Innovative Landing String system for ultra-deep offshore

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Introduction

- **Offshore industry trends:**
  - Deeper water depths (up to 12,000 ft)
  - Associated to deeper total depths

- **Landing strings:**
  - are used for setting casing strings inside the well
  - Hook loads can currently reach 2.5 million lbs → slip crushing challenges

- **Slip Crushing phenomenon:**
  - Extensive slip damages on the outer surface of the pipe
  - Crushing can yield the tube/pipe in extreme cases
  - Slip section of the tube shall be designed accordingly
  - Enhanced slip designs and heavy carrier needed
Landing Strings types

- **Conventional Landing Strings (< 2.0 MM lbs resistance):**
  - Various available OD’s: 5 ½”, 5-7/8” & 6-5/8”
  - Heavy wall sections up to 6-5/8” OD x 0.938” thick
  - High strength proprietary grades: VM-140, VM-150 & VM-165 DP
  - API or proprietary double shoulder connection
  - Clientele history since 2007

- **Crush free Landing Strings (> 2.0 MM lbs resistance):**
  - Patent pending based on an integral design
  - No special handling tools required
## Enhanced Slip design for 2.5MM lbs

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Working pressure</td>
<td>2320-3045 psi</td>
</tr>
<tr>
<td></td>
<td>180-210 bar</td>
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<tr>
<td>Required flow rate</td>
<td>6-10 GPM</td>
</tr>
<tr>
<td></td>
<td>22-37 l/min</td>
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<tr>
<td>Temperature working range</td>
<td>-4° to 104°F</td>
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<tr>
<td></td>
<td>-20° to 40°C</td>
</tr>
<tr>
<td>On request temp range</td>
<td>-40° to 104°F</td>
</tr>
<tr>
<td></td>
<td>-40° to 40°C</td>
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<tr>
<td>Safe working load</td>
<td>1250 tons</td>
</tr>
<tr>
<td>Pipe diameter</td>
<td>3.1/2&quot; to 14&quot;</td>
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<tr>
<td>Weight (without slip ass.)</td>
<td>10803 lbs</td>
</tr>
<tr>
<td></td>
<td>4900 Kg</td>
</tr>
<tr>
<td>Rotary table (national, emsco, wirth)</td>
<td>49.1/2&quot;</td>
</tr>
</tbody>
</table>

- Specific designed of landing-string insert-carrier
- Designed to handle 1250 short tons (2.5 MM lbs)
- Usable with new designed bottom guide plate system
- B+V Type PS-1250-1 Hydraulic operated Power
- Slip Pipe Range 3.1/2" - 14", for 49.1/2"
- National RT, 1250 ton,
- c/w Hydraulic Guide System
- Less Slips, Insert Carrier, and Guides Plates
- API 7K (Acc. to PSL2)
Enhanced Slip design advantages

- Flush mounted PS (max. stick out length 6.7”)
- API 7k Equipment
- Production in accordance to PSL2 to guarantee highest quality
- Carrier and slip design
- Fast, safe and easy carrier changing
- Improved hinged design for 1250tons
- Improved pipe crushing avoidance design
- 28” contact length on slip proof area
- 4 slip design for advanced 360° pipe contact
- C/w hydraulic centering system
- Possibility of using bottom guides
- Optional pipe wiper system for standard 19” wipers
- Automated greasing system
- 6.5/8” landing string special slip for 1250tons
- Possibility of using BV & varco control
- All rotary tables interchangeable (-W, N, -E)
- 5” overbore (to 19”) for passing large stabilizer / centralizer
- 55,000 ft lbs backup torque at 10.3/4”
- Top cover load rated for 500tons
Landing String Carrier

landing-string carrier for 6.5/8“ with 6.906“
Crush free section

standard 6.5/8“
insert-carrier with
additional dies rows
for reducing pipe
crushing
Landing String solution

- **A full integral solution:**
  - Flexibility of designs (tube OD & ID, light weight section length)
  - **No weld** and therefore **no Heat Affected Zone** in the material
  - A dual Yield Strength design combining tube tensile requirements and the use of an API connection

- **Slip Crush Resistance:**
  - 8 ft of minimum length for the crush free section
  - Extendable up to the full length

- **Improved hydraulics:**
  - Flush ID design
Landing String system design (tube)

- Elevator Recess
- Slip Section

Measurements:
- 90”
- 18”
- 72”
Landing String system design (tube)

- **Heavy Duty Drill Pipe**
  - Full length crush free and flush ID

![Diagram of Landing String system design](image)

- 6-5/8 OD
- 3-3/8 ID
- 6-5/8” FH connection
- 8-5/8” OD x 3-3/8” ID
Landing String system design (tube)

- **Variable OD Drill Pipe**
  - Light weight section
  - Flush ID

*6-5/8” FH connection also available*
Landing Strings Qualification

**Industrialization:**
- Product manufactured at Vallourec Drilling Products, Houston, Texas
- 19 pieces prototypes 100% completed

**Qualification tests:**
- FEA on elevator, threaded connections and slips
- Successful physical tests performed in Germany (B+V):
  - Slip crush and elevator under 2.5 MM lbs tension
  - Slip crush and elevator until 4 MM lbs tension

**Additional features:**
- Internal Plastic Coating, Hardbanding on Box (and/or Pin) tool joints, Make & Break…
- Several API connections available
FEA Calculations

Slip Crushing FEA performance on 2.5MM lbs:

- The FEA performance demonstrated that the applied stresses do not lead to a failure of the structure under the static load conditions
- Yielding predicted at the bottom of the slip
- FEA performance to be verified with physical tests
Physical Tests

Slip Crushing tested at Blohm + Voss (Hamburg, Germany)

— Use of the enhanced slip design B+V PS1250, 1250 ton slips
— CrushFree™ Landing String: 6.938” OD x 4” ID x 165 ksi tube
— Strain gauges on slip body and tube ID
Tests Results – 2,500,000 lbs

- No failure observed
- No change in tube OD

- No material yielding \(\rightarrow\) although predicted by FEA modeling
Tests Results – 2,500,000 lbs

- No defect / crack detected by MPI
- No defect detected by 360 degrees UT inspection
Tests Results – 4,400,000 lbs

- Same configuration as 2.4MM lbs sample
- Exceeded yields tension of tube and elevator shoulder
- Did not break tube or slips
Tests Results – 4,400,000 lbs

- Tube necking outside the slip area

- No cracks detected using MPI and UT inspection
Conclusion and perspectives

- To address recent and upcoming challenges linked to the ultra deepwater drilling & completion operations:
  - An enhanced slip design and heavy carrier have been developed for 2.5 MM lbs capacity
  - An innovative “CrushFree™” Landing String design has been designed, in order to both exhibit 2.5 MM lbs slip crushing resistance, and to eliminate any risk of placing slips on a tubular weak point

- Both pieces of equipment have been extensively tested using both the FEA and full scale trials in Germany

- Both the new Landing String and enhanced power slips are now available on the market
Thank you! Any question?