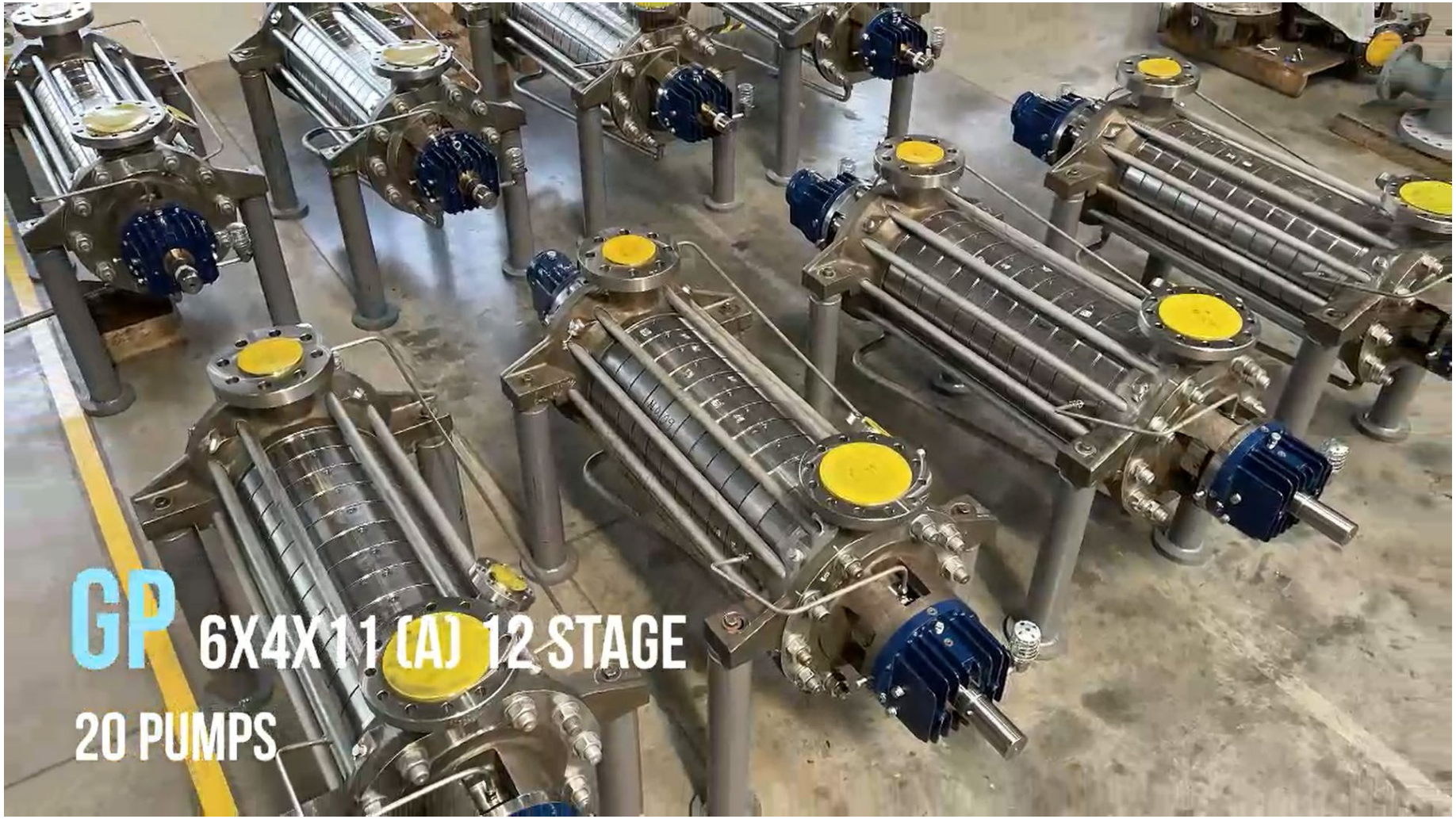
# Session 21 –
# Single Case, Multistage, Radially Split Case Pumps
# API Type BB4

*This short course will look at BB4 Pumps with a particular emphasis on the Power Industry (Boiler Feedwater Pumps). They are also commonly used in the Reverse Osmosis & Desalination Market (which will be the subject of a future session).*

*Aimed at Process and Mechanical Engineers, and Consultant Engineers who specify pumping equipment as well as Applications & Sales Engineers selecting and quoting them*

# Pump Type BB4
# Single Case, Multistage, Radially Split Case Pumps
# (also called “Ring-Section”, “Segmental Ring”, and “Tie-rod” pumps)

- 20 GP pumps 6x4x11 supplied by RP India



# INTRODUCTION TO COMBINED CYCLE POWER PLANTS

# INTRODUCTION TO COMBINED CYCLE POWER PLANT

In a **Single Cycle Plant** a Gas Turbine burns natural gas and drives a generator to produce electricity. The hot exhaust gases goes as waste. There is no application for a Boiler Feed Water Pump in such a plant.

In a **Combined Cycle Power Plant** (CCPP) / Combined Cycle Gas Turbine (CCGT) plant, a gas turbine generator generates electricity

**AND**

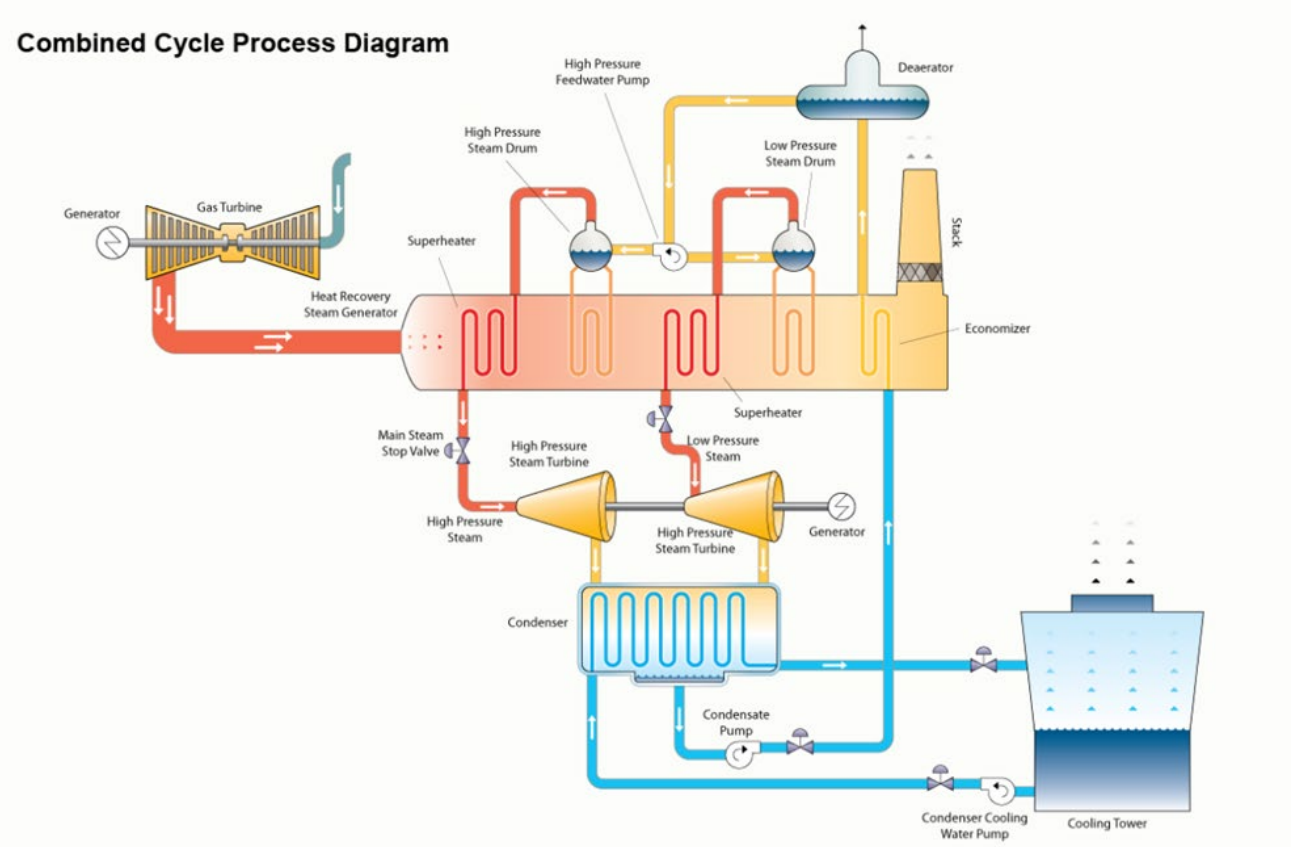
the waste heat is used to make steam to generate additional electricity via a steam turbine; this last step enhances the efficiency of electricity generation.

# COMBINED CYCLE POWER PLANT

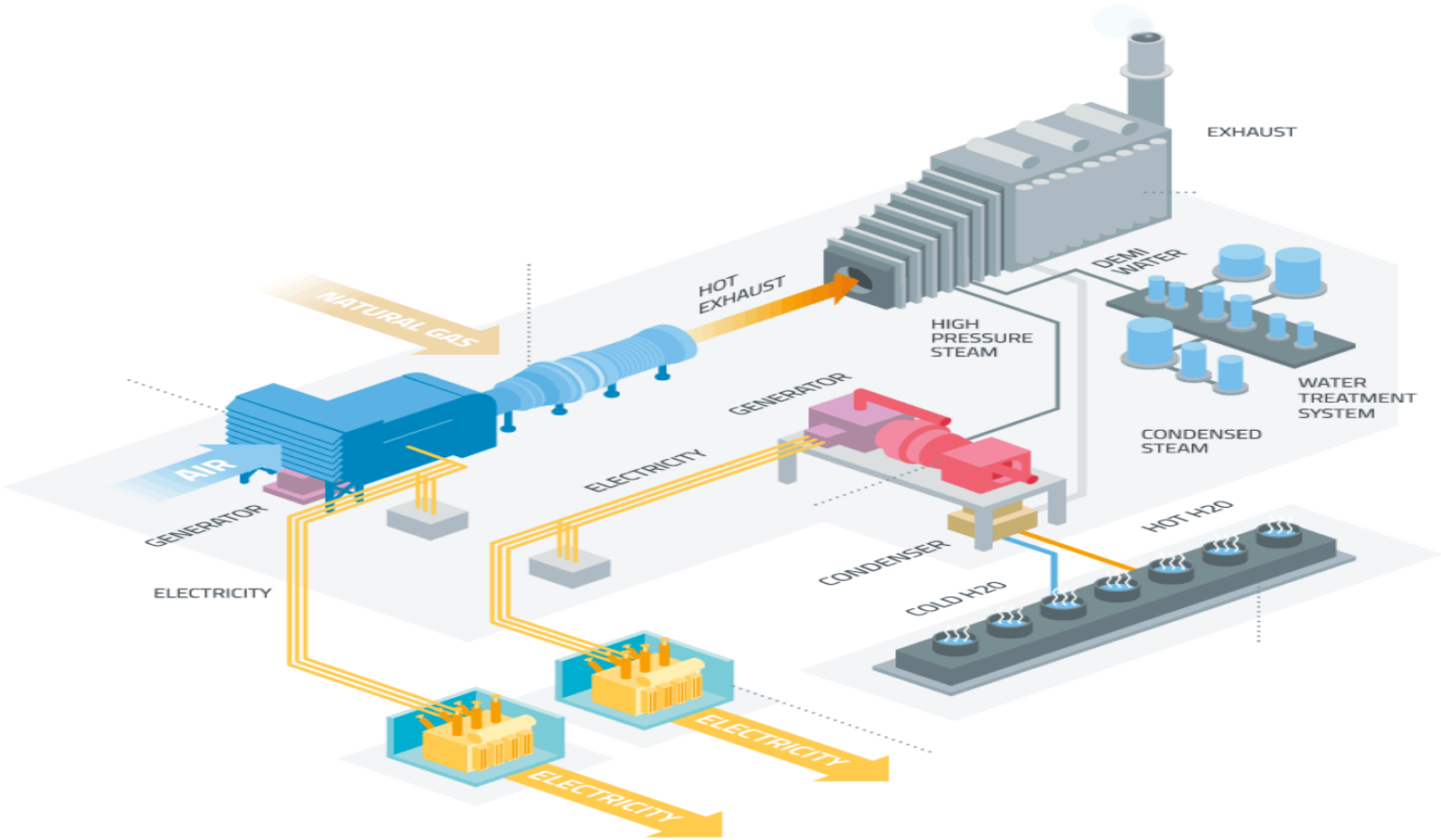
Combined cycle units are made up of one or more gas turbines with a waste heat steam generator arranged to supply steam to a steam turbine, thus forming a combined cycle block or unit.

Combined cycle power plants (CCPP) have Heat recover steam generator (HRSG) boilers and Auxiliary steam boilers.

GP pump is designed for HRSG boiler feed and not for small Auxiliary steam boilers.



# COMBINED CYCLE POWER PLANTS



# INTRODUCTION TO COMBINED CYCLE POWER PLANT

Combined cycle (gas) plants are seeing a resurgence and are popular because they have a number of benefits over large thermal (coal)/conventional power plants.

- **Fuel efficiency** - In conventional power plants turbines have a fuel conversion efficiency of 33% . The turbines in combined cycle power plant have a fuel conversion efficiency of 50% or more, which means they burn about half amount of fuel as a conventional plant to generate same amount of electricity.
- **Low capital costs** - The capital cost for building a combined cycle unit is two thirds the capital cost of a comparable coal plant.
- **Commercial availability** - Combined cycle units are easily manufactured, shipped and transported.
- **Abundant fuel sources** - The turbines used in combined cycle plants are fueled with natural gas, which is more versatile than a coal or oil
- **Reduced emission and fuel consumption** - Combined cycle plants use less fuel per kWh and produce fewer emissions than conventional thermal power plants

BUT ... The gas turbine can only use Natural gas or high grade oils like diesel fuel and because of this the combined cycle can be operated only in locations where these fuels are available and cost effective.

