Sanitary Centrifugal Pumps

FP and FPX Series

Performance Curves

Fristam PUMPS INC

Pump Basics: Background Information

Pump Series – FP or FPX

Both the FP and FPX Series pumps are manufactured of 316L SS and use the same pump head. The FP incorporates a heavy-dutyt pedestal flange between the motor and pump head. The FPX is a motor mouted pump used for standard duties. Double seals are only available in the FP. The FP is used for vacuum withdrawl, high temperature, high viscosity, aseptic processes and other demanding applications.

Pump Model/Housing Size

Fristam offers both volute and non-volute (circular) housings in many sizes to best match different process needs. The 700 and 1700 models are non-volute pumps designed for lower capacities. Their shorter, steeper curves provide better efficiencies on low flows and superior accuracy when used with control devices. The 3400 and 3500 models are volute high capacity pumps. Their long, flat curves provide greater capacity and an ability to provide steady discharge pressure over a wide flow range.

Speed

Pumps are sized using two standard speeds, 1750 and 3500 rpm. Speed selection is made when selecting a housing. The last digit of the Fristam model number indicates the speed. All models ending in 1 are 1750 rpm. All models ending in 2 are 3500 rpm.

Efficiency

The efficiency of centrifugal pumps varies over the individual curve. The most efficient point of two curves is illustrated in Figure 1. When sizing, it is helpful to select a pump whose curve puts the duty point as close to this bend in the curve as possible.

Impeller Size

Within a given housing, the impeller diameter will determine the flow and pressure produced. Pressure results from the velocity achieved within the pump. The highest velocity occurs at the tip of the impeller and is directly proportional to the square of the impeller diameter. At a given speed, a larger diameter impeller will impart more velocity and produce more pressure.

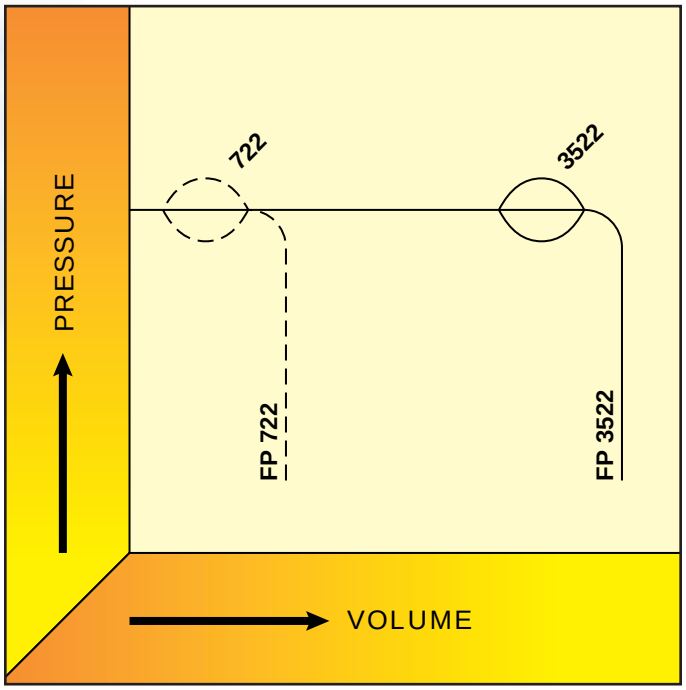


Figure 1

Horsepower

Horsepower must be matched to a given duty or duties. The requirements are determined by individual curves. Enough horsepower must be supplied to handle the most demanding duty, often the duty requiring the most flow, pressure or the pumping of the heaviest product.

Net Positive Suction Head (NPSH)

Product must be forced into a centrifugal pump for it to function properly. This force is called NPSH. Your process must have sufficient NPSH available to meet or exceed the NPSH required.

Seals

Fristam offers a wide selection of seals. Most processes require a standard single seal of chrome oxide faced stainless on carbon. More difficult applications will require harder seal materials such as silicon carbide or tungsten carbide. Double seals are used where a flush is required, where abrasion or stickiness is a problem, for vacuum withdrawal or where a sterile barrier is required between the process and atmosphere.

Selecting A Fristam Pump: A Step by Step Guide

Special Considerations

All curves are based on 70°F water. If your process involves products under vacuum, with high viscosity, high specific gravity, high temperatures, un-dissolved solids or entrained air there are special considerations which affect pump selection. In such cases, please consult Fristam Pumps Inc. or your local Fristam distributor.

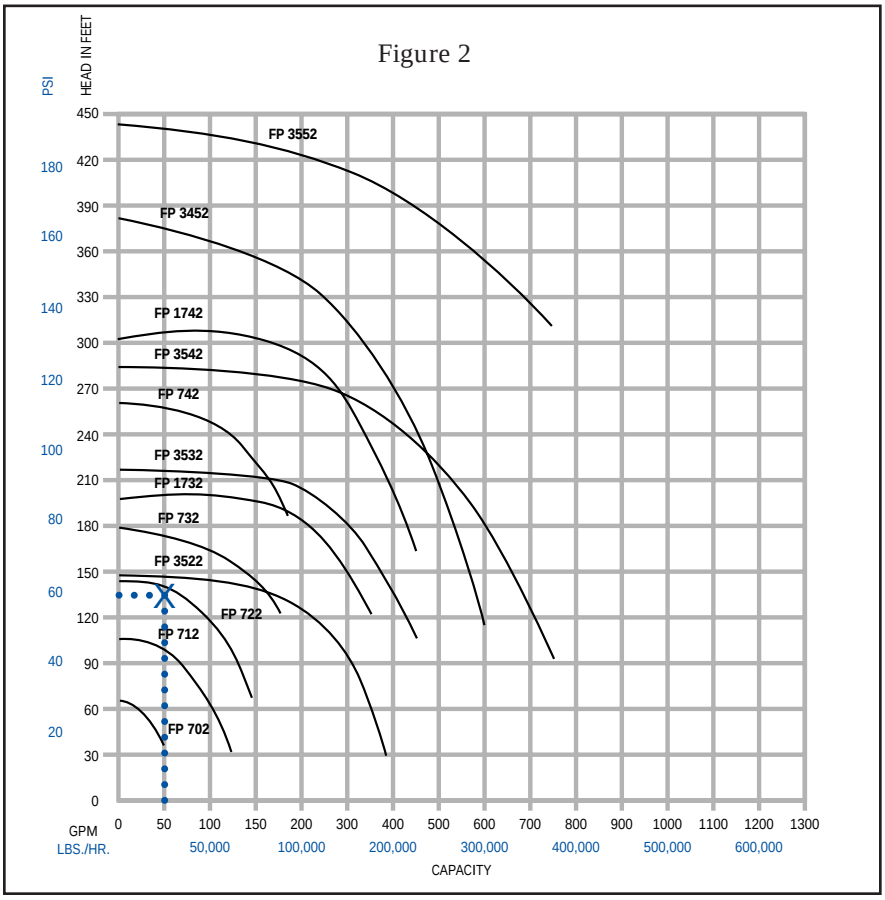
Choosing the FP or FPX

In general, FPX will be suitable for your application unless the following apply:

- A double seal is desired
- Viscosity is greater than 600 cps
- Vacuum of more than 12" Hg exists at the inlet
- Product temperature of 400°F or more
- Horsepower requirement exceeds 50 HP
- Aseptic conditions exist
- A John Crane seal is desired

If any of these conditions exist, the FP will be the proper selection.

Figure 2



Selecting a pump model from the composite curves

Composite curves appear on pages 4 and 5. To select the correct pump model from the composite curves, find the desired flow rate along the bottom scale and the desired pressure on the left-hand vertical scale. Find the point where the vertical line from the flow rate and a horizontal line from the pressure intersect. The curves immediately above this point will be most suitable.

Example

As an example, size a pump to pump 50 gallons per minute and generate 135 feet of head. In the composite shown in figure 2, find the intersection point of 50 GPM on the bottom of the graph and 135 feet on the side. The pump curve directly above the duty point is the 722. In this example, model 3522 might also be considered. A quick review of the duty point on their individual curves (pages 22-23) reveals the 722 will be more efficient than the 3522.

Considering Speed and Efficiency

If both pumps are the same speed, consider which will be more efficient based on the information discussed in Figure 1. If both a high and low speed pump can handle the duty, the high speed will generally be more economical, but the low speed model may have a lower NPSH requirement.

Choosing impeller size and horsepower

Having chosen a pump model based on the first two steps, find the specific curve for the pump model chosen on pages 6 through 31. To determine the impeller diameter and horsepower move vertically from the flow and horizontally from the pressure or head desired. Find the intersecting point.

The next higher curve indicates the correct impeller diameter. The blue line immediately to the right of the intersection identifies the motor horsepower required.

Example

Using our previous example of 50 gallons per minute and 135 feet of head, we can determine from Figure 3 that the impeller diameter should be 145 millimeters (5.7 inches). The motor required is 5 horsepower.

Checking NPSH (Net Positive Suction Head)

To assure there is sufficient product pressure at the inlet of the pump the suction conditions need to be checked. The NPSH required can be determined by finding the point on the individual pump curve where the vertical line from the desired flow rate intersects the NPSH curve. From this point, a horizontal line to the right will intersect the NPSH scale at the net positive suction head required.*

The procedure for determining the NPSH available is described on page 33. When the NPSH available is determined, it must meet or exceed the NPSH required for the pump to function properly. If the NPSH available is insufficient, a change to the inlet conditions, an enlarged inlet or another pump selection may be required.

Example

A 722 pumping 50 GPM against 135 feet of head will require 3 feet or more of NPSH. The installation must provide 3 feet or more when the calculations described on page 33 are made.

*Please note that the NPSH values shown are for full size impellers. Smaller impellers may require somewhat greater NPSH.

Seal Selection

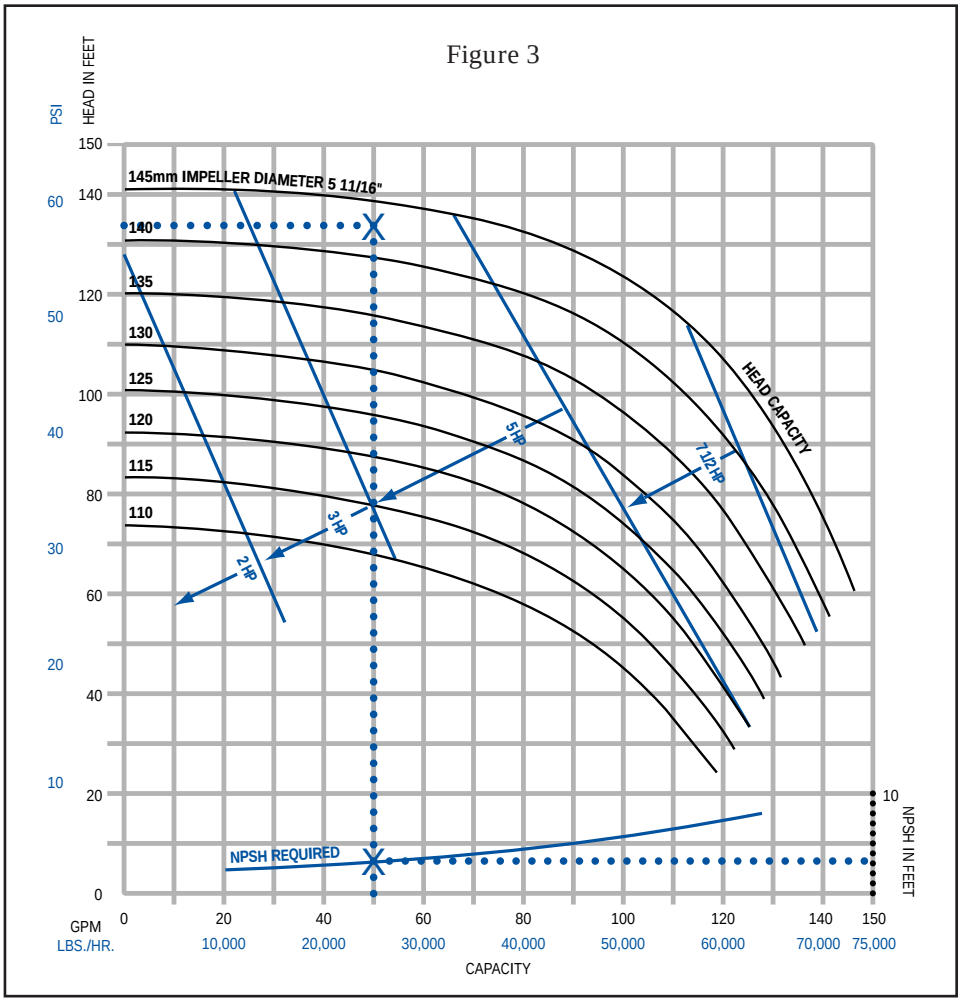
Generally choosing an FP or FPX series pump determines whether the seal is single or double. The primary remaining decision is whether the standard seal materials are appropriate. The standard seal materials are: chrome oxide vs. carbon. To review other seal options, see Fristam's Seal Options Guide.

Applications involving abrasive products or other special conditions may require other combinations. Please consult Fristam Pumps, Inc. or your local distributor in such cases.

Elastomers

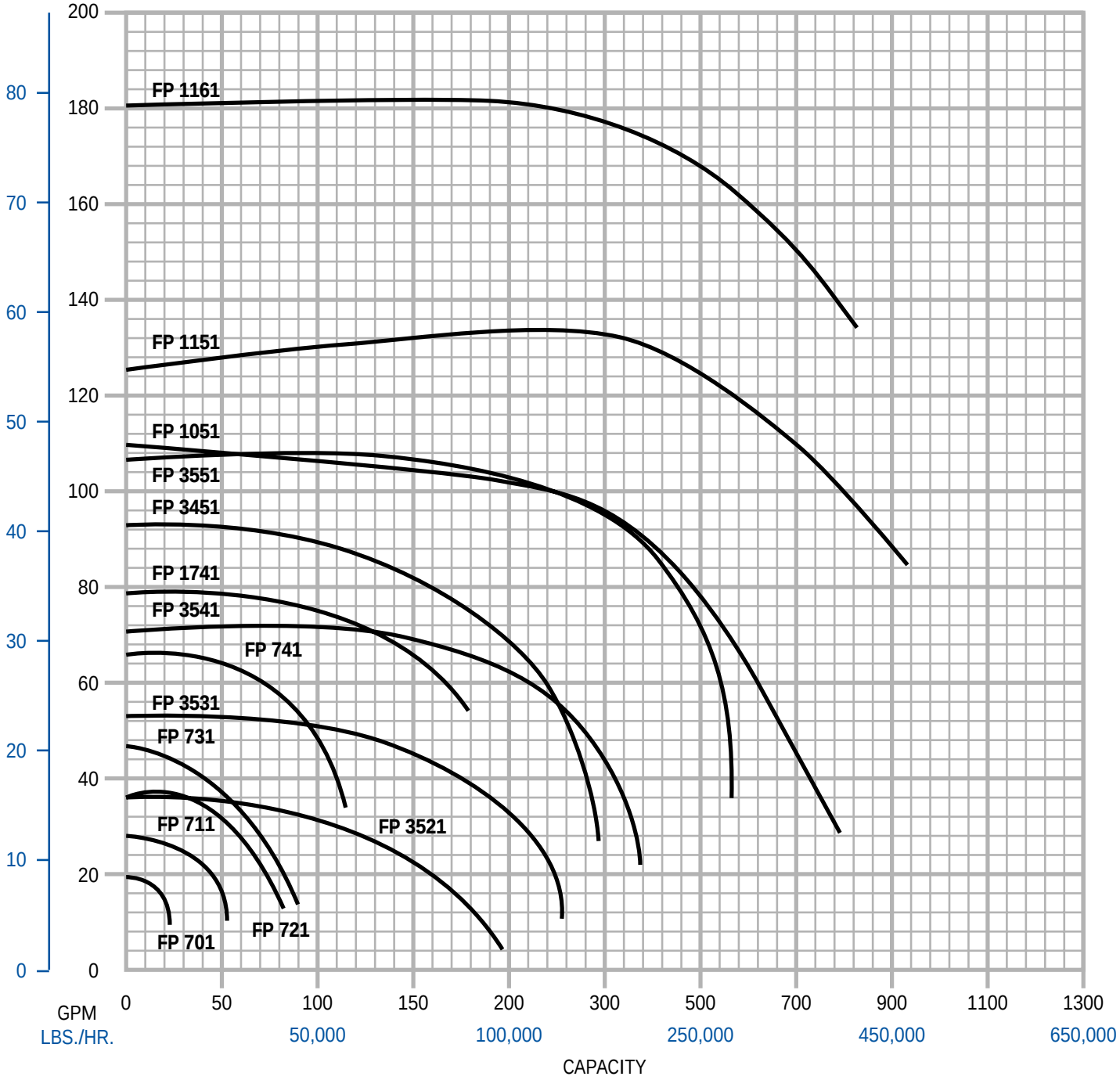
Viton is the standard seal elastomer and BUNA is standard for the cover gasket. Other materials and combinations are available to meet your application or process needs.

Figure 3



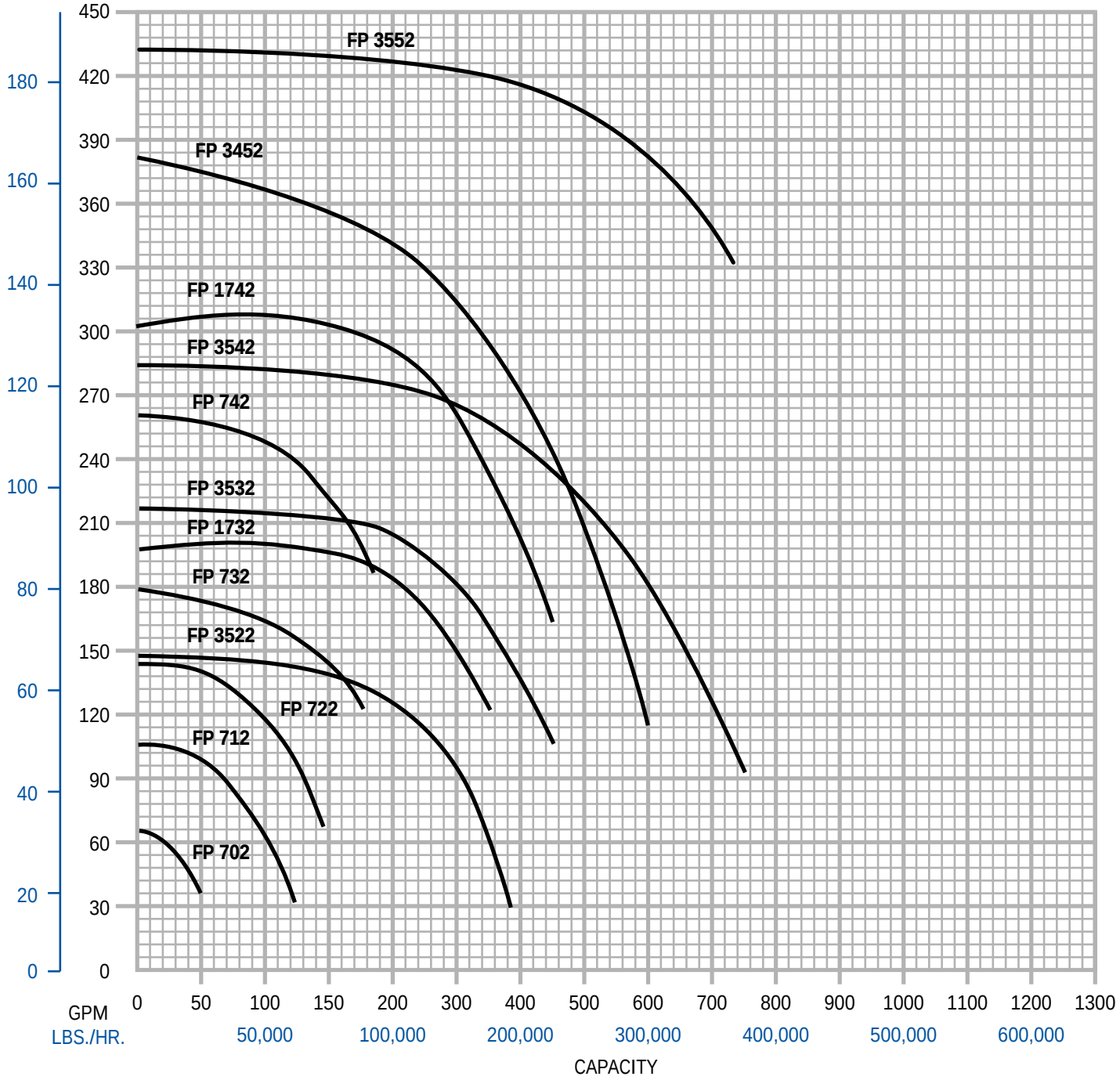
1750 Composite Performance Curve

Performance curves based on tests using 70°F water. Please contact us for different conditions. A tolerance of ±5% applies to all figures.



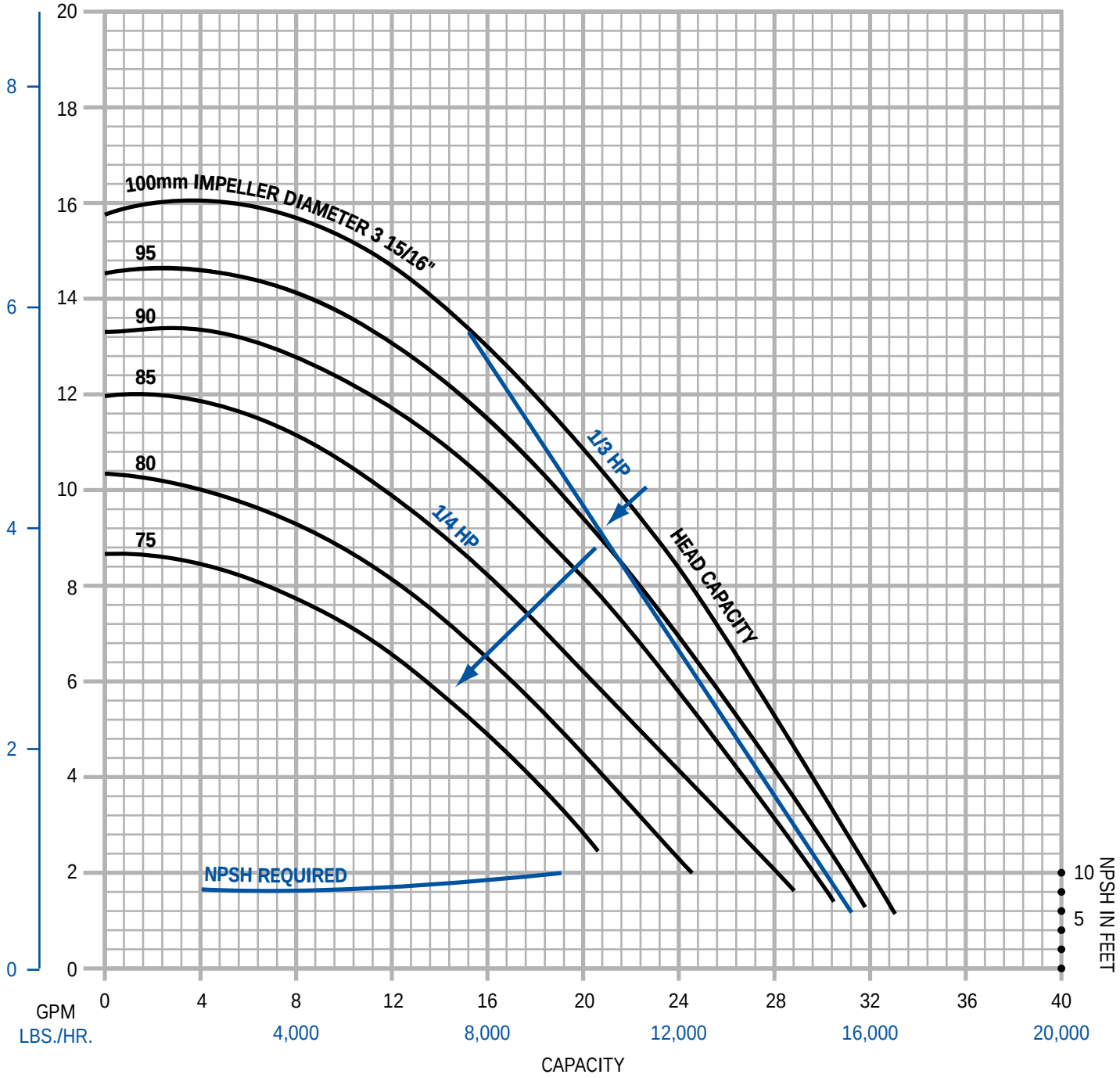
3500 Composite Performance Curve

Performance curves based on tests using 70°F water. Please contact us for different conditions. A tolerance of ±5% applies to all figures.



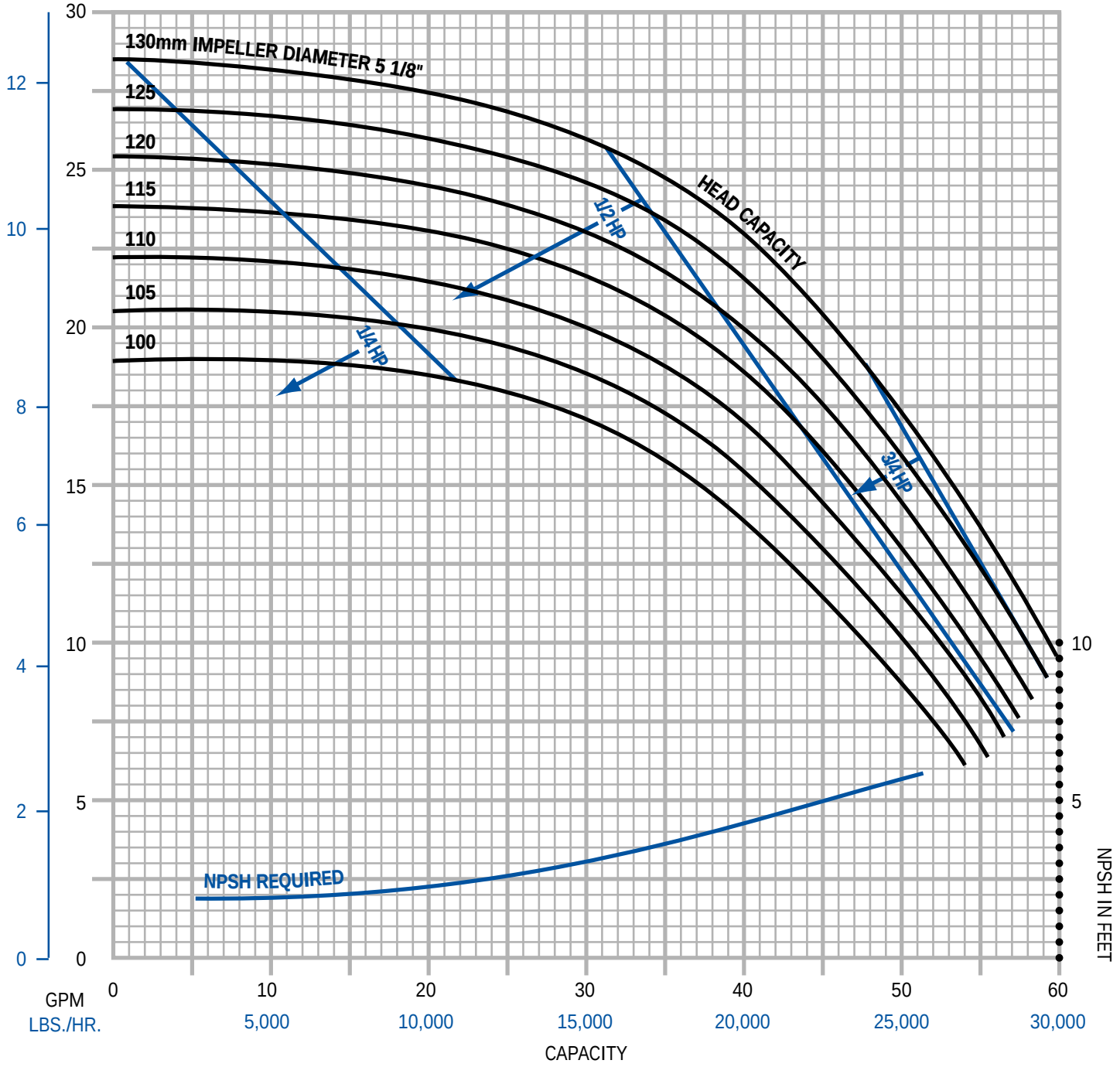
FP/FPX 701 1750 RPM Inlet 1 1/2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 701 is a 1 HP, 143TC frame.



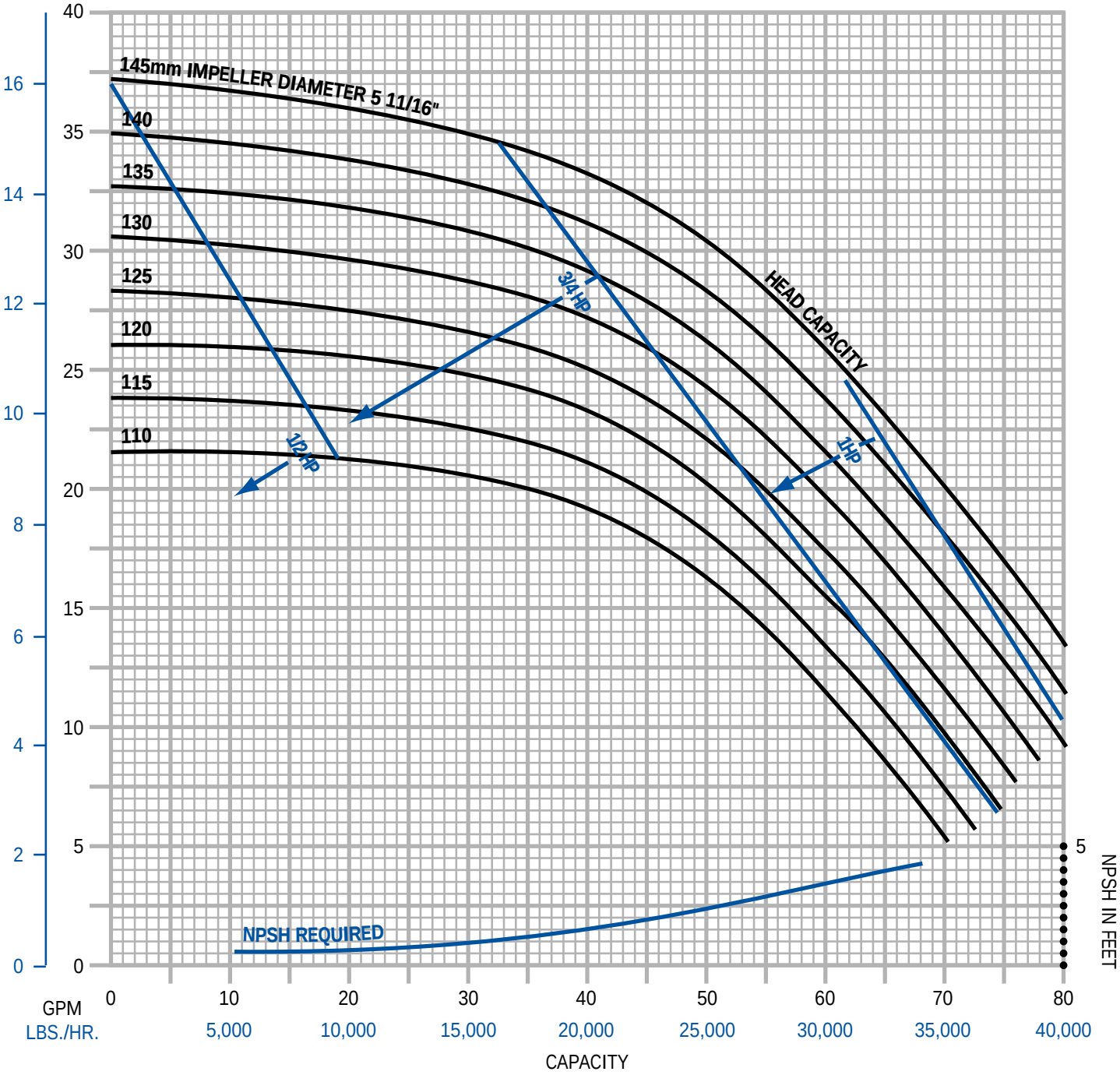
FP/FPX 711 1750 RPM Inlet 2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 711 is a 1 HP, 143TC frame.



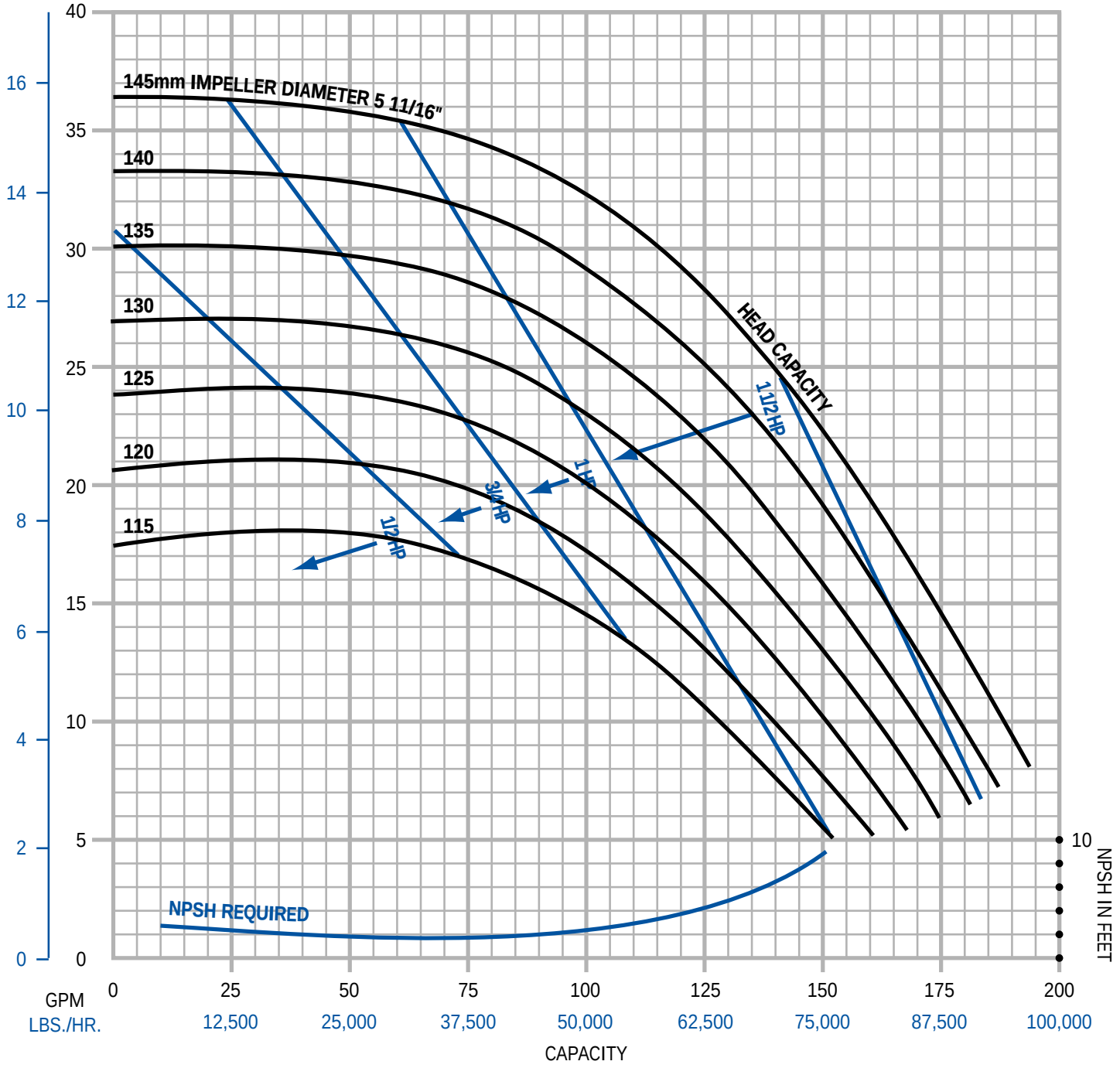
FP/FPX 721 1750 RPM Inlet 2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 721 is a 1 HP, 143TC frame.



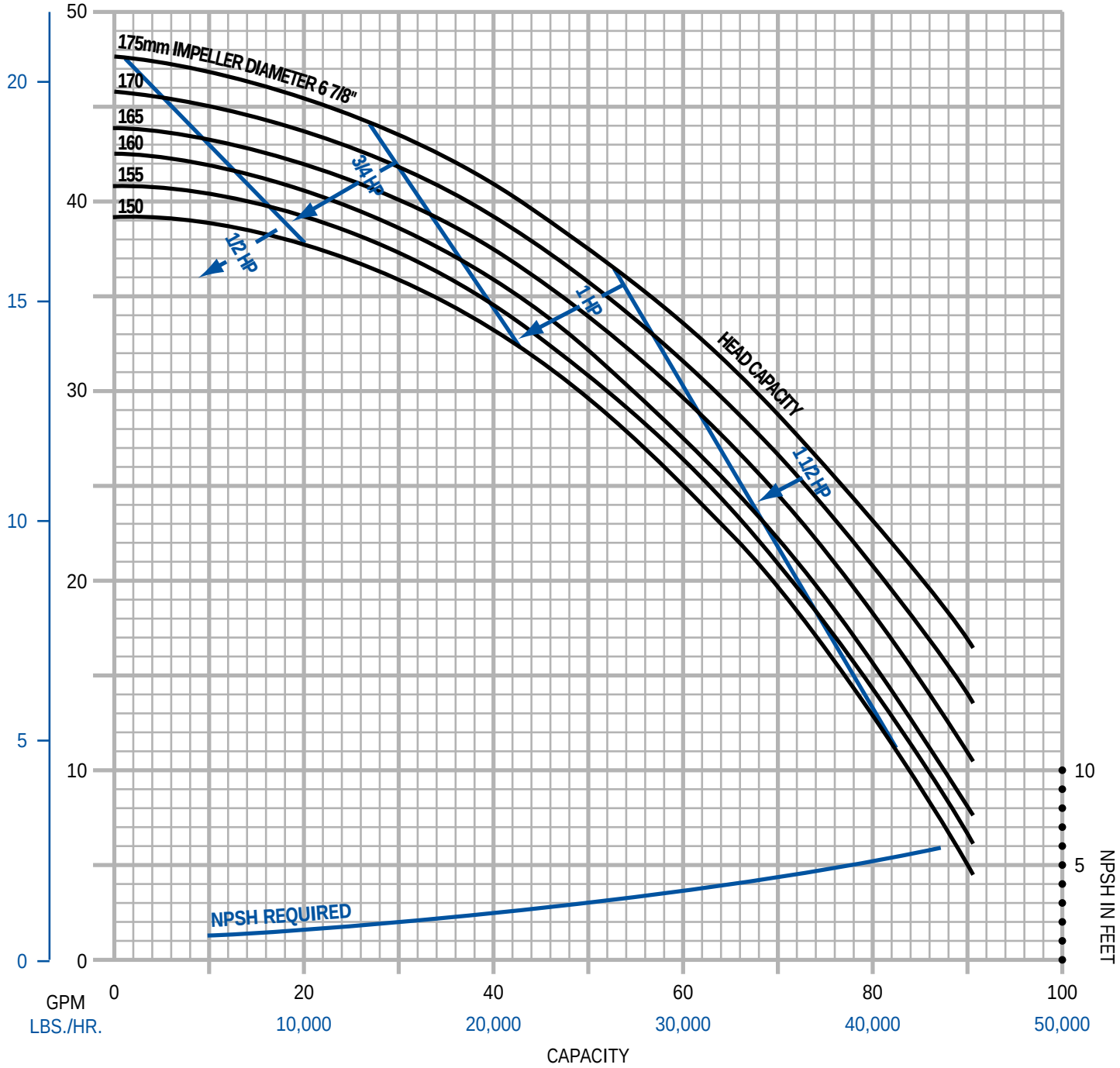
FP/FPX 3521 1750 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 3521 is a 1 HP, 143TC frame.



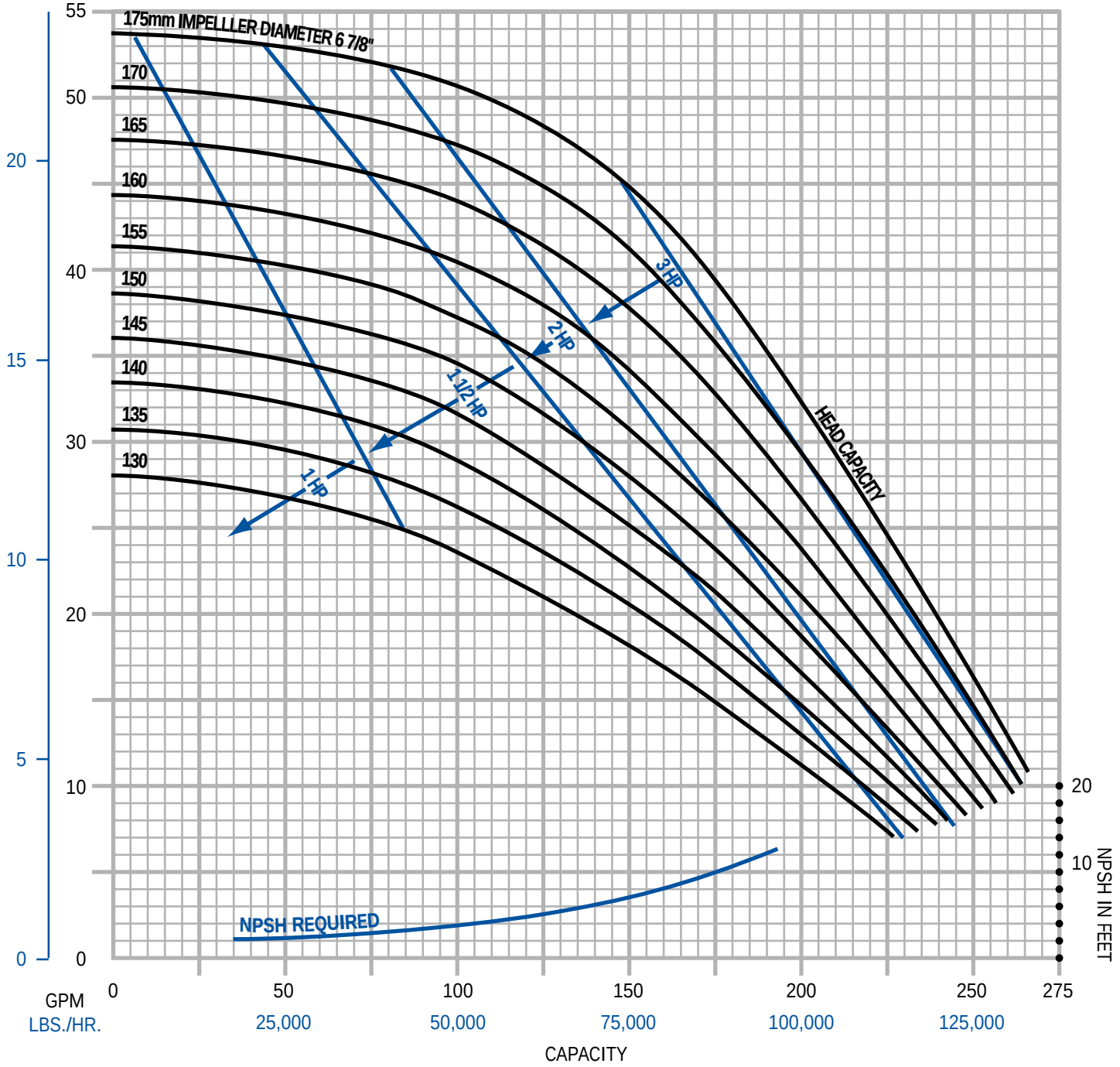
FP/FPX 731 1750 RPM Inlet 2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 731 is a 1HP, 143 TC frame.



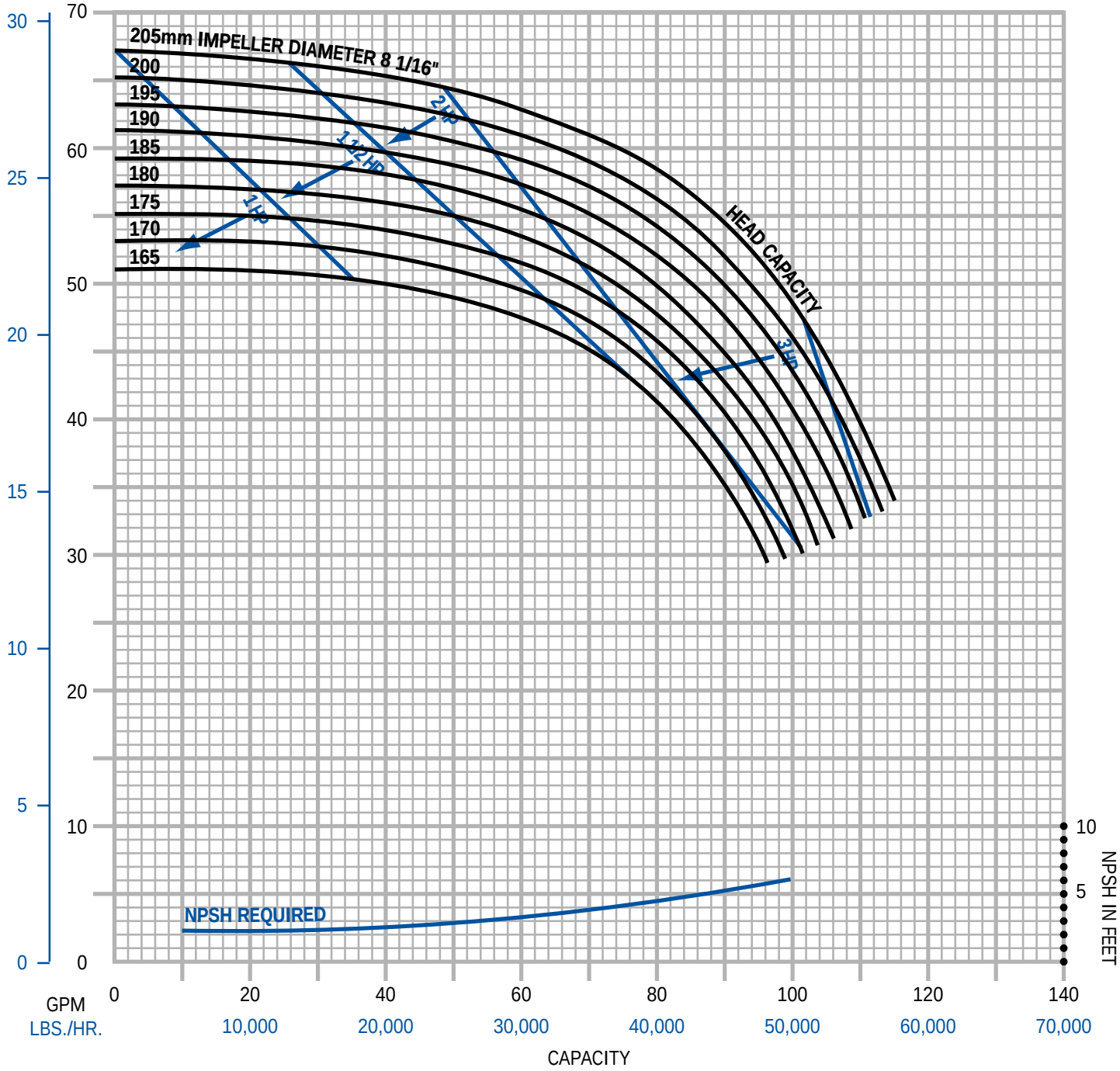
FP/FPX 3531 1750 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



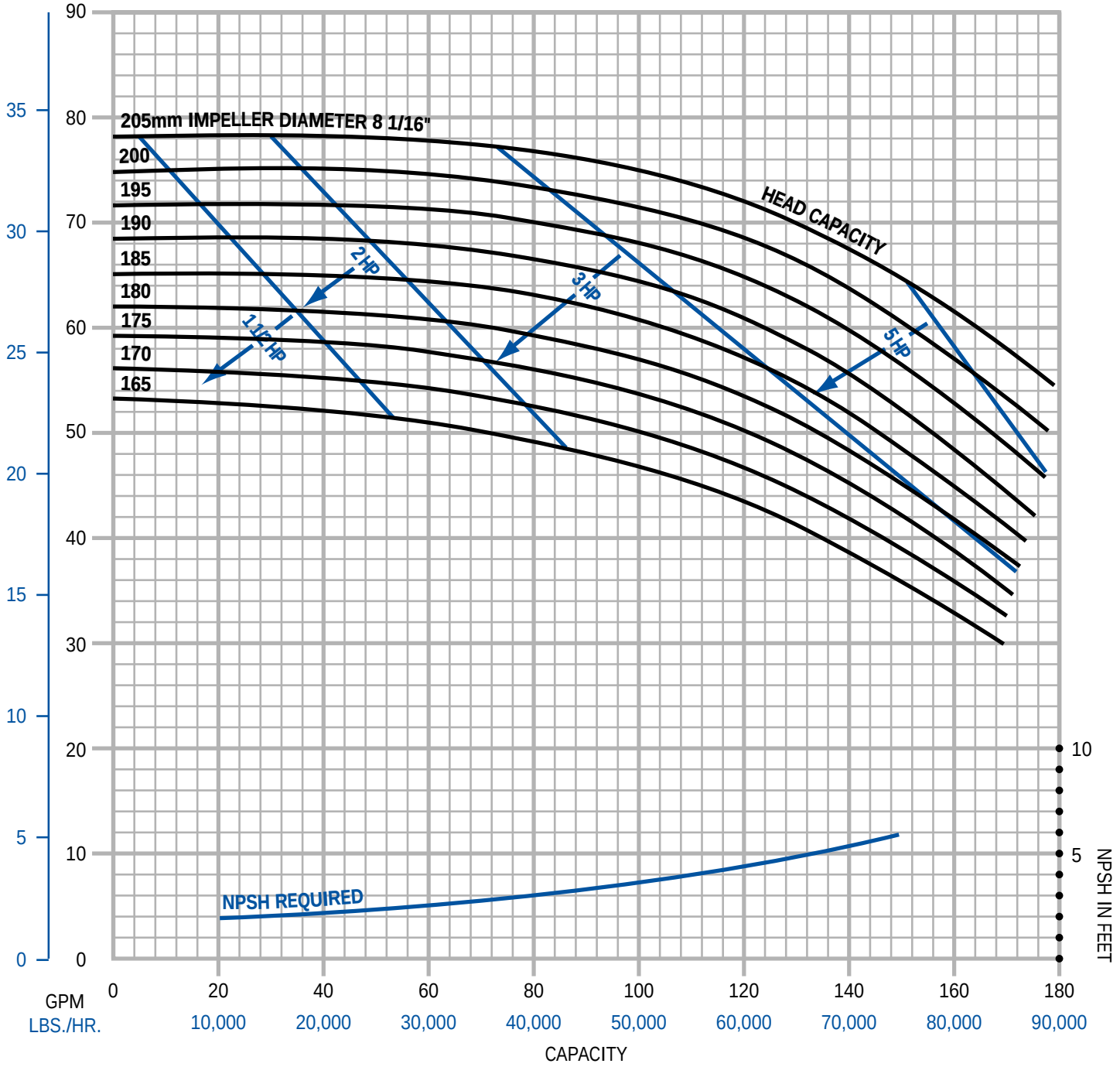
FP/FPX 741 1750 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



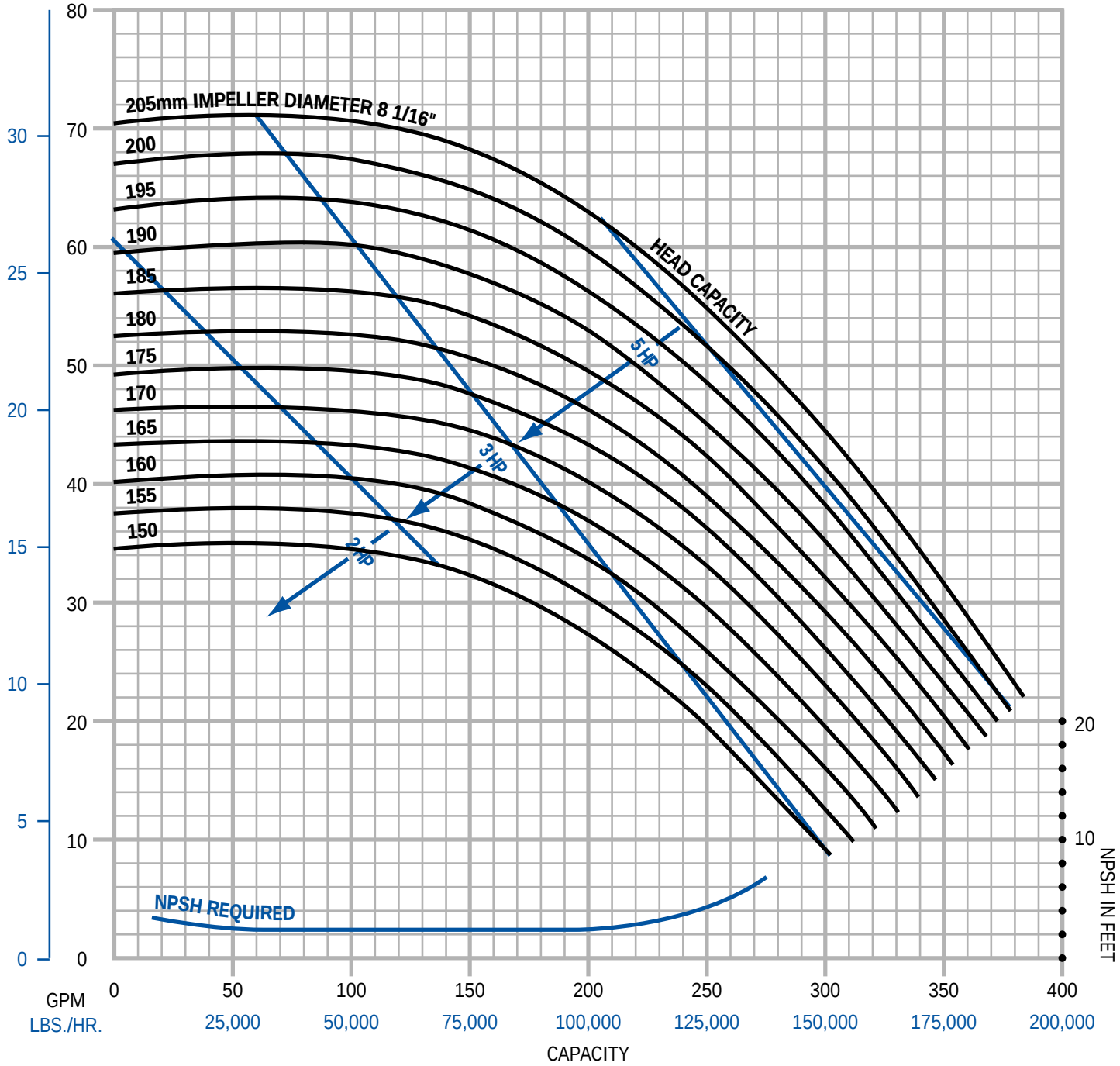
FP/FPX 1741 1750 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



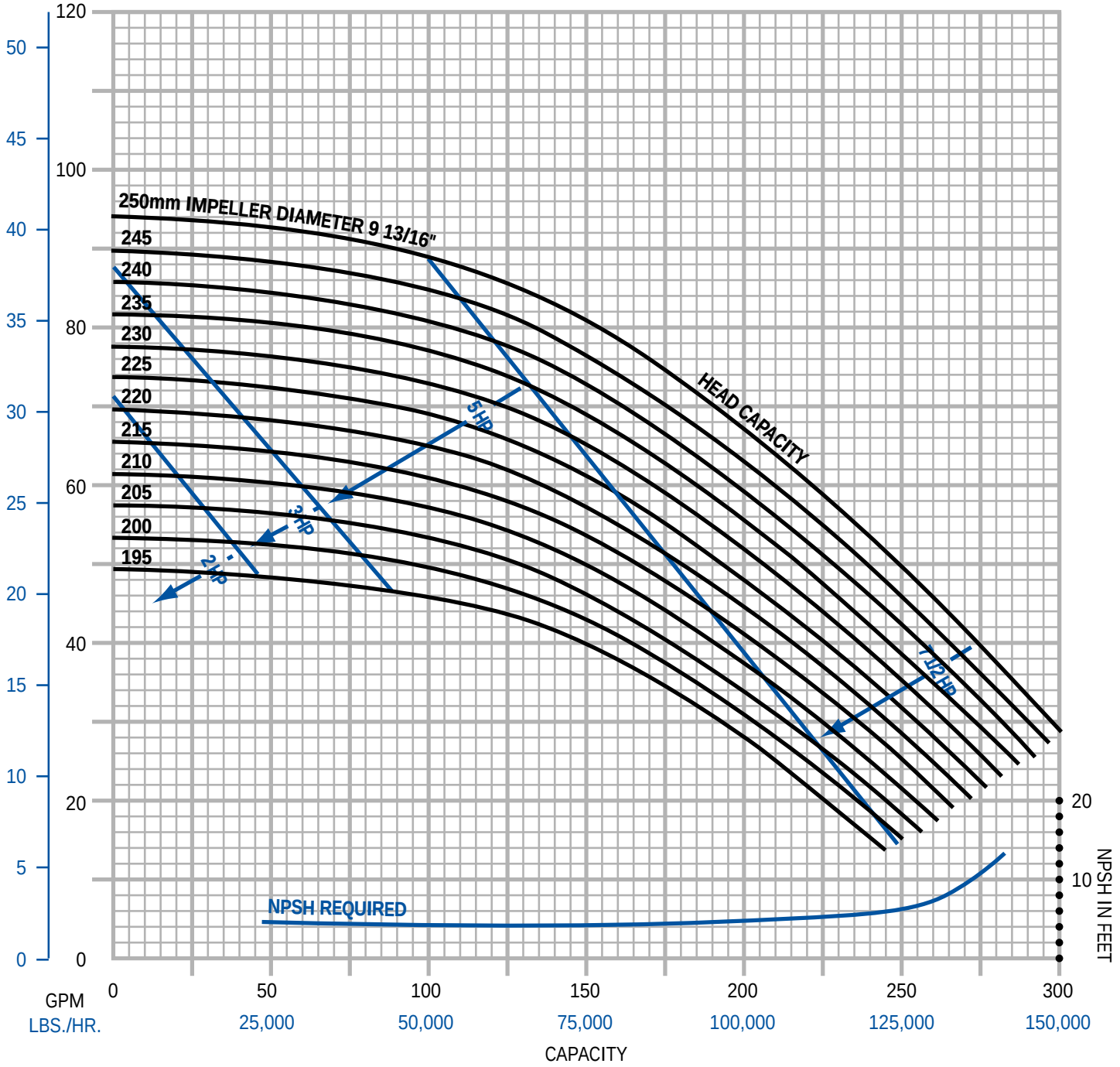
FP/FPX 3541 1750 RPM Inlet 3"-Outlet 2 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



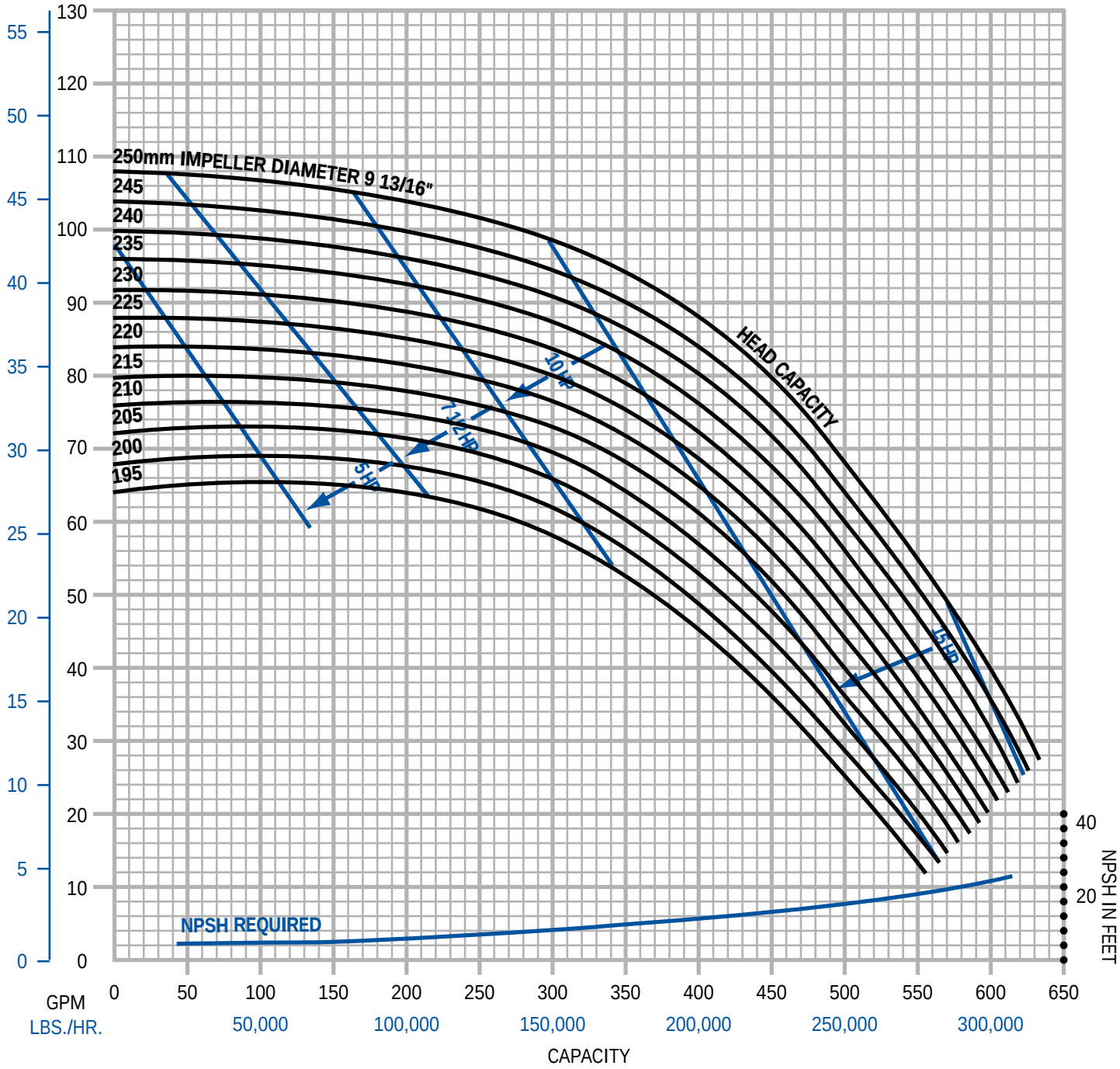
FP/FPX 3451 1750 RPM Inlet 3"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



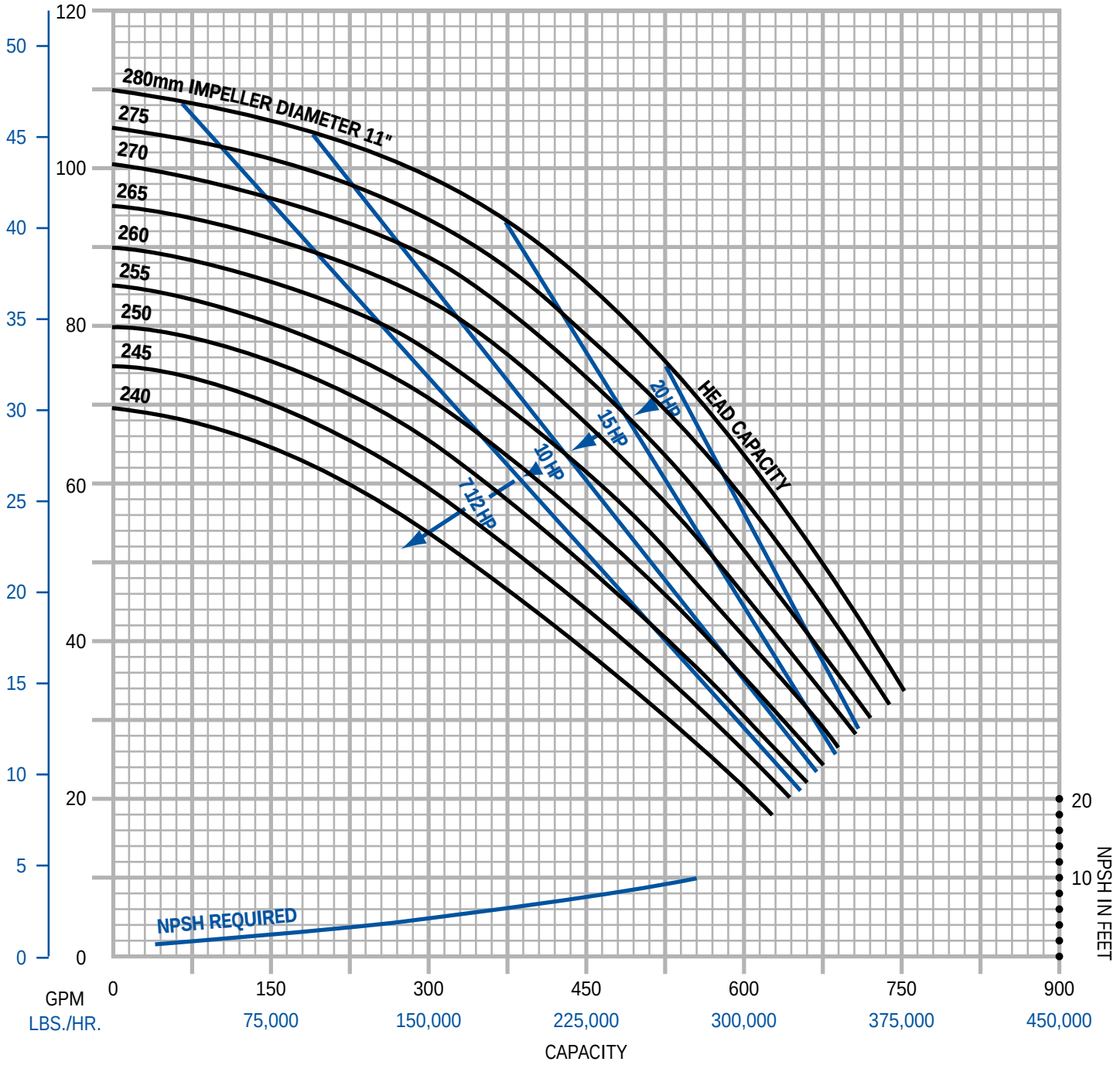
FP/FPX 3551 1750 RPM Inlet 3"-Outlet 2 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



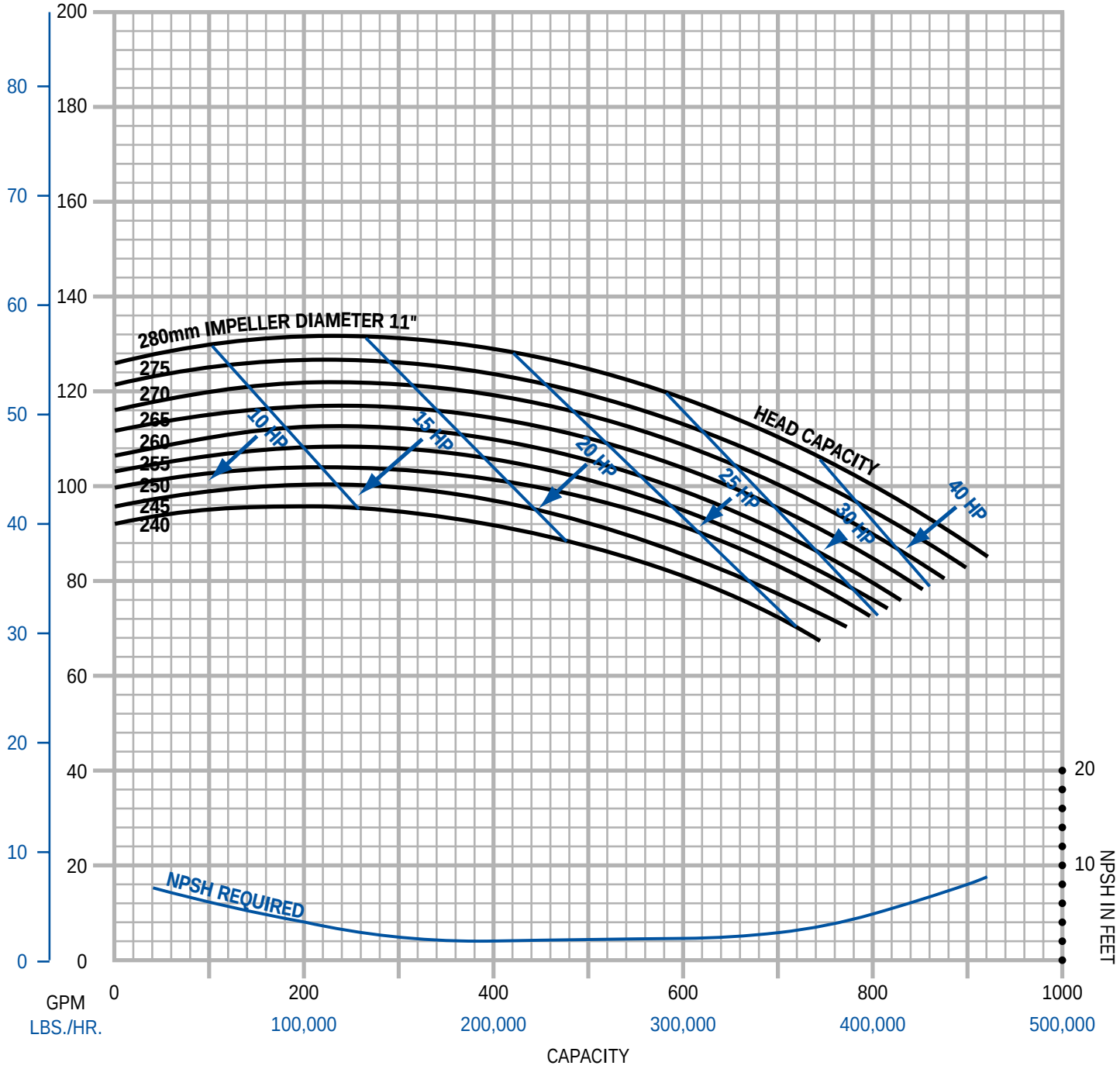
FP/FPX 1051 1750 RPM Inlet 4"-Outlet 4"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



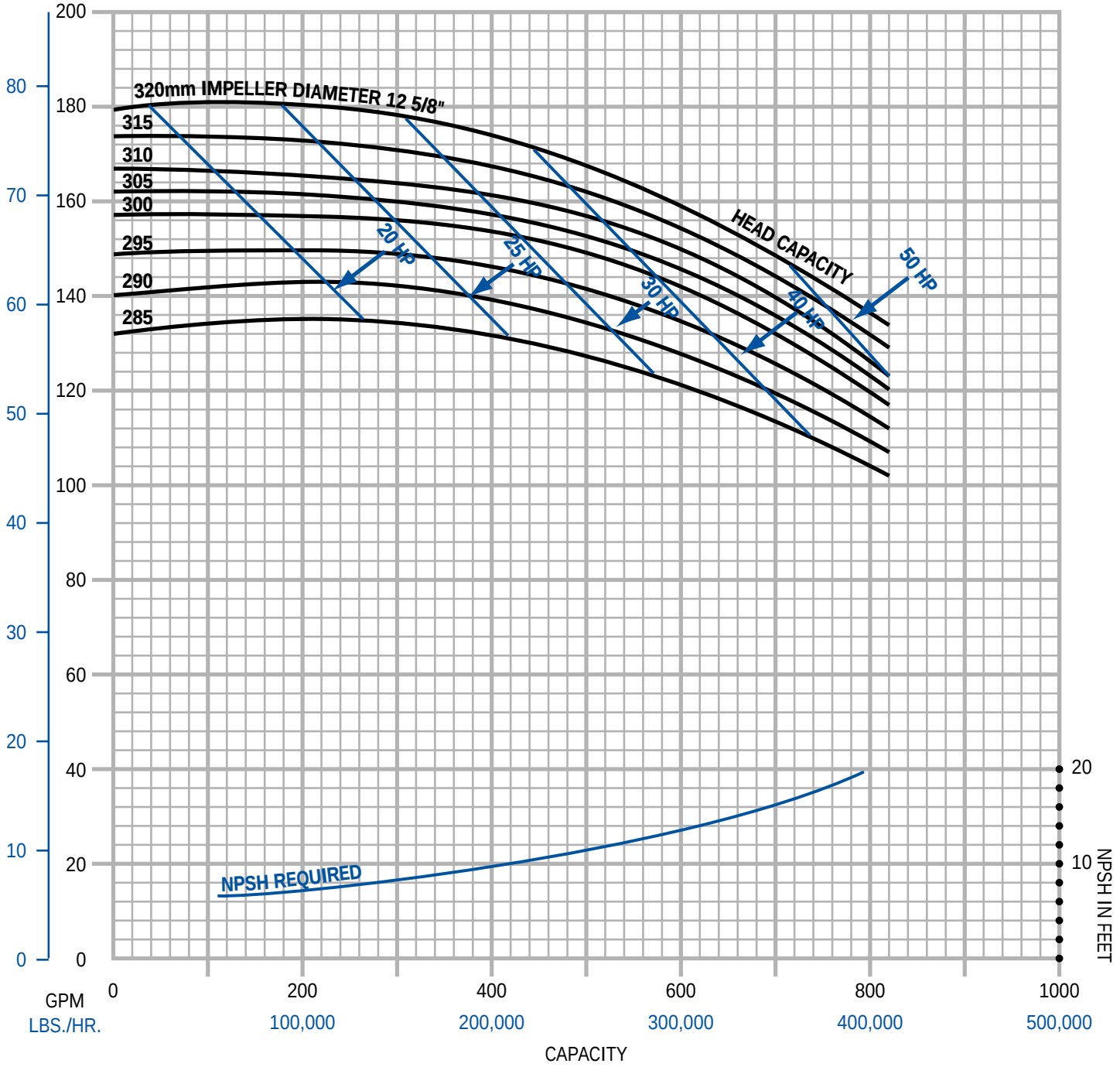
FP/FPX 1151 1750 RPM Inlet 4"-Outlet 4"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam pumps.



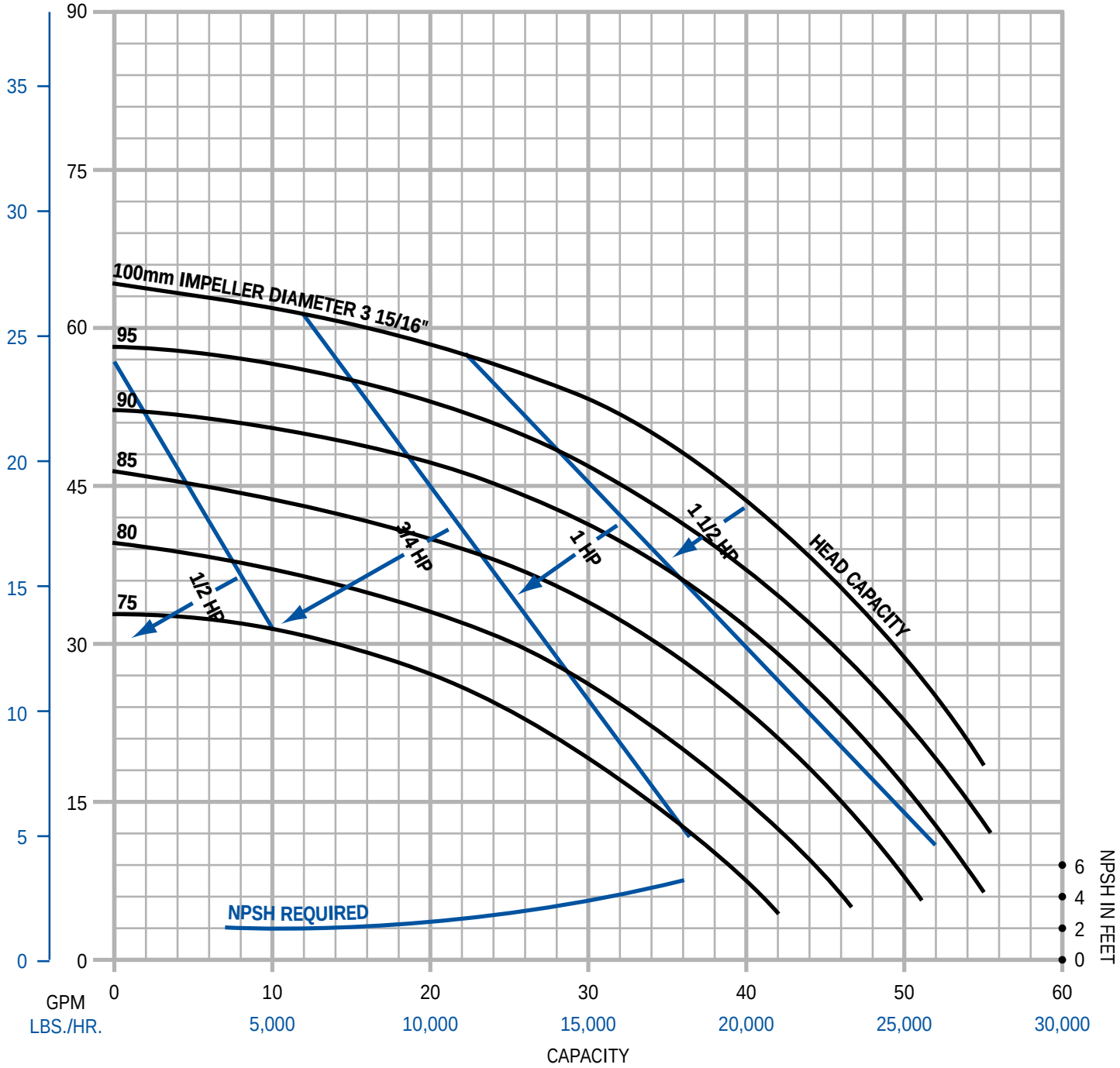
FP/FPX 1161 1750 RPM Inlet 4"-Outlet 4"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



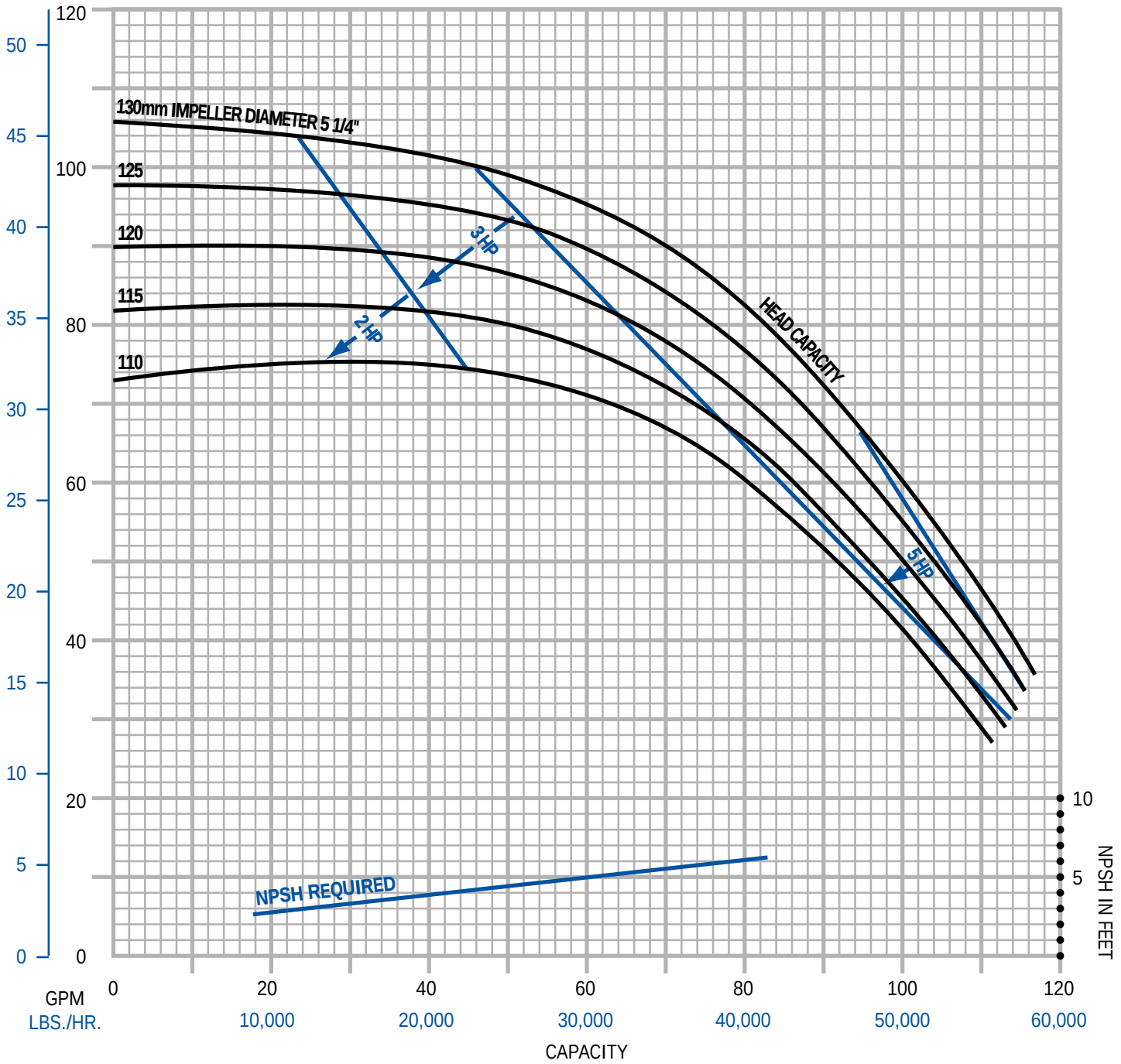
FP/FPX 702 3500 RPM Inlet 1 1/2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps. The smallest motor available for the FPX 702 is a 1.5 HP, 143TC frame.



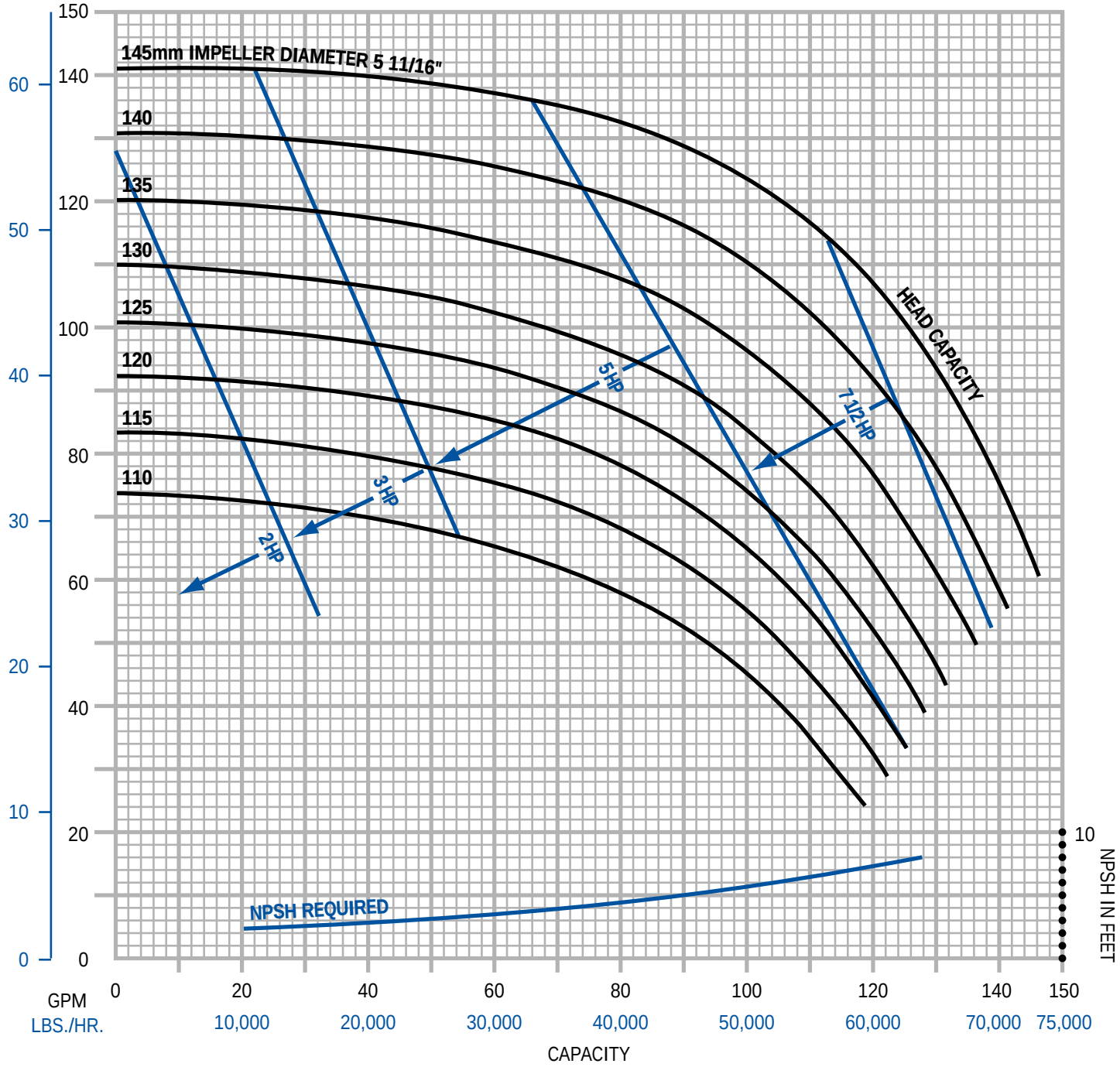
FP/FPX 712 3500 RPM Inlet 2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



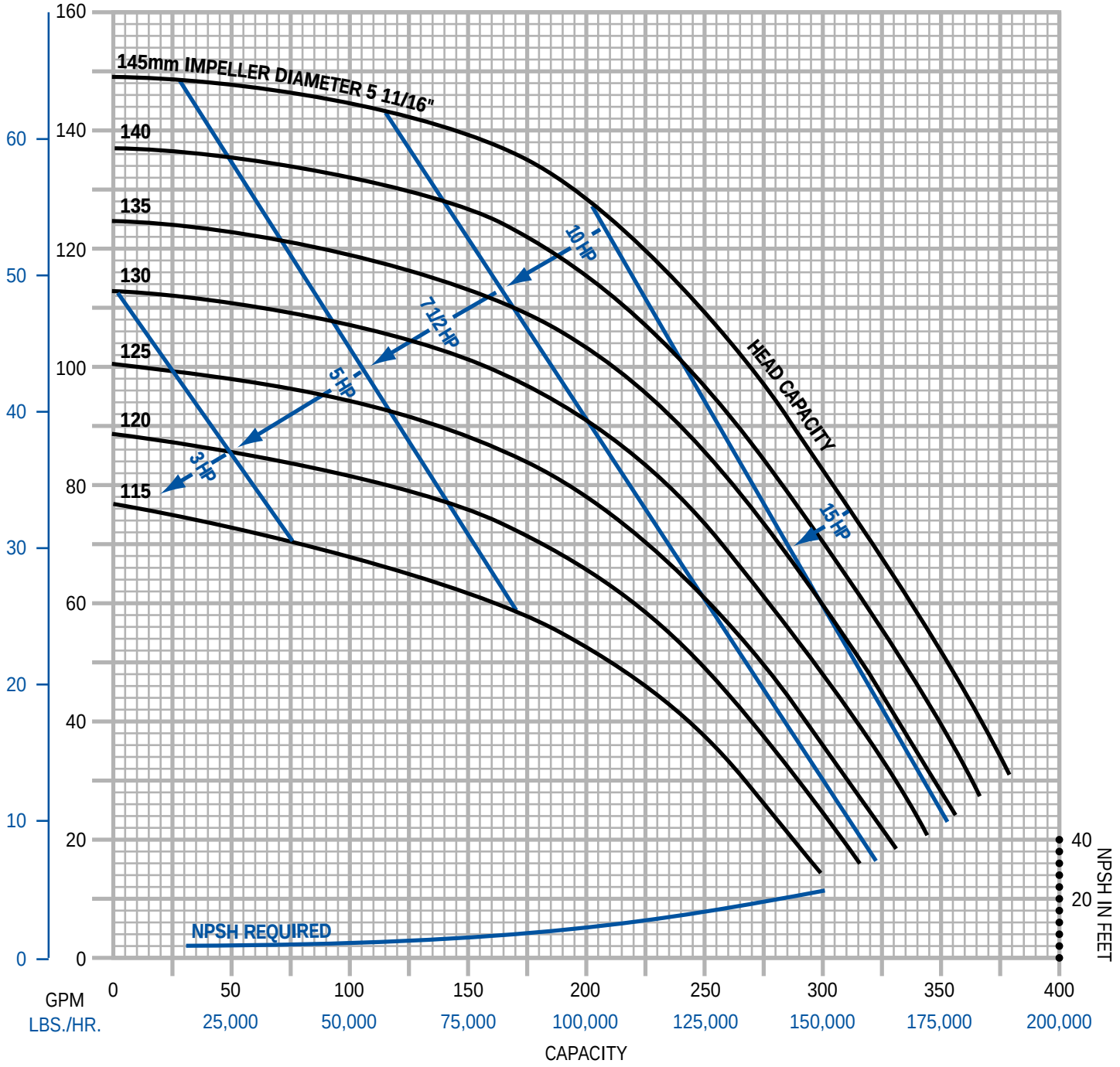
FP/FPX 722 3500 RPM Inlet 2"-Outlet 1 1/2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



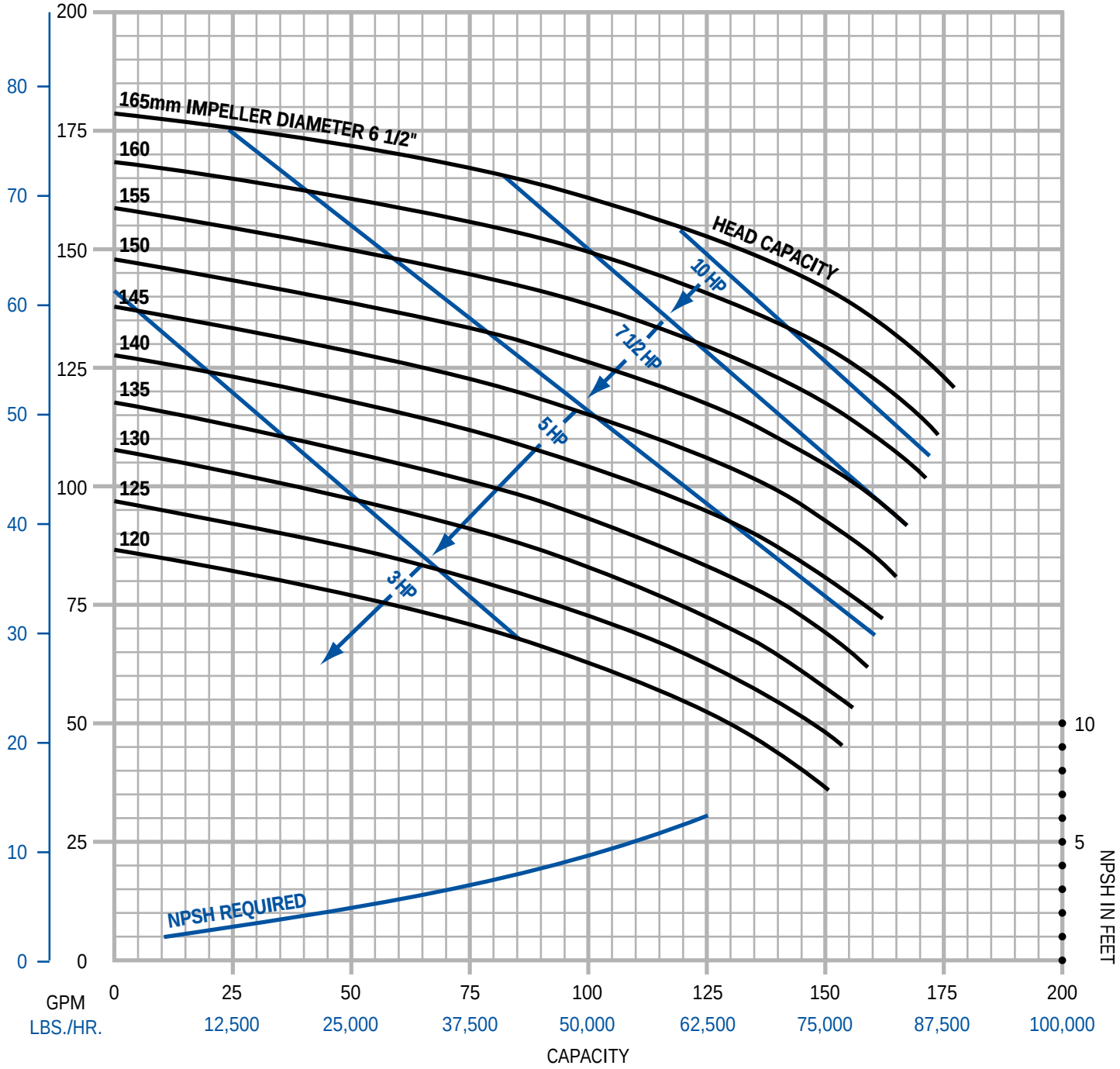
FP/FPX 3522 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



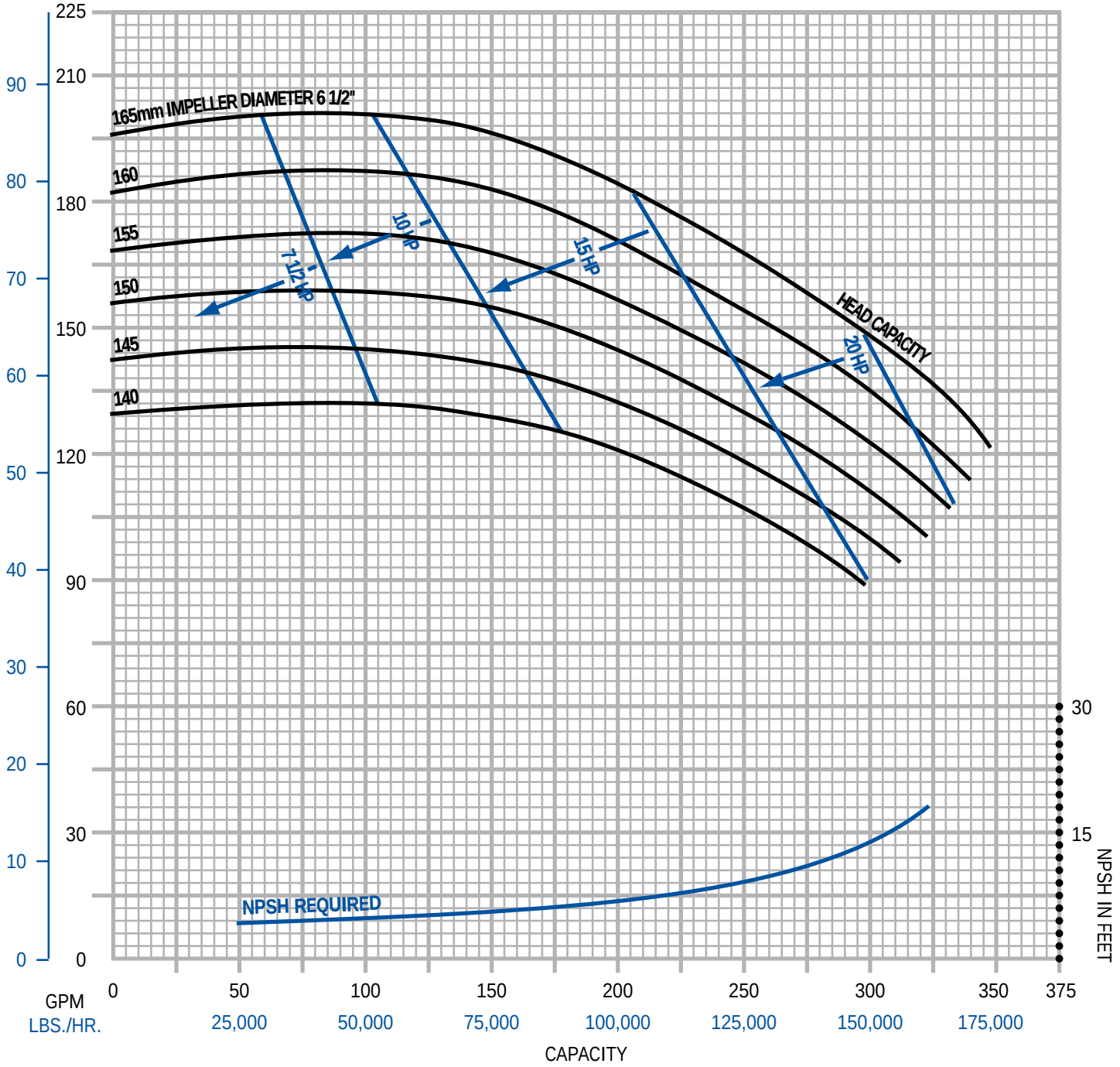
FP/FPX 732 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



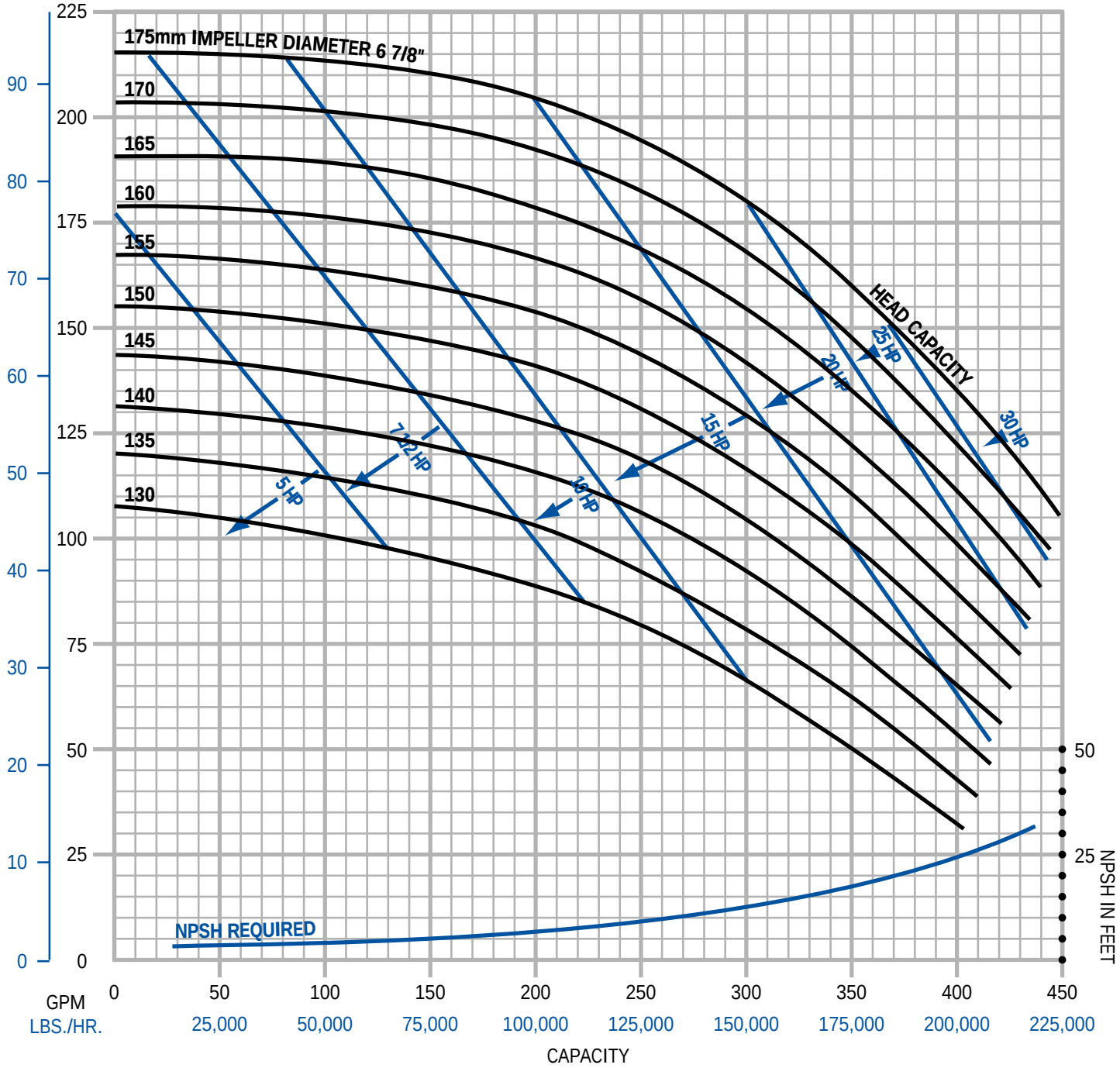
FP/FPX 1732 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



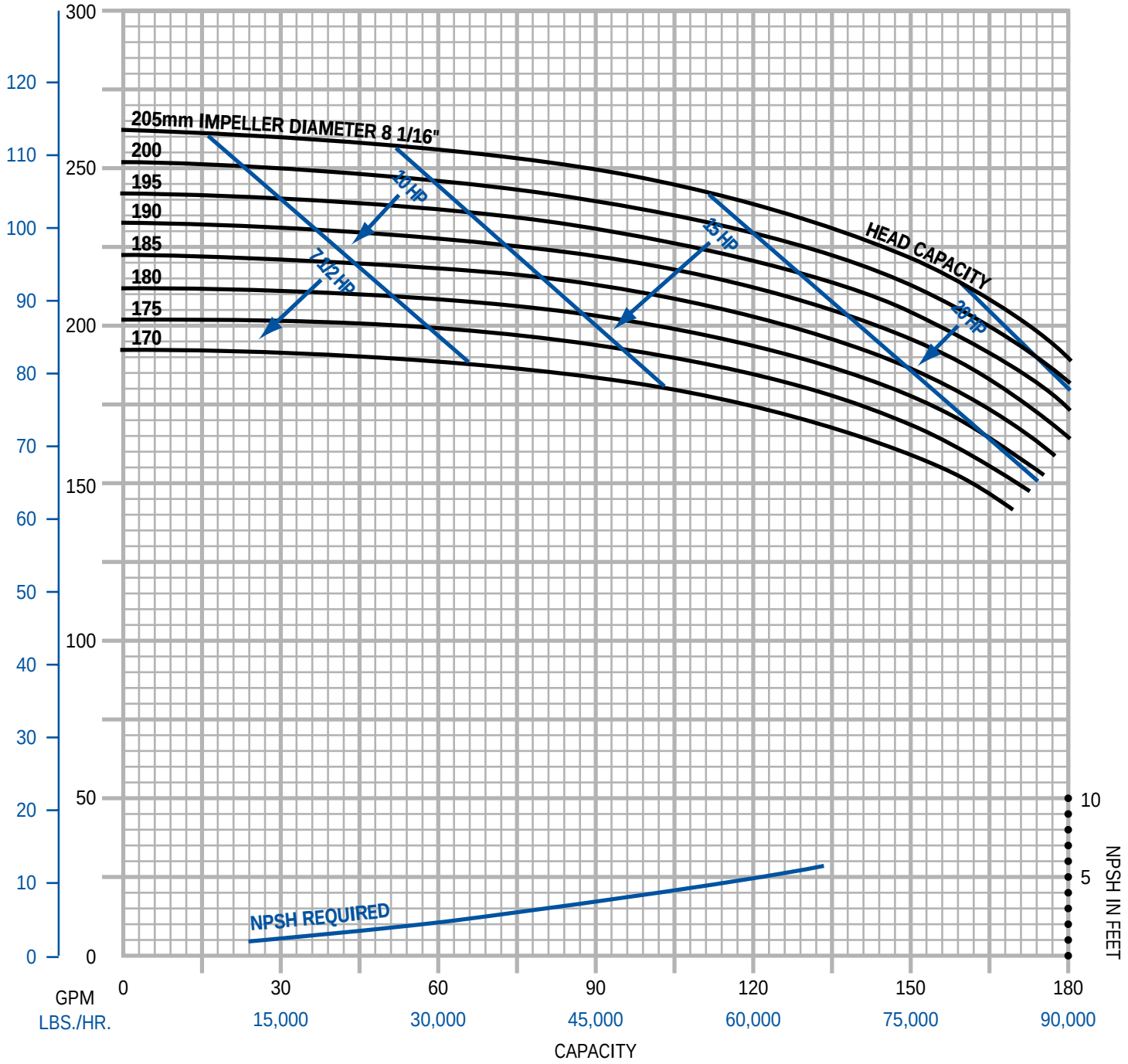
FP/FPX 3532 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



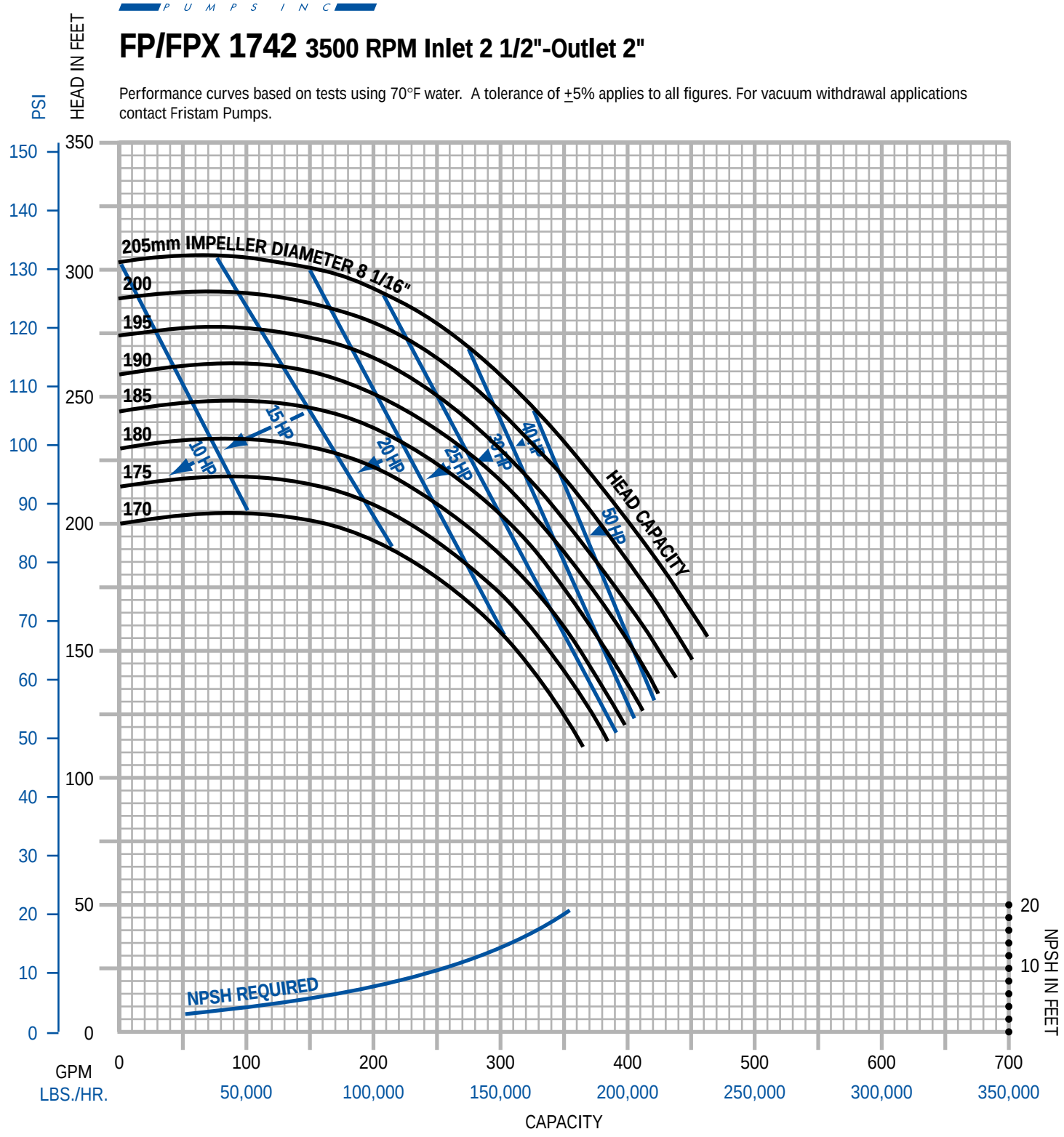
FP/FPX 742 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



