



Specialist for Pumping Technology

Session 11 – Vertical Pumps Part 1 (VS1, VS2, VS3)

Simon Smith January 2022





Presenter Profile – Simon Smith

Simon graduated with an honours degree in Chemical Engineering from the University of Surrey in 1978 and began a long career in the engineered pump industry spanning 41 years (so far!) with Peerless Pump, BW/IP International / Flowserve, SPP Pumps, Ruhrpumpen and Ebara Cryodynamics.

Over his long career he has filled various roles as Applications Engineer / Manager, Project Manager, Key Account Specialist, Vertical Pump Product Specialist, International Sales Engineer / Manager / Director and he has considerable experience in Training & Mentoring young engineers.



Session 11 – “Vertical Pumps (VS1, VS2, VS3)”

Session 12 – “Vertical Pumps (VS4, VS6, VS7)”

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

While engineers generally have a good understanding of horizontal pumps, their exposure to vertical pumps is more limited and as a result they are frequently misunderstood and under-utilised.

This course will look to put that right and explain the features and benefits of vertical pumps and how they can frequently be problem solvers.



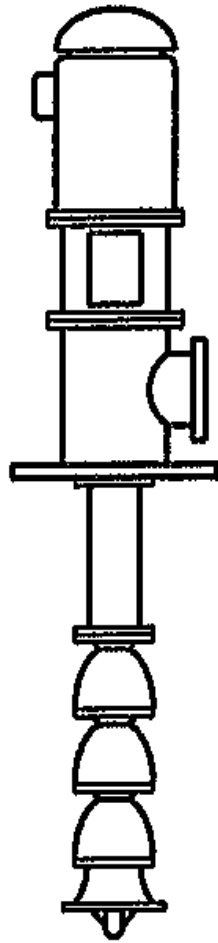
VERTICAL PUMPS INTRODUCTION

- Ruhrpumpen has a complete selection of vertically suspended pumps, axial flow, mixed flow and radial products to meet a huge range of duties and services.
- VS1, VS2, VS3, VS4, VS6, VS7 designs available
- One of the widest range of hydraulics available in the Marketplace.
- Flows up to 320,000 USGPM / 73,000 m³/hr
- Head up to 3,500 ft / 1,067 m
- Can be provided according to API 610 or Hydraulic Institute construction

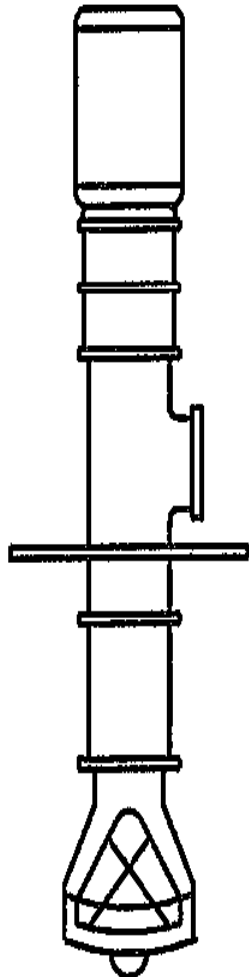


VERTICAL PUMP CONFIGURATIONS

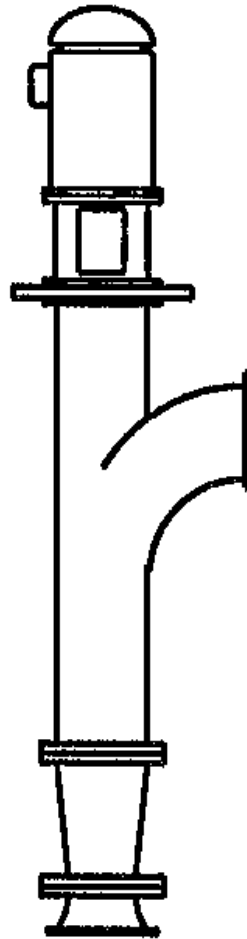
API 610 CONFIGURATIONS



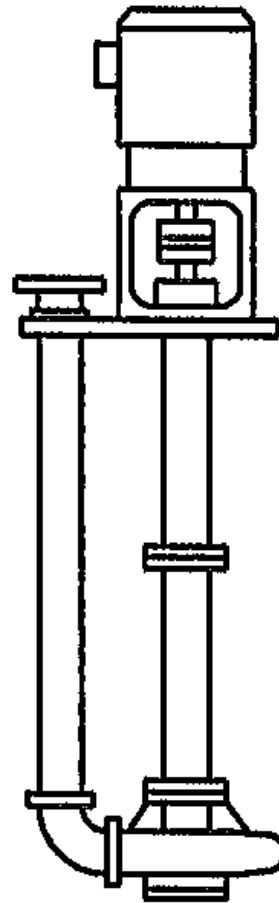
VS1



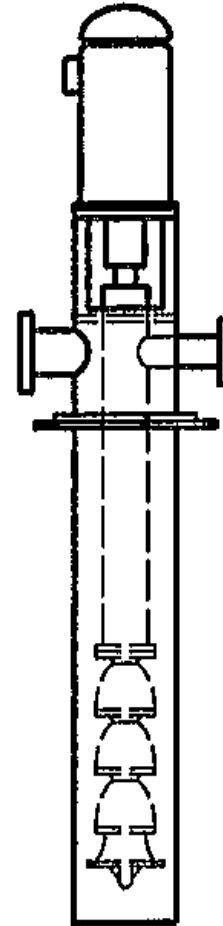
VS2



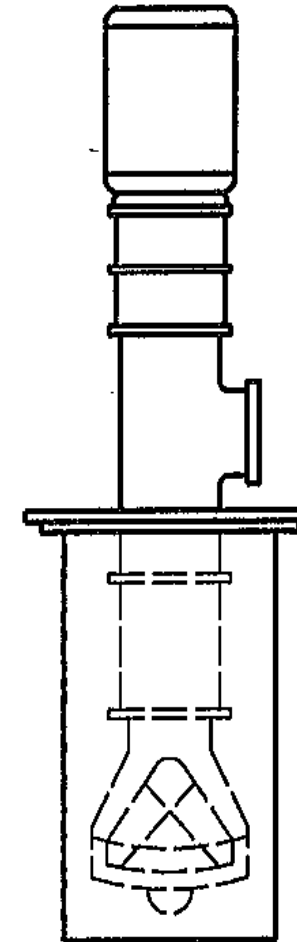
VS3



VS4/5



VS6



VS7

RUHRPUMPEN VERTICAL PRODUCTS



VS1



VS1



VS2



VS3



VS4/5



VS6



VS6

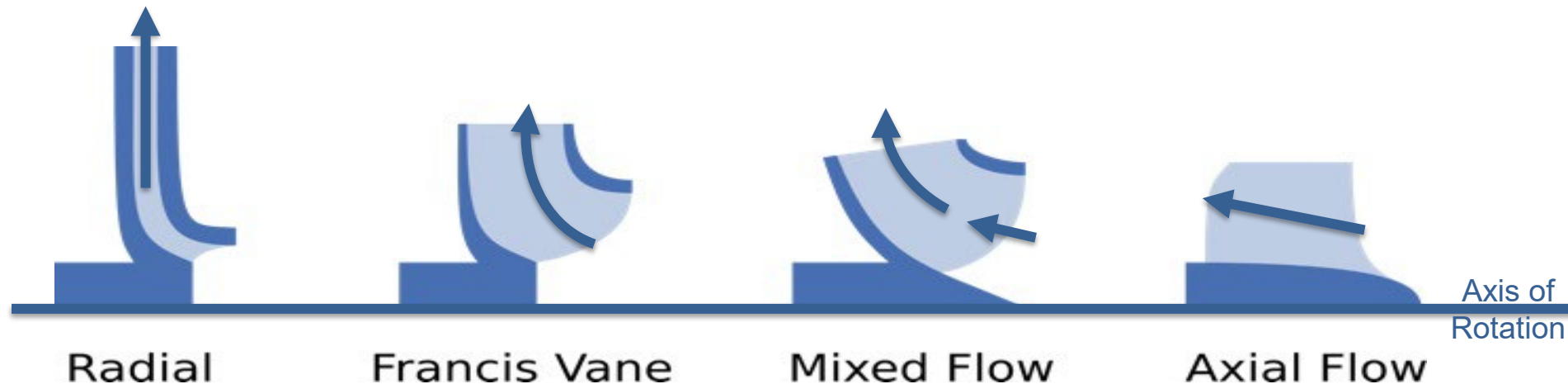


PUMP THEORY



IMPELLER TYPES

- There are 4 major impeller types
- Below illustration shows each type of impeller and how it handles the fluid flow
 - Radial flow flow exit through impeller is radial (perpendicular to shaft)
 - Francis vane modified radial flow (smoother transition from entrance to exit)
 - Mixed flow combination of radial and axial
 - Axial flow flow exit through impeller is parallel to shaft
- The result of these different physical characteristics is different hydraulic ranges (radial flow – higher head, axial flow – high flow)



www.neutrium.net



SPECIFIC SPEED, N_s

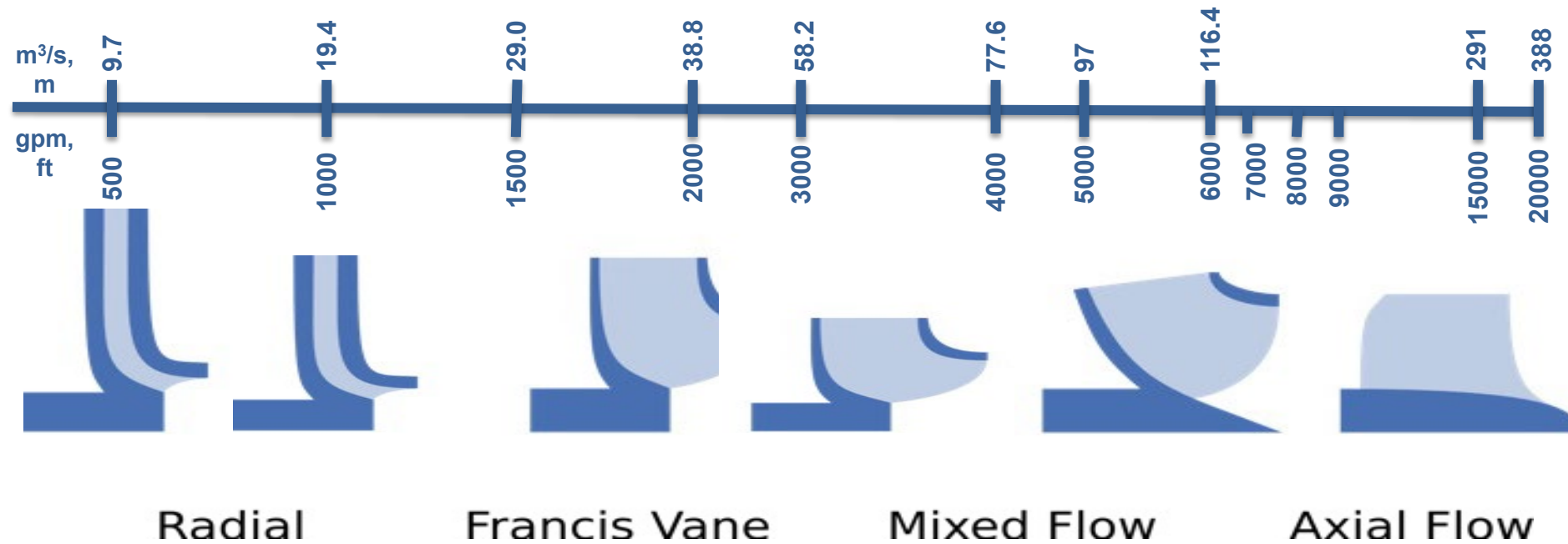
- N_s is a single number that allows us to easily describe the impeller head/flow performance

$$N_s = n \cdot \frac{\sqrt{Q}}{Head^{0.75}}$$

- N_s is specific speed
- n is pump rotational speed
- Q is flowrate (m^3/s or usgpm) at the point of best efficiency
- Head total head (m or ft) per stage at the point of best efficiency
- speed in revolutions per minute at which a geometrically similar impeller would operate if it were of such a size as to deliver one gallon per minute against one foot of hydraulic head.
- Since impellers of similar type have similar specific speeds – we can also predict impeller type from N_s