Adapted from http://electrical-engineering-portal.com/an-overview-of-combined-cycle-power-plant (see link to learn more)

Play this link for an excellent video related to combined cycle power:
(You Tube video by energy supplier EDF which runs for about 3 minutes.)

https://www.youtube.com/watch?v=ZQzg5hPeGi0

# BOILER FEED SERVICE

- A boiler feed water pump is a specific type of pump used to provide feed water to a power plant steam boiler at high pressures.
- Commonly a **BB4** pump is specified and suitable. End users such as Shell, Exxon, Linde will frequently specify a **BB5** (Double Case or Barrel) type
- A boiler feed water pump is used to pump feed water into a steam boiler/Heat Recovery Steam Generator (HRSG). The water is received from the deaerator/storage tank.
- Traditionally on Base Load plants, the feed water pumps run constantly with few starts and stops. Increasingly commonly nowadays, Gas Fired Power Stations are used as Peak Shavers alongside renewable energy plants and so are seeing far more frequent stops and starts and thermal cycling. This is a more exacting requirement for the pumps to be designed to withstand
- Pumps are commonly supplied in C-6 materials due to strength and corrosion resistance (but S-6, A-8, D-1 & D-2 are available)
- Commonly single seals (sometimes with Plan 23 due to high temperatures)

# KEY EVALUATION POINT FOR BFW

- What is a key evaluation factor for Boiler Feed Water Pumps?
- **EFFICIENCY!!**
- Because efficiency is a key criteria for a power plant … better efficiency = more electricity = more $$ for plant owner!
- Power Generation applications are one of the cases where efficiency can be more important than the capital cost of the equipment. Lifecycle Cost Analysis is critical! (Compare this with a refinery service where EPC is supplying pumps on a lump sum contract and so capital cost is the main driver)

There are two different concepts to consider when looking at Efficiency

- High Initial Efficiency
- High Sustainable Efficiency

# APPROACHES TO BFW PUMP ROTOR DESIGN

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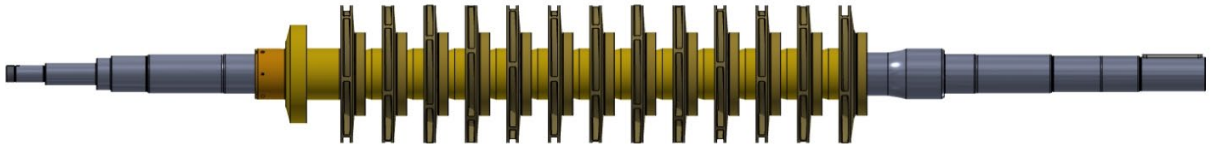
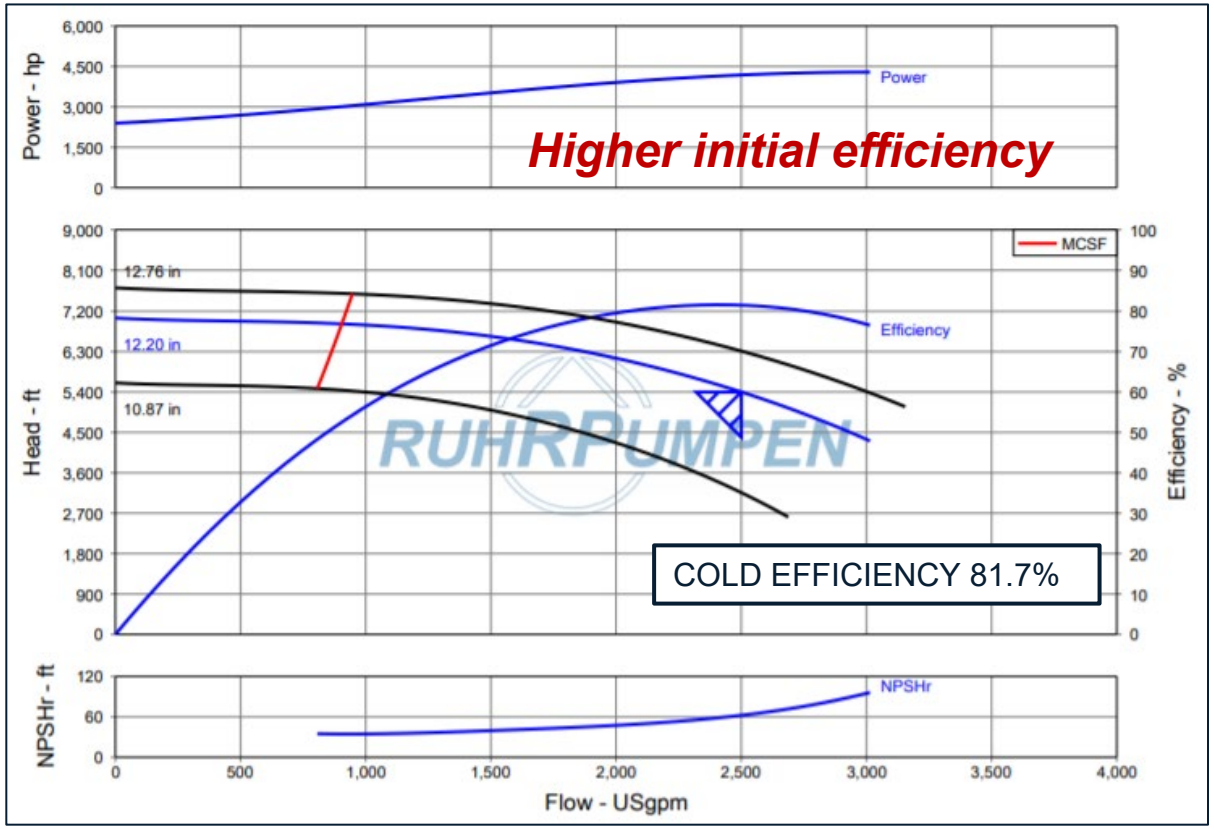
## High specific speed rotor

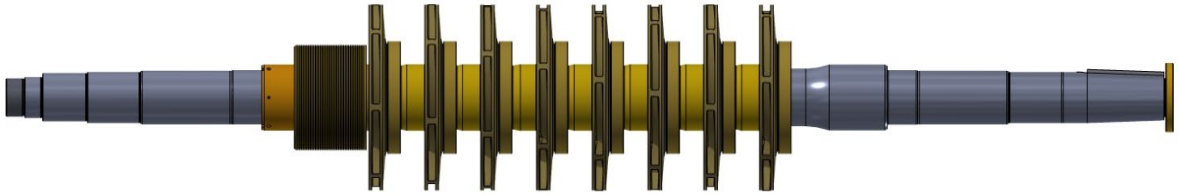
More slender shaft (smaller diameter and large number of impellers)

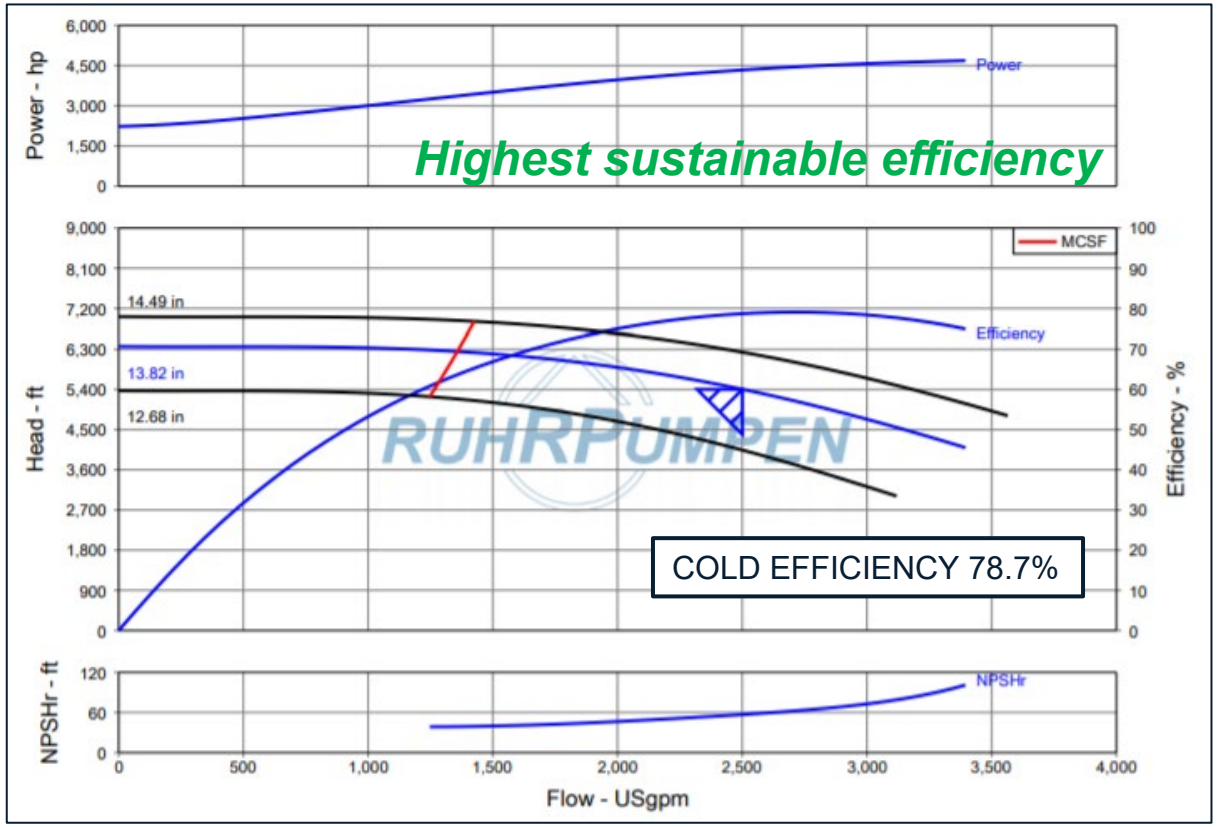





## Low specific speed rotor

Stiffer shaft (larger diameter and fewer impellers)





# APPROACHES TO BFW PUMP ROTOR DESIGN

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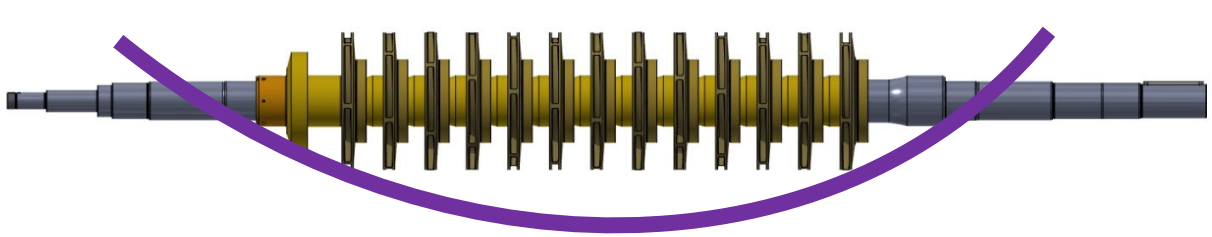
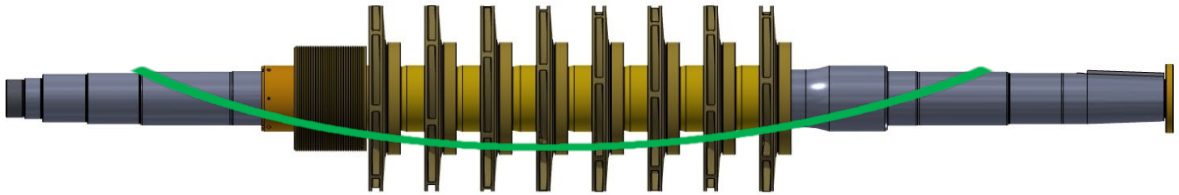
High specific speed (Ns) rotor



Low specific speed (Ns) rotor



**Longer/lower diameter shaft = Slender shaft**
**Less 'self supporting'**

- More shaft deviation (sag) at rest
- More dependent on Lomakin effect acting at close clearances to achieve critical speed margins and acceptable rotor deflections during running.
- When the shaft deviation at rest is greater than the running clearances, this results in contact between stationary and rotating wear parts at startup -> wear -> running clearances become quickly enlarged -> Increased recirculation -> efficiency is soon reduced compared with initial tested efficiency. Plus Lomakin forces reduce as the clearances wear.

**Shorter/higher diameter shaft = Stiffer shaft**
**More 'self supporting'**

- Less shaft deviation at rest
- Less dependence on Lomakin effect acting running clearances
- Non-contacting rotor maintains as-built clearances over a long period of operation time, hence sustaining initial efficiency for longer and extending MTBM.

# APPROACHES TO BFW PUMP ROTOR DESIGN

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## Lomakin Effect (very simplified!)

In any wear ring or bushing with pressure differential, there will be axial flow passing through the clearance.

If the rotating part moves away from the center of the stationary part, there will be different clearances on each side.

The side with the greater clearance will pass more flow than the side with the tighter clearances.

More flow passing through the clearance will result in locally higher velocity and hence the effective local pressure will be lower.

This affect tends to be stabilizing.  The force of lower pressure on the side with larger clearance and higher pressure on the side with tighter clearance makes the rotating part want to move back toward the center.

In effect, the wear ring or bushing becomes a stable bearing. This reduces the chance of a rub, even with a flexible rotor.

BUT NOT AT START-UP AND RUN-DOWN! This is when wear rings and bushings might touch.

# APPROACHES TO BFW PUMP ROTOR DESIGN

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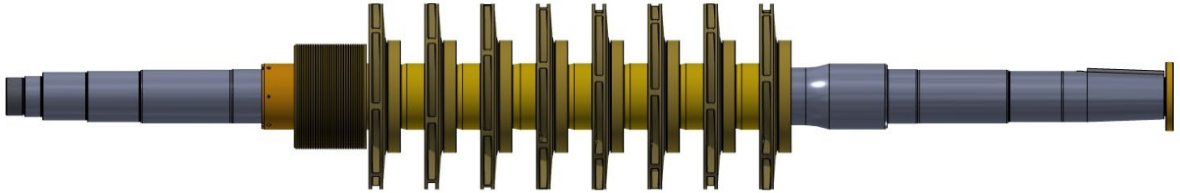
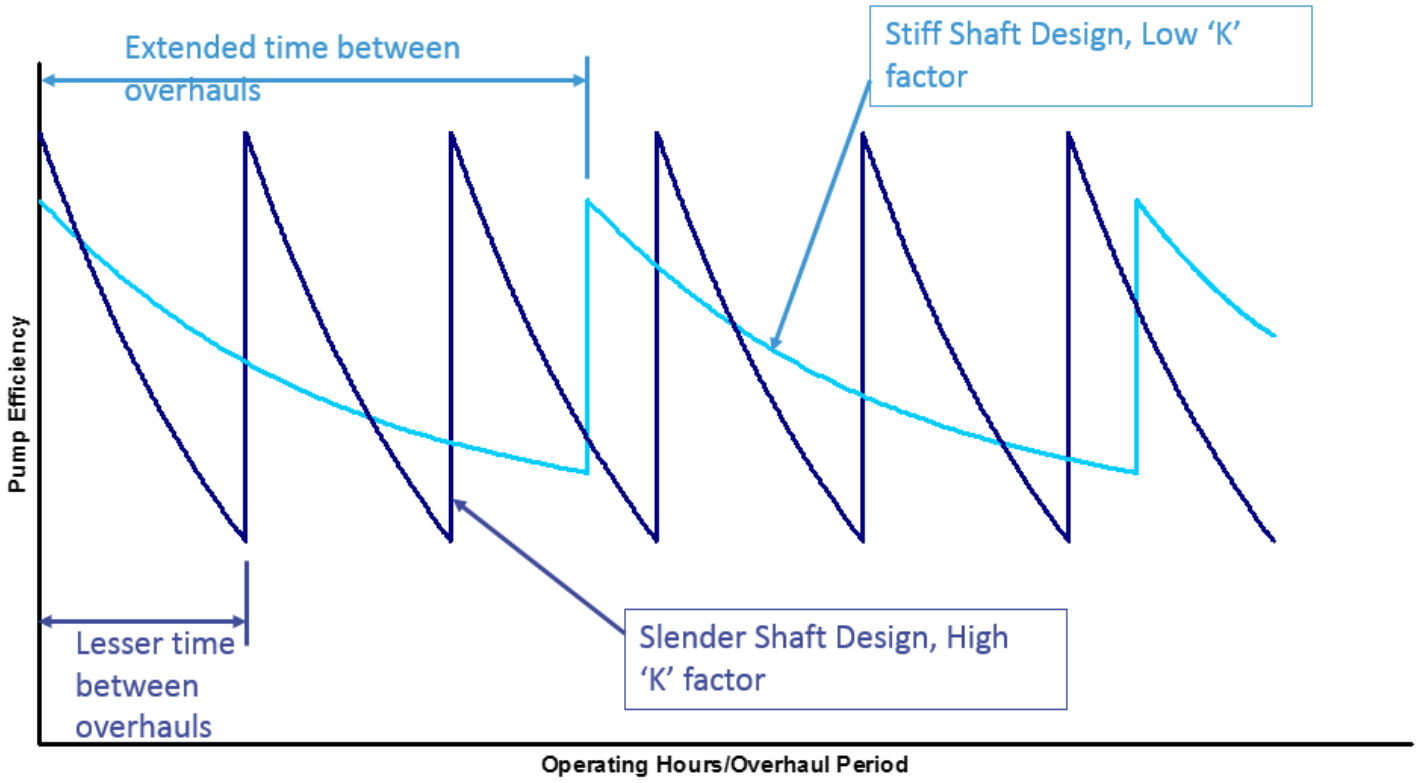
Stiff shaft, non-contacting design






"For the highly demanding Boiler Feedwater Pump service, Ruhrpumpen is focused to provide a stiff shaft, non-contacting pump with long MTBM and which maintains its efficiency over a long period of time and has a longer mean time between maintenance = lower maintenance cost in the long term".