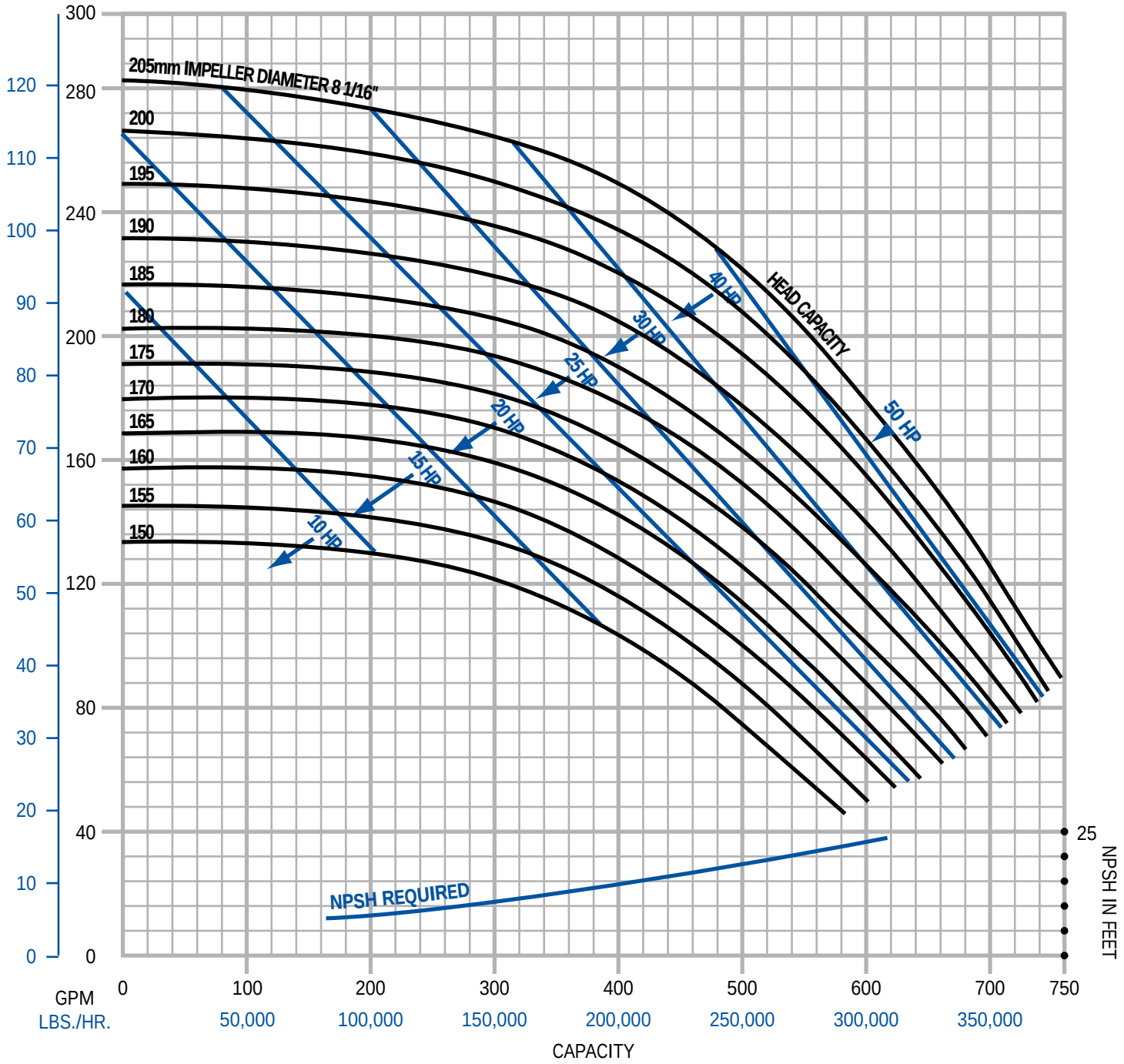
FP/FPX 1742 3500 RPM Inlet 2 1/2"-Outlet 2"

Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



FP/FPX 3542 3500 RPM Inlet 3"-Outlet 2 1/2"

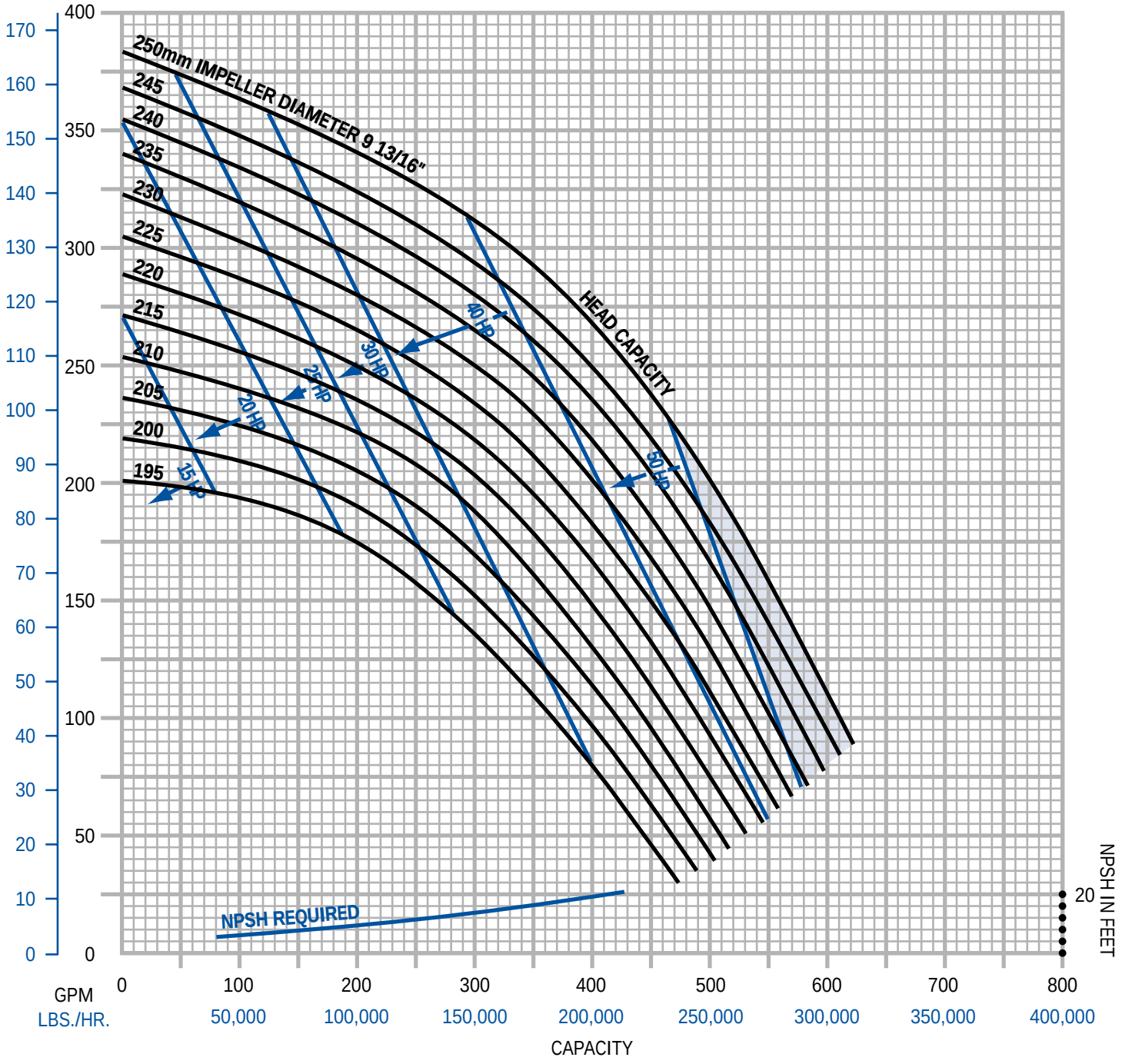
Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



Tinted areas indicate FP Series only

FP/FPX 3452 3500 RPM Inlet 3"-Outlet 2"

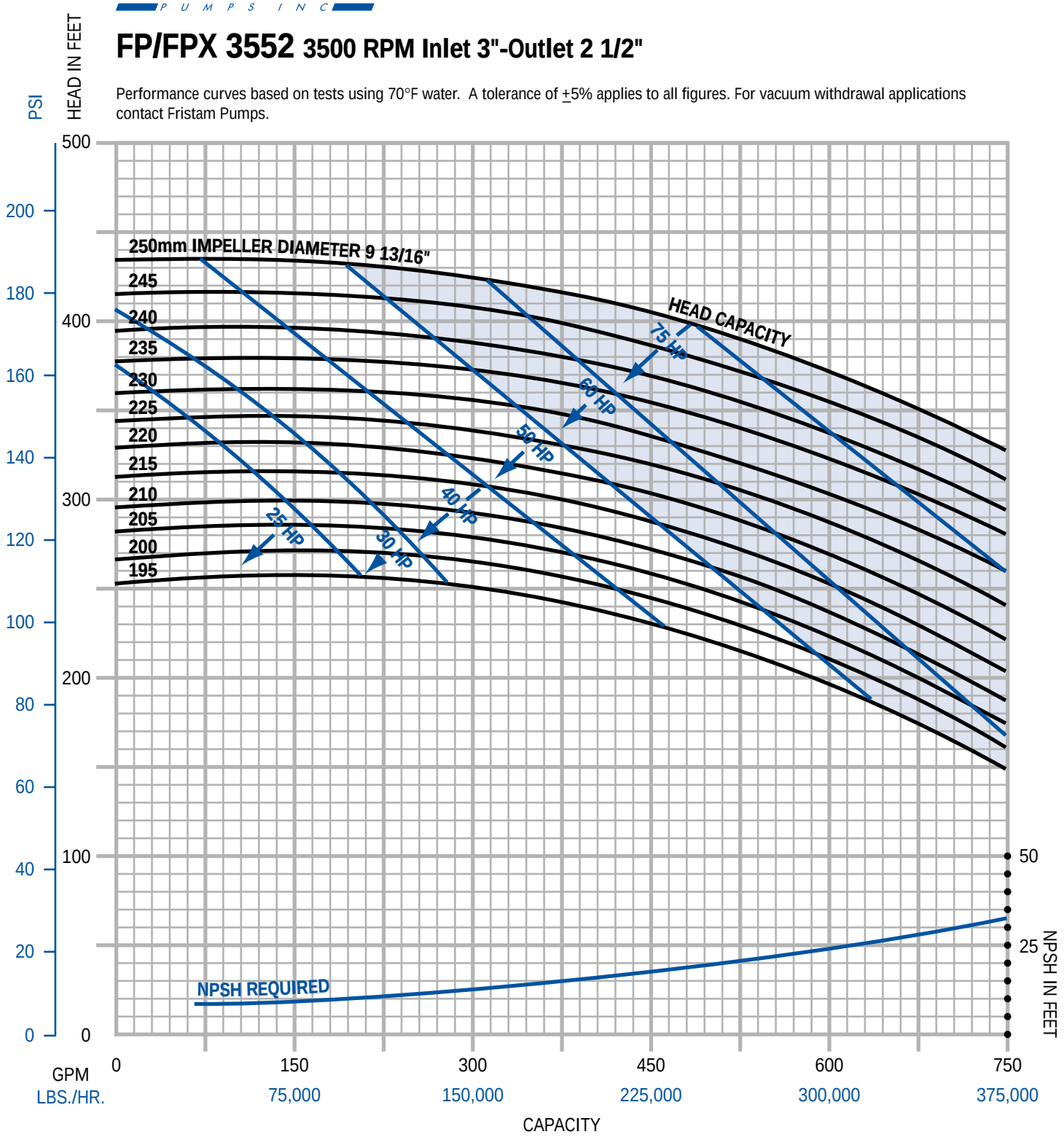
Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



Tinted areas indicate FP Series only

FP/FPX 3552 3500 RPM Inlet 3"-Outlet 2 1/2"

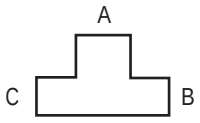
Performance curves based on tests using 70°F water. A tolerance of ±5% applies to all figures. For vacuum withdrawal applications contact Fristam Pumps.



Loss of Head Due to Friction in Feet per Foot of Stainless Steel Tubing and in Feet for Sanitary Fittings

Notes:

1. Flow Elbows—R/D = 1.5
2. Flow Through Tees—Flow A to B Port C Capped Off.
3. Test Medium—Water at 70°F
4. 16 gauge tubing was used for the measurements when the outer diameter (O.D.) was between 1" - 3" and 14 gauge tubing was used with the 4" O.D. measurement.



Prepared by Members of the Sanitary Pump Subgroup of N.A.D.E.M.

Capacity in U.S. G.P.M.	O.D. - 1″ I.D. - .870″			O.D. - 1½″ I.D. - 1.370″			O.D. - 2″ I.D. - 1.870″			O.D. - 2½″ I.D. - 2.370″			O.D. - 3″ I.D. - 2.870″			O.D. - 4″ I.D. - 3.834″		
	Tubing	Elbow	Tee	Tubing	Elbow	Tee	Tubing	Elbow	Tee	Tubing	Elbow	Tee	Tubing	Elbow	Tee	Tubing	Elbow	Tee
2	.01	.01	.1															
4	.025	.02	.2															
5	.035	.025	.25															
10	.12	.06	.4	.02	.01	.15	.005	.015	.1									
15	.25	.1	.8	.04	.02	.25	.013	.02	.15									
20	.43	.22	1.5	.06	.03	.3	.02	.025	.2	.005	.02	.1	.003	.02	.06			
25	.66	.4	2.3	.08	.04	.4	.025	.03	.25	.006	.03	.15	.004	.03	.08			
30	.93	.7	3.3	.105	.06	.55	.035	.05	.3	.008	.05	.2	.005	.04	.1			
35	1.22	1.25	5.2	.135	.09	.8	.04	.06	.4	.011	.06	.25	.006	.05	.13			
40				.17	.11	1.0	.05	.08	.5	.015	.07	.3	.007	.06	.15			
45				.21	.16	1.3	.063	.1	.6	.02	.09	.35	.008	.065	.18			
50				.25	.2	1.6	.073	.12	.7	.022	.1	.4	.01	.07	.2			
60				.34	.35	2.2	.1	.18	.9	.03	.12	.45	.015	.08	.25			
80				.57	.76	3.7	.16	.3	1.5	.05	.15	.55	.02	.1	.4			
100				.85	1.35	5.8	.23	.44	2.3	.075	.18	.6	.03	.11	.5	.008	.04	.1
120				1.18	2.05	9.1	.32	.64	3.3	.105	.21	1.0	.04	.13	.6	.01	.05	.15
140							.42	.85	4.5	.14	.23	1.25	.05	.16	.8	.013	.06	.2
160							.54	1.13	5.8	.17	.28	1.6	.07	.2	1.1	.015	.07	.25
180							.67	1.45	7.4	.205	.31	2.0	.08	.21	1.3	.02	.08	.3
200							.81	1.82	9.0	.245	.35	2.5	.1	.26	1.6	.025	.09	.4
220							.95	2.22	11.0	.29	.41	3.0	.12	.3	1.9	.028	.1	.5
240							1.10	2.63	13.5	.34	.48	3.7	.14	.33	2.2	.035	.11	.55
260										.39	.53	4.5	.165	.39	2.5	.04	.115	.6
280										.45	.61	5.3	.19	.42	2.8	.045	.12	.65
300										.515	.7	6.2	.22	.5	3.1	.05	.13	.7
350										.68	1.05	8.5	.28	.67	4.1	.07	.15	.9
400										.86	1.55	11.0	.36	.88	5.2	.085	.18	1.2
450										1.05	2.25	13.5	.44	1.1	6.6	.105	.2	1.5
500													.54	1.4	8.0	.13	.23	1.75
550													.64	1.7	9.5	.15	.27	2.1
600													.75	2.05	10.2	.175	.3	2.5
650													.87	2.41	13.0	.2	.34	2.8
700													1.0	2.8	15.0	.23	.4	3.4
750																.26	.43	3.8
800																.3	.5	4.4
850																.33	.56	5.0
900																.37	.62	5.7
950																.41	.7	6.3
1000																.45	.8	7.0
1100																.53	1.06	8.6

How To Calculate Required Pressure

Example:

Find the head under these conditions: Pump is drawing from an open tank to discharge through a heat exchanger into an open tank that is 20 ft. above the pump. The supply is 8 ft. above the pump. 50 GPM flow is required.

Solution:

1. Height to be pumped is 20 ft. minus 8 ft. =12.0 ft.

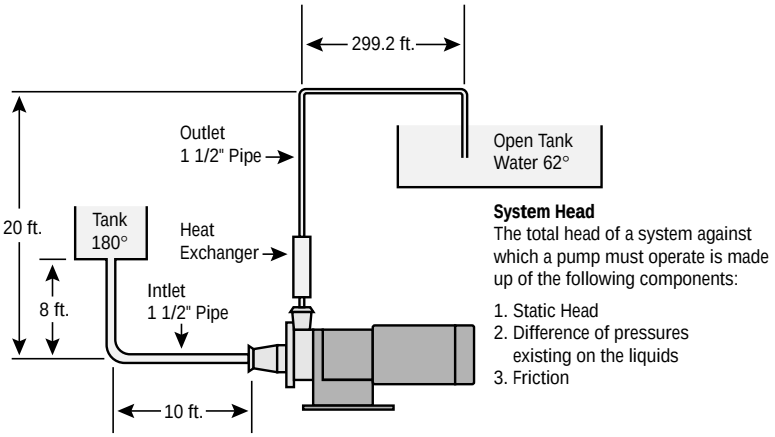
2. Friction loss from pipe is
(8 ft. + 10 ft. + 20 ft. + 299.2 ft. = 337.2 ft.)
337.2 x .25 ft./ft. =84.3 ft.

3. Friction loss from 3 elbows is = .6 ft. = .6 ft.

4. *Heat Exchanger loss 2.31 times 16.5 PSI =38.1 ft.

The Total Head Loss is . . . . . 135.0 ft.

*Heat Exchanger information supplied by manufacturer.



System Head
The total head of a system against which a pump must operate is made up of the following components:

1. Static Head
2. Difference of pressures existing on the liquids
3. Friction

Determining Net Positive Suction Head (NPSH)

Fristam pumps are well known for requiring less net positive suction head available than other sanitary centrifugal pumps. However, due to the hydraulic principles involved, some level of NPSH is still required in order for the pump to run efficiently and without cavitating.

The NPSH required for each Fristam pump model has been determined by careful testing. The results of these tests are illustrated by the NPSH curve under the performance curves for each pump model.

To determine the NPSH available, first add the physical height of the liquid above the centerline of the pump inlet to the pressure above the liquid (in an open tank this is atmospheric pressure). From this total, subtract the friction losses of the line and fittings on the suction side and the vapor pressure of the liquid at the operating temperature. The remainder is the NPSH available. This number must meet or exceed the NPSH required in order for the pump to function properly. As an example, figure the NPSH available and required to pump 50 GPM and generate 135 feet water column of pressure.

The pump required is an FP/FPX 722/145 (see Selecting A Fristam Pump, pages 2 and 3). From the actual pump curve on page 22 or from the example in Selecting A Fristam Pump, we see that the NPSH required is 3 feet.

Assuming 10 feet of 1 1/2 inch line and one elbow in the suction line, 8 feet of height of liquid above the pump center line and pumping 180°F water from an open tank, we can compute the NPSH available.

NPSH available = Physical height of liquid + atmospheric pressure - friction losses - vapor pressure (see page 35).

NPSH available = 8 ft. + 33.9 ft. - 4.7ft. - 17.3 ft. = 19.9 ft.

Since the NPSH available of 19.9 feet is greater than the NPSH required 3 feet, the pump has sufficient NPSH available to run properly.

Specific Gravity and Viscosity For Various Liquids

Detailed information is available on viscosity correction factors. Write Fristam Pumps for details. The following viscosities may vary, depending upon products, formulas, and processes used by processors.

