

Gas Lift Valves Barrier Testing

Sven Aarrestad, IRIS

Jørn Andre Carlsen, Statoil

Statoil & IRIS*

- In 1982 Statoil introduced a qualification testing program for Down Hole Safety Valves
- This was the start for International Research Institute of Stavanger (IRIS)* of their third part testing for Statoil
- More than 25 years experience of testing down hole equipment is the base for gas lift valve barrier testing



“Gulfaks Accelerated Production Project” - 1983.

- The current API 14a was not sufficient for the qualification requirements needed for a sub sea installed DHSV in the North Sea
- Testing of DHSV according to Statoil`s requirements resulted in:
 - Improvement of the reliability
 - Elimination/reduction of work overs
- The following companies where represented in the testing:
 - Baker
 - Otis (Halliburton)
 - Camco (Schlumberger)
 - AVA



Requirements for gas lift valves as well control barrier elements

- The Norwegian Petroleum Government:

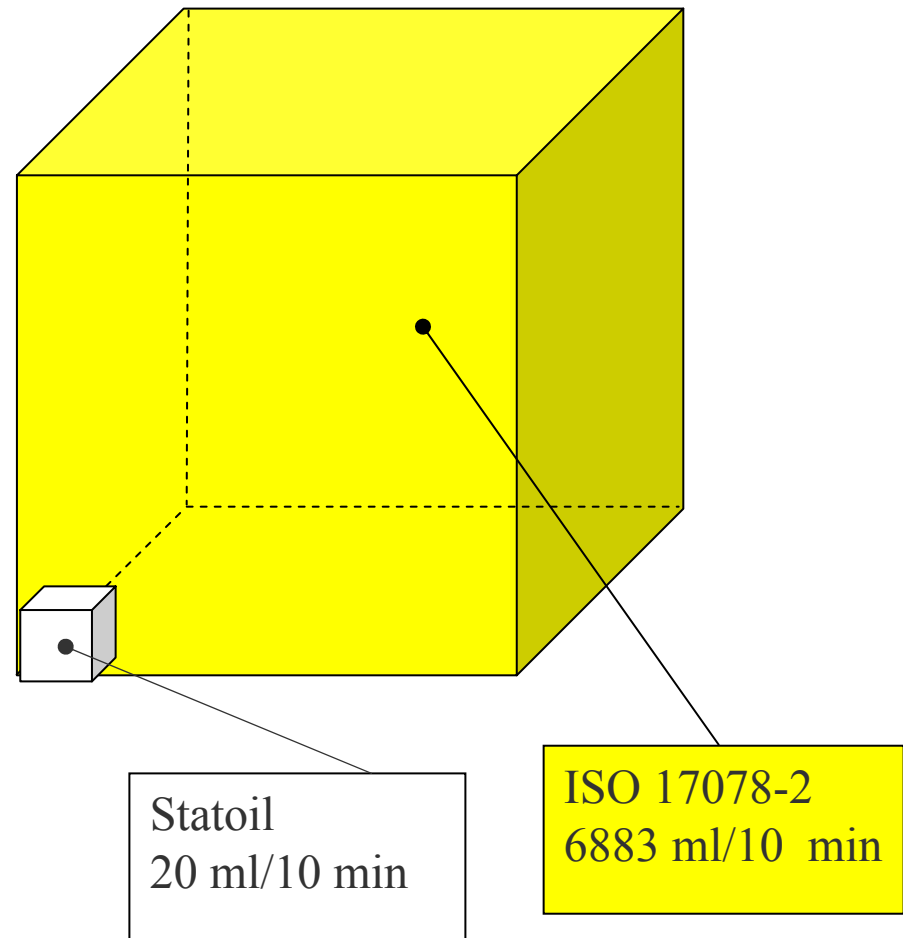
”An operator that wants to use gas lift valves as satisfactory barrier elements against the reservoir must consider these valves to be down hole safety valves”

- NORSOK D-010:

”For gas lift valves to qualify as a well barrier there shall be a qualification test demonstrating the valves ability to be gas tight over an operator defined number of cycles”

Why a qualification test program?

- As a Barrier Valve in the Tubing?
 - According to ISO 17078-2:
“ they are not designed nor intended to be a part of the safety system, nor to be a part of a tight shut-off pressure safety seal”
 - The gas lift valve is allowed to leak 35 std cu ft/day or 6883 ml/10min
 - Statoil requirement is: ~0,1 std cu ft/day or 20 ml/10min



Why a qualification test program?

- In Sub Sea Applications with a high intervention cost
 - Replace the need for installing a Dummy Valve
- Installed during the initial completion
 - Withstand the initial pressure test of the completion.
- Not be eroded during the unloading nor during the gas lift sequences



Valve suppliers

- Valves from the following suppliers have been tested in the period of 2005 – 2009:
 - Schlumberger, Baker Oil Tools, Weatherford and Petroleum Technology Company (PTC)



Test Facility at IRIS



Test Facility at K-Lab



Gas Lift Test Facility – main capacities

- Back flow integrity test

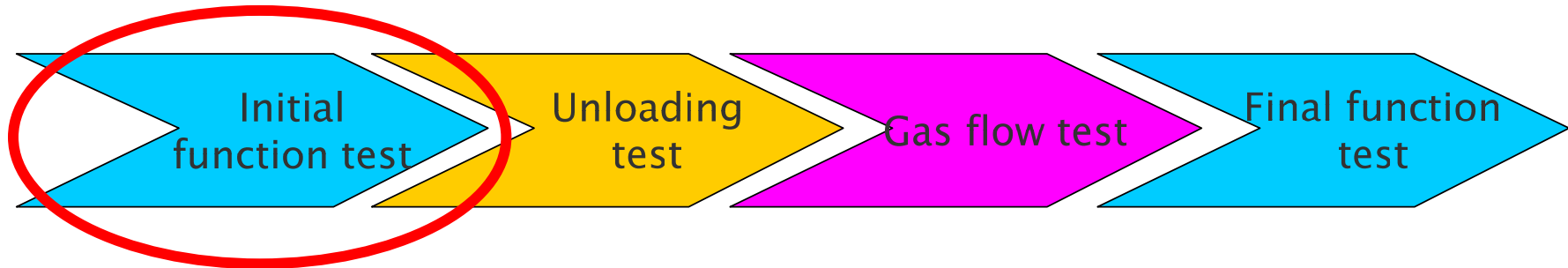
- 100 psi to 10000 psi by use of gas (nitrogen) and water
- Bubble detection system: Visual reading by use of camera from 0 to 30 ml/10 sec

- Unloading test

- Test flow rate: 1.5 bbl`s /min
- Max. during test: 3 bbl`s / min
- Max. flowing condition: 4350 psi ~2 bbl/min

