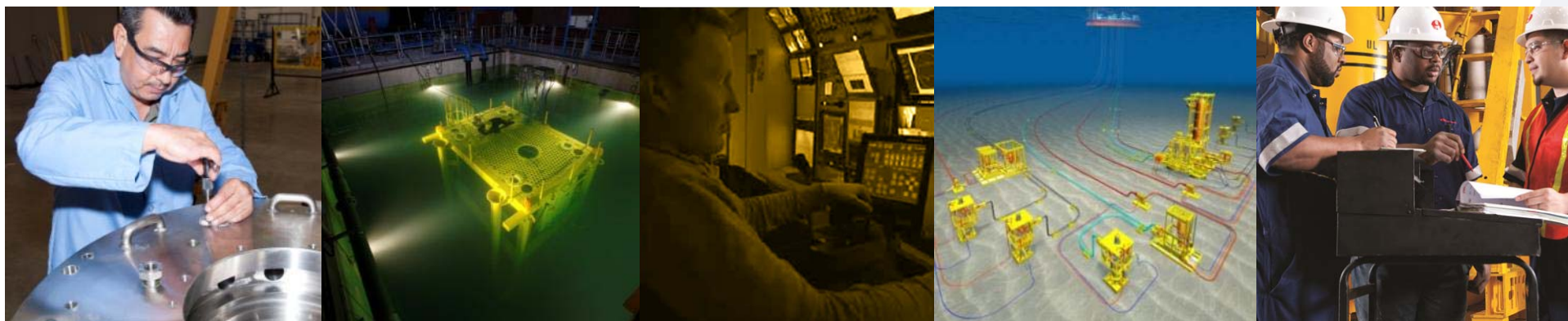




We put you first.  
And keep you ahead.

# FMC Subsea Pumping

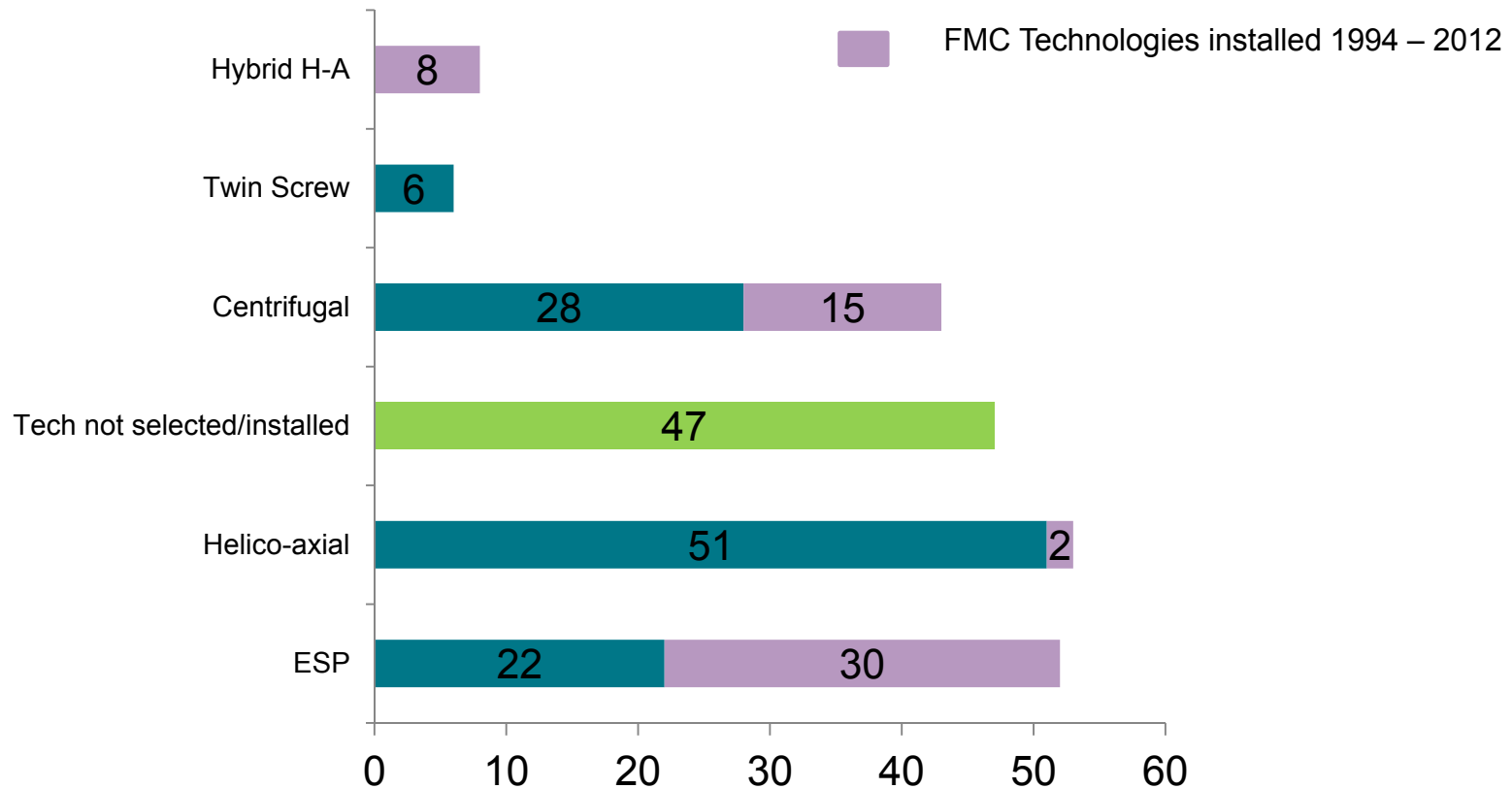
Offshore Power and Rotating Equipment  
April 2013