Based on our API 610 BB5 rotor design , Ruhrpumpen 'GP' pump is a heavy duty, robust pump that withstand the rigorous demands of the combined cycle power plant.

# DUNCAN AND HOOD DIAGRAM

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**Shaft stiffness :**
**" K " Factor**

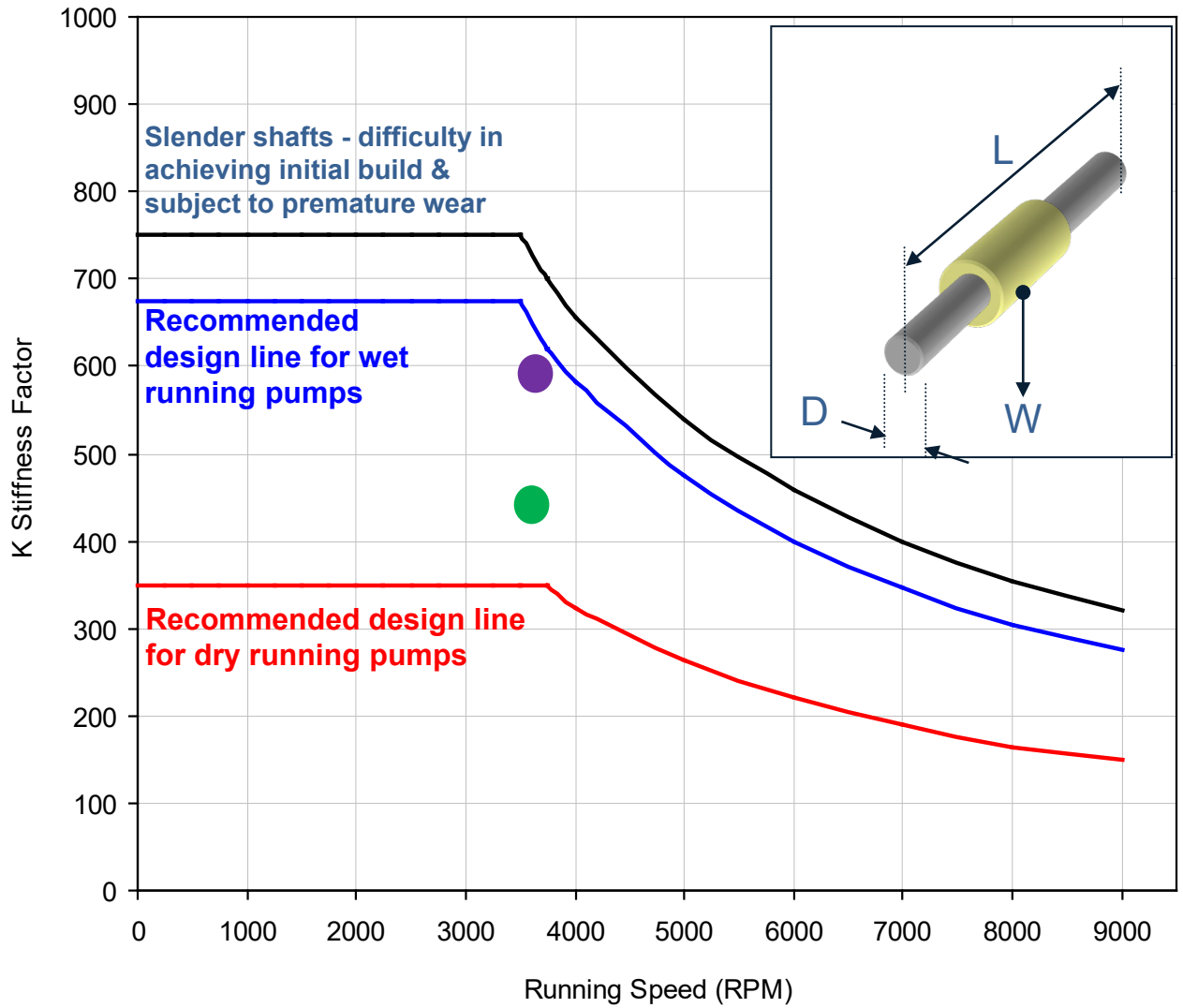
Parameters considered :

L = Shaft length (mm)
W = Load (N)
D = Diameter (mm)

$$K = \frac{L^{3/2} \times W^{1/2}}{D^2}$$

Looking at the equation for 'K' factor it can be seen that lower 'K' factors are achieved with shorter shaft length (bearing span), reduced mass of components (impeller(s)) and larger basic shaft diameter.

Low 'K' factors represents high stiffness of the rotor which equates to high critical speed margins and low deflections.



### 4.2.2.11 Pump Type BB4

Single-casing, radially split, multistage, between-bearings pumps shall be designated pump type BB4 (Figure 10). These pumps are also called ring-section pumps, segmental-ring pumps, or tie-rod pumps. These pumps have a potential leakage path between each segment. (This type does not meet all the requirements of this standard; see Table 3.)

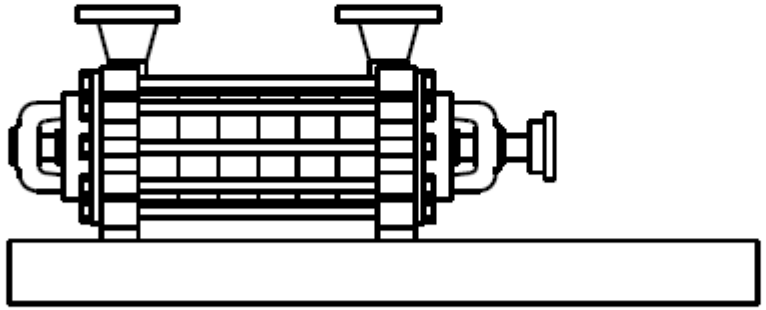


Figure 10—Pump Type BB4

# API vs NON-API Design

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| Typical for Boiler Feedwater Applications<br>RP Standard Design | What would be required for API 610 |
|---|---|
| Threaded Casing Connections | Integrally Flanged Casing connections |
| Balance disk or drum is available with appropriate bearing selections (see slides regarding bearing selection) | Balance Drum only with appropriate bearing selections (see slides regarding bearing selection) |
| RP standard clearances | API Clearances |
| Options for:<br>• Stacked rotor design with staggered keyways<br>• Stepped rotor design with light interference fit | Stepped rotor design of stiffness class „large shaft wet running“. Individually secured impellers by split ring |
| Options for:<br>• Straight bore shaft end allows standard coupling hub<br>• Straight bore keyed, tapered 1:16 keyed and tapered 1:24 hydraulic fit shaft end are available. | Tapered 1:16 keyed or 1:24 keyless hydraulic fit shaft end |
| Mechanical Seals do not have to be according to API 682 | Mechanical Seals according to API 682 |
| Seal piping comprised of tubing | Seal piping per API 610 |
| Non API Baseplate | API Baseplate |
| Testing tolerance – as specified by customer or RP | Testing tolerance/requirements per API 610 |
| Lube Oil System can be standard industrial design | Lube Oil System shall follow appropriate API standards |

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# Ruhrpumpen BB4 Pump – “GP”

The GP pump is a diffuser type, horizontal, multi-stage, between bearings, ring section pump-type BB4. It is engineered to be the most reliable and exceptional pumping solution for the most demanding high-pressure and high temperature applications across many industries.

Its compact design, together with high efficiency hydraulics, provides superior performance and exceptional reliability combined with easy maintenance and minimal operating costs.

# HYDRAULIC DESIGN

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Designed for speeds up to 2 poles - 50 Hz/60 HZ design

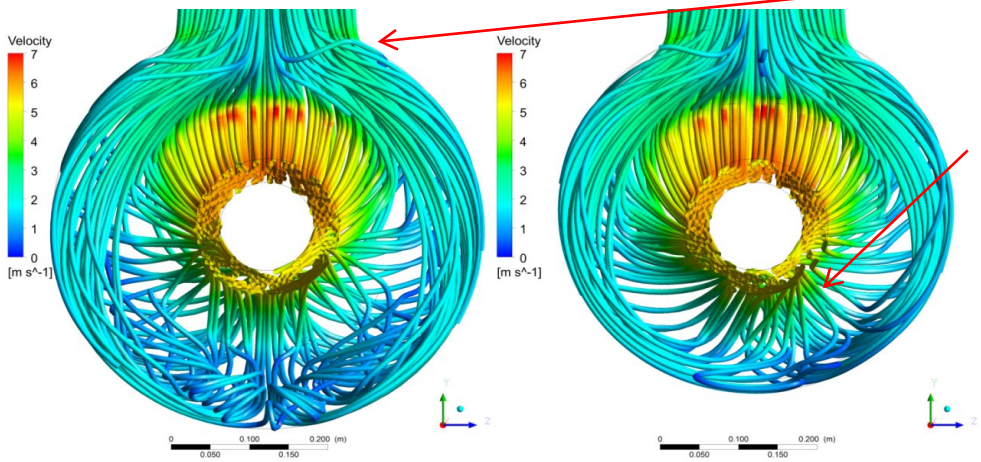
Wide range of hydraulics (A and B impellers for same casing are available to cater to different flow/head requirements with optimum efficiency)

Optimum NPSH performance with special, low NPSH first stage available

Specially designed stages to accommodate interstage take-off flow

# HYDRAULIC DESIGN

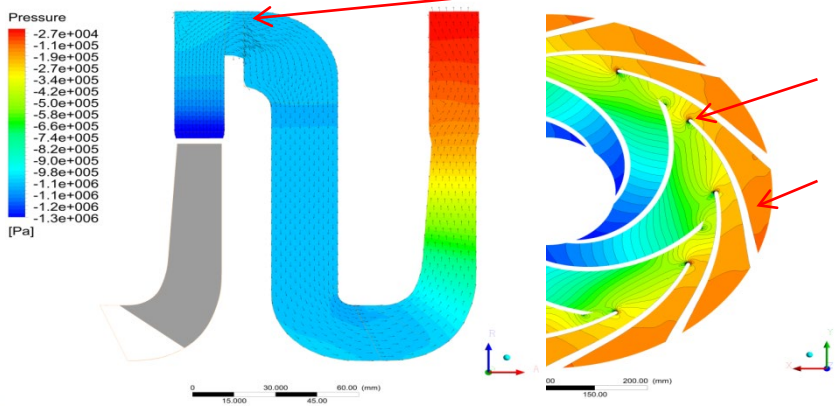
## Flow simulation and optimization of the suction chamber with CFX *




flow optimization in the transition to the suction chamber (vortex reduction)

flow alignment in the suction chamber
(reduction of turbulence losses)