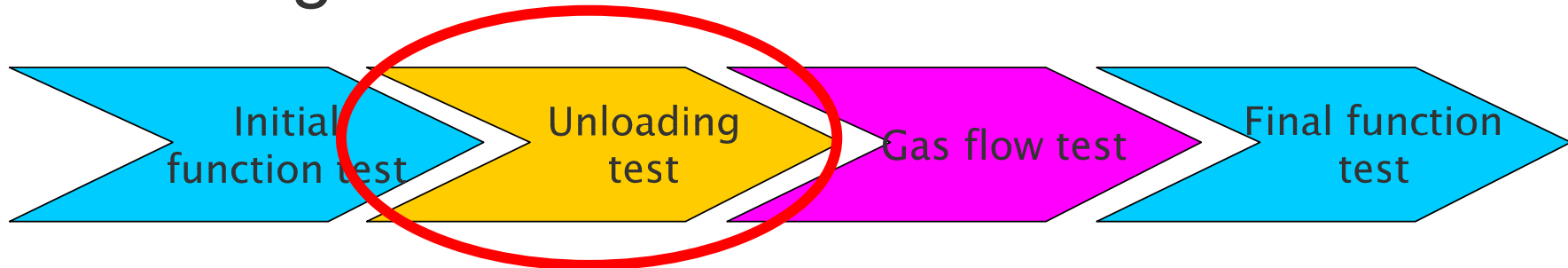


Test Program



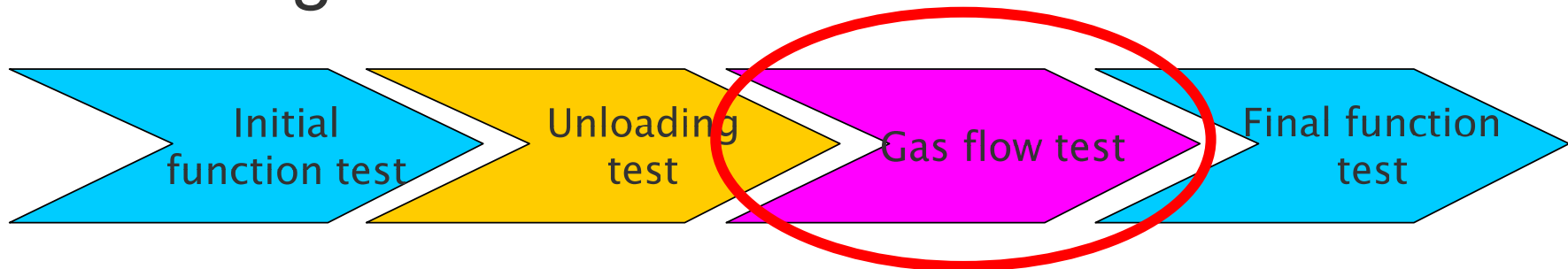
- Back check valve is free to move from closed to open position
- Minimum amount of reverse flow and pressure required to close the back check valve
- Back check valve is water and gas tight

Test Program



- Unloading operation as in a real well
- Determine the back check valve function (open-close)
- Verify barrier integrity after a predefined circulated volume at a certain flow rate

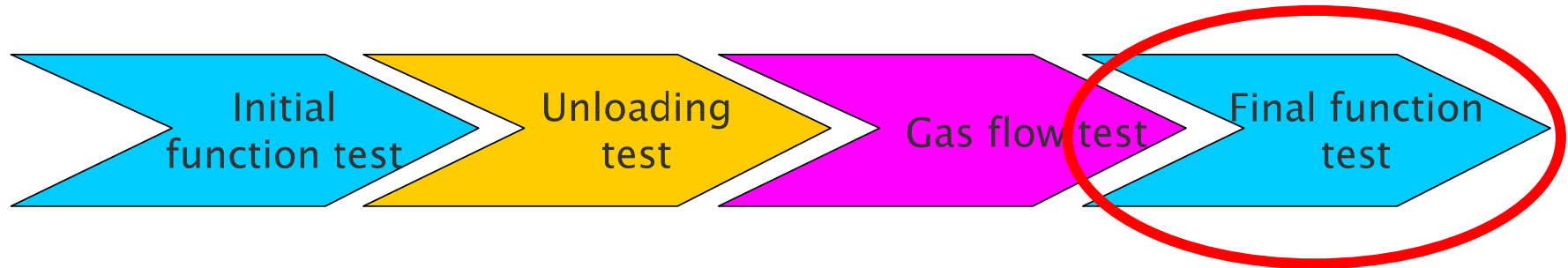
Test Program



- Gas lift operation as in a real well
- Determine the back check valve function (open-close)
- Verify barrier integrity (gas tight) after 100 cycles



