Tubing-Retrievable Safety Valves
Unsurpassed Reliability for
Conventional Shelf, HP/HT and
Deepwater Applications
Agenda

- NE™ Tubing-Retrievable Safety Valve
- SP™ Tubing-Retrievable Safety Valve
- DepthStar® Tubing-Retrievable Safety Valve
- High Performance Piston Seals
NE™ Tubing-Retrievable Safety Valves
NE™ TRSV - Benefits of Design

- 100% MTM well containment
- No construction seals in the communication system
- Highest hydraulic piston actuator pressure rating in the industry
- Most reliable, field-proven piston actuator in the industry
- MTM body connections
- Enhanced debris isolation
Enhanced Debris Isolation and Protection

- Flapper isolated from wellbore by MTM seating of flow tube
- Inverted flow tube prevents debris from accumulating on its upper end
Uses the Field-Proven SP™ TRSV Actuator

- Single rod piston
- Non-elastomer seals
- Solid top sub construction provides for highest
- Hydraulic control chamber rating in the industry
Permanent Lock Open and Communication System

- No leak paths in secondary communication system

- Separate lockout and communication capability

- Combined mechanical (slickline) and hydraulic operation

- Secondary wireline-retrievable safety valve capability
SP™ Tubing-Retrievable Safety Valves
SP™ Tubing-Retrievable Safety Valve

- Control Line
- Piston Rod
- Flow Tube
- Flapper & Seat Closure Mechanism
- Piston
- Communication Shear Plug in Top Sub (View A-A)
- Flapper Torsion Spring & Hinge Pin (View B-B)
SP™ Tubing-Retrievable Safety Valve

- Nipple Profile
- Lockout Sleeve With Profile
- Exercise Profile
- Power/Closing Spring
- Upper Polished Bore
- Lower Polished Bore
Enhanced Debris Isolation

Isolation of Upper End

- Wiper seal isolates the top
- Flow holes ensure continuous flushing during flowing conditions
- MTM seal on piston isolates the hydraulic system
Enhanced Debris Isolation

Isolation of Upper End

- MTM Downstop Seat
- Complete Isolation of the Closure Mechanism
- Eliminates Flow From Entering the Operator of the Valve
- Full Protection During Flowing Conditions
Dedicated Exercise Profile

- Standard feature within all SP™ TRSVs
- Allows flow tube to be manipulated upwards or downwards via slickline
- Helps prevent TRSV permanent lock open
DepthStar® Tubing-Retrievable Safety Valve
Challenges

- Limited system operating pressure
- Depth limitations
- High-pressure deepwater wells
- Expensive dedicated subsea umbilical for SSSV
- Reliability concerns
 DepthStar® TRSV

- Magnetic coupler straddles the housing where the couplers are suspended magnetically
- Primary magnet cylinder outside the main TRSV body hydraulically actuated by the operating piston
- Secondary magnet cylinder moved by the magnetic attraction between the two cylinders
- Piston actuator isolated from the wellbore
Magnetic Coupler

Low Force

High Force

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Tests Performed to Evaluate Magnetic Coupler

- Electric Coils
- Perforator Detonator
- Collar Locator
- Thermal Multi-decay Logging Tool
- Memory Gauge
- Metal Shavings

- DPU
- Reservoir Monitor Tool Elite
- Firing Head
- Hostile Gamma Neutron Tool
- TEC Line
- Fiber Optics Cable

✓ 15 separate tests specifically related to the Magnetic Coupler
✓ All tools performed normally with no affects from the magnetic coupler
DepthStar® vs. SP™ Component View

- Control Line
- Rod Piston Up Stop
- Rod Piston
- Rod Piston Bore
- Rod Piston Down Stop
- Power Spring
- Flow Tube
- Flapper Seat
- Flapper
DepthStar® TRSV – A Complete Solution

- Actuator removed from wellbore
  - Proven SP™ Actuator
- Enhanced reliability
  - No moving seals and 100% MTM within wellbore
- Low operating pressure
  - Operates independent of depth and wellbore pressure

Winner of the Woelfel Best Mechanical Engineering Achievement, OTC Spotlight on New Technology, World Oil Best Completion Technology and Energy Institute Technology Awards
High-Performance Piston Seals
High-Performance Piston Seal

- Multi-ring non-elastomer piston seal stack qualification program
  - 50 psi to 25,000 psi gas
  - -4°C (25°F) to 232°C (450°F) temperature
- Zero bubble performance – static and dynamic seals, and MTM seal independently verified gas tight for every valve manufactured
# Piston Seal Qualification Test Summary

## Cold Temperature Test

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Temperature</th>
<th>Nitrogen Pressure</th>
<th>No. of Cycles</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25°F (-4°C)</td>
<td>50 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
<tr>
<td>2</td>
<td>25°F (-4°C)</td>
<td>5000 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
<tr>
<td>3</td>
<td>25°F (-4°C)</td>
<td>25,000 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
</tbody>
</table>
# Piston Seal Qualification Test Summary

## Hot Temperature Test

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Temperature</th>
<th>Nitrogen Pressure</th>
<th>No. of Cycles</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>450°F (232°C)</td>
<td>50 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
<tr>
<td>2</td>
<td>450°F (232°C)</td>
<td>5000 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
<tr>
<td>3</td>
<td>450°F (232°C)</td>
<td>25,000 psi</td>
<td>90</td>
<td>Zero bubbles / no hyd fluid leaks</td>
</tr>
</tbody>
</table>

- 500+ cycles = > 40 years service
- 30 day long term pressure differential test
Thank You

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