## Verification of impeller and return stage design with CFX *




Minimizing flow separations

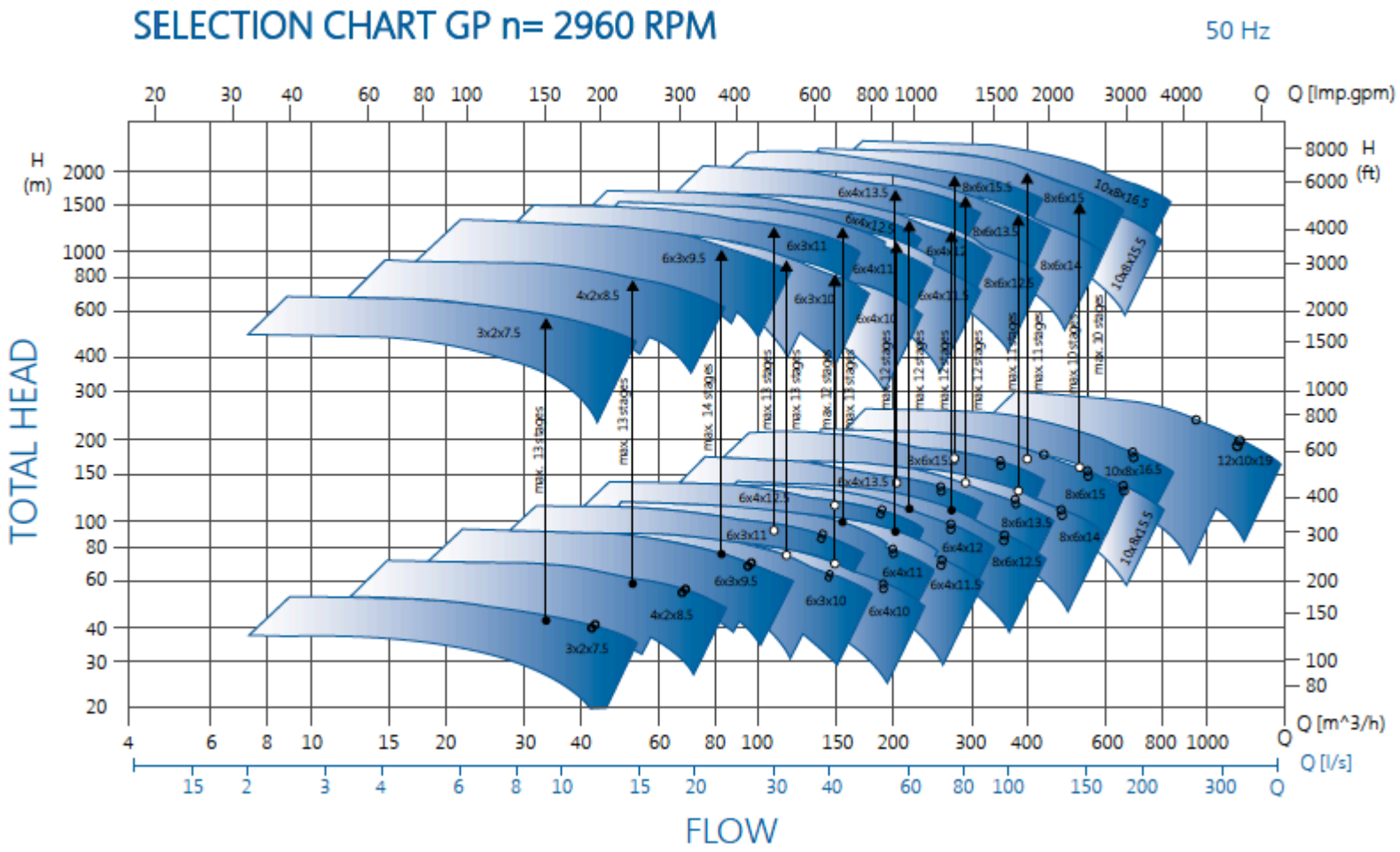
adaptation of inlet angle

continously rising pressure



* computational fluid dynamics (CFD) software program by Ansys

# GP RANGE CHART



# GP RANGE CHART

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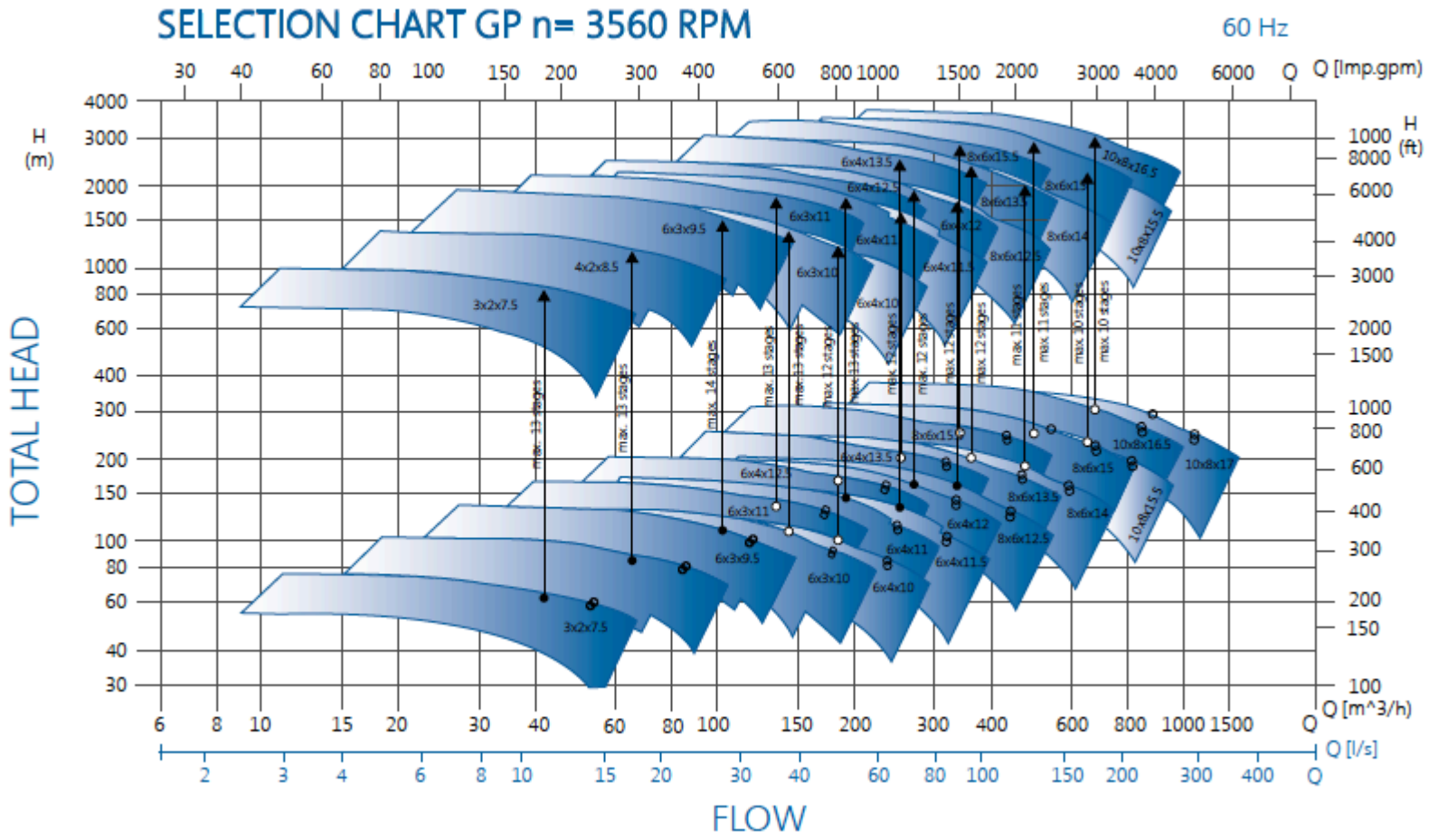


# MECHANICAL DESIGN

Design with typical features for Industrial Services

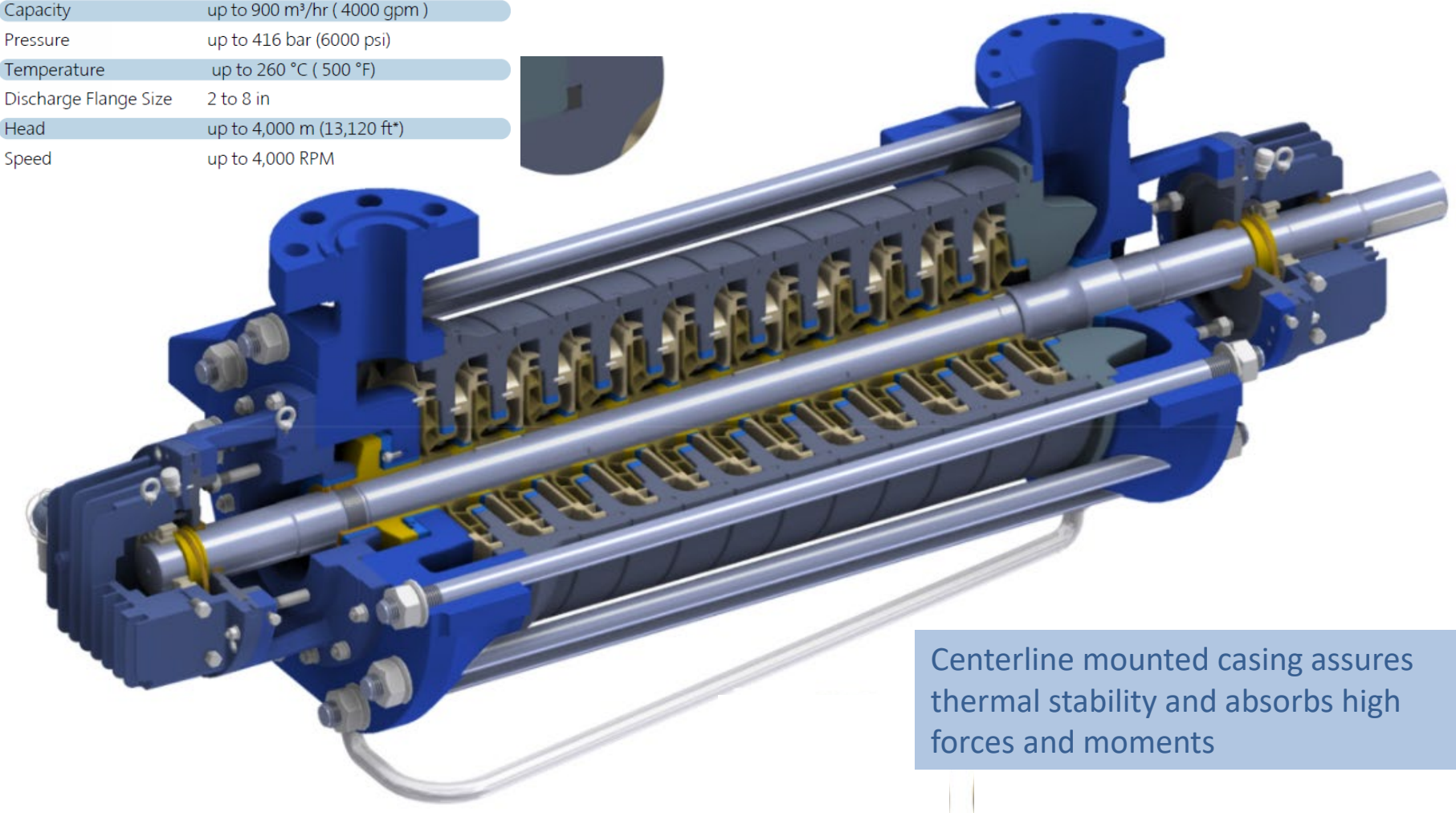
Design with typical features for Power Market Applications

Design with typical features for API 610 Applications

# GP PUMP

## PERFORMANCE DATA

| | |
|---|---|
| Capacity | up to 900 m³/hr ( 4000 gpm ) |
| Pressure | up to 416 bar (6000 psi) |
| Temperature | up to 260 °C ( 500 °F) |
| Discharge Flange Size | 2 to 8 in |
| Head | up to 4,000 m (13,120 ft*) |
| Speed | up to 4,000 RPM |



Centerline mounted casing assures thermal stability and absorbs high forces and moments

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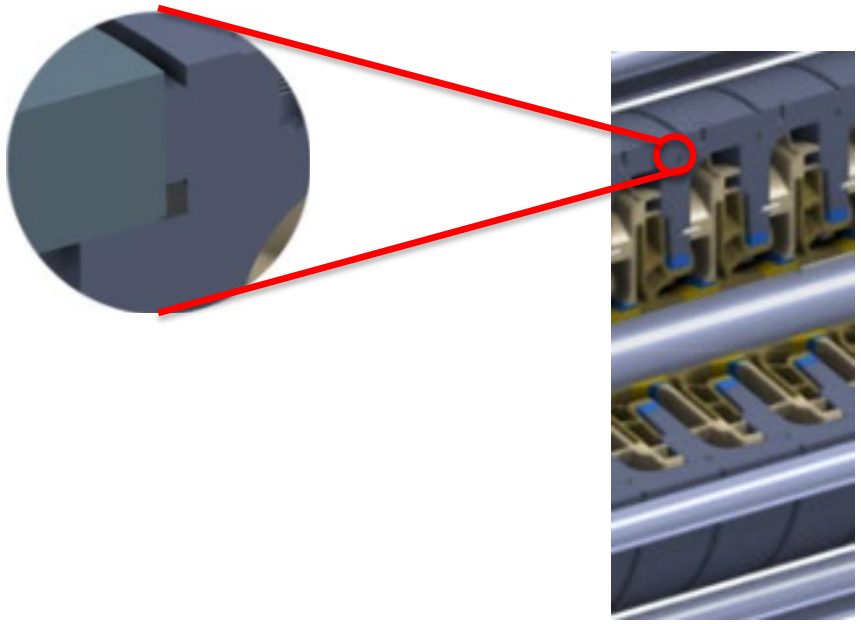
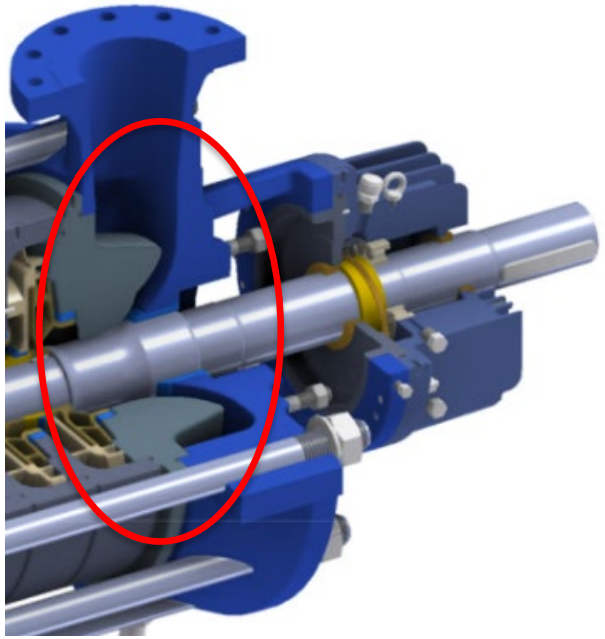
Casings are sealed with elastomeric o-rings suitable for rapid temperature variations. Elastomers are confined in grooves and therefore not subject to shear forces and so are less likely to be damaged during assembly and disassembly

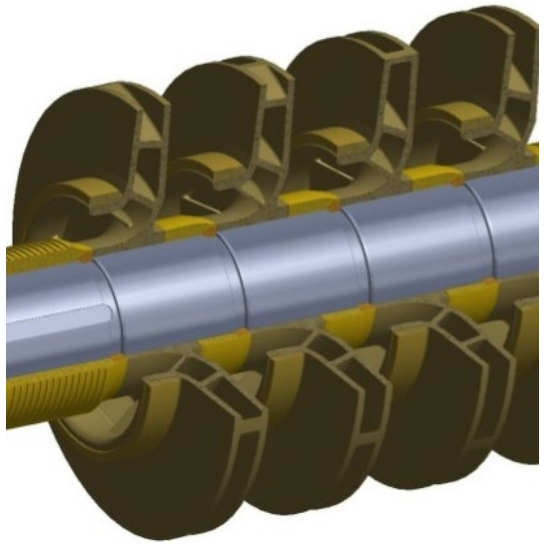


## CASING



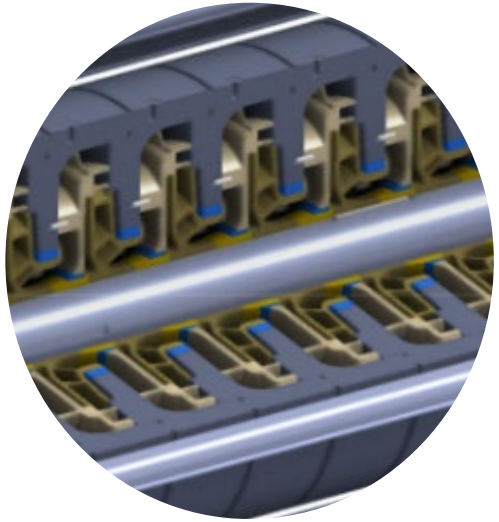
Suction chamber with inlet channel ensures optimum flow distribution

