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NEW REQUIREMENTS TO GAS LIFT VALVES

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Why new requirements?

Most operators will not qualify the standard Gas Lift Valve as a barrier element

WHY?

- **The traditional valve has not been taken through a qualification program as for well barriers**

- **The other items in the well barrier envelope is normally subjected to stringent test requirements**

  i.e. API 6A for well head, ISO 14310 for packers, ISO 10432:2004 for down hole safety valves etc.

New requirements

The industry (authorities and operators) identifies a need for new qualification requirements based on the desire for higher performance levels

PREFERRED PROCESS

- Similar process as the development of ISO 10432:2004 for Downhole Safety Valves (often referred to as the "Rogalands test")
- The traditional gas lift valves failed to meet the new requirements

HOW?

MERGER OF ISO 14310 (Packers and bridge plugs) AND ISO 17078 – 2 Gas lift valves

CONCLUSION

- New Gas Lift Valve technology needed to be developed

GLV`s former design requirements

API 11 V1, 1995/2000	Specifications for Gas Lift Equipment
API V5, 1999	Recommended Practice for Operation, Maintenance and Trouble-shooting of Gas Lift Installations
API V7, 1999	Recommended Practice for Repair, Testing and Setting of Gas Lift Valves
ISO 17078 part 2, 2004	Flow Control Devices for Side-pocket Mandrels
NORSOK D-10, 2004	Well Integrity in Drilling and Well Operations

SafeLift® development background

Operator GLV requirements

"The gas lift valve (s) shall together with the tubing be part of the primary barrier"

&

Gas Lift Valve Acceptance criteria's

1. **Leak test (liquid):**
   No more than 1% reduction in the differential pressure over the hold period after sufficient time has been allowed for stabilisation

2. **Leak test (gas):**
   No more than 20 cc leakage over the hold period after sufficient time has been allowed for stabilisation. The bubble rate shall not increase during the hold period.

3. **Closing:**
   The back check valve shall close at a differential pressure of less than 25 psi.

Vendors validation test results

A qualification program was performed in 2005-2006 where 7 different gas lift valves from 3 vendors were tested

RESULT

- **Testing revealed weaknesses to back check valve function:**
  - **Damaged to soft seal, dart and spring elements**
  - **Leakage high above accept criteria's (gas: 3-30 l/10 min)**
  - **Inconsistency in seating and integrity**

CONCLUSION:

None of the valves are qualified to be a well barrier

➔ Development of gas lift valve technology was required!

Development of SafeLift® orifice valve

The goal was to develop a safe and reliable Gas Lift Valve that:

- **Fulfils the well barrier requirements**
- **Reduce well intervention frequency => reduced OPEX**

Two design concepts were found to have the greatest potential:

- **Petroleum Technology Company (PTC):**
  ***SafeLift*® (1 ½" OD) spring activated sliding sleeve / dart**

- **Baker Oil Tool (BOT):**
  ***Gas Lift Barrier Valve*® (1 ½" OD) spring loaded flapper valve**

SafeLift® detail design activities

The test program was developed based on the requirements in;

- **ISO 17078-2: Flow control devices for side-pocket mandrels**
- **ISO 14310: Packers and bridge plugs (V1)**
- **ISO 10432: Subsurface safety valve equipment**

SafeLift® qualification results

- The PTC SafeLift® (1 ½" OD) orifice valve fulfils all acceptance criteria's set forth in the qualification test program.
- The valve is qualified to be a well barrier according to NORSOK D-010 and StatoilHydros's governing documents: Well Construction.
- The back check valve function has successfully passed through the comprehensive test program without any damaged to the valve and with consistency for all tests performed.
- Qualification testing demonstrates that the reliability of the valve is high and that number of well interventions and OPEX can be expected to be reduced.

