

VAM LDR

Lower stress joints are usually made from 80,000 PSI material. The VAM LDR connector is available to ease the transition from a higher to a lower strength material.

The qualification program included:

- 2 samples undergoing 25 M&B test (no galling)
- 4 samples undergoing the ISO13679 CAL II test with bending and external pressure test. Max test loads :

Tension	Compression	Bending	Internal pressure (gaz)	External pressure (water)
1691 kips	791 kips	20° / 100 ft	21,525 psi	5,000 psi

- 6 samples being tested for fatigue with 8,000 psi internal pressure (capped end induced tension) SAF better than 1.13 based on B curve.

Industry Compliance

Three industry standards can be used to guarantee the performance of Risers:

ISO 13679:2002 establishes minimum design verification testing procedures and acceptance criteria for casing and tubing connections for the oil and natural gas industries. These physical tests are part of a design verification process and provide objective evidence that the connection conforms to the manufacturer's claimed test load envelope and limit loads.

ISO 13679:2002 addresses only three of the five distinct types of primary loads to which casing and tubing strings are subjected in wells: fluid pressure (internal and/or external), axial force (tension or compression), bending (buckling and/or wellbore deviation), as well as make-up torsion. ISO 13679:2002 specifies tests to be performed to determine the galling tendency, sealing performance and structural integrity of casing and tubing connections that apply to the service application and not to the diameter of the pipe.

> **VAM DPR HP connector** was developed following the qualification procedure ISO13679 CAL II.

- ISO 13679:2002, Petroleum and natural gas industries procedures for testing casing and tubing connections (so called API RP5C5, 3rd edition, July 2003)

ISO 13628-7:2005 gives requirements and recommendations for the design, analysis, materials, fabrication, testing and operation of subsea completion/workover (C/WO) riser systems run from a floating vessel. It is applicable to all new C/WO riser systems and may be applied to modifications, operation of existing systems and reuse at different locations and with different floating vessels.

> **A complementary program** was carried out in 2009 in order to qualify the connector according to the ISO13628-7:2005 standard. It demonstrated that:

- VAM DPR HP 120ksi connection offers better performance in fatigue than the pipe 6 5/8" wt0.625" G105 and better than DVN-B reference curve under 5,000 psi internal working pressure.
- VAM DPR HP 120ksi connection remains gastight during class U (-18° to 121°C) low temperature cycling tests after M&B wearing.

IRP 1.8 Critical Sour Drilling helps to develop highly engineered Risers for Sour Service environments and optimizes them for real well and drilling conditions.

Conclusion

Drill pipe risers are an innovative alternative to more complex and costly technologies commonly used in well completion and intervention in offshore applications. Primary advantages include:

- Higher tensile strength
- Higher fatigue resistance
- Larger ID clearance
- Reduced weight
- Seal-ability and durability
- Multiple make & breaks
- Faster tripping times

Drill pipe risers from have been field proven through extensive operations and applications in Brazil, West Africa and the North Sea for more than 10 years.

Operations and applications of risers for more than 10 years.

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Drill Pipe Risers with Gastight Rotary Shoulder Connections for Completion and Intervention in Deep and Ultra-Deep Water

The History of Drill Pipe Riser Systems

Well completion and intervention operations in offshore environments are becoming increasingly complex due to increasing water depths and working pressure requirements. These environmental factors are having a great impact on tube body minimum tensile load capacity and gastight connection requirements. As early as 1996, Petrobras S.A. accelerated

the development of a new type of completion and intervention system when it discovered the Roncador field in 1,800 m of water. At the time, Petrobras was using a standard dual vertical-bore riser which was too heavy for use in this ultra-deepwater field, exhibited extended tripping times, had poor gas-sealing capability.

A dedicated project team was created to develop the Drill Pipe Riser Intervention System (DPRIS). The first system delivery was achieved in 1999. The new DPRIS could be used for Subsea Tubing Hanger and Production Tree installations and as an Early Production Riser (EPR).