Product	SP. Gr.	Visc. (cps)	Temp °F	Condition
Acetone	0.80	1	70	
Acid:				
Acetic	1.01	1	100	5%
Citric	1.02	1	140	10%
Lactic	1.10	1	140	
Nitric	1.02	18	70	
Alcohol:				
Ethyl	0.82	1.4	70	
Methyl	0.79	0.6	70	
Alum	1.33	80	40	50% Conc.
Barbecue Sauce	1.10	150	70	33° Brix
Beer	1.02	1	40	
Beverage Concentrate	1.26	80	80	
Blood	1.00	5	20	
Brine	1.10 to 1.20	1	40	Sodium Chloride 1.20
Butter–melted	0.95	90	90	
Buttermilk	1.04	20	40	
Carbon Tetrachloride	1.59	1	70	
Catsup	1.15	100	60	
Chocolate Bar Coating	1.08	65	120	
Cream	0.99	20	40	40% Fat
Dye, Water Base	1.10	10	70	
Egg—Whole	1.04	68	40	
Egg Yolk	1.12	400	68	
		200	86	
Ethylene Glycol	1.10	18	70	
Fat–Animal Melted	0.90	43	110	
Glaze–Donut	1.22	55	120	
Honey	1.30	230	100	81.2° Brix
		1500	70	
Ice Cream Mix	1.15	300	40	Varies
Ink, Printer's	1.20	520	130	
Juice–Single Strength:				
Apple, Clear	1.05	20	140	
Cranberry	1.03	10	140	
Grape	1.05	25	140	
Orange	1.05	20	140	
Tomato	1.03	180	140	
Juice–Concentrate:				
Apple	1.36	600	50	Thixotropic
Cranberry	1.03	250	100	Thixotropic
Grapefruit		1000	38	Thixotropic
Orange	1.32	5000	38	Thixotropic
Liqueurs	1.15	10	70	
Margarine	0.93	50	120	
Milk–Whole	1.03	1	40	
Milk–Concentrated	1.10	1000	50	40% TS
	1.30	100	131	75% TS
Milk–Concentrated	1.20	20	110	45% TS
Skim	1.10	95	70	30% TS
Milk–Evaporated	1.17	60	70	48% TS
Milk–Skim Condensed	1.20	20	110	45% TS
Milk–Sweetened	1.25	2000	50	
Condensed		500	150	
Milk of Magnesia	1.08	200	70	
Oils:				
Butter	0.90	40	70	
Corn	0.93	150	60	
Frying	0.90	10	400	
Lard	0.96	165	80	
Mineral	0.93	150	70	
Olive	0.92	110	60	
Peanut	0.92	100	60	
Soybean	0.93	95	60	
Vegetable	0.92	40	100	
Paint Solvents	0.90	10	70	
Paper Coatings	1.05	400	70	35% TS
Paraffin	0.90	9	140	
Pear Puree	1.30	4000	160	Thixotropic
Perfume	0.95	1	70	
Pie Filling	1.20	200	140	
Propylene Glycol	1.02	20	30	50%
Sauce–Apple		2000	71	
		800	190	
Salad Dressing	0.96	5000	75	
Shampoo	1.00	350	70	
Sorbitol	1.30	150	70	75%
Soup, Clear	1.00	20	160	
Spaghetti Sauce	1.10	200	140	
Syrups:				
Corn	1.39	240	180	40° Be
Dextrose	1.35	280	180	77° Brix
HFCS 42	1.35	160	70	42% TS
HFCS 55	1.35	800	70	55% TS
Invert	1.38	800	80	76° Brix
Maple	1.37	600	68	
Sugar	1.33	220	80	68° Brix
Soft Drink	1.26	80	80	
Toulene	0.87	1	70	
Tomato Paste	1.14	150	75	11% TS
	1.14	100	180	11% TS
	1.14	1500	200	17% TS
Varnish	0.90	125	100	
Vinegar	1.01	1	70	
Water	1.00	1	70	Includes WFI
Wax, Liquid	1.00	75	70	
Whey:				
Acid/Sweet	1.06	2	100	
Condensed	1.11	20	100	27% TS
	1.20	800	40	40% TS
	1.20	400	130	50% TS
	1.20	550	65	50% TS
	1.24	1500	65	60% TS
Sweetened	1.20	900	55	50% TS
	1.24	600	145	60% TS
Salt	1.06	2	80	
Wort	1.05	100	150	
Yeast –Brewer's				
Fermenting	1.10	150	40	20% TS
Yeast Slurry	1.10	270	45	35% TS
Yogurt Mix	1.03	20	40	

Conversion Factors

Length

Meters	x	3.281	= Feet
Centimeters	x	0.394	= Inches
Millimeters	x	0.0394	= Inches

Mass

Kilograms	x	2.2	= Lbs.
Gallons Of Water	x	8.34	= Lbs.
Cubic Feet of Water	x	62.4	= Lbs.
Pounds	x	0.454	= Kilograms

Volume

Liter	x	0.264	= Gallon
Cubic Feet	x	7.48	= Gallon
Lbs. Of Water	x	0.119	= Gallon
Imperial Gallon (British)	x	1.2	= Gallon (U.S.)
U.S. Gallon	x	3.785	= Liter

Pressure

Feet of Water	x	0.433	= PSI
Inches of Hg.	x	0.491	= PSI
Atmosphere	x	14.7	= PSI
Meters of Water	x	1.42	= PSI
Kilograms/sq. Centimeter	x	14.22	= PSI
Bar	x	14.7	= PSI

Pressure (continued)

Atmosphere	x	33.9	= Feet of Water
PSI	x	2.31	= Feet of Water
Inches of Hg.	x	1.13	= Feet of Water

Flow

Lbs. Of Water/Hour	x	0.002	= GPM
Lbs. Of Fluid/Hour / Specific Gravity	x	0.002	= GPM
Cu. Meter/Hour	x	4.4	= GPM
Kg. Of Water/Minute	x	0.264	= GPM
Liters/Minute	x	0.264	= GPM
GPM	x	3.785	= Liters/Minute

Power

$$\text{Liquid HP} = \frac{\text{GPM} \times \text{Head ft.} \times \text{Specific Gravity}}{3960}$$

$$\text{BHP} = \frac{\text{GPM} \times \text{Head ft.} \times \text{Specific Gravity}}{3960 \times \text{Pump Efficiency}}$$

Viscosity

$$\frac{\text{Centipoise}}{\text{Specific Gravity}} = \text{Centistokes}$$

Centistokes x 4.64 = SSU (Approx.)

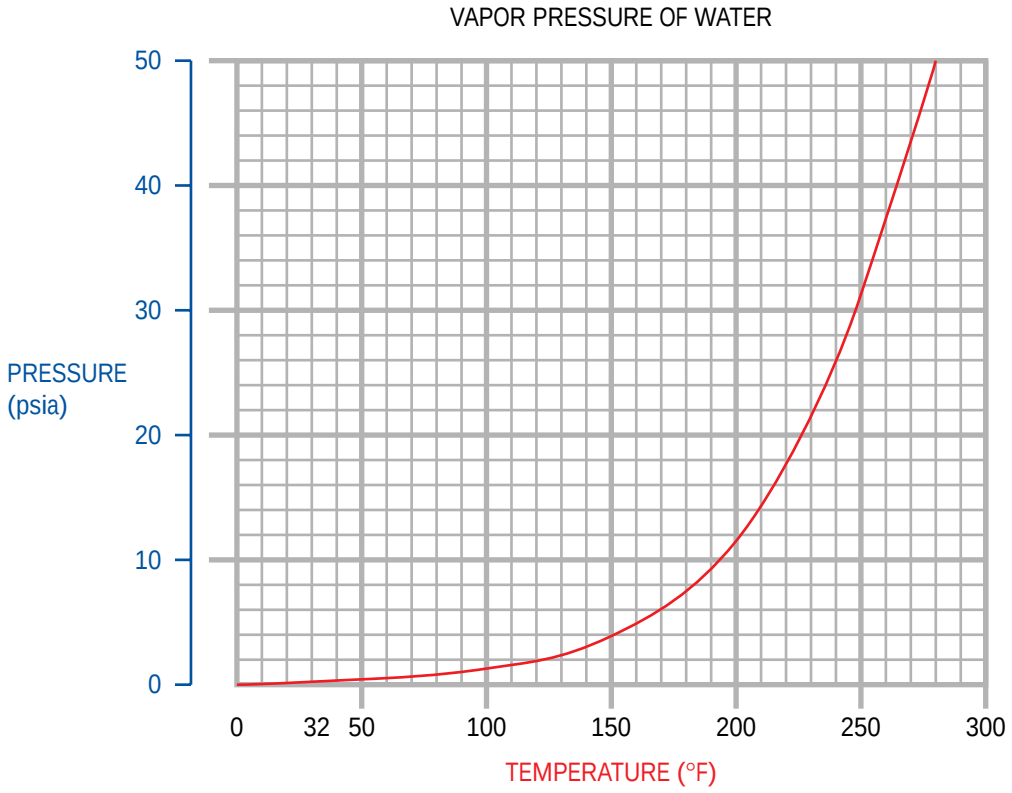
Temperature

(1.8 X °C) + 32 = °F

.555 (°F – 32°) = °C

Degrees Kelvin – 273.2 = Degrees Centigrade

Vapor Pressure Chart



Pump Inquiries

To properly process an inquiry we need the following information:

Requested by _____ Date _____

Customer _____

Address _____

Telephone _____ Fax _____

Description of product to be pumped _____

_____

Temperature _____ Specific Gravity _____ or Density _____ lb./gal.

Viscosity _____ Centipoise (CPS) or other

Desired Flow Rate _____ GPM or lb./hr.

Discharge Head _____ Ft. or PSI

Suction Conditions

Is the pump withdrawing from a vacuum? _____ Yes _____ No

If so, how much? _____ in. Hg.

Is the product level on the inlet side of the pump above or below the center line of the pump inlet?

_____ Above _____ Below _____ By how much? _____ in. or ft.

Tubing _____ in. Diameter _____ Length _____ No. of elbows _____ No. of tees

Tubing _____ in. Diameter _____ Length _____ No. of elbows _____ No. of tees

No. of size of valves in suction piping:

_____ no. _____ size (in.)

_____ no. _____ size (in.)

Other equipment in the suction piping _____

_____

If you do not know the desired discharge head, please provide the following:

Discharge Conditions

Is the final destination of the pump above or below the center line of the pump inlet?

_____ Above _____ Below _____ By how much? _____ in. or ft.

Tubing _____ in. Diameter _____ Length _____ No. of elbows _____ No. of tees

Tubing _____ in. Diameter _____ Length _____ No. of elbows _____ No. of tees

Tubing _____ in. Diameter _____ Length _____ No. of elbows _____ No. of tees

No. and size of valves in suction piping:

_____ no. _____ size (in.)

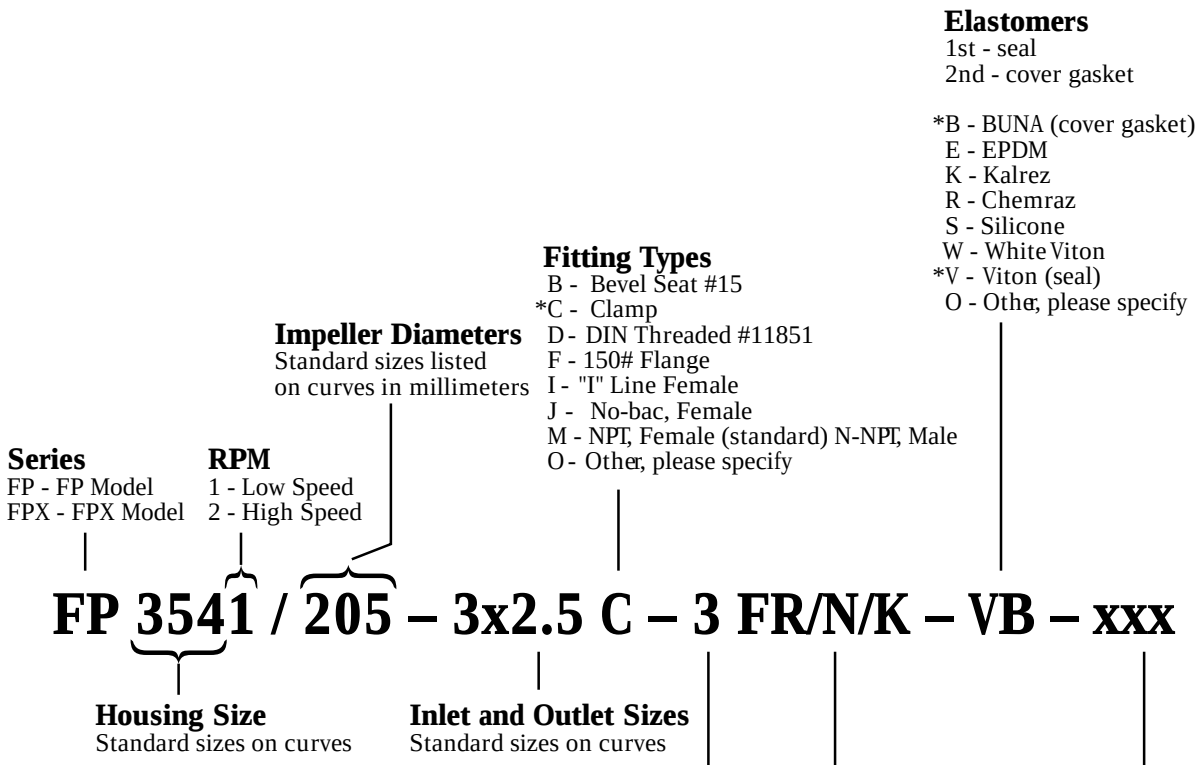
_____ no. _____ size (in.)

_____ no. _____ size (in.)

Other equipment and the drop or pressure requirement (PSI) in the discharge piping _____

_____

Ordering Matrix



Seal Types
1 - Single Internal (FP or FPX)
2 - Single Internal w/water casade (FP or FPX)
3 - Double Internal (FP only)
4 - Single External (FPX only) C/N, Standard
5 - John Crane Type 8 Single
6 - John Crane Type 8 Double
7- Other

Seal Materials
1st - Internal Rotating
2nd - Center Stationary
3rd - External Rotating

● FR - Chrome Oxide
○ N - Carbon
■ K - Ceramic
□ C - Silicon Carbide
◆ CN - Silicon Carbide/Carbon split
TC - Tungsten Carbide
O - Other, please specify

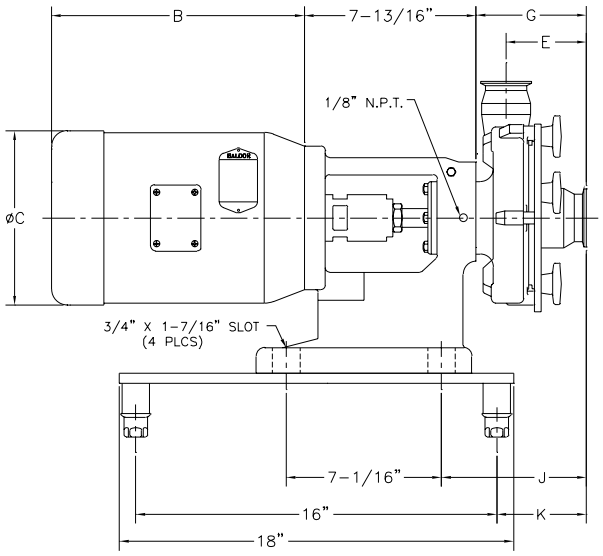
Options
A - Aseptic
B - Bearing Block Mounting
D - Discharge Orientation if other than vertical
E - Enlarged Inlet
F - Front Seal Flush
I - I.E.C. Motor Adapter
J - Jacketed Rear Housing
L - Adjustable Base with Legs
S - Stainless Steel Flange Support/ Pedestal
T - Tungsten Carbide Coating (specify)
W - WFI Modifications (specify)

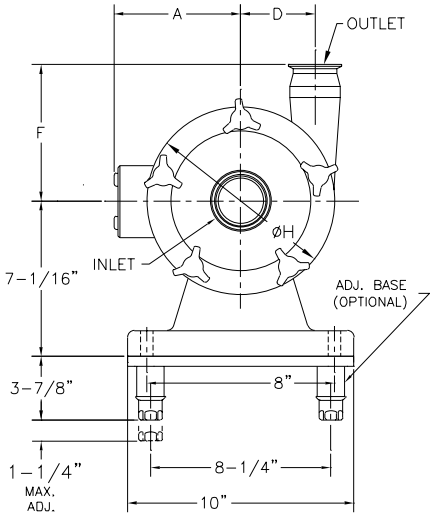
Legend
* Standard
● Standard Internal Rotating
○ Standard Center Stationary
■ Standard External Rotating
□ Internal or External Rotating only
◆ Center Stationary only

Additional Items
Motors: motors must be specified in addition to the above matrix.
Standard motors are C-faced TEFC, others must be specified.

Horsepower Range:
FP Series: 0.25HP - 100HP
FPX Series: 1.0HP - 50HP

FP-Single Flange Dimensions





NOTE:
(1) Motor dimensions A, B, and C may vary depending upon motor manufacturer and type.

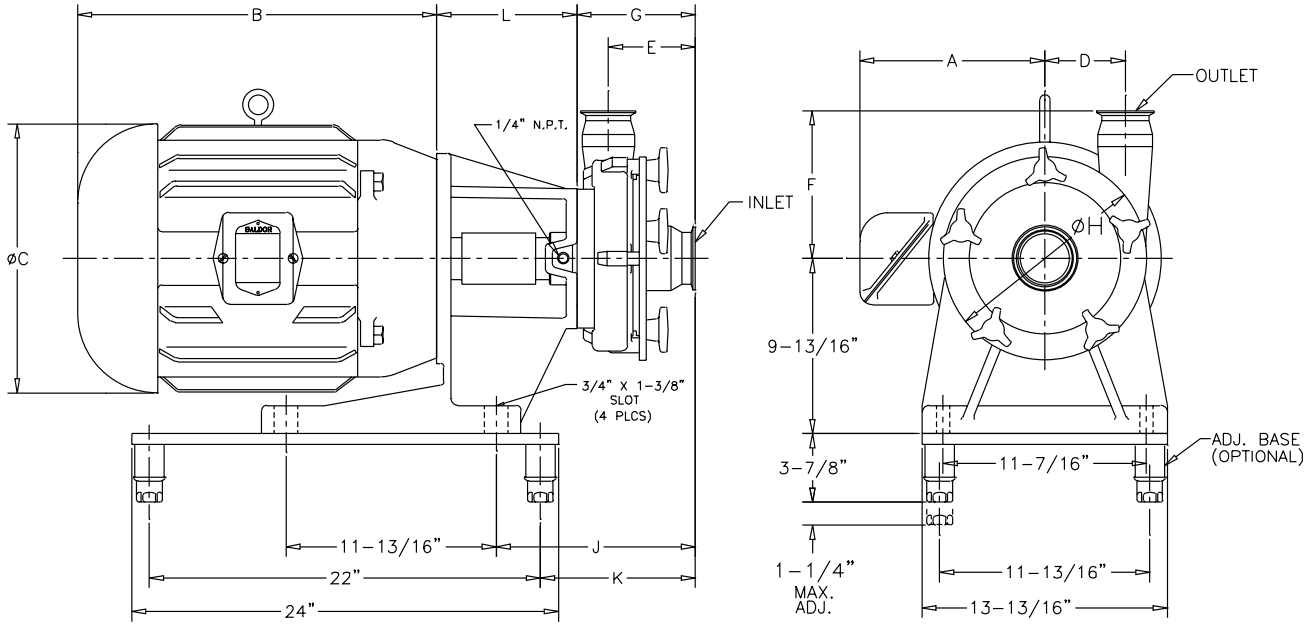
(2) Dimensions E, F, G, J, and K apply to pumps with clamp connections only. (Dimensions based on Baldor TEFC motors)

Dimensions are to the nearest 1/16"

1750 RPM	3500 RPM	MOTOR FRAME SIZE	MOTOR SHAFT DIAMETER	MOTOR DIMENSIONS IN INCHES/SINGLE FLANGE		
HP	HP			A	B	C
	0.5	56C	5/8"	4 1/2"	9 5/16"	6 1/8"
0.75	0.75	56C	5/8"	4 1/2"	9 5/16"	6 1/8"
	1.0	56C	5/8"	4 1/2"	9 5/16"	6 1/8"
1.0	1.5	143TC	7/8"	5 1/4"	11 1/4"	7 3/16"
1.5		145TC	7/8"	5 1/4"	11 1/4"	7 3/16"
2.0	2.0	145TC	7/8"	5 1/4"	11 1/4"	7 3/16"
	3.0	145TC	7/8"	5 1/4"	12 1/16"	7 3/16"
3.0		182TC	1 1/8"	5 7/8"	12 5/16"	8 1/2"
5.0	5.0	184TC	1 1/8"	5 7/8"	13 11/16"	8 1/2"
	7.5	184TC	1 1/8"	5 7/8"	15 3/16"	8 1/2"
7.5	7.5	213TC	1 3/8"	7 3/8"	15 5/16"	10 3/16"
	10.0	215TC	1 3/8"	7 3/8"	15 5/16"	10 3/16"
10.0	15.0	215TC	1 3/8"	7 3/8"	16 1/16"	10 3/16"

PUMP TYPE	PIPE CONNECTIONS		PUMP DIMENSIONS IN INCHES/SINGLE FLANGE						
FP	INLET	OUTLET	D	E	F	G	H	J	K
FP 701/702	1 1/2"	1 1/2"	1 3/4"	4 5/16"	4 1/4"	5 3/4"	5 7/8"	7 5/16"	4 13/16"
FP 711/712	2"	1 1/2"	2 1/4"	4 7/16"	5 11/16"	5 7/8"	7 5/16"	7 1/2"	4 15/16"
FP 721/731/722	2"	1 1/2"	3 1/8"	4 7/16"	6 11/16"	5 7/8"	9 1/16"	7 1/2"	4 15/16"
FP 741/732/742	2 1/2"	2"	3 3/4"	4"	7 11/16"	5 9/16"	10 5/8"	7 1/8"	4 5/8"
FP 1741/1732/1742	2 1/2"	2"	3 9/16"	4 1/8"	7 7/8"	6"	10 5/8"	7 1/2"	5"
FP 3521/3522	2 1/2"	2"	3 1/8"	4 5/8"	7 1/2"	6 3/8"	9 1/16"	7 15/16"	5 7/16"
FP 3531/3532	2 1/2"	2"	3 3/4"	4 9/16"	7 1/2"	6 3/8"	10 1/4"	7 15/16"	5 7/16"
FP 3541/3542	3"	2 1/2"	4 1/2"	4 5/8"	8 1/4"	6 3/8"	11 7/16"	7 15/16"	5 7/16"
FP 3451/3452	3"	2"	5 1/2"	4 1/2"	8 1/4"	6 1/4"	13 3/4"	7 13/16"	5 1/4"
FP 3551	3"	2 1/2"	5 1/2"	4 11/16"	9 1/16"	6 5/8"	13 3/4"	8 3/16"	5 11/16"

FP Double Flange Dimensions



Dimensions are to the nearest 1/16"

NOTE:
(1) Motor dimensions A, B, and C may vary depending upon motor manufacturer and type.

