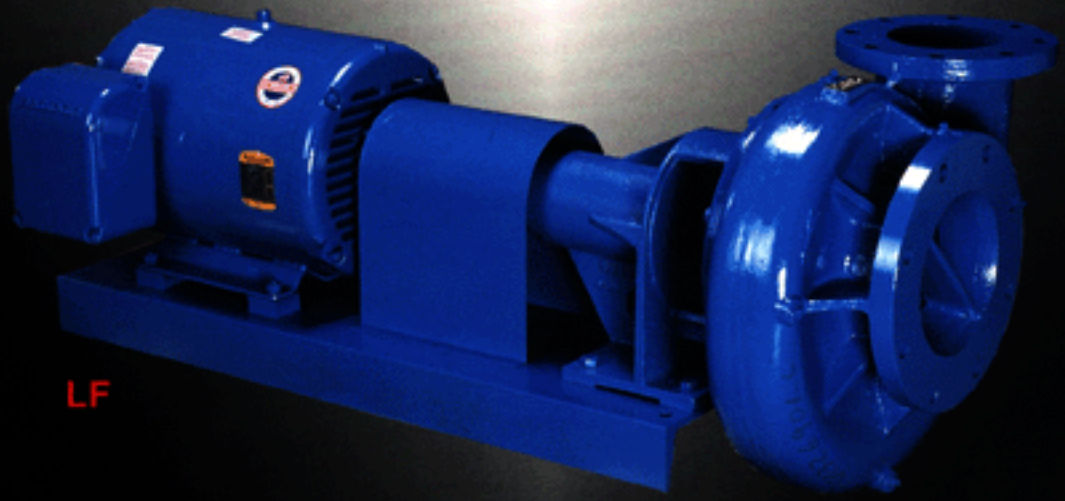
PACO®
PUMPS

The "Smart Pumps"

LC

LCV



LF

End Suction Pumps

Type LC
Close Coupled
Flows to 4000 GPM
Heads to 400 Feet
Horsepower to 200

Type LF
Frame Mounted
Flows to 6000 GPM
Heads to 400 Feet
Horsepower to 300

Type LCV Close Coupled,
Vertically Mounted
Flows to 4000 GPM
Heads to 400 Feet
Horsepower to 200

PACO End Suction Pumps

The right choice - for a lot of good reasons

Culminating more than 90 years of commitment to advanced pump technology, PACO end suction, single stage pumps serve as industry standards in performance, quality and durability. Available in 37 sizes, more than any other supplier within this hydraulic range, they are designed to meet the following application requirements:

- Flows up to 6000 GPM
- Dynamic heads up to 400 feet
- Discharge sizes from 1" to 10"
- Horsepower ranges from 1/3 to 300

Features that make a genuine difference

Advanced features incorporated as standard on PACO end suction pumps ensure optimum performance and reliability. These PACO features, as well as optional features that meet specialized needs, are available on the broadest line of high-efficiency pumps offered to industry.

Standard pump features include:

- Higher efficiency - maintained over an extended operating range
- ANSI/NSF-61 Standard Certified
- ANSI/NSF-50 Standard Certified
- Double-volute casings on models with higher specific speeds
- Dynamically balanced enclosed-type impellers
- Mechanical seals or packed box
- Lead-free bronze construction
- Back pull-out capability
- Suction and discharge pressure gauge taps
- Full-flanged connections 2-1/2" discharge and larger
- Integrally cast suction splitter on flanged models
- Low NPSH requirements

Optional pump features include:

- All Iron or All Lead-free Bronze construction
- Special alloy shafts and sleeves
- Special mechanical seals
- Regreaseable or oil-lubed bearing frames
- Cast iron or steel bases
- TEFC or explosion-proof motors
- Abrasive separators
- Engine drives

Type LF

Frame mounted pumps are provided with threaded connections through 2" discharge. Bases are available in steel or cast iron. Steel bases are channel steel, with standard venting and grout holes. Cast iron bases are provided with drip rim, drain and grout access. Bearings are furnished permanently sealed, with optional regreaseable or oil-lubed.

