

# Reeling of Pipe-in-Pipe

The (economic) benefits of the greater resistance of PiP systems against local buckling



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# HMC EXPERIENCE — J-LAY



**650  
KM**

Pipes  
installed  
since 1991



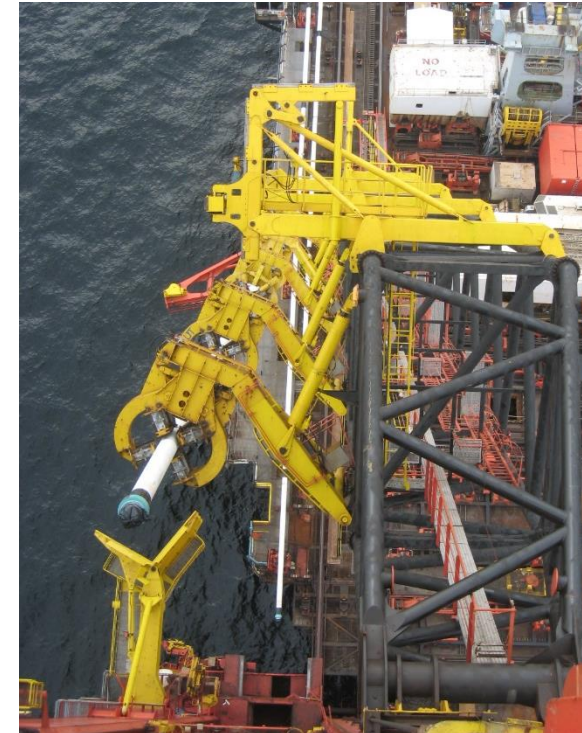
**2**

Pipelay vessels  
Balder and Aegir



**VARIED  
PIPES**

CLAD  
Lined  
PiP



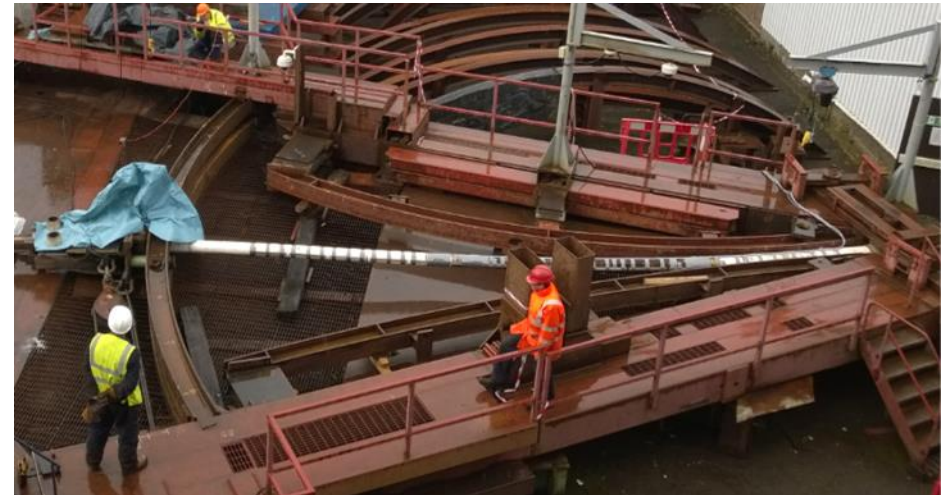


# REELING TECHNOLOGY DEVELOPMENT



**PIPES  
TESTED**

Thick coatings  
Seam welded  
Pipe-in-Pipe  
Mechanically lined  
Transition piece





