

How do Upset Linepipes Extend SCR's Range of Application In Deepwater Developments ?

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Upset ends linepipes – a field-proven technology

- URSA project – SHELL - 2008

- Gulf of Mexico
- 1200 m Water Depth
- Steel Catenary Risers
- 2 Oil & Gas Export Risers
- Reel-Lay
- Installed by TechnipFMC – Deep Blue Vessel
- OD x WT : 273,1 x 28,3mm (10'' x 1,1'')
- Upset Extra WT: +2,9mm
- 7,9 km

- P55 project – PETROBRAS - 2011

- Brazil
- 1500-1900 m Water Depth
- Steel Catenary Risers (1st in Brazil)
- 2 Oil Exports Risers, 1 Gas Export Riser
- J-Lay
- Installed by SAIPEM – FDS vessel
- OD x WT : 323,9 x 22,2mm (12'' x 0,87'')
- Upset Extra WT: +2,1mm
- 12,7 km

2 examples of PURE®65 upset ends used on projects

What is an upset end?

- Upset = thicken the end especially by hammering or pressure when heated. (*Oxford Dictionary*)
- The feature that is targeted for a linepipe is the thickening of the pipe end. Upsetting is one way to obtain it.
- Example: PURE®65
 - Thickened ends
 - ID & OD machining at very tight tolerances
 - ID-tolerance of +/- 0,25mm (0,01")
 - Wall Thickness tolerance: +/- 0,5mm (0,02")
 - X65 grade

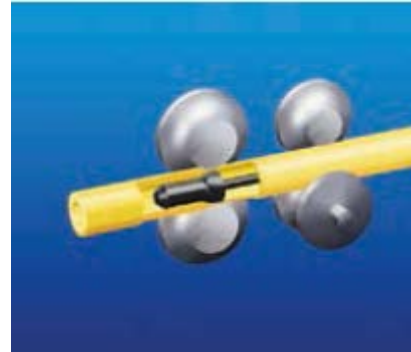


How to manufacture Upset Ends / Thicker Ends?

