tested, remain focused on well control and maintain good well control procedures.

To assist in detecting a failure of the barriers the following should be used;

- Good pit management plan, monitored by the Driller and Mud Loggers returns to pits and check against seawater bbls/min pumped. A chart could be prepared.
- Flow in / flow out, primary indicator if going underbalance.
- Have kill sheet for cleanout assembly ready if required.
- Pumping schedule with chart identifying when the well will be approaching underbalance. (see *charts below*)

# **Displacing to an under-balanced fluid during completion operations**

## **Example displacement charts**

The example displacement charts shown in the next two pages show typical pressure profiles resulting from displacing to a lighter completion fluid which is under-balanced with respect to formation pressure.

When preparing to displace to a completion fluid which will put the well under-balanced, a displacement pumping schedule must be developed and then followed. Monitoring the volume alone is inadequate and does not satisfy the requirement for "a known monitored column of fluid". The pumping schedule must identify:

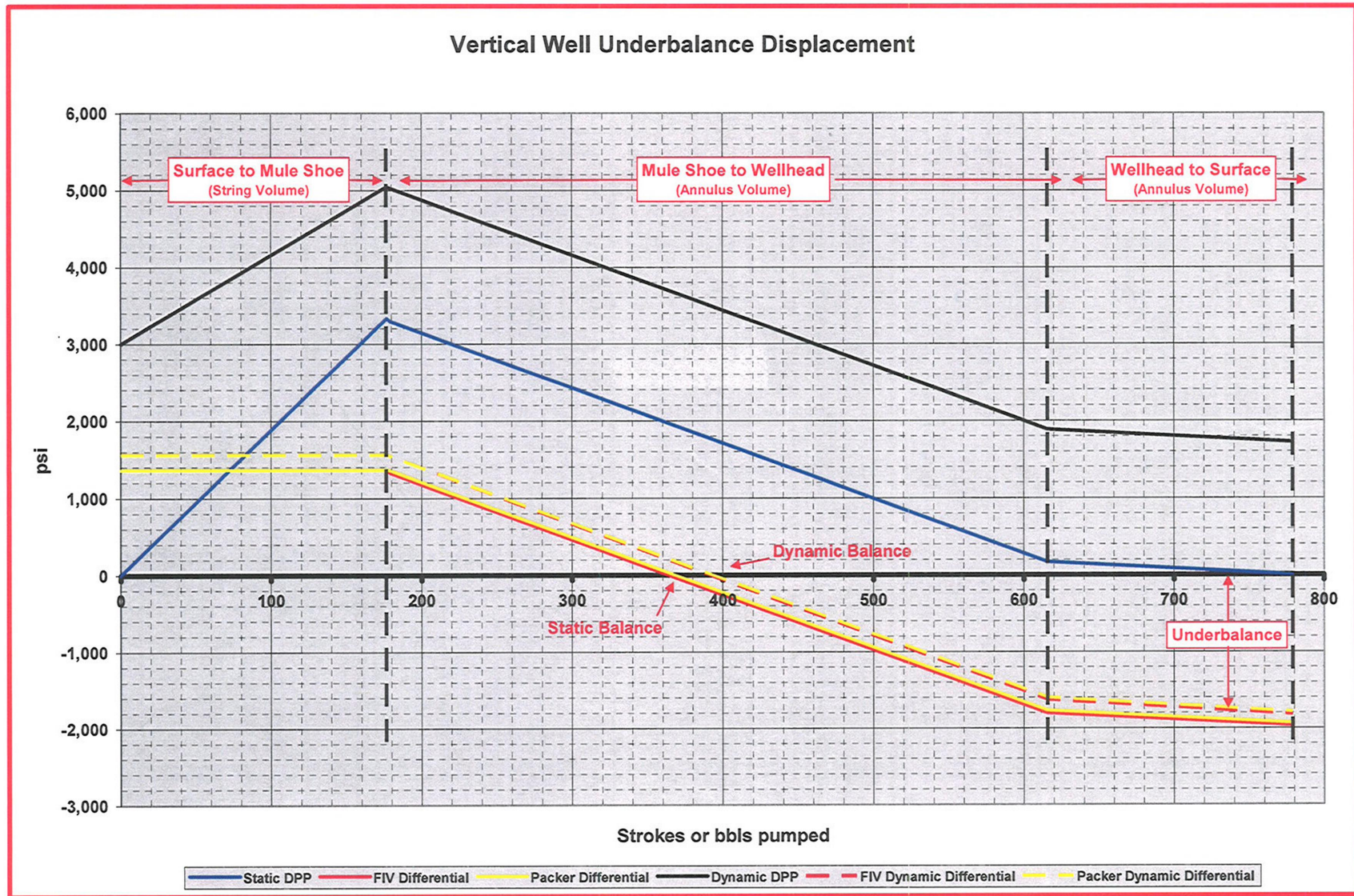
1. Volumes to be pumped,
2. Planned displacement rate(s),
3. Position of the fluid interface(s) at all times,
4. Resultant U-tube pressures in the well at all times and,
5. Most importantly the point at which the completion fluid will become under-balanced with respect to formation pressure.

During this process the integrity of existing mechanical barriers must be monitored at all times. Any increase in return flow will indicate that a barrier may have failed and the well must be immediately shut-in. There have been situations in the past where a tested mechanical barrier has failed during completion operations.



## Displacing to an under-balanced fluid during completion operations

Example Displacement Chart Vertical Well:





## Displacing to an under-balanced fluid during completion operations

Example Displacement Chart Deviated Well:

