HPcp Barrel Casing Pumps

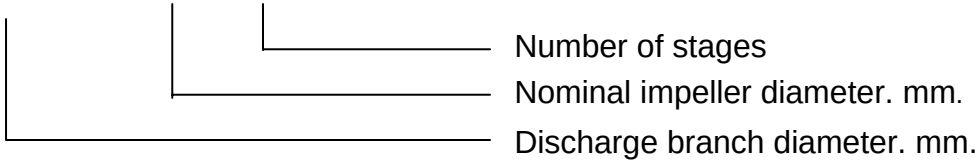
Sulzer Pumps

HPcp
Designation & Description

- API type BB5

  Between bearings, multistage, radially split, double casing.

- Sulzer designation HPcp xxx **-** yyy **-** n stages



- HPcp is a **diffuser** design, full pull-out cartridge barrel casing pump.
- It is available in alternate configurations to suit different applications and operating requirements

HPcp
Main applications

- **Seawater & Produced Water Injection**

- **Oil Export**

- **Pipeline**

HPcp
Range coverage

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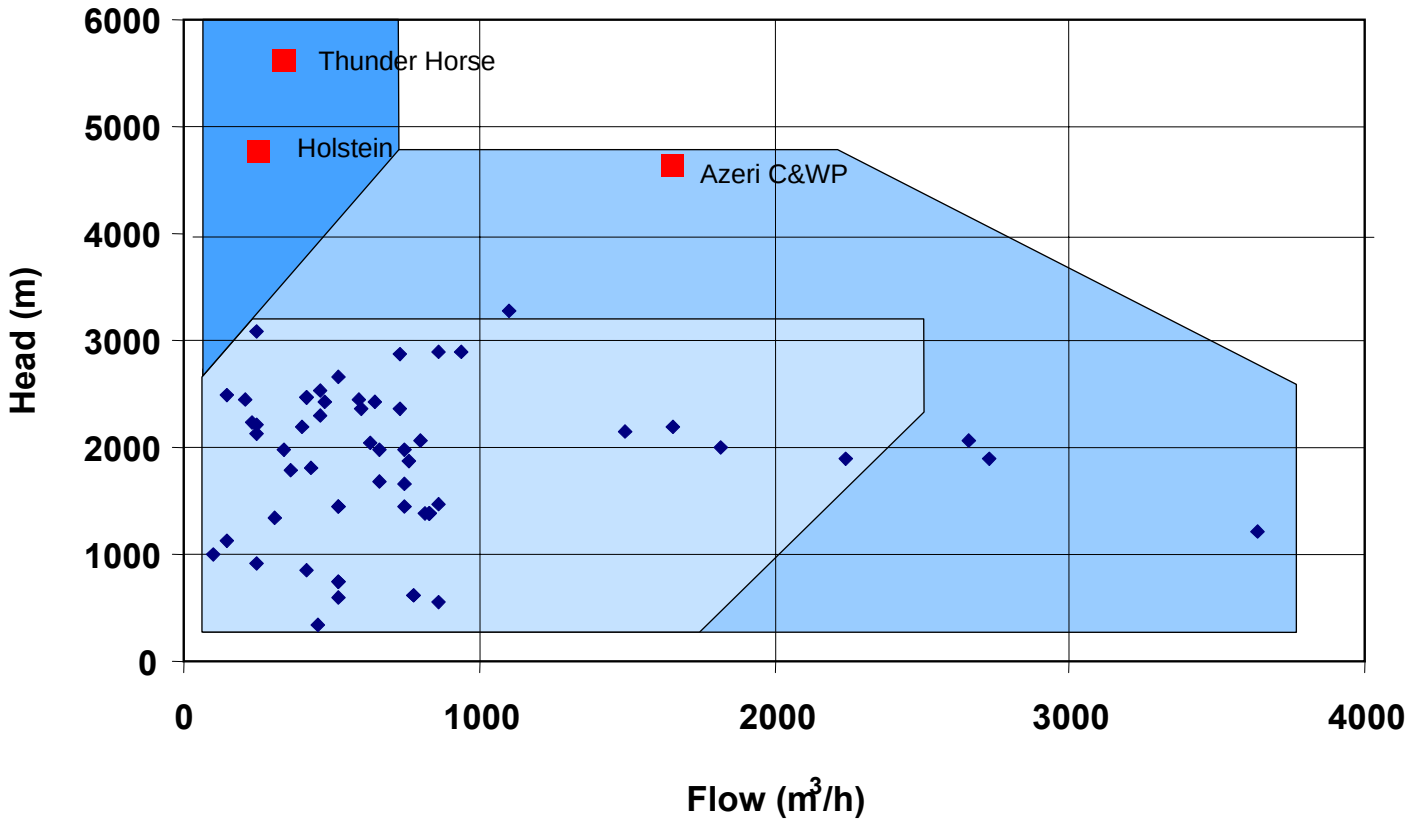
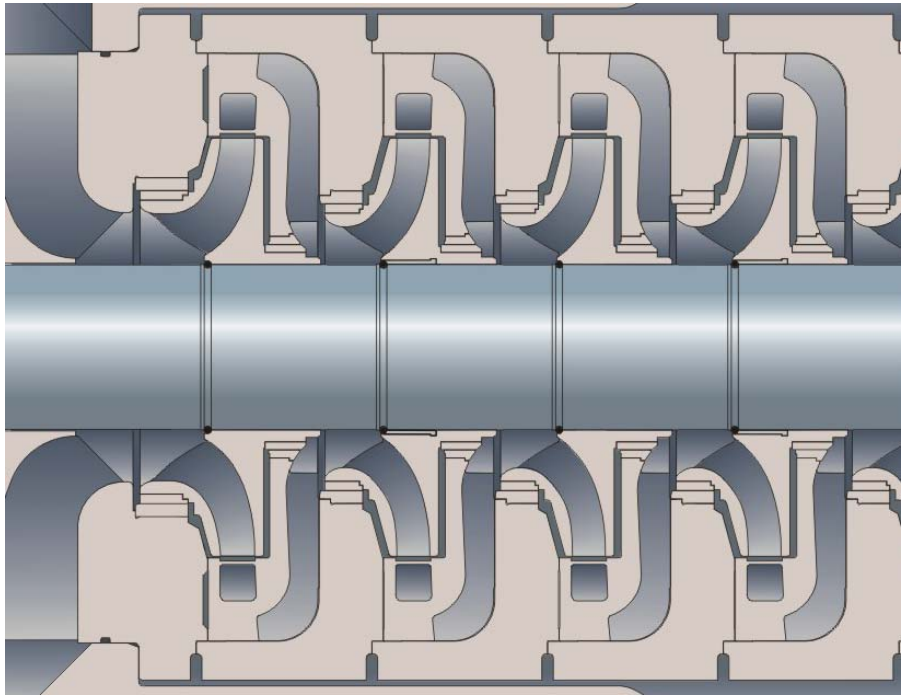


HPcp
Design Features – Hydraulics

- Well proven hydraulics in the NQ 13 to 36 range.

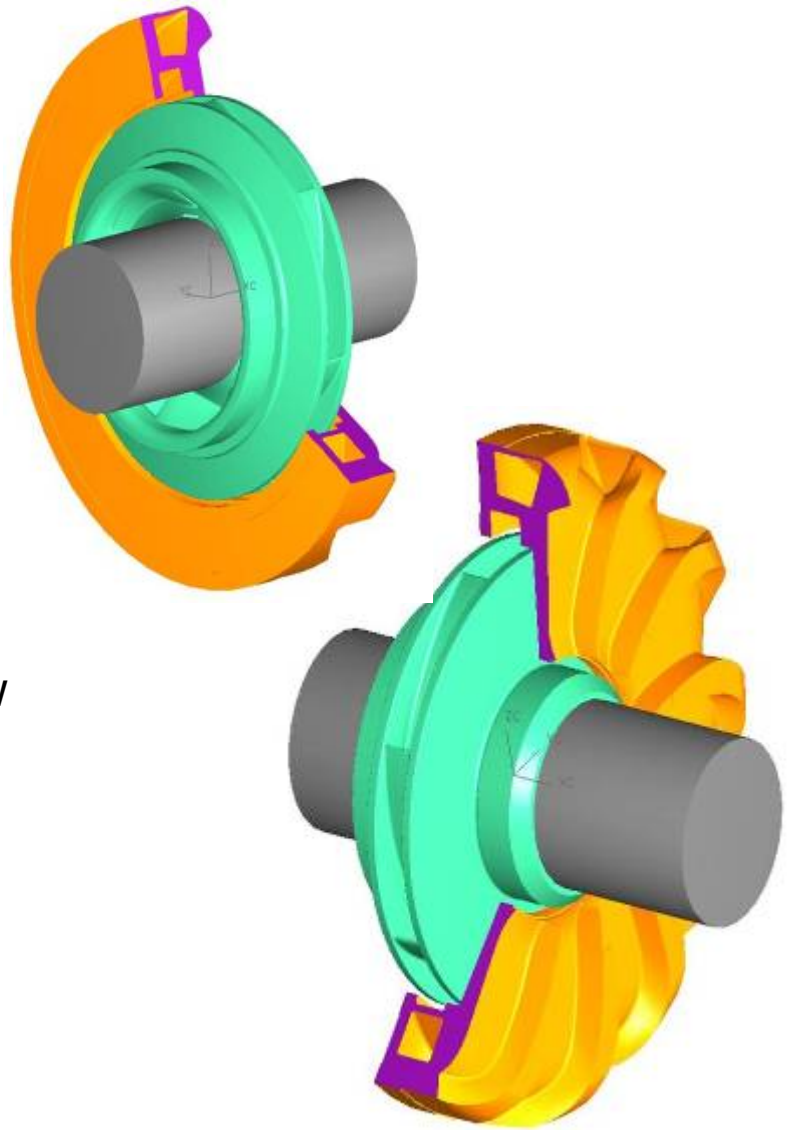
- Reliable suction performance backed up by life warranties if required – Sulzer were the first pump company to give 40,000 hour guarantees on suction impellers.

- Swirl break technology aids rotor stability even in the fully worn condition.