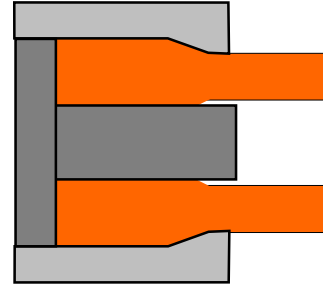
Piercing



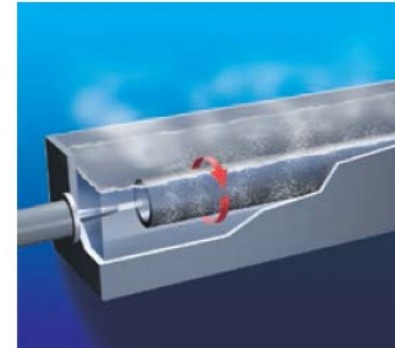
Rolling



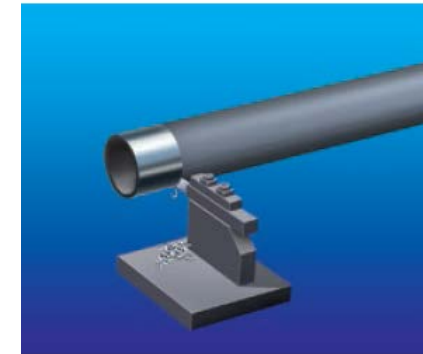
Upsetting



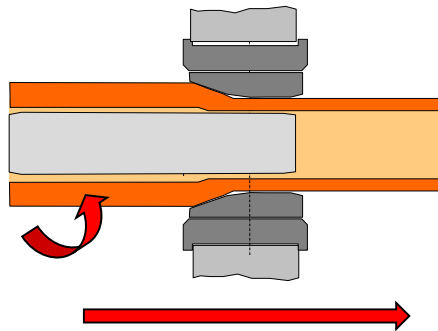
Heat Treatment



Machining



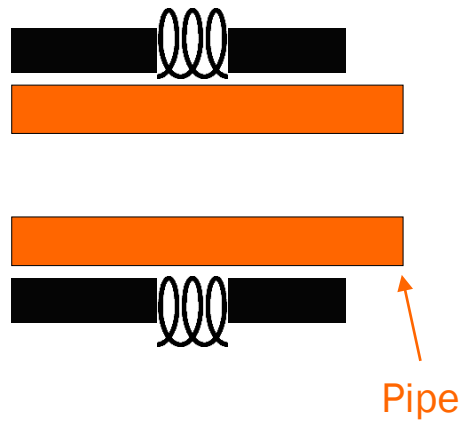
Radial forging



2 production routes offering complementary products

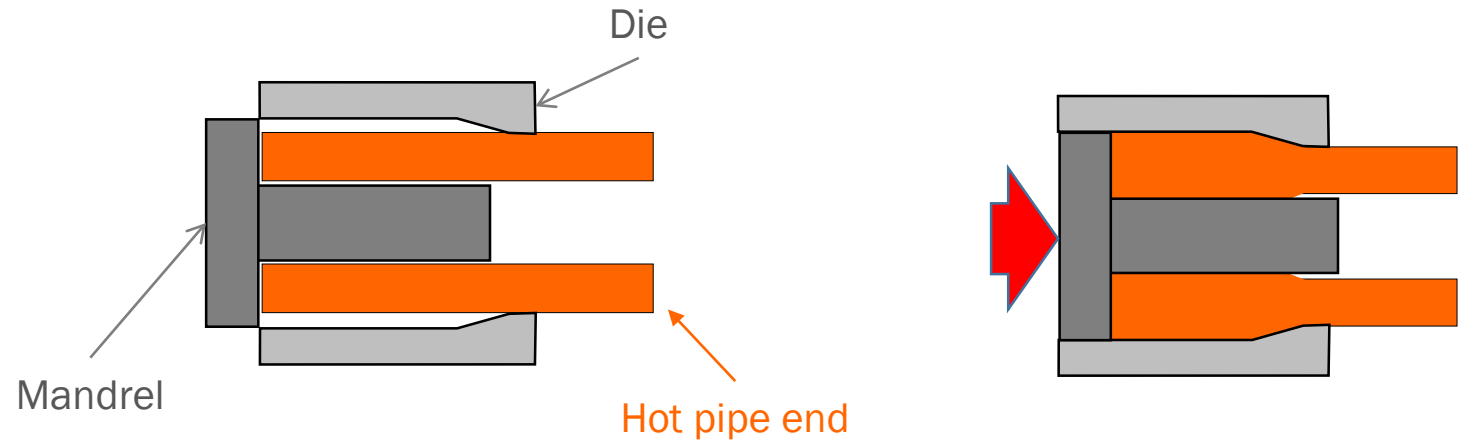
Upsetting in pictures

Induction heating



Pipe end is heated

Upsetting

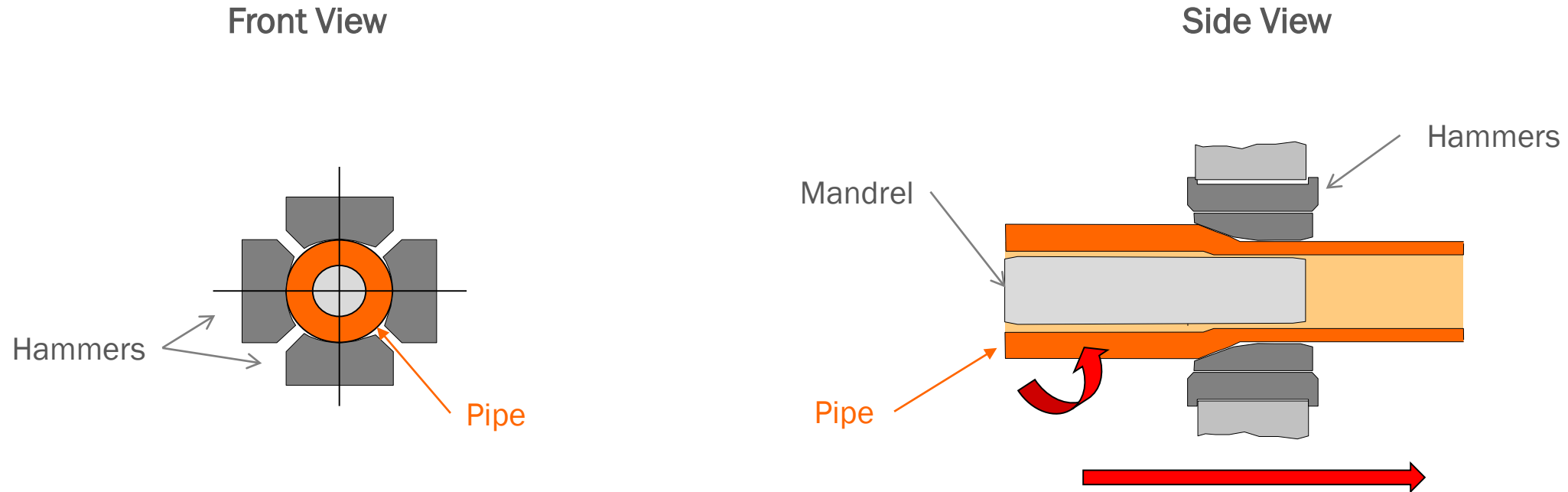


Pipe is clamped to the press

Wall Thickness is pushed between mandrel & die

