Application and Reference Data

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DEFINITIONS AND TERMINOLOGY

DATUM is the horizontal plane defined by the elevation of the bottom of the discharge head. Sometimes the centerline of the discharge is referred to as the datum, but then the vertical distance in feet between the centerline of discharge and the bottom of the discharge head should be accounted for.

SETTING is the distance in feet from the column connection datum at the discharge head to the column connection at the bowl assembly.

STATIC LEVEL is the distance, in feet, between the datum and the liquid level when the pump is not operating.

PUMPING LEVEL is the distance, in feet, between the datum and the liquid level when the pump is operating.

DRAWDOWN is the difference, in feet, between the static level and the pumping level.

CAPACITY is the rate of flow, usually expressed as gallons per minute (GPM).

STATIC DISCHARGE HEAD is the vertical distance in feet the liquid must be raised above the datum.

LIFT (HEAD) BELOW DATUM is the vertical distance, in feet, between the datum and the pumping water level.

VELOCITY HEAD is the kinetic energy of the liquid in feet of head per unit weight.

HEAD ABOVE DATUM is the static discharge head plus the friction loss through the discharge line and fittings plus the velocity head.

PUMP TOTAL HEAD is equal to the lift below datum plus head above datum. This is the head for which the customer is responsible and is exclusive of any pump losses.

COLUMN FRICTION LOSS is the friction loss, in feet of head, through the column and is dependent upon both capacity and the length and diameter of column and shaft used. Column friction loss is determined from a COLUMN FRICTION LOSS CHART and is indicated in feet of head per hundred feet of column and shaft. (See page 034).

DISCHARGE HEAD FRICTION LOSS can be determined from the DISCHARGE ELBOW FRICTION LOSS CHART on page 038. These losses are usually very small and can be ignored.

BOWL TOTAL HEAD (OR LABORATORY HEAD) is the head, in feet, on the pump bowl and is equal to the pump total head plus the column friction loss and the discharge elbow loss. (Shown as total head on performance curves).

BOWL TOTAL HEAD = PUMP TOTAL HEAD + COLUMN FRICTION LOSS + DISCHARGE ELBOW LOSS

BOWL EFFICIENCY (OR LABORATORY EFFICIENCY) is the efficiency as indicated on the bowl performance curve, including any applicable corrections.

SPECIFIC GRAVITY is a relative term which expresses the fluid's density with reference to water at 39.2 degrees F. Specific gravity of water is 1.0

$$\text{SPECIFIC GRAVITY} = \frac{\text{DENSITY OF FLUID PUMPED (LBS./FT.}^3\text{)}}{\text{DENSITY OF WATER (LBS./FT.}^3\text{)}}$$

BOWL HORSEPOWER (OR LABORATORY HORSEPOWER) is the horsepower required at the bowl shaft to deliver the required capacity against the bowl total head and is defined by the following formula:

$$\text{BOWL HORSEPOWER} = \frac{\text{BOWL TOTAL HEAD (FEET) X CAPACITY (GPM) X SPECIFIC GRAVITY}}{\text{3960 X BOWL EFFICIENCY}}$$

SHAFT LOSS is the friction loss, measured in horsepower, between the shaft and its bearings. Line shaft loss is determined from the LINE SHAFT LOSS CHART and is indicated in horsepower per hundred feet of shafting. (See page 038).

BRAKE HORSEPOWER (OR FIELD HORSEPOWER) is the horsepower required at the top shaft and is equal to the bowl horsepower plus shaft loss.

BRAKE HORSEPOWER = BOWL HORSEPOWER + SHAFT LOSS

PUMP FIELD EFFICIENCY is the efficiency of the complete pump with all losses accounted for.

$$\text{PUMP FIELD EFFICIENCY} = \frac{\text{PUMP TOTAL HEAD (FT) X CAPACITY (GPM) X SPECIFIC GRAVITY}}{\text{3960 X BRAKE HORSEPOWER}}$$

VISCOSITY of a liquid is a measured of the internal friction tending to resist flow. The performance of vertical turbine pumps is affected when handling viscous liquids. The exact affect on performance when handling viscous liquids can be determined from the information published in the Fairbanks Nijhuis™ *Hydraulic Handbook* or in the Hydraulic Institute *Engineering Data Book*.

TOTAL PUMP THRUST is composed of the weight of the rotating parts in the pump bowls, the weight of the lineshaft, and the hydraulic thrust of the liquid being pumped. Total pump thrust equals the summation of:

K_t X BOWL HEAD;
WHERE (K_t) IS THE HYDRAULIC CONSTANT

K_a X NUMBER OF STAGES;
WHERE (K_a) IS ROTOR WEIGHT PER STAGE

K_s X LENGTH OF LINESHAFT;
WHERE (K_s) IS WEIGHT PER FOOT OF LINESHAFT

THRUST BEARING LOSS is the friction loss, in horsepower, developed by the total thrust load on the motor bearings. Bearing manufacturers estimate the loss in angular contact bearings to be approximately 0.0075 HP per 1000 Lbs. Thrust Load. It can be determined using a THRUST BEARING CHART, available from the Motor Manufacturer, or by the following formula:

THRUST BEARING LOSS = RPM / 100 X THRUST / 1000 X 0.0075

DRIVER EFFICIENCY is the ratio of driver output to driver input with no external thrust load and therefore must be adjusted to reflect the thrust bearing loss.

$$\text{DRIVER EFFICIENCY} = \frac{\text{DRIVER OUTPUT (NAMEPLATE RATING)}}{\text{DRIVER INPUT + THRUST BEARING LOSS}}$$

OVERALL EFFICIENCY (WIRE TO WATER EFFICIENCY) is the efficiency of the pump and motor complete.

OVERALL EFFICIENCY = PUMP FIELD EFFICIENCY X DRIVER EFFICIENCY

DRIVER INPUT HORSEPOWER is the total power required to operate the pump and motor and a measure of the amount of power that must be supplied by the user.

INPUT HORSEPOWER = OUTPUT HORSEPOWER (NAMEPLATE) / DRIVER EFFICIENCY (NO LOAD RATING)

NPSH (NET POSITIVE SUCTION HEAD) can be defined as the head, in feet, at the eye of the impeller that causes the liquid to flow. Available NPSH in open systems is the summation of the barometric pressure plus the distance from the static liquid level to the impeller eye minus the vapor pressure of the pumped liquid. Available NPSH in closed systems is the summation of the gage pressure, in feet, at the suction flange plus the vertical distance, in feet, to the impeller eye* minus friction losses between the gage connection and the impeller eye.

*If the suction flange is below the impeller eye, subtract this distance from the gage pressure.

For additional discussion of NPSH, refer to the Fairbanks Nijhuis *Hydraulic Handbook*.

PURPOSE

The purpose of the Application and Reference Data Section is to provide a section that, hopefully, the most inexperienced person, with careful reading and study, can select and apply a vertical pump given a set of parameters with which to work. This section contains a list of commonly used terminology and definitions, what information is required to select and apply a pump, an example of pump selection, modifications required for items not covered in the example, and the necessary charts and graphs which are referred to in the text of this section.

PUMP SELECTION (GENERAL)

The following is an example of pump selection. The statement on the left is the user requirement, and immediately following in ( ) is the data regarding the application that must be known and would normally be supplied by the user.

USER REQUIREMENTS

1. Quantity required:	(2)
2. Delivery requirement:	(Within 6 weeks)
3. Driver Type: e.g. motor, gear, belt, speed	(Electric motor, 1770 RPM)
4. Type of power available: A. Electrical Phase, frequency, voltage B. Mechanical Engine type, fuel, clutch requirements, accessories, etc.	(Electric) (3/60/460 V.) (None)
5. Line shaft lubrication (oil, product) A. Oil B. Product e.g. water, fuel, etc.	(Oil lubrication)
6. Type of discharge A. Above ground B. Below ground Location of centerline of discharge with respect to the bottom of the motor pedestal is required.	(Above ground) (N/A)
7. Pump setting: A. Total length of column and wall thickness	 (400 Ft., 0.280” wall)
8. Length of suction pipe, if any	(10 Feet)

PUMP OPERATING CONDITIONS

9. Design capacity in GPM	(750 GPM)
10. Datum elevation in feet	(Sea level)
11. Pumping water level at design capacity in feet below datum	(400 feet)
12. Head above datum, including losses through discharge line plus velocity head	(246 feet)
13. Pump total head at design capacity A. Line 9 plus line 10	(646 feet)
14. Operating range, if any A. Minimum pump total head B. Maximum pump total head	(None)
15. Any other operating conditions of note	(None)

WELL CONDITIONS

16. Minimum inside diameter of well	(12”)
17. Maximum outside diameter of bowl	(11 5/8”)
18. Total depth of well or sump	(500 ft.)
19. Is well straight to pump setting depth? Note: A well is considered straight if a 20 ft. cylinder equal to the maximum diameter of the bowl will not bind when lowered to a depth equal to the pump setting	(Yes)
20. Static water level below datum, in feet	(350 ft.)
21. Sand in water	(No)
22. Gas in water, parts per million	(None)
23. Other unusual conditions	(None)

ACCESSORY REQUIREMENTS

24. Companion flange required?	(Yes)
25. Discharge stub required?	(Yes)
26. Strainer required? Type? Material?	(Yes, Cone, Galvanized)
27. Lubricator required? Type?	(Yes, One gal., Manual)
28. Automatic controls required? Type? Lubricator Time delay Float switch	(None)
29. Prelube water tank required? Capacity?	(No)
30. Airline and gauge required?	(Yes)
31. Motor accessories required? Space heaters, voltage Non-reverse ratchet Bearing and winding temperature detectors Extra high thrust Special Insulation Inverter duty Other	 (No) (Yes) (No) (To be determined) (No) (No) (No)

PUMP SELECTION (SPECIFIC)

Having established the parameters for the given installation, we can now proceed to specific pump selection and evaluation. In most cases there are four major components that must be selected and evaluated. These are: bowl assembly, column and shaft, discharge head and packing box, and driver. A step by step approach for the selection and evaluation of each follows:

BOWL ASSEMBLY

Having established the design capacity, pump total head, speed and maximum permissible bowl outside diameter, the initial step in bowl selection is to determine which bowls supply the required capacity. Since column friction loss and discharge elbow loss have not yet been established, add 5 feet for every 100 feet of column to the pump total head to establish a tentative bowl total head. (Discharge elbow loss is usually small and will be ignored at this point.)

Example: Tentative Bowl Total Head = 646 feet + (5 feet/100feet X 400 feet) = 666 feet

It has now been established above that this application requires:

Capacity: 750 GPM
Pump total head: 666 feet
Speed: 1770 RPM
Maximum bowl outside diameter: 11-5/8”

Using your H2Optimize software program, the available bowl selections are the 10G, 10J, 11M, 12A, 12B, 12D, 12F, 12G, 12K, 12M, 12S and 13F. Now begin the process of elimination to find the best selection. At this point the obviously inappropriate bowls can be eliminated for the following reasons:

A. The bowl will not physically fit into the well casing. Again, referring to the H2Optimize data, eliminate any bowls whose diameter is larger than the inside diameter of the well (or the maximum permissible outside diameter).

Example: The 12M (12.26" O. D.), 12K and 12S (11.75" O. D.) and the 13F (12.5" O. D.) must be eliminated.

B. The bowl pressure capability is less than the required bowl head. (H2Optimize will warn you if the bowl pressure limits have been exceeded.

C. The bowl horsepower is too high.

Example: The 12F can be eliminated since it is the only remaining pump to require more than 200 horsepower.

After tentative bowl head is established, and you have selected your bowls from the catalog curves, eliminate all bowls that cannot meet this requirement. Refer to the BOWL PRESSURE RATING CHART on page 017.

Example:

BOWL	MAX PRESSURE IN FEET
10G	450 PSI X 2.31 FT/PSI = 1039 FEET
10J	450 PSI X 2.31 FT/PSI = 1039 FEET
11M	488 PSI X 2.31 FT/PSI = 1127 FEET
12A	580 PSI X 2.31 FT/PSI = 1339 FEET
12B	580 PSI X 2.31 FT/PSI = 1339 FEET
12D	580 PSI X 2.31 FT/PSI = 1339 FEET
12G	400 PSI X 2.31 FT/PSI = 924 FEET

Since the tentative bowl total head is 666 feet, all of the bowls can produce the required tentative bowl total head.

D. The bowl cannot be staged to meet the required head. H2Optimize will not list any bowls that exceed the maximum number of stages. If you selected your bowls from the catalog curves, you can either refer to the TECHNICAL DATA shown on the bowl performance curve to find the nominal maximum number of stages for that bowl or, for a more precise analysis, proceed as indicated below.

The MAXIMUM NUMBER OF STAGES data shown on the bowl performance curve is footnoted to indicate that the values are nominal. The reason for this is that the limitation on staging is a function of the pressure capability of the bowl, the horsepower and thrust rating of the bowl shaft, and the length of the bowl shaft. The nominal value shown on the performance curve is based upon what is generally considered to be the USEFUL PORTION of the head-capacity curve. Based on the specific job, a higher number of stages may be possible.

Establish the number of stages required to produce the tentative bowl total head by first referring to the bowl performance curve to determine head per stage at design capacity. Then divide tentative bowl total head by head per stage to determine staging. Round off any fractions to the next higher whole number.

Example:

BOWL	HEAD PER STAGE @ 750 GPM	CALCULATION	NO. OF STAGES REQUIRED
10G	37.0	666/37.0 = 18	18
10J	40.5	666/40.5 = 16.44	17
11M	61.0	666/61.0 = 10.91	11
12A	67.0	666/67.0 = 9.94	10
12B	72.0	666/72.0 = 9.25	10
12D	78.0	666/78.0 = 8.53	9
12G	68.0	666/68.0 = 9.79	10

H2Optimize will not list any bowls that have inadequate bowl shafts. If you have selected your bowls from the catalog curves, you must now determine whether or not the bowl shaft will carry the estimated bowl horsepower and thrust. To do this, list for each bowl the bowl efficiency, and the thrust constants K_t (thrust factor) and K_a (rotor weight per stage). This information can be found on the bowl performance curve. In determining bowl efficiency be sure to account for any corrections due to staging or special materials. Staging corrections are shown on the performance curve and material correction factors are shown on page 018, EFFICIENCY CORRECTION CHART for special materials. Calculate the estimated bowl horsepower using the following formula:

$$\text{Estimated Bowl horsepower} = \frac{\text{Tentative Bowl Head (feet) X Capacity (GPM) X Specific Gravity}}{\text{3960 X Bowl Efficiency}}$$

Calculate the thrust imposed on the bowl shaft by the formula: Thrust = (thrust factor X Tentative Bowl Total Head) + (rotor weight per stage X Number of Stages)

Example: 10G = (6.00 X 666) + ((18.3 X 17) + 34.6) = 4342

To determine the maximum allowable horsepower and thrust rating of the bowl shaft, refer to the BOWL SHAFT RATING CHART on page 019.

Example:

BOWL	**STAGES**	**EFFICIENCY**	**EST. HP**	**THRUST FACTOR**	**ROTOR WT. 1ST**	**ROTOR WT. Add'l**	**THRUST (LBS.)**
10G	18	82.8%	152	6.00	34.6	18.3	4342
10J	17	78.3	163	11.00	32.2	15.9	7613
10J	18	78.7	161	11.00	32.2	15.9	7629
11M	11	82.6	155	5.02	22.0	22.0	3586
11M	12	82.7	154	5.02	22.0	22.0	3607
12A	10	82.6	154	5.80	42.2	21.5	4099
12A	11	82.7	153	5.80	42.2	21.5	4120
12B	10	83.2	152	5.60	43.6	22.4	3975
12B	11	83.2	153	5.60	43.6	22.4	3997
12D	9	81.3	156	7.20	43.5	22.3	5017
12D	10	81.7	156	7.20	43.5	22.3	5039
12G	10	73.3	172	9.40	58.0	31.0	6598

As a result of this analysis, we find all of the bowl shafts are within the horsepower and thrust limitations.