DPRIS use has greatly expanded from the initial two Petrobras systems to more than fifty DPR systems presently operating in deepwater offshore regions.

More recently in 2006, the development of new high-pressure gas fields in the North-Eastern area of Brazil (Espírito Santo basin) led to the need to upgrade the initial DPRIS in order to cope with more stringent technical drivers: gas instead of oil production, higher service pressures and future exposure to potential sulphide stress cracking related to the presence of H₂S.

This resulted in the development of drill pipe risers featuring new connection designs, evaluation, testing and performances.

Drill Pipe Riser Uses

Before DPRIS, operators used conventional drill pipe available on rig to install and retrieve the production adapter base and tree cap. These were simple, open-sea operations that did not require annulus control, pressure containment or fluids circulation. Occasionally companies used drill pipe as a work-string in tubing hanger retrieval operations. Pipe could be deployed with a hydraulic jar to un-stick tubing hangers. While success varied, the difficulties and risks of using a hydraulic umbilical inside the riser were clearly identified and made it evident that technology improvement was needed to minimize interference between the pipe and the hydraulic lines.

The existing designs for dual vertical-bore risers were adequate for shallow water completions, but as time passed and subsea completions moved to increasingly deeper waters, risers became a more costly and less desirable solution.

Some of Petrobras' main drivers for the development of the original DPRIS were:

- Weight reduction;
 - Faster tripping times;
 - Larger production bore;
 - Extended depth capability for deepwater operations.
- A few limitations on the use of the DPRIS were also acknowledged. These included:
- Restricted ID and flow-path for annulus access or circulation;
 - Risks of corrosion resistance as DPRIS systems are usually not fully NACE compliant;
 - Lack of accessibility in the annulus bore for wireline operations.

Today, drill pipe risers:

- Serve as running string for the installation and retrieval of subsea trees and tubing hangers;
- Provide an improved flow-path for annulus access of circulation;
- Are fully NACE compliant for the most extreme Sour Service environments;
- Provide conduit to the surface vessel for well production testing and wireline or coiled tubing services;
- Can be run in open sea mode and inside drilling riser and BOP systems.

Drill Pipe Riser Design Process

Drill pipe riser design incorporates a tube body with standard nominal external diameter of 6.625" and a wall thickness of 0.500" or larger. These tubes are manufactured using a proprietary chemistry and heat treatment process to achieve a minimum material yield strength of 95,000 or 105,000 PSI. Tube body design is based on the API 5DP specification.

Tool joint design respects the API 5DP specification with a minimum material yield strength of 120,000 PSI or 110,000 PSI for Sour Service applications. The tool joints have an external diameter of 8" and internal diameter up to 5.190".

Drill pipe risers can also be manufactured in full compliance to the IRP 1.8 specification for critical Sour Service environments using material recommendations and NACE MR-0175 and NACE TM-0177 testing methods.

Different types of rotary double-shoulder connections can be used in the drill pipe riser design. VAM Drilling provides two different gastight rotary double shoulder connections: VAM DPR SR and VAM DPR HP.

> **VAM DPR SR** has an API thread profile. The gastight seal is a result of the Teflon ring housed at the base of the pin.

> **VAM DPR HP** has a proprietary thread design. The gastight seal is a result of the metal-to-metal seal on the pin nose.

VAM Drilling Connection Performance

VAM DPR SR

The VAM DPR SR connection combines the advantages of standard drill pipe with a rugged thread profile allowing multiple make-ups with other gastight connections.

When the VAM DPR SR was evaluated and tested, fatigue performance was measured through analytical calculations and finite element analysis (FEA). Seal-ability was tested through FEA and physical lab tests. Finally, run-ability was tested using physical make-and-break lab tests. The maximum calculated stress concentration factor 13 (SCF13) is 0.5.