## HMC EXPERIENCE — REEL-LAY



**ANADARKO LUCIUS**

**GOLF OF MEXICO**

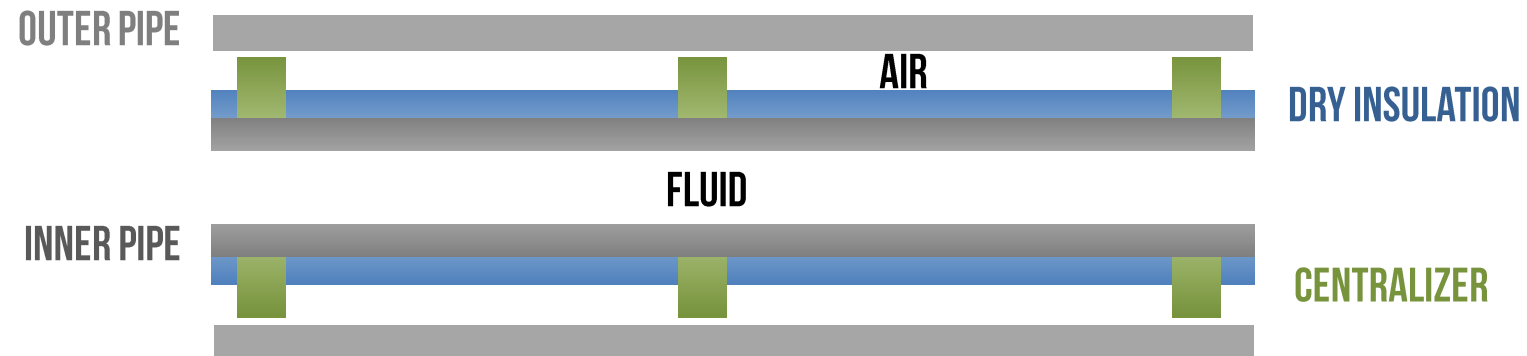


**INPEX ICHTHYS**

**AUSTRALIA**



# THE SLIDING **PIPE-IN-PIPE** SYSTEM





# PIPELINE FAILURE MODES



**BURST**



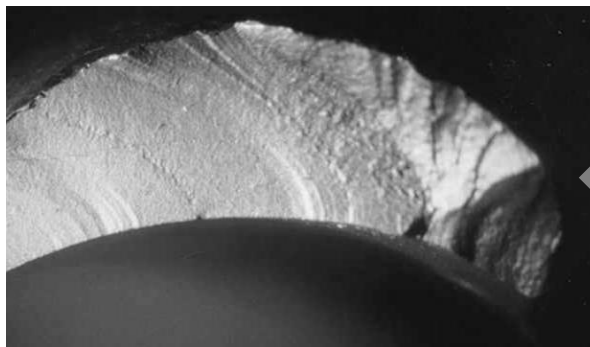
**COLLAPSE**



Local  
**BUCKLING**



Global  
**BUCKLING**

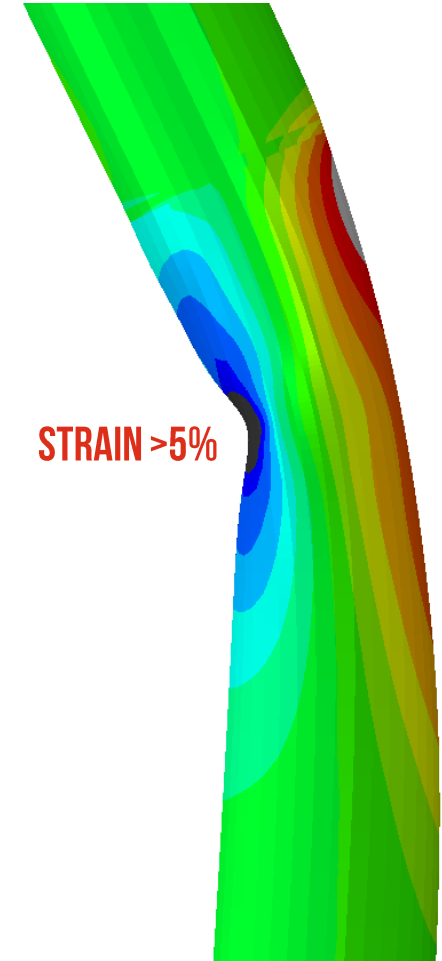
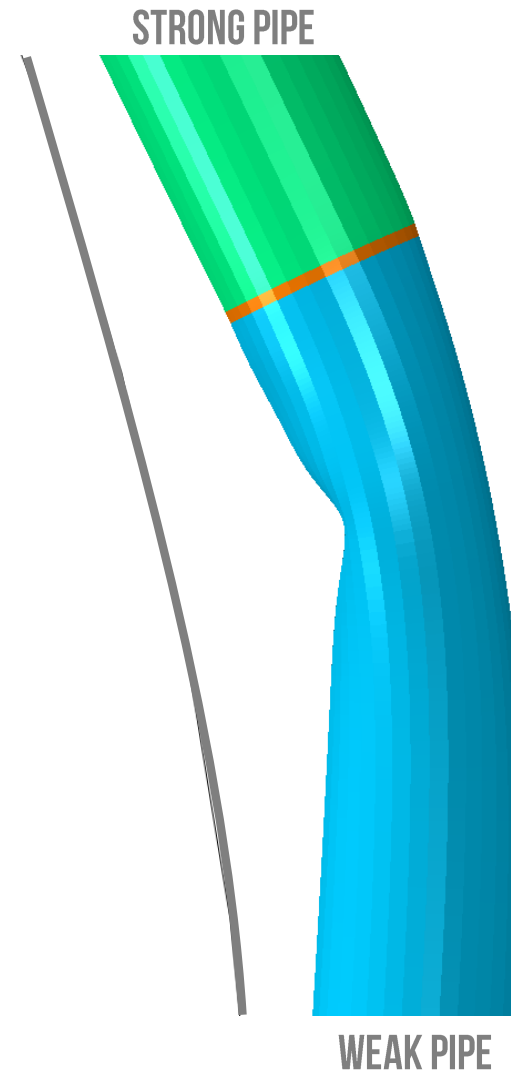
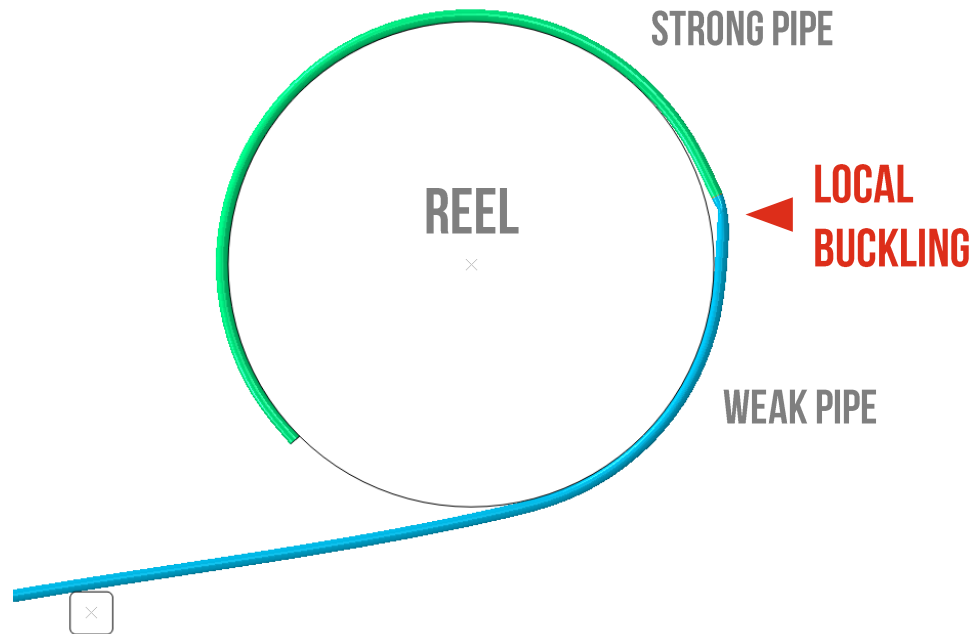


