

Innovative Landing String system for ultra-deep offshore



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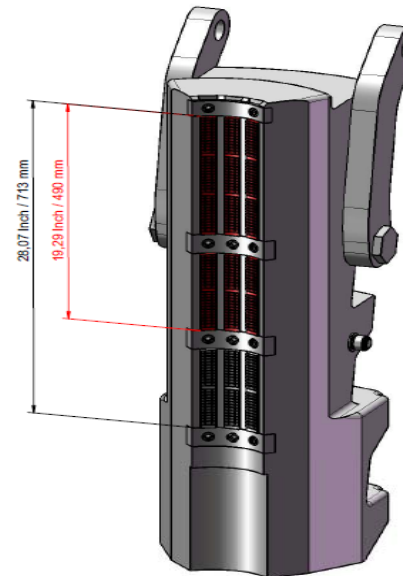
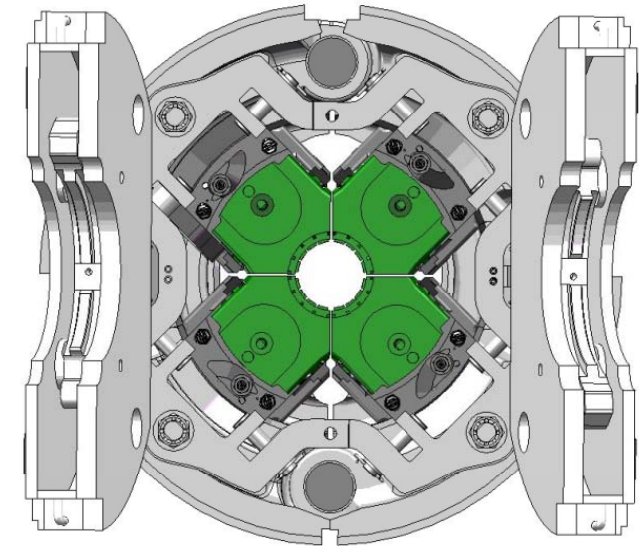
Introduction

- **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



Enhanced Slip design for 2.5MM lbs

- **Specific designed of landing-string insert-carrier**
 - Designed to handle 1250 short tons (2.5 MM lbs)
 - Usable with new designed bottom guide plate
- **B+V Type PS-1250-1 Hydraulic operated Power**
- **Slip Pipe Range 3.1/2" - 14", for 49.1/2"**
- **Less Slips, Insert Carrier, and Guides Plates**
- **API 7K (Acc. to PSL2)**
- **4 slip design for advanced 360° pipe contact**
 - Improved pipe crushing avoidance design
 - Up to 28" contact length on slip proof area
 - Fast, safe and easy carrier changing
 - Automated greasing system



Landing-string carrier
for 6.5/8" with 6.906"
Crush free section

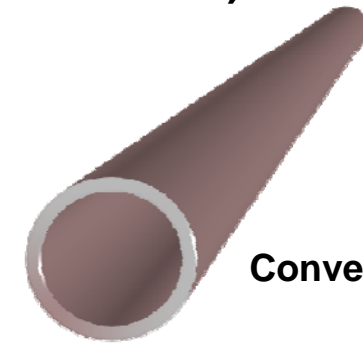


Landing Strings types



- **Conventional Landing Strings (< 2.0 MM lbs resistance):**

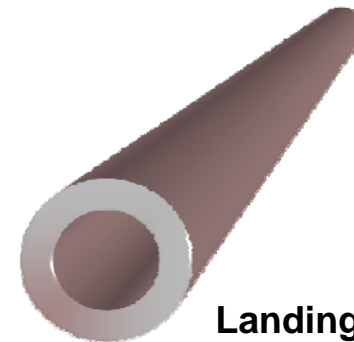
- Various available OD's: 5 1/2", 5-7/8" & 6-5/8"
- Heavy wall sections up to 6-5/8" OD x 0.938" thick
- High strength proprietary grades
 - VM-140, VM-150 & VM-165 DP
- API or proprietary double shoulder connection
- Clientele history since 2007