# Agenda

- Subsea pumps by technology and power
- Multiphase motors and pumps
- Key Technologies
  - ✓ Motor
  - ✓ Barrier fluid
  - ✓ Hydraulic bundle
- FMC Technologies is the leader in subsea systems integration
  - Collaborating with Sulzer Pumps Ltd. and acquired Direct Drive Systems to provide integrated multiphase boosting systems

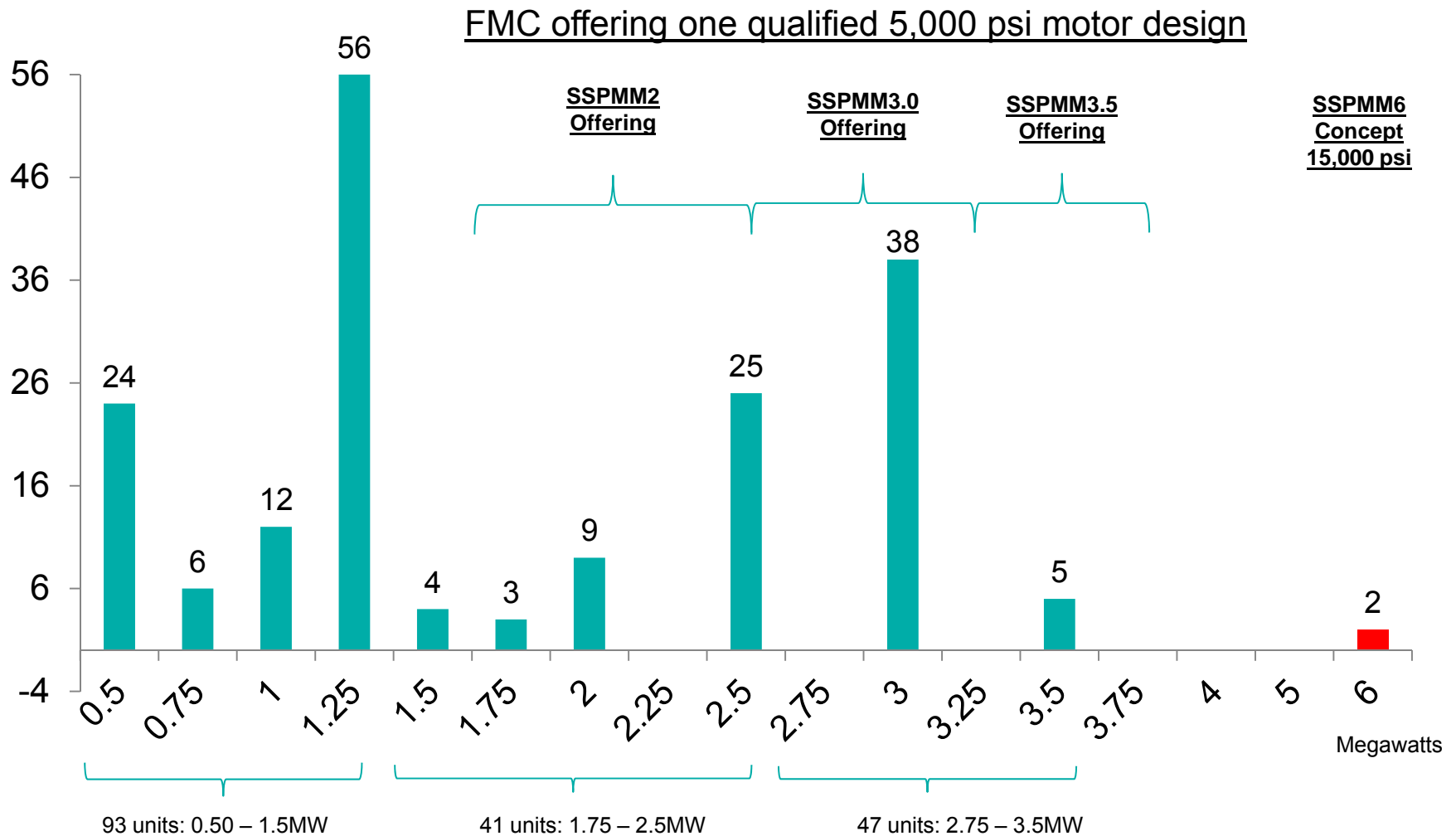
# Subsea pump units by technology



- FMC integrating 34% of the MPP installations for 18 years
- Vertical integration best practices focus on safety, simplicity, efficiency, barrier fluid system, service & support