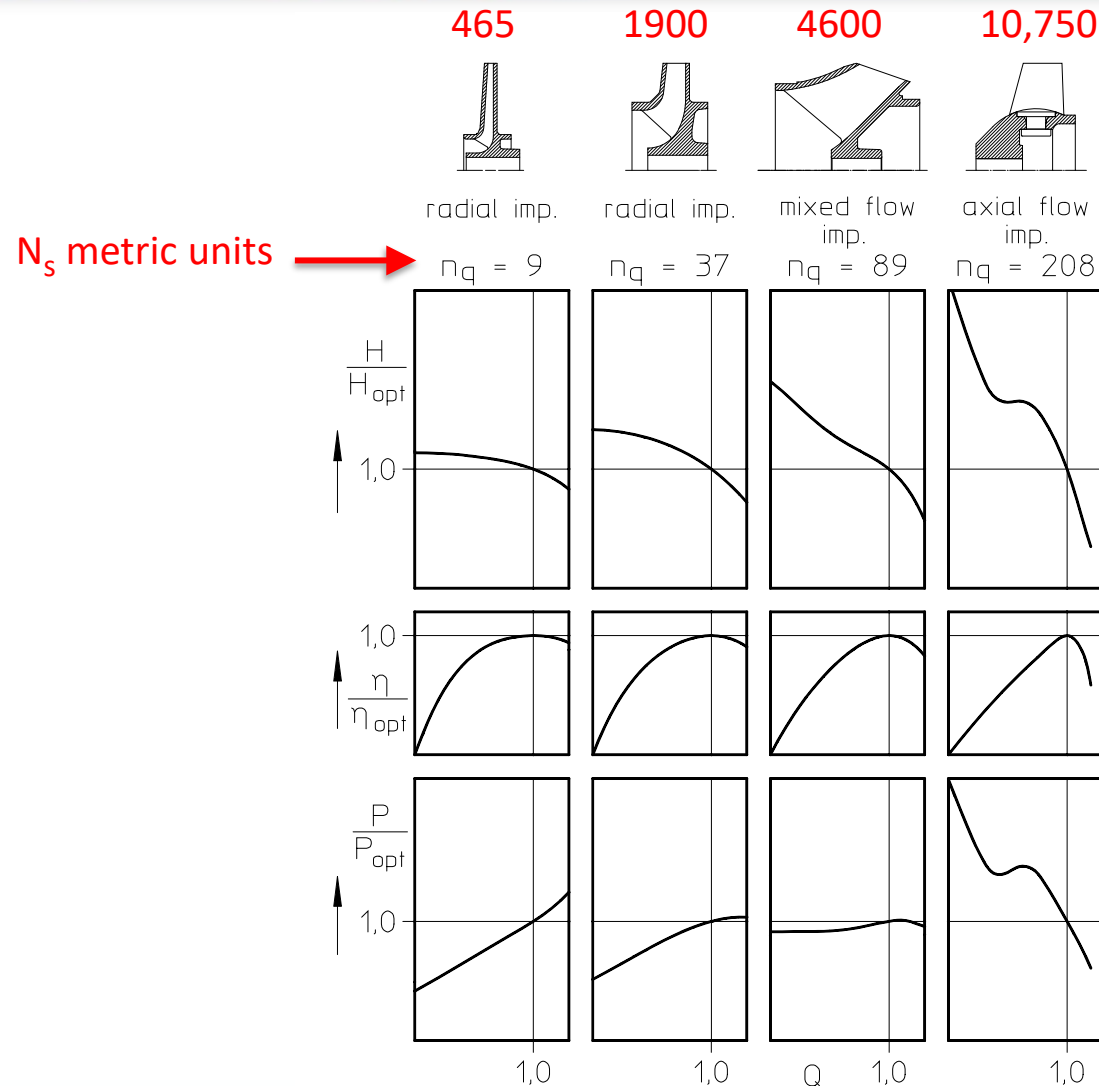


SPECIFIC SPEED, N_s



(Specific Speed in $\text{m}^3/\text{s}, \text{m}$, $\text{rpm} \times 51.6 = \text{Specific Speed in usgpm, ft, rpm}$)

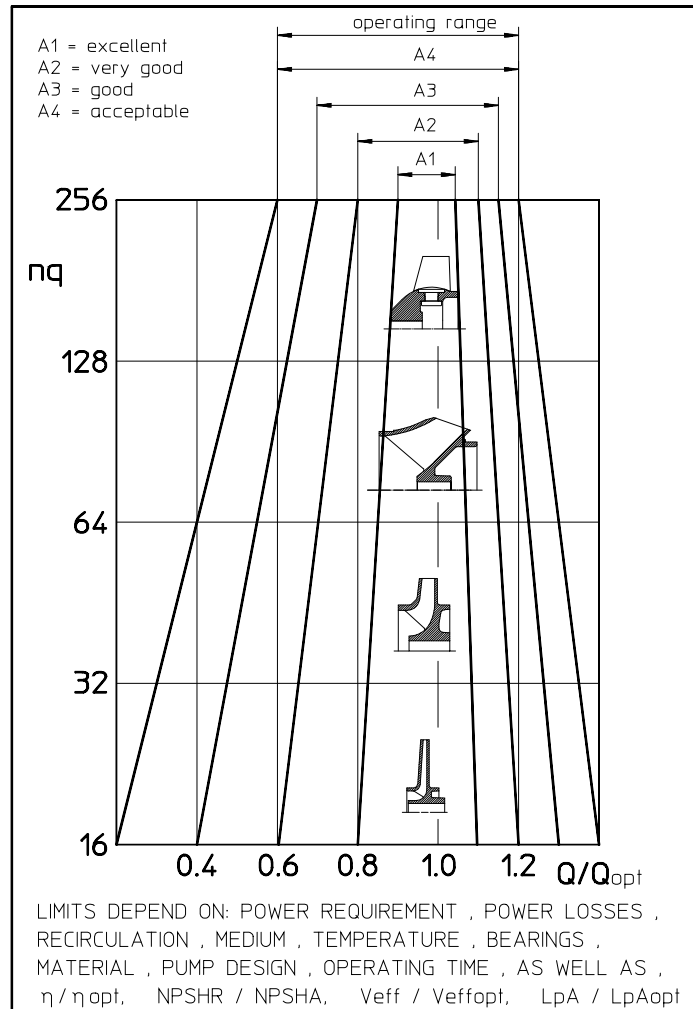
CURVE SHAPE



N_s US Units

- Pumps with similar specific speeds have similar shapes of curve
- Axial flow impellers have steep curves (around 300% head rise)
- Radial flows impellers have very flat curves
- Rule of thumb for steepness (BEP to shut-off) of ALL centrifugal pumps (not just Ruhrpumpen pumps): $100 + n_s$ (metric) = steepness (%)
- Example: $n_s = 45 \Rightarrow$ head rise about 145%
- This means that often the specification requirements for 120 % steepness is not possible to fulfil.
- (Specific speed in $m^3/s, m, rpm$) $\times 51.6 = usgpm, ft, rpm$

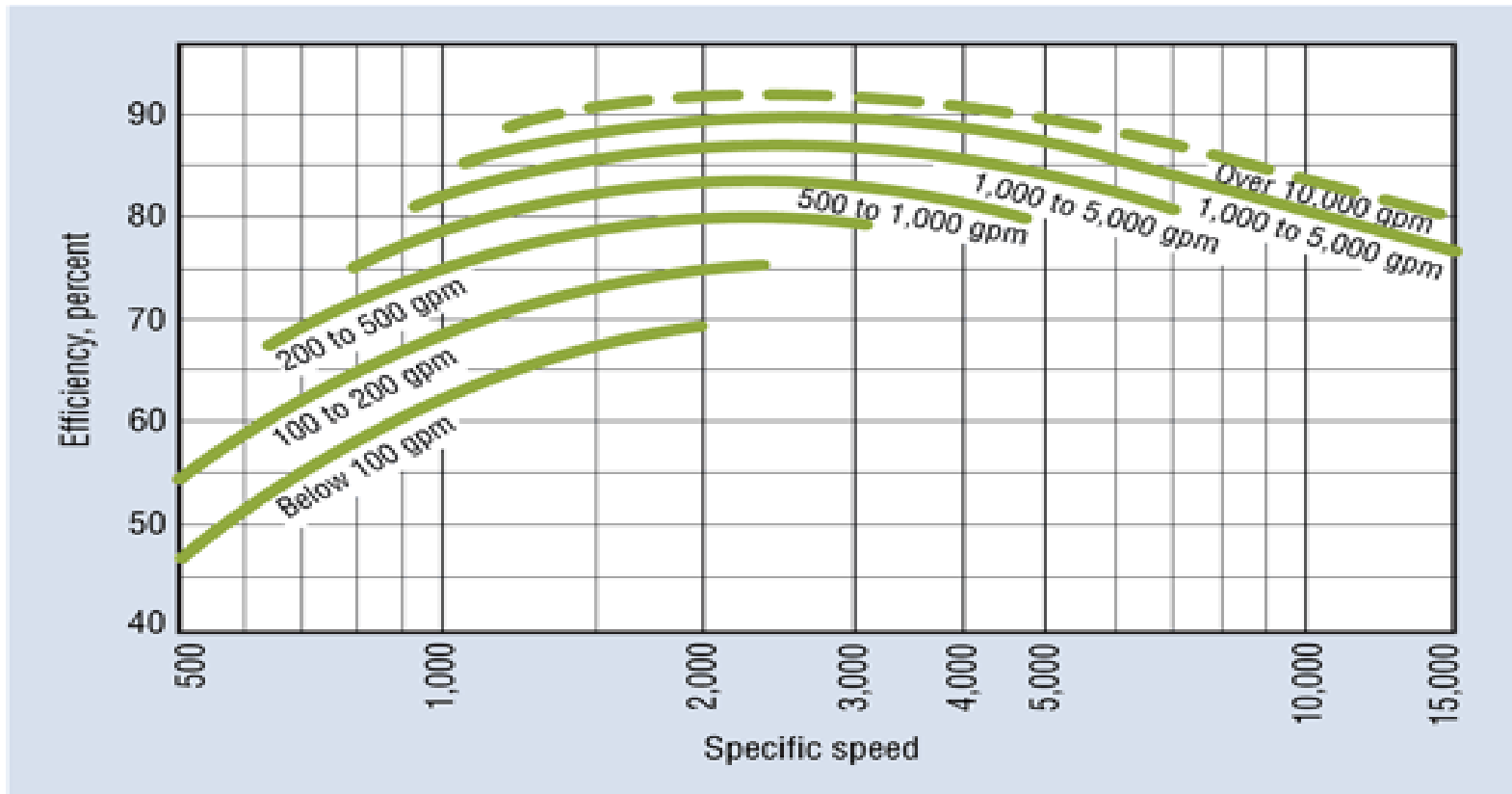
OPERATING REGION



- Radial impellers tend to have wider operating range than axial types

EFFICIENCY

- Optimum specific speed for highest efficiency is between 2000-3000 US / 40-60 Metric

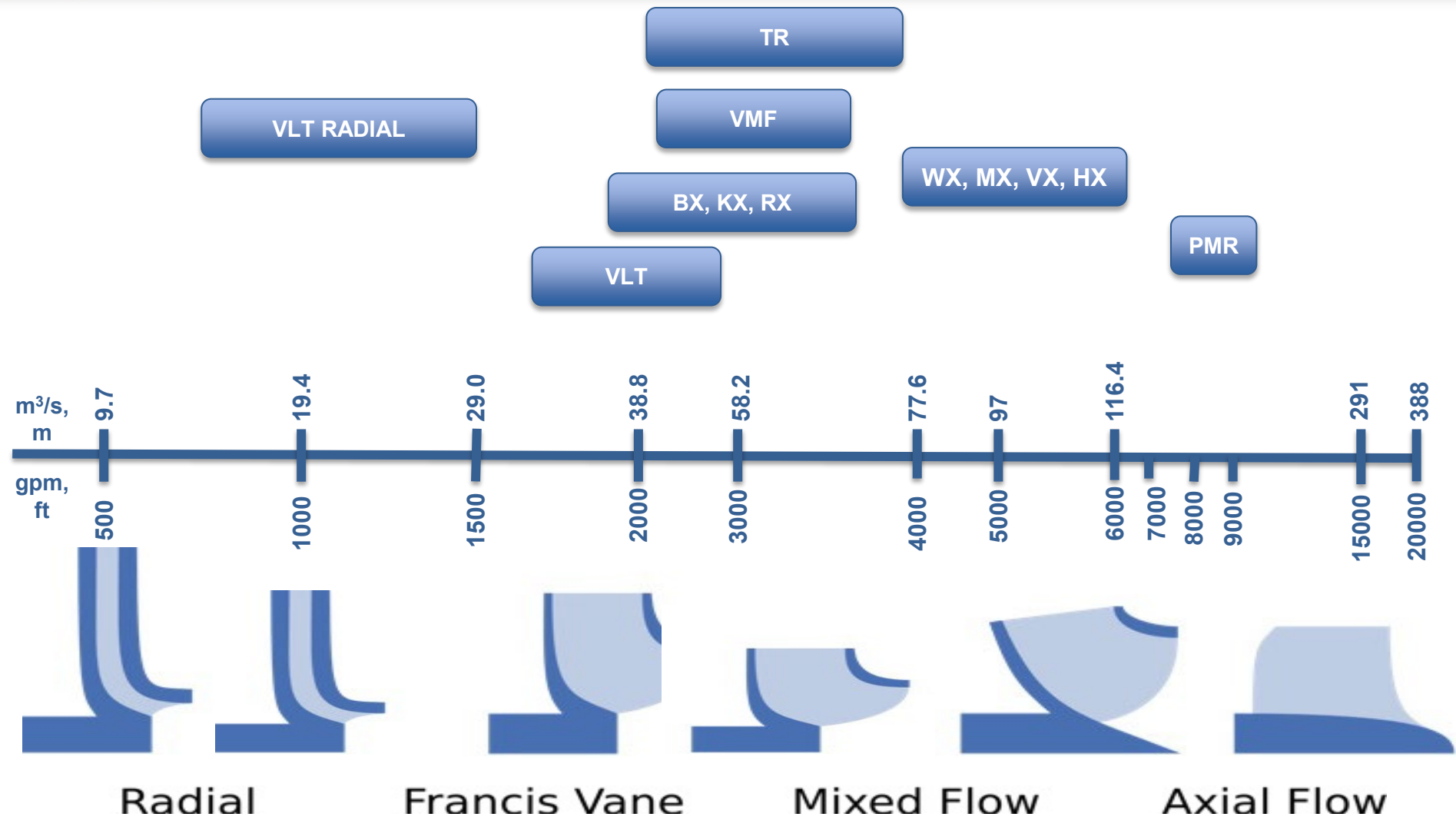


Hydraulic Institute specific-speed chart.