# IMPELLERS AND ROTOR



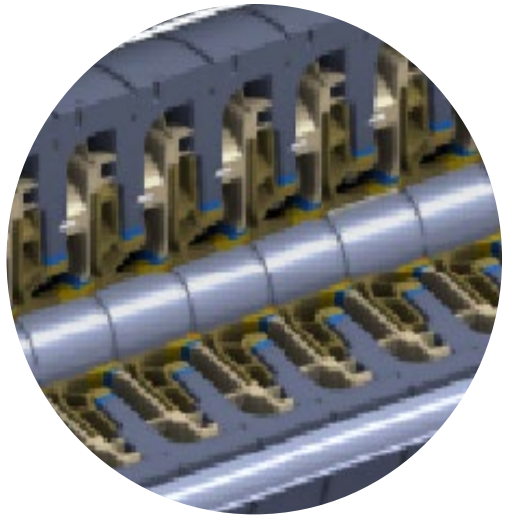
- Closed, single suction impeller design
- Investment casting offers best efficiency and repeatability of hydraulic data
- Keyed to shaft
- Impellers and complete rotor balance to G 2.5 of ISO 1940 (~8w/n) (G 1.0 ~4w/n is optional)
- First stage impeller design for low NPSH is available
- Inline rotor arrangement

# IMPELLER MOUNTING AND SHAFT



**TYPICAL FEATURE FOR POWER MARKET DESIGN**

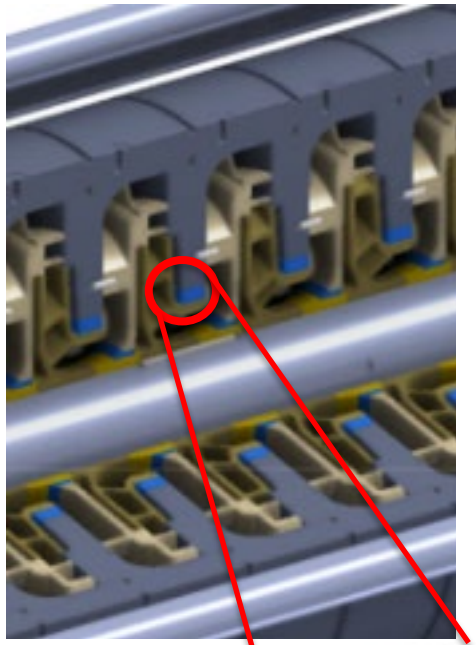
Stacked rotor design with
staggered keyways

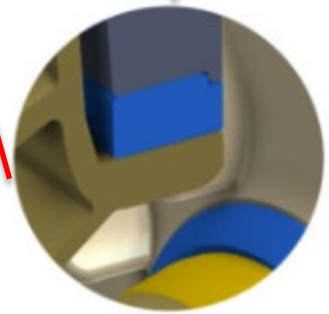


**TYPICAL FEATURE FOR API 610 PUMP DESIGN**

Stepped rotor design with light
Interference/transition fit allows easy
assembly and disassembly.
Individually secured impellers by split ring

# WEARING PARTS

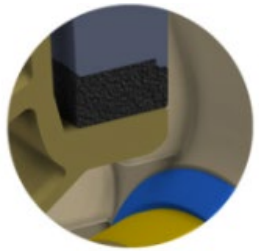




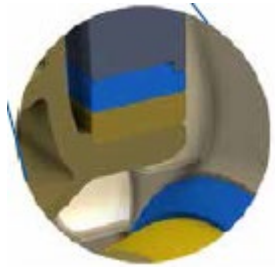
Stationary casing wear rings and interstage bushings are standard

**OPTIONAL FEATURES**

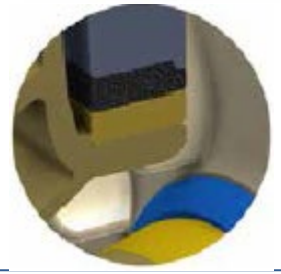
- Non-metallic casing wear rings with reduced clearances for enhanced efficiency



- Replaceable impeller wear rings



- Optional non-metallic casing wear rings + replaceable wear rings with reduced clearances for enhanced efficiency



# BEARING HOUSING

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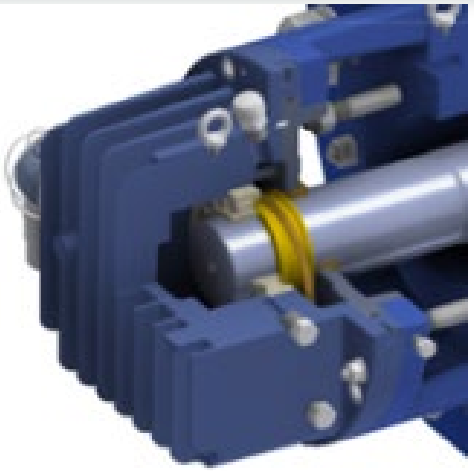
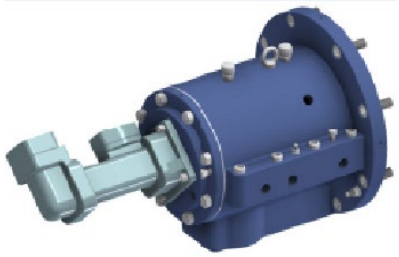
- Rigid, 360° bearing support ensures low vibration
- Clamped bearing cover without screws provides better access to the seals
- Bearing housing with vertical fins provides optimal cooling
- Radial bearing - single row cylinder roller anti-friction with splash oil lubrication and constant level oiler is standard
- “Inpro” bearing isolator



## OPTIONAL FEATURES



Shaft driven main oil pump for forced feed lubrication (API 610 is standard with API 614 optional available)

- Oil Mist lubrication
- Water cooled bearing housing
- Radial sleeve bearings for higher loads
- Thrust bearing where required
- Double acting tilting pad thrust bearing with radial sleeve, axial split hydrodynamic bearing with forced feed lubrication in high power applications.

# HYDRAULIC BALANCING

# PURPOSE OF BALANCING DEVICES

- In any centrifugal pump, the rotor tends to produces some amount of thrust because of different pressures and different geometries on the two sides of the impeller. This thrust is handled by the pump thrust bearing.
- In a high pressure multi-stage pump (such as BFW) the number of impellers is high, thus the net thrust would be large (putting high load on thrust bearings) unless something is done to reduce it.
- Main ways to reduce the net thrust are to oppose the impellers (for example AB pump) or to use a balance disk/drum (for example in GP pump)
- The balance device (disk or drum) is located after the last stage so it has full discharge pressure on one side. On the other side the balance line is routed back to the suction.
- The main between a balance disk and a balance drum is whether the pressure drop is across a radial clearance (drum) or an axial face (disk).

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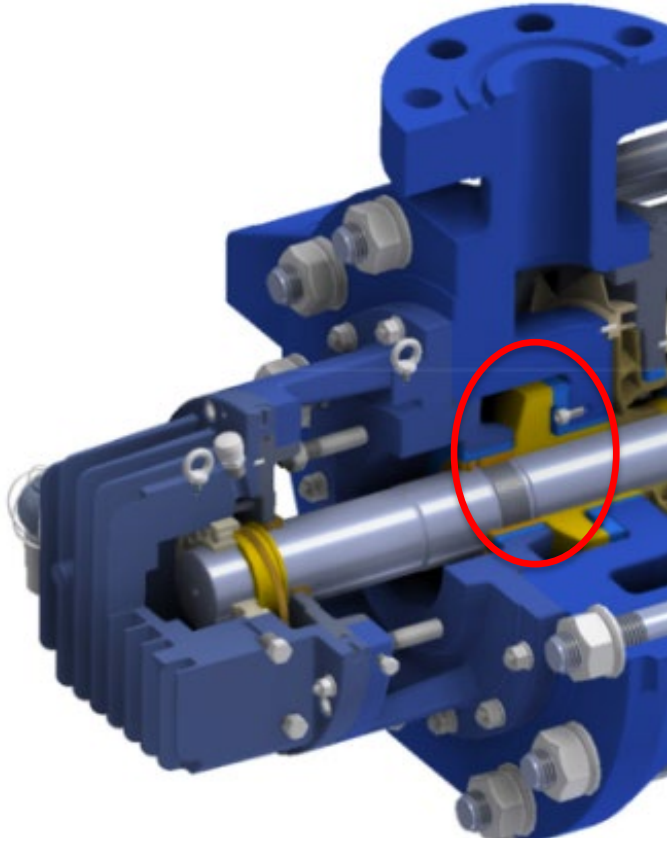
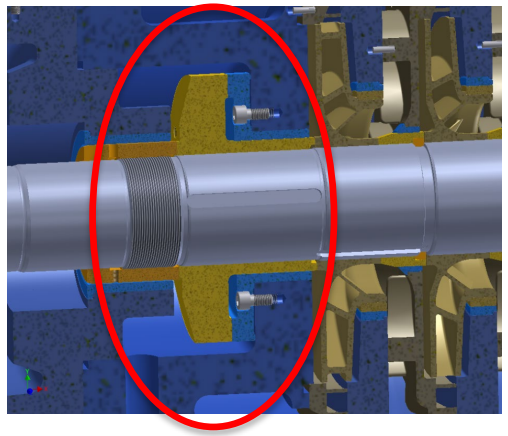
# BALANCE DISK



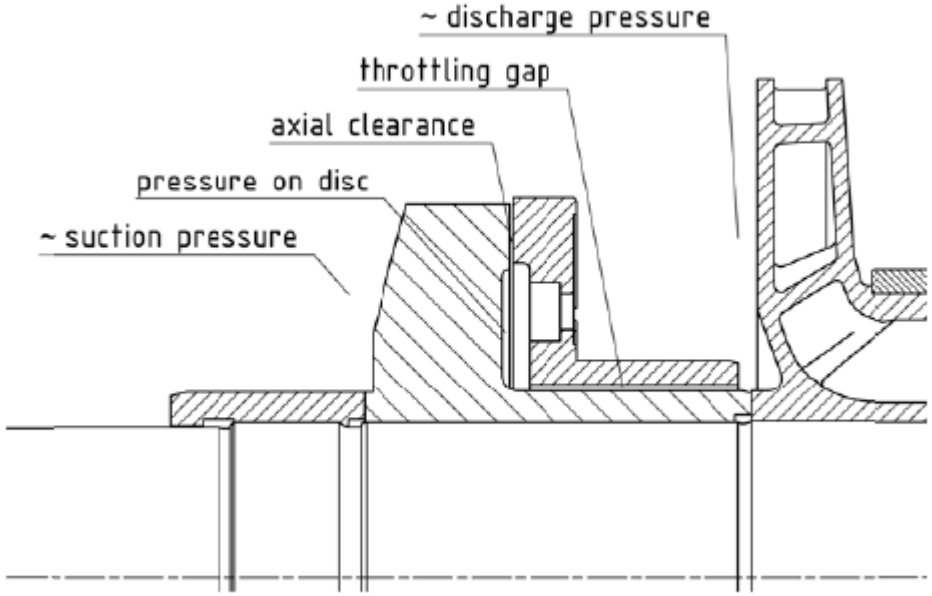
- Uses a close axial clearance to compensate 100% of the axial thrust across the complete pump operating range therefore removing the need for a thrust bearing
- Self adjusting because the clearance increases and decreases with the axial position of the impellers and shaft based on the actual thrust produced
- Suitable for applications with non-abrasive pumping fluid and constant pressure



- Highest efficiency balancing method because this has the lowest leakage rate
- Accurate axial rotor setting during assembly is important because there is a risk of contacting of pump and disk

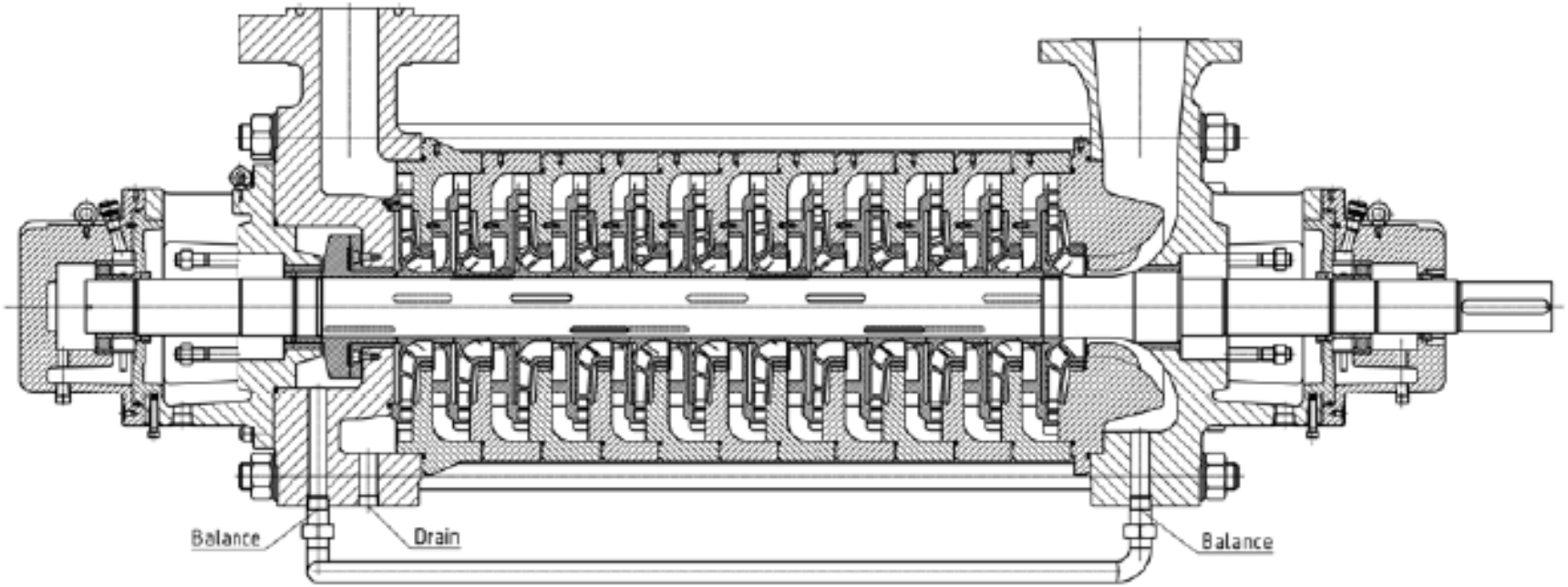
# BALANCE DISK

- Available for GP pump
- Clearance is in range 50-100 µm
- Suitable for use in:
  - Non-API applications
  - Non-abrasive process fluids
  - Applications without frequent pressure changes
  - Applications without frequent transient conditions such as pressure drops
  - Applications with head > 160m