At this point it may be possible to narrow the bowl selection process by comparing efficiencies and initial costs of the remaining bowls. Bowl efficiencies have already been established to calculate bowl horsepower.

The cost per bowl can be obtained from the price pages. Now rank the bowls from the lowest to highest cost showing staging and efficiency. Eliminate all bowls that are both high in cost and low in efficiency.

Example:

BOWL	**COST**	**STAGES**	**EFFICIENCY**
12D	lowest	9	81.3%
11M		11	82.6
12A		10	82.6
12B		10	83.2
12D		10	81.7
11M		12	82.7
12A		11	82.7
12B		11	83.2
12G		10	73.3
10J		17	78.3
10G		18	82.8
12J	highest	18	78.7

If the pump setting is less than 50 feet, then relative shaft stretch (discussed later in this text) is not a factor and the remaining bowls can be analyzed to determine the best overall selection.

COLUMN CONNECTION

The discharge case of the bowl assembly is sized to accommodate the capacity produced by the bowl at its best efficiency point with minimal friction loss. Therefore, column size is normally selected as a function of the available discharge case connection sizes.

In some cases, deep settings would cause the total column friction loss to be significant and a larger size column may be appropriate. The cost of the larger size column and the necessary adaptations required should be weighed against the cost savings of a smaller motor, associated electrical equipment and cost of power.

In other cases, where initial cost is the most important factor and pump settings are such that additional column friction losses are acceptable, a smaller size column could be used.

When a smaller size column is desired, and a smaller discharge case is not available, a column reducing bushing is required to adapt this smaller column to the bowl used. This column reducing bushing causes additional friction losses due to the sudden reduction in size. These losses would need to be added to the bowl total head. These losses are shown in the COLUMN REDUCING BUSHING LOSS CHART on page 022.

It should be noted that a change in column size would change the relative shaft stretch and column friction losses both of which are discussed later in this text.

Since all bowls in the preliminary selection have 8” discharge cases available, we will use 8” column.

Before proceeding further, check the maximum setting allowed for the size column being used by referring to the MAXIMUM COLUMN SETTING CHART on page 022.

In the example, we are using 400 feet of 8” standard column. Referring to the MAXIMUM COLUMN SETTING CHART, we find that 400 feet is well below the maximum allowable setting of 950 feet, and can be used.

SHAFT SELECTION

Line shaft selection is a function of horsepower requirement, shaft stretch restrictions, and thrust requirements.

Estimated bowl horsepower and thrust have been calculated above, however since the top section of lineshaft must also carry the weight of all of the shaft below it, total thrust must be calculated.

In the example, we find that the horsepower requirement ranges from 152 HP to 172 HP and the required thrust ranges from 3586 lbs. to 7629 lbs. Referring to the LINESHAFT RATING CHART on page 024, the 1-1/2” diameter lineshaft appears to be within this range and has a Ks value of 6.0. Now calculate the thrust due to the weight of the lineshaft by the formula:

$$\text{Thrust} = Ks \times \text{Setting}$$

Example: 6.0 X 400 = 2400 lbs.

Adding this to the bowl thrust of 7629 lbs., it is now confirmed that the 1-1/2” diameter shaft will carry the horsepower (172) and the thrust (2400 lbs. + 7629 lbs. = 10029 lbs.) imposed on it.

LINESHAFT STRETCH

This section can be ignored if pump setting is less than 50 feet.

We are not so much concerned with the lineshaft stretch as we are with the RELATIVE STRETCH between the column, enclosing tube (when required) and the lineshaft combination.

This relative stretch should be calculated and compared to the allowable shaft stretch of each bowl. Refer to the BOWL TECHNICAL DATA on page 501 of SECTION 400 to find this value.

List the bowl size, column connection size, lineshaft size selected above, allowable shaft stretch, and the stretch constant from the appropriate chart found on page 027 for each bowl under consideration. These charts are dependent on the shaft configuration (open or enclosed).

Example:

BOWL	COLUMN	SHAFT	ALLOWABLE STRETCH	STRETCH CONSTANTS K	K'
11M	8"	1-1/2"	.67"	5.3379	3.5401
12A	8"	1-1/2"	.70"	16.0193	3.5401
12B	8"	1-1/2"	.70"	9.0415	3.5401
12D	8"	1-1/2"	.70"	14.1407	3.5401

The shaft stretch in each case can now be calculated simply by the following formula:

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10,000,000}$$

Where: L = Setting; H = Bowl Total Head; S.G. = Specific Gravity

Example: 11M

$$\text{Stretch} = \frac{400\ ([666 \times 5.3379] + [2 \times 666 \times 3.5401] - [400 \times 3.5401]) \times 1.0}{10,000,000} = 0.27"$$

Performing this calculation for all bowls under consideration produces the following data:

BOWL	ALLOWABLE STRETCH	CALCULATED STRETCH
11M	.67"	.27"
12A	.70"	.56"
12B	.70"	.37"
12D	.70"	.51"

CONFIRMATION OF BOWL SELECTION

For the purpose of this example, we will assume that lowest initial cost is the final criteria for bowl selection. Therefore, the 11 stage 11M will be used.

Actual bowl total head can now be calculated. In the initial bowl selection, column losses were not known and thus were assumed to be 5 feet for every 100 feet of column. Since the 11M bowl, 8" column, and 1-1/2" shaft have been selected, the actual friction loss can now be calculated.

Referring to the COLUMN FRICTION LOSS CHART on page 034, it indicates that at 750 GPM, an 8" column with 1-1/2" lineshaft (either open or enclosed) loses 2.4 feet of head per 100 feet of column. Therefore, the actual column friction loss is:

$$2.4 \times 400/100 = 9.6 \text{ (feet)}$$

Note that the discharge head losses have been discounted as being insignificant (typically less than ½ foot) when the discharge head flange size is matched to the column size. This can be verified by referring to the DISCHARGE ELBOW LOSS CHART found on page 038. If the discharge head loss is significant, it should be included with the column losses.

Bowl total head (exclusive of material and staging corrections) can now be calculated by the formula:

Bowl total head = Pump total head + column friction loss + discharge elbow loss

Example: 646 feet + 9.6 feet = 655.6 feet

Since efficiency corrections are not required in this example for either staging or material, the actual number of stages and head per stage can now be calculated. To verify staging, divide the actual bowl total head by the maximum head per stage at the desired capacity (from the pump performance curve), or by using your H2Optimize software.

Example: 655.6/64 = 10.24 or 11 stages

Required head per stage would then be the actual bowl total head divided by the number of stages required.

Example: 655.6/11 = 59.6 feet per stage

Again, since efficiency changes for staging or materials are not required, the bowl efficiency as shown on the performance curve at the conditions of 750 GPM @ 59.6" bowl total head per stage is 82.6%.

If efficiency corrections were required due to staging or materials, it would necessitate a change in the head per stage. To do this, use the following formula:

Head correction due to material correction:

HA = HP ([EP – EC]/EP
EA = EP – EC

Head correction due to staging correction:

HA = HP ([EP – .5EC]/EP
EA = EP – EC

Where: HA = Head after correction
HP = Performance curve head
EA = Efficiency after correction
EP = Performance curve efficiency
EC = Efficiency change

Confirmation of staging would be calculated as follows:

Bowl total head/actual head per stage after correction = number of stages (if greater than had been previously selected, go back through procedure with this in mind.

DRIVER SELECTION

To make a driver selection, in this example an electric motor, both total pump thrust and brake horsepower (BHP) must be established.

Total thrust has previously been established; however, tentative bowl head was used in that calculation. Since actual total bowl head has now been established, that calculation should be redone using the correct bowl total head, and remembering to include the weight of the lineshaft as calculated previously.

Initial calculation of horsepower was based upon estimates of losses. Final selection can be made by calculating all pertinent losses. These losses are shaft loss and thrust bearing loss.

Shaft loss can be found in the chart on page 038. This chart is based on enclosed lineshaft which has bearings located on 5 foot centers. It can, however, be used for open lineshaft.

Example: 400 feet of 1-1/2” lineshaft at 1800 RPM

1.20HP/100 ft. x 400 ft. = 4.8 HP

Thrust bearing loss can be calculated as follows and is expressed in units of horsepower:

HP = .0075 HP x (Speed/100) x (Total pump thrust/1000 lbs.)

Example: .0075 x (1770/100) x (6644/1000) = .88 HP

Brake horsepower can now be calculated as follows:

BHP = ([GPM x Total Head x S.G.] / [3960 x Bowl efficiency]) + Shaft loss + Thrust bearing loss

Example:

BHP = ([750 x 655.6 x 1.0] / [3960 x .803]) + 4.8 + 0.88 = 160.3

Referring to the motor manufacturer’s data in the VENDOR EQUIPMENT section, it is established that a 200 HP motor will carry the load and the thrust of 6644 lbs. If the thrust exceeds the standard maximum thrust rating of the motor, then the motor must be ordered with an extra high thrust option.

Pump efficiency can now be calculated by the following formula:

Pump Efficiency = ([GPM x bowl total head] / [3960 x BHP])

Example:

([750 x 655.6] / [3960 x 160.3]) = .775 = 77.5%

Estimated driver input can now be calculated by the following formula:

Input HP = Output horsepower (Nameplate) / Driver efficiency (manufacturer’s no thrust rating)

Example:

Input HP = 200 / .93 = 215

Estimated driver efficiency can now be calculated by the following formula:

Efficiency = Driver output (Nameplate HP) / (Driver input + Thrust bearing loss)

Example:

Efficiency = 200 / (215 + 0.88) = .926 = 92.6%

NOTE: The efficiency used in this calculation is an efficiency that is obtained from the motor vendor and is a nominal value only, and not guaranteed.

It should be noted that, at the customer’s option, a 150 HP motor with a 1.15 service factor (172.5 useable HP) could be used.

Overall efficiency can now be calculated using the formula:

Overall Efficiency = Pump efficiency x Driver efficiency

Example:

Overall Efficiency = 77.5% x 92.6% = 71.8%

CONFIRMATION OF LINESHAFT SELECTION

Having established the brake horsepower and total pump thrust, the lineshaft selection can be confirmed.

Using the BHP of 160.3 and the total pump thrust of 6644 lbs., refer to the LINESHAFT RATING CHART on page 024 to determine whether the 1-1/2" lineshaft is still adequate. Since the 1-1/2" lineshaft has a maximum allowable BHP of 201 HP at 1770 RPM and at a thrust of 7500 lbs., it is still adequate for this application.

Since the setting exceeds 50 feet, the shaft stretch should be rechecked using the actual bowl total head rather than the tentative bowl total head used in the original calculation. Doing this we find the stretch is equal to:

$$\text{Stretch} = \frac{400\,([655.6 \times 5.3379] + [2 \times 655.6 \times 3.5401] - [400 \times 3.5401]) \times 1.0}{10{,}000{,}000} = 0.267"$$

This is still less than the maximum allowable and is still acceptable.

DISCHARGE HEAD SELECTION

Discharge head size is based upon driver size, hanging weight, discharge pressure, and capacity pumped. As noted under CONFIRMATION OF BOWL SELECTION, the discharge head flange is typically matched to the column size unless the loss through the discharge head becomes significant.

Usual practice is to size the base diameter of the head to the base diameter of the motor.

On deep setting pumps (setting exceeding 300 feet) the most significant factor in selecting the head is whether the head can carry the hanging weight load.

This value can be found in the DISCHARGE HEAD HANGING WEIGHT chart on page 023. The hung weight includes the bowl assembly, column pipe, shafting, enclosing tube, discharge head and stuffing box.

Since the column size is 8" and the motor base diameter is 16-1/2" (found in motor vendor catalog), the nominal head size is 16-1/2 x 8.

To determine the correct head to use, make the following weight calculations obtaining applicable weights from the technical data section and performance curves.

Example:

11 Stage 11M Bowl Assembly	890 lbs.
400' of 8" Column	9880 lbs.
39 Column Couplings	936 lbs.
400' of 2-1/2" Enclosing Tube	3064 lbs.
79 Connector Bearings	395 lbs.
400' of 1-1/2" Lineshaft	2404 lbs.
40 Lineshaft Couplings	72 lbs.
16-1/2 x 8 "D" Discharge Head	476 lbs.
(Including stuffing box)	
	18111 lbs.

From the DISCHARGE HEAD HANGING WEIGHT chart, find the maximum hung weight for the heads under consideration. The maximum allowable hung weight for 0-125 PSI discharge pressure is 15000 lbs. for the 16-1/2 x 8 CT head, and 26500 lbs. for the 16-1/2 x 8 D head. Therefore, only the 16-1/2 x 8 D head is suitable for this application with respect to hanging weight.

STUFFING BOX SELECTION

The stuffing box selection is based on the type of shaft lubrication required, the shaft size used, and the discharge pressure. The styles standardly available and most commonly used are listed below.

A. Open Lineshaft
1. Product lubricated stuffing box with conventional packing
2. Mechanical shaft seals

B. Enclosed Lineshaft
1. Oil lubricated stuffing box
2. Water flush stuffing box

VARIATIONS

POT/CAN PUMPS

Can pumps are those pumps in which the bowl assembly is enclosed in a CAN. They may be referred to by many names but the most common ones are CAN, POT, TANK or BARREL pumps.

This type of pump is most often seen as booster pumps, transfer pumps, or pumps for applications where NPSHA values are low.

It is not uncommon for this type of pump to see high temperatures, high pressures, and as previously mentioned, low NPSH values.

Can pumps are normally supplied with fabricated L, or T discharge heads, although there are some applications where one of the cast D, DT, or CT heads may be used.

The following example follows the same format as the previous example of pump selection. When specific information is required, it will be given. This example will not be as detailed as the previous but when required for clarity, it will be given.

Specific information must be given such as was described in PUMP SELECTION – GENERAL. Some of the ones previously specified will be valid for can pumps while some of it is not. Generally, pump operating conditions will include the following information.

USER REQUIREMENTS

1. Quantity required:	(2)
2. Delivery requirement:	(Within 16 weeks)
3. Driver Type: e.g. motor, gear, belt, speed	(VSS Electric motor, 1770 RPM)
4. Type of power available: A. Electrical Phase, frequency, voltage B. Mechanical Engine type, fuel, clutch requirements, accessories, etc.	(Electric) (3/60/460 V.) (None)
5. Line shaft lubrication	(Product)
6. Type of discharge A. Above grade (datum) suction and discharge B. Below grade (datum) suction and above grade (datum) discharge Location of below grade (datum) suction inlet C. Stuffing box type 1. Packed Box 2. Mechanical Seal	(Above grade suction and discharge) (Mechanical seal)

PUMP OPERATING CONDITIONS

7. Design capacity in GPM	(750 GPM)
8. Static suction pressure	(10 feet)
9. Static discharge pressure	(656 feet)
10. Differential pressure (pump total head)	(646 feet)
11. Bowl efficiency minimum	(82%)
12. Available NPSH at what point	(5 feet at datum)
13. Pumping temperature	(150 degrees F)
14. Specific gravity	(0.981)
15. Elevation of installation	(2000 feet)
16. Liquid pumped	(Water)

WELL CONDITIONS

Since this application is not going into a well, no well conditions are required. It may be noted in this section, however, any limiting factors of the proposed new installation such as maximum depths that would effect can length, restrictions on can diameter, location of inlet, etc.

ACCESSORY REQUIREMENTS

No additional requirements.

BOWL SELECTION

Proceed as in the previous example with the following changes:

A. It will not be necessary to add column friction to the pump total head to determine bowl total head as there is essentially no column used, therefore the bowl total head and pump total head can be considered equal. (Again the discharge elbow losses were assumed to be small and were neglected.)
B. No bowls are required to be eliminated due to maximum diameter (at this point).
C. When listing the bowls in order of increasing cost, include the NPSHR value for each bowl. This value is found on the performance curve or H2Optimize.
D. Eliminate all bowls that do not meet specified minimum bowl efficiency. In this example that requirement will eliminate all but the 10G, 11M, 12A and 12B. Since efficiency is the primary factor, the 10 stage 12B is the best selection with 83.2% efficiency. It would be well, at this time, to make any efficiency corrections required due to special materials or staging before proceeding further.
E. Refer to the CAN SELECTION CHART on page 041, and make a preliminary CAN selection.

Example: Capacity required is 750 GPM
A 18" can when used with the 10 stage 12B and the column size normally used with this bowl (8") is acceptable for capacities up to 1950 GPM (based on the recommendations of the Hydraulic Institute Standards).

F. Establish the approximate length of the can. To do this it is necessary to know the following:
Bowl length
Bell clearance
Inside can bottom to outside can bottom (Dimension "N"). Refer to 046 for this dimension
Column length
Distance from centerline of suction to suction bell lip (as required by Hydraulic Institute Standards)

Refer to the performance curve for the given bowl and make a note of the 1st stage length (with bell), length for each additional stage and the dimension from the bottom of the bell to the 1st impeller.

Example:	12B Bowl 1st stage with bell	21.625"
	Each additional stage	9.375"
	To first impeller	6.00"

Total bowl length for a 10 stage bowl then would equal L = 21.625" + (9 x 9.375") = 106.00"

Refer to the SUCTION CAN DESIGN STANDARDS on page 045 and determine the proper bell clearance dimension.

Example: 12B bowl = 7.00”

Since the design parameters specified the available NPSH at grade, it is indicated that a T head is required since GRADE indicates the bottom of the head.

We must provide sufficient column length to supply the pump with proper NPSH at the 1st impeller.

Example:	Available NPSH at grade	5 Feet
	Required NPSH at 1st impeller	10.3 Feet
	Difference	- 5.3 Feet

The negative sign indicates it must be at least 5.3 feet (63.6”) from the bottom of the discharge head to the 1st (bottom) impeller.

The Hydraulic Institute standards require the distance from the centerline of suction to the suction bell lip to be 4 times the CAN diameter when using a T head.

Example: Can diameter 18” x 4 = 72”
Column length can now be calculated.

Column length = NPSH difference + dimension from bell to 1st stage impeller – bowl total length;

Or

Column length = Suction centerline to bell lip – bowl total length;

Whichever is greater.

Example:

Column length = 5.3 x 12 in/ft. + 6.00 – 106.00 = -36.4”; or

Column length = 72.00” – 106.00” = -34.0”

The negative column length(s) indicate the additional length required has been made up in the length of the bowl assembly and only a minimum length of column is required. (Note: in some cases, the bowl assembly can be bolted directly to the discharge head. Refer to the factory to establish if this is possible for this application).

The can length can now be calculated. For this example, we will use a column length of 6”. The can length would then equal the sum of the bell clearance plus the “N” dimension plus the bowl length plus the column length.

Example:

Bell clearance	= 6.000”
“N” dimension	= 2.125”
Bowl length	= 106.000”
Column length	= 6.000”
Can length	= 120.125” minimum

COLUMN SELECTION

We had previously selected 8” column and determined the can size of 18” was acceptable. The CAN SELECTION CHART is based on using flanged column pipe. If threaded column is used or if the column size is changed, refer back to the CAN SELECTION CHART to determine if the can size must be increased.

SHAFT SELECTION

It should be noted that, in our example, a one piece impeller and lower head shaft will be required because of the use of a minimum length of column. If the calculated required column length is 3 feet or greater, determine the shaft selection as described in the previous sections.

LINESHAFT STRETCH

As previously mentioned, lineshaft stretch can usually be ignored on all jobs that do not combine both high total pump heads and deep setting. If it has been noted that a particular bowl selection has a smaller than average allowable stretch and is pumping at a very high pressure, then lineshaft stretch may have to be considered.

CONFIRMATION OF BOWL SELECTION

Since column losses are not of any significance, we can proceed to any efficiency or head corrections that may be required due to any special materials.

DRIVER SELECTION

A. Review job specifications for any particular requirements.
B. For applications requiring mechanical seals, it is strongly suggested that vertical solid shaft drivers with adjustable, spacer type, API tolerance design couplings be used. If vertical hollow shaft motors are used, a steady bearing must be furnished with the motor.
C. Since this is a short setting unit HP shaft loss will be negligible, however the thrust bearing loss should be considered.
D. Momentary up thrust of 30% is required.

DISCHARGE HEAD SELECTION

A. Hanging weight on short setting or can type pumps is usually not a factor and can be ignored.
B. As in the first example, the discharge head flange size is matched to the discharge case size or, if a different size column is used, then it is matched to the column.
C. Refer to the discharge head data section and review all of the T type heads with 8” discharge and determine which one will be compatible with the 18” can previously selected and the motor BD.
D. The discharge head should be reviewed to determine if there is enough room for an adjustable, spacer type shaft coupling, when a VSS motor is used.
E. Make a preliminary selection of a coupling. Factors that are necessary to do this are:
   1. Horsepower per 100 RPM
   2. Maximum thrust
   3. Motor shaft diameter
   4. Pump shaft diameter
   5. Mechanical seals or packing
F. Refer to the VENDOR EQUIPMENT section for coupling catalogs containing dimensional information as well as selection tables. A high ring base may be necessary for use with this type of coupling.

STUFFING BOX SELECTION SHOULD BE MADE AS PREVIOUSLY DISCUSSED

The above examples of pump selection are meant to be a guide only, and illustrate the proper sequence of events in selection the necessary components of a vertical turbine pump. Since one example can not meaningfully cover all of the possibilities, any problems encountered in an analysis of a selection, such as excessive shaft stretch, should be referred to the factory for possible solutions.

BOWL PRESSURE RATING CHART

Standard Construction (1)(2)(3)(4)			
6A,B	530	14C,F,D	400
6D,F	530	14M	433
6M	826	14I,J	400
6G,J	400	15H	476
7M	823	16E	300
7A,B,D	400	17M	460
8B	800	17H	452
8P,T,V	400	18H	300
8M	804	19A,B	300
10A,B,D,E	700	21H	465
10M	475	22A,B	350
10G,J	450	23HLC,M,H	RTF
11M	488	27ML,M	377
11H	488	30D,E	300
12A,B,D,F	580	31M	485
12K,S	410	33HH	RTF
12M	380	34H	363
12E,G,I	400	36F,G	300
12N,U,W	400	38A,B	320
12V	400	42A	310
13E,F	400	44A,B	300
13H	380	57H	329

1. Standard Construction is cast iron bowls with Grade 5 bolting.
2. Maximum hydrostatic test pressure is 1.5 times PSI value shown.
3. PSI limits shown are maximum pump operating pressure, including shut-off, if the pump is to operate at shutoff.
4. If leak-proof bowl flange joints are required, refer to the factory.

EFFICIENCY REDUCTION FOR SPECIAL MATERIALS

Pump Size and Figure Number	Bronze Bowl and Impellers	Standard Bowls with Impellers of Monel®, Ni-Resist or Stainless Steel	Bowls and Impellers of Monel®, Ni-Resist or Stainless Steel
6A,B 6D,F 6M 6G,J 7M 7A,B,D	0	3	5
8B 8P,T,V 8M	0	2.5	4
10A,B,D,E 10M 10G,J	0	2	4
11M 11H 12A,B,D,F	0	2	4
12K,S	0	3.5	8
12M 12E,G,I	0	2	4
12N,U,W	0	3.5	8
12V 13E,F 13H 14C,F,D 14M 14I,J 15H	0	2	4
16E 17M 17H 18H 19A,B	0	2	5
All Other Sizes	RTF	RTF	RTF

BOWL SHAFT RATING CHART

Shaft Size and Bowl Size	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of: 500	1000	2000	3000	5000	7500	10000	20000
1.000	3550	135	135	135	134	132	127	---	---
	1770	67	67	67	67	65	63	---	---
6A,B,D,F	1170	44	44	44	44	43	42	---	---
6M,G,J	880	33	33	33	33	32	31	---	---
7M,A,D,B	100	3.82	3.82	3.81	3.79	3.72	3.59	---	---
1.188	3550	---	231	231	230	228	225	219	---
	1770	---	115	115	115	114	112	109	---
8B,M,P	1170	---	76	76	76	75	74	72	---
8T,V	880	---	57	57	57	56	55	54	---
	100	---	6.53	6.52	6.5	6.44	6.34	6.19	---
1.437	3550	---	---	422	422	420	417	413	382
	1770	---	---	210	210	209	208	206	190
10M	1170	---	---	139	139	138	137	136	126
11M	880	---	---	104	104	104	103	102	94
11H	705	---	---	84	83	83	82	82	76
	100	---	---	11.91	11.90	11.86	11.77	11.65	10.78
1.500	3550	---	---	475	475	473	470	466	437
	1770	---	---	237	237	236	235	233	218
10A,B,D,E	1170	---	---	157	157	156	155	154	144
10G,J	880	---	---	118	118	117	117	116	108
	705	---	---	94	94	94	93	93	87
	585	---	---	78	78	78	78	77	72
	100	---	---	13.39	13.38	13.34	13.25	13.14	12.31
1.688	3550	---	---	698	698	697	694	690	665
	1770	---	---	348	348	347	346	344	331
12A,B,D,F	1170	---	---	173	173	172	172	171	164
12K,M,S,V	880	---	---	138	138	138	137	137	132
13E,F,H	705	---	---	115	115	114	114	113	109
	585	---	---	19.68	19.67	19.63	19.56	19.46	18.75
	100								

		3000	5000	7500	10000	20000	30000	50000	65000
1.937	3550	1075	1074	1072	1068	1047	1010	---	---
	1770	536	535	534	532	533	503	---	---
12E,G,I,N	1170	354	354	353	352	345	332	---	---
12U,W	880	266	266	265	264	259	250	---	---
14M,15H	705	213	213	212	212	207	200	---	---
	585	177	177	176	176	172	166	---	---
	100	30.29	30.26	30.20	30.11	29.50	28.46	---	---

1. Above chart is based on ASTM-A582-416 shaft material.
2. For ratings other than those shown above, use the following formula:

$$\text{BHP (Allowed)} = \frac{\text{RPM}}{100} \times \text{BHP @ 100 RPM}$$

Example: 1.687" shaft @ 2300 RPM, 5000 lbs. Thrust

$$\text{BHP (Allowed)} = \frac{2300}{100} \times 20.02 = 460.46 \text{ HP}$$

3. Multipliers for various shaft materials:

Type	Multipliers 1 - 2.188	2.438-5.5
304/316	0.55	0.5
17-4 PH	1.45	1.4
Monel	0.7	0.65
K-Monel	1.45	1.4

BOWL SHAFT RATING CHART

Shaft Size and Bowl Size	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of:							
		3000	5000	7500	10000	20000	30000	50000	65000
2.188	1770	793	793	792	790	781	765	---	---
	1170	524	524	523	522	516	506	---	---
14C,D,F,I,J	880	394	394	393	363	388	380	---	---
16E,17M,H	705	316	315	315	315	311	304	---	---
18H	585	262	262	261	261	258	253	---	---
	505	226	226	226	225	222	218	---	---
	100	44.84	44.82	44.76	44.68	44.15	43.25	---	---
2.188	1770	775	775	773	772	760	741	---	---
(KEYED)	1170	512	512	511	510	502	490	---	---
	880	385	385	384	384	378	368	---	---
19A,B	705	309	308	308	307	303	295	---	---
20HL	585	256	256	256	255	251	245	---	---
	505	221	221	221	220	217	211	---	---
	100	43.79	43.76	43.69	43.60	42.95	41.84	---	---
2.438	1770	---	1154	1153	1152	1143	1129	1084	---
	1170	---	762	762	761	756	746	716	---
	880	---	573	573	572	568	561	529	---
21H	705	---	459	459	458	455	450	431	---
23HL,M,H	585	---	381	381	380	378	373	358	---
	505	---	329	329	328	326	322	309	---
	100	---	65.21	65.16	65.09	64.62	63.84	61.25	---
2.687	1170	---	1024	1024	1023	1018	1010	983	---
	880	---	770	770	769	766	759	739	---
	705	---	617	617	616	613	608	592	---
22A,B	585	---	512	512	511	509	505	491	---
24E	505	---	442	442	441	439	436	424	---
	100	---	87.58	87.54	87.48	87.05	86.35	84.04	---
3.187	1170	---	1589	1588	1588	1582	1574	1546	---
	880	---	1195	1195	1194	1190	1184	1163	---
27M,ML	705	---	957	957	956	953	948	931	---
30D,E	585	---	794	794	794	791	787	773	---
	505	---	686	685	685	683	679	667	---
	100	---	135.84	135.80	135.73	135.29	134.55	132.16	---
3.437	1170	---	1993	1993	1992	1987	1979	1954	---
	880	---	1499	1499	1498	1495	1489	1469	---
36F,G	705	---	1201	1201	1200	1197	1193	1177	---
38C,D	585	---	996	996	996	993	989	977	---
	505	---	860	860	860	858	854	843	---
	100	---	170.42	170.38	170.32	169.91	169.23	167.02	---

1. Above chart is based on ASTM-A582-416 shaft material.
2. For ratings other than those shown above, use the following formula:

BHP (Allowed) = $\frac{\text{RPM}}{100}$ X BHP @ 100 RPM

Example: 1.687" shaft @ 2300 RPM, 5000 lbs. Thrust

BHP (Allowed) = $\frac{2300}{100}$ X 20.02 = 460.46 HP

3. Multipliers for various shaft materials:

Type	Multipliers	
	1 - 2.188	2.438-5.5
304/316	0.55	0.5
17-4 PH	1.45	1.4
Monel	0.7	0.65
K-Monel	1.45	1.4

BOWL SHAFT RATING CHART

Shaft Size and Bowl Size	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of:							
		3000	**5000**	**7500**	**10000**	**20000**	**30000**	**50000**	**65000**
3.687	1170	---	2461	2461	2460	2456	2448	2424	---
	880	---	1851	1851	1850	1847	1841	1823	---
31M	705	---	1483	1483	1482	1480	1475	1461	---
33HH	585	---	1230	1230	1230	1228	1224	1212	---
42A	505	---	1062	1062	1062	1060	1056	1046	---
44A,B	100	---	210.41	210.37	210.32	209.94	209.3	207.25	---

		15000	**20000**	**30000**	**50000**	**65000**	**85000**		
5.500	880	4975	4974	4971	4960	4949	4929	---	---
	705	3986	3985	3982	3974	3965	3949	---	---
	585	3307	3307	3304	3297	3290	3276	---	---
57H	505	2855	2854	2852	2846	2840	2828	---	---
	440	2487	2487	2485	2480	2474	2464	---	---
	100	565.45	565.32	564.94	563.74	562.43	560.15	---	---

1. Above chart is based on ASTM-A582-416 shaft material.
2. For ratings other than those shown above, use the following formula:

$$\text{BHP (Allowed)} = \frac{\text{RPM}}{100} \times \text{BHP @ 100 RPM}$$

Example: 1.687" shaft @ 2300 RPM, 5000 lbs. Thrust

$$\text{BHP (Allowed)} = \frac{2300}{100} \times 20.02 = 460.46 \text{ HP}$$

3. Multipliers for various shaft materials:

Type	Multipliers	
	1 - 2.188	2.438-5.5
304/316	0.55	0.5
17-4 PH	1.45	1.4
Monel	0.7	0.65
K-Monel	1.45	1.4

COLUMN REDUCING BUSHING LOSS CHART

Size	Pump Size	Head Loss in Feet at Flow (GPM) of:										
		100	200	300	400	500	600	700	800			
6 x 4	8"		6.1	13.6	24.2	37.9	54.5					
	10"		2.7	6.0	10.7	16.7	24.0	32.7	42.7			

		400	600	800	1000	1200	1400	1600	1800	2000		
8 x 6	10" - 12"	2.4	5.5	9.7	15.2	21.8	29.7	38.8	49.1	60.6		

		1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
10 x 8	13"	3.7	5.3	7.2	9.4	11.9	14.7	17.8	21.2	24.9	28.8	
	14"	5.0	7.2	9.8	12.8	16.2	20.0	24.2	28.8	33.8	39.2	45.0

		1200	1400	1600	1800	2000	2200	2400	2800	3200	3600	4000
12 x 10	15" - 16"	2.2	3.0	3.9	5.0	6.2	7.5	8.9	12.1	15.8	19.9	24.6