Upset process is designed for mass production

Radial Forging in pictures



Pipe Shaping in one step, just after billet piercing

Process allows for small quantities and large variations of design

VALLOUREC / DORIS - a Collaborative Work



- Welding productivity documented
- Pipe features



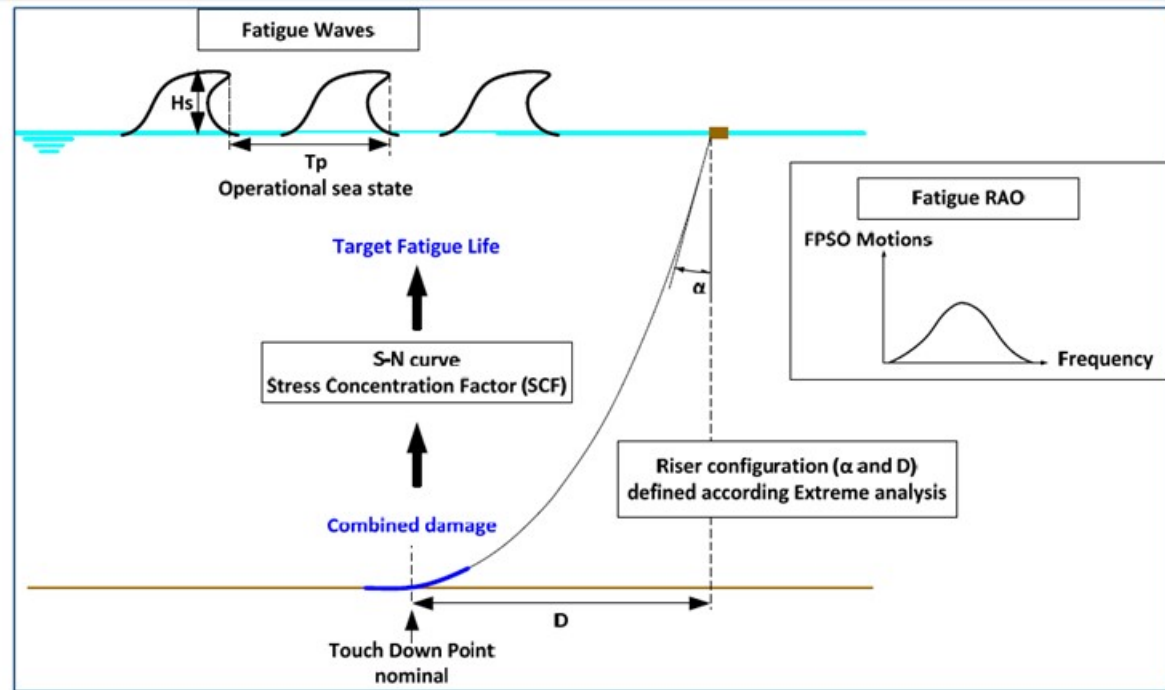
- Concept-neutral / contractor-independent
- Riser Design
- Perform high level fatigue parametric study

PURE®

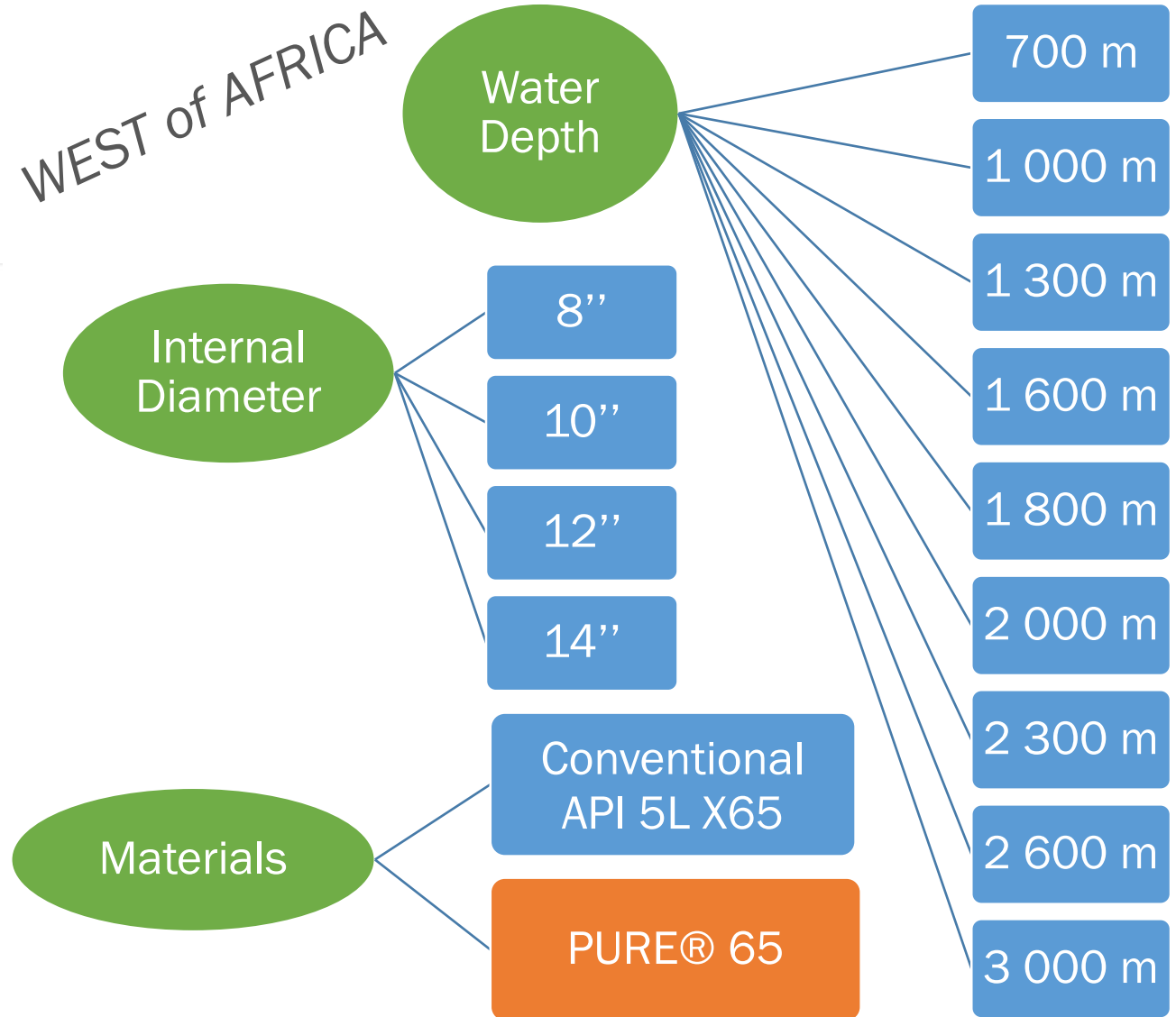
- How can PURE® impact SCR fatigue life ?
- How can PURE® contribute to riser design simplification ?