SafeLift® orifice valve features

1 ½" OD orifice valve (orifice range: 1/8" to 1/2")

- True metal-to-metal seals (no soft seals inside valves)
- Valve design is optimized for seal area protection (flow erosion)
- Spring activated valve with positive sealing
- Spring is protected from flow
- Vibrations are eliminated by design
- 25-180°C working temperature envelope (ISO 14310-V0 tested at +2 to +165C)
- Designed for 10 000 psi working pressure
- Capable of flow rates exceeding 240 000 Sm^3/day
- Spring can be pre-set to various opening differentials

GLV`s former acceptance criteria`s

- API – no barrier requirements for gas lift valves
- ISO – have adopted API performance requirements
- NORSOK – referring to API / ISO performance requirements
- PSA – referring to down hole saftey valve requirements and performance
- Ptil – referring to leak tight performance and pending on operators test program for qualification

The new GLV test & qualification program

To qualify the GLV as a well barrier:

- **Norsok D10. "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".**
- **Petroleum Safety Authority (PSA) " An operator that wants to use gas lift valves as satisfactory barrier element against the reservoir must consider these valves to be down hole safety valves"**
- **StatoilHydro " The Gas Lift Valve shall together with the tubing be part of the primary barrier**

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(Photo: Karl Henrik Pedersen for Statoil)

The new GLV test & qualification program

Test program was developed on this basis as;

- **StatoilHydro Gas Lift Qualification / back check valve testing test procedure**
- **The tests have been performed at:**
  - **International Research Institute of Stavanger AS (IRIS)**
  - **K-lab at Kårstø - Full scale gas test**

The new GLV back check test program

continued

The validation test program consists of four phases:

1. **Initial function test, water and gas**
   - Open and close (back check) tests at ambient and elevated temperature, with and without spring installed
2. **Unloading tests (water)**
   - 600 bbl, 1.5 bbl/min
   - Back check leak tests at each 200 bbl with water and gas
3. **Full scale gas flow test at 1885 psi**
   - 100 open / close cycles with back check leak test after each 10 o/c sequence
   - Min. 140hrs of maximum gas flow circulation (250.000 m^3/d)
4. **Final function test, water and gas**
   - Open and close (back check) tests