		2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
14 x 12	17" - 19"	2.7	4.2	6.0	8.2	10.7	16.5	16.7	20.2	24.0	28.2	32.7

MAXIMUM COLUMN SETTING CHART

Column Size	Schedule Number	Wall Thickness	Maximum Settings			
			Threaded Column (Feet – Approx.)	Total Weight (Lbs.) (1)	Flanged Column (Feet – Approx.)	Total Weight (Lbs.) (1)
4"	40	.237"	1,100	12,000	275	3,500
6"	40	.280"	1,100	21,000	275	6,500
8"	30	.277"	950	23,500	225	7,500
10"	---	.279"	800	25,000	175	7,500
12"	30	.330"	900	39,500	200	12,000
14"	30	.375"	1,000	55,000	200	15,000
16"	30	.375"	---	---	230	19,000
18"	---	.375"	---	---	250	25,000
20"	20	.375"	---	---	250	27,500
24"	20	.375"	---	---	225	30,000
30"	---	.375"	---	---	175	30,000
36"	---	.375"	---	---	125	30,000

1. Total weight includes column, lineshaft, enclosing tube, bowl assembly, suction pipe and strainer.

DISCHARGE HEAD HANGING WEIGHT CHART

Hanging Weight (Lbs.) (1)							
Discharge Head	**Discharge Pressure (PSI)**	**Column Size**					
		4"	**6"**	**8"**	**10"**	**12"**	**14"**
12 x 4 DT	**0 - 125**	13,000	---	---	---	---	---
	126 - 250	7,000	---	---	---	---	---
	251 - 400	---	---	---	---	---	---
16 1/2 X 6 CT	**0 - 125**	---	11,500	---	---	---	---
16 1/2 X 6 D	**0 - 125**	13,000	21,500	25,000	---	---	---
	126 - 250	7,000	15,000	21,000	---	---	---
	251 - 400	---	7,000	15,000	---	---	---
16 1/2 X 8 CT	**0 - 125**	---	---	15,000	---	---	---
16 1/2 X 8 D	**0 - 125**	---	21,500	26,500	29,000	32,000	---
	126 - 250	---	15,000	21,000	24,000	28,000	---
	251 - 400	---	7,000	15,000	18,000	23,000	---
16 1/2 X 10 CT	**0 - 125**	---	---	---	20,000	---	---
20 X 10 D	**0 - 125**	---	21,500	26,500	29,000	32,000	---
	126 - 250	---	15,000	21,000	24,000	28,000	---
	251 - 400	---	7,000	15,000	18,000	23,000	---
20 X 12 CT	**0 - 125**	---	---	---	---		---
20 X 12 H	**0 - 125**	---	---	20,000	20,000	20,000	---
24 1/2 X 14 H	**0 - 125**	---	---	---	20,000	20,000	20,000

(1) Total weight includes discharge head, column, lineshaft, enclosing tube, bowl assembly, suction pipe and strainer.

LINESHAFT RATING CHART

Shaft Size and Weight per Ft.	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of:							
		500	1000	2000	3000	5000	7500	10000	20000
1	3550	126	126	125	124	122	117	---	---
	1770	62	62	62	62	61	58	---	---
Ks = 2.8	1170	41	41	41	41	40	38	---	---
	880	30	30	30	30	30	28	---	---
	100	3.6	3.6	3.5	3.5	3.4	3.3	---	---
1 1/4	3550	---	234	233	232	231	227	221	---
	1770	---	116	116	116	115	113	110	---
Ks = 4.2	1170	---	77	77	76	76	74	73	---
	880	---	57	57	57	56	55	54	---
	100	---	6.6	6.6	6.6	6.5	6.4	6.2	---
1 1/2	3550	---	---	410	409	407	404	399	364
	1770	---	---	204	204	203	201	199	181
	1170	---	---	135	135	134	133	131	120
Ks = 6.0	880	---	---	100	100	99	99	97	82
	705	---	---	81	81	81	80	79	72
	100	---	---	11.6	11.5	11.5	11.4	11.3	10.3
1 11/16	3550	---	---	605	604	603	600	596	566
	1770	---	---	301	301	300	299	297	282
	1170	---	---	199	199	198	197	196	186
Ks = 8.1	880	---	---	148	148	147	147	146	138
	705	---	---	120	120	119	119	118	112
	585	---	---	99	99	99	98	98	93
	100	---	---	17.1	17.0	17.0	16.9	16.8	16.0

		3000	5000	7500	10000	20000	30000	50000	65000
1 15/16	3550	918	916	913	909	877	823	---	---
	1770	457	457	455	453	437	410	---	---
	1170	302	302	301	299	289	271	---	---
Ks = 10.6	880	225	224	223	222	215	201	---	---
	705	182	182	181	180	174	163	---	---
	585	151	151	150	149	144	135	---	---
	100	25.87	25.82	25.73	25.61	24.73	23.20	---	---
	1770	620	620	618	616	601	577	---	---
2 3/16	1170	410	409	408	407	397	381	---	---
	880	305	304	303	302	295	283	---	---
Ks = 13.6	705	247	246	246	245	239	229	---	---
	585	205	204	204	203	198	190	---	---
	505	177	176	176	175	171	164	---	---
	100	35.07	35.03	34.94	34.82	34.01	32.60	---	---

1. Above chart is based on AISI-C1045 shaft material.
2. For ratings other than those shown above, use the following formula:

$$\text{BHP (Allowed)} = \frac{\text{RPM} \times \text{BHP @ 100 RPM}}{100}$$

Example: 1 11/16" shaft @ 2300 RPM, 5000 lbs. Thrust

3. Multipliers for various shaft materials:

Type	Multipliers	
	1-2 3/16	2 7/16 & Larger
416	1.1	1.2
304/316	0.6	0.6
17-4 PH	1.6	1.7
Monel	0.8	0.8
K-Monel	1.6	1.7

LINESHAFT RATING CHART

Shaft Size and Weight per Ft.	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of:							
		3000	5000	7500	10000	20000	30000	500000	65000
2 7/16	1770	---	859	857	855	842	820	745	---
	1170	---	568	566	565	557	542	493	---
	880	---	422	421	420	414	403	366	---
Ks = 17.0	705	---	342	341	340	335	326	297	---
	585	---	284	283	282	278	271	246	---
	505	---	245	244	244	240	234	212	---
	100	---	48.57	48.44	48.33	47.60	46.36	42.14	---
2 11/16	1770	---	1151	1150	1148	1137	1117	1051	---
	1170	---	761	760	759	751	738	695	---
	880	---	566	565	564	558	549	517	---
	705	---	458	458	457	452	445	418	---
Ks = 21.0	585	---	380	380	379	375	369	347	---
	505	---	328	328	327	324	318	300	---
	440	---	286	286	285	252	277	261	---
	100	---	65.07	65.00	64.90	64.24	63.13	59.43	---
2 15/16	1770	---	---	1508	1506	1495	1477	1419	---
	1170	---	---	996	995	988	976	938	---
	880	---	---	741	740	735	726	697	---
	705	---	---	600	599	595	588	565	---
Ks = 25.0	585	---	---	498	497	494	488	469	---
	505	---	---	430	429	426	421	405	---
	440	---	---	374	374	372	367	352	---
	100	---	---	85.2	85.1	84.5	83.5	80.2	---
3 3/16	1170	---	---	---	1272	1265	1255	1220	---
	880	---	---	---	946	941	933	907	---
	705	---	---	---	767	762	756	735	---
Ks = 27.1	585	---	---	---	636	632	627	610	---
	505	---	---	---	549	546	541	526	---
	440	---	---	---	478	476	472	458	---
	100	---	---	---	108.8	108.2	107.3	104.3	---
3 7/16	1170	---	---	---	1597	1591	1580	1547	---
	880	---	---	---	1187	1183	1175	1151	---
	705	---	---	---	980	958	952	932	---
Ks = 31.6	585	---	---	---	798	795	790	773	---
	505	---	---	---	689	686	682	668	---
	440	---	---	---	600	598	594	582	---
	100	---	---	---	136.5	136.0	135.1	132.3	---

1. Above chart is based on AISI-C1045 shaft material.
2. For ratings other than those shown above, use the following formula:

$$\text{BHP (Allowed)} = \frac{\text{RPM}}{100} \times \text{BHP @ 100 RPM}$$

Example: 1 11/16" shaft @ 2300 RPM, 5000 lbs. Thrust

$$\text{BHP (Allowed)} = \frac{2300}{100} \times 17.0 = 391.0 \text{ HP}$$

3. Multipliers for various shaft materials:

Type	Multipliers	
	1 - 2 3/16	2 7/16 & Larger
416	1.1	1.2
304/316	0.6	0.6
17-4 PH	1.6	1.7
Monel	0.8	0.8
K-Monel	1.6	1.7

LINESHAFT RATING CHART

Shaft Size and Bowl Size	Speed (RPM)	Allowable Brake Horsepower at Thrust (lbs.) of:							
		3000	5000	7500	10000	20000	30000	50000	65000
3 11/16	1170	---	---	---	1971	1966	1957	1926	---
	880	---	---	---	1465	1462	1455	1432	---
	705	---	---	---	1187	1185	1175	1161	---
Ks = 36.3	585	---	---	---	985	983	978	963	---
	505	---	---	---	850	848	844	831	---
	440	---	---	---	741	739	736	724	---
	100	---	---	---	168.5	168.1	167.3	164.7	---
4	880	---	1531	1529	1531	1529	1524	1505	1485
	705	---	1240	1239	1240	1239	1235	1219	1203
	585	---	1029	1028	1029	1028	1024	1012	998
Ks = 42.7	505	---	888	887	888	887	884	873	862
	440	---	774	773	774	773	770	761	751
	100	---	176.0	175.8	176.0	175.8	175.2	173.0	170.7

		20000	30000	50000	65000	85000	105000	125000	150000
4 1/2	880	2134	2132	2116	2098	2067	---	---	---
	705	1732	1727	1715	1700	1675	---	---	---
	585	1437	1433	1423	1411	1390	---	---	---
Ks = 59.0	505	1240	1237	1228	1218	1200	---	---	---
	440	1081	1078	1070	1061	1045	---	---	---
	100	245.7	245.1	243.3	241.2	237.7	---	---	---
5	880	---	2924	2910	2894	2866	2831	---	---
	705	---	2370	2358	2345	2323	2294	---	---
	585	---	1966	1956	1946	1927	1904	---	---
Ks = 73.0	505	---	1697	1689	1680	1664	1643	---	---
	440	---	1479	1471	1463	1449	1432	---	---
	100	---	336.2	334.5	332.7	329.5	325.5	---	---
5 1/2	880	---	3941	3928	3915	3889	3858	3819	---
	705	---	3194	3183	3172	3152	3126	3094	---
	585	---	2650	2641	2632	2615	2594	2568	---
Ks = 80.8	505	---	2288	2280	2272	2257	2239	2216	---
	440	---	1993	1987	1980	1967	1951	1931	---
	100	---	453.1	451.6	450.0	447.1	443.5	439.0	---
6	880	---	4930	4918	4905	4882	4852	4817	4763
	705	---	3995	3985	3974	3956	3932	3903	3859
	585	---	3315	3307	3298	3283	3263	3239	3202
Ks = 96.1	505	---	2861	2854	2847	2834	2816	2796	2764
	440	---	2493	2487	2480	2469	2454	2436	2409
	100	---	566.7	565.3	563.8	561.2	557.8	553.7	547.5

1. Above chart is based on AISI-C1045 shaft material.
2. For ratings other than those shown above, use the following formula:

$$\text{BHP (Allowed)} = \frac{\text{RPM}}{100} \times \text{BHP @ 100 RPM}$$

Example: 1 11/16" shaft @ 2300 RPM, 5000 lbs. Thrust

$$\text{BHP (Allowed)} = \frac{2300}{100} \times 17.0 = 391.0 \text{ HP}$$

3. Multipliers for various shaft materials:
4. 4" diameter lineshaft & larger use keyed couplings.

Type	Multipliers	
	1 - 2 3/16	2 7/16 & Larger
416	1.1	1.2
304/316	0.6	0.6
17-4 PH	1.6	1.7
Monel	0.8	0.8
K-Monel	1.6	1.7

STRETCH CONSTANTS
WATER LUBRICATED - STANDARD WALL COLUMN

PUMP	COL	SHAFT	K	K'
6A	4	1	7.7716	2.0161
	4	1 1/4	3.8876	2.0161
6B	4	1	4.5950	2.0161
	4	1 1/4	1.6277	2.0161
6D,F	4	1	11.2658	2.0161
	4	1 1/4	6.3734	2.0161
6M	4	1	4.5315	2.0161
	4	1 1/4	1.5825	2.0161
6G,J	4	1	9.0422	2.0161
	4	1 1/4	4.7915	2.0161
7M	4	1	9.7411	2.0161
	4	1 1/4	5.2887	2.0161
7A,B,D	4	1	18.8897	2.0161
	4	1 1/4	11.7971	2.0161
8B	4	1	12.5365	2.0161
	4	1 1/4	7.2773	2.0161
8B	6	1	8.7007	2.6019
	6	1 1/4	3.3375	2.6019
	6	1 1/2	0.5173	2.6019
8P, T, V	6	1	16.2532	2.6019
	6	1 1/4	8.5065	2.6019
	6	1 1/2	4.3916	2.6019
8M	4	1	8.2163	2.0161
	4	1 1/4	4.2039	2.0161
8M	6	1	4.7501	2.6019
	6	1 1/4	0.6337	2.6019
	6	1 1/2	-1.5092	2.6019
10A	6	1	26.1296	2.6019
	6	1 1/4	15.2660	2.6019
	6	1 1/2	9.4579	2.6019
	6	1 11/16	6.7533	2.6019
10A	8	1	21.8416	3.5401
	8	1 1/4	10.9463	3.5401
	8	1 1/2	5.0994	3.5401
	8	1 11/16	2.3610	3.5401
10B	6	1	20.3199	2.6019
	6	1 1/4	11.2898	2.6019
	6	1 1/2	6.4777	2.6019
	6	1 11/16	4.2482	2.6019
10B	8	1	16.1981	3.5401
	8	1 1/4	7.1362	3.5401
	8	1 1/2	2.2852	3.5401
	8	1 11/16	0.0219	3.5401

PUMP	COL	SHAFT	K	K'
10J	8	1	55.7031	3.5401
	8	1 1/4	33.8069	3.5401
	8	1 1/2	21.9843	3.5401
	8	1 11/16	16.3955	3.5401
10E	6	1	13.3484	2.6019
	6	1 1/4	6.5184	2.6019
	6	1 1/2	2.9015	2.6019
	6	1 11/16	1.2420	2.6019
10E	8	1	9.4258	3.5401
	8	1 1/4	2.5640	3.5401
	8	1 1/2	-1.0918	3.5401
	8	1 11/16	-2.7850	3.5401
10D	6	1	21.4819	2.6019
	6	1 1/4	12.0851	2.6019
	6	1 1/2	7.0738	2.6019
	6	1 11/16	4.7492	2.6019
10D	8	1	17.3268	3.5401
	8	1 1/4	7.8982	3.5401
	8	1 1/2	2.8480	3.5401
	8	1 11/16	0.4897	3.5401
10M	4	1	17.6190	2.0161
	4	1 1/4	10.8931	2.0161
10M	6	1	13.3484	2.6019
	6	1 1/4	6.5184	2.6019
	6	1 1/2	2.9015	2.6019
	6	1 11/16	1.2420	2.6019
10G	6	1	43.5585	2.6019
	6	1 1/4	27.1945	2.6019
	6	1 1/2	18.3986	2.6019
	6	1 11/16	14.2688	2.6019
10G	8	1	38.7724	3.5401
	8	1 1/4	22.3766	3.5401
	8	1 1/2	13.5418	3.5401
	8	1 11/16	9.3782	3.5401
10J	6	1	60.9874	2.6019
	6	1 1/4	39.1230	2.6019
	6	1 1/2	27.3392	2.6019
	6	1 11/16	21.7842	2.6019