SCR Riser Analysis Methodology

- Line Pipe Sizing (burst/collapse)
- Extreme Analysis
- Fatigue Analysis

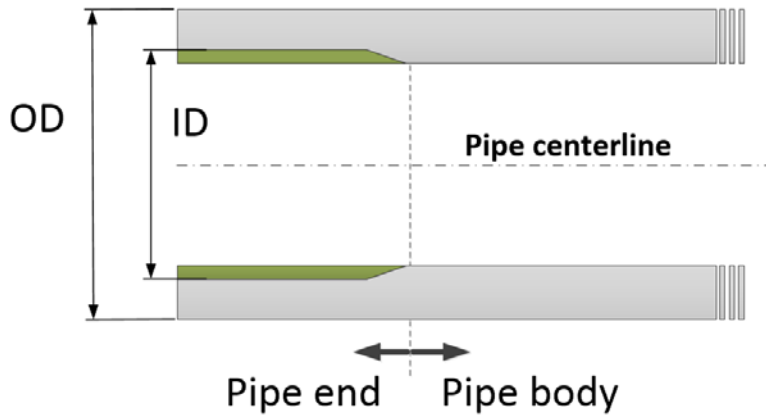


Key parameters



PURE® design advantage

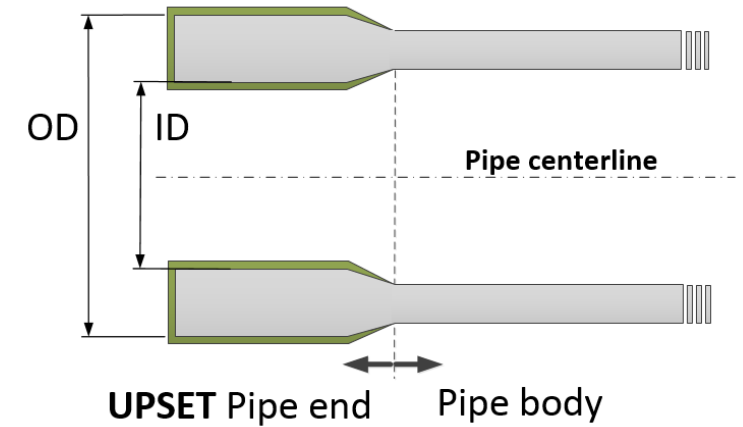
Conventional ID Machining



$$\frac{WT\ end}{WT\ body} < 1$$

$$\frac{WT\ end}{WT\ body} > 1$$

PURE®



Pipe end ID & OD machining

- Hi-lo = 0,5mm
- t fab = 0,5mm

➔ Axial Misalignment (e) = +/- 1mm

Pipe end ID machining

- Hi-lo = 0,5mm
- t fab = 10%.WT (>1,3mm)