Source: INTECSEA-Offshore

# Subsea pumps by power - all years

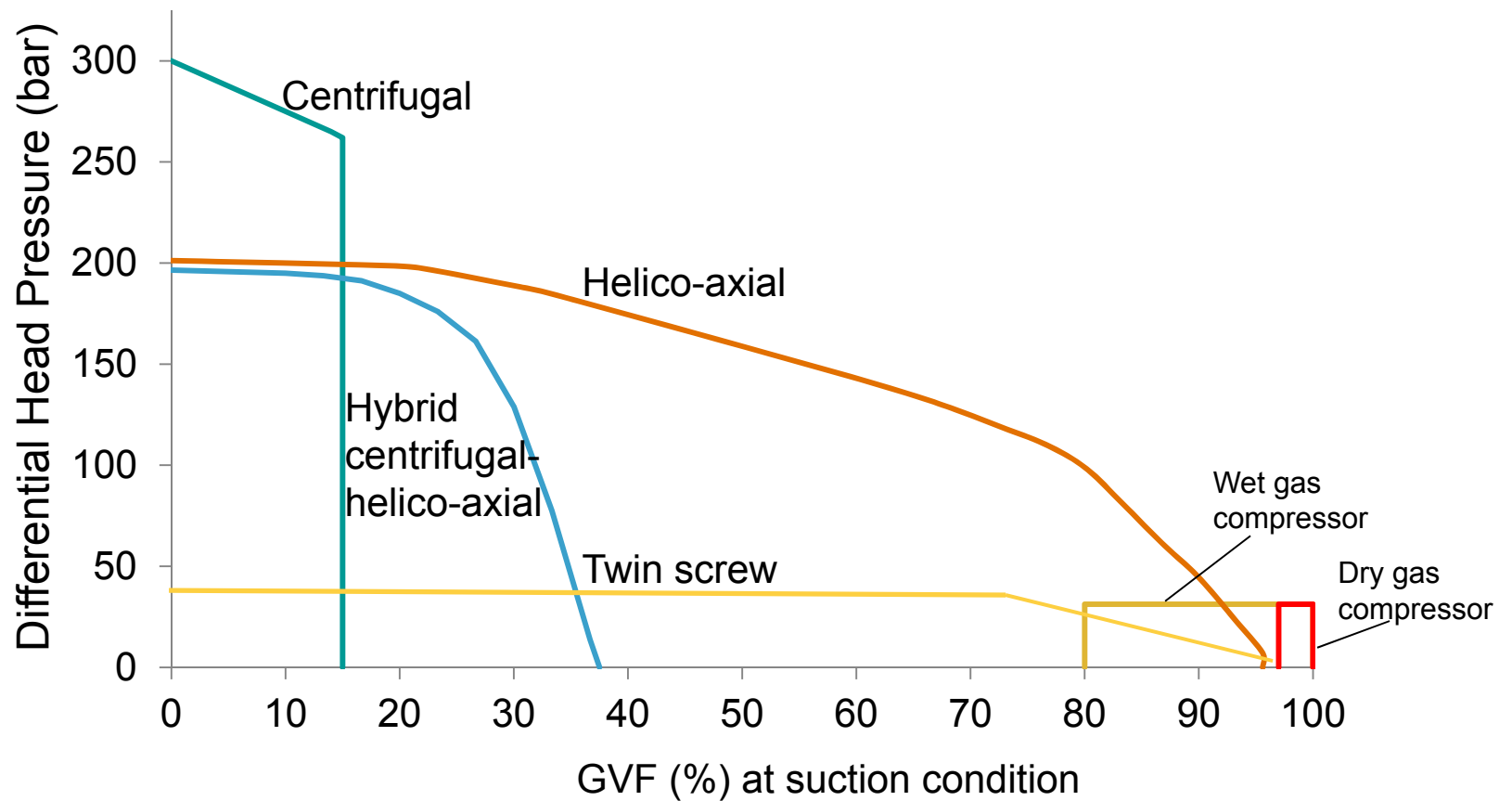


Three motor rotor diameters to optimize efficiency