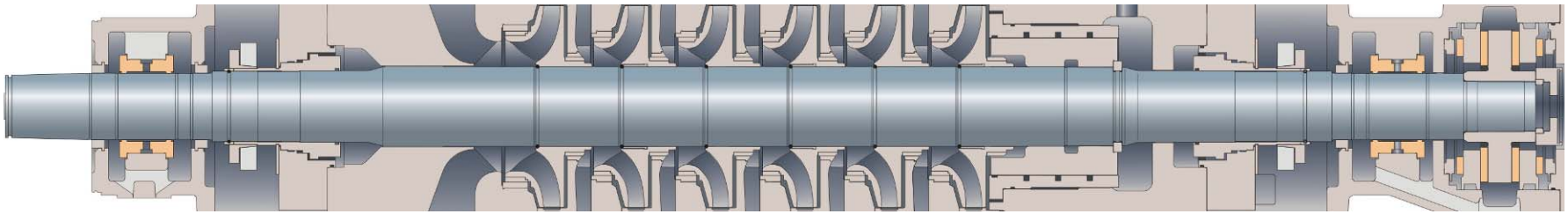
HPcp
Design Features – Hydraulics

- Thick shrouds provide high strength for high head duties
- Natural frequency away from resonance thus avoiding shroud breakage
- Continuous channel diffuser gives high efficiency
- Precision castings give high efficiency and low hydraulic unbalance



HPcp
Design Features – Rotor Construction

- Shrink fit impellers driven by double keys and located by titanium thrust rings
- Hydraulic fit balance piston

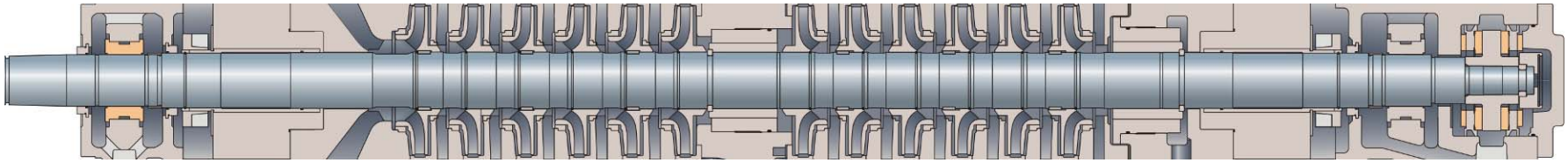


- Hydraulic fit thrust collar
- Absence of threads eliminates stress raisers
- Component balance to ISO grade 1.0 and check rotor balance to grade 2.5

HPcp
Design Features – Rotor Construction

- Back to back design naturally balances axial thrust reducing bearing size

- Differential pressure across bushes reduced to 50% of full pressure

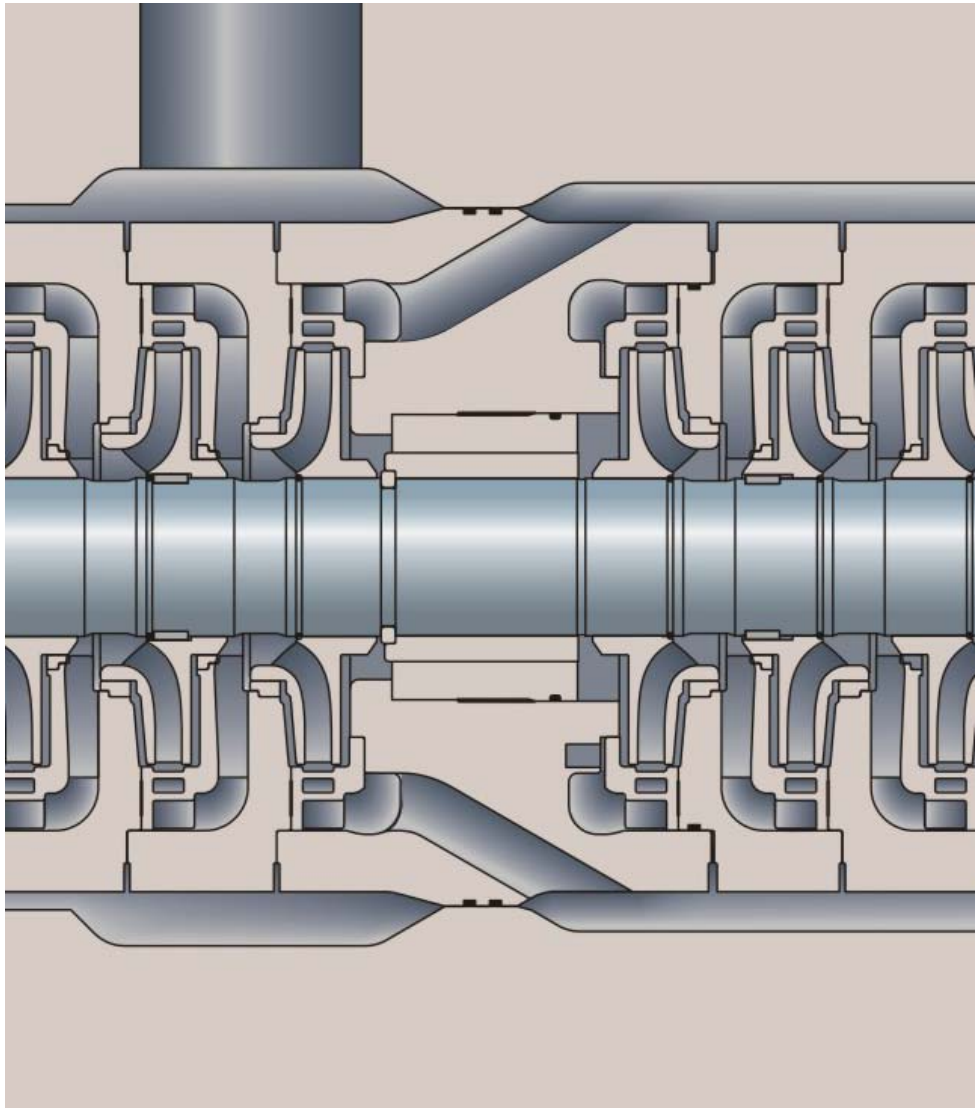


- Case cover only sees 50% discharge pressure

- Centre bush acts as a support allowing 8 stage+ construction

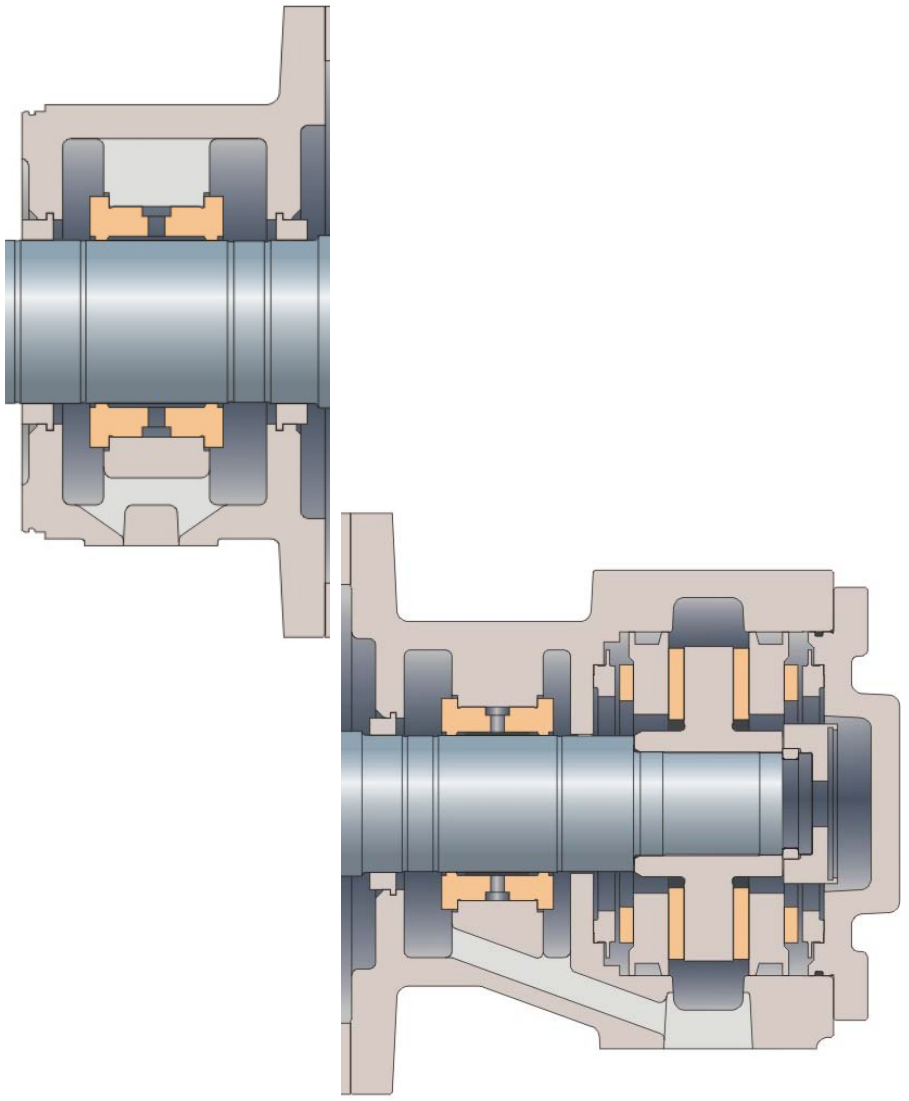
HPcp
Design Features – Rotor Construction

- Center bush on back to back layout acts as a product lubricated bearing controlling shaft deflection and reducing vibration



HPcp
Design Features – Bearings

- 4 lobe arc journal bearings.
- 8 pad center pivoted thrust bearings, these may be specified to accommodate thrust loads in either direction if required.
- A self contained design not requiring a separate oil system is available for smaller size pumps.
- Full instrumentation of the bearings is possible.