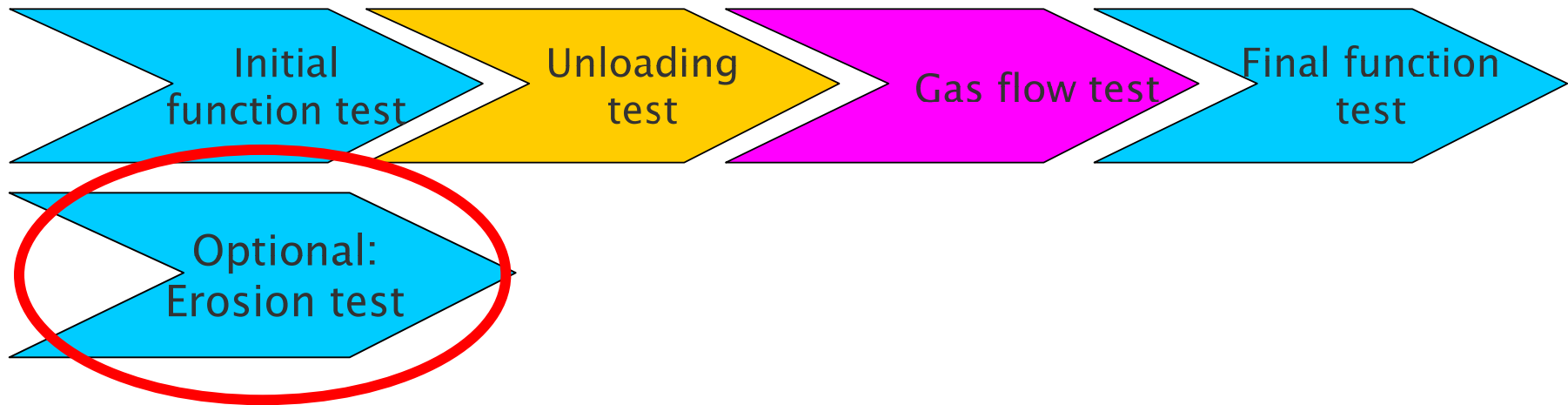
Test Program



- Similar to the Initial function test
- All tests were performed in horizontal position



Test Program Optional



- Simulate the effect of debris that may be present in the annulus
- To be performed only when the valve has been qualified
- Failing during the erosion test will not disqualify the valve

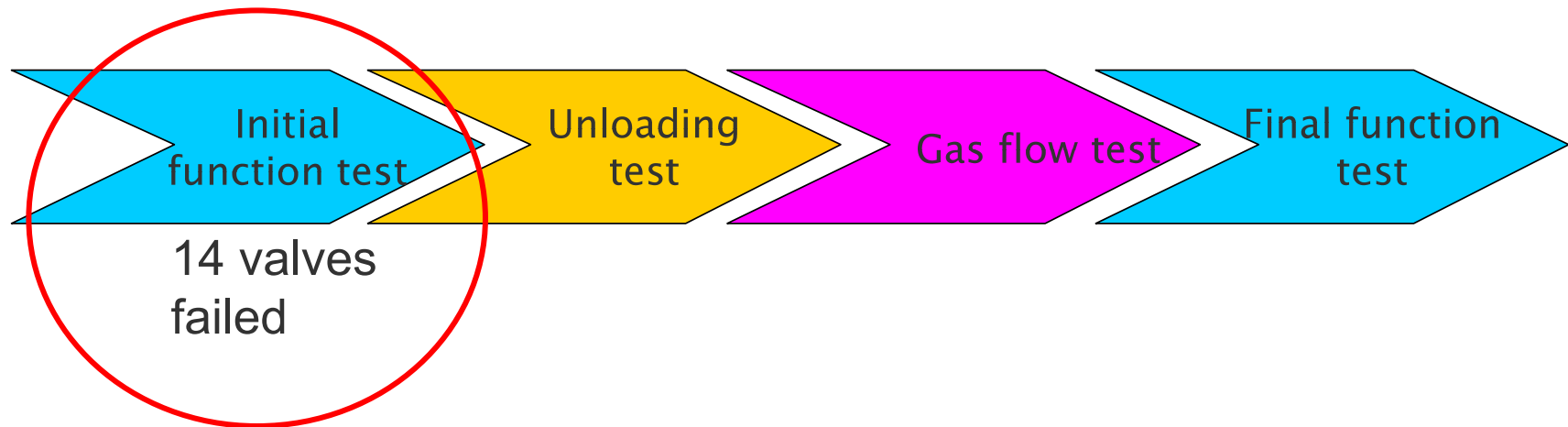
Test Acceptance Criteria

1. The back check valve shall close at a differential pressure of less than 25 psi
2. Liquid: No more than 1% reduction in the differential pressure over the hold period of 10 min
3. Gas: No more than 20 ml gas leakage over the hold period of 10 min