Source: INTECSEA-Offshore  
1994-2012

# Subsea pumps by technology

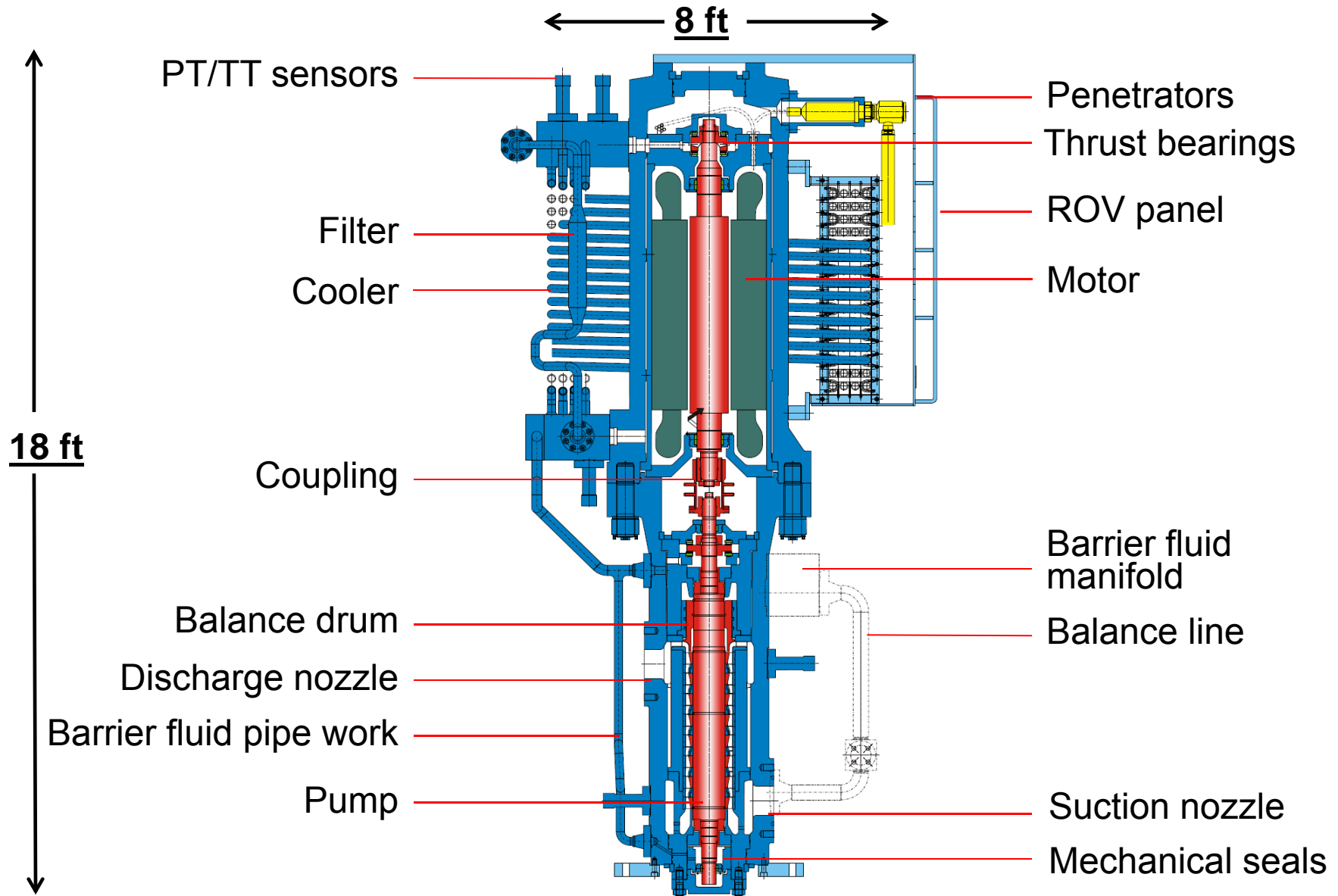
GVF vs differential pressure  
Operational and conceptual capabilities