HPcp
Design Features – Main Connections

- The three main alternatives are
  - **Flange**, traditional ANSI standard bolted flange. Heavy (expensive) and space consuming
  - **Pad**, studded pad on the pump casing to accept a standard ANSI flange being bolted to it. Light but still requires a flange to connect with so space limitations may still apply
  - **Techloc**, clamping arrangement, both light and space efficient

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Design Features – Flange Connections

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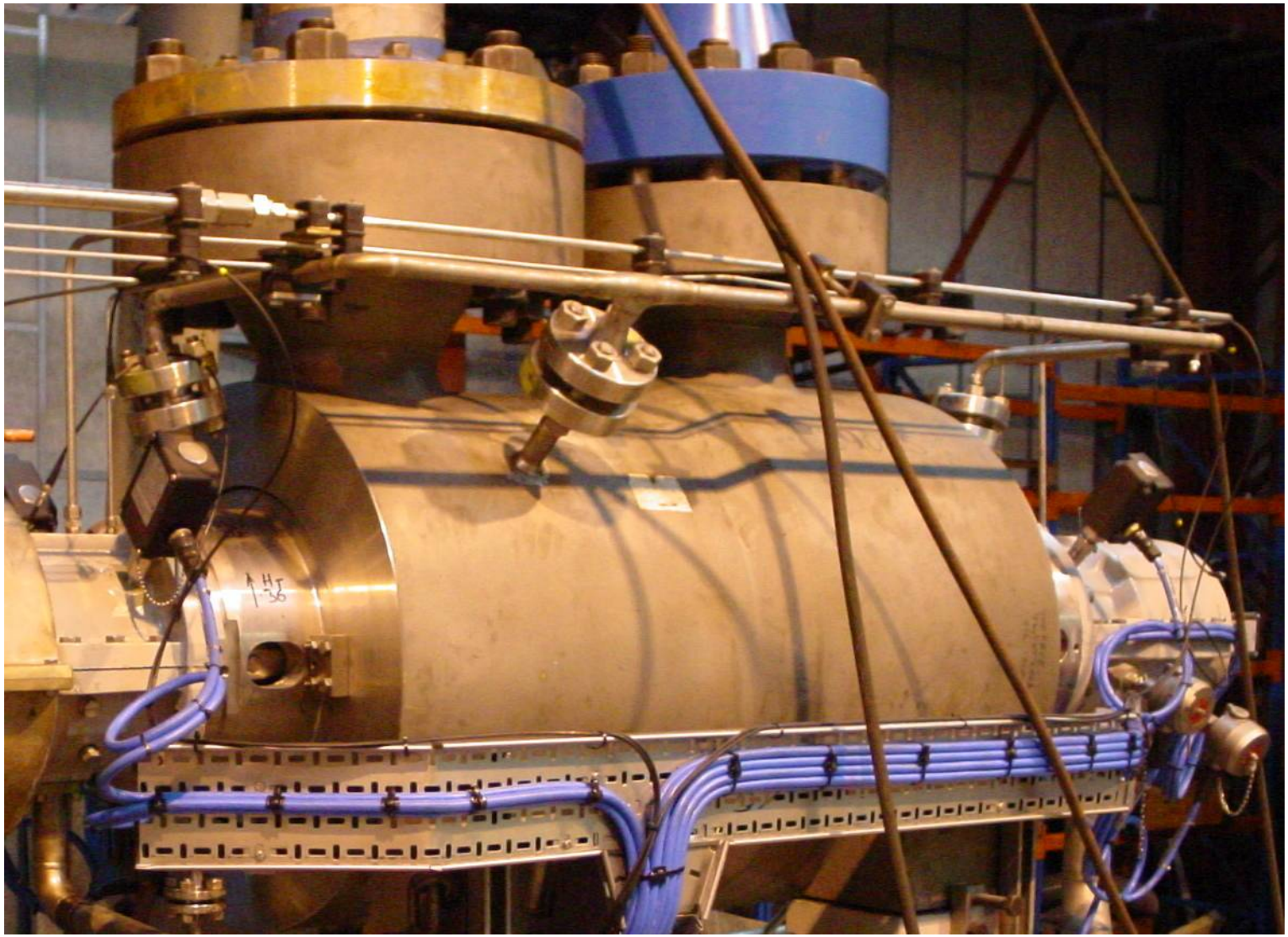

HPcp
Design Features – Pad Connections

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Design Features – Techloc Connections

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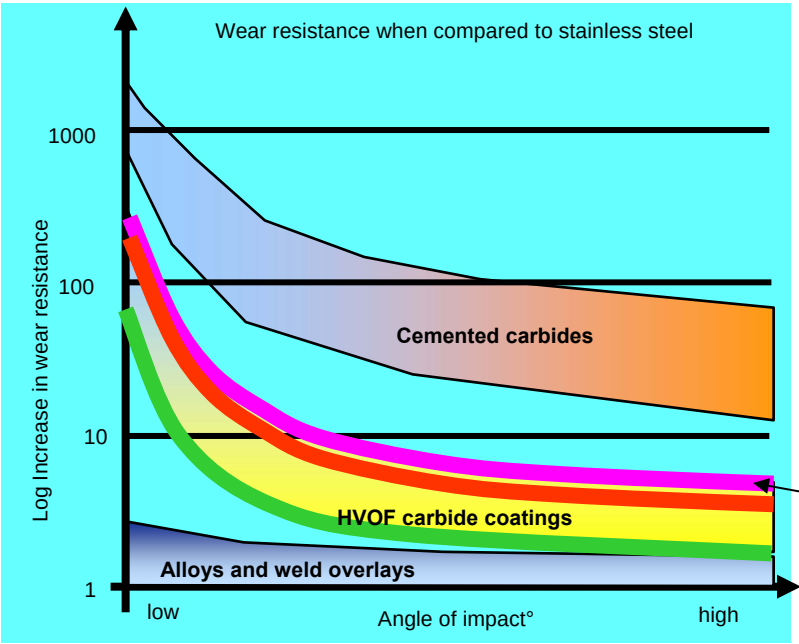
HPcp
Design Features – Materials

- Standard Materials
  - Duplex or Super Duplex construction throughout.
  - Stellite overlay on all internal wear parts

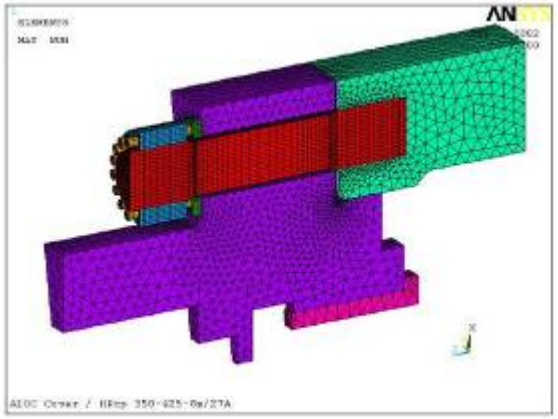
- Enhanced wear parts for Produced Water and other abrasive applications
  - **SUME®*PUMP* SA 30** 3rd generation coating on all wear parts



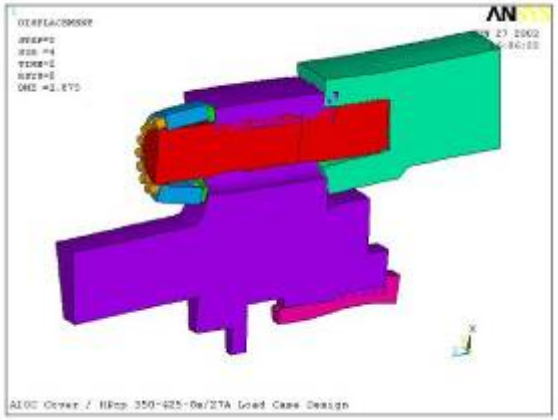
SUME®*PUMP* SA 30

HPcp
Pressure Containment

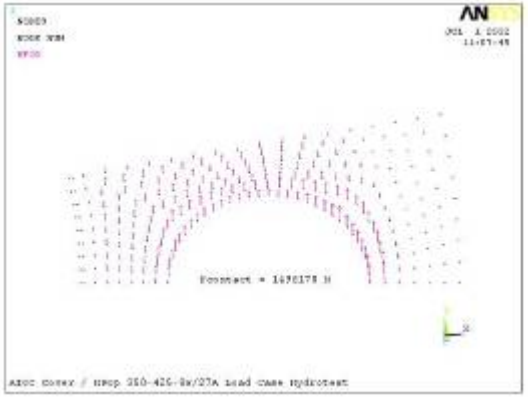
- Sulzer has developed advanced,well proven 3D FEA tools



Basic 3D model



Deformation in operation



Casing/cover contact on hydro-test

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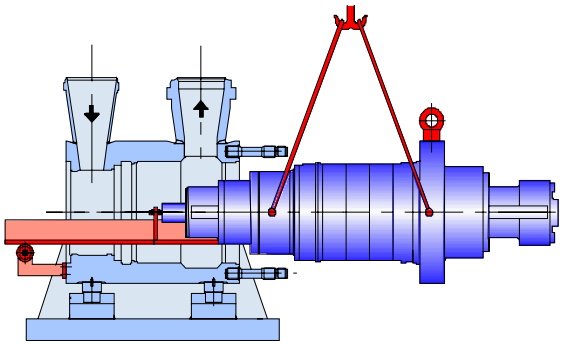
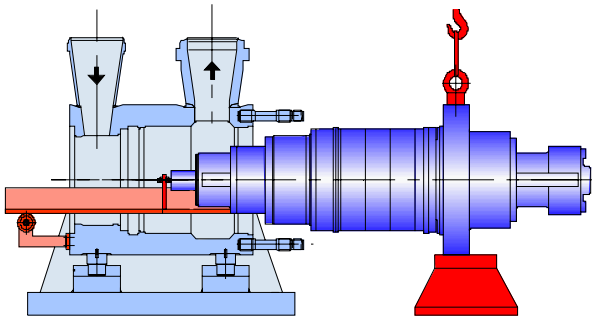
Full cartridge design