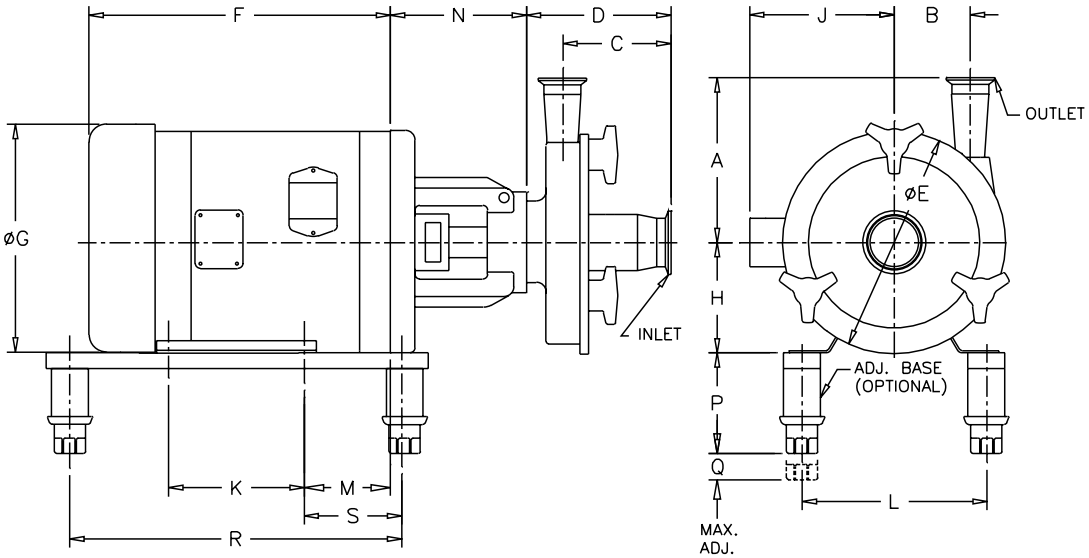
(2) Dimensions E, F, G, J, and K apply to pumps with clamp connections only.

3) Dimensions are based on Baldor Motor Standard TEFC motors.

1750 RPM	3500 RPM	MOTOR FRAME SIZE	MOTOR SHAFT DIAMETER	MOTOR DIMENSIONS IN INCHES/DOUBLE FLANGE			
HP	HP			A	B	C	L
7.5	7.5	213TC	1⅜″	7⅜″	15⁵⁄₁₆″	10³⁄₁₆″	7⅞″
10.0	15.0	215TC	1⅜″	7⅜″	16¹⁄₁₆″	10³⁄₁₆″	7⅞″
15.0	15.0	254TC	1⅝″	9⅝″	20″	13¼″	7⅞″
20.0	20.0	256TC	1⅝″	9⅝″	20″	13¼″	7⅞″
	25.0	284TSC	1⅝″	13⅛″	23³⁄₁₆″	15⁹⁄₁₆″	7⅞″
25.0		284TC	1⅞″	13⅛″	23³⁄₁₆″	15⁹⁄₁₆″	7⅞″
	30.0	286TSC	1⅝″	13⅛″	23³⁄₁₆″	15⁹⁄₁₆″	7⅞″
30.0		286TC	1⅞″	13⅛″	23³⁄₁₆″	15⁹⁄₁₆″	7⅞″
	40.0	324TSD	1⅞″	14⅛″	25¼″	16¹⁵⁄₁₆″	8¹¹⁄₁₆″
40.0		324TD	1⅞″	14⅛″	25¼″	16¹⁵⁄₁₆″	8¹¹⁄₁₆″
	50.0	326TSD	1⅞″	14⅛″	25¼″	16¹⁵⁄₁₆″	8¹¹⁄₁₆″
50.0		326TD	1⅞″	14⅛″	25¼″	16¹⁵⁄₁₆″	8¹¹⁄₁₆″

PUMP TYPE	PIPE CONNECTIONS		PUMP DIMENSIONS IN INCHES/DOUBLE FLANGE						
FP	INLET	OUTLET	D	E	F	G	H	J	K
FP 732/742	2½″	2″	3¾″	4″	7¹¹⁄₁₆″	5¹¹⁄₁₆″	10⅝″	10³⁄₁₆″	7¹¹⁄₁₆″
FP 1732/1742	2½″	2″	3⁹⁄₁₆″	4⅛″	7⅞″	6″	10⅝″	10⁹⁄₁₆″	8″
FP 3532	2½″	2″	3¾″	4⁹⁄₁₆″	7½″	6½″	10¼″	11″	8½″
FP 3542	3″	2½″	4½″	4⅝″	8¼″	6½″	11⁷⁄₁₆″	11″	8½″
FP 3452	3″	2″	5½″	4½″	8¼″	6⁵⁄₁₆″	13¾″	10¹³⁄₁₆″	8⁵⁄₁₆″
FP 3551/3552	3″	2½″	5½″	4¹¹⁄₁₆″	9¹⁄₁₆″	6¹¹⁄₁₆″	13¾″	11¼″	8¹¹⁄₁₆″
FP 1051/1052	4″	4″	6¹¹⁄₁₆″	6⁹⁄₁₆″	9¹³⁄₁₆″	7¹⁵⁄₁₆″	16″	12½″	10″
FP 1151/1152	4″	4″	6¹¹⁄₁₆″	4⅜″	9¹³⁄₁₆″	5¾″	16″	10⁵⁄₁₆″	7¹³⁄₁₆″
FP 1161	4″ or 6″	4″	6¹¹⁄₁₆″	4⅜″	9¹³⁄₁₆″	5¾″	16″	10⁵⁄₁₆″	7¹³⁄₁₆″

FPX
Single Flange Dimensions



NOTE:
(1) Motor dimensions F, G, and J may vary depending upon motor manufacturer and type.

(2) Dimensions A, C, and D apply to pumps with clamp connections only.

(3) Dimensions are based on Baldor Motor Standard TEFC motors.

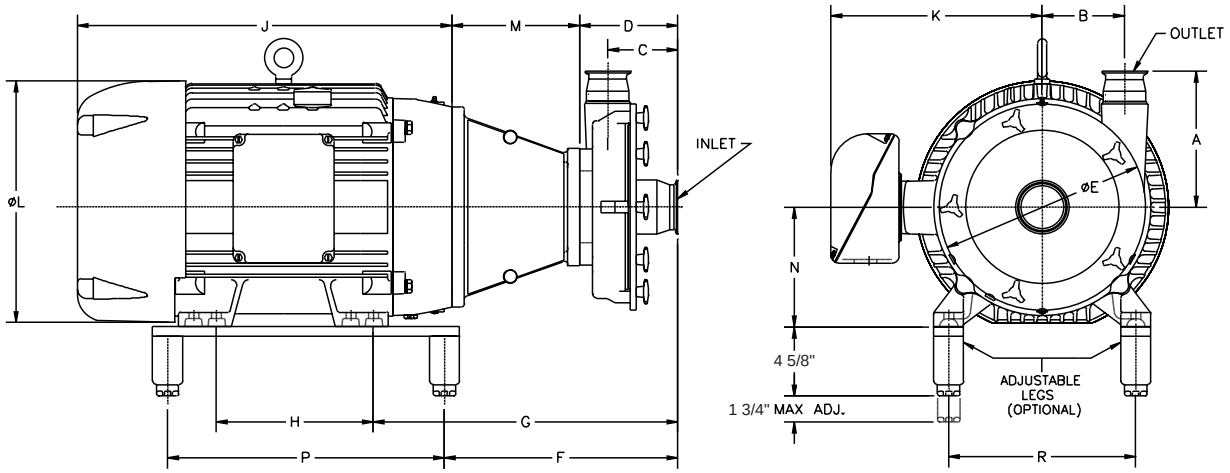
Dimensions are to the nearest 1/16"

RPM		FRAME	MOTOR DIMENSIONS IN INCHES											
1750	3500													
HP	HP	TC	F	ØG	H	J	K	L	M	N	P	Q	R	S
1	1.5	143	11¼″	7 3/16″	3½″	5¼″	5″	5½″	2⅞″	4¾″	3⅞″	1½″	13½″	4¾″
1.5		145	11¼″	7 3/16″	3½″	5¼″	5″	5½″	2⅞″	4¾″	3⅞″	1½″	13½″	4¾″
2	2	145	11¼″	7 3/16″	3½″	5¼″	5″	5½″	2⅞″	4¾″	3⅞″	1½″	13½″	4¾″
3	3	182	12 5/16″	8½″	4½″	5⅞″	4½″	7½″	3⅜″	5½″	3⅞″	1½″	13½″	4″
5	5	184	12 5/16″	8½″	4½″	5⅞″	5½″	7½″	3⅜″	5½″	3⅞″	1½″	13½″	4″
	7.5	184	15 3/16″	8½″	4½″	5⅞″	5½″	7½″	3⅜″	5½″	3⅞″	1½″	13½″	4″
7.5	7.5	213	12 5/16″	10 3/16″	5¼″	7⅜″	5½″	8½″	4¼″	5½″	3⅞″	1½″	13½″	4″
10	10	215	12 5/16″	10 3/16″	5¼″	7⅜″	7″	8½″	4¼″	5½″	3⅞″	1½″	13½″	4″
10	15	215	16 1/16″	10 3/16″	5¼″	7⅜″	7″	8½″	4¼″	5½″	3⅞″	1½″	13½″	4″
15		254	19¾″	13¼″	6¼″	9⅝″	8¼″	10″	4¾″	6⅝ or *7⅞″	3⅞″ or *4⅝″	1½″ or *1¾″	13½″ or *17½″	2⅝″ or *4¾″
20	20	256	19¾″	13¼″	6¼″	9⅝″	10″	10″	4¾″	6⅝ or *7⅞″	3⅞″ or *4⅝″	1½″ or *1¾″	13½″ or *17½″	2⅝″or *4¾″

*FOR 1051, 1151, 1161 ONLY

PUMP TYPE	PIPE CONNECTIONS		PUMP DIMENSIONS IN INCHES				
FPX	INLET	OUTLET	A	B	C	D	ØE
FPX 701/702	1½″	1½″	4¼″	1¾″	4 5/16″	5¾″	5⅞″
FPX 711/712	2″	1½″	5 1/16″	2¼″	4 7/16″	5⅞″	7¼″
FPX 721/731/722	2″	1½″	6 1/16″	3⅛″	4 7/16″	5⅞″	9 1/16″
FPX 741/732/742	2½″	2″	7 1/16″	3¾″	4	5 9/16″	10⅝″
FPX 1741/1732/1742	2½″	2″	7⅞″	3 9/16″	4⅛″	5 15/16″	10⅝″
FPX 3521/3522	2½″	2″	7½″	3⅛″	4⅝″	6⅜″	9 1/16″
FPX 3531/3532	2½″	2″	7½″	3¾″	4 9/16″	6⅜″	10¼″
FPX 3541/3542	3″	2½″	8¼″	4½″	4⅝″	6⅜″	11 7/16″
FPX 3451/3452	3″	2″	8¼″	5½″	4½″	6¼″	13¾″
FPX 3551/3552	3″	2½″	9 1/16″	5½″	4 11/16″	6⅝″	13¾″

FPX Double Flange Dimensions



NOTE:

(1) Motor dimensions may vary depending on manufacturer requested.

(2) Pump dimensions are based on clamp fittings.

RPM		FRAME	MOTOR DIMENSIONS IN INCHES							
1750 HP	3500 HP		H	J	K	L	M	N	P	R
	25	284TSC	9½″	23″	13⅛″	14 3/8"	7 ⅞″	7″	17½″	11″
	30	286TSC	11″	23″	13⅛″	14 3/8"	7 ⅞″	7″	17½″	11″
40		324TC	10½″	25″	14⅛″	16 1/8"	8½″	8″	18½″	12½″
	40	324TSC	10½″	25″	14⅛″	16 1/8"	8½″	8″	18½″	12½″
50		326TC	12″	25″	14⅛″	16 1/8"	8½″	8″	18½″	12½″
	50	326TSC	12″	25″	14⅛″	16 1/8"	8½″	8″	18½″	12½″

PUMP TYPE	PIPE CONNECTIONS		PUMP DIMENSIONS IN INCHES/DOUBLE FLANGE					284-6TSC		324-6TSC/TC	
FPX	INLET	OUTLET	A	B	C	D	E	F	G	F	G
FPX 1742	2½″	2″	7⅞″	3 9/16″	4⅛″	6″	10⅝″	13⅞″	18 11/16″	15″	19¾″
FPX 3532	2½″	2″	7½″	3¾″	4 9/16″	6½″	10¼″	14⅜″	19⅛″	15½″	20¼″
FPX 3542	3″	2½″	8¼″	4½″	4⅝″	6½″	11 7/16″	14⅜″	19⅛″	15½″	20¼″
FPX 3452	3″	2″	8¼″	5½″	4½″	6 5/16″	13 13/16″	14⅛″	18 15/16″	15 5/16″	20 1/16″
FPX 3552	3″	2½″	9 1/16″	5½″	4 11/16″	6 11/16″	13 13/16″	14 9/16″	19 5/16″	15 11/16″	20 7/16″
FPX 1051	4″	4″	9⅞″	6 11/16″	6 9/16″	7 15/16″	16″	13⅝″	18⅜″	16 15/16″	21 11/16″
FPX 1151	4″	4″	9⅞″	6 11/16″	4 5/16″	5¾″	16″	13⅝″	18⅜″	14¾″	19½″
FPX 1161	6″	4″	9⅞″	6 11/16″	4 5/16″	5¾″	16″	13⅝″	18⅜″	14¾″	19½″

FP & FPX Pump Seals

Fristam pump seals are one of the pumps' most outstanding features. The long life and ability to prevent air from entering the product are two of the greatest benefits of the seal.

Fristam pump seals last far longer than competitive pump seals even under extreme duties. For instance, it is common in product withdrawal from evaporators, which run 24 hours per day, for the seal life to be measured in years, not weeks.

The special internal seal design will absorb pressure surges without releasing product out of the pump.

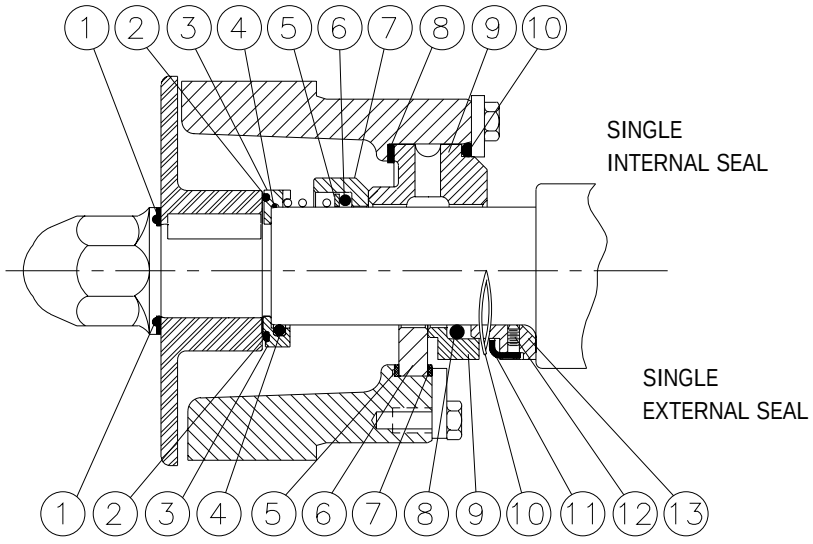
The inboard design of the seal enables the product or cleaning solution to clean, cool and lubricate the front seal area. Because of this construction, there is no contact between seal wear surfaces and any pump component such as a back plate or wear plate. There is never a need to replace pump components because of wear where they interface with the seal.

The illustration shown at right represents the single internal seal components and single external seal components. The external seal was developed as an option for applications where the customer prefers an external seal design.

The wear components of the standard double seal consist of a chrome oxide-coated stainless steel front seal face, carbon center seal and ceramic rear seal. The chrome oxide against carbon front wear face combination is particularly good for reducing the friction

ITEM	QUANTITY	DESCRIPTION	MATERIAL*
1	1	Impeller nut gasket	Viton
2	1	Outside O-ring front spring disc	Viton
3	1	Front spring disc driver	Stainless steel
4	1	Inside O-ring front spring disc (factory installed)	Viton
5	1	Front seal washer	Stainless steel
6	1	Front seal O-ring	Viton
7	1	Front seal ring	Chrome oxide coated stainless steel
8	1	Center seal flat gasket	Viton
9	1	Center seal	Carbon
10	1	Center seal O-ring	Viton

*Standard materials shown. Other materials available.



ITEM	QUANTITY	DESCRIPTION	MATERIAL*
1	1	Impeller nut gasket	Viton
2	1	Outside O-ring front spring disc	Viton
3	1	Seal driver spacer	Stainless steel
4	1	Inside O-ring seal drive spacer (factory installed)	Viton
5	1	Flat gasket	Viton
6	1	Stationary center seal	Silicon carbide
7	1	Flat gasket	Teflon
8	1	Inside O-ring front seal ring	Viton
9	1	Front seal ring	Carbon
10	1	Spring	Stainless steel
11	1	Seal drive ring	Stainless steel
12	2	10-32 set screw	Stainless steel
13	1	Driver	Stainless steel

*Standard materials shown. Other materials available.

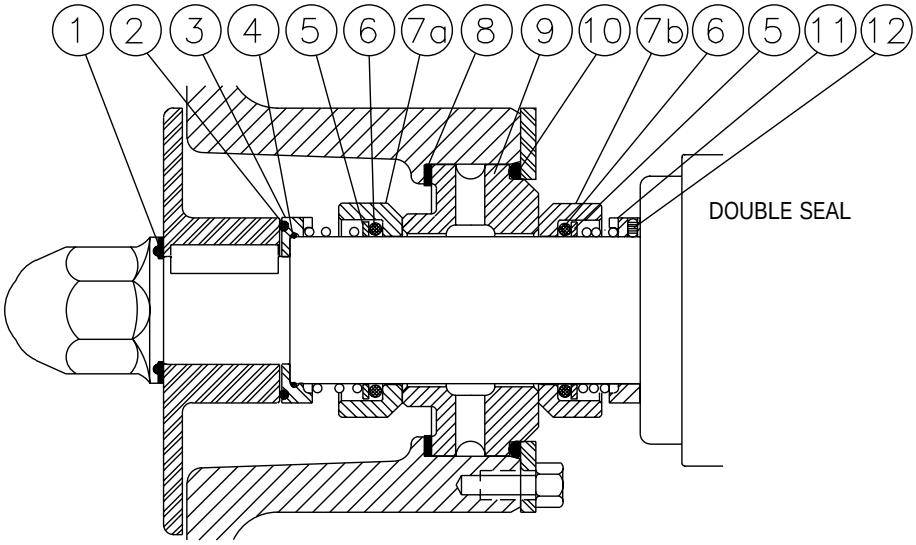
FP & FPX Pump Seals *(continued)*

and heat that cause wear.
The standard double seal, available on the FP series only, includes piping for a water flush. The water not only cools and lubricates the contact surfaces, but also helps to provide a barrier against air.

Properly installed, the double seal and water flush prevent air being drawn into the product area through the seal. If the seal should wear to the point that it leaks, then either the seal water will become discolored with product or the flow from the discharge will be interrupted. This is an obvious indication of the necessity to replace the seal.

There are only 3 seal sizes for all of the American manufactured Fristam centrifugal pumps. This eliminates the need to stock a large number of seals. The smallest seal size fits pumps with motors up to frame size 215 TC. The next size fits pumps with motors up through 30 horsepower.

The largest seal size fits pumps with motors over 40 horsepower and all 1050 and 1150 models.



ITEM	QUANTITY	DESCRIPTION	MATERIAL*
1	1	Impeller nut gasket	Viton
2	1	Outside O-ring front spring disc	Viton
3	1	Front spring disc driver	Stainless steel
4	1	Inside O-ring front spring disc (factory installed)	Viton
5	1	Front/rear seal washer	Stainless steel
6	1	Front/rear seal O-ring	Viton
7A	1	Front seal ring	Chrome oxide coated stainless steel
7B	1	Rear seal ring	Ceramic
8	1	Center seal flat gasket	Viton
9	1	Center seal	Carbon
10	1	Center seal O-ring	Viton
11	1	Rear spring disc (driver)	Stainless steel
12	2	10-32 set screw	Stainless steel

*Standard materials shown. Other materials available.

Options

Aseptic Design
Fristam FP Series pumps are available with a steam-traced cover. Used with aseptic fittings and steam on a double seal, this pump provides a steam barrier between the atmosphere and the product.

Bearing Blocks
Fristam pumps are available with a bearing block style mounting which can accomodate motors up to 125 HP. The base plate is stainless steel.

Adjustable Base
Fristam pumps' adjustable bases use solid stainless steel components with adjustable legs.

Shroud
A stainless steel shroud is available to protect pump motors from direct water spray and provide the clean look of stainless steel.

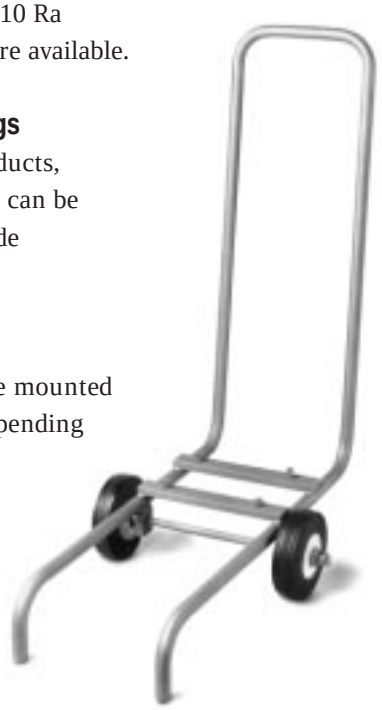
Fittings
Fristam pumps can be supplied with most types of sanitary or industrial fittings. Some alternate inlet sizes are also available. (Note: Non-sanitary fittings cannot be used on pumps that are required to meet 3-A standards.)

Motors
The standard motors are TEFC with locked front bearings. They are C-faced up to 326 TSC and D-flange for 40 and 50 HP motors on the FP series. Base-mounted pumps use TEFC rigid base motors. Any brand or duty motor that meets these requirements can be used. The following options are offered:
- Washdown
- Premium Efficiency
- Explosion-Proof
- Chemical Duty
- IEC

Surface Finish
Standard surface finish is 32 Ra (150 grit) finish. Finer finishes up to 10 Ra (320 grit) electropolished are available.

Tungsten Carbide Coatings
For extremely abrasive products, internal pump components can be coated with tungsten carbide to prevent erosion.

Portable Cart
Most Fristam pumps can be mounted on a stainless steel cart, depending on motor size.



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