Source: INTECSEA-Offshore

# Motor/pump design – cross section

**26T wt**



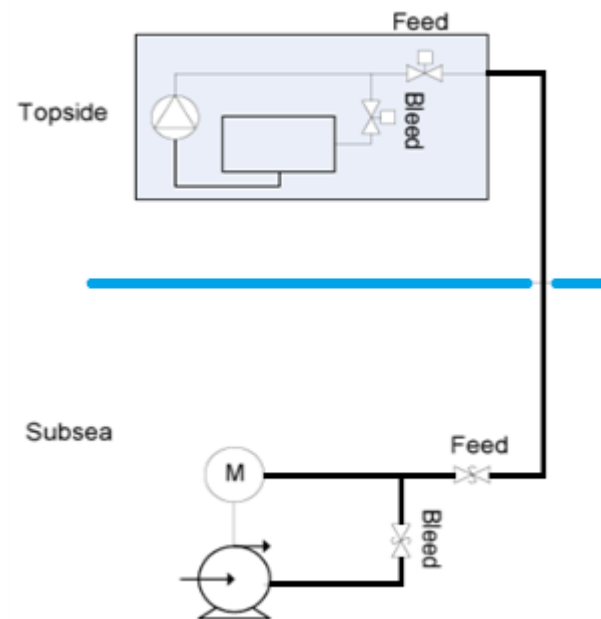
# Key technologies – Permanent magnet motor

- **High efficiency** Synchronous motor performance, 3 x 'air gap' and small diameter PM rotor increase efficiency ~10% liberating surface power for other uses
- **High Speed** Selections at 5,000rpm with 6,000rpm capability allow for changes in production and GVF
- **Sealed** Cable wound stator and carbon sleeve rotor allow use of more environmental friendly water-based barrier fluid
- **Eliminates subsea moisture control systems** because barrier fluid is not part of motor insulation system
- **Modular construction** allows same motor and unit concept for all pump types