Type LC

Close coupled pumps are provided with threaded connections through 2" discharge. Foot mounting is standard, with additional steel or cast iron base plate options available. Customized stuffing box easily permits the use of various seal types in a variety of materials.

Type LCV

Close coupled vertically mounted pumps are provided with threaded connections through 2" discharge.
Steel or cast iron support stands are bolted directly to the pump suction from below, requiring no further pump bracing.
Suction elbows are cast iron and are separate from the support stand. Available elbow configurations include - Standard Radius, Long Radius and Reducing.
Vertical design is available from 1" through 8" discharge.

Registered Firm
ISO-9001/Q9001
Certificate QSR-184

Member of: The Hydraulic Institute
American Water Works Association
Water Environment Federation

Suggested Specifications for PACO End Suction Pumps - type LC, LF, LCV

The contractor shall furnish and install as shown in the plans and described in these specifications, PACO (close coupled type LC, frame mounted type LF, close coupled vertically mounted type LCV) high performance end suction pumps designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).

Efficiency- Pump(s) shall meet or exceed the efficiency shown in the pump schedule.

NPSH(R)- To insure cavitation-free operation, each pump's NPSH Requirement must be low enough to permit stable, continuous operation at 120% or greater of best efficiency point.

Noise- Each pump shall be capable of continuous operation without producing noise in excess of the Hydraulic Institute and OSHA guidelines.

Casing- Pump casing shall be close grain cast iron fitted with a replaceable (lead-free bronze, cast iron) case wear ring. Pumps with a specific speed greater than 1600 shall have double-volute casings with suction splitter to reduce radial loading and shaft deflection. All pumps shall be of the back pull-out design so that the rotating element can be removed from the casing without disconnecting the suction or discharge piping.

Impeller- Pump impeller shall be of the enclosed type of cast (lead-free bronze, iron) and shall be statically and dynamically balanced. Impeller diameter shall be trimmed for the specified design conditions.

Shaft Sealing- Pump shaft shall be fitted with (a leakless mechanical seal, non-asbestos shaft packing) suitable for the temperatures and pressures indicated.

Motor- Motor shall be of the horsepower and speed shown in the pump schedule. Pumps requiring larger horsepowers shall not be acceptable. Pump shall be (flexible, close) coupled to a (3, 1) phase, (60, 50) Hertz, _____volt, (horizontal, vertical), (ODP, TEFC, Explosion Proof) motor with (1.15, 1.0) service factor. 40°C ambient.

For bearing frame mounted (type LF) pumps, add the following two paragraphs:

Bearing Frame- Pump shall be mounted on a heavy duty cast-in-one-piece cast iron bearing frame. Shaft shall be of (carbon steel, stainless steel). Pump bearings shall be (permanently sealed, regreaseable, oil-lubed).

Base, Coupling and Guard- Pump and motor shall be mounted on a channel steel base, adequately reinforced against deflection. Pump shall be connected to the drive motor by a flexible coupling capable of withstanding all torsional, radial and axial loads. Coupling and exposed rotating components of the pump and motor shall be protected by an OSHA approved guard.

For close coupled vertically mounted (type LCV) pumps, add the following two paragraphs:

Pump Support- The pump shall be supported from below by a cast iron or fabricated steel mounting stand that shall be bolted directly to the suction connection of the pump. Supporting the casing from the side or top shall not be required, nor allowed.

Suction Elbow- The pump shall be provided with a (long radius, reducing, standard radius) suction elbow that shall be separate from the support stand. Integrally cast elbows and stands shall not be required, nor allowed.

Optional Features Recommended for Specification

To ensure quality pump installation, PACO further recommends that you specify the following items. If it is decided that these features be specified, special attention should be given to ensure that the required quality is reflected in submittals received.