www.hpac.com



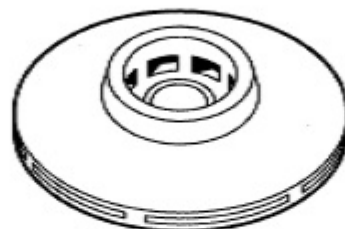
SPECIFIC SPEED, N_s



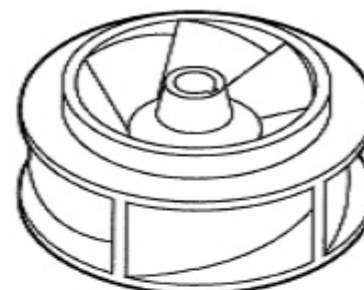
CLOSED vs OPEN vs SEMI OPEN



OPEN IMPELLER



SINGLE-SUCTION
CLOSED IMPELLER



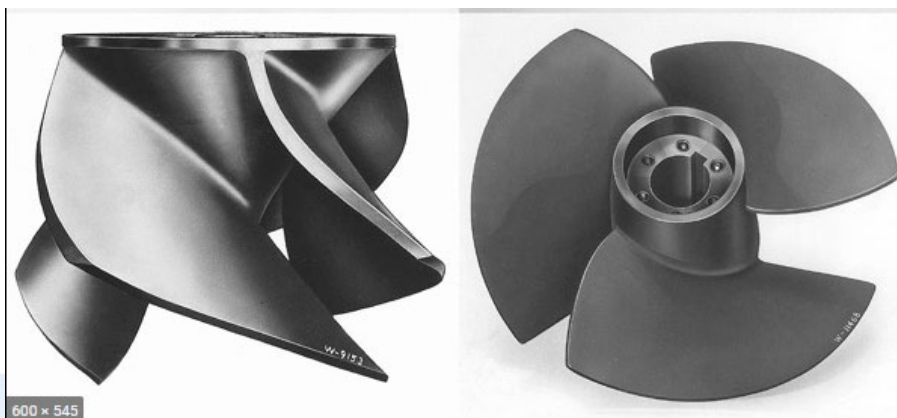
DOUBLE-SUCTION
IMPELLER



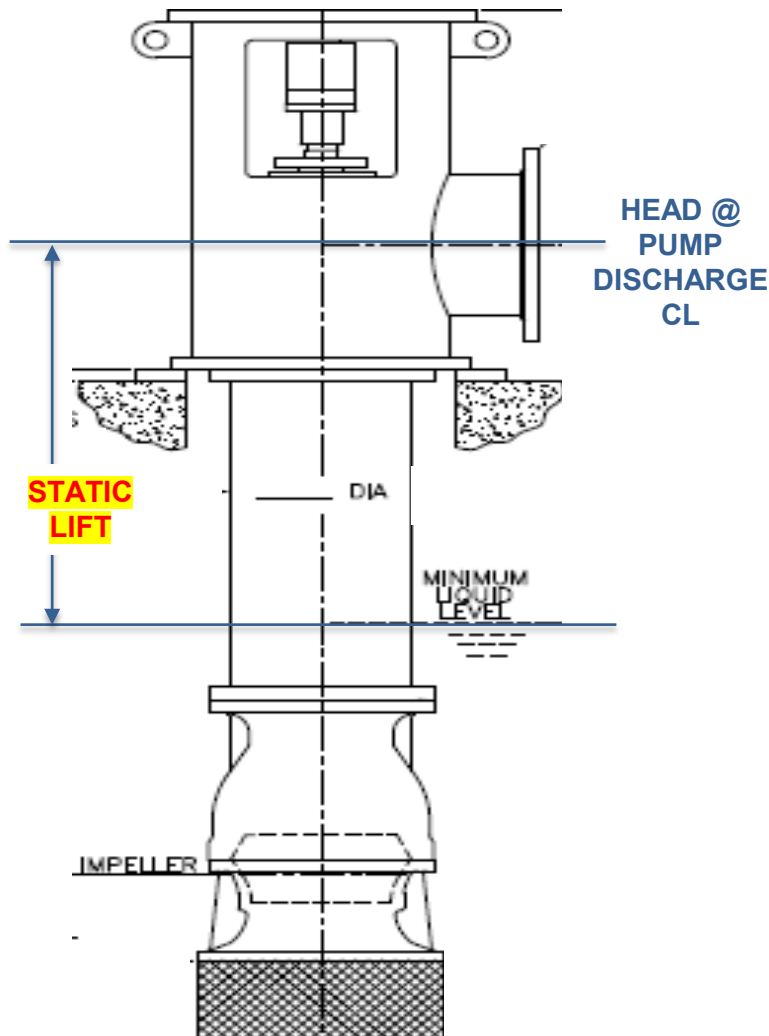
SEMI-OPEN IMPELLER



MIXED-FLOW
IMPELLER



STATIC LIFT (VS1,2,3,4,5 Types)



- For a pump in open pit/sump configuration (in a river, lake or sump) it is crucial to take into account the Static Lift from sump liquid level to the discharge flange
- Bowl assembly has to lift the fluid from the sump liquid level to discharge flange (static lift) AND produce customer required head at discharge flange
- Head can be specified by the customer at several different points:
 - Low liquid level (minimum)
 - Normal Liquid Level
 - Centerline of discharge nozzle
- In case the head is specified by customer at CL discharge nozzle, the static lift **can** be included by customer in the head stated in datasheet or it **can** be added by the vendor when selecting the pump. It needs to be clear on the data sheet which approach is being considered.



VS1

VCT/VLT
TR/VLT-TR
VMF

Vertical Turbine Pumps

Characteristics

- API 610 latest edition construction (VS1 type)
- Multistage vertical centrifugal pumps with diffuser type bowl
- Semi-Open / enclosed impellers
- Counterclockwise rotation viewed from coupling end
- Basket or conical strainer, according to pump requirements
- Product or oil lubricated
- Oversized bowl shaft sizing for longer life
- Epoxy coated bowls
- Collet mounted impellers
- Integral cast wear surfaces with optional wear rings in bronze or SS

Materials

Bowls

- Cast iron bowls
- Bronze impellers
- 416 SS shafting
- Optional materials on request

Columns

- Carbon steel pipe – threaded or flanged
- AISI-1045 carbon steel or 416 SS line shafting
- Optional materials on request

Discharge Head

- Cast Iron with 125# ANSI FF flanges
- Fabricated steel with 150# or 300#

Bearing Material

- Bronze as standard
- Other materials and configurations

Options

- ANSI flanges
- Custom fabricated discharge head to meet your criteria

Applications

- Deep Well
- Irrigation
- Sump
- Condensate
- Can pump requirements
- Fire service
- Municipal



VTP / HQ

Capacity	13,636 m ³ /h	60,000 U.S. gpm
Head	762 m	2,500 ft
Temperature	121°C	250°F
Pressure	74 bar	1,080 psi



Vertical Circulator and Mixed Flow Pumps

Characteristics

- API 610 latest edition construction (VS3 type)
- Vertical space saving construction
- Integral bearing retainer
- Wide range of impeller designs and specific speeds (1,800-14,000) for optimum hydraulic coverage
- Engineered to customer specifications
- Oil, fresh water or self-lube column construction
- Open, semi-open and closed impellers
- Threaded or flanged column (depending on its size), with water or oil lubrication
- Packed stuffing box or mechanical seal
- Above or below ground discharge
- Sizes 20 cm (8 in) to 305 cm (120 in)

Options

- Pull-out design for ease in maintenance (except VMF and TR)
- Pump mounted thrust bearings
- Rotor 'Pull-Out' design

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



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

Capacity	50,000 m³/h	220,000 U.S. gpm
Head	175 m	575 ft
Temperature	-30 to 135°C	-20 to 275°F
Pressure	10 bar	156 psi



Vertical Axial Flow Pumps

Characteristics

- API 610 latest edition construction (VS3 type)
- Multi-stage vertical centrifugal pump, diffuser type bowl
- Axial flow impeller, high efficiency
- Handles solids up to 23 cm diameter (9 in)
- Counterclockwise rotation viewed from shaft coupling
- Discharge elbows designed to reduce friction losses, diffusers designed to minimize turbulence and increase efficiency
- Product, oil, or fresh water lubrication
- Above or below base discharge

Materials

- Bowls: Cast iron with bronze impeller
- Column: Carbon steel with AISI-1045 shaft
- Discharge head: Fabricated steel
- Other materials of construction

Options

- Rotor 'Pull-Out' design
- Basket type strainer
- Extended Suction bell to minimize vortices

Applications

- Drainage
- Wastewater
- Flood control
- Irrigation
- Waste treatment plants
- Underpass drainage
- Condenser cooling
- Construction dewatering
- Ditch pumps
- Raw water intakes

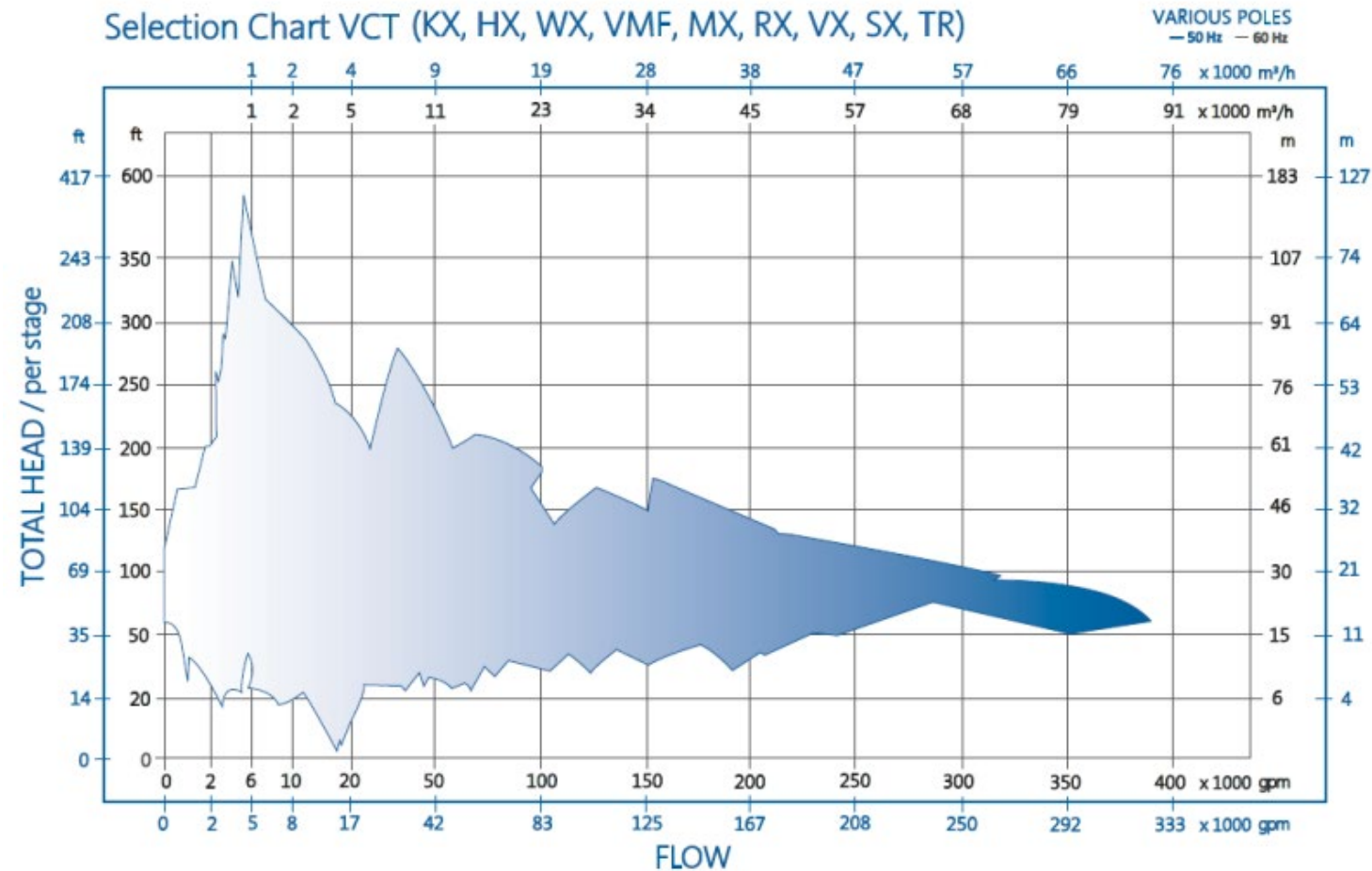


VAF / POV / PV
PMR / VPO / PVD

Capacity	72,680 m³/h	320,000 U.S. gpm
Head	27 m	90 ft
Temperature	95°C	230°F
Pressure	5 bar	75 psi