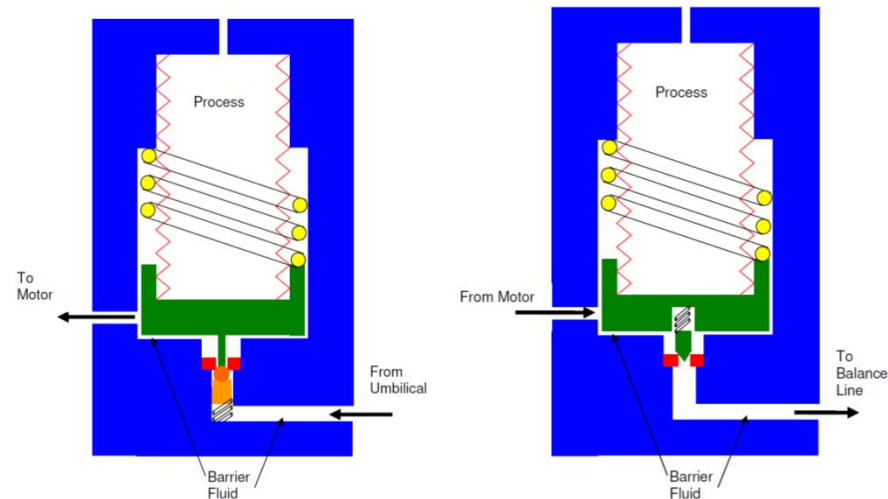
# Key technologies – Barrier fluid system

- Purpose
  - Protects motor from process fluid
  - Motor cooling
  - Lubrication of seals and bearings
- Features
  - Environmentally friendly barrier fluid (Water/Glycol)
  - Pure mechanically-based system
    - Reduced complexity
    - No control system delay
  - Redundant system
- Components
  - Topside hydraulic pressure unit (HPU)
  - Subsea regulation mechanical valves



Supply Valve (Pressure Reducing Valve)

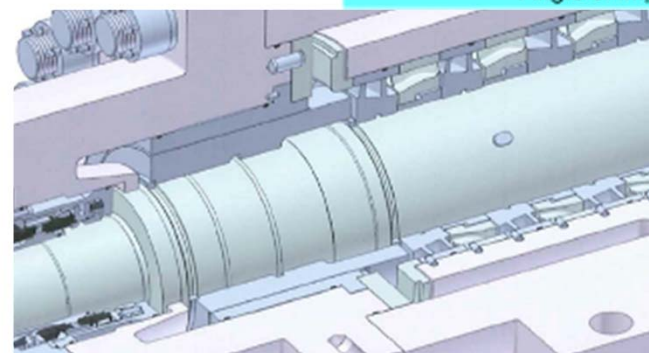
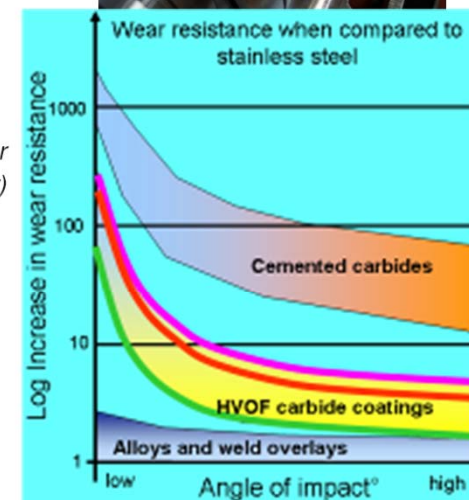
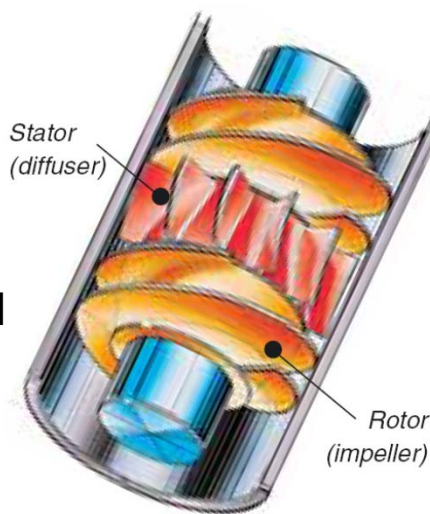
Relief Valve (Back Pressure Control Valve)