The bubble rate shall not increase during the hold period

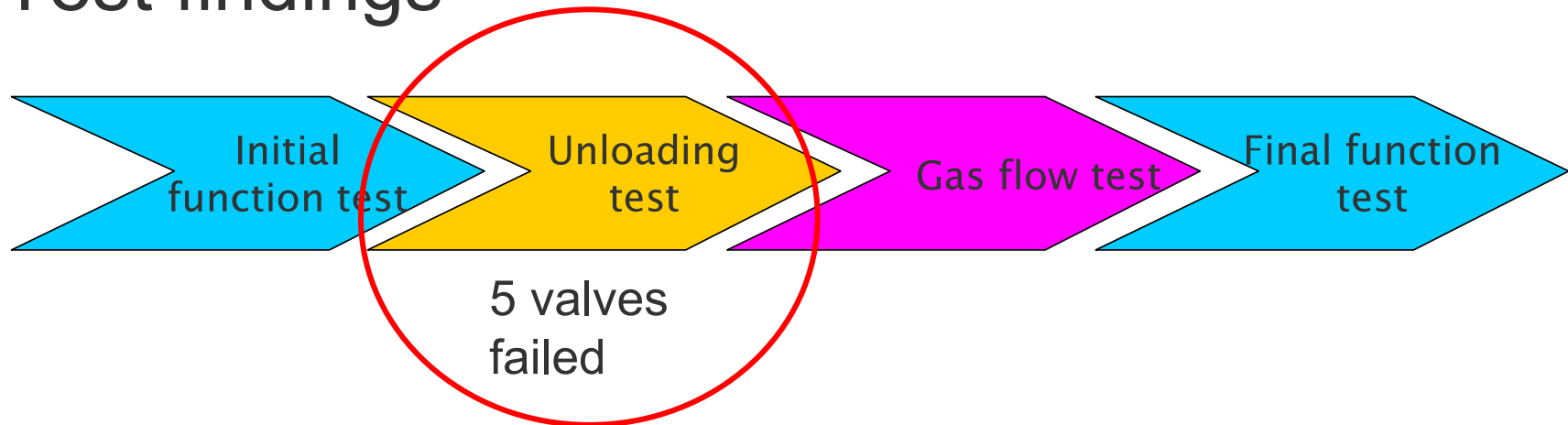
- Final qualification: Field proven – 10% of expected life time

Test findings



- Valves did not meet the Back Flow Integrity Test
- Valves had to be slammed closed to seal off
- Valves failed due to incorrect tolerances
- Valves did not behave in a consistence manner
- Valves failed also after lapping of sealing surfaces

Test findings

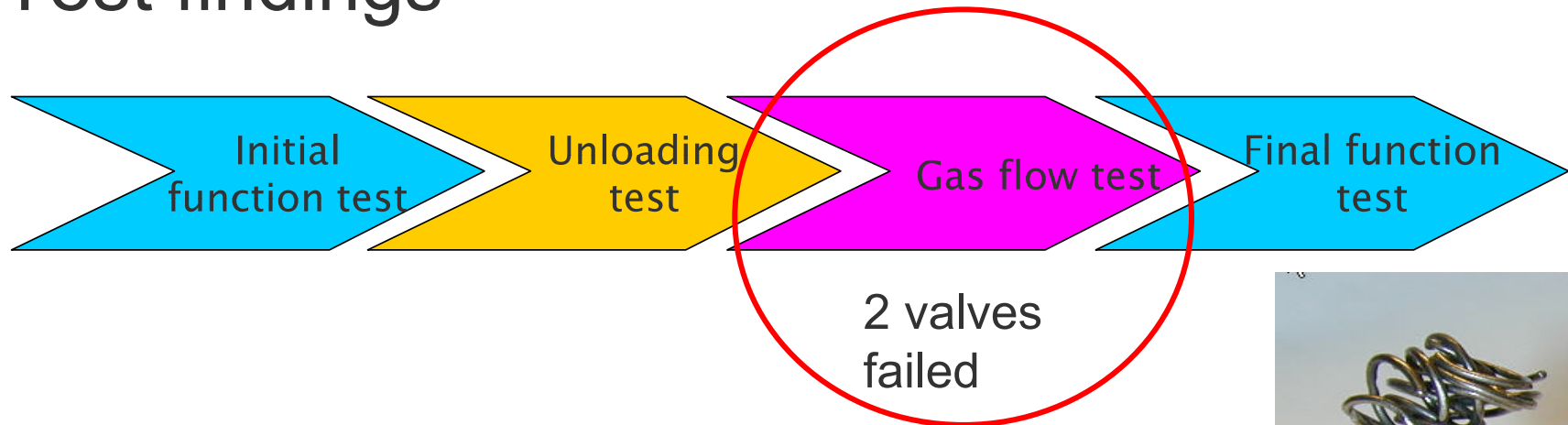


- Valves did not meet the Back Flow Integrity Test
- Valves failed due to incorrect tolerances (stuck check)
- Check did not seal off after lapping of sealing surfaces
- The differential pressure to keep the valve in fully open position was found to be almost 50 % higher than stated by the valve supplier