Cast Iron Base (Close Coupled)- To ensure full benefit of the pump back pull-out feature, entire pumping unit shall be mounted on a cast iron drip rim base using cap screws. Pumps shall not be secured with floor studs.

Cast Iron Base (Frame Mounted)- Entire pumping unit shall be mounted on a cast iron base with drip rim. Base shall have enclosed ends and access to permit grouting.

Drip Pan (Packed Pump)- All pumps with shaft packing shall be supplied on a base having a drip pan with drain connection.

High Efficiency Motors- For additional energy savings, high efficiency motors should be specified. Desired efficiency should be stated by motor size.

Energy Evaluation- If pumps other than those in the schedule are offered, the pump supplier shall submit an energy evaluation for the engineer's approval prior to manufacture of the pumps. This evaluation shall compare proposed equipment to the specified efficiency and show that the total job operating cost will be lower or meet the operating cost at specified efficiency.

PACO Pumps, the Smart Choice for actual system conditions

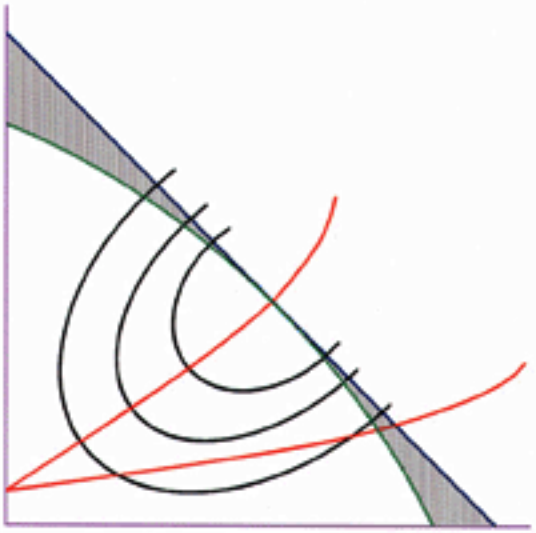


Figure 1: Pump curve closely approximates the theoretical pump curve with minimal losses. Broad band efficiencies allow for more efficient pump operation even when system conditions force pump operation away from BEP.

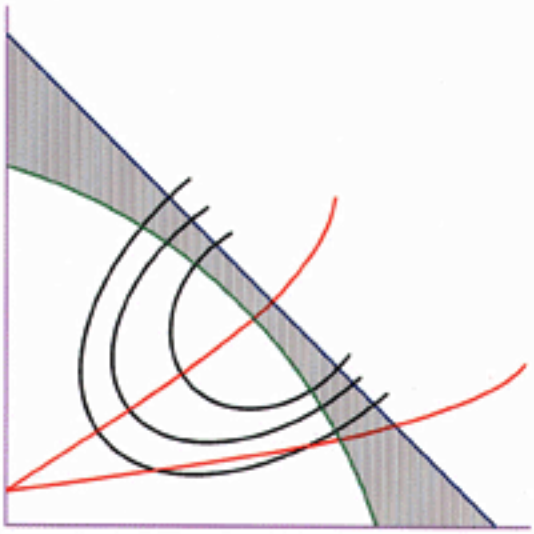


Figure 2: Pump curve deviates from theoretical pump curve illustrating losses due to turbulence, recirculation, shock, and friction. Broad band efficiencies allow for more efficient pump operation at actual system curve even with these losses.

From initial installation through an extended operating life, PACO end suction pumps deliver advantages that make them the logical choice of engineers, contractors and users.

Lower initial cost

The higher performance of PACO end suction pumps, plus the expanded selection of 37 pump sizes, adds up to a smarter pump choice - such as a lower horsepower, smaller pump optimally suited to the precise application requirements.

Reduced operating cost - over a wide range of conditions

Beyond offering high efficiency at the pump selection condition, PACO pumps use hydraulic design that provides wider bands of high efficiency. As a result, low operating costs are ensured even during off-design operating conditions. The capability for maintaining minimal operating costs - a key design objective - derives largely from the application of computer technology to the design of PACO's end suction pumps.