The new GLV back check test program
continued

Additional Gas Lift Valve - Optional testing

1. ISO 14310 – V0 Gas test at ambient and elevated temperature
   - "zero gas bubbles during hold period of 15 minutes"

2. Erosion test
   - water and barite
   - Extended unloading rate
   - "zero gas bubbles"

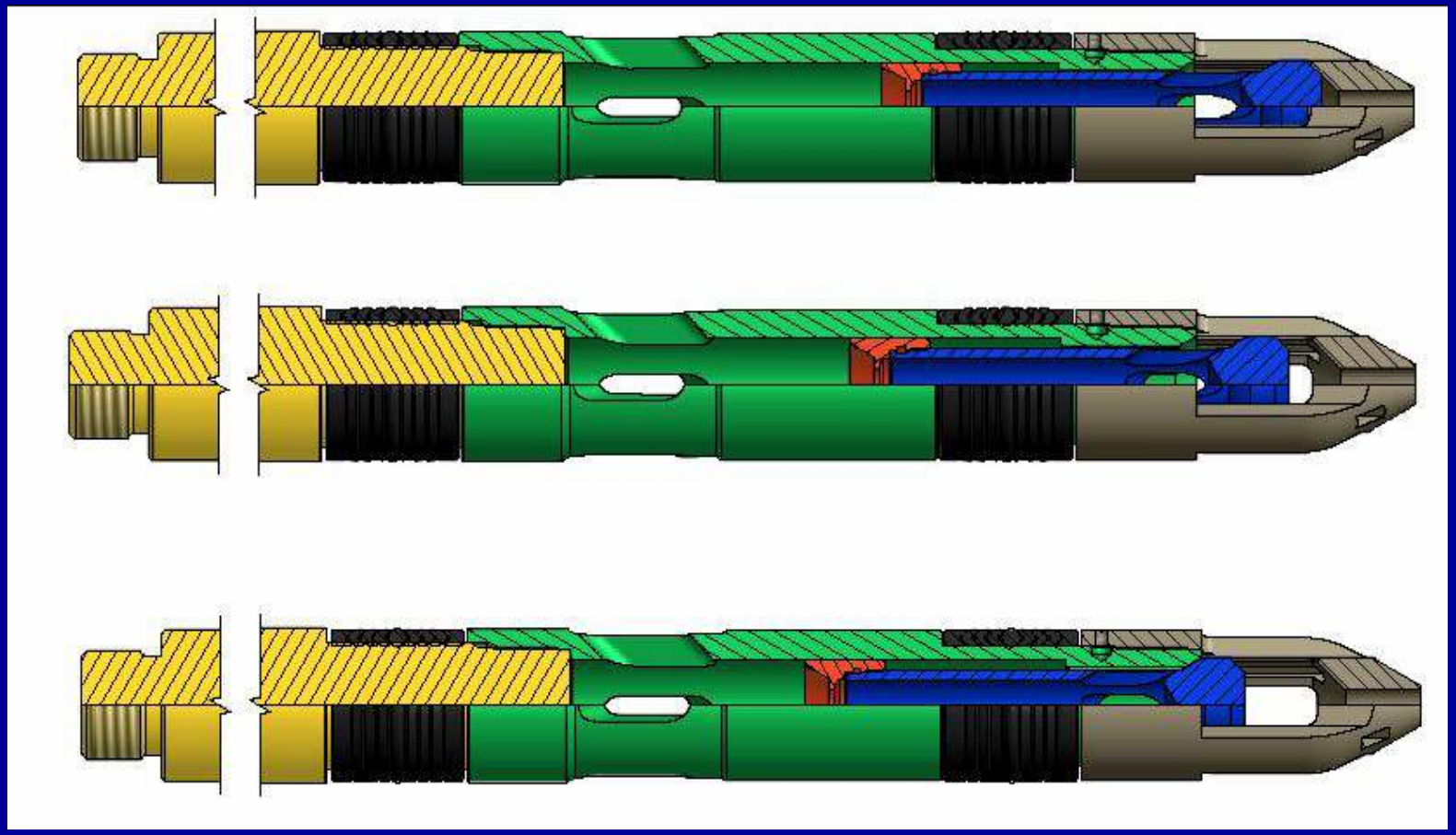
New requirements – New GLV`s

The SafeLift® gas lift valve:

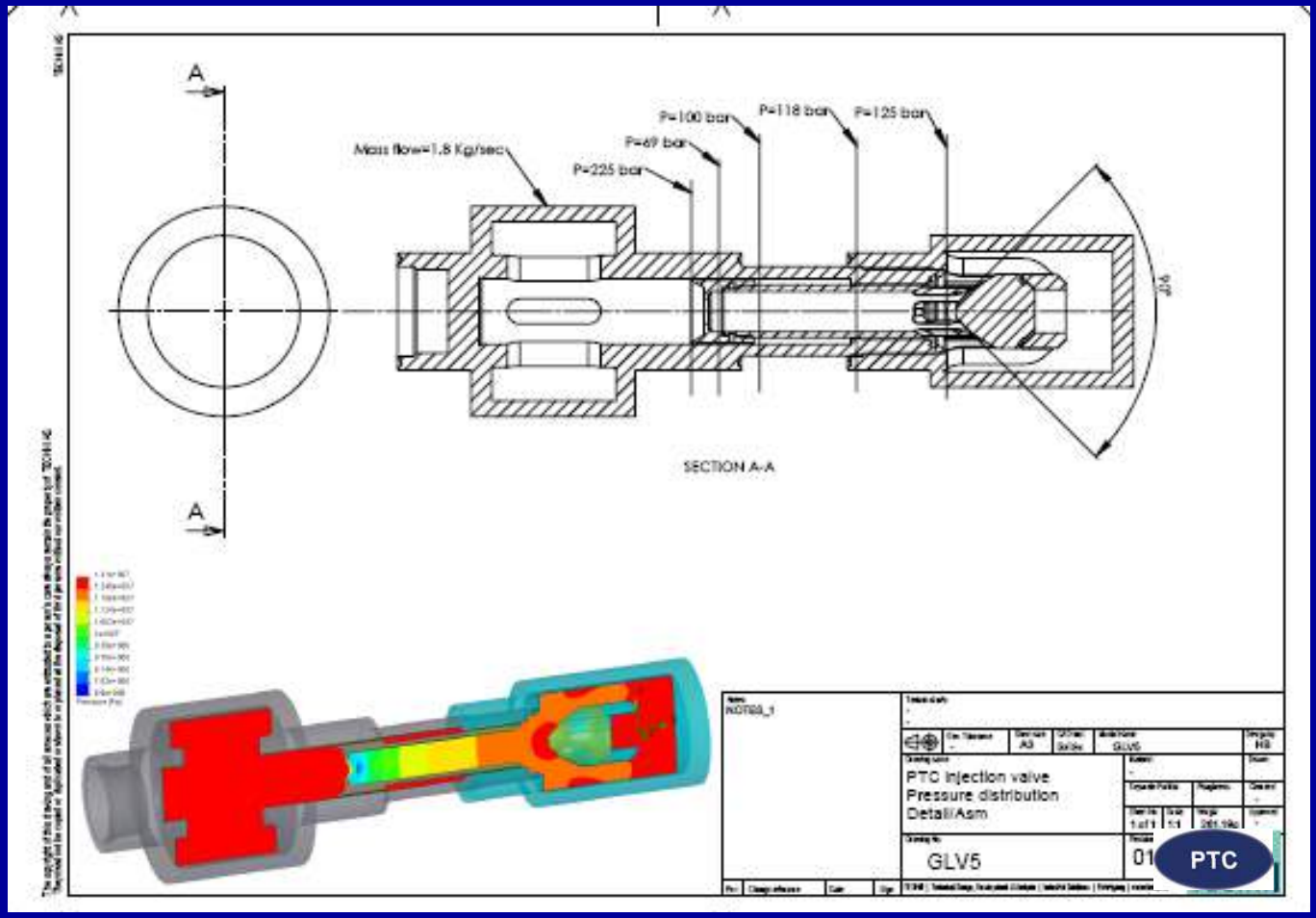
- Qualified as a barrier element according to Norsok D10 and StatoilHydro

- Extended life time
- Increased fluid flow capacity
- Increased gas flow capacity
- Increased tolerance for particle erosion