Conventional Tube

- **Crush free Landing Strings (> 2.0 MM lbs resistance):**

- Patent based on an integral design
- No special handling tools required

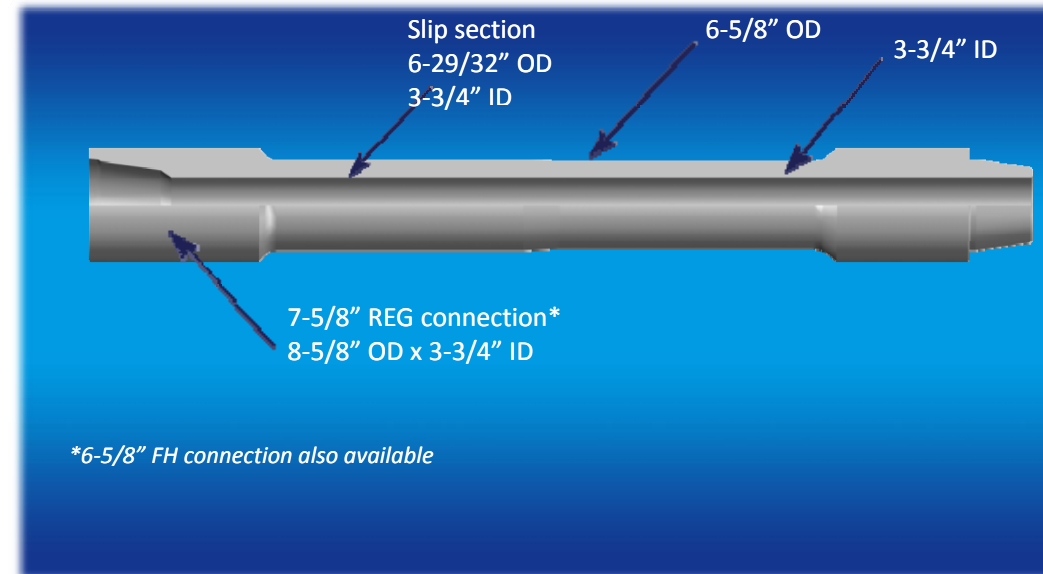


Landing String Tube



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
 - Decreased running time
- **Improved hydraulics:**
 - Flush ID design



Landing Strings Qualification

- **Qualification tests:**

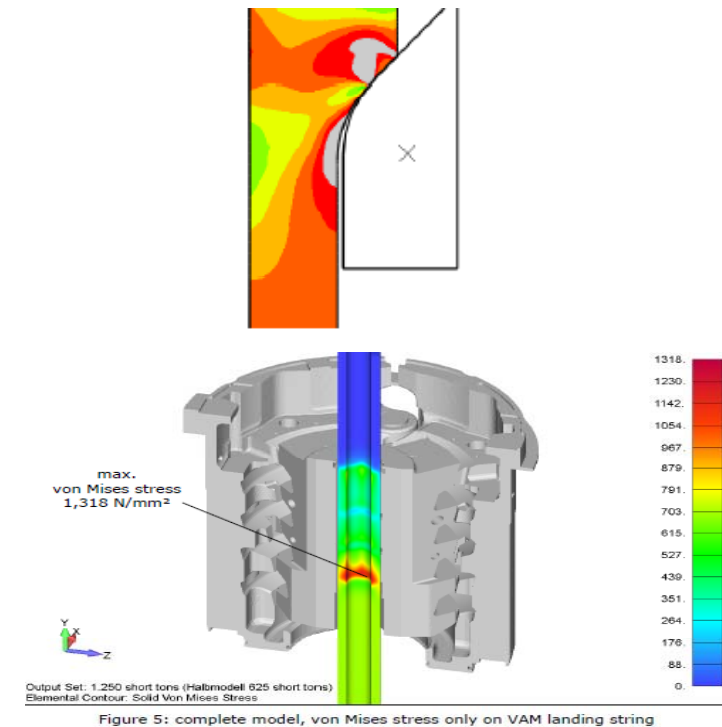
- FEA on elevator, threaded connections and slips
- Applied stresses do not lead to a failure of the structure under the static load conditions
- Yielding predicted at the bottom of the slip
- FEA performance to be verified with physical tests