Low maintenance cost and maximum reliability

The PACO end suction pumps' mechanical design minimizes downtime and reduces maintenance. Short shaft overhang reduces shaft deflection to .002" at seal faces. Dynamically and hydraulically balanced impellers reduce axial loads and vibration.

When indicated by specific speed, and allowed by pump size, a compensated double-volute casing design is used to reduce radial loading of the impeller, resulting in extended life for bearings and mechanical seals. The lower NPSH required, characteristic in PACO pump designs, minimizes cavitation - and the resultant risk of impeller damage - at flows substantially above pump design points.

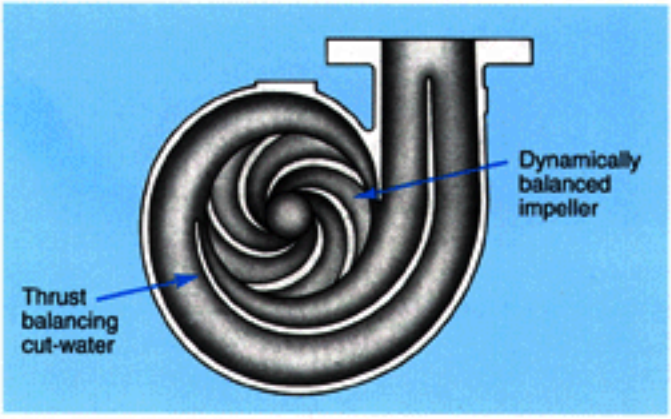
When maintenance is needed, PACO's "back pull-out" feature - common to all PACO end suction pumps- permits repairs to be made without disconnecting suction and discharge piping. Further, all pumps having 2-1/2" or larger discharge use full flanges with through-bolts, eliminating the delays associated with studded suction connections and corroded threading.

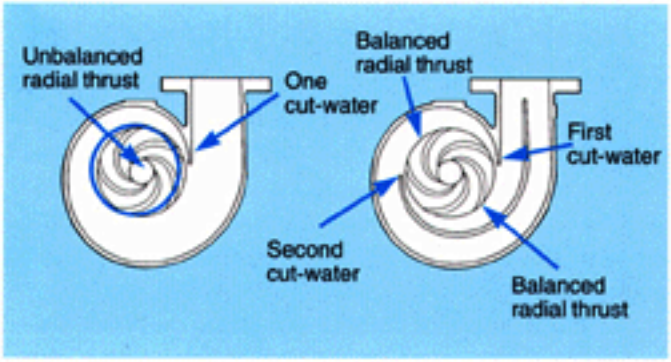
Quiet operation

The superior hydraulic and mechanical design that produces higher efficiency and reliability in PACO end suction pumps also reduces pump noise. The impeller vane outlet design, for example, avoids pulsations at the fluid exit. Further, features such as the compensated double-volute, dynamically balanced impellers and short shaft overhang help keep vibration to a minimum.

The Right Pump Choice. . .The Smart Pump

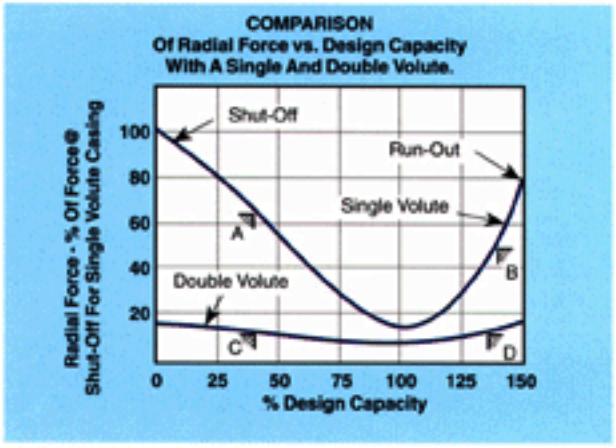
PACO's compensated double - volute design reduces maintenance, extends bearing and seal life, while providing quieter operation





Flanged Single & Double Volute Pump Models

Single Volute Models	Double Volute Models
2570	4070
2595	4095
2512	4012
3070	5095
3095	6095
3012	6012
3015	6015
4015	8012
5012	8015
5015	1015



In smaller pumps, the radial forces on the shaft at the impeller are low enough that a single volute design is normally adequate. As the impeller diameter and speed increase, however, unbalanced radial loads cause shaft deflection, resulting in premature wear of mechanical seals, bearings and wear rings.