➔ Axial Misalignment (e) > +/- 1,8mm

Compared with the conventional pipe

All the PURE® products have a better tolerance of fabrication

PURE® benefit on SCF

Stress Concentration Factor (SCF) formula

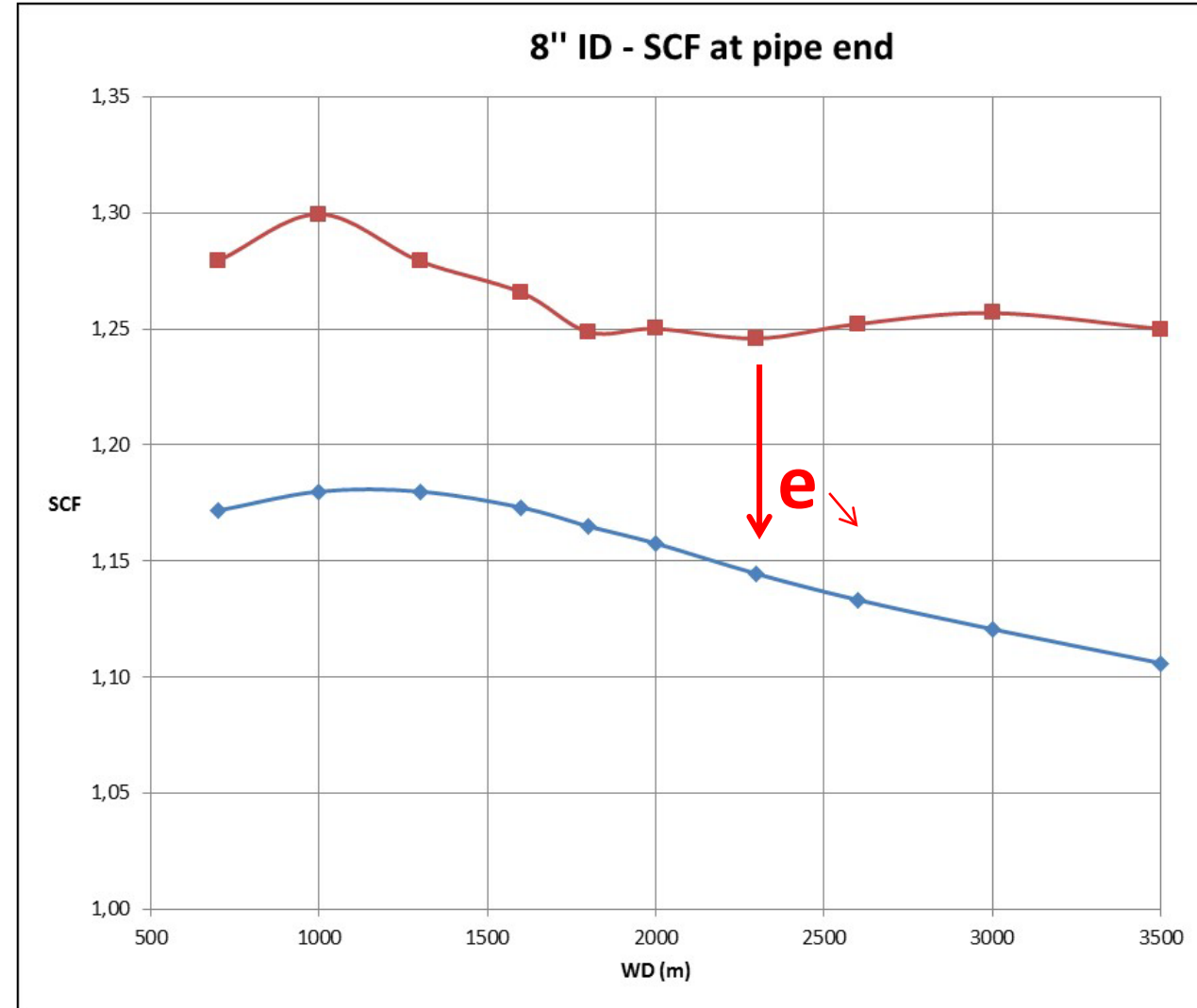
$$SCF = 1 + \frac{3e}{t} \cdot \exp\left(-\left(\frac{OD}{t}\right)^{-0.5}\right)$$

With

- t = Pipe wall thickness
- e = Eccentricity / axial misalignment
- OD = nominal outside diameter

Compared with the conventional pipe,
the SCF for PURE® products decreases

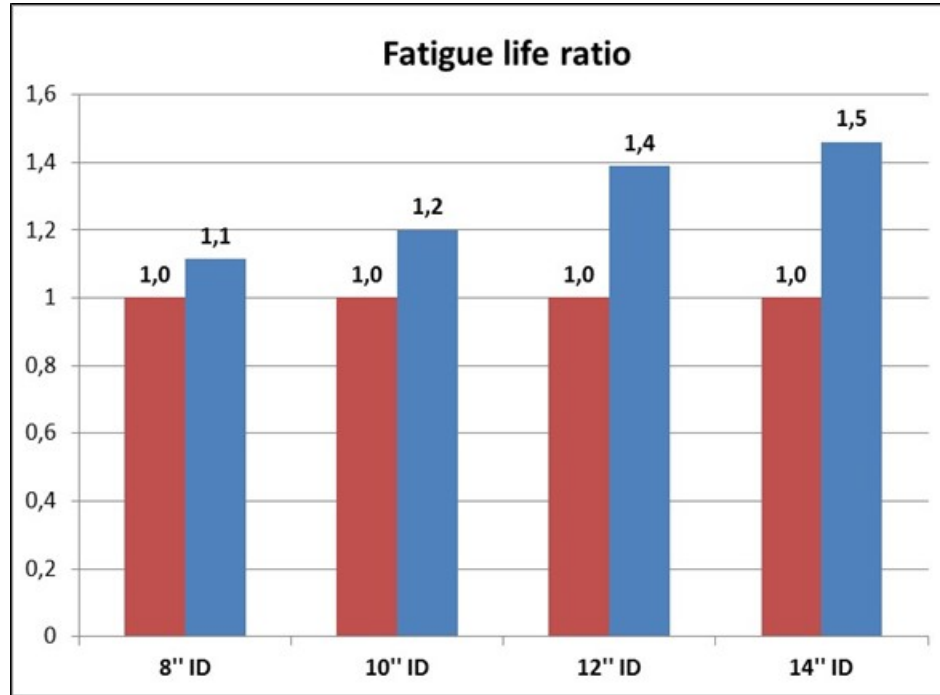
Lower SCF → direct increase of Fatigue life