**FATIGUE**



**FRACTURE**

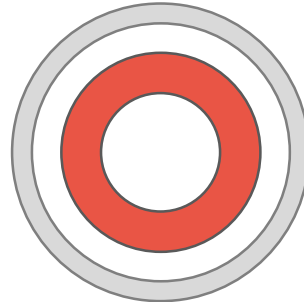
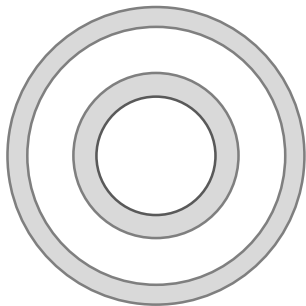
# LOCAL BUCKLING DUE TO COMBINED LOADS



# (SOME) FAILURE MITIGATION FOR REELED PIPE-IN-PIPE

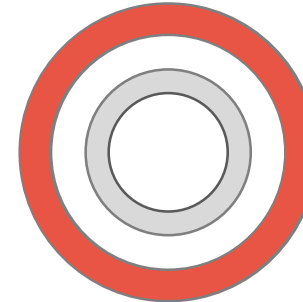
**BURST**

Increase  
**INNER PIPE**  
wall thickness



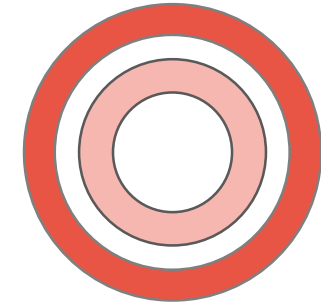
**COLLAPSE**

Increase  
**OUTER PIPE**  
wall thickness



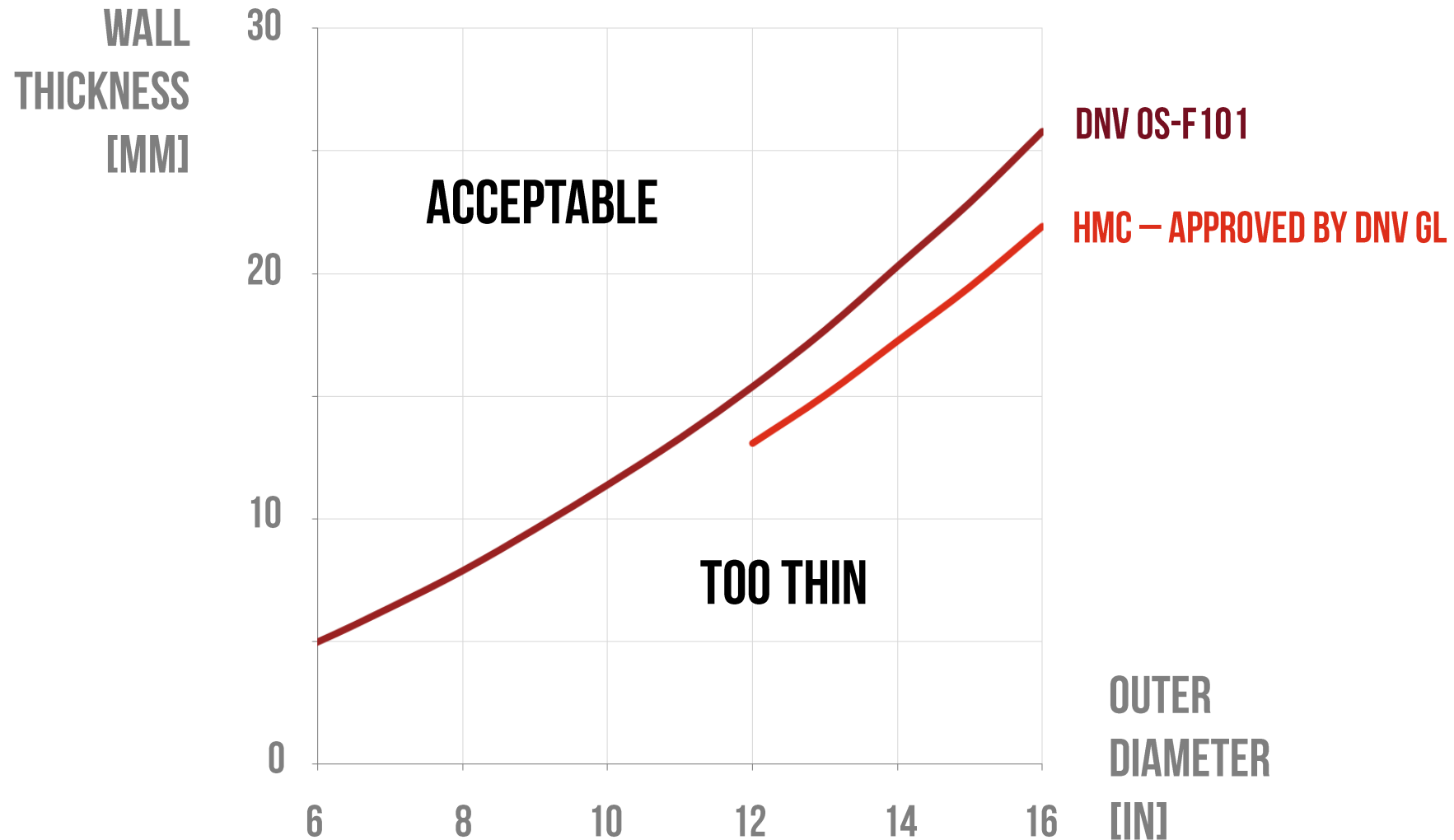
Local  
**BUCKLING**

Increase  
**OUTER PIPE**  
& sometimes  
**INNER PIPE**  
wall thickness



