

**Top-Entry Triple Offset Metal Seated Valves
Verification of Performance and Maintainability through Life Cycle Type Approval Test
The Saudi Aramco case study**

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Valve ServiceLife



Reliability

Service
capability

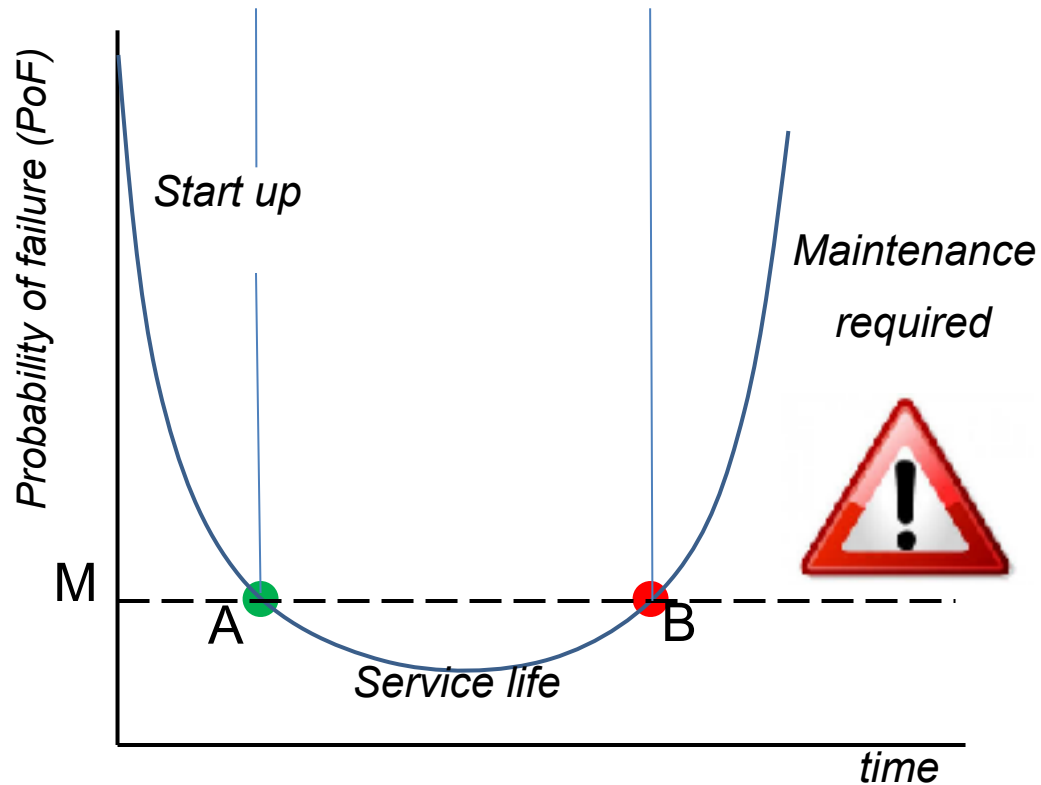