Step 1

Suspended and supported on rollers at DE

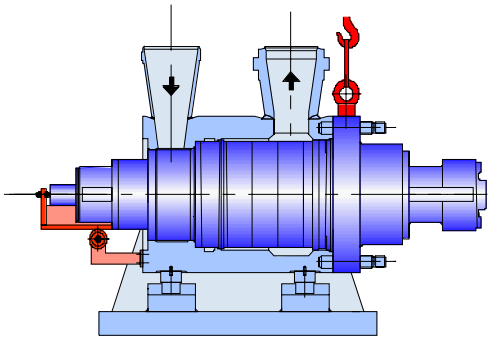


Step 2

Supported for re-rigging

Advantage

Quick and safe cartridge change including bearings and seals as a complete unit



Step 3

Final installation

HPcp Options
Twistlock Cover, In Line Construction

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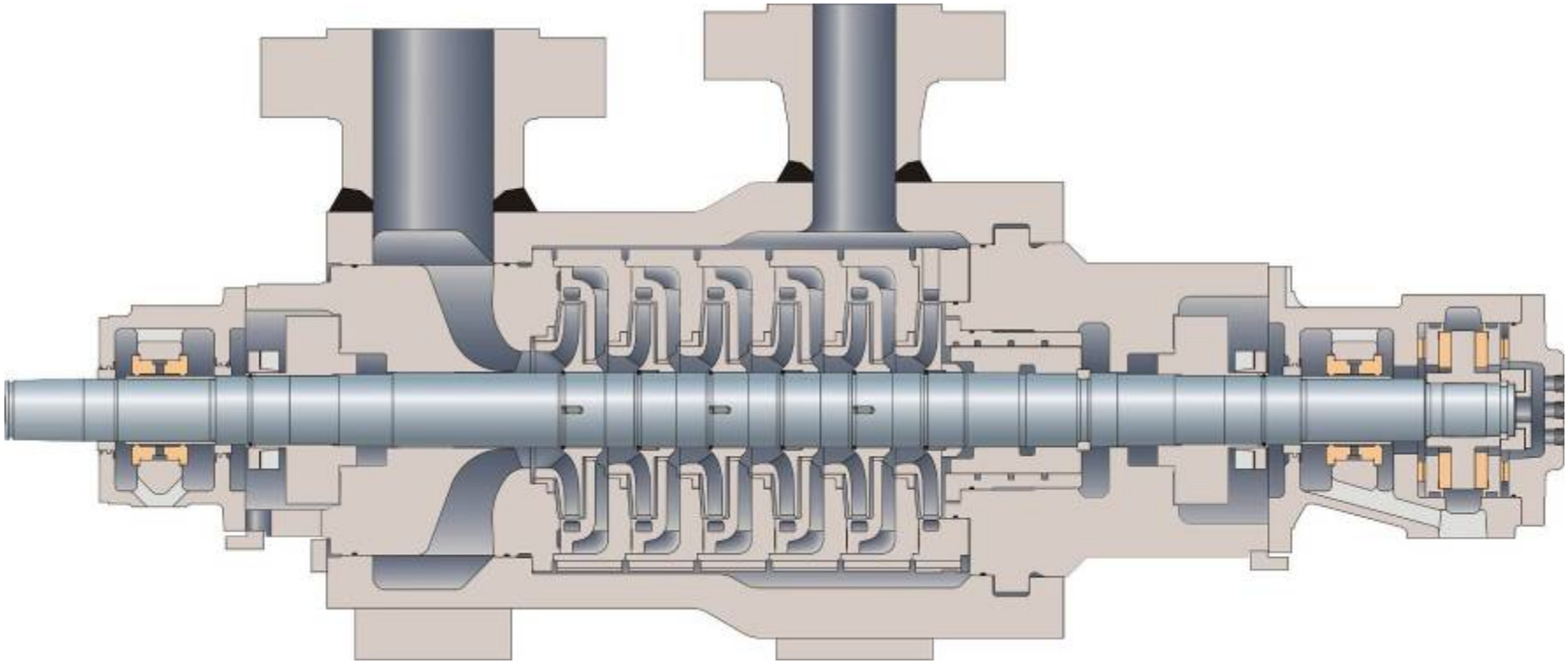
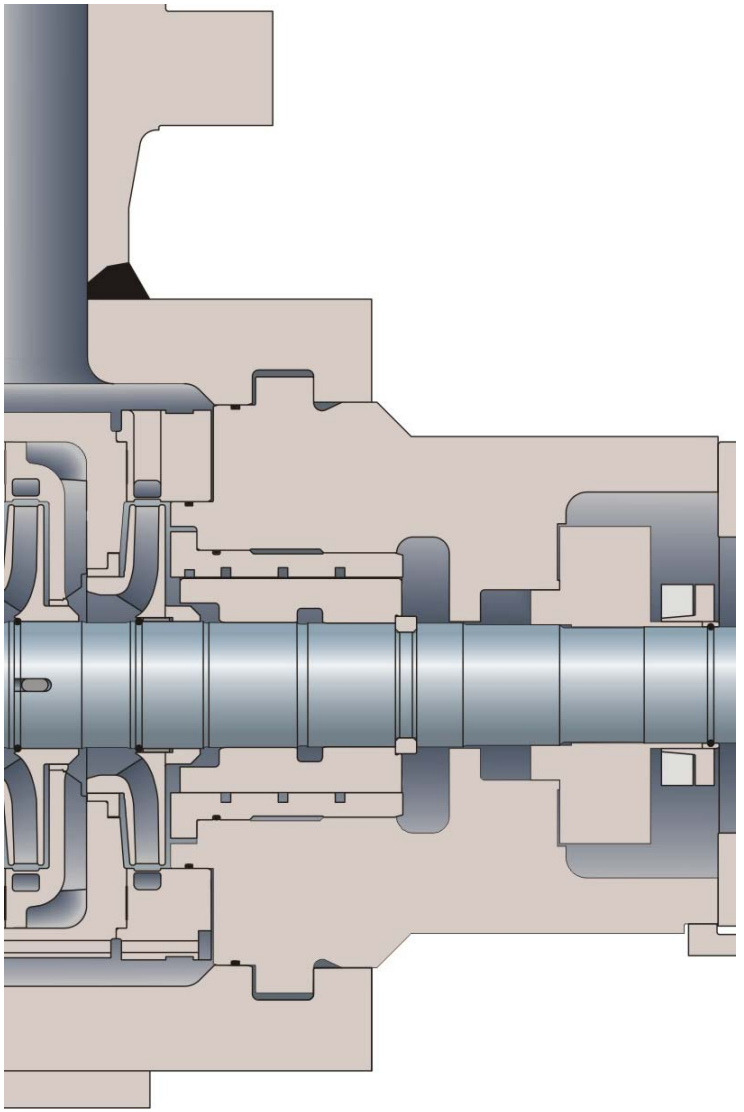


In-line impeller arrangement
with dry twist lock closure for up to 8 stages and design pressures below ~400 bar

HPcp
Design Features – Twistlock System

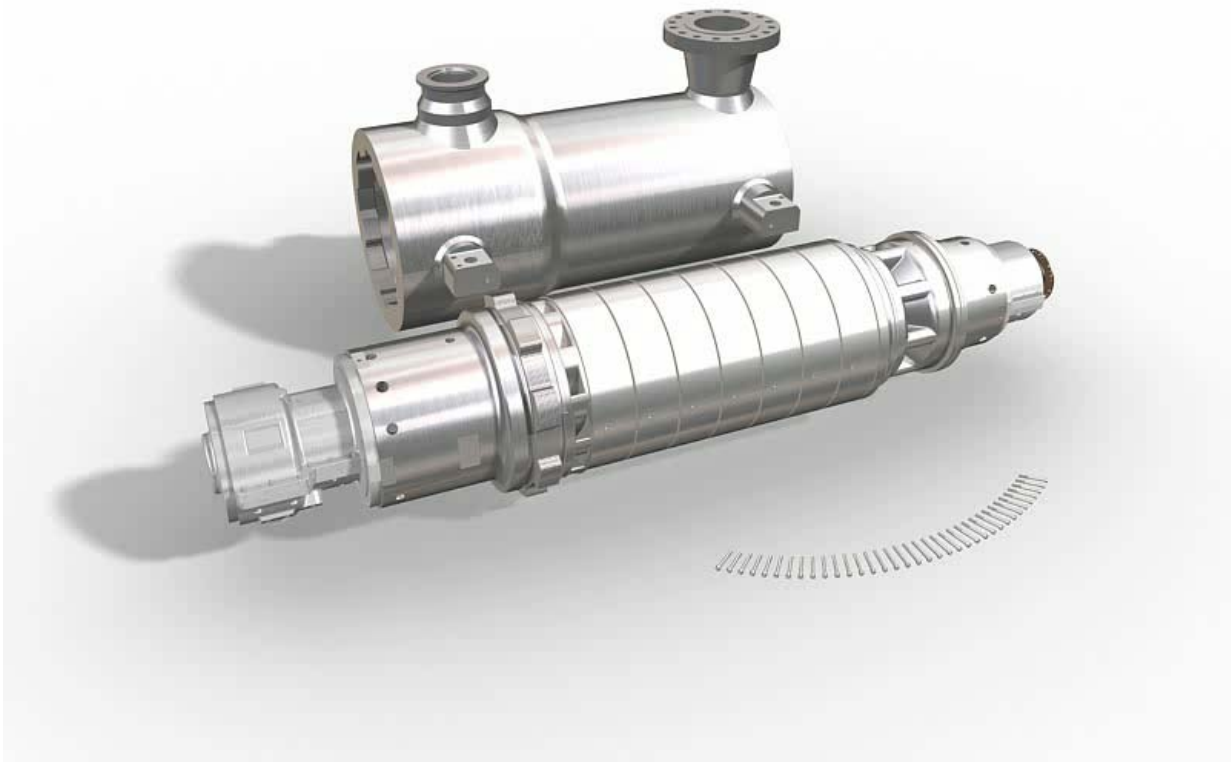
- No heavy bolting required.
- Suitable for operation up to 400 bar depending on pump size.
- Minimizes barrel size (no heavy bolts to be accommodated).
- Minimizes cartridge size (no cover flange.
- Cartridge change out within a single shift.



HPcp
Design Features – Twistlock System

- Cartridge assembled and ready for fitting.

- Initial line-up to the barrel.