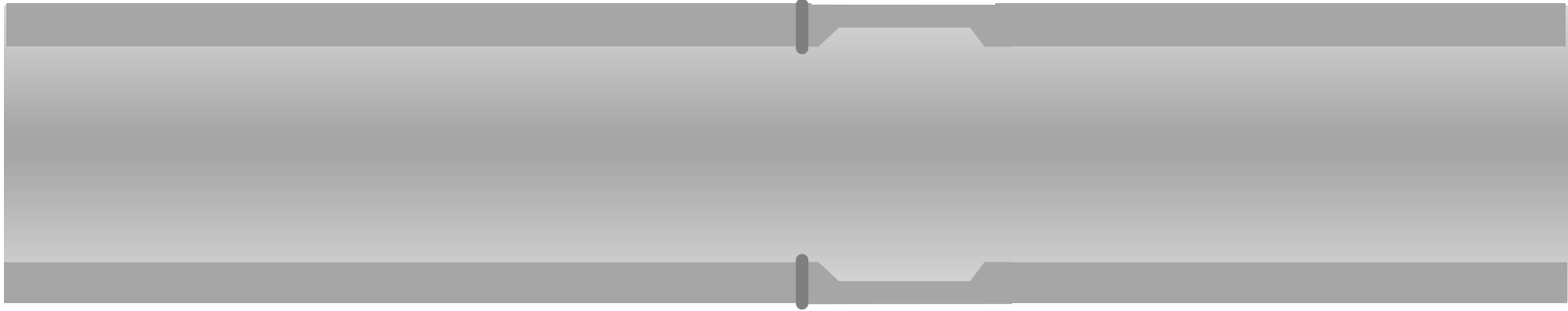


# WALL THICKNESS DESIGN FOR REELING



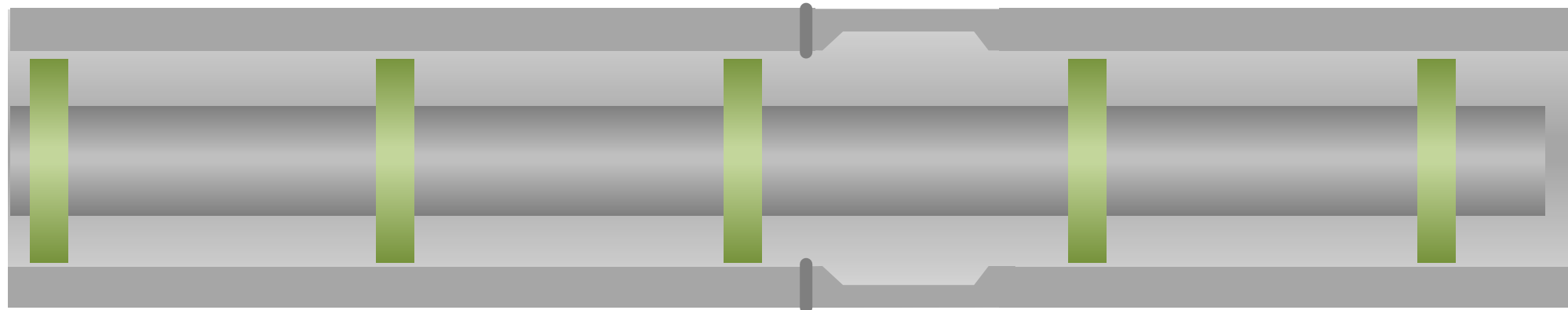
# STIFFNESS MISMATCH BETWEEN JOINTS

## SINGLE PIPE

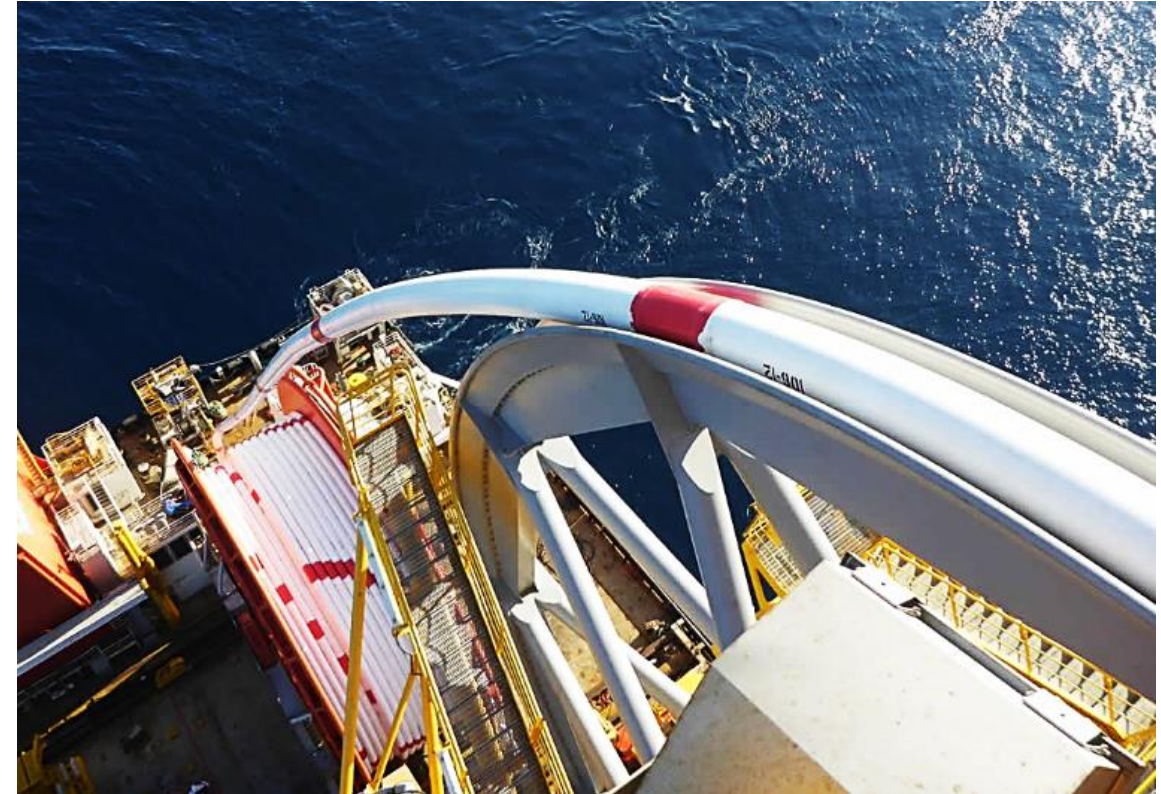
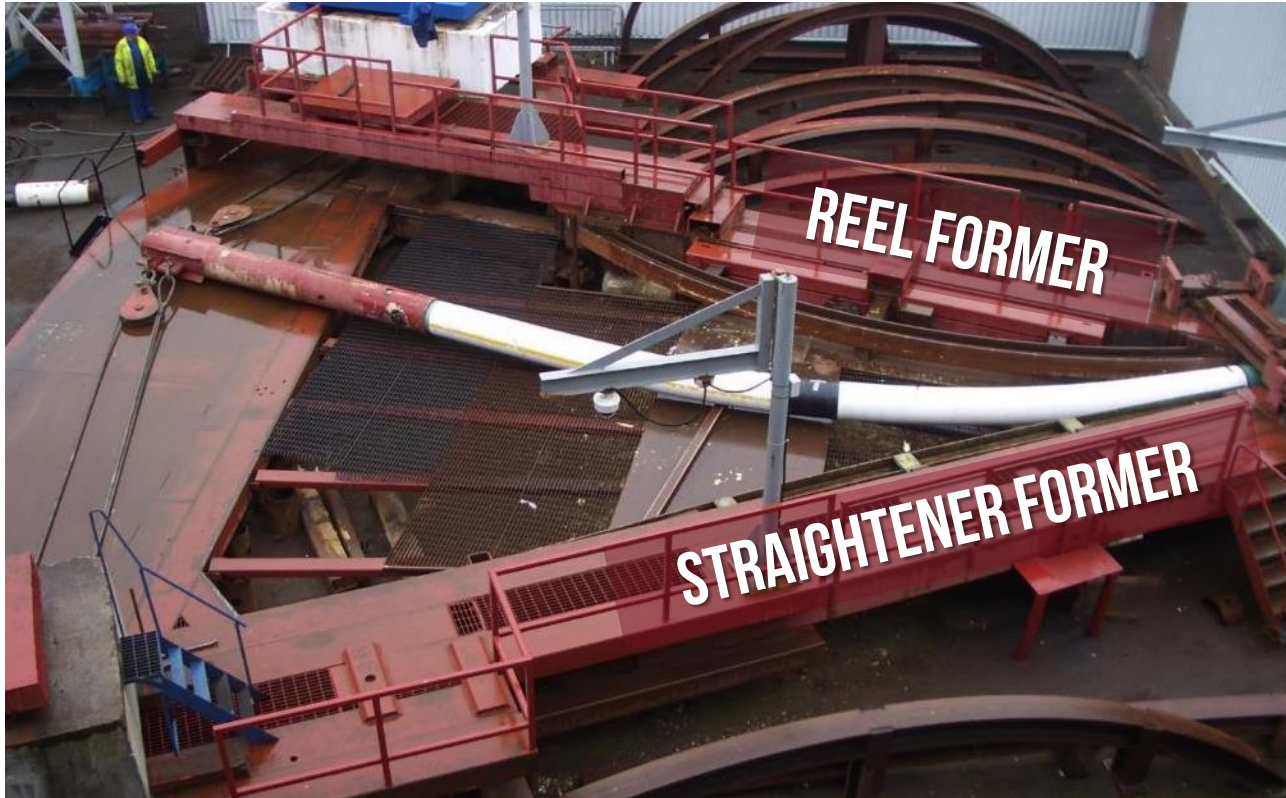