RANGE



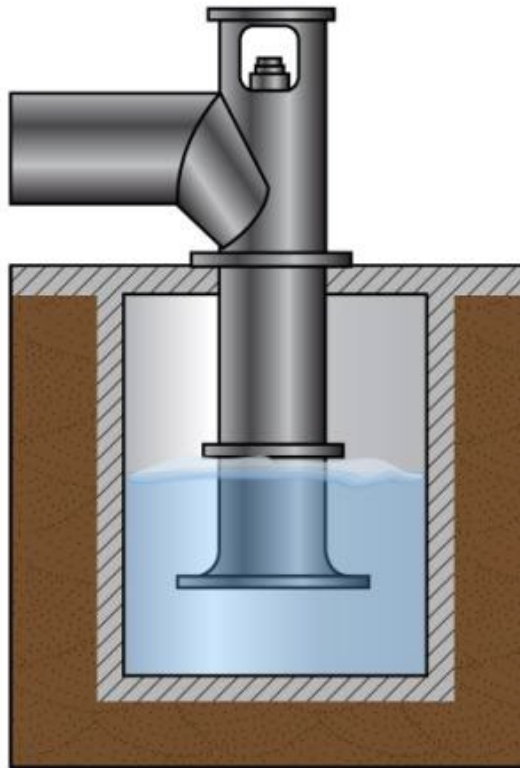
VERTICAL PUMPS

Vertical pumps consist of a bowl assembly (3), single stage or multistage, suspended on a discharge head (1) from baseplate at the mounting floor. The column (2) length is dictated by the application and installation site

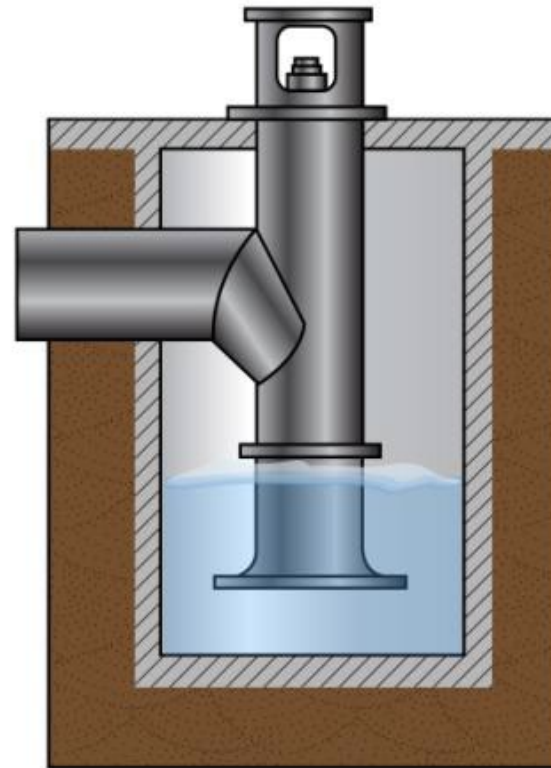


FEATURES AND BENEFITS DISCHARGE HEAD OPTIONS

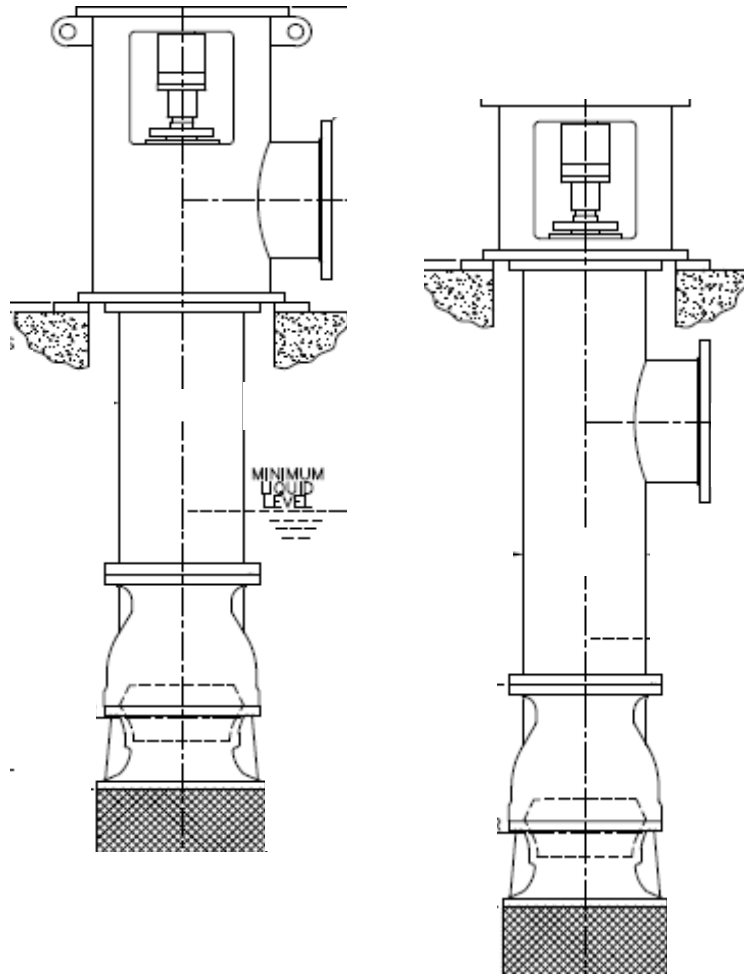
Above Ground Discharge



Below Ground Discharge



VS1 (L HEAD AND BELOW GRADE DISCHARGE)

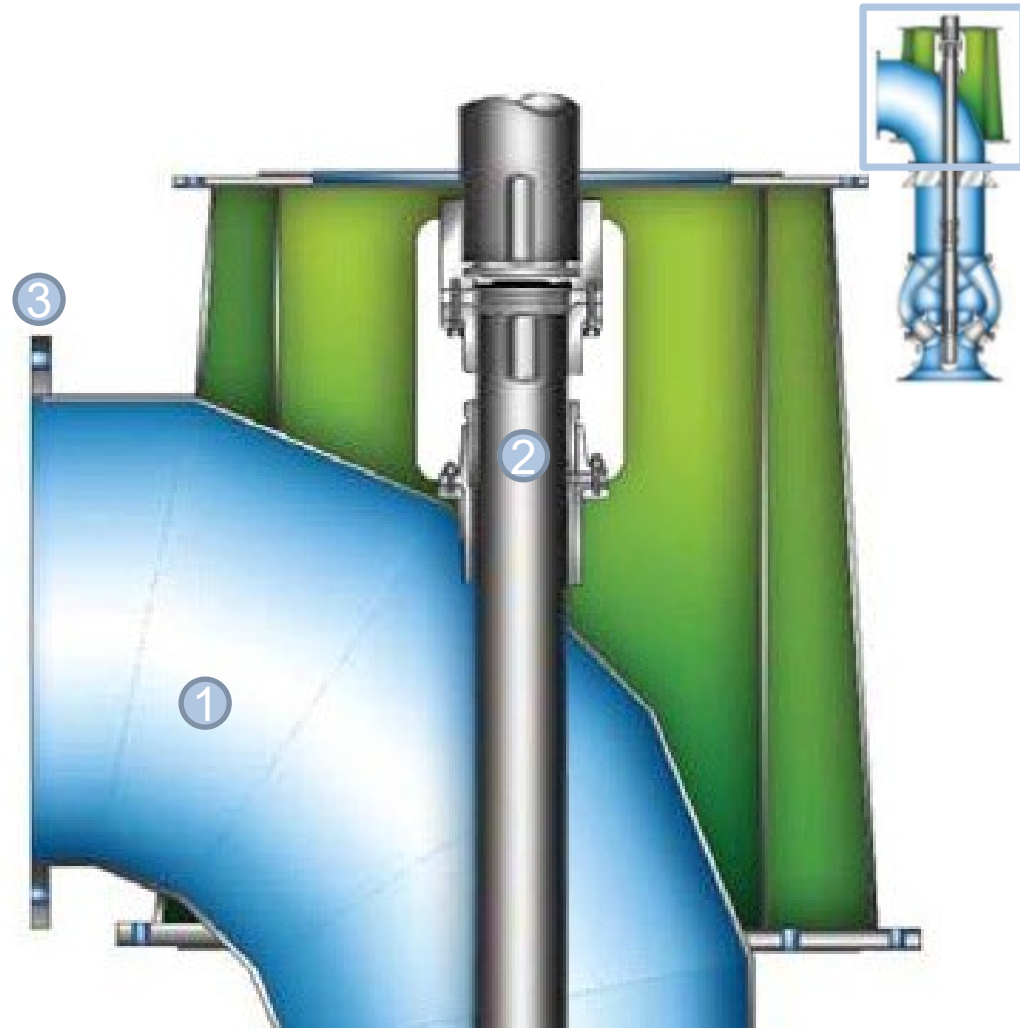


- Use in sump (open system) or tank (closed system) type applications
- Pressure boundary is Head, Bowls and Column
- Configuration chosen to meet customer pipework requirements

FEATURES AND BENEFITS

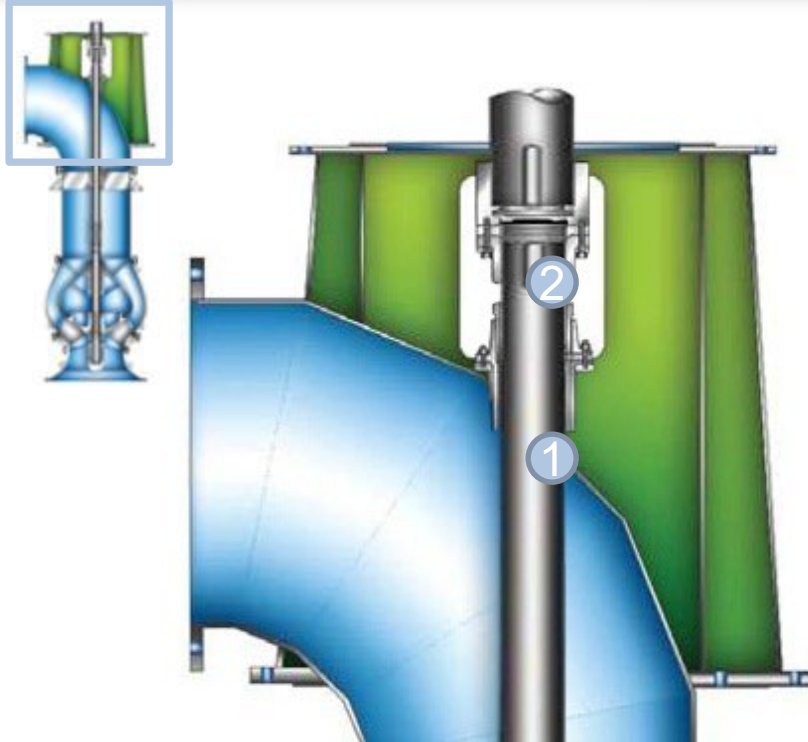
DISCHARGE HEAD

1. **Most commonly T or L fabricated head.** Mitered head may be used in some applications. Some options for cast heads
2. **Large stuffing box** - TR pump is standard with packing but can be equipped with mechanical seals (split seal is preferred). VCT and VMT pumps can be supplied with mechanical seal or packing
3. **Heavy duty flanges** – Positive and registered fit alignment