# SECTIONAL DRAWING OF GP PUMP SHOWING BALANCE LINE AND BALANCE DISK

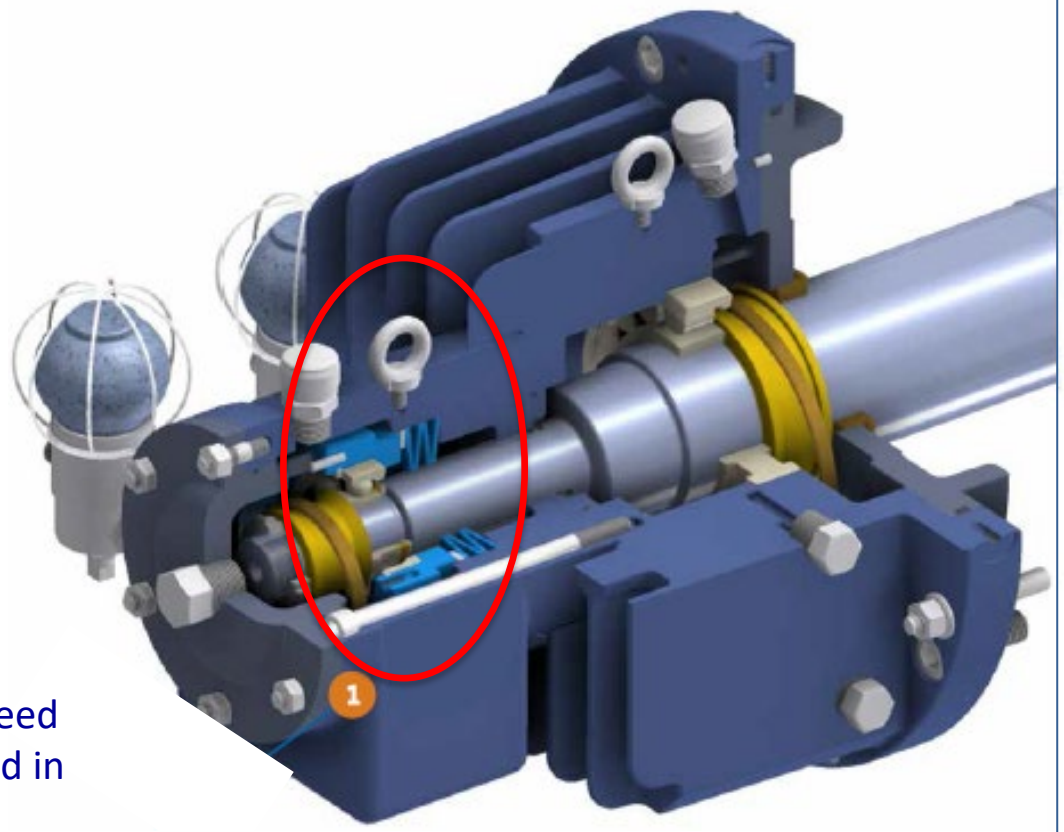
RUHRPUMPEN
Specialist for Pumping Technology



# LIFT OFF DEVICE

**FEATURE FOR POWER APPLICATIONS WITH FREQUENT START/STOP OR LOW SPEED**

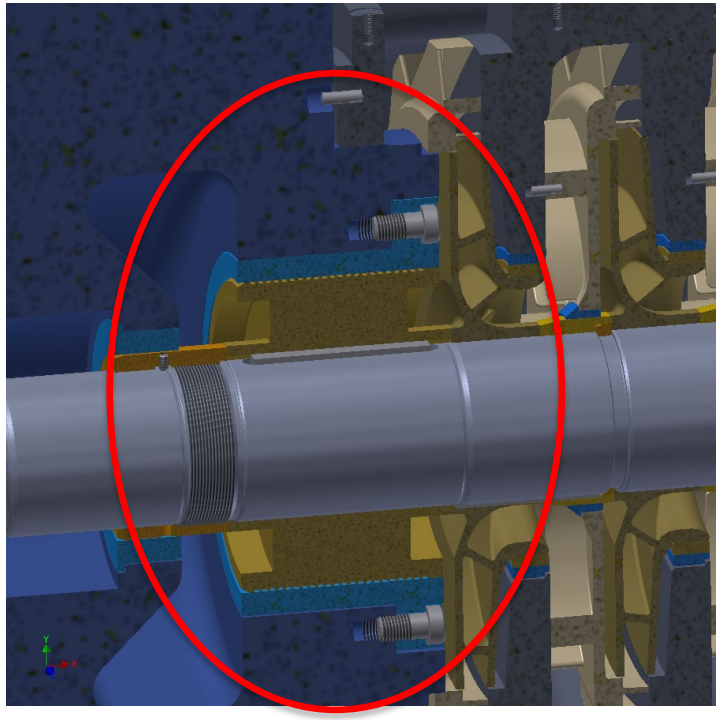
- Optional feature to work alongside balance disk
- The lift-off device ensures that the balancing disk is open during the rest, start-up and run-down of the pump by means of preloaded springs and an angular contact ball bearing.
- It is required in applications with frequently start and stop and/or operating speed below 1000 rpm
- Frequent start-stop is often seen in Boiler Feed Applications, so this feature is often required in pumps for such Power Plants



# BALANCING DRUM

**REQUIRED FEATURE FOR API 610 COMPLIANT PUMPS**

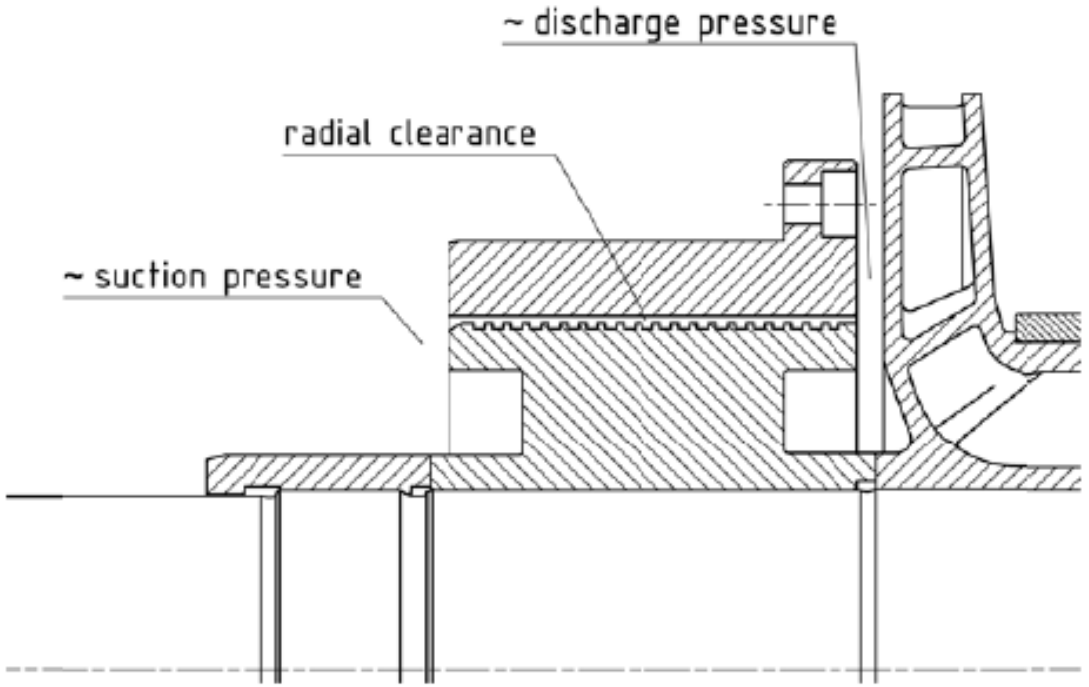
- Unlike the balancing disk the balancing drum has a constant radial clearance set by the pump design
- Balances large proportion (85-90%) of generated axial forces at the rated operating point
- Residual forces are handled by a thrust bearing which retains the rotor axial position
- Constant clearance allows the use of a balancing drum in all applications and it provides high reliability in applications with transients such as start up and run down, temperature changes, frequent starts and stops



- Used for API 610 pumps because the standard precludes thrust balancing by use of axial clearances (API 610 11$^{th}$ edition 6.7.1) so balance disk cannot be used

# BALANCING DRUM

- Available for GP pump
- Slightly reduced efficiency compared with balance disk due to marginally higher leakage rates
- Easy and safe axial rotor setting due to radial clearance (compared with more critical rotor setting for balance disk method with axial clearance)



# BEARING SELECTION

# AVAILABLE BEARING SELECTIONS WITH BALANCE DISK

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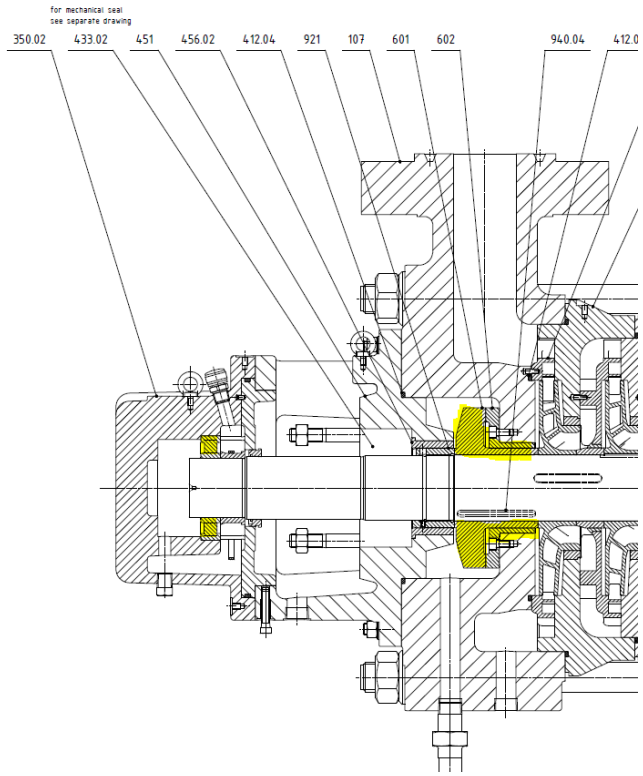
Specialist for Pumping Technology

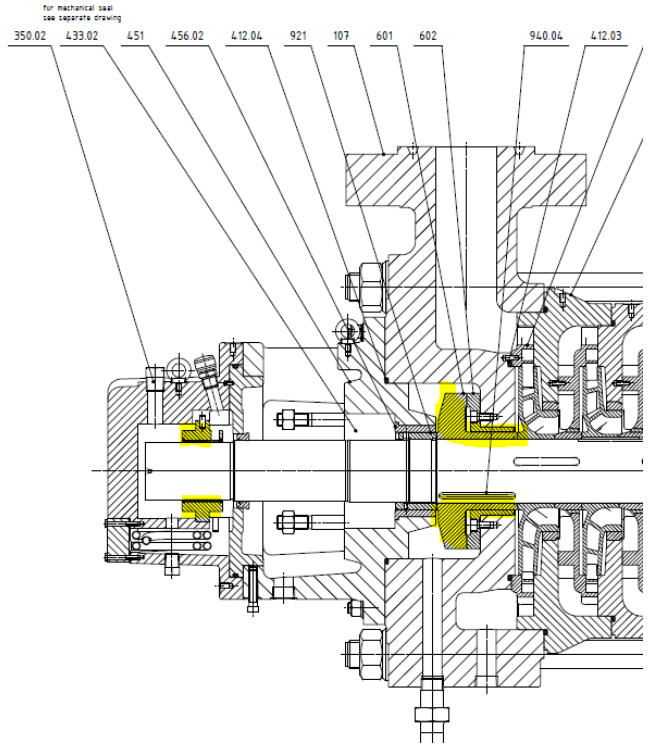
## Antifriction

- DE/NDE: Single row, cylindrical roller bearing (no thrust bearing required)
- Lubrication: Ring oil lubrication with Constant Level Oiler and Sight Glass [Option for Oil Mist]




## Hydrodynamic

- DE/NDE: Radial Sleeve bearing (no thrust bearing required)
- Lubrication: Ring oil lubrication with Constant Level Oiler and Sight Glass
- Cooling: Water cooling coil

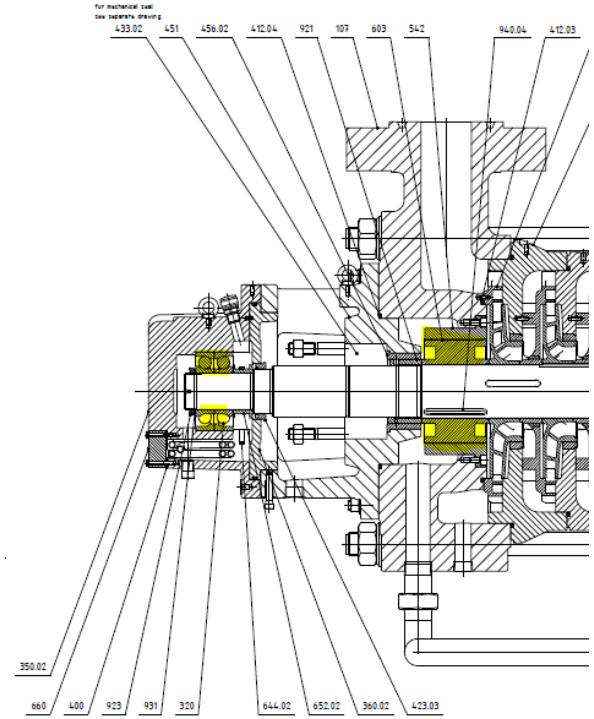


# AVAILABLE BEARING SELECTIONS WITH BALANCE DRUM

RUHRPUMPEN
Specialist for Pumping Technology

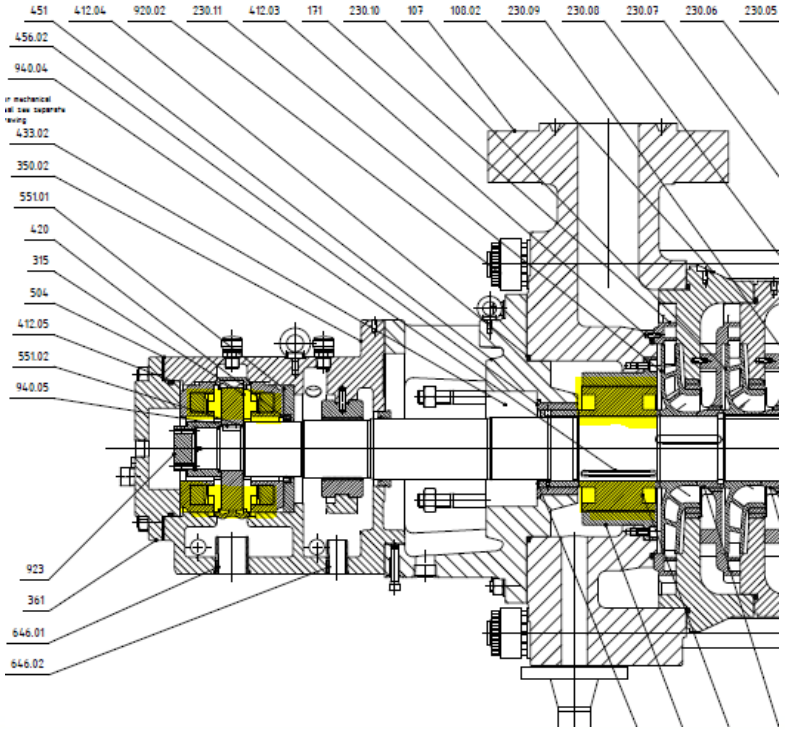
## Antifriction

- DE: Single row, deep groove ball bearing
- NDE: Paired back to back, single row, angular contact ball bearings
- Lubrication: Ring oil lubrication with Constant Level Oiler and Sight Glass [Option for Oil Mist]