HPcp
Design Features – Twistlock System

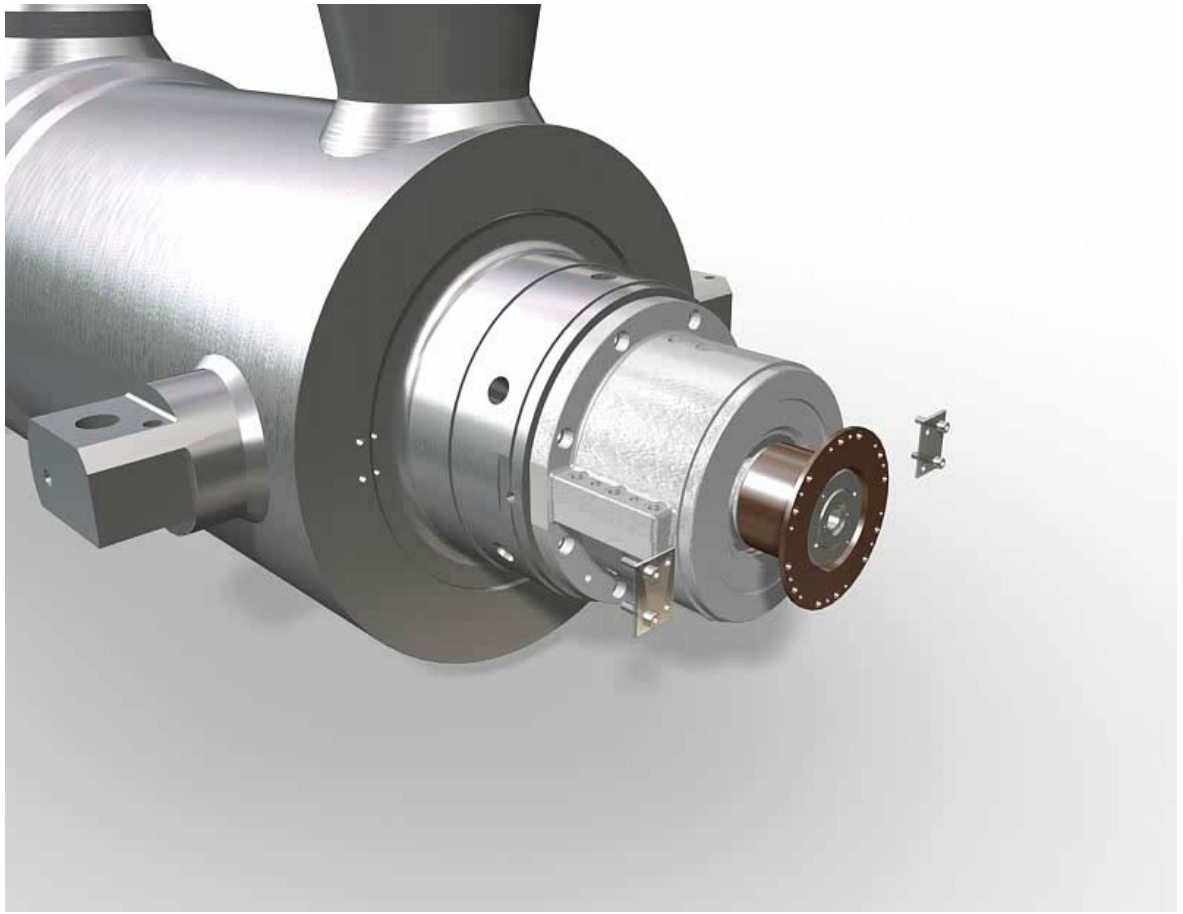
- Cartridge teeth turned to align with the slots in the barrel.
- Cartridge is then inserted into the barrel.

HPcp
Design Features – Twistlock System

- Suction end retaining plates ready for fitting.

HPcp
Design Features – Twistlock System

- Suction end retaining plates being fitted to lock the cartridge from the suction end.

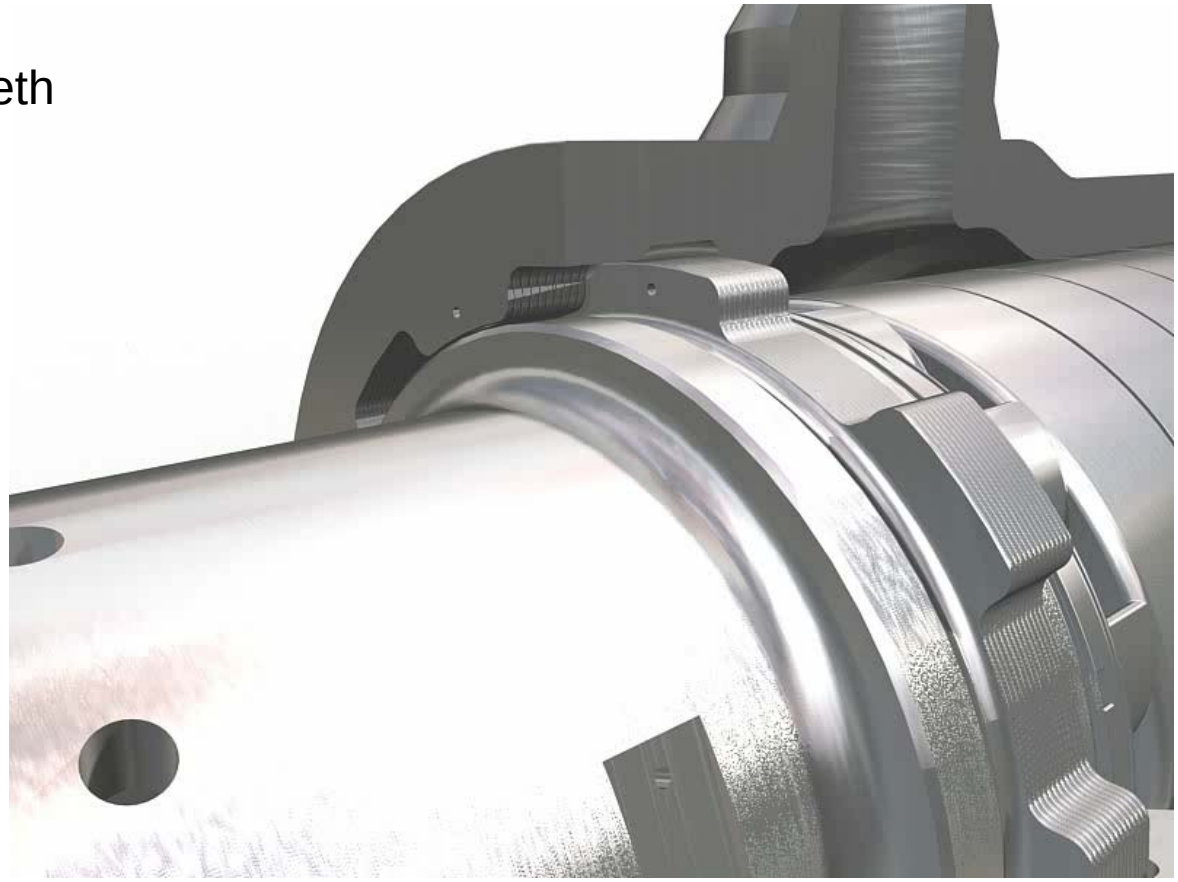


HPcp
Design Features – Twistlock System

- The suction end is now assembled, work now commences at the discharge end.

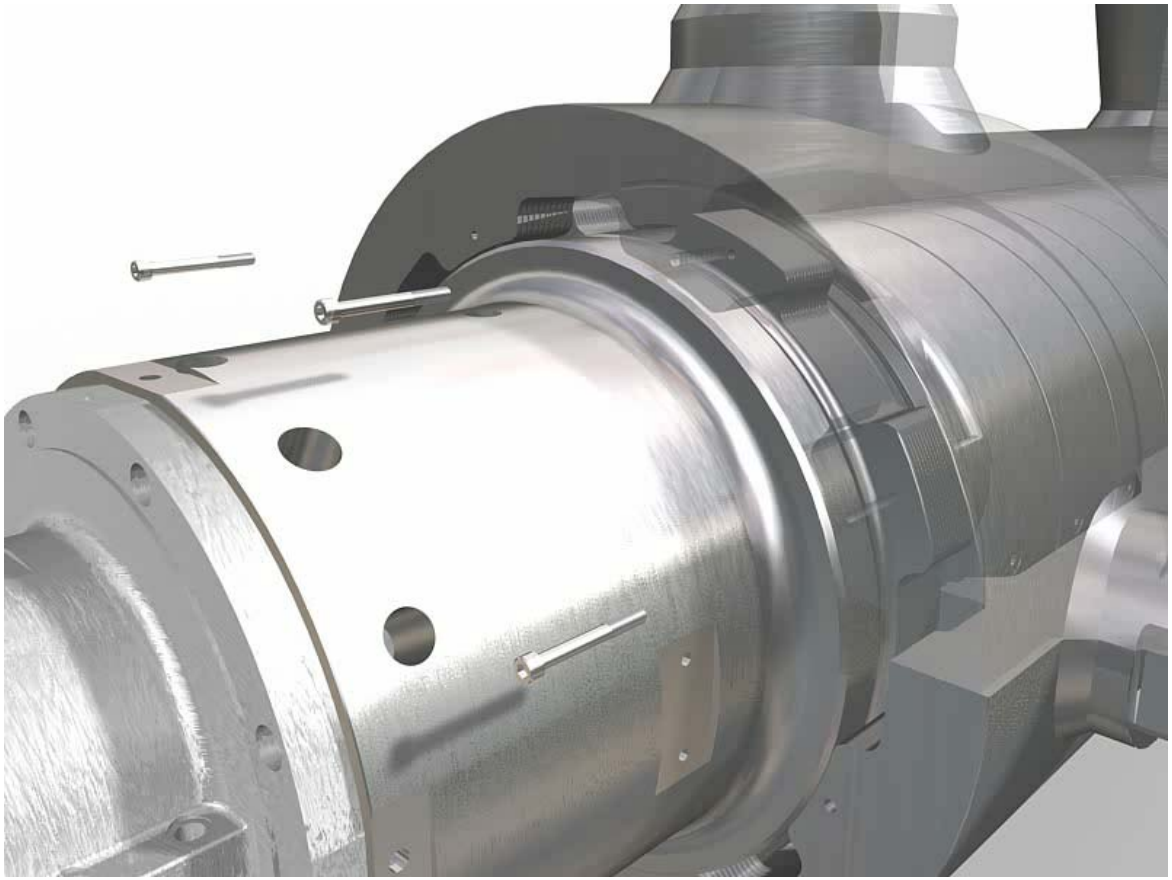
HPcp
Design Features – Twistlock System

- The cartridge end block is now rotated to lock the teeth into position.