FEATURES AND BENEFITS

COUPLING



VMT

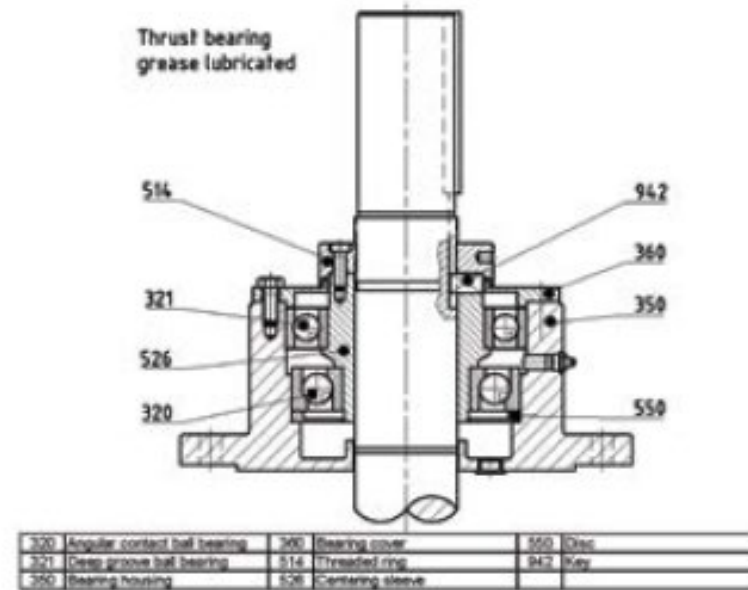
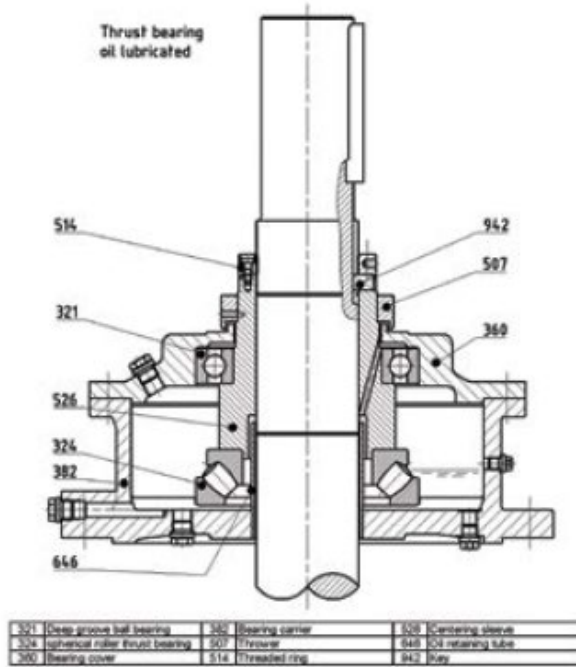
All metal **three piece adjustable coupling** – Ensures positive, foolproof shaft alignment.

All metal **Ruhrpumpen four piece coupling** when mechanical seal is used. Coupling has removable spacer that allows a mechanical seal to be replaced without removing the motor. The spacer is not needed when packing is used.

In case of using an external thrust pot 4 piece spacer coupling (Ruhrpumpen manufacture) used between pump and thrust pot. Flexible non spacer coupling between thrust bearing and motor

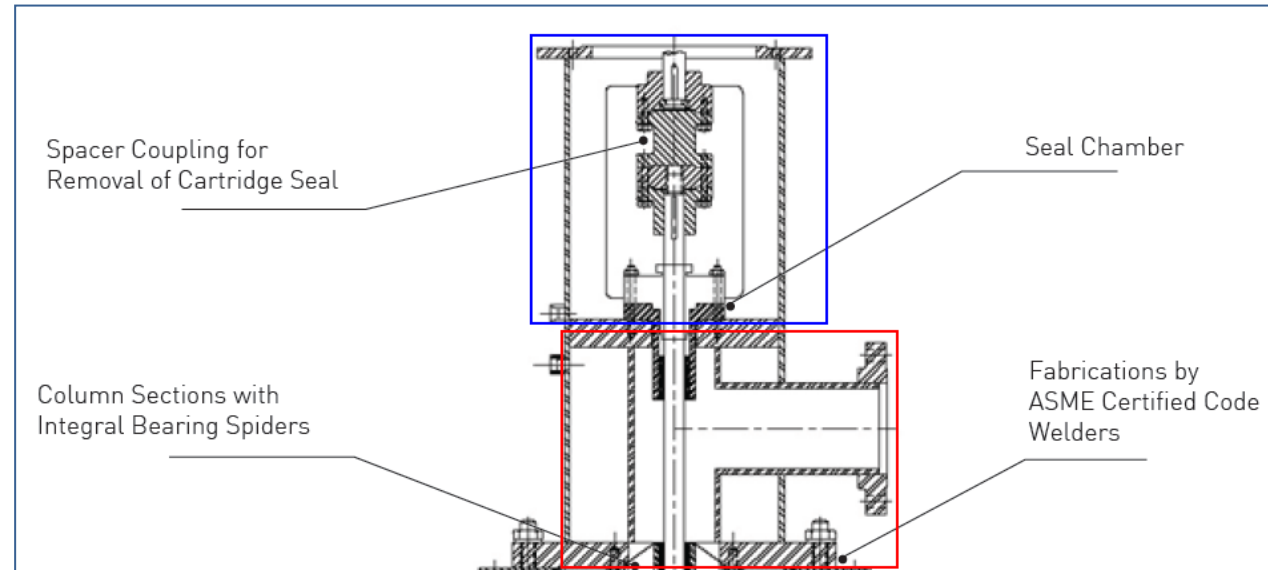
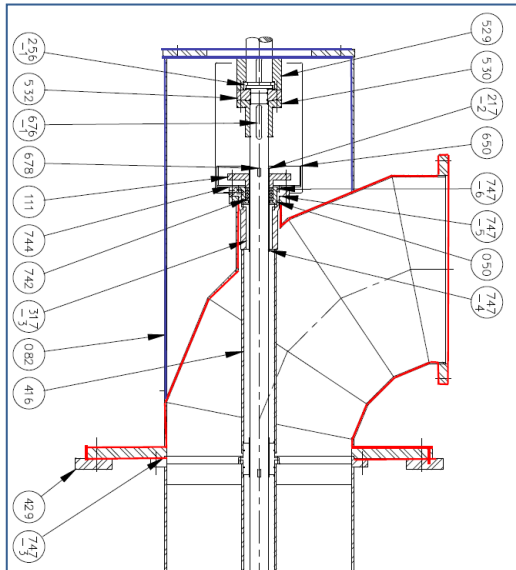
TR Flexible coupling with rubber or steel elements manufactured to high accuracy are standard. The coupling guard is in the scope of supply and conforms to appropriate safety standards. The TR can also be equipped with spacer couplings on request. For information on spacer length consult engineering

- Thrust bearing in the pump

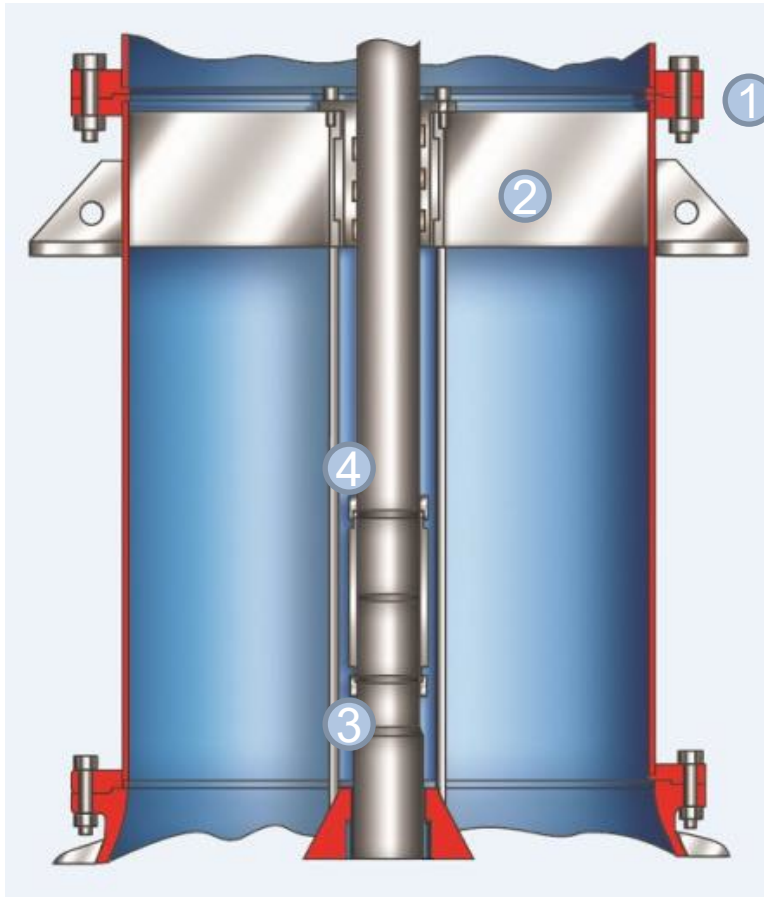


5-PIECE ELBOW NOZZLE HEAD WITH DUAL-MATERIALS

- Where the application requires high alloy wetted parts Ruhrpumpen is able to save cost and offer reduced price to customer by offering the nozzle head with alloy wetted areas and non-wetted/structural parts in carbon steel
- This is a standard construction nozzle head for us – the design is not changed. The only thing we do differently is that we use different weld procedures as needed for each seam.
- Alloy wetted areas (shown in red) and non-wetted/structural parts in carbon steel (shown in blue) in below examples



FEATURES AND BENEFITS COLUMN



1. **Heavy duty flanges** – Positive and registered fit alignment
2. **Bearings** – product lubricated (open line shaft) or externally lubricated (closed line shaft)
3. **Sleeve type coupling** is standard on VMT. Ensures proper alignment and fast assembly/disassembly. Sleeve coupling is keyed. Threaded coupling is possible but unusual on this product.

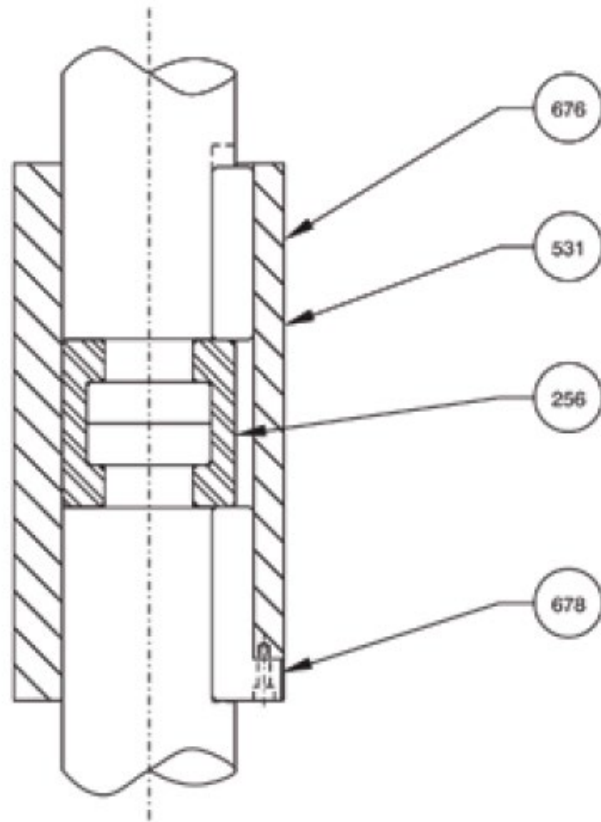
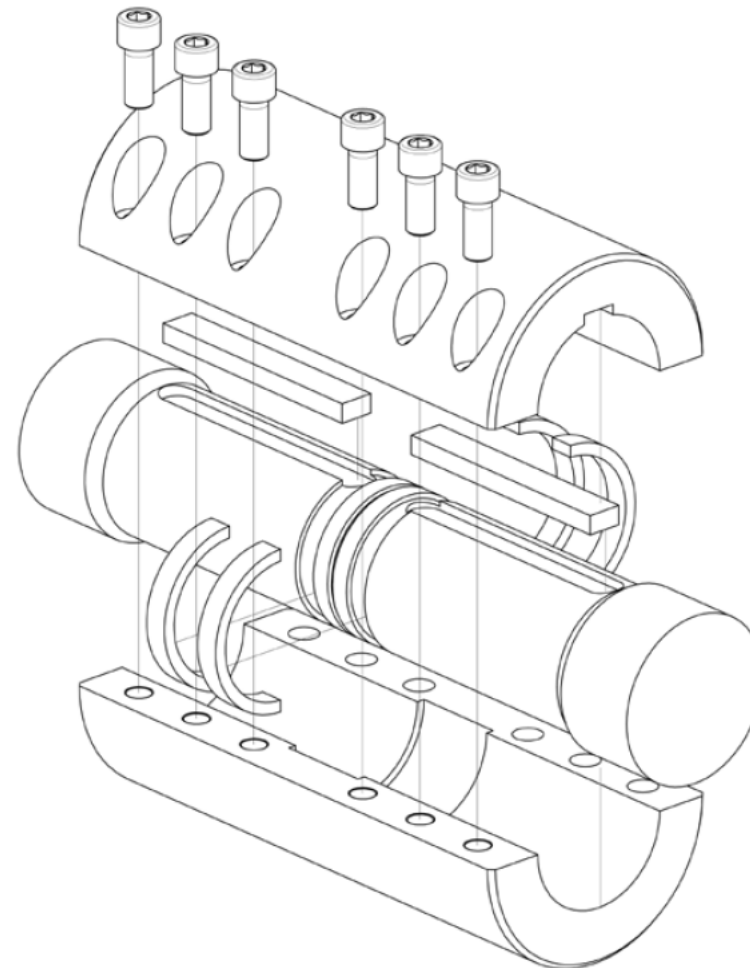
Split muff type coupling on TR