Maintenan
ce

Ease of
maintenan
ce

After
maintenan
ce test

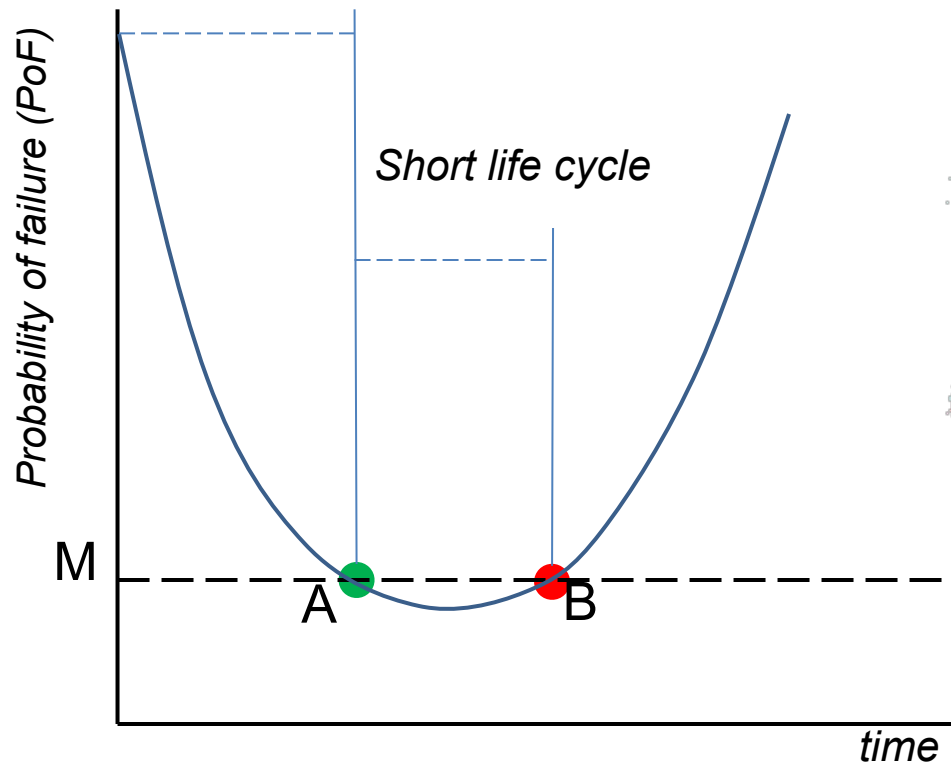


Valve service life



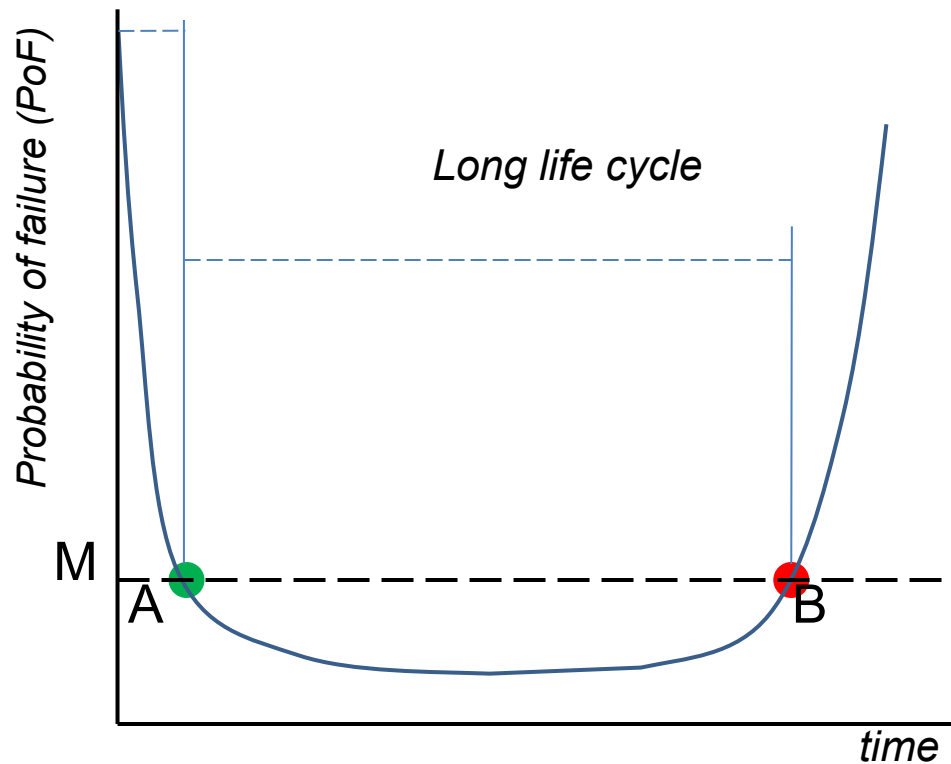
Valve service life

Long time to reach acceptable level of reliability

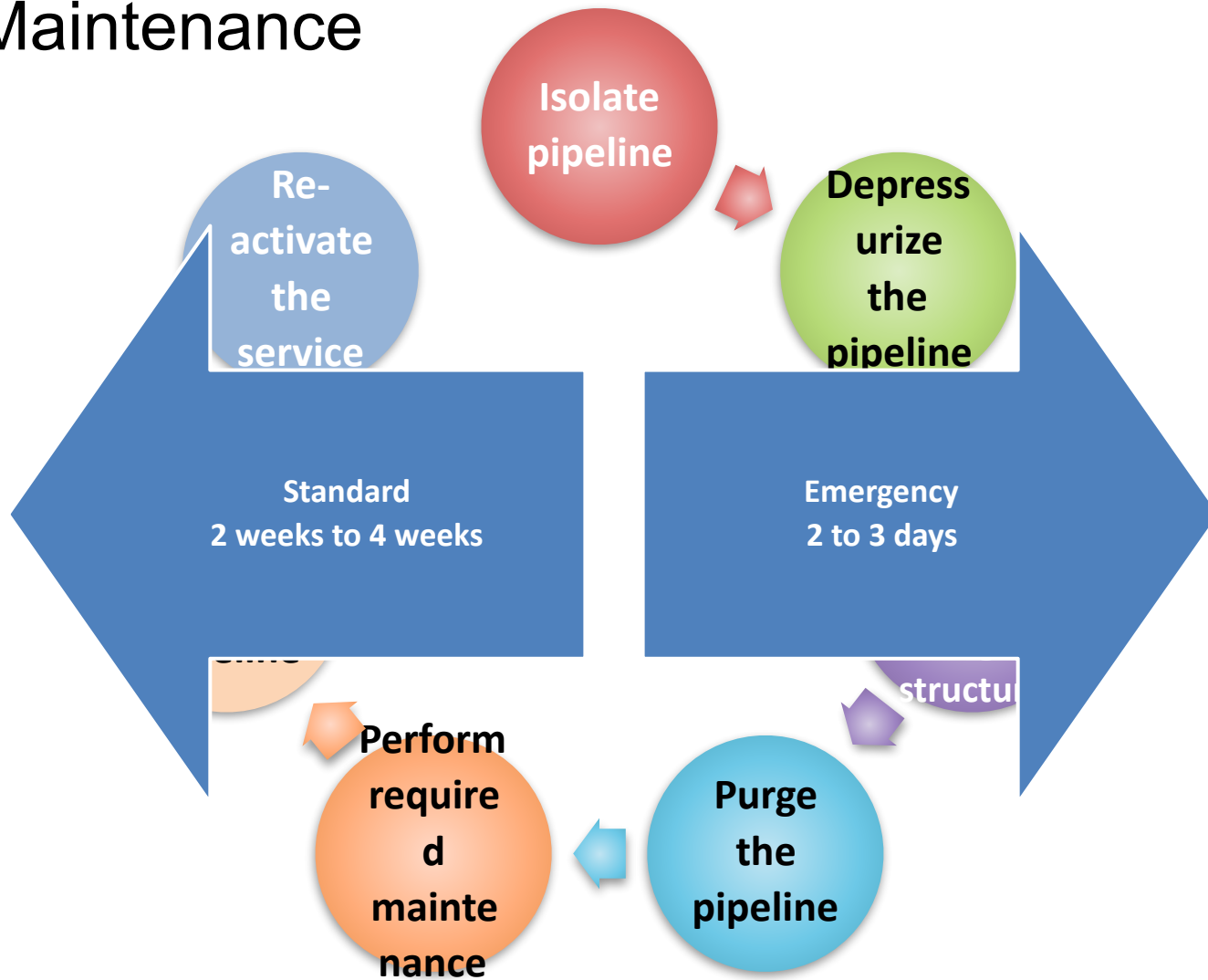