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

WATER LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	SHAFT	K	K'
11M	6	1	20.4361	2.6019
	6	1 1/4	11.3693	2.6019
	6	1 1/2	6.5373	2.6019
	6	1 11/16	4.2983	2.6019
11M	8	1	16.3109	3.5401
	8	1 1/4	7.2124	3.5401
	8	1 1/2	2.3415	3.5401
	8	1 11/16	0.0687	3.5401
11H	6	1	41.8737	2.6019
	6	1 1/4	26.0414	2.6019
	6	1 1/2	17.5343	2.6019
	6	1 11/16	13.5423	2.6019
11H	8	1	37.1357	3.5401
	8	1 1/4	21.2717	3.5401
	8	1 1/2	12.7257	3.5401
	8	1 11/16	8.6999	3.5401
12A	8	1	38.7724	3.5401
	8	1 1/4	22.3766	3.5401
	8	1 1/2	13.5418	3.5401
	8	1 11/16	9.3782	3.5401
	8	1 15/16	5.6622	3.5401
12A	10	1	34.4993	4.4684
	10	1 1/4	18.0816	4.4684
	10	1 1/2	9.2199	4.4684
	10	1 11/16	5.0330	4.4684
	10	1 15/16	1.2816	4.4684
12B	8	1	24.0991	3.5401
	8	1 1/4	12.4703	3.5401
	8	1 1/2	6.2250	3.5401
	8	1 11/16	3.2966	3.5401
	8	1 15/16	0.7032	3.5401
12B	10	1	20.1245	4.4684
	10	1 1/4	8.4737	4.4684
	10	1 1/2	2.2016	4.4684
	10	1 11/16	-0.7502	4.4684
	10	1 15/16	-3.3790	4.4684
12D,F	8	1	34.8219	3.5401
	8	1 1/4	19.7095	3.5401
	8	1 1/2	11.5719	3.5401
	8	1 11/16	7.7409	3.5401
	8	1 15/16	4.3271	3.5401
12D,F	10	1	30.6292	4.4684
	10	1 1/4	15.4948	4.4684
	10	1 1/2	7.3304	4.4684
	10	1 11/16	3.4760	4.4684
	10	1 15/16	0.0268	4.4684
12K,S	8	1	54.5744	3.5401
	8	1 1/4	33.0449	3.5401
	8	1 1/2	21.4214	3.5401
	8	1 11/16	15.9277	3.5401
	8	1 15/16	11.0027	3.5401
12K,S	10	1	49.9799	4.4684
	10	1 1/4	28.4285	4.4684
	10	1 1/2	16.7782	4.4684
	10	1 11/16	11.2611	4.4684
	10	1 15/16	6.3007	4.4684

PUMP	COL	SHAFT	K	K'
12M	6	1	28.0468	2.6019
	6	1 1/4	16.5781	2.6019
	6	1 1/2	10.4414	2.6019
	6	1 11/16	7.5800	2.6019
	6	1 15/16	5.0680	2.6019
12M	8	1	23.7040	3.5401
	8	1 1/4	12.2036	3.5401
	8	1 1/2	6.0280	3.5401
	8	1 11/16	3.1329	3.5401
	8	1 15/16	0.5696	3.5401
12E,G,I	8	1	41.0298	3.5401
	8	1 1/4	23.9006	3.5401
	8	1 1/2	14.6675	3.5401
	8	1 11/16	10.3139	3.5401
	8	1 15/16	6.4251	3.5401
	8	2 3/16	3.8700	3.5401
12E,G,I	10	1	36.7108	4.4684
	10	1 1/4	19.5597	4.4684
	10	1 1/2	10.2997	4.4684
	10	1 11/16	5.9227	4.4684
	10	1 15/16	1.9986	4.4684
	10	2 3/16	-0.5969	4.4684
12N,U,W	8	1	62.4754	3.5401
	8	1 1/4	38.3790	3.5401
	8	1 1/2	25.3613	3.5401
	8	1 11/16	19.2024	3.5401
	8	1 15/16	13.6730	3.5401
	8	2 3/16	10.0067	3.5401
12N,U,W	10	1	57.7202	4.4684
	10	1 1/4	33.6019	4.4684
	10	1 1/2	20.5573	4.4684
	10	1 11/16	14.3751	4.4684
	10	1 15/16	8.8102	4.4684
	10	2 3/16	5.1037	4.4684
12V	8	1	66.4259	3.5401
	8	1 1/4	41.0461	3.5401
	8	1 1/2	27.3312	3.5401
	8	1 11/16	20.8398	3.5401
	8	1 15/16	15.0081	3.5401
12V	10	1	61.5904	4.4684
	10	1 1/4	36.1887	4.4684
	10	1 1/2	22.4468	4.4684
	10	1 11/16	15.9321	4.4684
	10	1 15/16	10.0650	4.4684
13E	8	1	53.4457	3.5401
	8	1 1/4	32.2829	3.5401
	8	1 1/2	20.8586	3.5401
	8	1 11/16	15.4599	3.5401
	8	1 15/16	10.6212	3.5401
13E	10	1	48.8742	4.4684
	10	1 1/4	27.6894	4.4684
	10	1 1/2	16.2383	4.4684
	10	1 11/16	10.8162	4.4684
	10	1 15/16	5.9422	4.4684

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

STRETCH CONSTANTS
WATER LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	SHAFT	K	K'
13F	8	1	52.3169	3.5401
	8	1 1/4	31.5209	3.5401
	8	1 1/2	20.2958	3.5401
	8	1 11/16	14.9921	3.5401
	8	1 15/16	10.2398	3.5401
13F	10	1	47.7684	4.4684
	10	1 1/4	26.9503	4.4684
	10	1 1/2	15.6984	4.4684
	10	1 11/16	10.3713	4.4684
	10	1 15/16	5.5837	4.4684
13H	8	1	55.8160	3.5401
	8	1 1/4	33.8831	3.5401
	8	1 1/2	22.0406	3.5401
	8	1 11/16	16.4423	3.5401
	8	1 15/16	11.4223	3.5401
13H	10	1	51.1963	4.4684
	10	1 1/4	29.2414	4.4684
	10	1 1/2	17.3720	4.4684
	10	1 11/16	11.7504	4.4684
	10	1 15/16	6.6950	4.4684
14C,F,D	10	1	70.4364	4.4684
	10	1 1/4	42.1012	4.4684
	10	1 1/2	26.7658	4.4684
	10	1 11/16	19.4910	4.4684
	10	1 15/16	12.9331	4.4684
	10	2 3/16	8.5541	4.4684
	10	2 7/16	5.5151	4.4684
14C,F,D	12	1	69.8404	3.8995
	12	1 1/4	41.4743	3.8995
	12	1 1/2	26.1011	3.8995
	12	1 11/16	18.7935	3.8995
	12	1 15/16	12.1857	3.8995
	12	2 3/16	7.7501	3.8995
	12	2 7/16	4.6476	3.8995
14I,J	12	1	111.1689	3.8995
	12	1 1/4	68.6850	3.8995
	12	1 1/2	45.6430	3.8995
	12	1 11/16	34.6773	3.8995
	12	1 15/16	24.7450	3.8995
	12	2 3/16	18.0580	3.8995
	12	2 7/16	13.3606	3.8995
14M	10	1	31.2373	4.4684
	10	1 1/4	15.9013	4.4684
	10	1 1/2	7.6273	4.4684
	10	1 11/16	3.7207	4.4684
	10	1 15/16	0.2240	4.4684
	10	2 3/16	-2.0820	4.4684
14M	12	1	31.7861	3.8995
	12	1 1/4	16.4192	3.8995
	12	1 1/2	8.1074	3.8995
	12	1 11/16	4.1679	3.8995
	12	1 15/16	0.6214	3.8995
	12	2 3/16	-1.7413	3.8995
15H	10	1	64.7418	4.4684
	10	1 1/4	38.2950	4.4684
	10	1 1/2	23.9855	4.4684
	10	1 11/16	17.2000	4.4684
	10	1 15/16	11.0867	4.4684
	10	2 3/16	7.0089	4.4684

PUMP	COL	SHAFT	K	K'
15H	12	1	64.3121	3.8995
	12	1 1/4	37.8344	3.8995
	12	1 1/2	23.4871	3.8995
	12	1 11/16	16.6687	3.8995
	12	1 15/16	10.5057	3.8995
	12	2 3/16	6.3712	3.8995
16E	12	1	114.926	3.8995
	12	1 1/4	71.1587	3.8995
	12	1 1/2	47.4195	3.8995
	12	1 11/16	36.1213	3.8995
	12	1 15/16	25.8868	3.8995
	12	2 3/16	18.9951	3.8995
	12	2 7/16	14.1527	3.8995
17M	12	1	99.7901	3.8995
	12	1 1/4	61.1932	3.8995
	12	1 1/2	40.2626	3.8995
	12	1 11/16	30.3041	3.8995
	12	1 15/16	21.2871	3.8995
	12	2 3/16	15.2200	3.8995
	12	2 7/16	10.9617	3.8995
17M	14	1	97.8077	4.3180
	14	1 1/4	59.2060	4.3180
	14	1 1/2	38.2695	4.3180
	14	1 11/16	28.3059	4.3180
	14	1 15/16	19.2811	4.3180
	14	2 3/16	13.2051	4.3180
	14	2 7/16	8.9370	4.3180
17H	12	1	86.1571	3.8995
	12	1 1/4	52.2172	3.8995
	12	1 1/2	33.8164	3.8995
	12	1 11/16	25.0645	3.8995
	12	1 15/16	17.1442	3.8995
	12	2 3/16	11.8197	3.8995
	12	2 7/16	8.0875	3.8995
17H	14	1	84.2386	4.3180
	14	1 1/4	50.2939	4.3180
	14	1 1/2	31.8872	4.3180
	14	1 11/16	23.1302	4.3180
	14	1 15/16	15.2021	4.3180
	14	2 3/16	9.8688	4.3180
	14	2 7/16	6.1267	4.3180
18H	12	1	143.9095	3.8995
	12	1 1/4	90.2415	3.8995
	12	1 1/2	61.1242	3.8995
	12	1 11/16	47.2607	3.8995
	12	1 15/16	34.6946	3.8995
	12	2 3/16	26.2240	3.8995
	12	2 7/16	20.2632	3.8995
19A,B	12	1	179.8706	3.8995
	12	1 1/4	113.9184	3.8995
	12	1 1/2	78.1282	3.8995
	12	1 11/16	61.0817	3.8995
	12	1 15/16	45.6228	3.8995
	12	2 3/16	35.1933	3.8995
	12	2 7/16	27.8447	3.8995

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

STRETCH CONSTANTS
OIL LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	TUBE	SHAFT	K	K'
6A	4	1 1/2	1	9.5377	2.0161
	4	2	1 1/4	6.1757	2.0161
6B	4	1 1/2	1	6.5197	2.0161
	4	2	1 1/4	4.1160	2.0161
6D,F	4	1 1/2	1	12.8574	2.0161
	4	2	1 1/4	8.4414	2.0161
6M	4	1 1/2	1	6.4594	2.0161
	4	2	1 1/4	4.0748	2.0161
6G,J	4	1 1/2	1	10.7448	2.0161
	4	2	1 1/4	6.9996	2.0161
7M	4	1 1/2	1	11.4088	2.0161
	4	2	1 1/4	7.4527	2.0161
7A,B,D	4	1 1/2	1	20.1004	2.0161
	4	2	1 1/4	13.3848	2.0161
8B	4	1 1/2	1	14.0646	2.0161
	4	2	1 1/4	9.2653	2.0161
8B	6	1 1/2	1	10.2917	2.6019
	6	2	1 1/4	5.4720	2.6019
	6	2 1/2	1 1/2	3.3669	2.6019
8P,T,V	6	1 1/2	1	17.6946	2.6019
	6	2	1 1/4	10.4460	2.6019
	6	2 1/2	1 1/2	6.9732	2.6019
8M	4	1 1/2	1	9.9602	2.0161
	4	2	1 1/4	6.4641	2.0161
8M	6	1 1/2	1	6.4195	2.6019
	6	2	1 1/4	2.8702	2.6019
	6	2 1/2	1 1/2	1.4806	2.6019
10A	6	1 1/2	1	27.3752	2.6019
	6	2	1 1/4	16.9505	2.6019
	6	2 1/2	1 1/2	11.6892	2.6019
	6	2 1/2	1 11/16	8.8388	2.6019
10A	8	1 1/2	1	23.3853	3.5401
	8	2	1 1/4	13.0364	3.5401
	8	2 1/2	1 1/2	7.9680	3.5401
	8	2 1/2	1 11/16	5.1176	3.5401
10B	6	1 1/2	1	21.6807	2.6019
	6	2	1 1/4	13.1244	2.6019
	6	2 1/2	1 1/2	8.9151	2.6019
	6	2 1/2	1 11/16	6.5398	2.6019
10B	8	1 1/2	1	17.8123	3.5401
	8	2	1 1/4	9.3194	3.5401
	8	2 1/2	1 1/2	5.2842	3.5401
	8	2 1/2	1 11/16	2.9088	3.5401

PUMP	COL	TUBE	SHAFT	K	K'
10J	8	1 1/2	1	56.8233	3.5401
	8	2	1 1/4	35.3388	3.5401
	8	2 1/2	1 1/2	24.0707	3.5401
	8	2 1/2	1 11/16	18.3699	3.5401
10E	6	1 1/2	1	14.8473	2.6019
	6	2	1 1/4	8.5330	2.6019
	6	2 1/2	1 1/2	5.5862	2.6019
	6	2 1/2	1 11/16	3.7810	2.6019
10E	8	1 1/2	1	11.1248	3.5401
	8	2	1 1/4	4.8589	3.5401
	8	2 1/2	1 1/2	2.0636	3.5401
	8	2 1/2	1 11/16	0.2584	3.5401
10D	6	1 1/2	1	22.8196	2.6019
	6	2	1 1/4	13.8896	2.6019
	6	2 1/2	1 1/2	9.4699	2.6019
	6	2 1/2	1 11/16	6.9996	2.6019
10D	8	1 1/2	1	18.9269	3.5401
	8	2	1 1/4	10.0628	3.5401
	8	2 1/2	1 1/2	5.8209	3.5401
	8	2 1/2	1 11/16	3.3506	3.5401
10M	4	1 1/2	1	18.8933	2.0161
	4	2	1 1/4	12.5609	2.0161
10M	6	1 1/2	1	14.8473	2.6019
	6	2	1 1/4	8.5330	2.6019
	6	2 1/2	1 1/2	5.5862	2.6019
	6	2 1/2	1 11/16	3.7810	2.6019
10G	6	1 1/2	1	44.4588	2.6019
	6	2	1 1/4	28.4291	2.6019
	6	2 1/2	1 1/2	20.0114	2.6019
	6	2 1/2	1 11/16	15.7358	2.6019
10G	8	1 1/2	1	40.1043	3.5401
	8	2	1 1/4	24.1876	3.5401
	8	2 1/2	1 1/2	16.0193	3.5401
	8	2 1/2	1 11/16	11.7437	3.5401
10J	6	1 1/2	1	61.5423	2.6019
	6	2	1 1/4	39.9076	2.6019
	6	2 1/2	1 1/2	28.3336	2.6019
	6	2 1/2	1 11/16	22.6328	2.6019