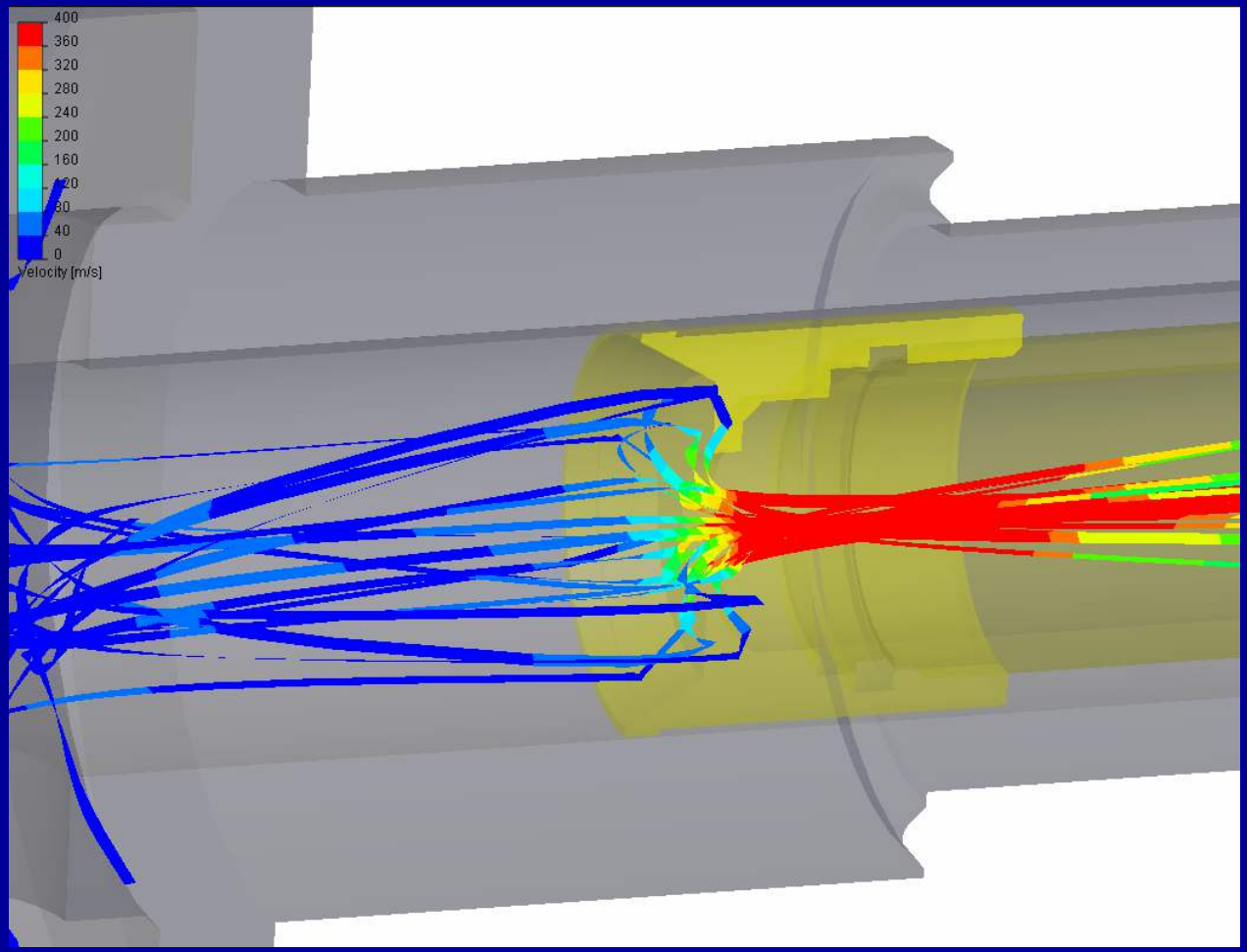
New requirements – New GLV`s



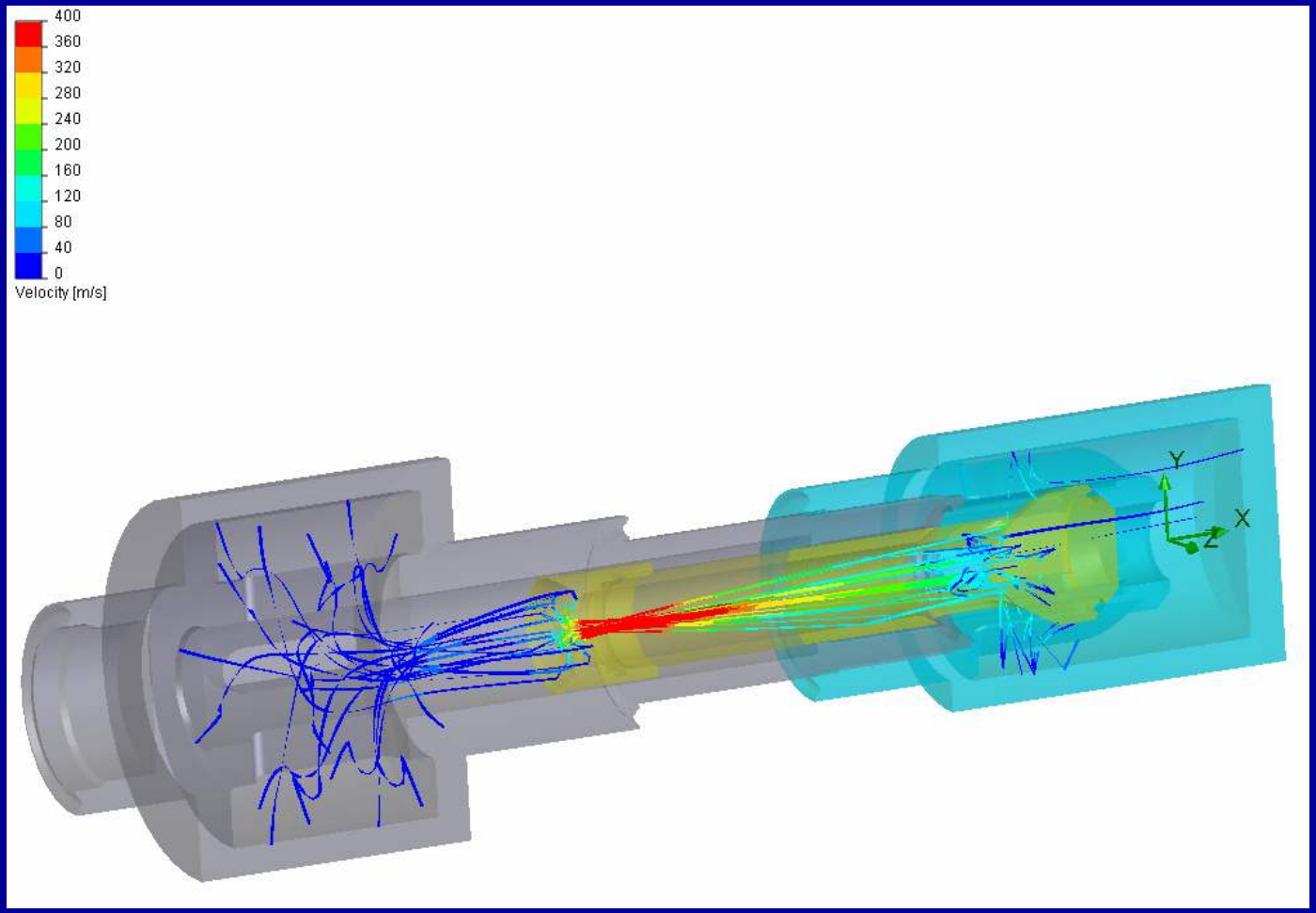
SafeLift® - Gas Lift Valve
CFD (Computational Fluid Dynamics analysis)
Pressure distribution