Valve service life

Short time to reach acceptable level of reliability



Plant Maintenance



Valve reliability



Key factor in trying to eliminate emergency maintenance

.... and to postpone as much as possible standard maintenance



Valve reliability



**100% shop
test**

Reliability

**100%
shop test**

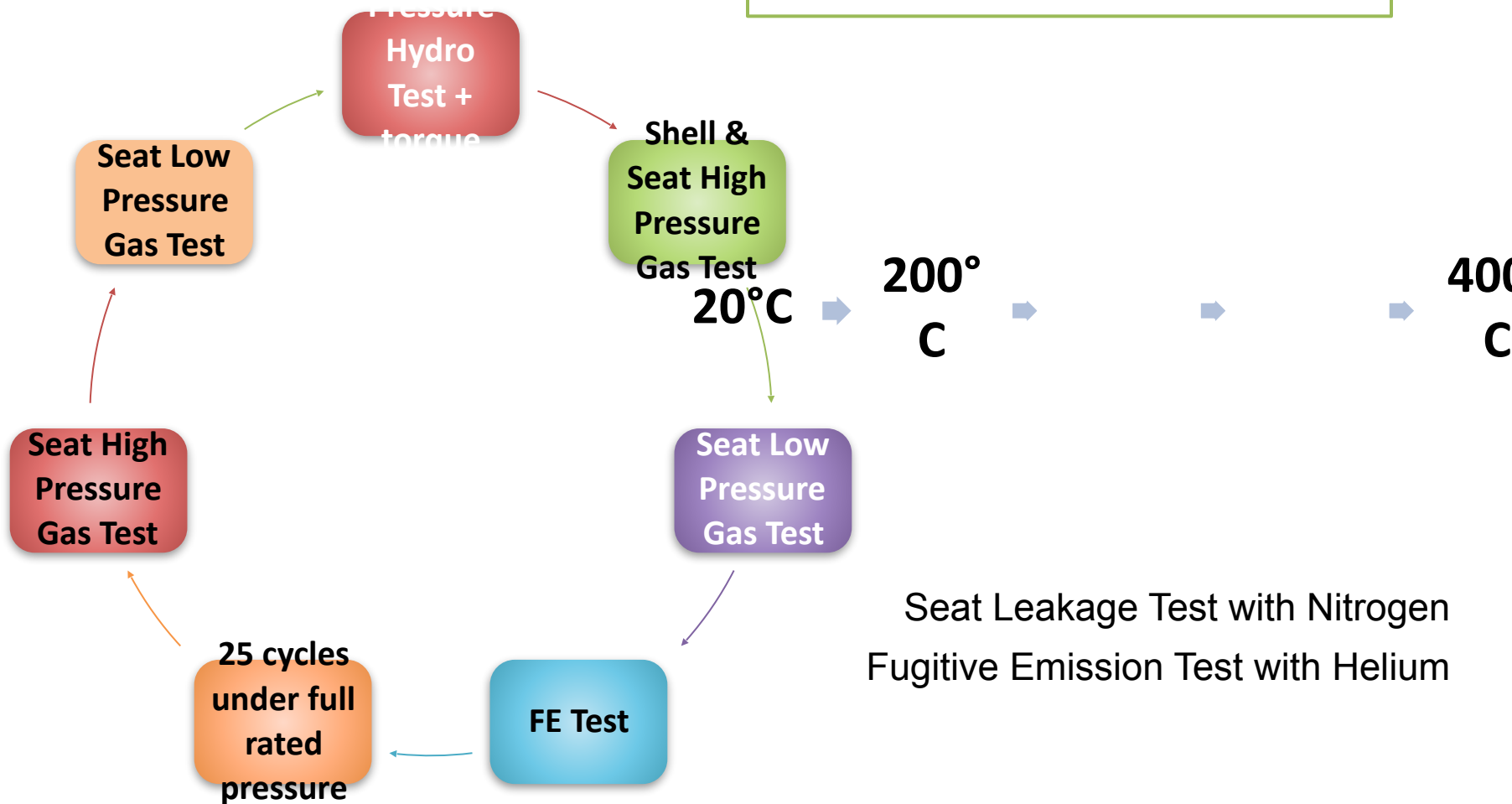
**Valve Life
Cycle test**

Valve Life Cycle Test

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Top-Entry TOBV
16" / 150



Valve Life Cycle Test

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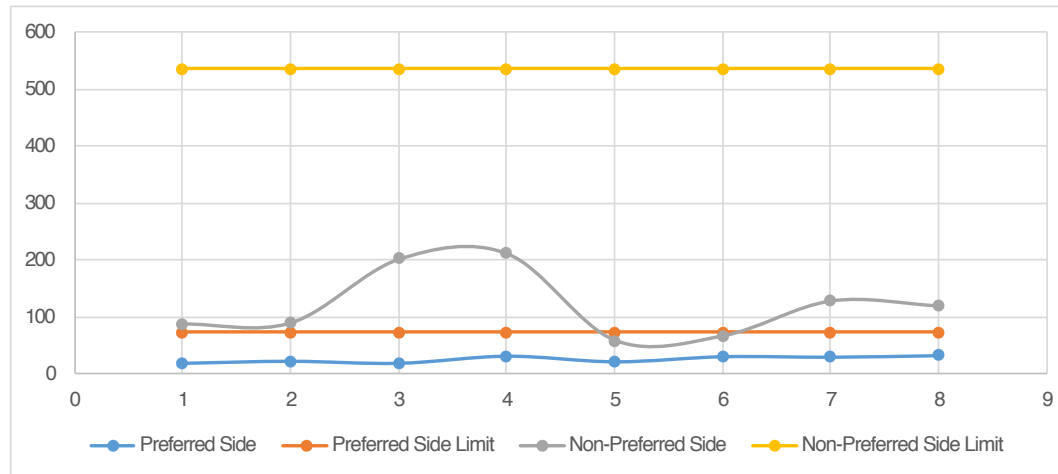