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

OIL LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	TUBE	SHAFT	K	K'
11M	6	1 1/2	1	21.7946	2.6019
	6	2	1 1/4	13.2009	2.6019
	6	2 1/2	1 1/2	8.9706	2.6019
	6	2 1/2	1 11/16	6.5858	2.6019
11M	8	1 1/2	1	17.9238	3.5401
	8	2	1 1/4	9.3937	3.5401
	8	2 1/2	1 1/2	5.3378	3.5401
	8	2 1/2	1 11/16	2.9530	3.5401
11H	6	1 1/2	1	42.8074	2.6019
	6	2	1 1/4	27.3195	2.6019
	6	2 1/2	1 1/2	19.2069	2.6019
	6	2 1/2	1 11/16	15.0691	2.6019
11H	8	1 1/2	1	38.4881	3.5401
	8	2	1 1/4	23.1097	3.5401
	8	2 1/2	1 1/2	15.2410	3.5401
	8	2 1/2	1 11/16	11.1032	3.5401
12A	8	1 1/2	1	40.1043	3.5401
	8	2	1 1/4	24.1876	3.5401
	8	2 1/2	1 1/2	16.0193	3.5401
	8	2 1/2	1 11/16	11.7437	3.5401
	8	3	1 15/16	8.7083	3.5401
12A	10	1 1/2	1	36.0280	4.4684
	10	2	1 1/4	20.1629	4.4684
	10	2 1/2	1 1/2	12.1348	4.4684
	10	2 1/2	1 11/16	7.8592	4.4684
	10	3	1 15/16	4.9331	4.4684
12B	8	1 1/2	1	25.6145	3.5401
	8	2	1 1/4	14.5233	3.5401
	8	2 1/2	1 1/2	9.0415	3.5401
	8	2 1/2	1 11/16	6.0011	3.5401
	8	3	1 15/16	4.1692	3.5401
12B	10	1 1/2	1	21.7713	4.4684
	10	2	1 1/4	10.7121	4.4684
	10	2 1/2	1 1/2	5.3398	4.4684
	10	2 1/2	1 11/16	2.2994	4.4684
	10	3	1 15/16	0.5528	4.4684
12D,F	8	1 1/2	1	36.2032	3.5401
	8	2	1 1/4	21.5857	3.5401
	8	2 1/2	1 1/2	14.1407	3.5401
	8	2 1/2	1 11/16	10.1976	3.5401
	8	3	1 15/16	7.4862	3.5401
12D,F	10	1 1/2	1	32.1897	4.4684
	10	2	1 1/4	17.6184	4.4684
	10	2 1/2	1 1/2	10.3054	4.4684
	10	2 1/2	1 11/16	6.3623	4.4684
	10	3	1 15/16	3.7538	4.4684
12K,S	8	1 1/2	1	55.7087	3.5401
	8	2	1 1/4	34.5954	3.5401
	8	2 1/2	1 1/2	23.5339	3.5401
	8	2 1/2	1 11/16	17.9282	3.5401
	8	3	1 15/16	13.5965	3.5401
12K,S	10	1 1/2	1	51.3814	4.4684
	10	2	1 1/4	30.3406	4.4684
	10	2 1/2	1 1/2	19.4524	4.4684
	10	2 1/2	1 11/16	13.8467	4.4684
	10	3	1 15/16	9.6504	4.4684

PUMP	COL	TUBE	SHAFT	K	K'
12M	6	1 1/2	1	29.2544	2.6019
	6	2	1 1/4	18.2132	2.6019
	6	2 1/2	1 1/2	12.6046	2.6019
	6	2 1/2	1 11/16	9.5975	2.6019
	6	3	1 15/16	7.6481	2.6019
12M	8	1 1/2	1	25.2244	3.5401
	8	2	1 1/4	14.2631	3.5401
	8	2 1/2	1 1/2	8.8536	3.5401
	8	2 1/2	1 11/16	5.8465	3.5401
	8	3	1 15/16	4.0470	3.5401
12E,G,I	8	1 1/2	1	42.3335	3.5401
	8	2	1 1/4	25.6745	3.5401
	8	2 1/2	1 1/2	17.0928	3.5401
	8	2 1/2	1 11/16	12.6272	3.5401
	8	3	1 15/16	9.4066	3.5401
	8	3	2 3/16	6.6582	3.5401
12E,G,I	10	1 1/2	1	38.2213	4.4684
	10	2	1 1/4	21.6168	4.4684
	10	2 1/2	1 1/2	13.1801	4.4684
	10	2 1/2	1 11/16	8.7146	4.4684
	10	3	1 15/16	5.6070	4.4684
	10	3	2 3/16	2.8586	4.4684
12N,U, W	8	1 1/2	1	63.5109	3.5401
	8	2	1 1/4	39.7993	3.5401
	8	2 1/2	1 1/2	27.2912	3.5401
	8	2 1/2	1 11/16	21.0204	3.5401
	8	3	1 15/16	16.0406	3.5401
	8	3	2 3/16	12.1811	3.5401
12N,U, W	10	1 1/2	1	59.0581	4.4684
	10	2	1 1/4	35.4295	4.4684
	10	2 1/2	1 1/2	23.1113	4.4684
	10	2 1/2	1 11/16	16.8404	4.4684
	10	3	1 15/16	12.0091	4.4684
	10	3	2 3/16	8.1496	4.4684
12V	8	1 1/2	1	67.4120	3.5401
	8	2	1 1/4	42.4012	3.5401
	8	2 1/2	1 1/2	29.1699	3.5401
	8	2 1/2	1 11/16	22.5665	3.5401
	8	3	1 15/16	17.2626	3.5401
12V	10	1 1/2	1	62.8964	4.4684
	10	2	1 1/4	37.9739	4.4684
	10	2 1/2	1 1/2	24.9407	4.4684
	10	2 1/2	1 11/16	18.3373	4.4684
	10	3	1 15/16	13.1884	4.4684
13E	8	1 1/2	1	54.5941	3.5401
	8	2	1 1/4	33.8520	3.5401
	8	2 1/2	1 1/2	22.9972	3.5401
	8	2 1/2	1 11/16	17.4864	3.5401
	8	3	1 15/16	13.2473	3.5401
13E	10	1 1/2	1	50.2847	4.4684
	10	2	1 1/4	29.6136	4.4684
	10	2 1/2	1 1/2	18.9297	4.4684
	10	2 1/2	1 11/16	13.4190	4.4684
	10	3	1 15/16	9.3135	4.4684

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

STRETCH CONSTANTS
OIL LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	TUBE	SHAFT	K	K'
13F	8	1 1/2	1	53.4795	3.5401
	8	2	1 1/4	33.1086	3.5401
	8	2 1/2	1 1/2	22.4604	3.5401
	8	2 1/2	1 11/16	17.0447	3.5401
	8	3	1 15/16	12.8982	3.5401
13F	10	1 1/2	1	49.1881	4.4684
	10	2	1 1/4	28.8866	4.4684
	10	2 1/2	1 1/2	18.4070	4.4684
	10	2 1/2	1 11/16	12.9913	4.4684
	10	3	1 15/16	8.9765	4.4684
13H	8	1 1/2	1	56.9347	3.5401
	8	2	1 1/4	35.4132	3.5401
	8	2 1/2	1 1/2	24.1243	3.5401
	8	2 1/2	1 11/16	18.4141	3.5401
	8	3	1 15/16	13.9805	3.5401
13H	10	1 1/2	1	52.5877	4.4684
	10	2	1 1/4	31.1403	4.4684
	10	2 1/2	1 1/2	20.0274	4.4684
	10	2 1/2	1 11/16	14.3171	4.4684
	10	3	1 15/16	10.0211	4.4684
14C,F D	10	1 1/2	1	71.6698	4.4684
	10	2	1 1/4	43.7897	4.4684
	10	2 1/2	1 1/2	29.1222	4.4684
	10	2 1/2	1 11/16	21.7587	4.4684
	10	3	1 15/16	15.8840	4.4684
	10	3	2 3/16	11.3520	4.4684
	10	3 1/2	2 7/16	8.8038	4.4684
14C,F D	12	1 1/2	1	70.6888	3.8995
	12	2	1 1/4	42.6525	3.8995
	12	2 1/2	1 1/2	27.7904	3.8995
	12	2 1/2	1 11/16	20.4269	3.8995
	12	3	1 15/16	14.3589	3.8995
	12	3	2 3/16	9.8270	3.8995
	12	3 1/2	2 7/16	7.138	3.8995
14I,J	12	1 1/2	1	111.8730	3.8995
	12	2	1 1/4	69.6688	3.8995
	12	2 1/2	1 1/2	47.0494	3.8995
	12	2 1/2	1 11/16	36.0280	3.8995
	12	3	1 15/16	26.5561	3.8995
	12	3	2 3/16	19.7728	3.8995
	12	3 1/2	2 7/16	15.4255	3.8995

$$\text{Stretch} = \frac{L(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

PUMP	COL	TUBE	SHAFT	K	K'
14M	8	1 1/2	1	32.7928	3.5401
	8	2	1 1/4	18.0183	3.5401
	8	2 1/2	1 1/2	10.5928	3.5401
	8	2 1/2	1 11/16	6.5976	3.5401
	8	3	1 15/16	3.9391	3.5401
	8	3	2 3/16	1.4802	3.5401
14M	10	1 1/2	1	31.3265	4.4684
	10	2	1 1/4	16.4276	4.4684
	10	2 1/2	1 1/2	8.8514	4.4684
	10	2 1/2	1 11/16	4.8561	4.4684
	10	3	1 15/16	2.0549	4.4684
	10	3	2 3/16	-0.4041	4.4684
15H	10	1 1/2	1	66.0219	4.4684
	10	2	1 1/4	40.0458	4.4684
	10	2 1/2	1 1/2	26.4303	4.4684
	10	2 1/2	1 11/16	19.5562	4.4684
	10	3	1 15/16	14.1487	4.4684
	10	3	2 3/16	9.9179	4.4684
15H	12	1 1/2	1	65.1797	3.8995
	12	2	1 1/4	39.0386	3.8995
	12	2 1/2	1 1/2	25.2142	3.8995
	12	2 1/2	1 11/16	18.3400	3.8995
	12	3	1 15/16	12.7273	3.8995
	12	3	2 3/16	8.4965	3.8995
16E	12	1 1/2	1	115.6170	3.8995
	12	2	1 1/4	72.1249	3.8995
	12	2 1/2	1 1/2	48.8002	3.8995
	12	2 1/2	1 11/16	37.4462	3.8995
	12	3	1 15/16	27.6649	3.8995
	12	3	2 3/16	20.6769	3.8995
	12	3 1/2	2 7/16	16.1789	3.8995
17M	12	1 1/2	1	100.5339	3.8995
	12	2	1 1/4	62.2306	3.8995
	12	2 1/2	1 1/2	41.7469	3.8995
	12	2 1/2	1 11/16	31.7326	3.8995
	12	3	1 15/16	23.1979	3.8995
	12	3	2 3/16	17.0344	3.8995
	12	3 1/2	2 7/16	13.1438	3.8995
17M	14	1 1/2	1	98.6112	4.3180
	14	2	1 1/4	60.3237	4.3180
	14	2 1/2	1 1/2	39.8798	4.3180
	14	2 1/2	1 11/16	29.8654	4.3180
	14	3	1 15/16	21.3616	4.3180
	14	3	2 3/16	15.1981	4.3180
	14	3 1/2	2 7/16	11.3337	4.3180

STRETCH CONSTANTS
OIL LUBRICATED – STANDARD WALL COLUMN

PUMP	COL	TUBE	SHAFT	K	K'
17H	12	1 1/2	1	86.9485	3.8995
	12	2	1 1/4	53.3187	3.8995
	12	2 1/2	1 1/2	35.3940	3.8995
	12	2 1/2	1 11/16	26.5863	3.8995
	12	3	1 15/16	19.1744	3.8995
	12	3	2 3/16	13.7536	3.8995
	12	3 1/2	2 7/16	10.4100	3.8995
17H	14	1 1/2	1	85.0816	4.3180
	14	2	1 1/4	51.4649	4.3180
	14	2 1/2	1 1/2	33.5754	4.3180
	14	2 1/2	1 11/16	24.7677	4.3180
	14	3	1 15/16	17.3827	4.3180
	14	3	2 3/16	11.9619	4.3180
	14	3 1/2	2 7/16	8.6414	4.3180
18H	12	1 1/2	1	144.4994	3.8995
	12	2	1 1/4	91.0714	3.8995
	12	2 1/2	1 1/2	62.3066	3.8995
	12	2 1/2	1 11/16	48.3872	3.8995
	12	3	1 15/16	36.2188	3.8995
	12	3	2 3/16	27.6519	3.8995
	12	3 1/2	2 7/16	21.9909	3.8995
18H	14	1 1/2	1	142.3959	4.3180
	14	2	1 1/4	88.9925	4.3180
	14	2 1/2	1 1/2	60.2823	4.3180
	14	2 1/2	1 11/16	46.3629	4.3180
	14	3	1 15/16	34.2382	4.3180
	14	3	2 3/16	25.6713	4.3180
	14	3 1/2	2 7/16	20.0463	4.3180

PUMP	COL	TUBE	SHAFT	K	K'
19A,B	12	1 1/2	1	180.3350	3.8995
	12	2	1 1/4	114.5792	3.8995
	12	2 1/2	1 1/2	79.0644	3.8995
	12	2 1/2	1 11/16	61.9622	3.8995
	12	3	1 15/16	48.8319	3.8995
	12	3	2 3/16	36.3060	3.8995
	12	3 1/2	2 7/16	29.2020	3.8995
19A,B	14	1 1/2	1	178.0842	4.3180
	14	2	1 1/4	112.3600	4.3180
	14	2 1/2	1 1/2	76.9120	4.3180
	14	2 1/2	1 11/16	59.8098	4.3180
	14	3	1 15/16	44.7336	4.3180
	14	3	2 3/16	34.2078	4.3180
	14	3 1/2	2 7/16	27.1479	4.3180

$$\text{Stretch} = \frac{(HK + 2HK' - LK') \times S.G.}{10{,}000{,}000}$$

COLUMN FRICTION LOSS CHART

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		0 - 900 GPM								
		100	200	300	400	500	600	700	800	900
4 x 1 1/2	4 x 1	2.90	4.60	9.00	14.50	---	---	---	---	---
4 x 2	4 x 1 1/4	5.30	9.20	21.80	---	---	---	---	---	---
6 x 1 1/2	6 x 1	---	0.73	1.60	2.70	3.80	5.20	7.00	8.90	11.50
6 x 2	6 x 1 1/4	---	0.95	2.00	3.40	4.90	7.00	9.00	12.00	14.50
6 x 2 1/2	6 x 1 1/2	---	1.40	2.90	4.70	6.90	9.50	12.50	16.20	---
	6 x 1 11/16	---								
6 x 3	6 x 1 15/16	---	2.20	4.50	7.60	11.80	17.10	---	---	---
8 x 1 1/2	8 x 1	---	---	---	---	---	---	0.98	1.30	1.60
8 x 2	8 x 1 1/4	---	---	---	0.61	0.91	1.30	1.80	2.20	2.80
8 x 2 1/2	8 x 1 1/2	---	---	---	0.74	1.10	1.55	2.10	2.70	3.20
	8 x 1 11/16									
8 x 3	8 x 1 15/16	---	---	---	1.05	1.55	2.20	2.90	3.70	4.70
	8 x 2 3/16									
10 x 1 1/2	10 x 1	---	---	---	---	---	---	---	---	---
10 x 2	10 x 1 1/4	---	---	---	---	---	---	---	0.58	0.72
10 x 2 1/2	10 x 1 1/2	---	---	---	---	---	---	0.50	0.67	0.83
	10 x 1 11/16									
10 x 3	10 x 1 15/16	---	---	---	---	---	---	0.62	0.80	1.00
	10 x 2 3/16									