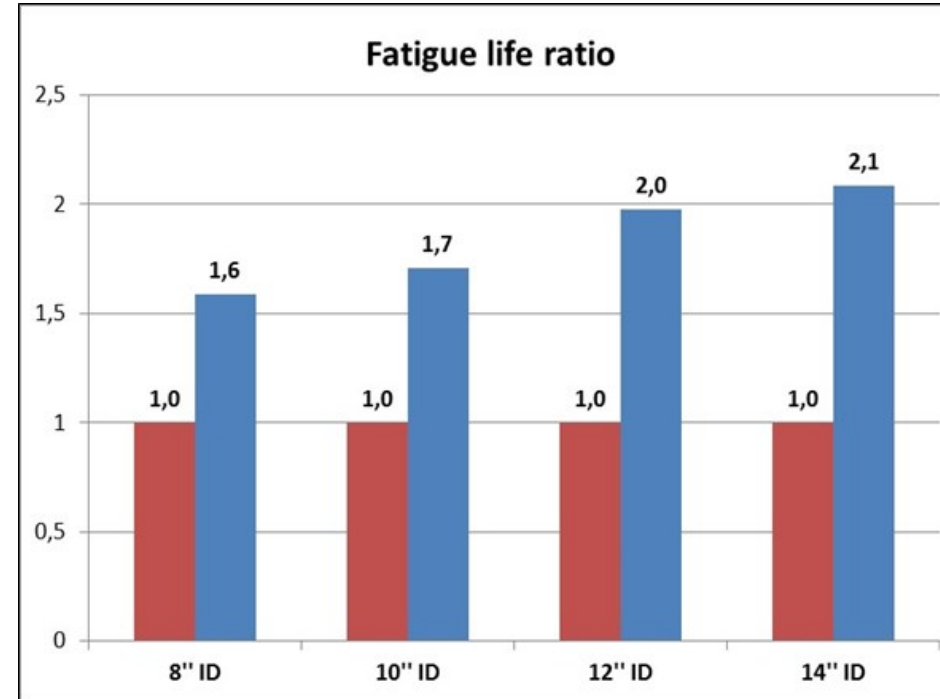
■ Conventional Pipe

■ Pure® 65

PURE® enables a better fatigue life



S-N Curve - Class E



S-N Curve - Class D

■ Conventional Pipe

■ Pure® 65

Compared with the conventional pipe

The PURE® products multiply the SCR fatigue life

- under class E, from 1,1 up to 1,5
- under class D, from 1,6 up to 2,1

8"ID – 1300m Water Depth application case

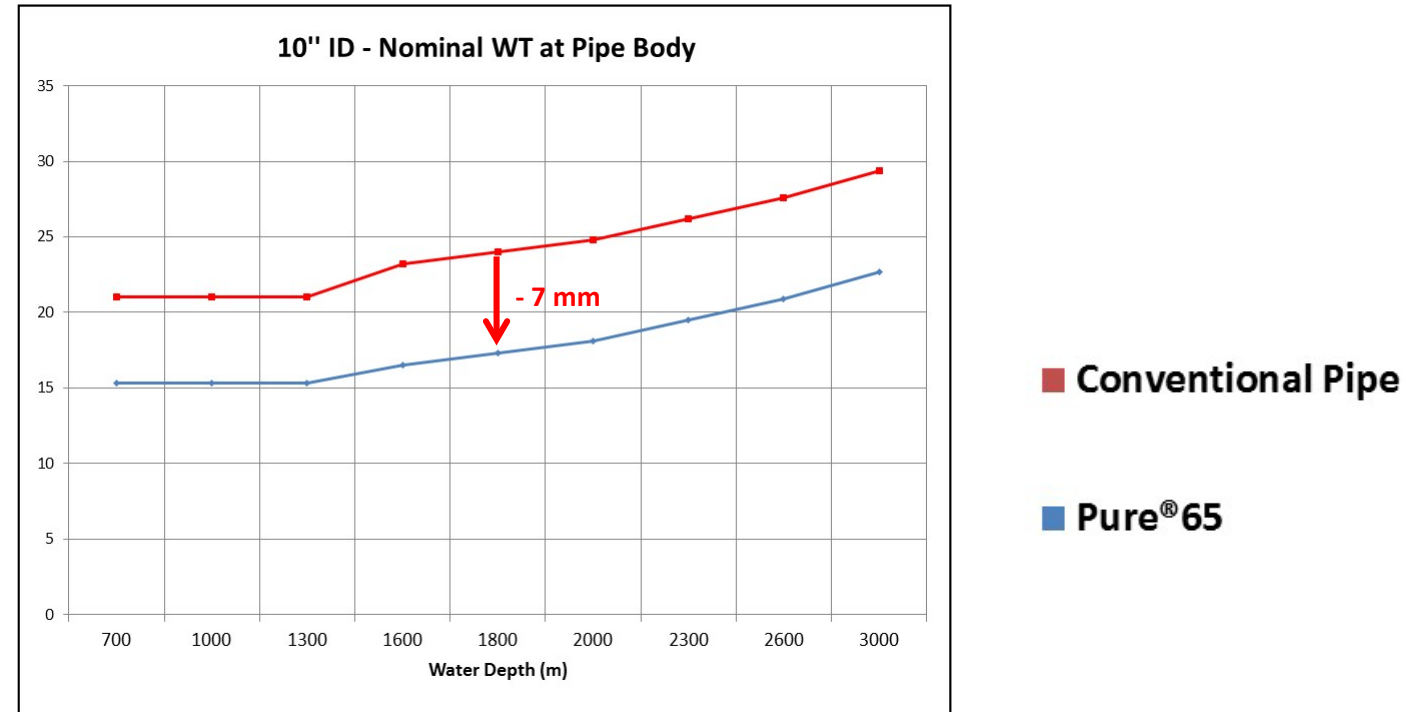
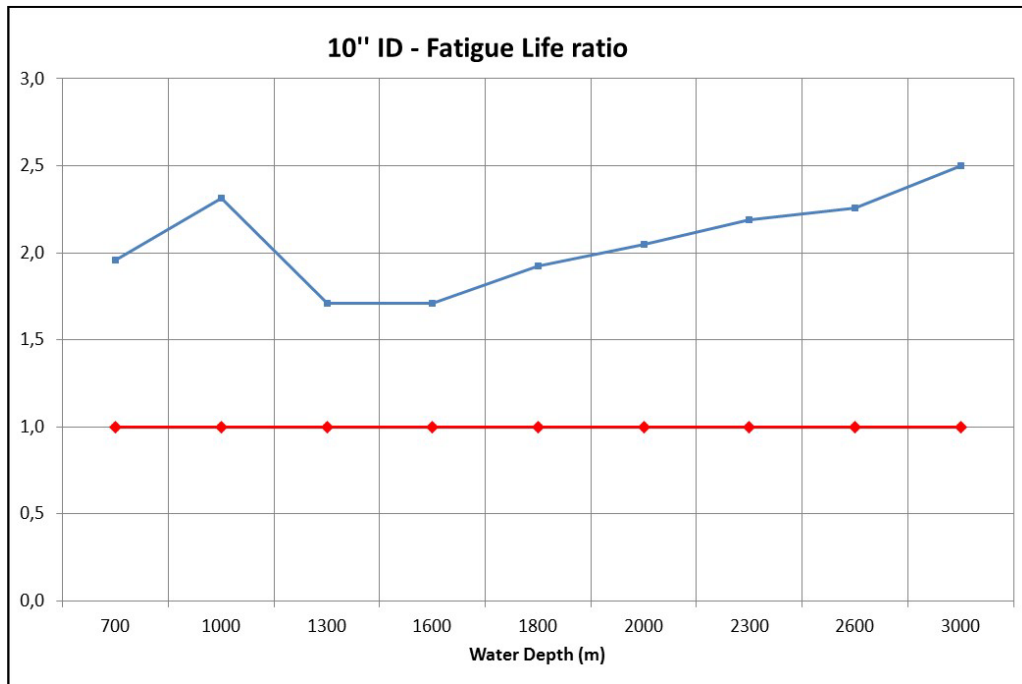
	Conventional Pipe ID Machining		PURE®	
	Thickness End	Thickness Body	Thickness Upset End	Thickness Body
Line Pipe Sizing (Burst / Collapse)	13.0 mm	14.7 mm	14.2 mm	13.4 mm
Extreme Analysis	14.0 mm	15.7 mm	14.5 mm	13.7 mm
Fatigue Analysis	17.0 mm	18.7 mm	14.5 mm	13.7 mm
TOTAL added WT	+ 4.0 mm		+ 0.3 mm	