PACO's compensated double-volute design effectively responds to this problem because the two volute areas create offsetting radial forces on the shaft. As a result, shaft deflection is minimized, operation is quieter, maintenance is reduced and pump life extended.

A double-volute pump should be specified for pumps with a specific speed greater than 1600. The chart above indicates PACO's flanged pump models with single and double-volutes.

Pumps are normally designed to operate at or extremely close to 100 percent of design capacity and design head resulting in minimal radial thrust. In actual operation, however, load variances or miscalculation of the system head curve frequently result in pumping conditions changing either toward the "shut-off" or "run-out" condition. In such a situation, the resultant radial thrust on an impeller encased in a single volute can be great enough to cause premature wear and shaft failure. The threat is intensified because the force is cyclic in nature, due to rotation. Note points A and B on the graph.

Traditionally, some manufacturers have attempted to deal with this condition through the use of larger, more expensive shafts and special bearings. PACO's innovative double-volute, however, solves the problem by dividing the fluid flow into two similar geometric regions with two cut-waters 180° as shown above. Although the volute pressure inequalities remain as in a single volute casing, there are two resultant impeller radial forces opposing each other. These opposing forces restrict the shaft to a normal axis of rotation, and the net radial force remains at a low level throughout the capacity range of the pump. See points C and D on the graph.

PACO high-efficiency end suction pumps

Current economic and environmental conditions are clearly reflected in the design climate of the late 20th century. In addition to overall increases in energy costs, urban renewal, larger industrial processes, and expanded irrigation areas make pump efficiency an important priority among engineers, contractors, owners and users. PACO pumps represent the state-of-the-art response to today's intensifying demands for higher efficiency, better matching of pump and system performance, and resulting reductions in operating costs.

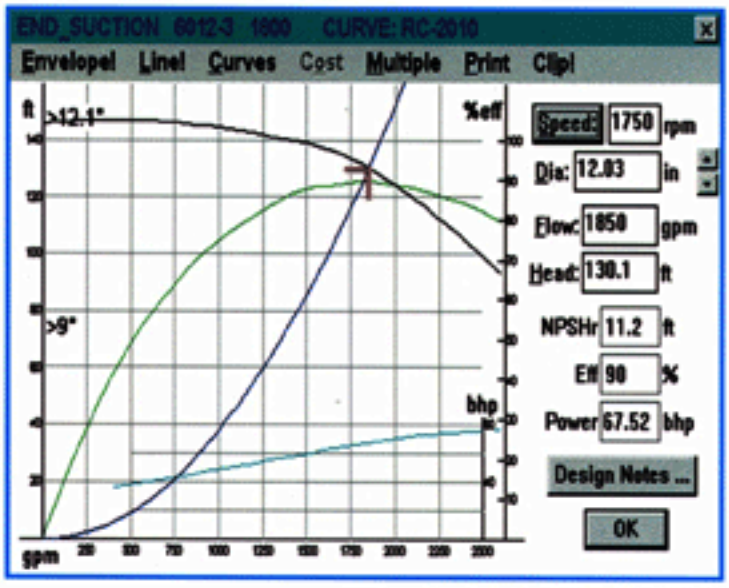
Indicated below is a "Cost of Pumping" formula used to calculate annual operating costs.