Valve Life Cycle Test

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SEAT LEAKAGE RATES for HIGH PRESSURE GAS TEST

	Preferred Side	Preferred Side Limit	Non-Preferred Side	Non-Preferred Side Limit
1 st ambient	17	72	87	535
2 nd ambient	21	72	89	535
1 st 200°C	17	72	202	535
2 nd 200°C	31	72	212	535
1 st 400°C	20	72	58	535
2 nd 400°C	30	72	66	535
1 st ambient	29	72	128	535
2 nd ambient	32	72	119	535



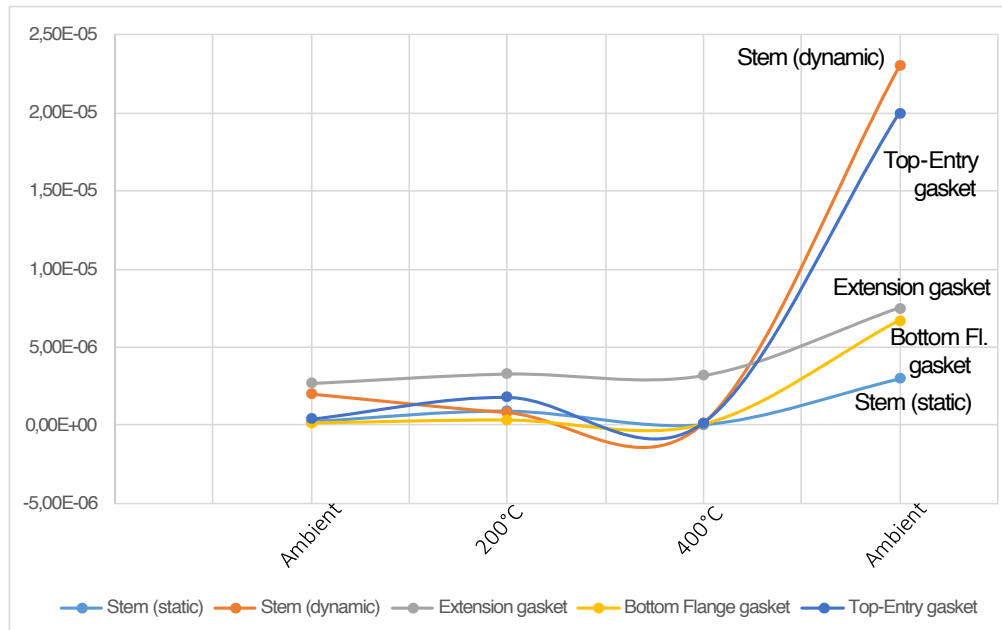
Valve Life Cycle Test

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FE LEAKAGE RATES

	Stem (Static)	Stem (Dynamic)	Extension gasket	Bottom Flange gasket	Top-Entry flange gasket
ambient	2,20E-07	2,00E-06	2,70E-06	1,85E-07	4,00E-07
200°C	9,00E-07	8,10E-07	3,30E-06	3,70E-07	1,80E-06
400°C	1,80E-08	1,20E-07	3,20E-06	1,00E-07	1,70E-07
ambient	3,00E-06	2,30E-05	7,50E-06	6,70E-06	2,00E-05
All. limit	8,90E-05	8,90E-05	5,00E-05	5,00E-05	5,00E-05

Note: in the test report leakages lower than $2,0 \times 10^{-6}$ ml/min have been rounded to this value due to constraints of the sniffing technique



