Drill String Safety Valve
Project Report

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Presentation Outline

- Background
  - Terminology
  - Problem Areas
- Objectives
- Approach
- Summary
- Recommendations
Terminology

- Stabbing Valves often used to stop flow on drill-string during trips.
- Once flow is stopped, an inside BOP can be put in place prior to stripping pipe back to bottom.
- Dynamic kill of UGB works best with drill-string on bottom.
Terminology

Drillstring safety valves are ball valves used to stop flow through the drillstring.

Traditional 2-Piece “TIW” Valve
Terminology

One-Piece Design

Upper seat

Stem

Stem link

Body

Seal

Ball

Lower seat

Seal
Terminology

One-Piece Canister Design

- Upper seat
- Stem
- Stem link
- Body
- Seal
- Ball
- Lower seat
Canister Design Cut-Away
Problem Areas

High Failure Rate for Pressure Tests

After Hauser, 1995
Problems Seen in Practice

- Failure to Close
- Failure to Open
- Failure to Seal
  - Bottom to top.
  - Top to bottom.
  - Inside to Outside.

• *Mobil Oil Survey of operators identified 29 failures during well control.*

• *Problems have led to blowouts and loss of life.*
Project Objectives

- Identify Common Modes of Failure.
- Identify Alternative/Auxillary Devices.
- Investigate Improved Design.
- Construct Test Apparatus.
- Evaluate Improved Design.
- Develop Recommendations for Improved Safety.
Valve Failures

- Upper seat
- Stem
- Stem link
- Body
- Seal
- Ball
- Lower seat
Flow-Cut Ball & Seat

Caused by Human Error
(Partially Closed Valve)
Wireline-Cut Ball
Over-Rotation of Ball
Valve Failures

Upper seat

Stem

Stem link

Body

Seal

Ball

Lower seat
Valve Stem Failure

- **Side View**
  - Valve Stem Stop
  - Eroded Hole

- **Interior View**
  - Eroded Hole

- **Exterior View**
  - Eroded Hole
Valve Failures

- Upper seat
- Stem
- Stem link
- Body
- Seal
- Ball
- Lower seat
canister cage
Valve Seat Failure
Auxillary Equipment

- Pit Volume Totalizer System
- Drill Collar Float
- Drop-In Check Valve
- Velocity Valve
- Double Valve Assembly
- Low Torque Valves
- Choke Manifolds
- Shear Rams
Student Design Projects

- New DSSV Design with Improved Torque Characteristics at high pressures.
- New DSSV Storage Stand.
LSU DSSV Design

Trunnion Mounted Ball
Spring Loaded Seats
Test Apparatus Design

- Control Room
- Air Supply
- Test Stand
- Trip Tank
- Halliburton Pump
- Swaco Automatic Choke
- Air Supply
- Shuttle Valve
- Pneumatic Operator
- Regulator
- Pressure Indicator
- Position Indicator
- Safety Valve
Torque & Position vs Time

Position (% closed) vs Time

0 10 20 30 40 50 60 70 80 90 100

Torque (ft-lbs) vs Time

0 100 200 300 400 500 600 700

100 gpm 120 gpm 140 gpm 160 gpm 180 gpm
## Closing Torque

With 2,000 psi Shut-In Pressure

<table>
<thead>
<tr>
<th>Flow Rate (gpm)</th>
<th>2-Piece DSSV</th>
<th>1-Piece DSSV</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>110</td>
</tr>
<tr>
<td>120</td>
<td>240</td>
<td>150</td>
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<td>140</td>
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<td>160</td>
<td>370</td>
<td>390</td>
</tr>
<tr>
<td>180</td>
<td>550</td>
<td>545</td>
</tr>
</tbody>
</table>

Water Hammer ?

900 psi
Closing Torque, 2.75-in. ID

- 2-piece, Floating Ball (LSU, water)
- ITAG
- 1-piece, Floating Ball (LSU, water)
- Hi-Kalibre
- LSU Design (water)
- M & M (Lite-Torc, LSU, water)
- M & M (GRI, mud)
- Hi-Kalibre (GRI, mud)
- ITAG (GRI, mud)
Effect of Valve cycling in 16 ppg mud

After Tarr - SPE39320

- Hi-Kalibre (GRI, mud, horizontal)
- M & M (GRI, mud, vertical)
- ITAG (GRI, mud, vertical)

0.5% Sand

Closing Torque (ft-lbs)

Number of Cycles (Close/Open)
Opening Torque (0% Equalized)

Pressure Differential across Valve (psi)

Torque (ft-lbs)

- LSU Design (water)
- M & M (Lite-Torq, LSU, water)
- 1-piece, floating ball (LSU, water)
- ITAG (GRI, water)
- ITAG (GRI, mud)
- M & M (GRI, mud)
General Observations

- Operating torque requirements for valve can vary greatly with valve use and weathering.
- Valve storage and maintenance is an important aspect of maintaining low torque valve operation.
Conclusions

- DSSV Failures are Significant.
- Common Modes of Failure Identified.
- Problems poorly understood in field.
- Improved design is possible.
- Valve maintenance is important.
Recommendations

1. The DSSV intended for use as a stabbing valve to stop flow through the drillstring during tripping operations should not be used in the drillstring for other operations. The stabbing valve should be maintained in a "like-new" condition and used only during periodic pressure testing with fresh water.

2. Operators and/or drilling contractors should check threads, valve wrench, and lift sub on the stabbing valve and actuate the stabbing valve close and open each tour.

3. Operators and/or drilling contractors should use a drillstring float whenever practical to provide redundant protection against a high-rate flow through the drill-string during tripping operations.

4. When floats are not used, shear rams are recommended for redundant protection against blowouts through the drillstring during tripping operations.

5. Drill String Safety Valves should not be the only means for stopping flow from the drillstring at the surface when reverse circulating the well during completion operations. Flow should be routed through hydraulically operated valves and a choke manifold.

6. Drill string safety valves should not be the only means for stopping flow through the drill string when significant piping and flow restrictions are present above the valve.