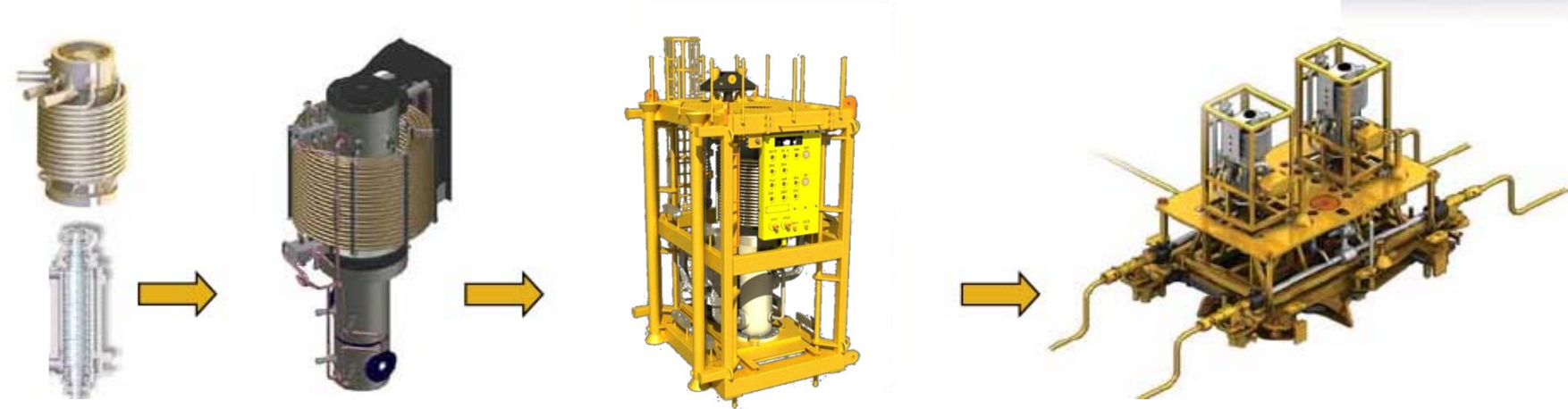
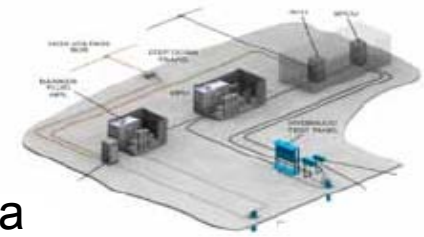
# Key technologies – Pump hydraulic bundle

- **10 years Experience** Sulzer building and installing helico-axial technology for over 10 years
- **Tolerant** Large axial flow path and clearances tolerate large particles and sand production
- **High Speed** Compressor-style assembly guarantees machine balance
- **Resistant** SUME HVOF coatings provide combination of corrosion and erosion resistance
- **Thrust** Balance piston application in multi-phase flow unique to Sulzer over 10 years