Typical Top-Entry Valves

Actuator

- Need to dismantle everything on top

Disassembly

- Completely disassemble the valve to change sealing gaskets

Heavy parts

- Need to handle heavy parts

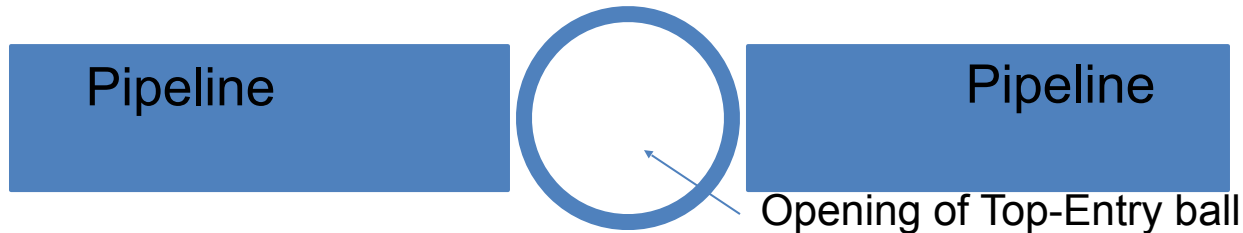
Deformations

- Deformation induced by valve and pipeline weight

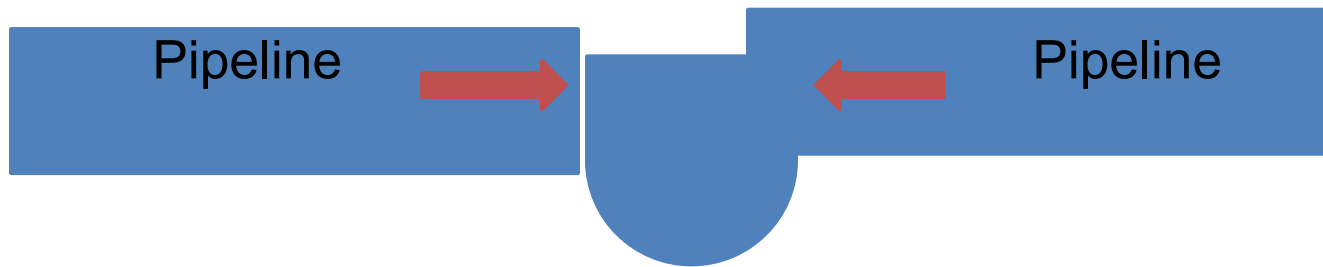


Different behaviour: Top-Entry butterfly vs Ball valves

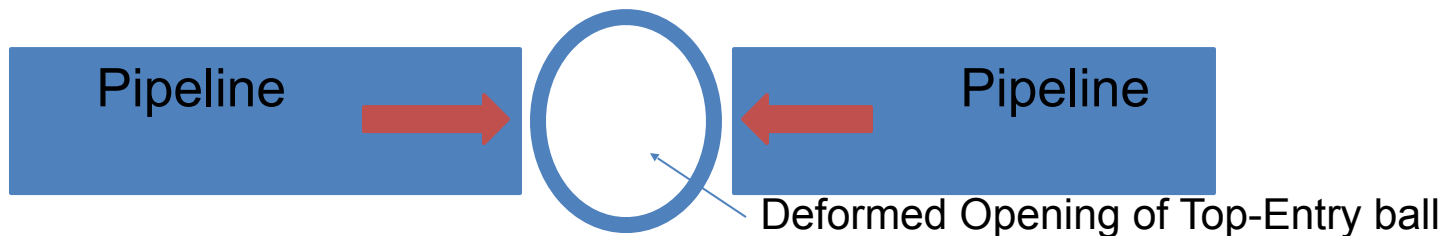
Un-Deformed condition: Top view



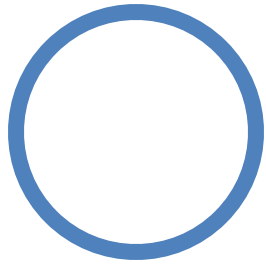
Deformed condition: side view



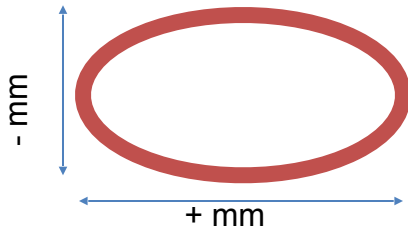
Deformed condition: top view



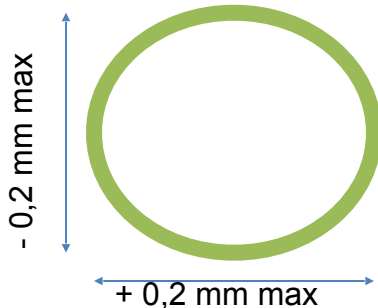
Different behaviour: Top-Entry butterfly vs Ball valves