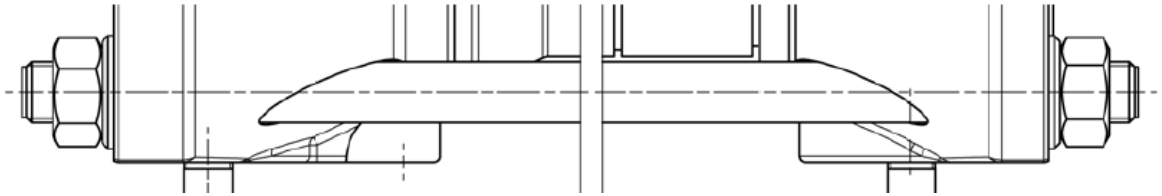

## Hydrodynamic

- DE: Radial Sleeve Bearing
- NDE: Radial Sleeve and double acting tilting pad thrust bearing
- Lubrication: Forced Feed Lubrication



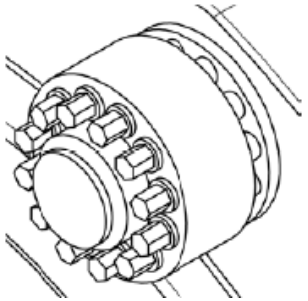
# TIE RODS AND BOLTING

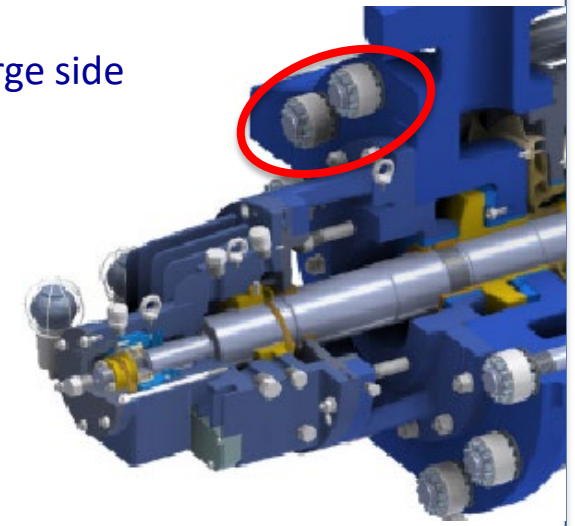
Pump casings held together by tie rods and hexagonal bolts with washers



**FEATURE FOR HIGH PRESSURE PUMPS, APPLICATIONS REQUIRING COLD START AND LARGER PUMP SIZE**

- Ruhrpumpen uses multiple screw mechanical tensioners on the discharge side of the pump (for example „Superbolts“)





# MULTIPLE SCREW MECHANICAL TENSIONERS –SUPERBOLTS*

**What is Superbolt?**

Superbolt tensioners are designed as direct replacements for conventional nuts and bolts. These devices can be threaded onto a new or existing bolt, stud, threaded rod or shaft. The main thread serves to position the tensioner on the bolt or stud against the hardened washer and the load bearing surface. Once it is positioned, actual tensioning of the bolt or stud is accomplished with simple hand tools by torquing the jackbolts which encircle the main thread. The jackbolts transfer the preload evenly into the main thread and, consequently, onto the joint. The main thread is tightened in pure tension.


*How Superbolt tensioners work:*

**1)** By tightening the jackbolts, a strong thrust (axial) force is generated. This thrust force is directed against a hardened washer. Jackbolts have a small friction diameter and can therefore create a high thrust force with relatively little torque input.

**2)** The loads are transferred through the nut body which is positioned on the main thread by hand.

**3)** A hardened washer is used to transfer the force while protecting the flange face.

**4)** The thrust (axial) force of many jackbolts and the opposite reaction force of the main bolt head create a strong clamping force on the flange.

**5)** The thrust (axial) force from the jackbolt creates an equally strong reaction force in the main bolt.

*The Superb*

**Proven in the field**

Superbolt tensioners are used in many industries: Hydropower, wind turbines, gas and steam turbines, nuclear, steel, mining, shipbuilding, offshore, chemical, transportation, to name a few.

## Benefits

- Pure tensile load on tie rods – absence of axial stresses allows higher capability of the rods
- Ensures uniform tightening on all tie rods
- Tie rod elongation can be measured as the gap between the nut body and the washer, giving additional verification of the tightening torque used
- Allows bolt tightening by use of simple hand tools (no need for heavy hydraulic tool) meaning that re-assembly is faster and more simple in the field and no special tools needed

* Trade Mark - Nordlock Group

# MULTIPLE SCREW MECHANICAL TENSIONERS – SUPERBOLTS *

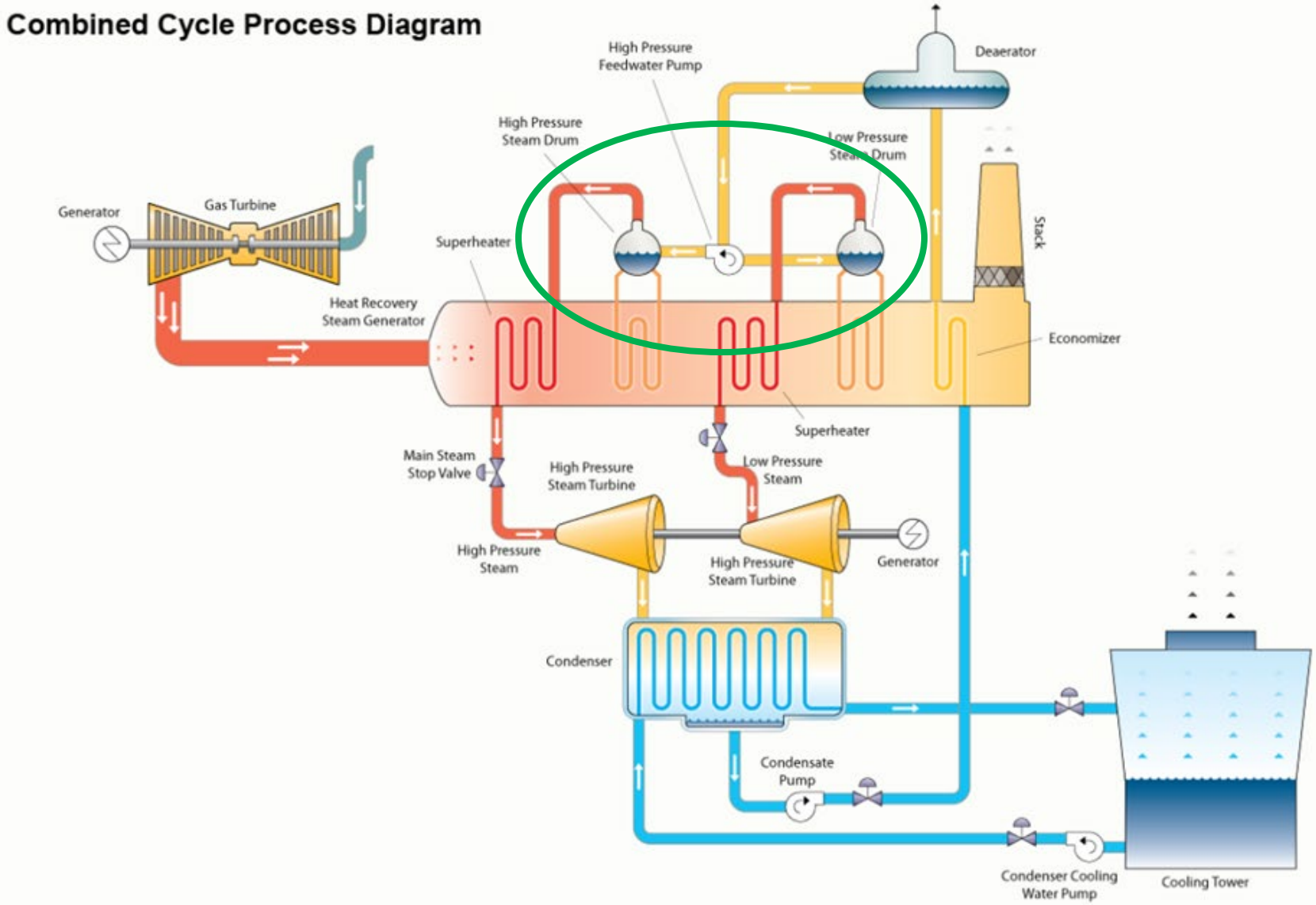

https://www.nord-lock.com/superbolt/products/superbolt-tool/

* Trade Mark - Nordlock Group

# INTERSTAGE TAKE-OFF

**TYPICAL FEATURE FOR POWER PLANT APPLICATIONS WHERE IS IT REQUIRED TO SUPPLY LOW AND MEDIUM PRESSURE DRUMS**

- 1 or 2 interstage take-off nozzles can be provided to supply flow of process fluid at less than full discharge pressure
- Nozzle is welded to appropriate stage casing that provides the needed pressure
- Special stage casings/impellers designed to handle additional flow

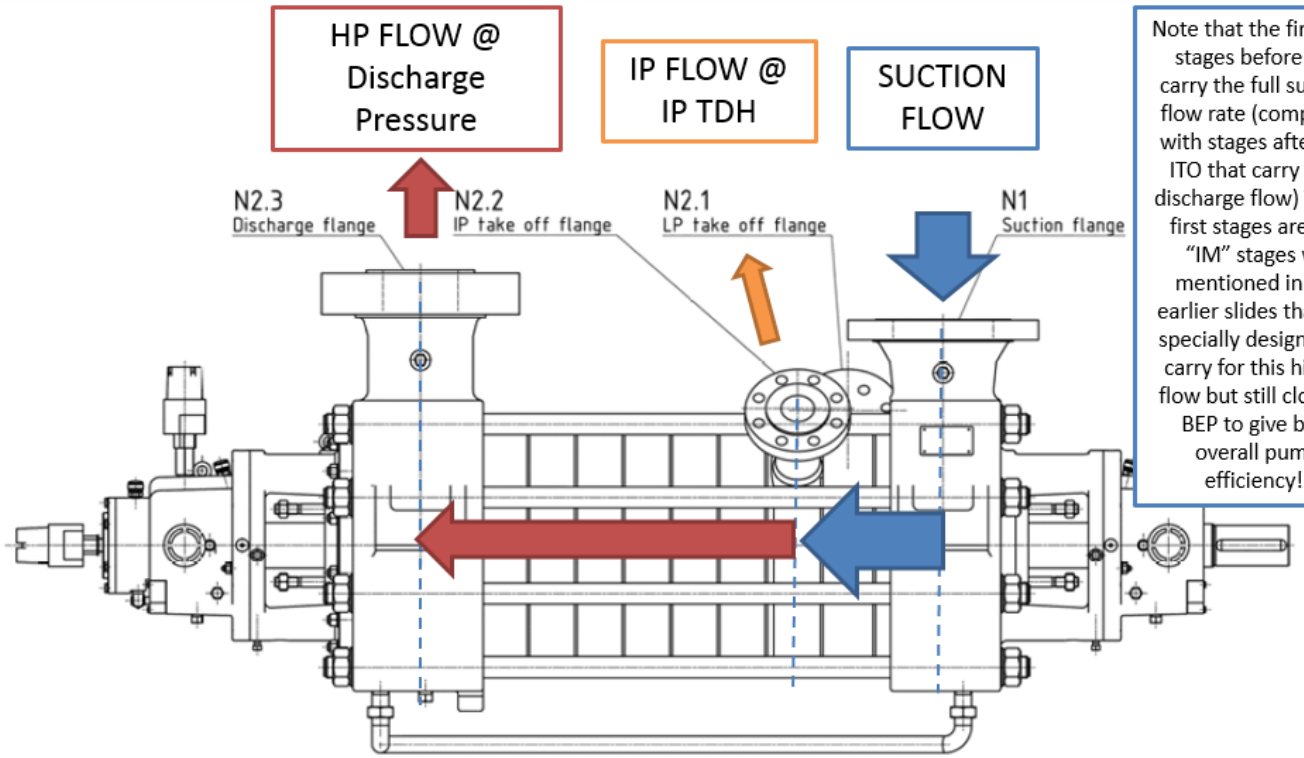

Combined Cycle Process Diagram
High Pressure Feedwater Pump
Deaerator
High Pressure Steam Drum
Low Pressure Steam Drum
Generator
Gas Turbine
Superheater
Stack
Heat Recovery Steam Generator
Economizer
Superheater
Main Steam Stop Valve
High Pressure Steam Turbine
Low Pressure Steam
High Pressure Steam
High Pressure Steam Turbine
Generator
Condenser
Condensate Pump
Condenser Cooling Water Pump
Cooling Tower

# INTERSTAGE TAKE-OFF

The purpose of the interstage (ITO) take-off connection is to supply water to the HRSG at a lower pressure.

As the turbine exhaust gases travel through the HRSG heating the water in to steam the temperatures decline. At lower temperatures, lower pressure and flows are required within the tubes. Therefore an Intermediate Pressure (IP) takeoff increases the system efficiency by supplying the water at a lower pressure rather than reducing the discharge pressure of the pump.

1 or 2 interstage take-off nozzles can be provided to supply flow of process fluid at less than full discharge pressure



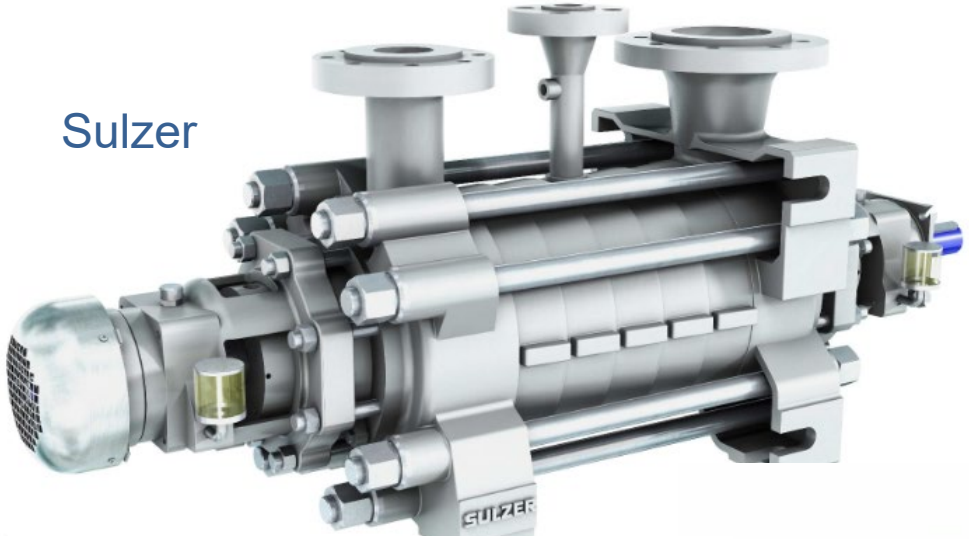

Note that the first few stages before ITO carry the full suction flow rate (compared with stages after the ITO that carry only discharge flow) These first stages are the "IM" stages we mentioned in the earlier slides that are specially designed to carry for this higher flow but still close to BEP to give best overall pump efficiency!!