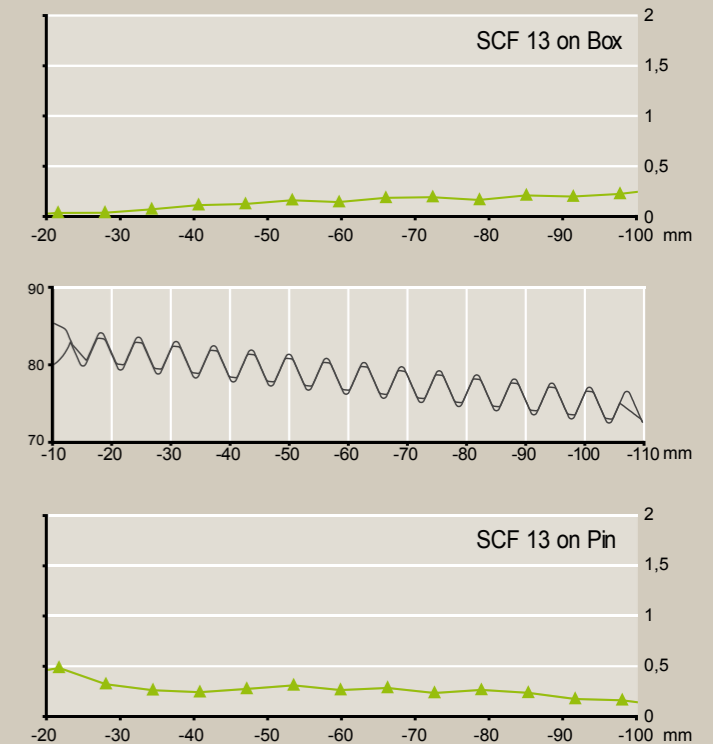


Fig.1: SCF repartitions in threads.

VAM DPR HP

The VAM DPR HP connection exceeds VAM DPR SR performance and offers higher tension efficiency and a gastight metal-to-metal seal rated up to 15,000 PSI.

Evaluation and testing of this connector included fatigue performance through analytical calculations, finite element analysis (FEA) and physical tests. Seal-ability was measured using FEA and physical lab tests. Finally, run-ability was tested using physical make-and-break lab tests. Calculated stress amplification factor (SAF) is 1.0.

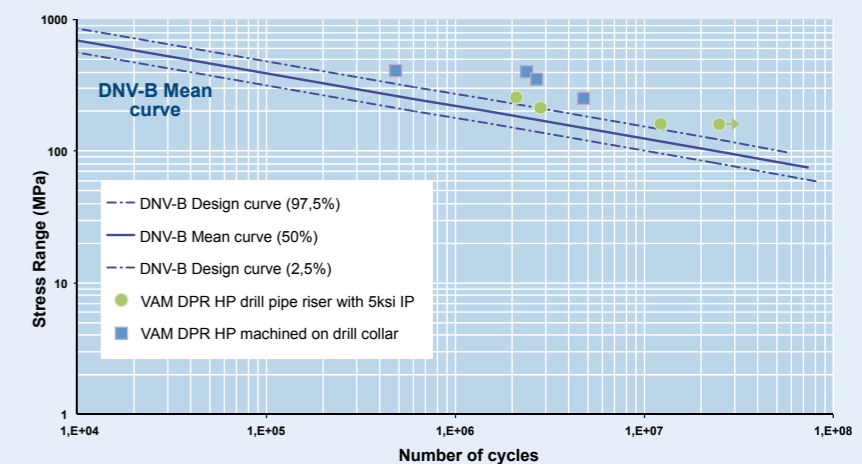


Fig.2: Fatigue test results on VAM DPR HP.

Connection	TJ OD (in) TJ ID (in)	Grade (ksi)	MUT (ft-lbs)	Gastight Pressure Rating (PSI)	# of Make and Breaks	Thread Profile
VAM DPR SR	8.000 5.102	120	38,000	7,500	>100*	API
VAM DPR HP	8.000 5.102	110	41,300	15,000	>100	Proprietary

*Teflon ring should be replaced after 20 make and breaks

Tab.1: Connector Performance Comparison.