Un-Deformed circular Cross sectional shape of pipeline



Excessive bending moment would lead to deformation of pipeline and pipe collapse



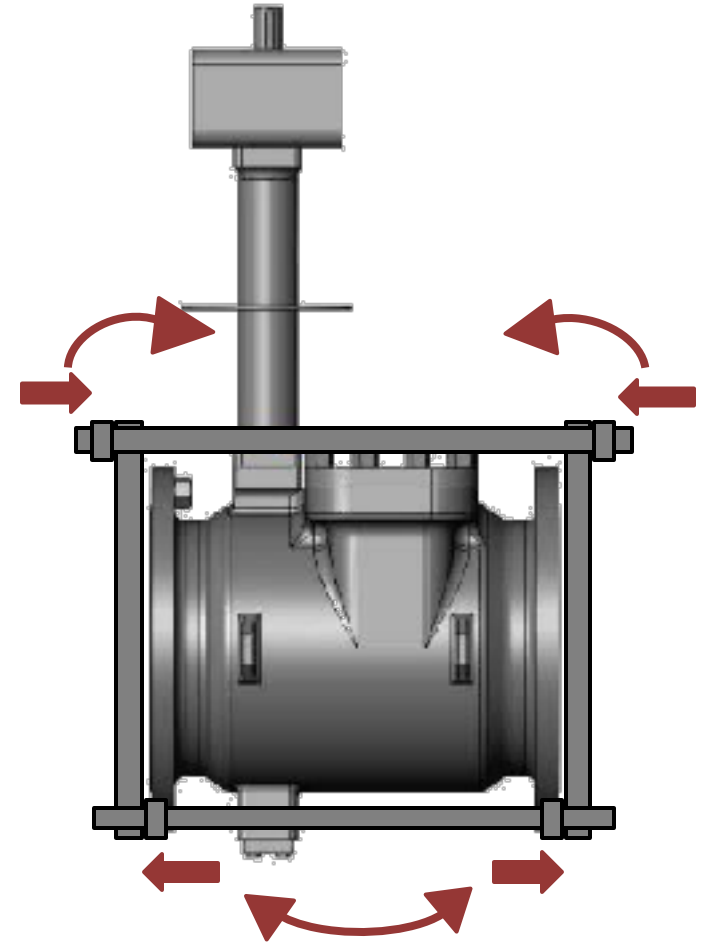
Maximum bending moment allowable for the pipeline leads to minimum deformation, fully compatible with seat assembly allowances



Maintenance Test

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- Step 1** • Evaluation of the maximum allowable pipeline bending moment
- Step 2** • Application of the same bending moment to the valve
- Step 3** • Measuring of internal deformation
- Step 4** • Disassembly & Re-Assembly of bolted seat under deformation



Maintenance Test

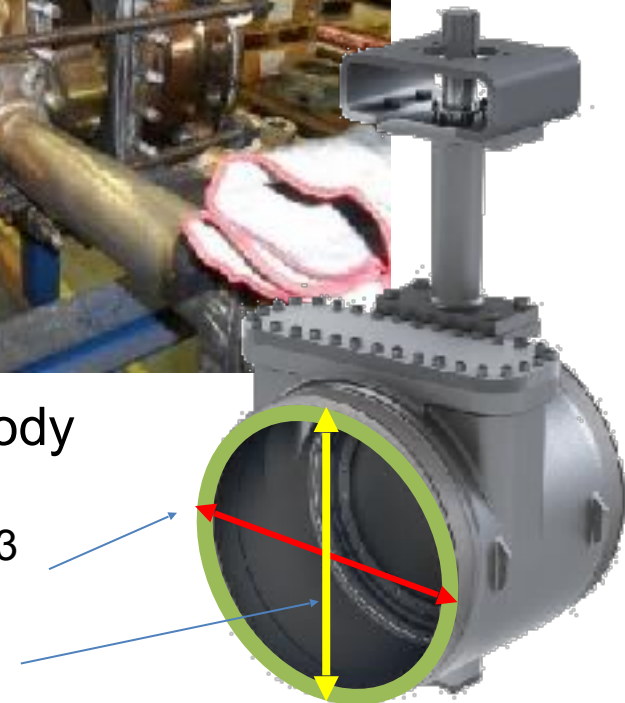
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Application of external loads to the body

Max Deformation on Horizontal Axis = + 0,13

Max Deformation on Vertical Axis = - 0,16



Maintenance Test

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Bolted Seat removed from its location

Test results

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Time needed for maintenance: less than 3 hours for test rig setup, seat disassembly and re-assembly



TOTAL MAINTENANCE TIME



depending on valve size

Test results

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TORQUE MEASUREMENTS & LEAKAGE RATES

high pressure hydro seat test

First ambient test	ETC (Nm)	All. leakage (ml/min)	Actual leakage (ml/min)	BTO (Nm)
Preferred side	1850	0,72	No drops	1300
Non-Preferred side	3450	1,92	No drops	250