Soft Seal was cut in two pieces



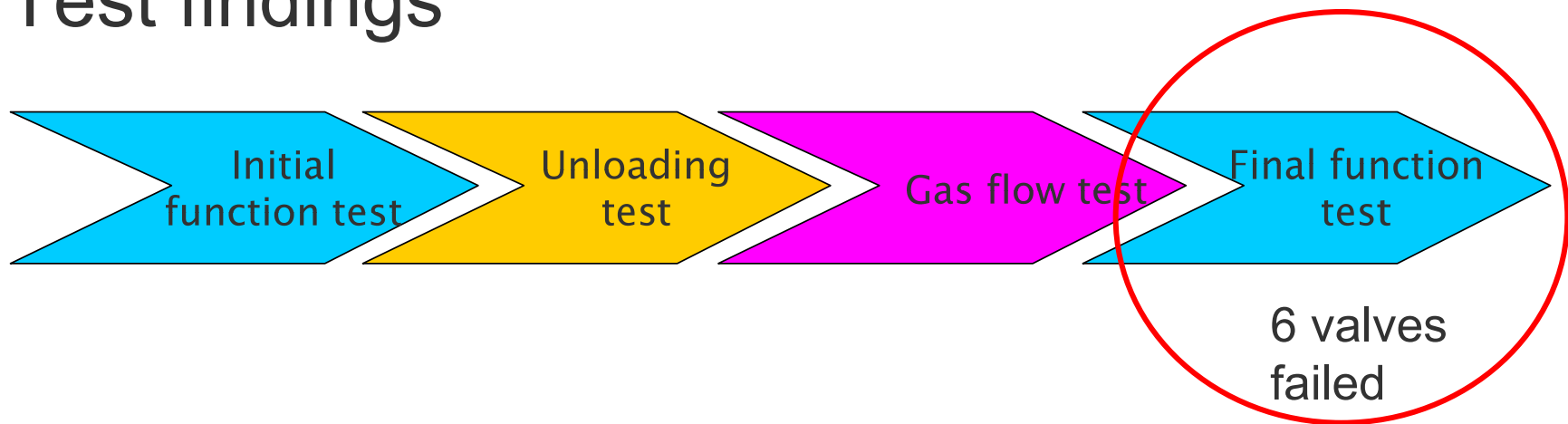
Test findings



- Check and spring were damaged
 - The check oscillated and rotated
- The sealing mechanism was damaged
 - Too low differential pressure across the valve



Test findings



- Valves did not meet the Back Flow Integrity Test.
- Valves had to be slammed closed to seal off
 - Some valves failed even though
- Squeezed soft seal
- The check had to be pushed off the seat by raising the annulus pressure to more than 250 psi



Valve sealing design

- The following check and soft seal combinations have been tested:
 - One check
 - Two checks
 - With and without spring
 - With and without soft seal
 - Combinations of the above



Conclusion test findings

- Combination qualified
 - One check
 - Metal to metal sealing surfaces

Status in 2007

- A total of 8 gas lift valve designs from different suppliers were tested from 2005 to 2007
- None of them satisfied the test acceptance criteria stated in Statoil`s qualification test program
 - Was the test realistic?
 - Did we have to reduce the test acceptance criteria?

Testing continued in 2007

- No revision of the test criteria was done
- A new gas lift supplier was introduced
 - 6 more gas lift valve designs were tested
- A total of 220 days has been used for testing at IRIS and 45 days at K-lab, from 2005 to 2008

Qualified valves

The following suppliers have qualified their valves

- Petroleum Technology Company (PTC)
 - 1", 1 ½" and 1 ¾" SafeLifts
- Schlumberger*
 - 1 ½" XJR and 1 ¾" X-Lift

*At Schlumberger provided test facility.

Conclusion

Barrier qualified gas lift valves are
now available to Statoil

Thank you

Presenters name: Jørn Andre Carlsen- Statoil
Sven Aarrestad - IRIS