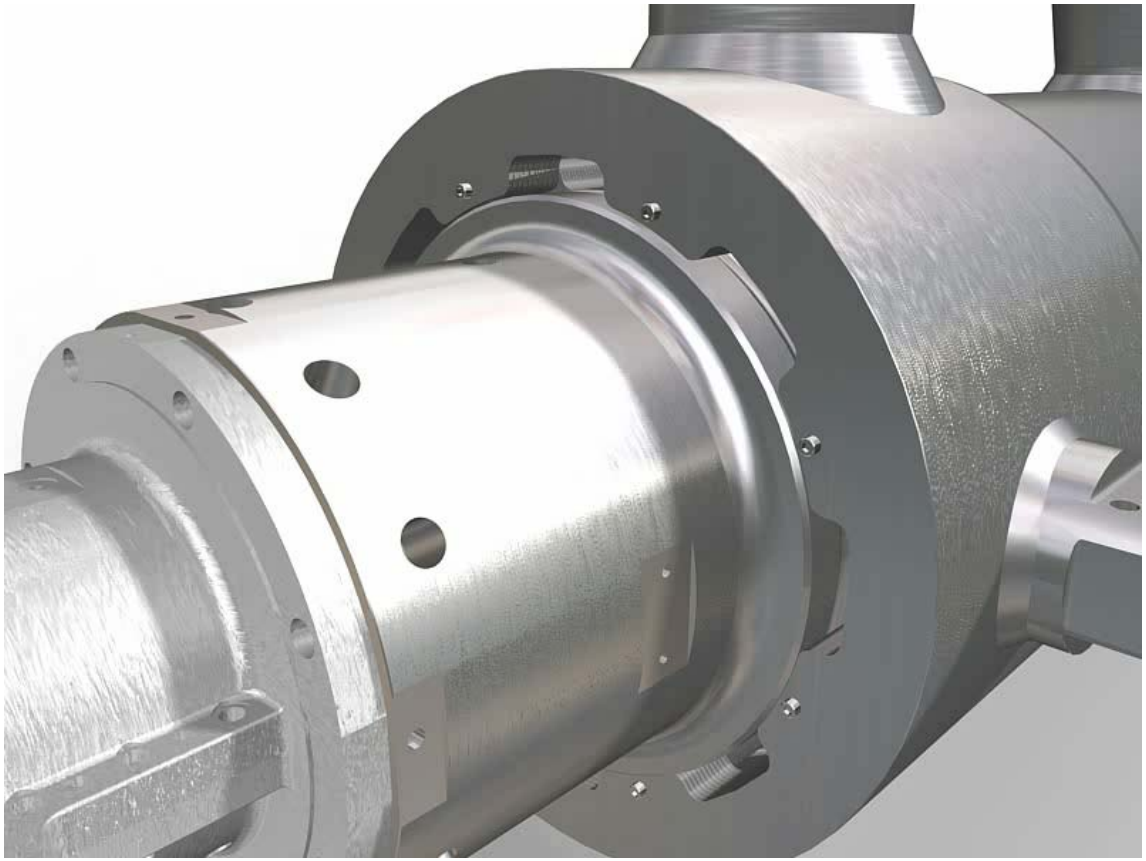
HPcp
Design Features – Twistlock System

- Discharge end retaining screws are now fixed in place. The cartridge is now locked from the suction and discharge end of the barrel.



HPcp
Design Features – Twistlock System

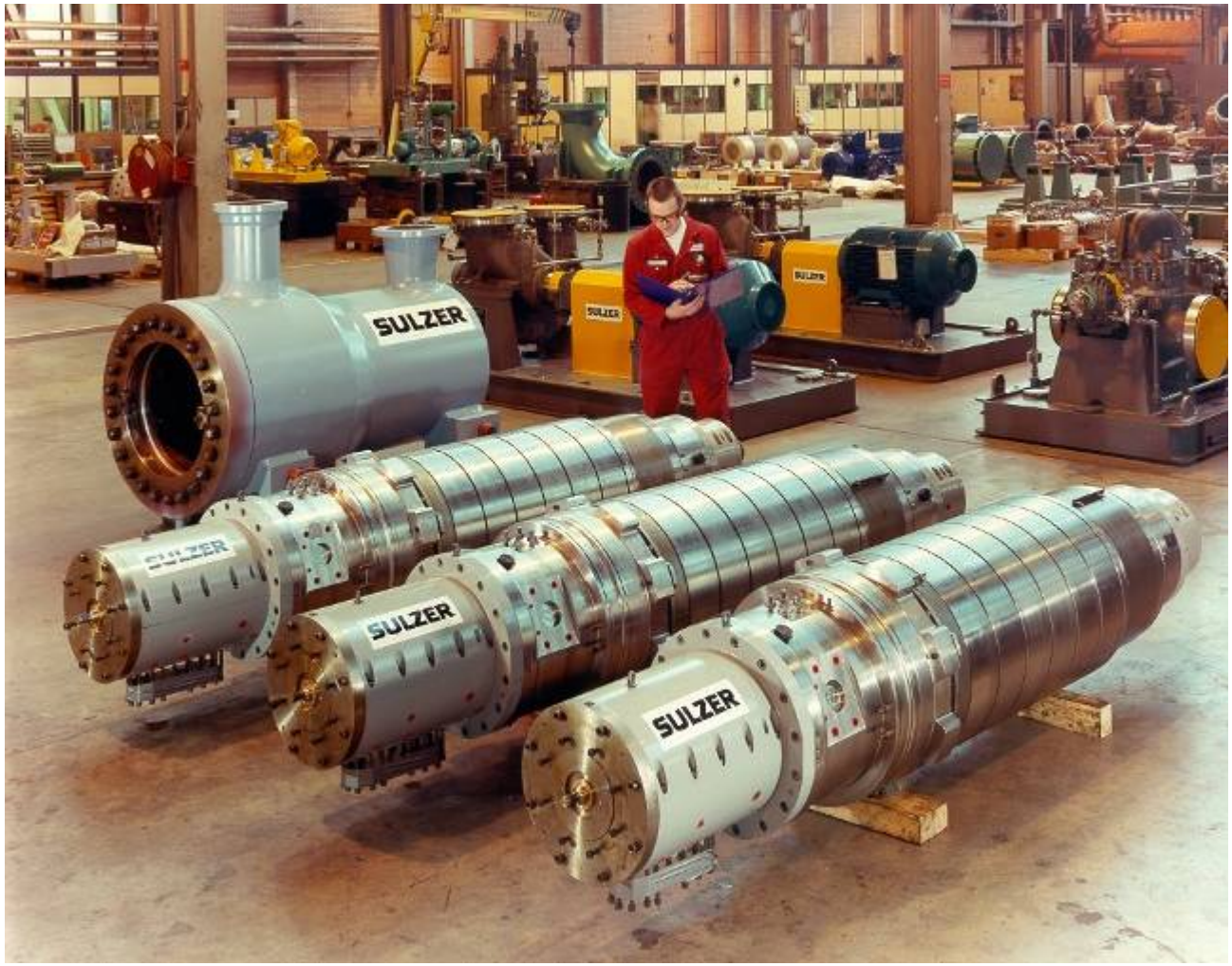
- Assembly is now complete and the pump ready to be put into service.



HPcp
Twistlock – Full Sequence

HPcp
Design Features – Twistlock System

- Twistlock cartridges and barrel



HPcp Options
Bolted Cover, In Line Construction

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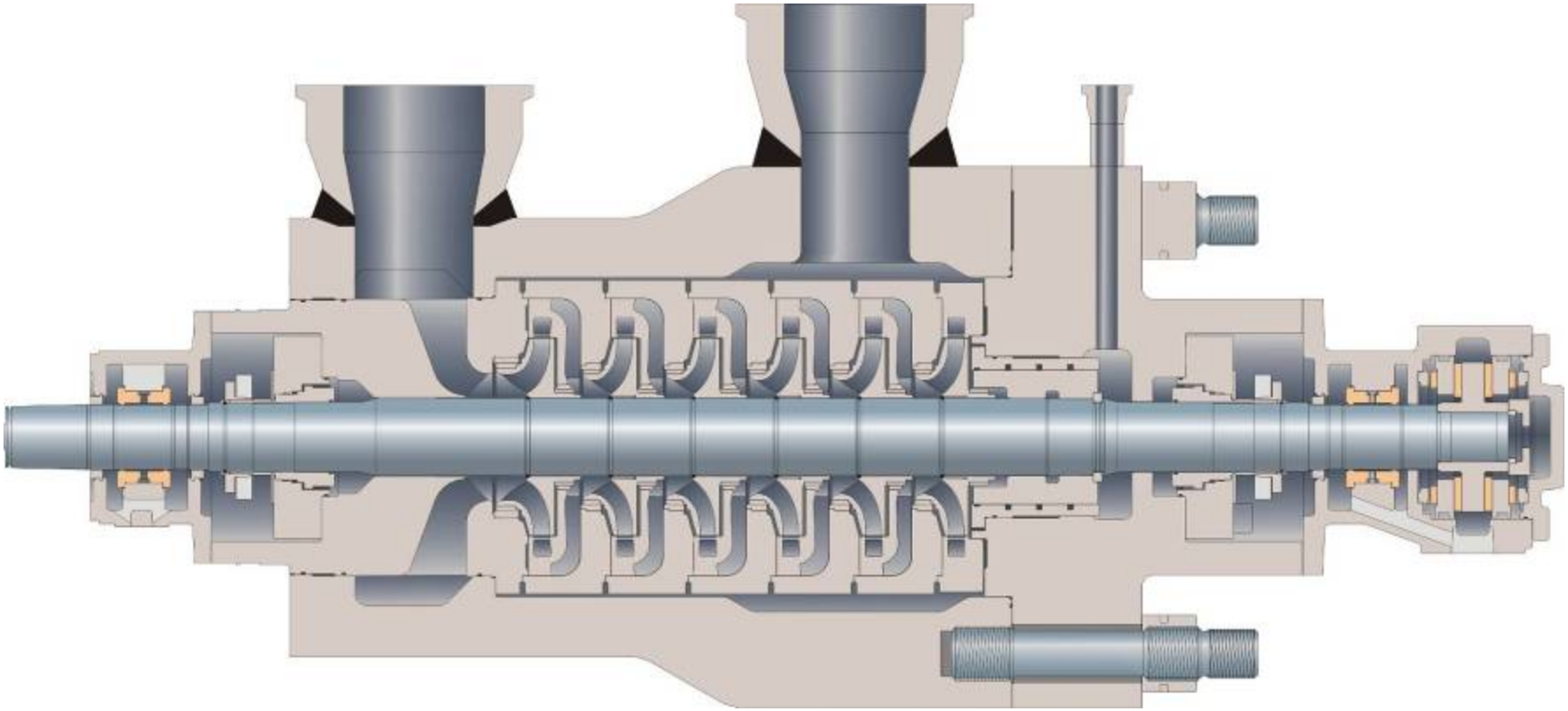