Final ambient test	ETC (Nm)	All. leakage (ml/min)	Actual leakage (ml/min)	BTO (Nm)
Preferred side	1850	0,72	0,04	1350
Non-Preferred side	3450	1,92	0,7	250

Allowable leakage rates for high pressure test:

ISO 5208 Rate C for Preferred Side / Rate CC for Non-Preferred side

Maintenance Test

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Less than 3 hours
maintenance time

Handling of parts
easily lifted by hand

After maintenance pressure test confirmed positive
results of maintenance activity

Tightening of bolted seat screws under Aramco's representative survey

(after bolted seat re-assembly, tie rods have been removed for ease of operation)

Test results

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TORQUE MEASUREMENTS & LEAKAGE RATES

after re-assembly

high pressure hydro seat test (5 minutes)

Final ambient test	ETC (Nm)	All. leakage (ml/min)	Actual leakage (ml/min)
Preferred side	1850	0,72	0,24
Non-Preferred side	3450	1,92	0,4

high pressure hydro seat test (15 minutes)

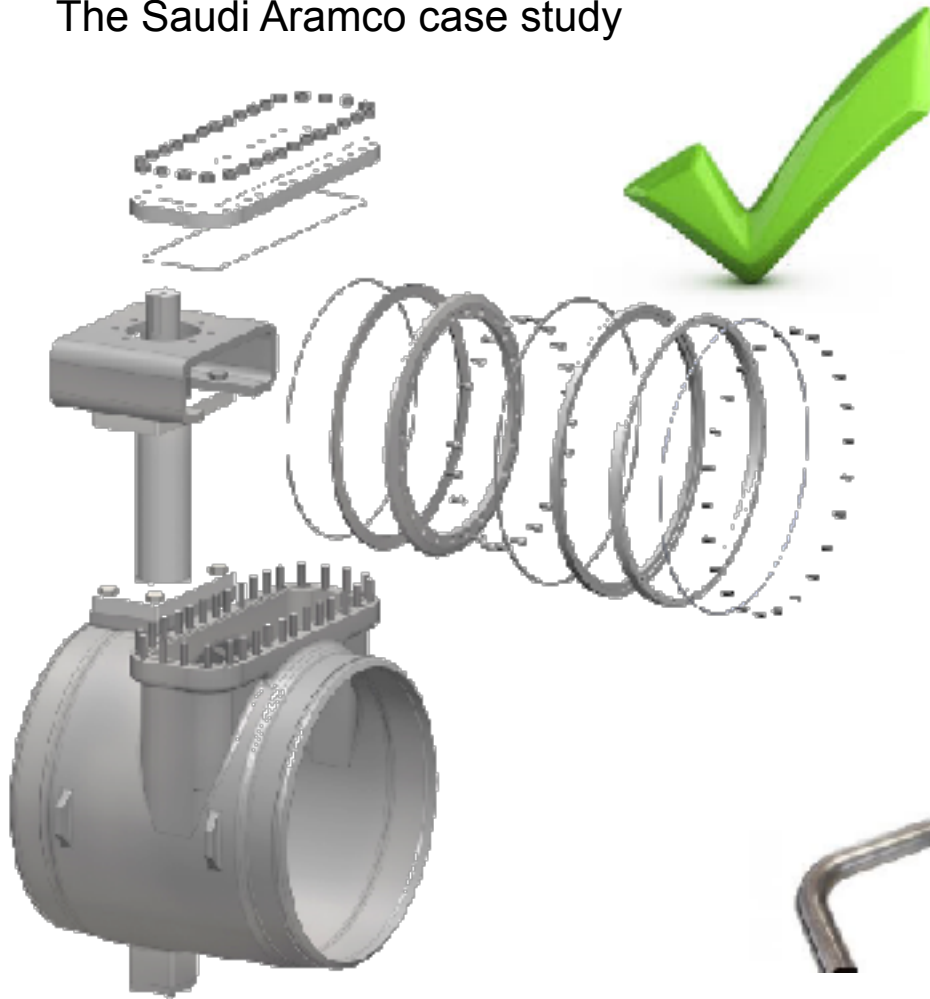
Final ambient test	ETC (Nm)	All. leakage (ml/min)	Actual leakage (ml/min)
Preferred side	1850	0,72	0,16
Non-Preferred side	3450	1,92	0,4

Allowable leakage rates for high pressure test:

ISO 5208 Rate C for Preferred Side / Rate CC for Non-Preferred side

After-Maintenance test

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Proven valve reliability



Ease of maintenance



No issues due to pipeline loads



Thank you