**22% WT MISMATCH**

## PIPE-IN-PIPE



# BEND TESTING

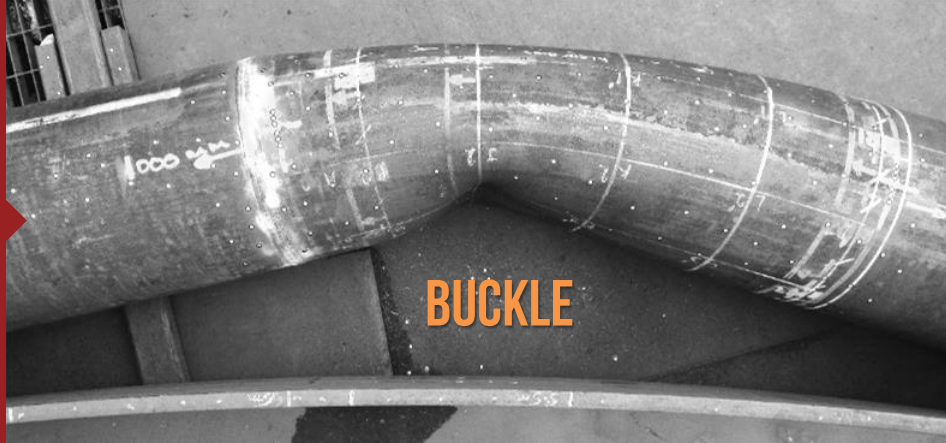




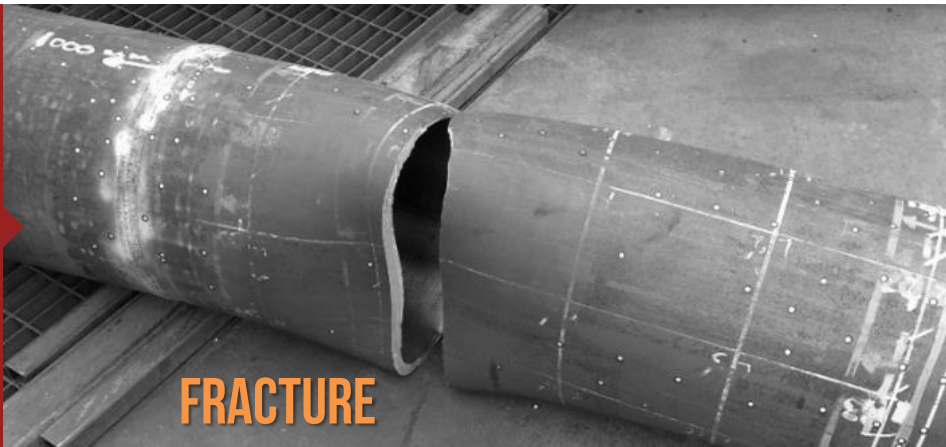
# BEND TEST RESULTS – CYCLE 1

## SINGLE PIPE

**BENDING**



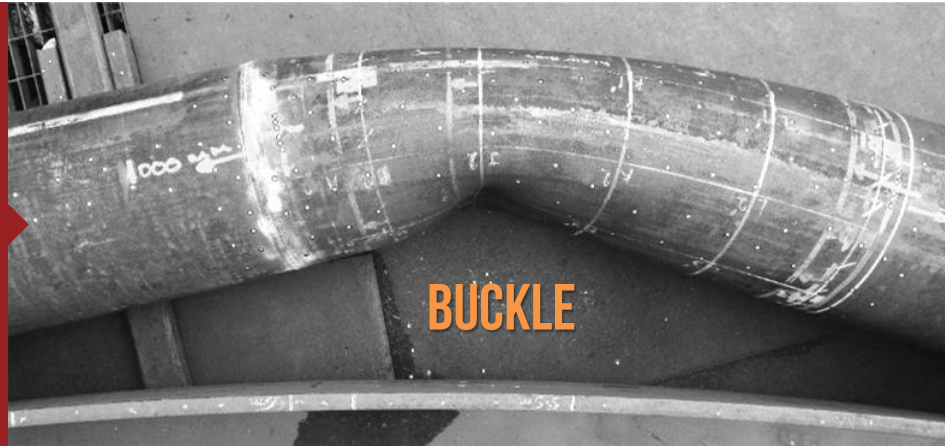
**STRAIGHTENING**



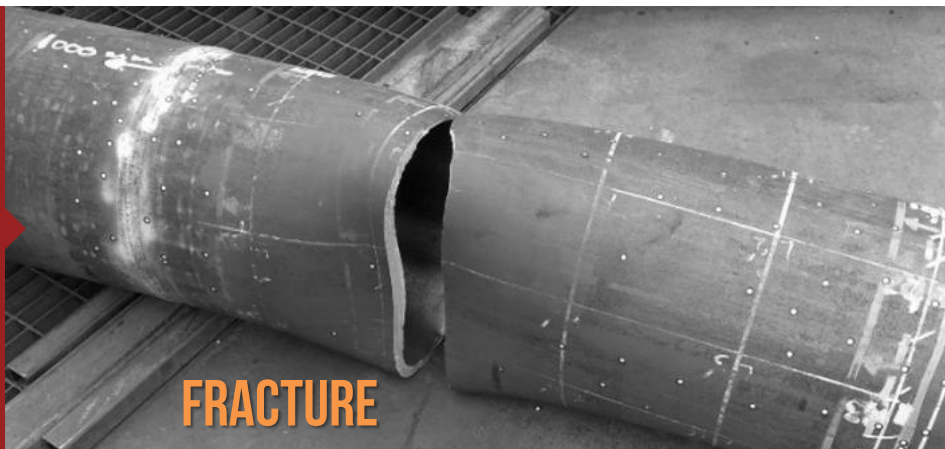
# BEND TEST RESULTS – CYCLE 1

## SINGLE PIPE

**BENDING**

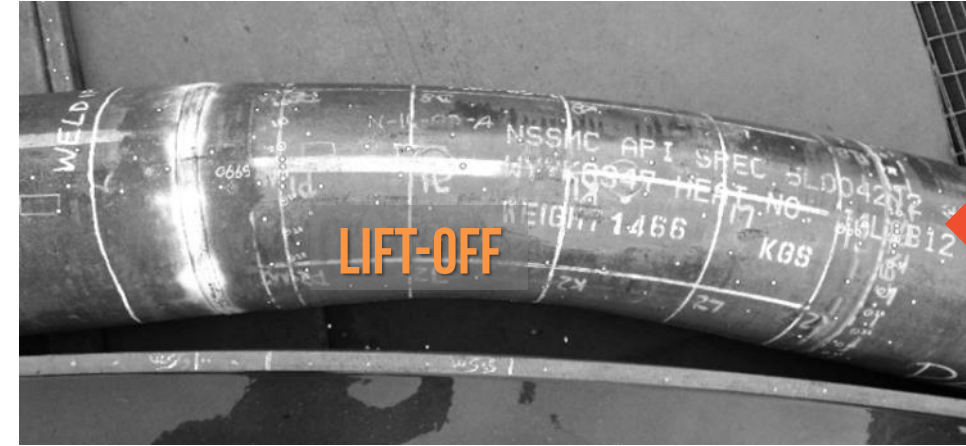