4. **Integral Spider** (welded spider) as standard. (Not drop-in type)



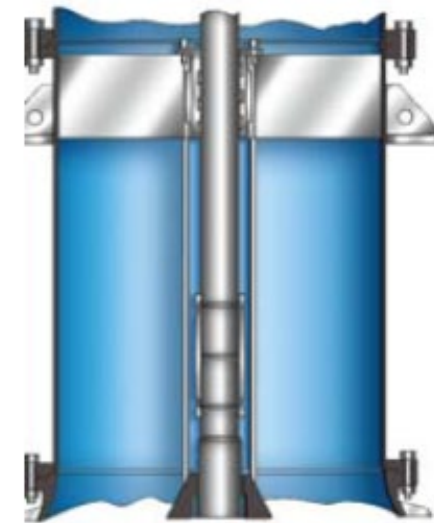
FEATURES AND BENEFITS SHAFT COUPLINGS

Split Muff Coupling



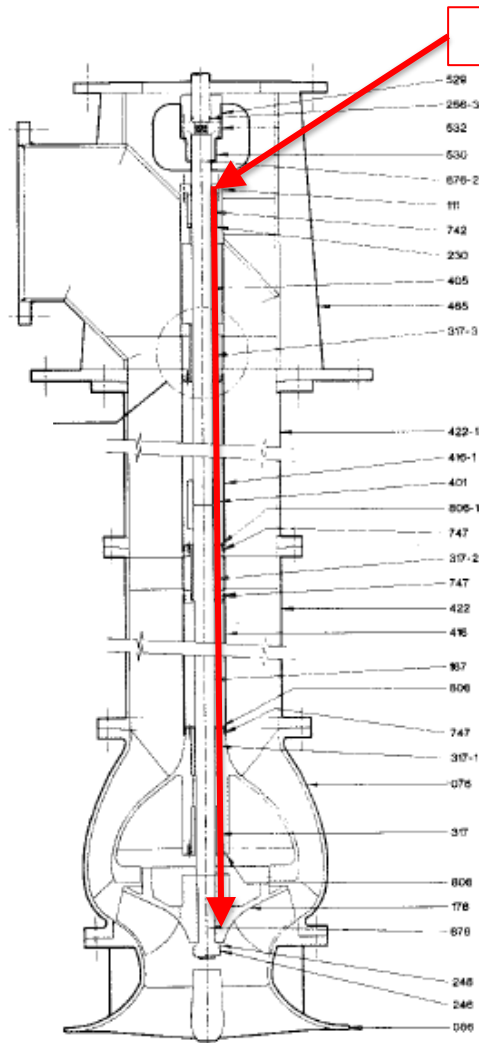
Sleeve (keyed) coupling

- Enclosed Line shaft
- Inner column isolates bearings from process fluid. Normally used for applications where customer requests it (for example fluid with high levels of abrasives) or for applications with more than 50ft length of line shaft above LLL (to prevent top bearings running dry during startup)
- Pressurized and non pressurized configurations are available
 - In pressurized version the enclosing tube is filled with fluid (normally water) supplied at a connection on the nozzle head and lubricates line shaft bearings and top bowl bearings
 - In non-pressurized configuration it is usual that a small flow rate of oil (approximately 0.1 sup flow) is supplied from external source and injected at the nozzle head normally below packing/seal. Can be supplied by customer from an external source or a small tank can be supplied by RP and mounted on nozzle head (see illustration on following slides)
- This is a more expensive solution than product lubricated bearings and Ruhrpumpen. In case of product containing some particles RP experienced engineers will determine whether upgraded bearing materials or enclosed line shaft would be the optimum solution



ENCLOSED LINESHAFT

ENCLOSED LINE SHAFT PRESSURISED LUBRICATION



Pressurized Lubrication

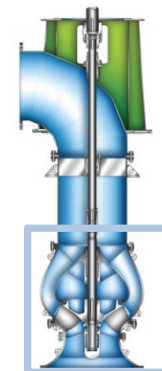
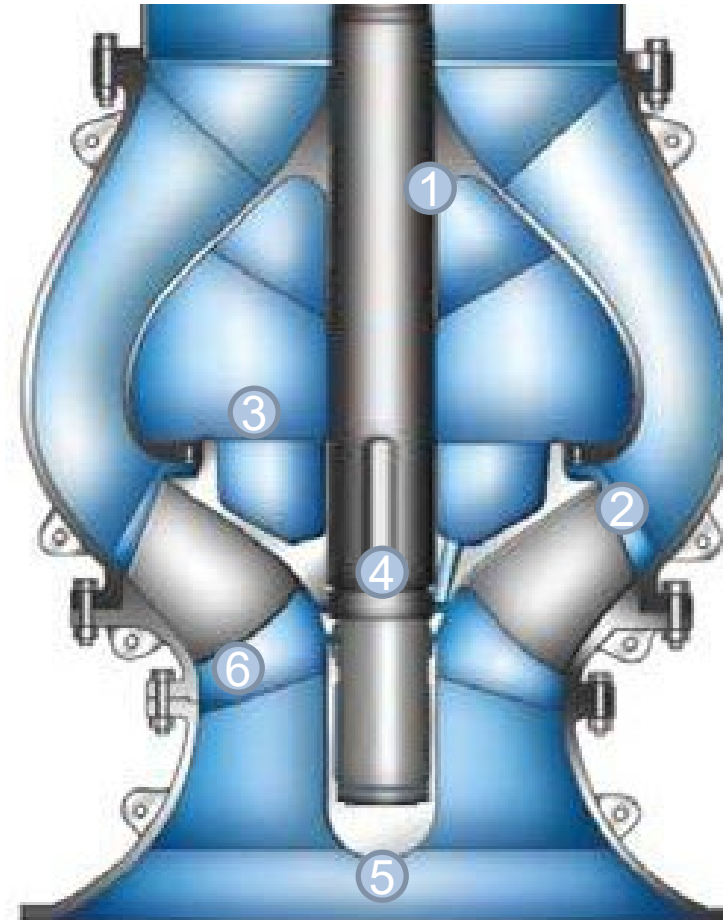
- Enclosing tube is filled with fluid and lubricates line shaft bearings and top bowl bearings
- Lubricating fluid is normally water
- Top bowl bearing flush water lubricated
- Other bowl bearings are product lubricated

-
- The image contains two architectural drawings. The left drawing is a longitudinal section of a building, showing a curved roof structure, stairs, and various structural elements. Dimensions are provided for various parts, including a total length of 346,000 and a width of 21,000. A red box highlights a specific area of the drawing. The right drawing is a detailed cross-section of the highlighted area, showing structural elements, dimensions, and callouts. A red arrow points to a specific feature in the detail.

-
- Technical drawing of a vertical pipe assembly. The drawing shows a cross-section of a pipe with a diameter of $\phi 36.00$. A red highlighted section indicates a specific component or area of interest. Key dimensions and labels include:
- 90**: Label for the top flange or cap.
 - 100**: Label for the top flange or cap.
 - 10**: Label for the top flange or cap.
 - 70**: Label for the top flange or cap.
 - 60**: Label for the top flange or cap.
 - DETAIL A**: Label for a specific detail view.
 - 23.812**: Dimension for the height of the red highlighted section.
 - ANY SQUARE 15.125 LENGTH**: Label for a square feature.
 - 80**: Label for the bottom flange or cap.

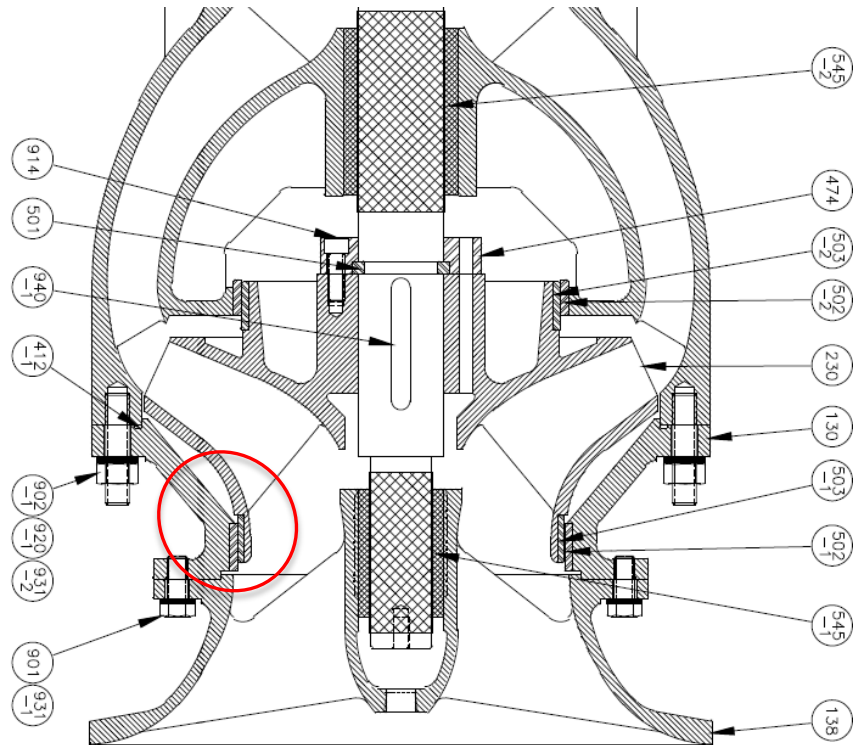
FEATURES AND BENEFITS BOWL ASSEMBLY

1. **Flanged bearings** - One or more bearings are located on the top case hub to provide maximum support and alignment to the impeller.
2. **Impeller** – Semi open, open or closed according conditions of service, 3 plane dynamically balanced
3. **Secured impeller**
4. **Suction Bell** - Less downtime, Bottom bearing keeps shaft aligned. Self lubed or greased for long service life