	Conventional Pipe ID Machining	PURE®
WT		
Thickness Axial Misalignment	e = 1.9 mm	e = 1 mm
SCF	1.28	1.18
Fatigue Life	1	1.6

With PURE® products

- Upset end reduces fatigue stresses
- WT of the pipe body is minimized → riser weight reduction

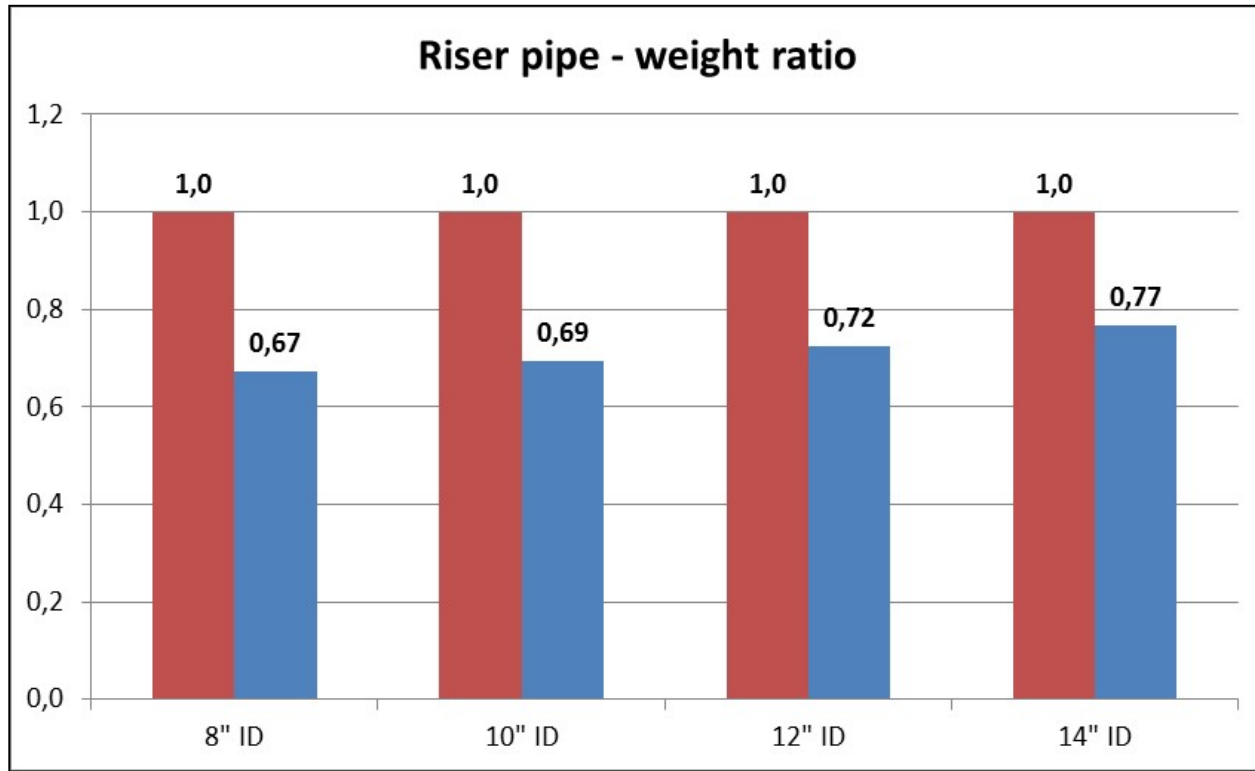
10" ID riser fatigue results – Water Depth from 700m to 3000m