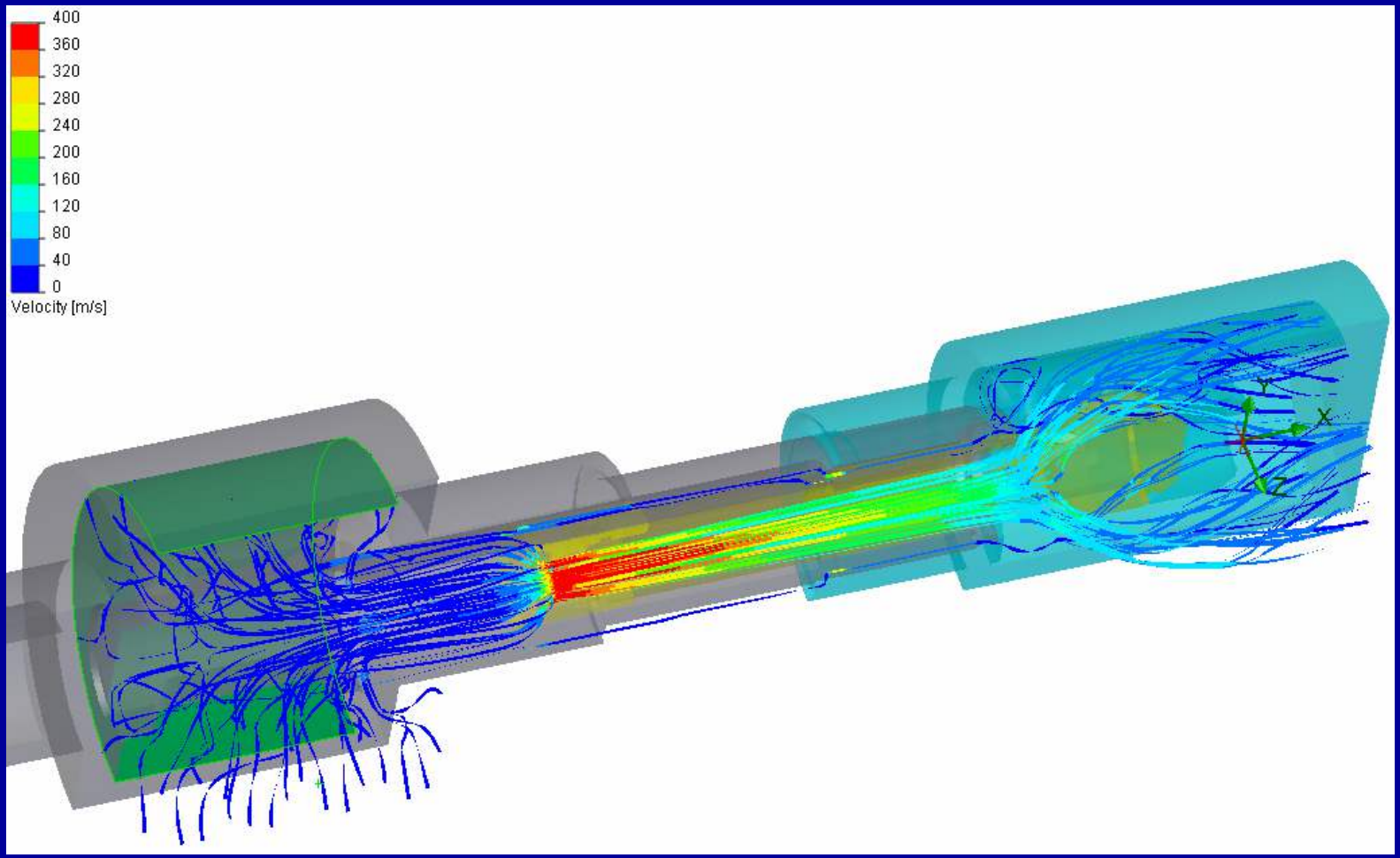
SafeLift® - Gas Lift Valve
CFD analysis - particle tracking



SafeLift® - Gas Lift Valve
CFD analysis - particle tracking
Initial phase



SafeLift® - Gas Lift Valve
CFD analysis - particle tracking final stage continuous flow



SafeLift® - Gas Lift Valve

SafeLift® Project History

- Project Start – January 2006
- Design and Manufacturing January – April 2006
- FMECA performed and closed June 2006
- Valve manufactured for qualification testing June - July 2006
- Testing of Valve at IRIS (RF) and Kårstø August - September 2006.
- Valve final validation tested and accepted November 2006
- Valve available to the market in December 2006

SafeLift® Series

SafeLift –S, Gas injection

- 1”, 1.5”, 1 ¾”

SafeLift –C, Chemical injection

- 1”, 1.5”, 1 ¾”

SafeLift® SPM Insertion test

SafeLift Accessories

-Variable spring force

-STEALTH orifice

-Surface coating, scale prohibiting

Current and future developments

- SafeLift -high pressure / high temp
  Above 10000psi and 200 °C
- Shear open valve
- Dump / kill valve
- Unloading valve / differential valve, IPO/PPO
- Chemical injection sub

All with barrier sealing technology developed for the SafeLift®

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