***HP FLOW + IP FLOW = SUCTION FLOW***

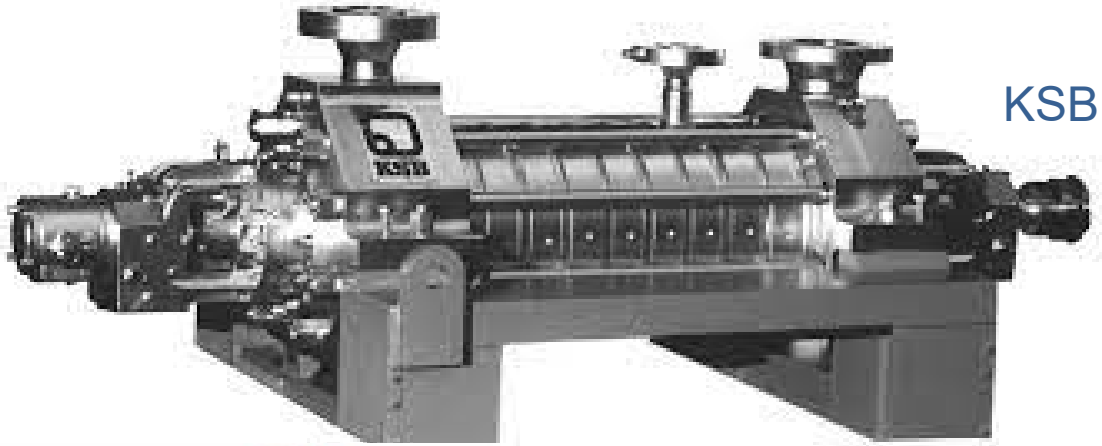
# WHO MAKES THEM?

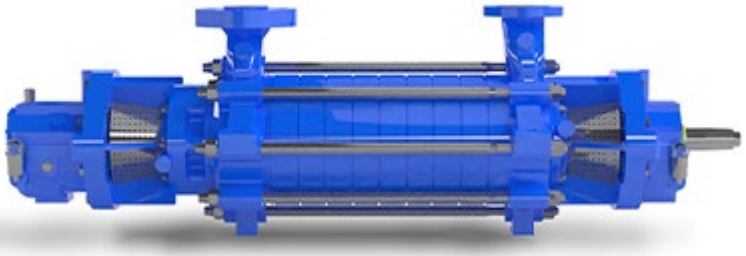
# Who Makes Them?

Sulzer

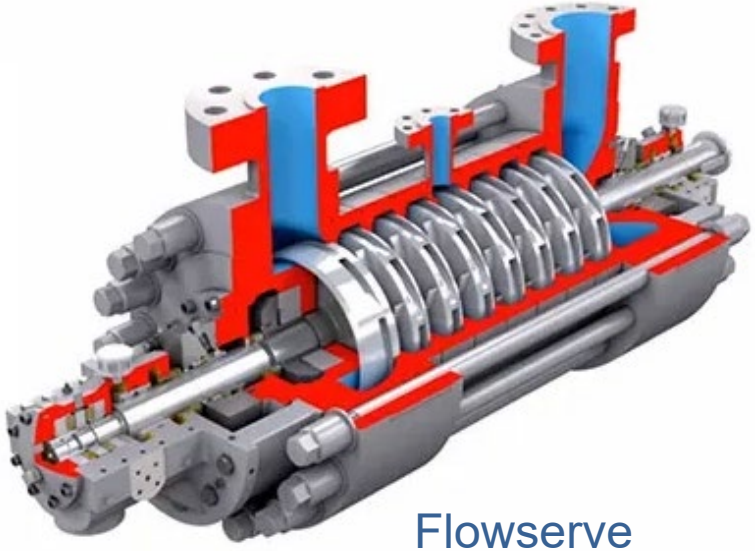



KSB

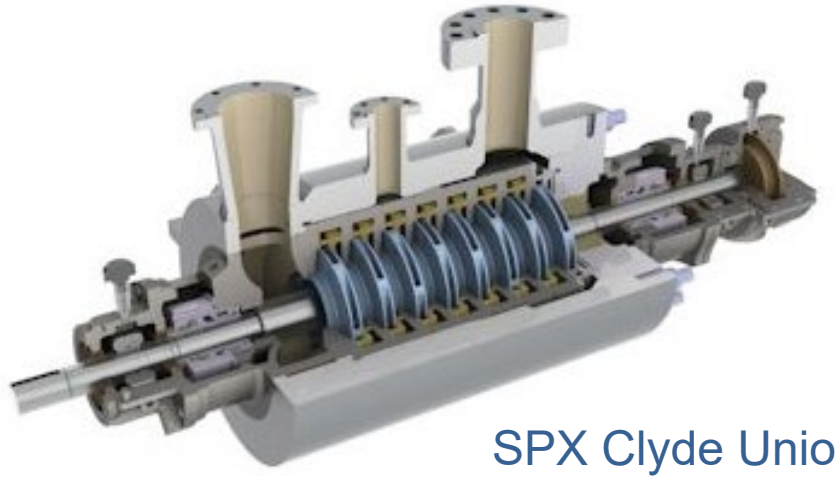


Ebara



Flowserve



SPX Clyde Union

# RUHRPUMPEN HAS A FULL RANGE OF COMPLEMENTARY PRODUCTS FOR POWER PLANT APPLICATIONS

Ruhrpumpen has a full range of pumps to meet all the stringent requirements of a high efficiency Combined Cycle Power Plant

- Condensate Pumps and Cooling Water Circulation
  - Services satisfied by Ruhrpumpen's vast hydraulic range of vertical pumps (in VS6 and VS1 configuration) available up to 108" bowl
  - Best-in-business Efficiencies

- Boiler Feedwater Pumps
  - BB4 – Ring Section Pumps – Ruhrpumpen Model GP
  - BB3 Type Volute Pumps

- Utility Pumps
  - BB1/2 - Split Case Pumps – Ruhrpumpen Model HS, ZW
  - Horizontal ANSI and large end suction
  - VS4 – Sump pumps – Ruhrpumpen Model VSP
- Fire Pumps
  - Bare pumps and Package systems including houses

# VERTICAL PUMP RANGE

RUHRPUMPEN
Specialist for Pumping Technology

## Single Suction Vertical Pumps

### APPLICATIONS

- Deep well
- Irrigation
- Sump
- Condensate
- Can pump requirements
- Fire service
- Municipal
- Industrial

### OPERATING LIMITS

- Capacity to 13,630 m³/hr (60,000 U.S. GPM)
- Head to 762 m (2,500 ft)
- Pressure to 74 bar (1,080 PSI)
- Temperature 121°C (250°F)

### RUHRPUMPEN NOMENCLATURE

- VTP
- HQ

## Circulating Water Pumps

### APPLICATIONS

- Power generation
- Condenser cooling water service
- Cooling tower service
- Flood service
- Storm water disposal
- Water treatment
- Primary water supply
- Waste treatment plants
- Industrial service
- Sump drainage

### OPERATING LIMITS

- Capacity to 90,850 m³/h (400,000 U.S. GPM)
- Head to 175 m (575 ft per stage)
- Pressure 10 bar (156 PSI)
- Temperature -30 to 135°C (-20 to 275°F)

### RUHRPUMPEN NOMENCLATURE

- TR
- HX
- KX
- MX
- RX
- SX
- VX
- WX
- VMF

## Double Suction Vertical Pumps

### APPLICATIONS

- Cooling towers and other applications requiring large volumes of liquid with relatively high head
- Raw water intake
- Pipeline booster pump

### OPERATING LIMITS

- Capacity 340 to 18,170 m³/h (1,500 to 80,000 GPM)
- Head 12 to 244 m (40 to 800 ft)
- Discharge flange size 10 to 48 in
- Maximum Pressure 19 bar (280 PSI)
- Temperature150°C (302°F)

### RUHRPUMPEN NOMENCLATURE

- DSV
- DX

## Vertical Condensate Pumps Type (VS6)

### CHARACTERISTICS AND DESIGN FEATURES

- HI design, cryogenic and API 610 latest edition (VS6) constructions available
- Low NPSH "shockless entry" first stage impeller
- Integral fabricated column support bearings
- One-piece shaft construction for shaft lengths up to 6 m (20 ft)
- Materials of construction per API 610 (other materials on request)

### APPLICATIONS

- Hydrocarbon processing
- Pipeline
- Refining
- Condensate
- Municipal water systems
- Molten salt applications

### OPERATING LIMITS

| | |
|---|---|
| Capacity | up to 45,000 gpm<br>up to 9,500 m³/h |
| Head | up to 4,900 ft<br>up to 1,494 m |
| Pressure | up to 2,020 psi<br>up to 140 bar |
| Temperature | up to 1,500 °F<br>up to 815 °C |

## Horizontal Volute Type (BB3)

### CHARACTERISTICS

- Axially split, horizontal multi-stage centrifugal pump
- Near-centerline mounted
- Double volute casing
- Single suction, enclosed impeller
- Double suction impellers for higher flows
- Thrust compensation by opposed impeller groups
- Side-Side nozzle arrangement
- Materials of construction per API 610, other materials on request

### RUHRPUMPEN NOMENCLATURE

- SM
- SM I

### APPLICATIONS

- Oil fields and terminals
- Crude oil and oil product
- Water pipelines
- Fluid injection
- High pressure services
- Power plants

### OPERATING LIMITS

- Capacity 50 to 3,000 m³/h (220 to 13,209 U.S. GPM)
- Head 200 to 3,000 m (656 to 9,843 ft)
- Discharge flange size 3 to 14 in
- Max. Pressure 420 bar (6,000 PSI)
- Temperature up to 205°C (400°F)

## Vertical Sump Pumps

### APPLICATIONS

- Water
- Hydrocarbons
- Process water
- River water
- Chemical solutions

### OPERATING LIMITS

- Capacity 3 to 1,931 $m^3/h$ (10 to 8,500 U.S. GPM)
- Head 3 to 130 m (10 to 425 ft)
- Max. Pressure 40 bar (580 PSI)
- Temperature 200°C (400°F)

### RUHRPUMPEN NOMENCLATURE

- VSP
- VSP CHEM

## End Suction Horizontal Pumps

### APPLICATIONS

- Petrochemical
- Oil & gas
- Steel industry
- Automotive
- Food processing
- Power generation
- Pharmaceuticals
- Water treatment
- General process

### OPERATING LIMITS

- Capacity to 1,150 $m^3/h$ (5,000 U.S. GPM)
- Head to 235 m (770 ft)
- Temperature -45 to 315 °C (-50 to 600 °F)
- Maximum Pressure up to 26 bar (375 PSI)

### RUHRPUMPEN NOMENCLATURE

- CPP
- IPP

## Between Bearing Horizontal Pumps

### APPLICATIONS

- Dewatering
- Mining
- Water
- Fire service
- Cooling towers
- Municipal
- Oil process
- Petrochemical
- Sugar industry
- Paper industry
- Pipeline
- Power generation
- Others

### OPERATING LIMITS

- Capacity to 31,800$m^3/h$ (140,000 U.S. GPM)
- Head to 480 m (1,575 ft)
- Pressure to 20 bar (298 PSI)
- Temperature 10 to 270°C (50 to 518°F)

### RUHRPUMPEN NOMENCLATURE

- HSC
- HSD
- HSR
- ZW

## Fire Pumps

### CHARACTERISTICS

- Single stage double suction impeller
- Split case design allows for service without disturbing the piping
- Dynamically balanced double suction Impeller to reduce thrust loads
- Clockwise or counterclockwise rotation (viewed from coupling side) available
- Grease lubricated bearings
- Standard materials are cast iron case, bronze impellers & wear rings, other materials available
- Special material for casing and internals on request
- Base fabricated steel capable of supporting the weight of the pump and driver, other base designs are available on request
- Complete packaged fire pump skids available
- Electric / Pneumatic starting system available for Diesel Engine
- Complete Fire Pump Housing per NFPA20 & UL/FM available

## Fire Pump Packaged Systems

### DESIGN FEATURES

- NFPA-20
- UL-448
- FM-1311
- FM-1312
- Special design available on request

### CHARACTERISTICS

- Electric motor or diesel engine
- Main and jockey pumps and controller mounted on a common base
- Complete equipment compatibility
- Reduced field cost installation
- Interconnection wiring in accordance with area classifications
- Delivered to site in a single shipment
- Factory piped suction, discharge and test pipe line manifolds (optional)
- Fuel tank into the common base with fuel lines (optional)
- System is totally wired and tested

### APPLICATIONS

- Commercial centers
- High rise buildings
- Oil & gas onshore and offshore platforms
- Power stations
- Manufacturing and chemical industries

# PUMP PACKAGING

RUHRPUMPEN
Specialist for Pumping Technology

**Characteristics**

- Single source responsibility
- Certificate of Product Liability Insurance
- Prefabricated and factory tested - NIST Traceable Test Facility
- ASME Section IX Certified Pipe Welders
- AWS D1.1 Certified Structural Welders
- Control Panels and Drives
- Engineered to Order designs
- Design and fabrication by RP companies

**Applications**

- Closed Cooling water skid
- Fuel oil & Fuel Forwarding skids
- Wash down systems
- Potable water skids
- Service and Demin. water skids
- General Service pump skids

# Coming Attractions ☺

"Decoking Process Overview & Hydraulic Decoking Equipment"

Thur 30th March – 08.00 (UK GMT+1) (Eastern Hemisphere) & 17.00 (UK GMT+1) (Western Hemisphere)

*Aimed at Process and Mechanical Engineers, Consultant Engineers and possibly even Instrumentation Engineers who specify pumping equipment as well as Applications & Sales Engineers selecting and quoting them.*

*This short course will look at the Decoking Process in Refineries as an overview and will look in detail at the Decoking Systems that Ruhrpumpen has developed and is now the market leader in their design and supply.*

*Future sessions :*

*– Pumps for the Desalination Market (Thursday 27th April)*

*– Magnetic Drive Pumps for the Chemical Process and API Industries (Thursday 25th May)*

*- Cryogenic Pumps (Thursday 22nd June (to be confirmed)*