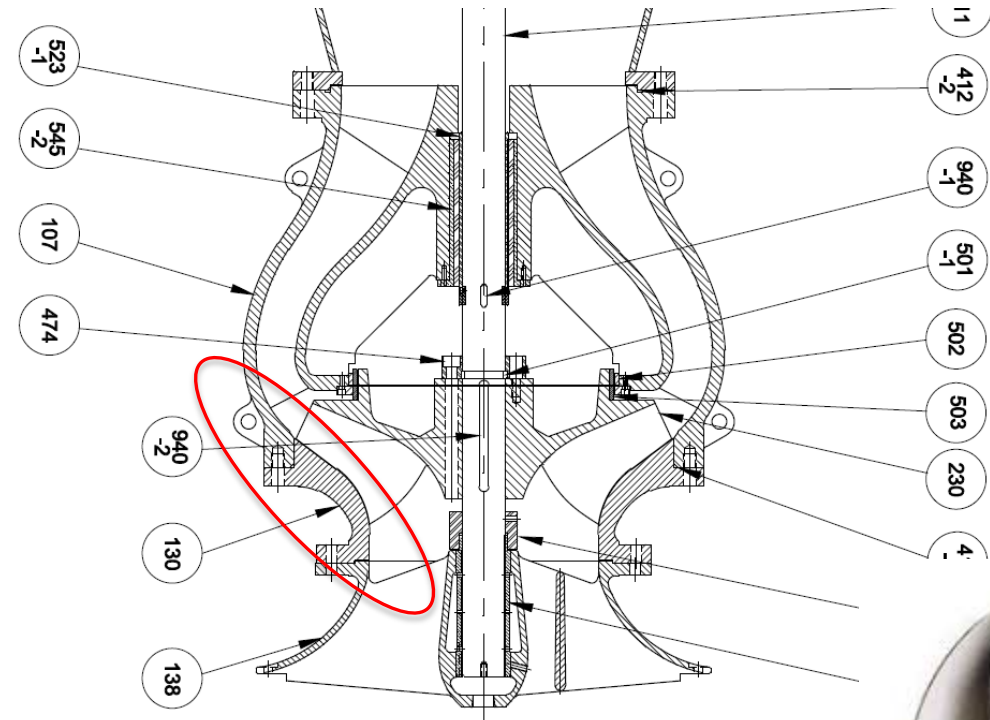
CLOSED VERSUS SEMI-OPEN IMPELLER

CLOSED IMPELLER



Closed impeller has a lower shroud which has a close-clearance with the bowl

SEMI-OPEN IMPELLER



Semi-impeller has no lower shroud and therefore no close-clearance areas



VS2

DOUBLE SUCTION DX, DSV





Double Suction Vertical Turbine Pumps

Characteristics

- API 610 latest edition construction (VS2 type)
- Above or below base discharge nozzle
- Single stage vertical, centrifugal, double volute
- Double suction enclosed impeller
- Counterclockwise rotation viewed from shaft
- Oil lubricated column, or may be force-lubricated by the pumped liquid

Materials

- Liquid End: cast iron with bronze impellers
- Column: carbon steel pipe and shaft
- Discharge Head: carbon steel with 150 and 300 ANSI flanges
- Other materials on request

Options

- Low NPSH first-stage design
- Enclosed line shaft with external lubrication

Applications

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



DSV / DX

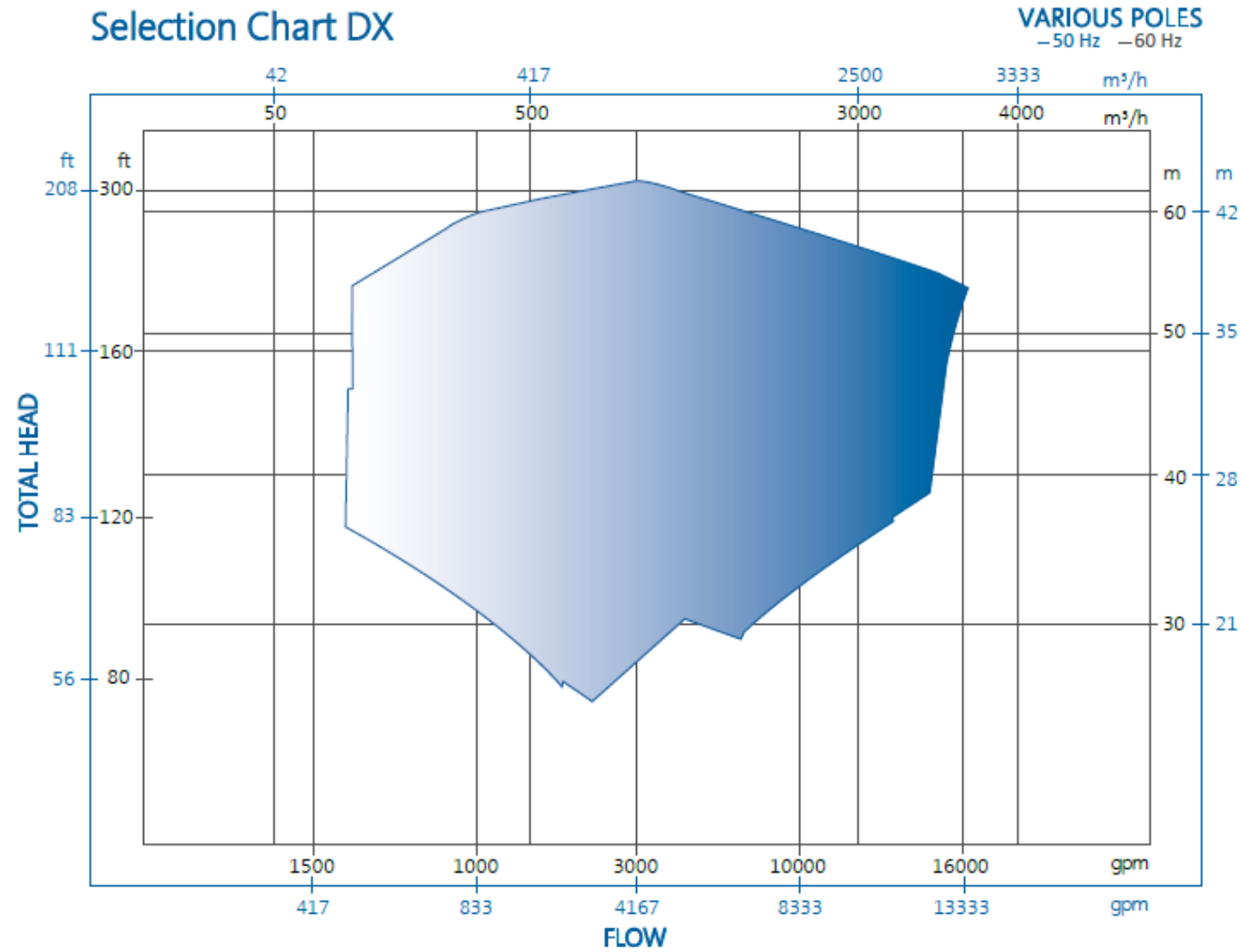
Capacity	340 to 18,170 m³/h	1,500 to 80,000 U.S. gpm
Head	12 to 244 m	40 to 800 ft
Temperature	150°C	302°F
Pressure	19 bar	280 psi



FEATURES AND BENEFITS

- DSV is a heavy-duty, vertical double-suction, twin volute, single-stage, centrifugal design.
- The single impeller, volute design develops the higher heads and capacities without the need for additional stages. This minimizes the number of wearing parts, resulting in easier maintenance and positive alignment. Unlike the vertical turbine pump, this completely eliminates the use of intermediate bowl bearings, which are vulnerable when handling abrasive liquids.

RANGE

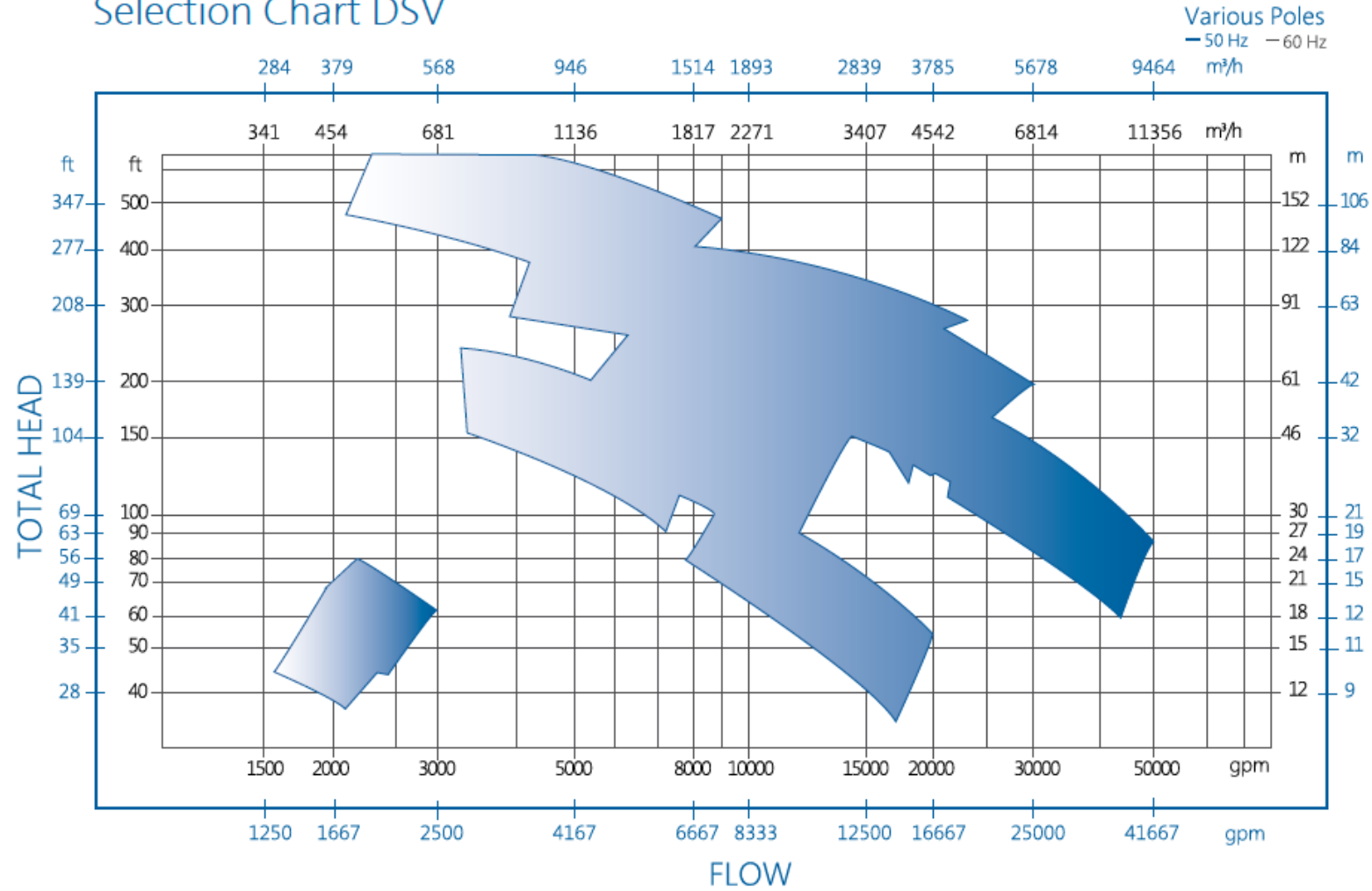


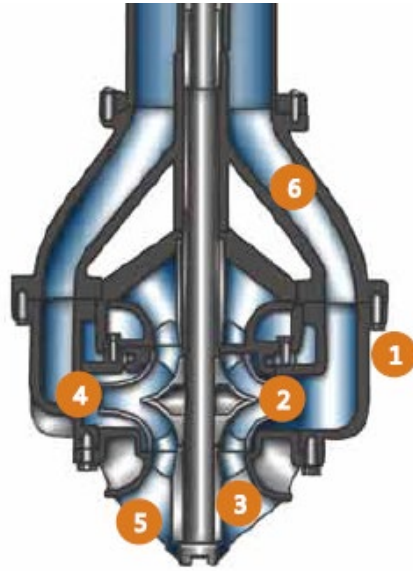


FEATURES AND BENEFITS

DSV

Selection Chart DSV





Double suction = lower NPSH

1 VOLUTE CASE.

The twin volute case is designed to efficiently convert to pressure the velocity added to the liquid by the impeller. The volute case directs the liquid from the impeller into the transition diffuser with a minimum of hydraulic losses.

2 IMPELLER.

The impeller is an enclosed double-suction centrifugal type which is keyed to the shaft and held in position by corrosion resistant retaining rings. The retaining rings are protected from abrasion by collars that turn with the impeller. The impeller is hydraulically and dynamically balanced to provide smooth operation. When specified, optional renewable impeller wear rings may be provided on both the upper and lower skirts to the impeller or they may be added later to renew the clearances.

3 SUCTION BELL.

The upper and lower flared suction bell directs the liquid into the impeller. It contains four guide vanes to prevent vortexing and provides the housing for the suction bell bearings.

4 CASING WEAR RINGS.

Are provided in the suction bell on both sides of the impeller. The wear rings are closely fitted to minimize the return of liquid from the discharge side of the impeller past the skirt to the suction side due to the pressure differential. The rate of wear depends on the character of the liquid pumped and the materials of construction. Hardened stainless steel wear rings are often used for severe service.

5 BELL BEARINGS.

Are located in the suction bells immediately adjacent to either side of the impeller. The bell bearings are a sleeve-type and grooved to receive proper lubrication and closely fitted to maintain alignment.

6 TRANSITION DIFFUSER.

The transition diffuser provides a smooth hydraulic flow from the volute to the column pipe. The transition diffuser contains the connector bearing that couples to the bottom section of the shaft tube flanged connections with registered fits are provided for bolting the column pipe.