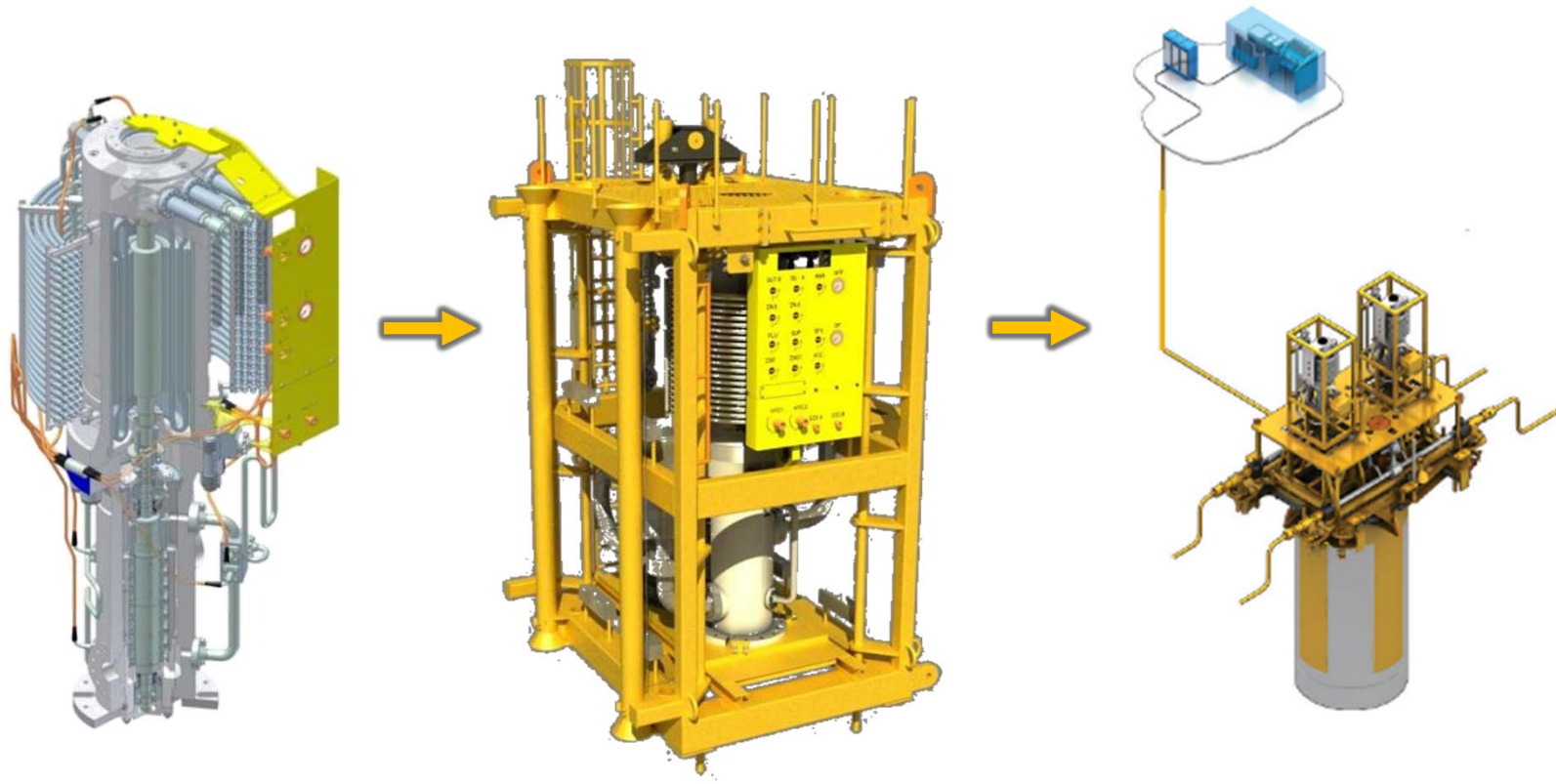


# Collaboration

- ✓ 2006 - Sulzer Pumps sanctions R&D activity into subsea pumping
- ✓ 2008 - Joint development agreement with FMC Technologies
  - Develop a subsea pump module to meet market requirements
  - Completion for qualification of first prototype
- ✓ 2012 – FMC Technologies and Sulzer Pumps enter long-term exclusive supply agreement



# Collaboration – Scope of supply



- Integration into subsea station
- Pipe connection
- Wet mateable connector
- Pump motor unit control system
- Drive system including umbilical
- High pressure barrier fluid supply unit

- Pump motor unit
- ROV panel
- Control logic
- Penetrator (same make as wet mateable connector)
- Instrumentation attached to pump

## Test summary



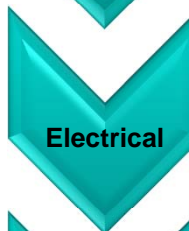
- Pump performance on single phase and two phase complete
- High boost (+100 bar dP) confirmed



- Sufficient margin on design to accommodate higher losses and provide cooling flexibility



- Motor and pump integrated system is predictable and stable



- VSD starting / running algorithm confirmed
- Long step out simulations confirmed
- Motor power at step loading confirmed



- Overpressure limits tested
- Mechanical seal leakage rate as expected

**Total 2013 unit running time: 1,000 h, 250 start/stops**

# Summary

- FMC Technologies is the leader in subsea systems integration
  - Collaborating with Sulzer Pumps Ltd. and acquired Direct Drive Systems to provide 1.5MW-6MW integrated multiphase pumping systems
- Key technologies
  - ✓ Motor: efficiency, speed, modular
  - ✓ Barrier fluid: environmentally friendly, eliminates moisture control
  - ✓ Hydraulic bundle: experience, tolerant, balanced and resistant

FMC Integration marinizing best of all technologies



We put you first.  
And keep you ahead.

Thank you