**STRAIGHTENING**



## PIPE-IN-PIPE

**LIFT-OFF**



**BENDING**

**WRINKLE**



**STRAIGHTENING**



# BEND TEST RESULTS – CYCLE 2

## SINGLE PIPE

Buckle after first cycle  
Fracture after straightening



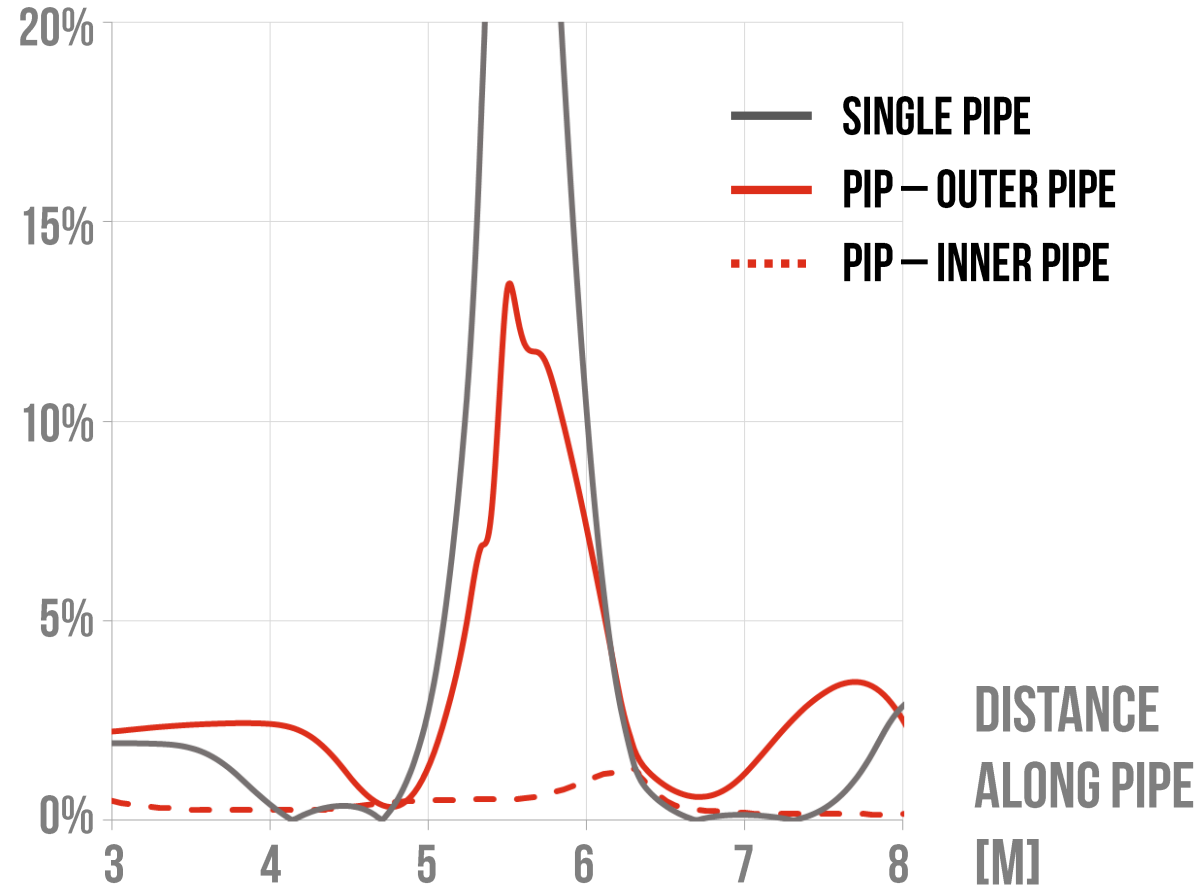
## PIPE-IN-PIPE

Buckle of the outer pipe after two cycles  
Inner pipe ovalized but not buckled



# LOCAL BUCKLING AND **OVALITY**

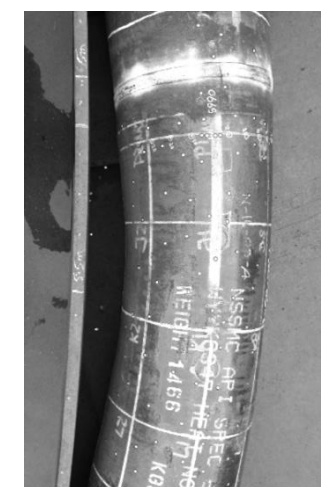
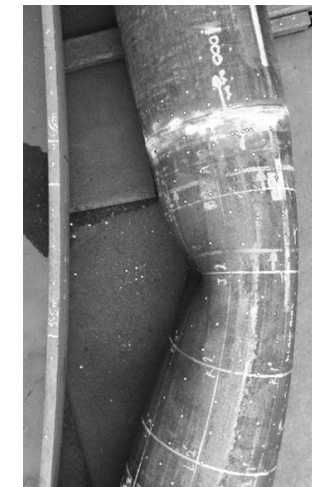
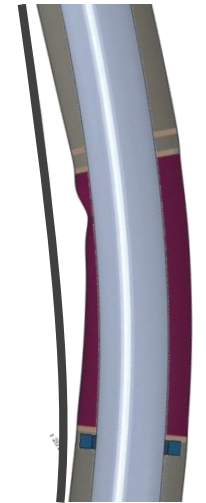