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		1000 - 2600 GPM								
		1000	1200	1400	1600	1800	2000	2200	2400	2600
8 x 1 1/2	8 x 1	1.90	2.60	3.50	4.50	5.50	6.70	7.90	9.40	11.00
8 x 2	8 x 1 1/4	3.30	4.50	5.95	7.55	9.40	12.50	15.10	---	---
8 x 2 1/2	8 x 1 1/2	3.90	5.50	7.20	9.20	14.00	---	---	---	---
	8 x 1 11/16									
8 x 3	8 x 1 15/16	5.40	7.50	9.98	13.00	16.40	---	---	---	---
	8 x 2 3/16									
10 x 1 1/2	10 x 1	---	1.06	1.40	1.79	2.20	2.69	3.20	3.75	4.33
10 x 2	10 x 1 1/4	0.89	1.20	1.59	3.02	2.50	3.02	3.60	4.20	4.90
10 x 2 1/2	10 x 1 1/2	1.00	1.38	1.81	2.30	2.88	3.50	4.10	4.80	5.60
	10 x 1 11/16									
10 x 3	10 x 1 15/16	1.17	1.65	2.18	2.78	3.50	4.25	5.05	5.95	6.90
	10 x 2 3/16									
12 x 2	12 x 1 1/4	---	---	---	---	0.99	1.20	1.42	1.68	1.92
12 x 2 1/2	12 x 1 1/2	---	---	---	0.90	1.11	1.36	1.60	1.89	2.18
	12 x 1 11/16									
12 x 3	12 x 1 15/16	---	---	---	1.04	1.29	1.57	1.85	2.18	2.50
	12 x 2 3/16									
12 x 3 1/2	12 x 2 7/16	---	---	1.02	1.30	1.65	1.95	2.35	2.76	3.23
14 x 2 1/2	14 x 1 1/2	---	---	---	---	---	---	0.95	1.13	1.30
	14 x 1 11/16									
14 x 3	14 x 1 15/16	---	---	---	---	---	---	1.07	1.26	1.46
	14 x 2 3/16									
14 x 3 1/2	14 x 2 7/16	---	---	---	---	---	1.05	1.24	1.46	1.68

COLUMN FRICTION LOSS CHART

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		2800 - 4400 GPM								
		2800	3000	3200	3400	3600	3800	4000	4200	4400
8 x 1 1/2	8 x 1	12.80	14.70	16.70	---	---	---	---	---	---
10 x 1 1/2	10 x 1	5.00	5.65	6.35	7.05	7.85	8.70	9.60	10.60	11.60
10 x 2	10 x 1 1/4	5.60	6.40	7.15	8.00	8.90	9.80	12.00	14.50	---
10 x 2 1/2	10 x 1 1/2	6.40	7.25	8.20	9.10	10.50	12.50	13.50	14.90	---
	10 x 1 11/16									
10 x 3	10 x 1 15/16	7.90	8.95	9.99	12.00	13.50	14.50	---	---	---
	10 x 2 3/16									
12 x 2	12 x 1 1/4	2.20	2.50	2.80	3.15	3.50	3.85	4.20	4.60	5.10
12 x 2 1/2	12 x 1 1/2	2.50	2.87	3.20	3.60	4.00	4.40	4.80	5.25	5.80
	12 x 1 11/16									
12 x 3	12 x 1 15/16	2.90	3.30	3.72	4.15	4.60	5.15	5.65	6.15	6.70
	12 x 2 3/16									
12 x 3 1/2	12 x 2 7/16	3.69	4.20	4.73	5.28	5.90	5.55	7.25	7.85	8.60
14 x 2 1/2	14 x 1 1/2	1.50	1.68	1.90	2.14	2.38	2.62	2.90	3.15	3.45
	14 x 1 11/16									
14 x 3	14 x 1 15/16	1.67	1.90	2.13	2.38	2.65	2.90	3.20	3.50	3.80
	14 x 2 3/16									
14 x 3 1/2	14 x 2 7/16	1.93	2.20	2.45	2.72	3.04	3.35	3.67	4.00	4.35
14 x 4	14 x 2 11/16	2.01	2.30	2.55	2.85	3.17	3.50	3.85	4.20	4.55
14 x 5	14 x 2 15/16	2.52	2.87	3.20	3.60	4.00	4.40	4.85	5.25	5.70
	Thru									
	14 x 3 11/16									
16 x 2 1/2	16 x 1 1/2	---	---	---	1.03	1.14	1.25	1.37	1.49	1.63
	16 x 1 11/16									
16 x 3	16 x 1 15/16	---	---	1.00	1.12	1.24	1.37	1.50	1.64	1.79
	16 x 2 3/16									
16 x 3 1/2	16 x 2 7/16	---	0.99	1.12	1.25	1.38	1.53	1.68	1.83	2.00
16 x 4	16 x 2 11/16	---	1.03	1.17	1.30	1.44	1.60	1.75	1.90	2.08
16 x 5	16 x 2 15/16	1.00	1.10	1.30	1.40	1.60	1.80	1.90	2.10	2.30
	Thru									
	16 x 3 11/16									

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		4600 - 8000 GPM								
		4600	4800	5000	5500	6000	6500	7000	7500	8000
10 x 1 1/2	10 x 1	12.70	13.80	15.00	---	---	---	---	---	---
12 x 2	12 x 1 1/4	5.50	5.90	6.40	7.60	9.00	10.60	12.30	14.10	16.00
12 x 2 1/2	12 x 1 1/2	6.30	6.80	7.30	8.70	10.40	12.20	14.10	16.20	---
	12 x 1 11/16									
12 x 3	12 x 1 15/16	7.25	7.90	8.55	10.30	12.30	14.40	16.80	---	---
	12 x 2 3/16									
12 x 3 1/2	12 x 2 7/16	9.30	10.10	11.10	13.30	15.80	---	---	---	---
14 x 2 1/2	14 x 1 1/2	3.70	4.00	4.35	5.15	6.10	7.10	8.10	9.20	10.50
	14 x 1 11/16									
14 x 3	14 x 1 15/16	4.10	4.45	4.80	5.70	6.70	7.70	8.90	10.20	11.60
	14 x 2 3/16									
14 x 3 1/2	14 x 2 7/16	4.72	5.15	5.53	6.50	7.65	8.85	10.30	11.18	13.40
14 x 4	14 x 2 11/16	4.95	5.40	5.80	6.80	8.00	9.30	10.80	12.40	14.10
14 x 5	14 x 2 15/16	6.2	6.72	7.20	8.60	9.99	11.70	13.60	15.60	---
	Thru									
	14 x 3 11/16									
16 x 2 1/2	16 x 1 1/2	1.77	1.90	2.06	2.45	2.87	3.30	3.80	4.30	4.80
	16 x 1 11/16									
16 x 3	16 x 1 15/16	1.93	2.10	2.25	2.70	3.13	3.60	4.15	4.70	5.25
	16 x 2 3/16									
16 x 3 1/2	16 x 2 7/16	2.16	2.32	2.52	2.98	3.48	4.03	4.65	5.27	5.87
16 x 4	16 x 2 11/16	2.25	2.42	2.63	3.10	3.60	4.20	4.80	5.50	6.10
16 x 5	16 x 2 15/16	2.50	2.70	2.90	3.50	4.10	4.70	5.40	6.10	6.85
	Thru									
	16 x 3 11/16									

COLUMN FRICTION LOSS CHART

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		8500 - 12000 GPM								
		8500	9000	9500	10000	10500	11000	11500	12000	---
14 x 2 1/2	14 x 1 1/2	11.80	13.20	14.80	16.40	---	---	---	---	---
	14 x 1 11/16									
14 x 3	14 x 1 15/16	13.10	14.70	16.40	---	---	---	---	---	---
	14 x 2 3/16									
14 x 3 1/2	14 x 2 7/16	13.10	---	---	---	---	---	---	---	---
14 x 4	14 x 2 11/16	15.90	---	---	---	---	---	---	---	---
16 x 2 1/2	16 x 1 1/2	5.40	6.00	6.60	7.25	7.99	8.77	9.59	10.40	---
	16 x 1 11/16									
16 x 3	16 x 1 15/16	5.90	6.50	7.20	7.90	8.71	9.56	10.40	11.40	---
	16 x 2 3/16									
16 x 3 1/2	16 x 2 7/16	6.55	7.30	8.05	8.85	9.76	10.70	11.70	12.70	---
16 x 4	16 x 2 11/16	6.80	7.60	8.40	9.20	10.10	11.10	12.20	13.20	
16 x 5	16 x 2 15/16	7.60	8.30	9.00	9.80	10.80	11.90	13.00	14.10	---
	Thru									
	16 x 3 11/16									
18 x 3	18 x 1 15/16	3.70	4.20	4.60	5.00	5.50	6.00	6.40	7.00	---
	18 x 2 3/16									
18 x 3 1/2	18 x 2 7/16	4.20	4.60	5.15	5.60	6.10	6.60	7.20	7.80	---
18 x 4	18 x 2 11/16	4.55	5.10	5.60	6.20	6.70	7.30	8.00	8.60	---
18 x 5	18 x 2 15/16	6.20	6.90	7.60	8.35	9.20	10.00	13.20	14.40	---
	Thru									
	18 x 3 11/16									
20 x 3	20 x 1 15/16	1.90	2.10	2.35	2.55	2.80	3.05	3.30	3.55	---
	20 x 2 3/16									
20 x 3 1/2	20 x 2 7/16	2.20	2.50	2.75	3.00	3.30	3.55	3.85	4.20	---
20 x 4	20 x 2 11/16	2.55	2.85	3.07	3.45	3.80	4.10	4.50	4.85	---
20 x 5	20 x 2 15/16	3.40	3.75	4.15	4.55	5.00	5.40	5.85	6.30	---
	Thru									
	20 x 3 11/16									
24 x 3 1/2	24 x 2 7/16	---	---	---	---	1.05	1.12	1.20	1.32	---
24 x 4	24 x 2 11/16	---	---	---	1.08	1.20	1.60	1.40	1.50	---
24 x 5	24 x 2 15/16	1.04	1.15	1.32	1.40	1.54	1.65	1.80	1.94	---
	Thru									
	24 x 3 11/16									

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting								
		12500 - 16000 GPM								
		12500	13000	13500	14000	14500	15000	15500	16000	---
16 x 2 1/2	16 x 1 1/2	11.30	12.30	13.20	14.20	15.20	---	---	---	---
	16 x 1 11/16									
16 x 3	16 x 1 15/16	12.30	13.40	14.40	15.50	---	---	---	---	---
	16 x 2 3/16									
16 x 3 1/2	16 x 2 7/16	13.80	15.00	---	---	---	---	---	---	---
16 x 4	16 x 2 11/16	14.30	15.50	---	---	---	---	---	---	
16 x 5	16 x 2 15/16	15.30	---	---	---	---	---	---	---	---
	Thru									
	16 x 3 11/16									
18 x 3	18 x 1 15/16	7.50	8.10	8.70	9.30	10.00	10.70	11.40	12.20	---
	18 x 2 3/16									
18 x 3 1/2	18 x 2 7/16	8.20	9.00	9.80	10.50	11.30	12.10	12.90	13.80	---
18 x 4	18 x 2 11/16	9.20	10.00	10.80	11.50	12.40	13.30	14.20	15.10	---
18 x 5	18 x 2 15/16	15.60	---	---	---	---	---	---	---	---
	Thru									
	18 x 3 11/16									
20 x 3	20 x 1 15/16	3.85	4.10	4.40	4.75	5.05	5.40	5.70	6.00	---
	20 x 2 3/16									
20 x 3 1/2	20 x 2 7/16	4.50	4.85	5.25	5.60	6.00	6.30	6.80	7.10	---
20 x 4	20 x 2 11/16	5.20	5.60	6.00	6.40	6.90	7.30	7.80	8.20	---
20 x 5	20 x 2 15/16	6.80	7.30	7.80	8.40	9.00	9.60	10.30	10.90	---
	Thru									
	20 x 3 11/16									
24 X 3	24 x 1 15/16	1.25	1.35	1.45	1.55	1.65	1.77	1.87	2.00	---
	24 x 2 3/16									
24 x 3 1/2	24 x 2 7/16	1.42	1.52	1.65	1.75	1.85	2.00	2.10	2.22	---
24 x 4	24 x 2 11/16	1.60	1.75	1.87	2.00	2.15	2.25	2.42	2.55	---
24 x 5	24 x 2 15/16	2.07	2.25	2.40	2.57	2.75	2.90	3.20	3.25	---
	Thru									
	24 x 3 11/16									

COLUMN FRICTION LOSS CHART

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting — 16500 - 20000 GPM							
		16500	17000	17500	18000	18500	19000	19500	20000
18 x 3	18 x 1 15/16 18 x 2 3/16	12.90	13.70	14.60	15.40	---	---	---	---
18 x 3 1/2	18 x 2 7/16	14.60	15.50	---	---	---	---	---	---
20 x 3	20 x 1 15/16 20 x 2 3/16	6.35	6.80	7.10	7.60	7.90	8.30	8.60	9.10
20 x 3 1/2	20 x 2 7/16	7.50	8.00	8.40	8.90	9.20	9.80	10.30	10.90
20 x 4	20 x 2 11/16	8.70	9.20	9.70	10.20	10.80	11.40	12.00	12.70
20 x 5	20 x 2 15/16 Thru 20 x 3 11/16	11.60	12.30	13.10	13.80	14.60	15.40	---	---
24 X 3	24 x 1 15/16 24 x 2 3/16	2.10	2.23	2.30	2.45	2.55	2.70	2.82	3.00
24 x 3 1/2	24 x 2 7/16	2.35	2.50	2.62	2.76	2.90	3.05	3.20	3.35
24 x 4	24 x 2 11/16	2.77	2.85	3.00	3.15	3.35	3.50	3.70	3.85
24 x 5	24 x 2 15/16 Thru 24 x 3 11/16	3.50	3.65	3.85	4.05	4.25	4.50	4.70	5.00
30 x 4	30 x 2 11/16	---	---	---	---	---	---	---	1.00
30 x 5	30 x 2 15/16 Thru 30 x 3 11/16	---	---	---	1.00	1.05	1.10	1.17	1.22

Column and Enclosing Tube Size	Column and Open Lineshaft Size	Friction Loss in Feet Per 100 Feet of Setting — 25000 - 60000 GPM							
		25000	30000	35000	40000	45000	50000	55000	60000
20 x 3	20 x 1 15/16 20 x 2 3/16	16.20	---	---	---	---	---	---	---
20 x 3 1/2	20 x 2 7/16	17.00	---	---	---	---	---	---	---
20 x 4	20 x 2 11/16	19.80	---	---	---	---	---	---	
24 X 3	24 x 1 15/16 24 x 2 3/16	4.50	6.20	8.30	10.60	13.70	16.90	---	---
24 x 3 1/2	24 x 2 7/16	5.10	7.10	9.40	12.30	15.50	---	---	---
24 x 4	24 x 2 11/16	6.00	8.67	11.80	15.40	---	---	---	---
24 x 5	24 x 2 15/16 Thru 24 x 3 11/16	7.40	10.50	14.30	18.70	---	---	---	---
30 x 4	30 x 2 11/16	1.53	2.12	2.87	3.70	4.60	5.60	6.70	7.90
30 x 5	30 x 2 15/16 Thru 30 x 3 11/16	1.75	2.50	3.30	4.20	5.20	6.30	7.50	8.80

LINESHAFT LOSS CHART

Shaft Diameter	Horsepower Loss Per 100 Feet of Setting										
	3600	2900	1800	1500	1200	1000	900	750	720	600	514
1	1.10	0.88	0.55	0.45	0.35	0.30	0.27	---	---	---	---
1 1/4	1.50	1.35	0.81	0.68	0.52	0.44	0.40	---	---	---	---
1 1/2	2.30	1.90	1.20	0.96	0.75	0.60	0.55	---	---	---	---
1 11/16	2.80	2.40	1.40	1.20	0.94	0.78	0.70	0.60	0.55	0.49	---
1 15/16	3.70	3.10	1.90	1.60	1.20	1.00	0.90	0.79	0.72	0.63	---
2 3/16	---	---	2.30	2.00	1.50	1.40	1.30	1.20	1.10	0.80	---
2 7/16	---	---	2.90	2.40	1.90	1.60	1.40	1.30	1.20	0.96	0.88
2 11/16	---	---	3.40	2.90	2.30	1.90	1.70	1.60	1.50	1.30	1.10
2 15/16	---	---	4.10	3.50	2.70	2.30	2.00	1.80	1.70	1.40	1.10
3 3/16	---	---	5.20	4.30	3.40	2.80	2.50	2.10	2.00	1.70	1.50
3 7/16	---	---	6.00	4.80	3.90	3.30	3.00	2.40	2.30	1.90	1.50
3 11/16	---	---	7.00	5.90	4.50	3.80	3.50	2.80	2.70	2.10	1.70
4	---	---	---	---	4.90	4.00	3.70	3.20	3.00	2.50	2.30
4 1/2	---	---	---	---	---	5.00	4.40	4.00	3.70	3.10	2.60
5	---	---	---	---	---	---	---	4.90	4.50	3.80	3.40
5 1/2	---	---	---	---	---	---	---	---	---	4.30	3.90
6	---	---	---	---	---	---	---	---	---	---	4.50

DISCHARGE ELBOW LOSS CHART

"CT", "D", "DT" & "H" Heads

Elbow Size	Flow (GPM)									
	400	450	500	600	700	800	900	1000	1200	1400
4	.25	.55	.90	1.75	2.75	3.90	4.90	-	-	-
6	-	-	-	-	-	-	-	.45	1.05	1.80
Elbow Size	**Flow (GPM)**									
	1600	**1800**	**2000**	**2200**	**2400**	**2600**	**3000**	**3400**	**3800**	**4200**
6	2.60	3.55	4.60	5.70	-	-	-	-	-	-
8	-	.55	.90	1.25	1.75	2.20	3.25	4.40	5.70	-
10	-	-	-	-	-	-	-	1.20	1.75	2.35
Elbow Size	**Flow (GPM)**									
	4200	**4600**	**5000**	**6000**	**7000**	**8000**	**9000**	**10000**	**12000**	**14000**
10	2.35	3.10	3.75	5.80	-	-	-	-	-	-
12	.65	.95	1.3	2.3	3.45	4.80	-	-	-	-
14	-	-	.25	.80	1.45	2.15	3.00	3.90	6.00	-

The above tabulation shows the additional elbow friction losses encountered when handling capacities greater than the maximum recommended capacity for a given head.