Cost Per Hour Per Pump Operation Formula

$$CPH = \frac{.000189 \times USGPM \times TDH \times SG \times \$/KWH}{WWE}$$

CPH = Cost Per Hour
.000189 = Constant relating horsepower to water to kilowatts
USGPM = flow in U.S. Gallons Per Minute
TDH = Total Dynamic Head in feet
SG = Specific Gravity
$/KWH = Operating cost in dollars per kwh
WWE = Wire to Water Efficiency
Wire to Water Efficiency:
Constant Speed Systems: WWE = PE X ME
Variable Speed Systems: WWE = PE x ME x DE
PE = Pump Efficiency
ME = Motor Efficiency
DE = Drive Efficiency

Indicated below is the PACO Select software program that calculates annual operating costs within seconds.



An Example of Savings in Operating Costs Resulting from Increased Pump Efficiency:

PERFORMANCE EVALUATION - PACO Pump model 6012-3

	FLOW gpm	SPEED rpm	TDH ft	PUMP %eff	POWER bhp	NPSHr ft	MOTOR %eff	POWER kWh	HRS/YR	COST
100%	1850	1750	130.1	90	67.52	11.20	90	55.94	2000	0.08
80%	1480	1750	139.2	87	59.80	8.87	90	49.55	4000	0.08
60%	1110	1750	143.1	78	51.43	6.77	90	42.61	1000	0.08
60%	1110	1750	143.1	78	51.43	6.77	90	42.61	1500	0.06

TOTAL ANNUAL POWER CONSUMPTION: 416,605 kWh **ANNUAL OPERATING COST: $ 32,050**

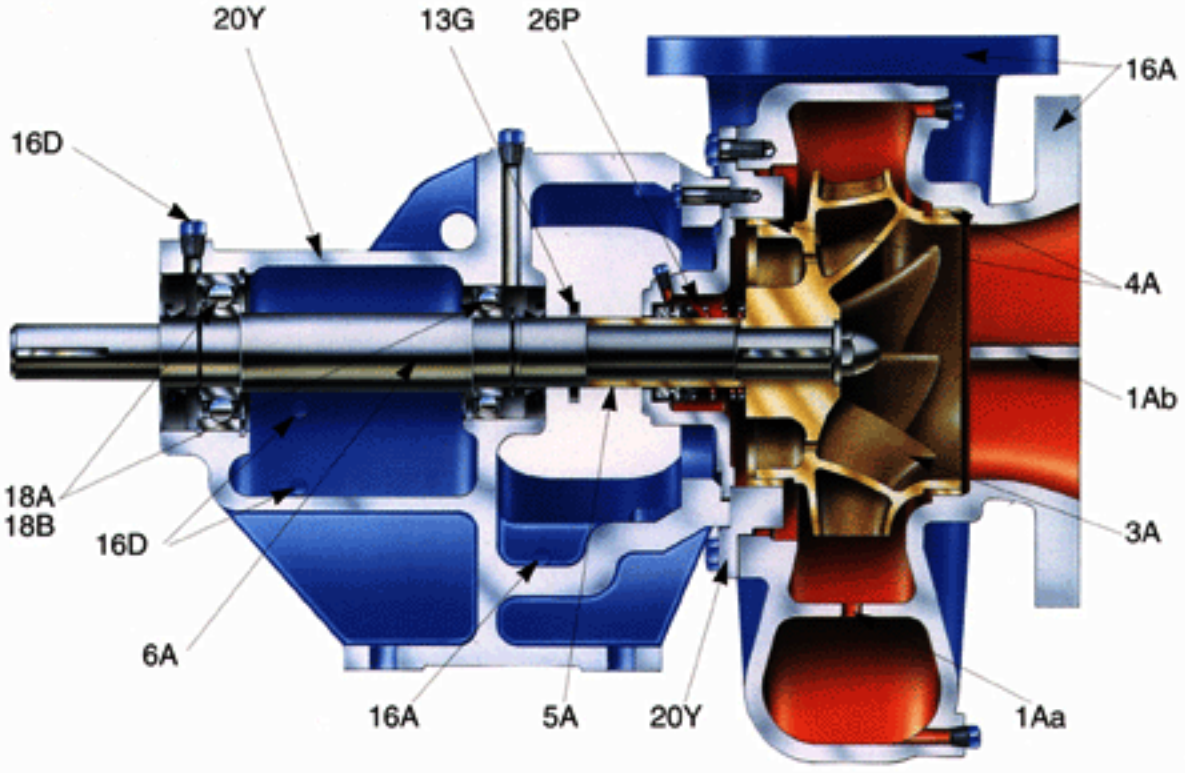
PERFORMANCE EVALUATION - Brand X Pump model 8x6x13