Inline impeller arrangement
with bolted delivery cover for up to 8 stages and design pressure above ~400 bar

HPcp Options
Bolted Cover, Back to Back Construction

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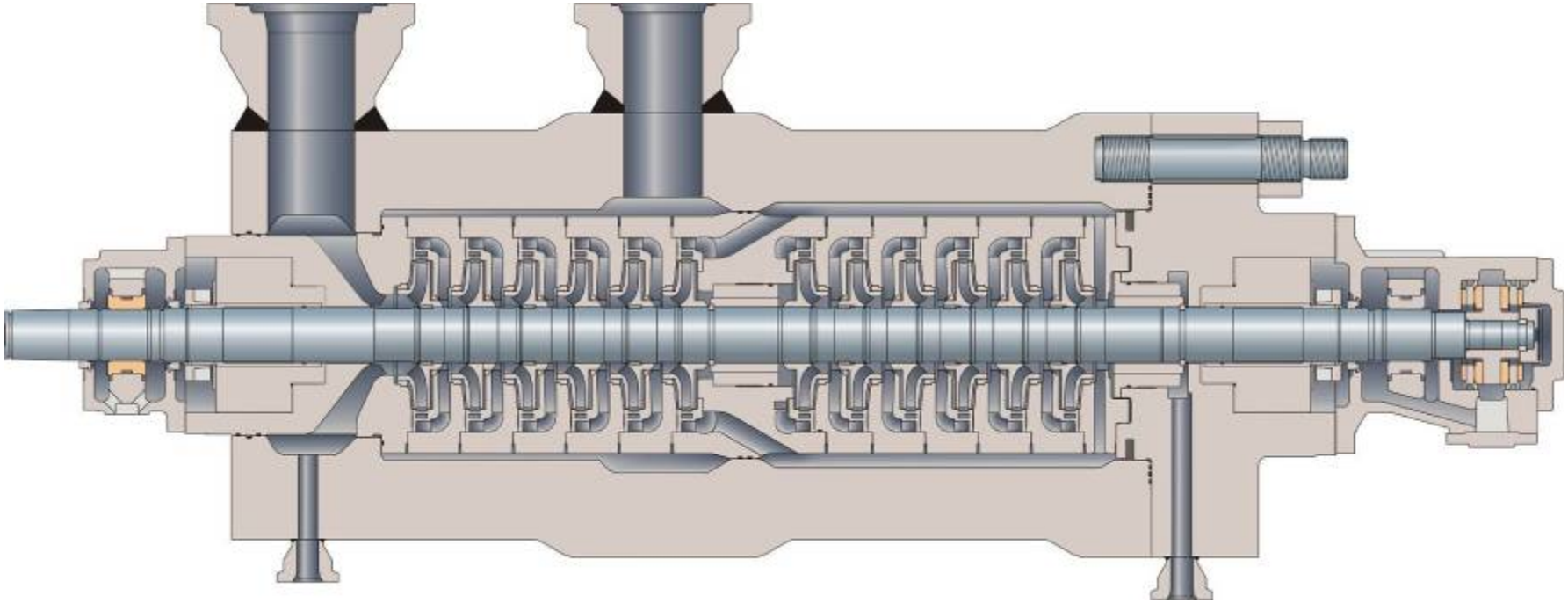
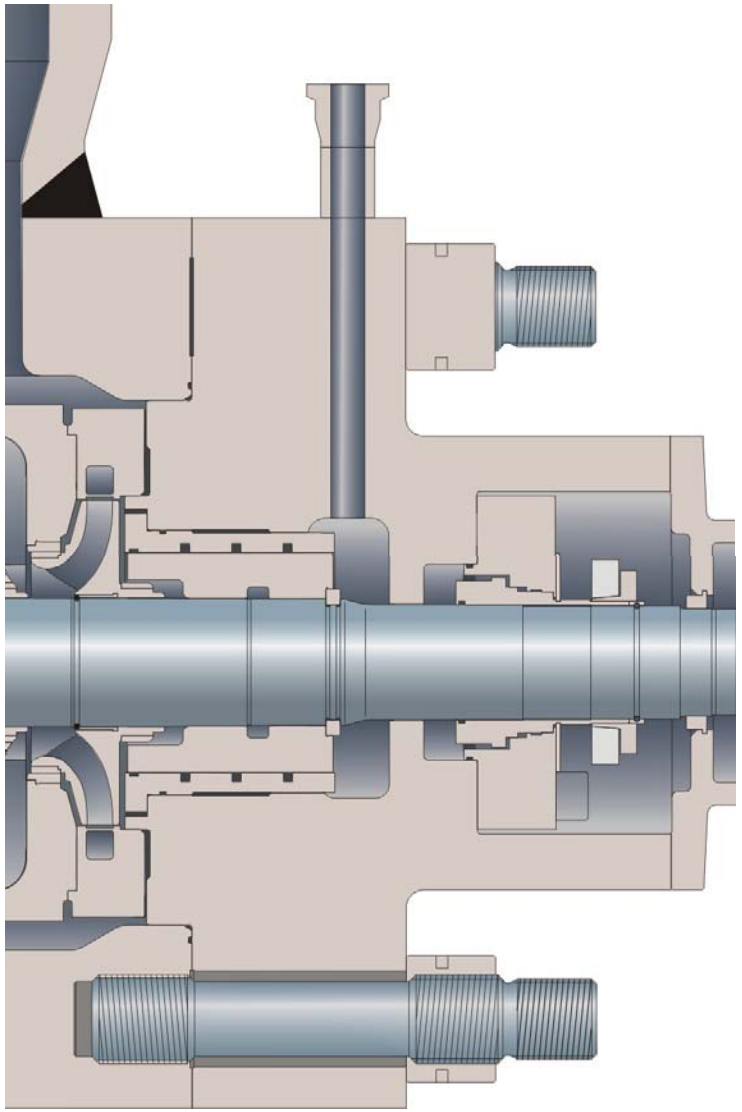


Back to back impeller arrangement with bolted delivery cover for more than 8 stages

HPcp
Design Features – Bolted End Cover

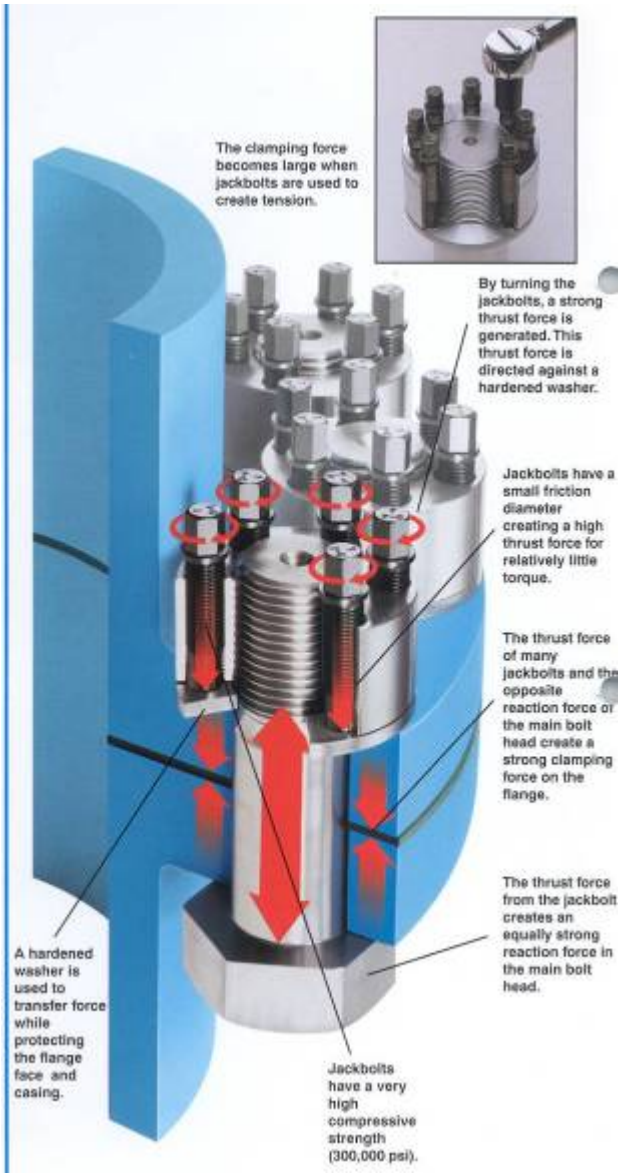
- Bolted design for pressures above 400 bar depending on pump size.
- Casing cover seal leakage instrumentation available.
- Worlds highest pressure centrifugal injection pump built using this layout (606 bar operating pressure, 909 bar test pressure).