Bowl Assembly Options



Double suction enclosed impeller as a first stage can be manufactured in VCT pumps



DX First Stage



CASE STUDIES AND PHOTOGRAPHS

CASE STUDY

Ruhrpumpen tests its largest ever multistage vertical pump

This 60 CKX model pump features 3 stages, 43,000 GPM/460 ft TDH with a 6100 HP/4000 volt/590 RPM motor, and is undoubtedly one of the largest vertical multistage pumps ever built in North and South America.

The customer, North Texas Municipal Water District, witnessed the test which ran very smoothly.

Testing was conducted at the Ruhrpumpen test lab in Monterrey, Mexico.





Technical Details

Pump	VCT 67HXH
Application	Circulating Water
Flow	91,500 gpm (20,782 m ³ /h)
Head	62 ft (19 m)
Motor	1,750 HP (1,305 kW)

Technical Details

Pump	43 KX
Application	Hydrocarbon
Flow	28,628 gpm (6,500 m ³ /h)
Head	160 ft (49 m)
Motor	750 HP (559 kW)



Technical Details

Pump	32KXL/H, 2 stages
Application	Crude Oil Blend
Flow	12,988 gpm (2,950 m ³ /h)
Head	370 ft (113 m)
Motor	2,300 HP (1,715 kW)





Technical Details

Pump	32KXH, 2 stages
Application	Diluted Bitumen
Flow	12,703 gpm (2,895 m ³ /h)
Head	250 ft (76 m)
Motor	1,250 HP (932 kW)



Technical Details

Pump	34KXH, 3 stages
Application	Synthetic Crude
Flow	15,410 gpm (3,500 m ³ /h)
Head	295 ft (90 m)
Motor	1,500 HP (1118 kW)

Technical Details

Pump	VCT 28KXH, 3 Stage
Application	Petrochemical
Flow	8,911 GPM (2,024 m ³ /h)
Head	335 ft (102 m)
Motor	1,500 HP (1,119 kW)



Technical Details

Pump	VCT 60CKXL
Application	Water Transfer
Flow	43,043 GPM (9,857 m ³ /h)
Head	1,066 ft (325 m)
Motor	6,100 HP (4,550 kW)





Technical Details

Pump	VCT 43 WX, 1 Stage
Application	Waste water
Flow	31,700 GPM (7,200 m ³ /h)
Head	83 ft (25 m)
Engine	959 HP (715 kW)

Technical Details

Pump	TR 1000/7/1000, 2 stages
Application	Cooling Water
Flow	50,630 GPM (11,500 m ³ /h)
Head	213 ft (65 m)
Motor	3,620 HP (2,700 kW)





Technical Details

Pump	TR 800/ 7/685 x 2
Application	Cooling Water
Flow	30,820 gpm (7,000 m ³ /h)
Head	223 ft (68 m)
Motor	4000 HP (2700 kW)



Technical Details

Pump	37KXH, 1 stage
Application	Service Water
Flow	20,165 GPM (4,580 m ³ /h)
Head	118 ft (36 m)
Motor	738 HP (550 kW)



* With Vane Grating Flow Modifier

Technical Details

Pump	VCT 30 KXH/Ho, 2 Stage
Application	Water
Flow	12,073 gpm (2,742 m ³ /h)
Head	335 ft (102 m)
Motor	1,500 HP (1,119 kW)





Coming Attractions 😊

“Vertical Pumps Part 2 (VS4/5, VS6, VS7)”

Thurs 27th Jan – 08.00 (UK GMT) (Eastern Hemisphere) & 17.00 (UK GMT) (Western Hemisphere)

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

While engineers generally have a good understanding of horizontal pumps, their exposure to vertical pumps is more limited and as a result they are frequently misunderstood and under-utilised.

This course will look to put that right and explain the features and benefits of vertical pumps and how they can frequently be problem solvers.

Future sessions : – Subject To Be Advised (I haven't decided yet!)



Specialist for Pumping Technology

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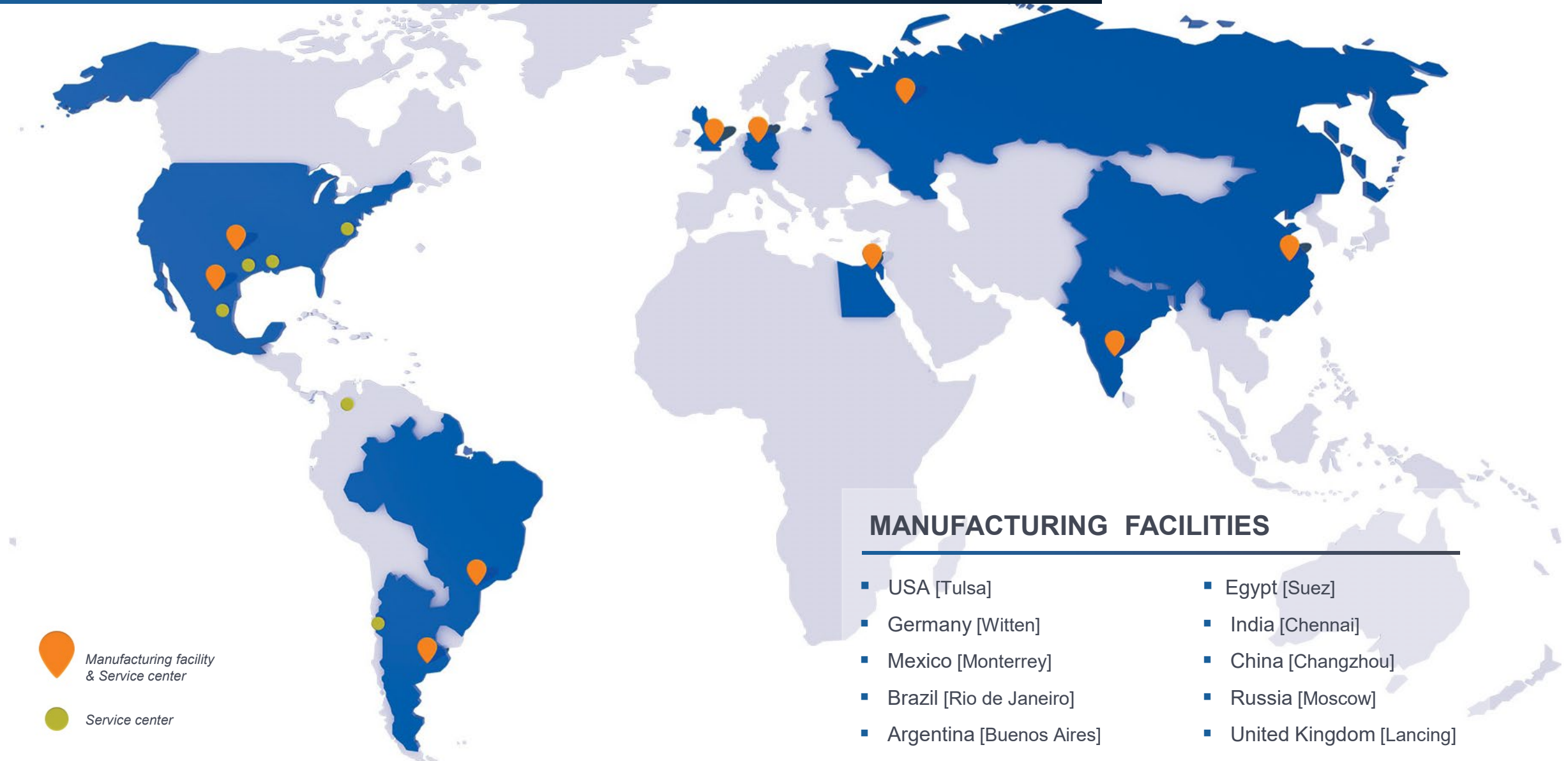
**+70 YEARS
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**15 SERVICE
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+70,000 PUMPING SOLUTIONS INSTALLED WORLDWIDE

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MARKETS WE SERVE

Our commitment to create innovations that offer reliable solutions to our customers allow us to provide a complete range of pump systems to support **core markets** as:





OUR PUMP LINES

Ruhrpumpen offers a broad range of highly engineered and standard pumping products that meet and exceed the requirements of the most demanding quality specifications and industry standards.

Our pumps can handle head requirements as high as 13,000 ft (4,000 m) and capacities up to 300,000 gpm (68,000 m³/hr). Moreover, our pump designs cover temperatures from cryogenic temperatures of -310 °F (-196 °C) up to 752 °F (400 °C).

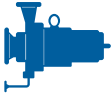





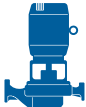
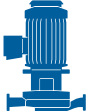


Products include:

- Single Stage Overhung Pumps
- Between Bearings Pumps
- Horizontal Multi-Stage Pumps
- Vertical Multi-Stage Pumps
- Vertical Mixed Flow & Axial Flow Pumps
- Positive Displacement Pumps
- Full Range of Industrial Pumps
- Submersible Pumps
- Magnetic Drive Pumps
- Decoking Systems
- Packaged Systems
- Fire Systems



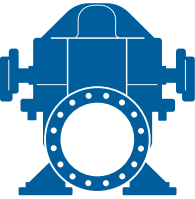




OVERHUNG PUMPS

CATEGORY	RP MODEL	DESIGN STANDARD	
Sealless Magnetic Drive Pumps	CRP-M / CRP-M-CC	ISO 2858 & 15783 HI design (OH11)	
	SCE-M	API 685	
Foot Mounted OH1 and General End Suction Pumps	IPP	HI design (OH1)	
	CPP / CPP-L	HI design (OH1) ANSI B73.1	
	CPO / CPO-L	HI design (OH1) ANSI B73.1	
	CRP	HI design (OH1) ISO 2858 & 5199	
	GSD	HI design (OH0)	
	SHD / ESK / SK / SKO SKV / ST / STV	HI design (OH1)	
	SWP	HI design (OH3A)	
Centerline Mounted	SCE	API 610 (OH2)	
Vertical In-Line Pumps	SPI	API 610 (OH3)	
	IVP / IVP-CC	HI design (OH4 / OH5)	
	IIL	HI design (OH5) Dimensionally compliant with ANSI B73.2	
	SPN	API 610 (OH5)	











BETWEEN BEARING PUMPS

CATEGORY		RP MODEL	DESIGN STANDARD	
1 and 2 stage	Axially split	HSC / HSD / HSL HSR / ZW	HI design (BB1)	
		HSM	HI design (BB3)	
		ZM / ZMS ZLM / ZME	API design (BB1)	
	Radially split	HVN / J	API design (BB2)	
		RON / RON-D	API design (BB2)	
Multi-stage	Axially split	SM / SM-I	API design (BB3)	
		JTN	API design (BB3)	
	Radially split <i>single casing</i>	GP	API design (BB4)	
	Radially split <i>double casing</i>	A LINE	API design (BB5)	













VERTICAL PUMPS

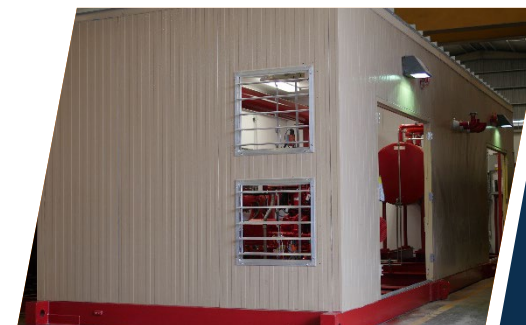
CATEGORY		RP MODEL	DESIGN STANDARD	
Single casing	Diffuser	VTP	HI & API 610 (VS1)	
		VCT	HI & API 610 (VS1)	
		HQ	HI & API 610 (VS1)	
		VLT	HI & API 610 (VS1)	
	Volute	DSV / DX	HI & API 610 (VS2)	
	Discharge through column – Axial flow	VAF	HI & API 610 (VS3)	
Double casing	Separate discharge line	VSP / VSP-Chem	HI & API 610 (VS4)	
	Diffuser	VLT / VMT	HI & API 610 (VS6)	
	Volute	DSV / DX	HI & API 610 (VS7)	
Submersible pumps		SMF	HI design (OH8A)	
		VLT-Sub / VTP-Sub	HI design (VS0)	





SPECIAL SERVICE PUMPS

CATEGORY	RP MODEL	DESIGN STANDARD	
Pitot tube pumps	COMBITUBE	HI design	
Reciprocating pumps	RDP	API 674 ISO 13710	
Vertical turbine generator	VTG	HI design (VS6)	
Barge	LS BARGE	HI design	
Floating dock pumps	ZVZ	HI design	
	LVZ	HI design	
Cryogenic pumps	SVNV	-	
	VTG Cryogenic	-	
	VLT Cryogenic VLTV	-	
Pre-packaged fire pump systems	Fire systems incorporate pumps, drivers, control systems and pipework in a single container. They can be skid mounted, with or without enclosure and supplied with electric motor or diesel engine.		 NFPA-20-850 UL and FM approved components





Vertical Pumps

V