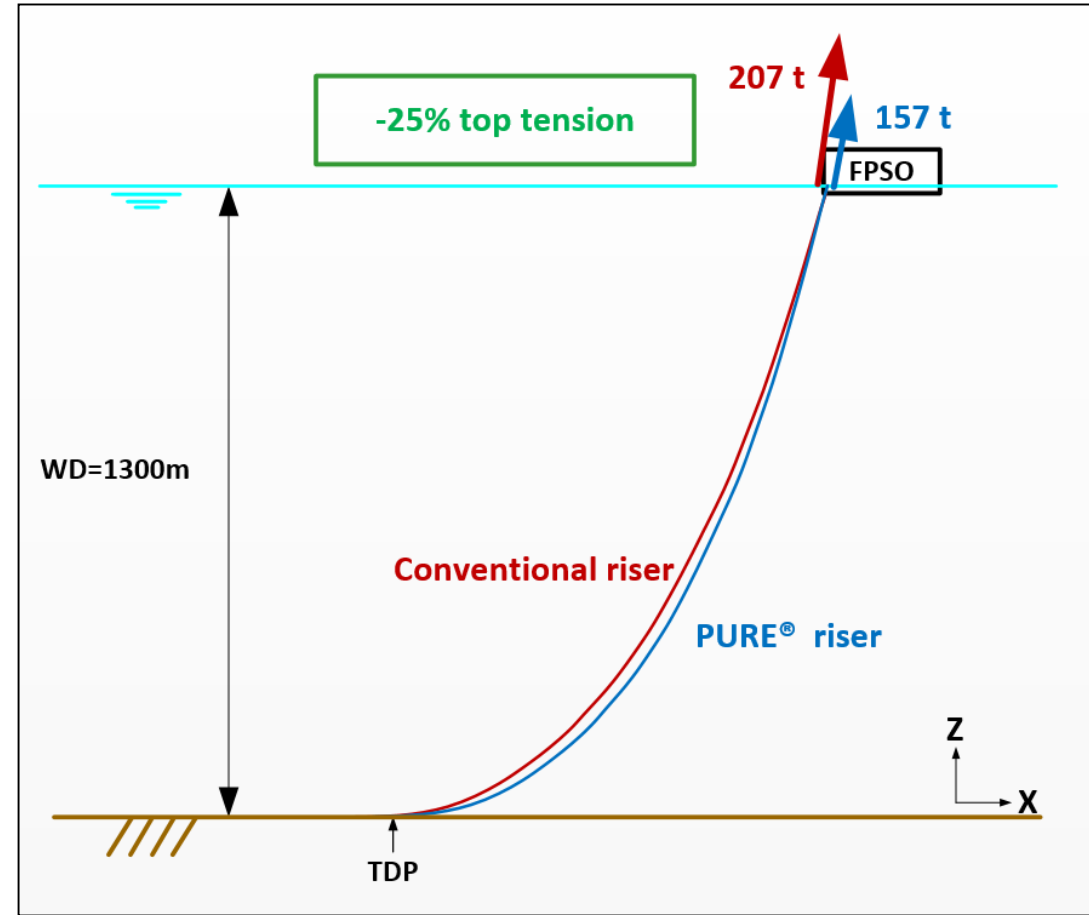
Compared with the conventional pipe,
 Increase of fatigue life by a minimum ratio of 1,7
 7 mm thinner PURE® pipes

Whatever the conditions, a PURE® product will have better fatigue life than a conventional pipe
 However the gain value will depend on each design condition

PURE® has a lighter design



- Conventional Pipe
- Pure® 65



Compared with the conventional pipe

For a given Water Depth, a PURE® riser could reduce the top tension applied to the vessel by 25% to 30%

Key Take Aways & Perspectives

- Fatigue Performance
 - ➔ Enabler for optimized designs: SCR vs SLWR; SLWR vs Flexibles
- Lighter Riser
 - ➔ Reduction of vessel structural costs / Use of converted vessels
- Excellent Pipe geometry
 - ➔ Improved welding productivity
- Reduced Wall Thickness
 - ➔ Less material to procure

- Field-proven with 2 mills available
 - ➔ Limited sourcing risk, complementary offers
- Large variety of possible designs
 - ➔ Customized solutions for Libra/Mero in Brazil, Liza, GoM...
- Combination with high strength steel
 - ➔ PURE®80 for Ultra Deep / HPHT

- Under development : Clad Lined PURE®

Thank you for your attention

Come to discuss it :

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