HPcp
Design Features – Superbolt Nut

Superbolt Nut

- Proven design
- No heavy hydraulic jack required
- No special tools required
- Smaller barrel casing OD



HPcp
Finite Element Analysis - Suction Casing

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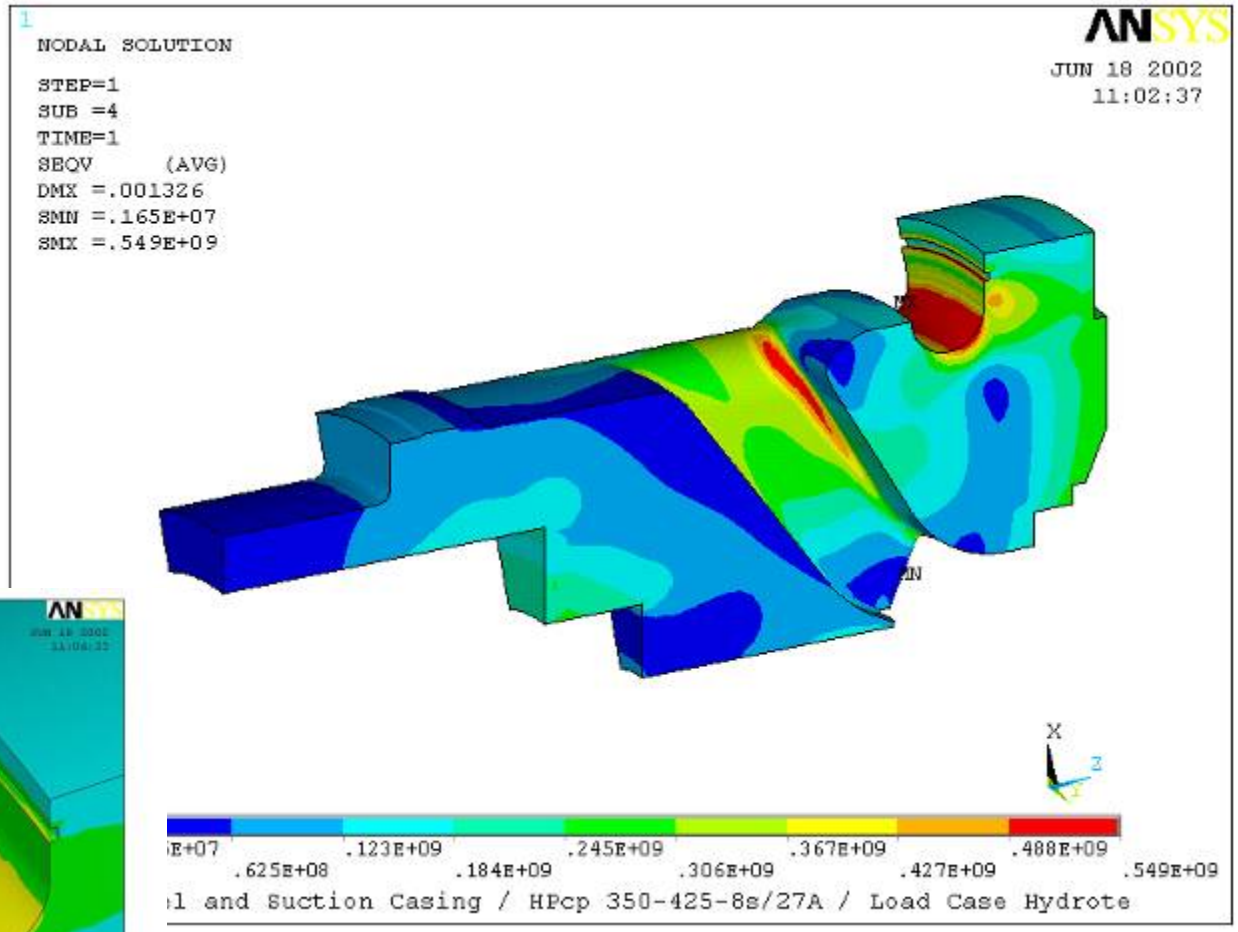
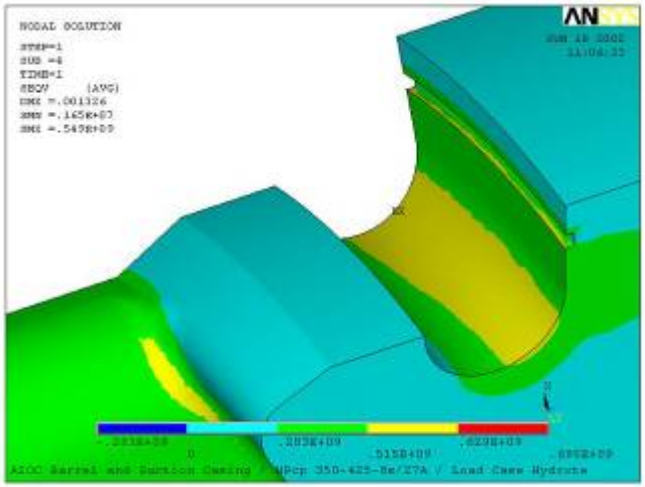
- Hydrotest
- Equivalent Stress





HPcp
Design Features – Cartridge Types

- Cartridge with bolted end cover

HPcp
Proven Performance

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- Physically testing pumps under all conditions verifies the correlation between theoretical and actual rotor dynamic behaviour

Thunder Horse	**New Condition**		**Worn Condition 2 X new clearances**	
Shaft Displacement	**DE**	**NDE**	**DE**	**NDE**
Calculated (Microns Pk)	1.9	5.8	4.5	5.5
Max. achieved on test. (Microns Pk)	2.0	6.0	4.8	5.1
Max. achieved on test. (Mils Pk – Pk)	0.16	0.48	0.38	0.40
Allowable per API (Mils Pk – Pk)	1.159	1.159	1.159	1.159

HPcp
Wear mechanisms - flow velocities

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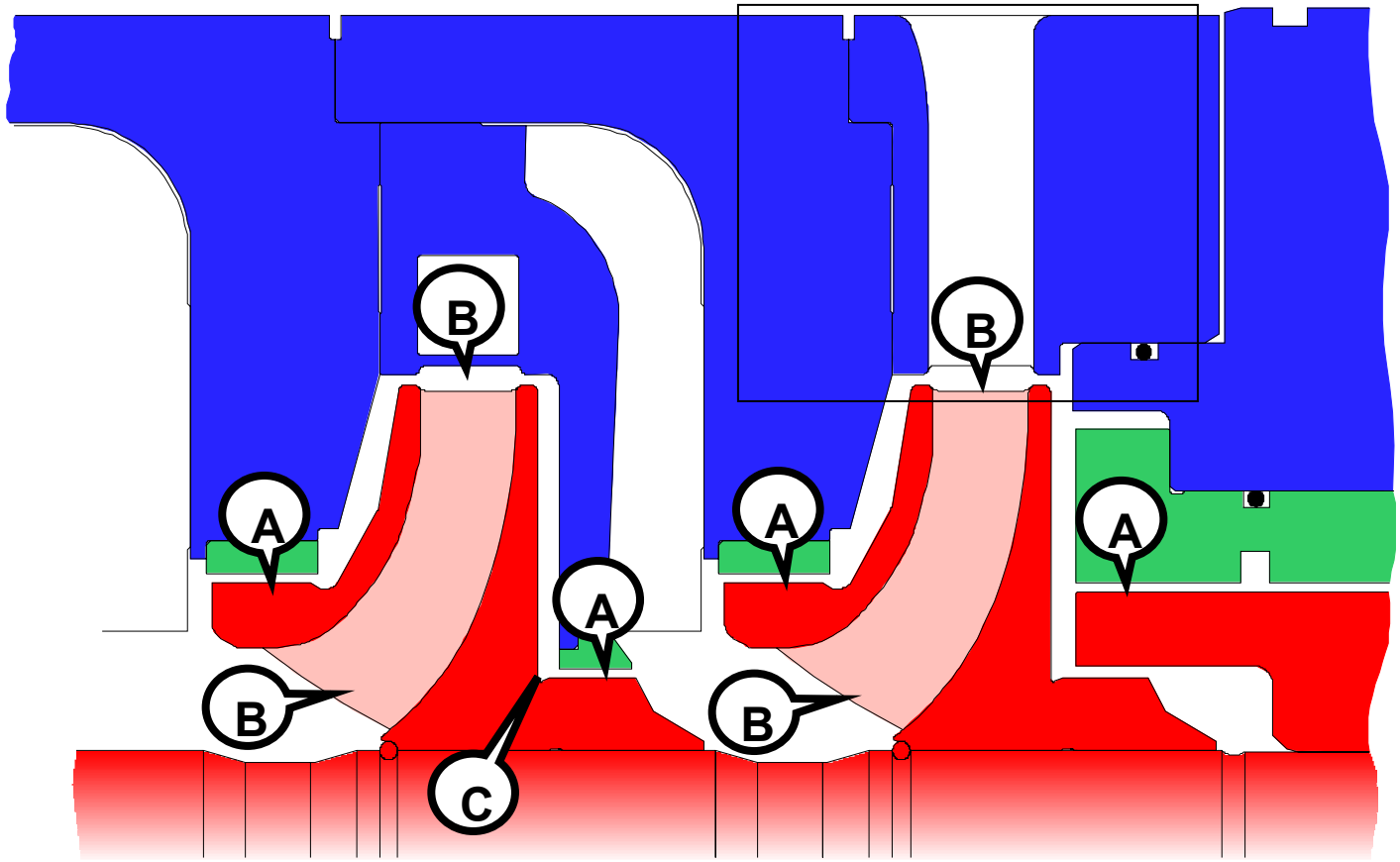

Velocities

A: high

B: medium to high

C: high (90° impact, jet)

HPcp
Wear mechanisms - flow velocities

- Influencing factors
  - Quality of pumped liquid, sea and/or produced water.
  - Velocity of pumped liquid.
    - δ **= constant * (1+10sin2ε) * csq,eq * w 3.4 * GSF * F Mat**
    - where:
    - δ material loss rate [μm/h]
    - **ε** impact angle [°]
    - c**sq,eq** equivalent quartz concentration [kg/m**3**]
    - w relative flow velocity of fluid [m/s]
    - G**SF** grain size factor [-]
    - F**mat** Material factor [-]
  - Pump selection/operation
    - Operation close to BEP reduces internal velocities
  - Pump selected and designed to give:-
    - Optimum speed, high number of stages, high specific speed,
    - all of which reduce internal velocities in wear sensitive areas.
  - Materials of wear parts

HPcp
Material Testing – Erosion/corrosion test Rig

- Rotor velocity up to 40 m/s
- 6 specimens in stator
- Corrosive media with solids

Electro-chemical monitoring to determine transition points

HPcp References

- **1975. World's first duplex injection pump.**

  Sonatrach – Algeria – 13 units

- **1977. World's largest injection pumps.**

  Saudi Aramco - 15.7 MW - 2 units

- **1981. World's largest injection pumps**

  Sohio – Alaska – 18.8 MW – 2 units

- **1984. World's Largest Offshore Injection Pump**

  Zadco - Abu Dhabi - 14.2 MW - 1 unit

- **1992. World's Largest Vertical Injection Pumps**

  Statoil - Norway - 6.7 MW - 2 units

- **2001. World's Highest Pressure Injection Pump**

  BP - Gulf of Mexico - 605 Bar - 4 units

- **2002. World's largest Injection Pumps**

  AIOC – Caspian Sea – 27 MW – 4 units

HPcp References

- Sulzer HPcp injection pumps

>1,250 MW installed power.
>120,000,000 operating hours
>99% availability