- **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

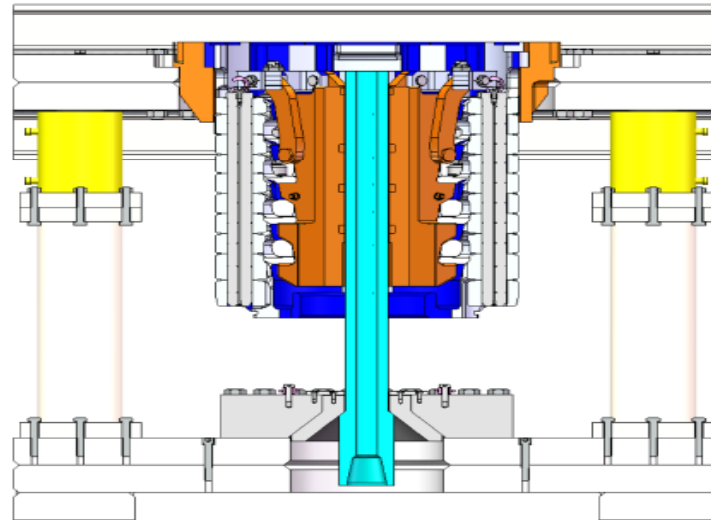
- **Industrialization:**

- 40+ pieces prototypes 100% completed
- Products manufactured in France and USA



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 → although predicted by FEA modeling

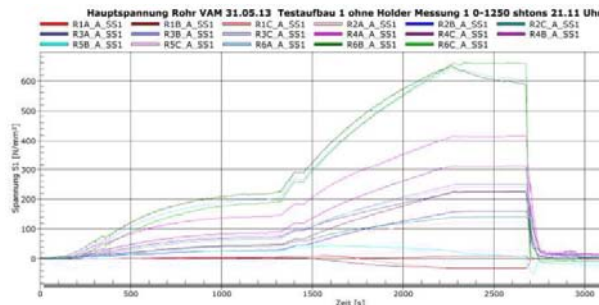
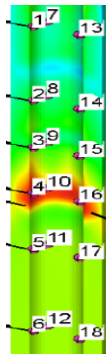
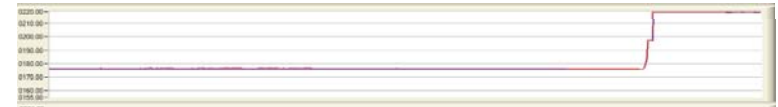
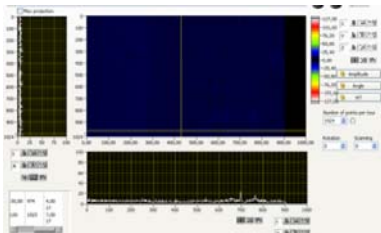


Bild 14: Rohr (Fa. VAM Drilling Inc.) gemäß Zeichnung B+V, Landing String 6.5/8" with 6.906 inch Slip Proof Section, Belastung 0 shtons - > 1250 shtons, Spannungserlauf $\sigma = \sigma(t)$ [N/mm²], RxA_A = Messstelle, SS1 = Hauptmessspannung 1
 Fig. 14: Drill pipe (PAM Drilling Inc.) acc. drawing B+V, Landing String 6.5/8" with 6.906 inch Slip Proof Section, load 0 shtons - > 1250 shtons, tension $\sigma = \sigma(t)$ [N/mm²], RxA_A = gauge, SS1 = mainmeasurion 1



- No defect / crack detected by MPI

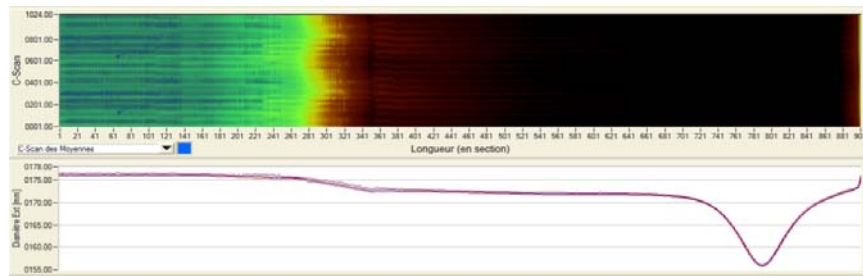


- No defect detected by 360 degrees UT inspection



Tests Results – 4,400,000 lbs

- Same configuration as 2.5 MM lbs sample
- Exceeded yields tension of tube and elevator shoulder
- Did not break tube or slips
- 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**