	FLOW gpm	SPEED rpm	TDH ft	PUMP %eff	POWER bhp	NPSHr ft	MOTOR %eff	POWER kWh	HRS/YR	COST
100%	1850	1750	130.6	84	72.61	9.43	90	60.16	2000	0.08
80%	1480	1750	138.3	78	66.27	7.98	90	54.91	4000	0.08
60%	1110	1750	142.0	68	58.52	7.62	90	48.49	1000	0.08
60%	1110	1750	142.0	68	58.52	7.62	90	48.49	1500	0.06

TOTAL ANNUAL POWER CONSUMPTION: 461,185 kWh **ANNUAL OPERATING COST: $ 35,440**

In this example, six points of lower pump efficiency, with all other variables remaining the same, generates an additional operating cost of $3,390 per year.—Nearly $68,000 in an expected 20 year life.

PACO Pumps…Features with proven benefits



Key No.	Feature	Benefit
1Aa	Compensated Double-Volute	Reduces radial loads, maximizing seal and bearing life, reducing maintenance costs and providing quieter operation.
1Ab	Integrally cast Suction Splitter	Requires minimal suction pipe, while reducing turbulence, providing for lower installation and operating costs.
3A	Statically and dynamically balanced, Lead-free Bronze Enclosed Impeller	Standard construction of lead-free bronze, designed for maximum efficiencies, reduces operating costs and assures long life.
4A	Replaceable Lead-free Bronze Case Wear Rings	Promote extended casing life, reducing maintenance costs and downtime.
5A	Replaceable Lead-free Bronze Shaft Sleeve	Increases shaft life, while reducing maintenance and inventory expenses.
6A	High strength Steel Shaft	Shaft deflection minimized (.002" at worst case, at shutoff) to promote long bearing and seal life, reducing downtime and maintenance costs.
13G	Rubber Water Slinger	Prevents leakage from the seal housing, protecting bearings, and promoting continuous operation.
16A	Gauge Taps (not pictured)	Allow for quick monitoring, preventative maintenance and system analysis.
16A	Drain Connection	Allows for ease of maintenance and shorter downtime.
18A 18B	Sealed For Life Bearings	Prevent environmental contamination, while decreasing maintenance and downtime.
16D	Grease Fitting for optional Regreaseable Bearings	Optional bearing lubrication provided to meet customer preference.
16D	Oil Fitting for optional Oil-lubed Bearings	Optional bearing lubrication provided to meet customer preference.
20Y	Heavy-duty, cast in-one-piece, cast iron Bearing Frame with back pullout design	Solid, one piece frame minimizes down time, provides long life and low operating costs. Back pullout feature reduces installation and maintenance expenses.
26P	Customized Insert Stuffing Box	Allows field change to match sealing with current pumpage, lower maintenance costs and long life.

Other PACO Products

- Vertical Turbines
- In-Line Pumps
- Split Case Pumps
- Boiler Feed Pumps
- Sludge Pumps
- Regenerative Turbine Pumps
- Booster Packages
- Vertical Sump Pumps
- Vertical Sewage Pumps
- Dry Pit Non-Clogs
- Submersible Non-Clogs
- Dewatering and Sump Pumps
- Condensate Packages
- VFD Packages
- Trash Pumps

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