PREDICTED  
OVALITY



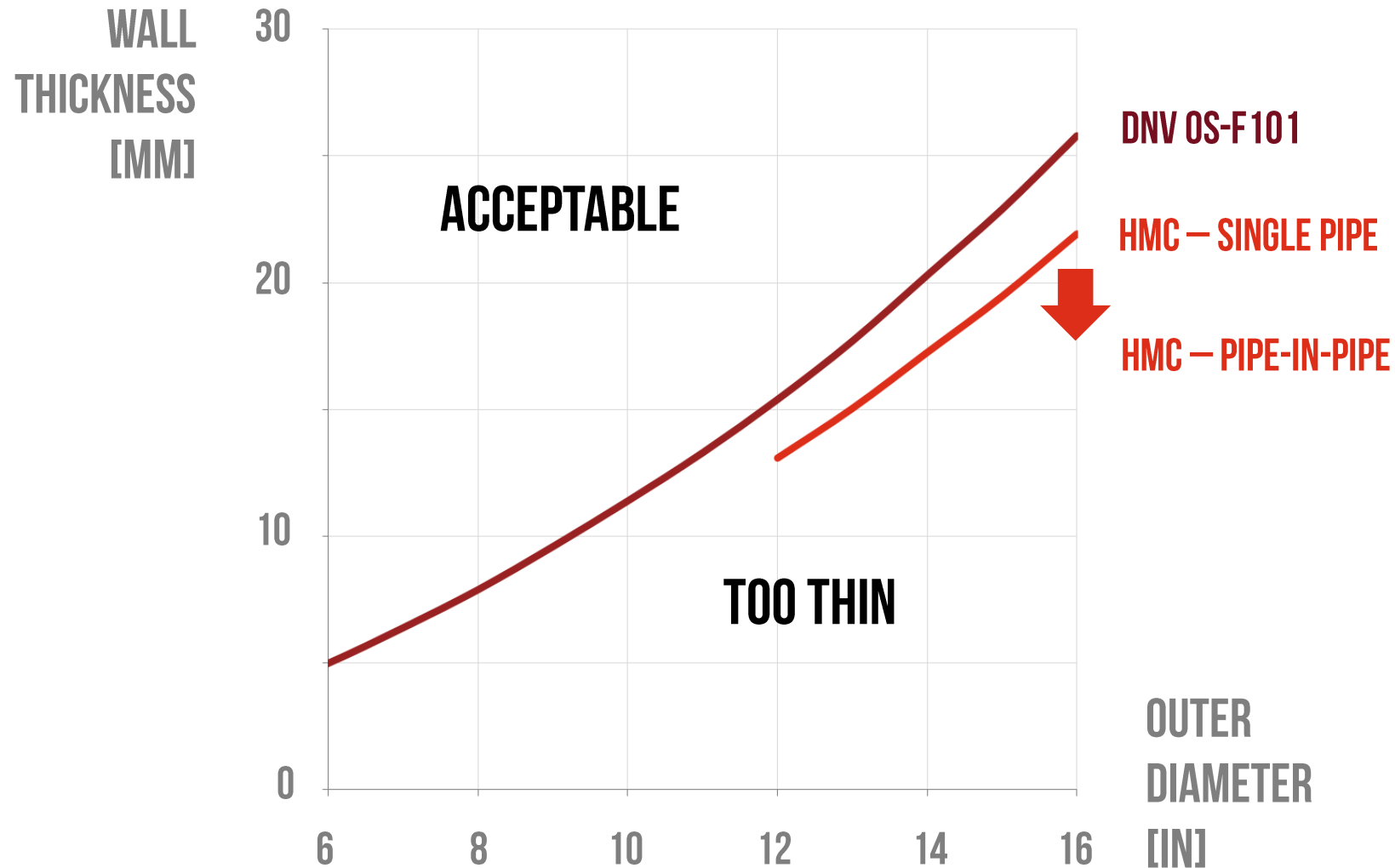
SINGLE PIPE



**PIPE-IN-PIPE**



# PIPE-IN-PIPE WALL THICKNESS DESIGN



# STABILITY OF REELED PIP TOWARDS LOCAL BUCKLING

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Detailed Finite Element and reliability analysis permit to reduce some conservatism and optimize the wall thickness design.

**Cost reduction** is the first benefit of pipe wall thickness reduction.