DISCHARGE ELBOW LOSS CHART

"L", "LS", "T" & "UG" Heads

Elbow Size	Flow (GPM)									
	200	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
4	.35	.46	.78	1.06	1.39	1.76	2.17	3.12	4.26	5.56
6	-	-	-	-	-	.34	.42	.61	.83	1.08
8	-	-	-	-	-	-	-	-	.27	.36
Elbow Size	**1000**	**1200**	**1400**	**1600**	**1800**	**2000**	**2200**	**2400**	**2600**	**3000**
6	1.69	2.43	3.31	4.32	5.46	6.74	-	-	-	-
8	.56	.81	1.11	1.44	1.82	2.25	2.71	3.23	3.80	5.06
10	-	-	.44	.58	.73	.91	1.09	1.30	1.75	2.03
12	-	-	-	-	.36	.45	.54	.65	.76	1.01
14	-	-	-	-	-	-	-	.45	.53	.70
16	-	-	-	-	-	-	-	-	-	.40
Elbow Size	**3500**	**4000**	**5000**	**6000**	**7000**	**8000**	**9000**	**10000**	**11000**	**12000**
10	2.76	3.63	5.65	8.18	-	-	-	-	-	-
12	1.37	1.80	2.81	4.05	5.51	7.19	-	-	-	-
14	.94	1.23	2.46	2.76	3.77	4.92	6.23	-	-	-
16	.55	.72	1.13	1.62	2.21	2.89	3.65	3.87	4.80	5.63
18	-	.45	.70	.82	1.12	1.47	1.85	2.29	2.82	3.34
20	-	-	.46	.66	.75	.99	1.25	1.54	1.85	2.24
24	-	-	-	-	.43	.55	.70	.73	.88	1.06
Elbow Size	**13000**	**14000**	**15000**	**16000**	**17000**	**18000**	**19000**	**20000**	**25000**	**30000**
18	4.73	5.52	6.32	7.21	-	-	-	-	-	-
20	3.08	3.59	4.09	4.66	5.28	5.90	6.56	7.29	-	-
24	1.48	1.71	1.97	2.23	2.53	2.82	3.16	3.48	5.46	7.84
30	.55	.63	.73	.83	.93	1.05	1.16	1.29	2.02	2.90
36	-	-	-	-	-	.44	.50	.55	.85	1.22
Elbow Size	**35000**	**40000**	**45000**	**50000**	**60000**					
24	10.74	-	-	-	-					
30	3.95	5.17	6.53	8.07	-					
36	1.66	2.17	2.75	3.40	4.89					

The above tabulation shows the additional elbow friction losses encountered when handling capacities greater than the maximum recommended capacity for a given head.

DISCHARGE ELBOW LOSS CHART

"F" & "UF" Heads

Elbow Size	Flow (GPM)									
	200	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
4	.20	.31	.45	.61	.79	1.0	1.24	1.78	2.42	3.16
6	-	-	-	-	.15	.19	.24	.35	.47	.61
8	-	-	-	-	-	-	-	-	.16	.21

Elbow Size	Flow (GPM)									
	1000	**1200**	**1400**	**1600**	**1800**	**2000**	**2200**	**2400**	**2600**	**3000**
6	.96	1.38	1.88	2.46	3.15	3.84	-	-	-	-
8	.32	.46	.63	.82	1.04	1.28	1.54	1.83	2.16	2.87
10	-	-	.25	.33	.44	.51	.63	.74	.86	1.15
12	-	-	-	-	-	.26	.31	.37	.44	.57
14	-	-	-	-	-	-	-	.25	.30	.40
16	-	-	-	-	-	-	-	-	-	.23

Elbow Size	Flow (GPM)									
	3500	**4000**	**5000**	**6000**	**7000**	**8000**	**9000**	**10000**	**11000**	**12000**
10	1.57	2.06	3.21	4.64	6.30	8.20	-	-	-	-
12	.78	1.02	1.60	2.30	3.13	4.08	5.15	-	-	-
14	.54	.70	1.09	1.57	2.14	2.80	3.54	3.80	4.60	5.45
16	.32	.41	.64	.92	1.25	1.64	2.07	2.20	2.70	3.20
18	-	.26	.40	.58	.79	1.03	1.30	1.60	1.90	2.30
20	-	-	.26	.38	.51	.66	.84	1.04	1.76	1.99
24	-	-	-	-	.25	.32	.40	.50	.60	.71

Elbow Size	Flow (GPM)									
	13000	**14000**	**15000**	**16000**	**17000**	**18000**	**19000**	**20000**	**25000**	**30000**
18	2.69	3.14	3.59	4.20	-	-	-	-	-	-
20	1.75	2.04	2.33	2.65	3.00	3.36	3.73	4.14	-	-
24	.84	.97	1.12	1.27	1.44	1.61	1.80	1.98	3.10	4.46
30	.31	.36	.42	.47	.53	.60	.66	.74	1.15	1.65
36	-	-	-	-	-	.25	.28	.31	.48	.69

Elbow Size	Flow (GPM)				
	35000	**40000**	**45000**	**50000**	**60000**
24	6.10	-	-	-	-
30	2.25	2.94	3.71	4.59	6.60
36	.95	1.24	1.57	1.93	2.78

The above tabulation shows the additional elbow friction losses encountered when handling capacities greater than the maximum recommended capacity for a given

SUCTION CAN SELECTION CHART

Fairbanks Model	Column Size	Flange O.D.	Max. Bowl O.D.	Clearance (A)	Allowable Capacity (GPM) at a Velocity of 5 Ft./Sec. — Can O.D. (D1)										
					8.625	10.75	12.75	14	16	18	20	24	30	36	42
6A	4	6.63	5.63	4			1250								
6B	4	6.63	5.63	4			1250								
6D	4	6.63	5.63	4			1250								
6F	4	6.63	5.63	4			1250								
6M	4	6.63	5.50	3			1250								
6G	4	6.63	5.50	4			1250								
6J	4	6.63	5.50	4			1250								
7M	4	6.63	6.60	3			1250								
7A	6	9.25	7.50	3.75				1100							
7D	6	9.25	7.50	3.75				1100							
7B	6	9.25	7.50	3.75				1100							
8B	4	6.63	7.75	4.5				1400							
	5	7.63	7.75	4.5				1400							
	6	9.25	7.75	4.5				1100							
8P	6	9.25	9.50	5					1740						
8T	6	9.25	9.50	5					1740						
8V	6	9.25	9.50	5					1740						
8M	4	6.63	8.00	6				1360							
	6	9.25	8.00	6				1100	1790						
10A	5	7.63	9.63	5.5					1700						
	6	9.25	9.63	5.5					1700						
	8	11.75	9.63	5.5					1150						
10B	6	9.25	9.63	5.5					1700						
	8	11.75	9.63	5.5					1150	1950					
10D	6	9.25	9.63	5.5					1700						
	8	11.75	9.63	5.5					1150	1950					
10E	6	9.25	9.63	5.5					1700						
	8	11.75	9.63	5.5					1150						
10M	4	6.63	10.00	7					1600						
	6	9.25	10.00	7					1600						
10G	6	9.25	9.75	5					1680						
	8	11.75	9.75	5					1150	1950					
10J	6	9.25	9.75	5					1680						
	8	11.75	9.75	5					1150	1950					
11M	6	9.25	11.38	7						2050					
	8	11.75	11.38	7						1950					
11H	6	9.25	11.48	7						2000					
	8	11.75	11.48	7						1950					
12A	6	9.25	11.50	6.25						2000					
	8	11.75	11.50	6.25						1950					
	10	13.88	11.50	6.25						1275	2175				
12B	8	11.75	11.75	6.25						1950					
	10	13.88	11.75	6.25						1275	2175				
12D	8	11.75	11.75	6.25						1950					
	10	13.88	11.75	6.25						1275	2175				
12F	8	11.75	11.75	6.25						1950					
	10	13.88	11.75	6.25						1275	2175				
12K	8	11.75	11.75	5.75						1950					
	10	13.88	11.75	5.75						1275	2175				

SUCTION CAN SELECTION CHART

Fairbanks Model	Column Size	Flange O.D.	Max. Bowl O.D.	Clearance (A)	Allowable Capacity (GPM) at a Velocity of 5 Ft./Sec.										
					Can O.D. (D1)										
					8.625	10.75	12.75	14	16	18	20	24	30	36	42
12S	8	11.75	11.75	5.75						1950	2800				
	10	13.88	11.75	5.75						1275	2175	4250			
12M	6	9.25	13.00	8							2450				
	8	11.75	13.00	8							2450				
12E	8	11.75	13.00	6.5							2450				
	10	13.88	13.00	6.5							2175				
12G	8	11.75	13.00	6.5							2450				
	10	13.88	13.00	6.5							2175				
12I	8	11.75	13.00	6.5							2450				
	10	13.88	13.00	6.5							2175				
12N	8	11.75	13.00	7							2450				
	10	13.88	13.00	7							2175				
	12	16.38	13.00	7							1250	3330			
12U	8	11.75	13.00	7							2450	4500			
	10	13.88	13.00	7							2175	4250			
	12	16.38	13.00	7							1250	3330			
12W	8	11.75	13.00	7							2450	4500			
	10	13.88	13.00	7							2175	4250			
	12	16.38	13.00	7							1250	3330			
12V	10	13.88	11.75	6							2175	4250			
13E	8	11.75	12.50	6							2600				
	10	13.88	12.50	6							2175				
13F	8	11.75	12.50	6							2600				
	10	13.88	12.50	6							2175				
13H	8	11.75	13.00	6							2450	2990			
	10	13.88	13.00	6							2175	4250			
14C	12	16.38	17.00	8.5							990	3075			
14F	12	16.38	17.00	8.5							990	3075			
14D	12	16.38	17.00	8.5							990	3075			
14M	10	13.88	14.75	9								3950			
14I	12	16.38	17.00	8.5								3075	6930		
14J	12	16.38	17.00	8.5								3075	6930		
15H	10	13.88	15.00	9								3860	7700		
	12	16.38	15.00	9								3330	7180		
16E	12	16.38	17.25	8.5								2970	6800		
	14	17.63	17.25	8.5								2810	6650		
17H	12	16.38	16.92	10								3110			
	14	17.63	16.92	10								2810	6960	11650	
17M	12	16.38	18.00	10								2650	6502		
	14	17.63	18.00	10								2650	6502		
18H	12	16.38	17.25	8.12								2970	6825		
	14	17.63	17.25	8.12								2810	6664		
19A	14	17.63	17.25	8.75								2810	6664	11390	
	16	20.00	17.25	8.75								1710	2990	10307	
19B	14	17.63	17.25	8.75								2810	6664	11390	
	16	20.00	17.25	8.75								1710	2990	10307	
20HLC	14	17.63	21.50	11									5190	9930	15500
	16	20.00	21.50	11									5190	9930	15500

SUCTION CAN SELECTION CHART

Fairbanks Model	Column Size	Flange O.D.	Max. Bowl O.D.	Clearance (A)	Allowable Capacity (GPM) at a Velocity of 5 Ft./Sec.										
					Can O.D. (D1)										
					30	36	42	48	54	60	72	84	96		
21H	14	17.63	20.75	10	5190	9930	15500								
	16	20.00	20.75	10	5190	9930	15500								
22A	14	17.63	22.50	11.25	4270	9000									
	16	20.00	22.50	11.25	4270	9000									
22B	14	17.63	22.50	11.25	4270	9000									
	16	20.00	22.50	11.25	4270	9000									
23HL	16	20.00	29.00	14		4918	10523	17016							
	18	22.00	29.00	14		4918	10523	17016							
	20	24.50	29.00	14		4918	10523	17016							
23HM	16	20.00	29.00	14		4918	10523	17016							
	18	22.00	29.00	14		4918	10523	17016							
	20	24.50	29.00	14		4918	10523	17016							
23HH	16	20.00	29.00	14		4918	10523	17016							
	18	22.00	29.00	14		4918	10523	17016							
	20	24.50	29.00	14		4918	10523	17016							
24E	16	20.00	24.00	11.25	3418	8150	13923								
	18	22.00	24.00	11.25	3418	8150	13923								
27ML	18	22.00	28.11	14		5532	11145	17638							
	20	24.25	28.11	14		5532	11145	17638							
27M	18	22.00	28.11	14		5532	11145	17638							
	20	24.25	28.11	14		5532	11145	17638							
30D	20	24.25	27.75	13.50		5775	11390	17884							
	24	28.50	27.75	13.50		5262	10875	17368							
30E	20	24.25	27.75	13.50		5775	11390	17884							
	24	28.50	27.75	13.50		5262	10875	17368							
31M	20	24.25	31.30	15			8629	15499	22957						
	24	28.50	31.30	15			8629	15499	22957						
33HH	24	28.50	41.50	21				6240	13771	21868					
	30	34.50	41.50	21				6240	13771	21868					
34H	24	28.50	34.75	16			6110	12679	20138						
	30	34.50	34.75	16			6110	12679	20138						
36F	24	28.50	40	20				7824	15283	23633	43005				
	30	34.50	40	20				7824	15283	23633	43005				
36G	24	28.50	40	20				7824	15283	23633	43005				
	30	34.50	40	20				7824	15283	23633	43005				
38C	20	24.25	34.25	17.13			6537	13106	20564						
	24	28.50	34.25	17.13			6537	13106	20564						
38D	20	24.25	34.25	17.13			6537	13106	20564						
	24	28.50	34.25	17.13			6537	13106	20564						
42A	24	28.50	43	20				4690	12064	20318	39468				
	30	34.50	43	20				4690	12064	20318	39468				
44A	30	34.50	43	21.5				4690	12064	20318	39468				
	36	40.50	43	21.5				4690	12064	20318	39468				
44B	30	34.50	43	21.5				4690	12064	20318	39468				
	36	40.50	43	21.5				4690	12064	20318	39468				
57H	30	34.50	55	27							25087	47759	73953		
	36	40.50	55	27							25087	47759	73953		

SUCTION INLET SIZE LIMITATION

SIZE	MAXIMUM FLOW (GPM)	
	"L" AND CAST IRON HEADS	"T" HEADS
4"	159	238
6"	361	540
8"	625	935
10"	986	1474
12"	1414	2114
14"	1724	2577
16"	2283	3414
18"	2921	4368
20"	3638	5440
24"	5307	7936
30"	8399	12560
36"	12723	19026
42"	16705	24980
48"	21918	34177
54"	27838	41627
60"	34350	51525
72"	49675	74510

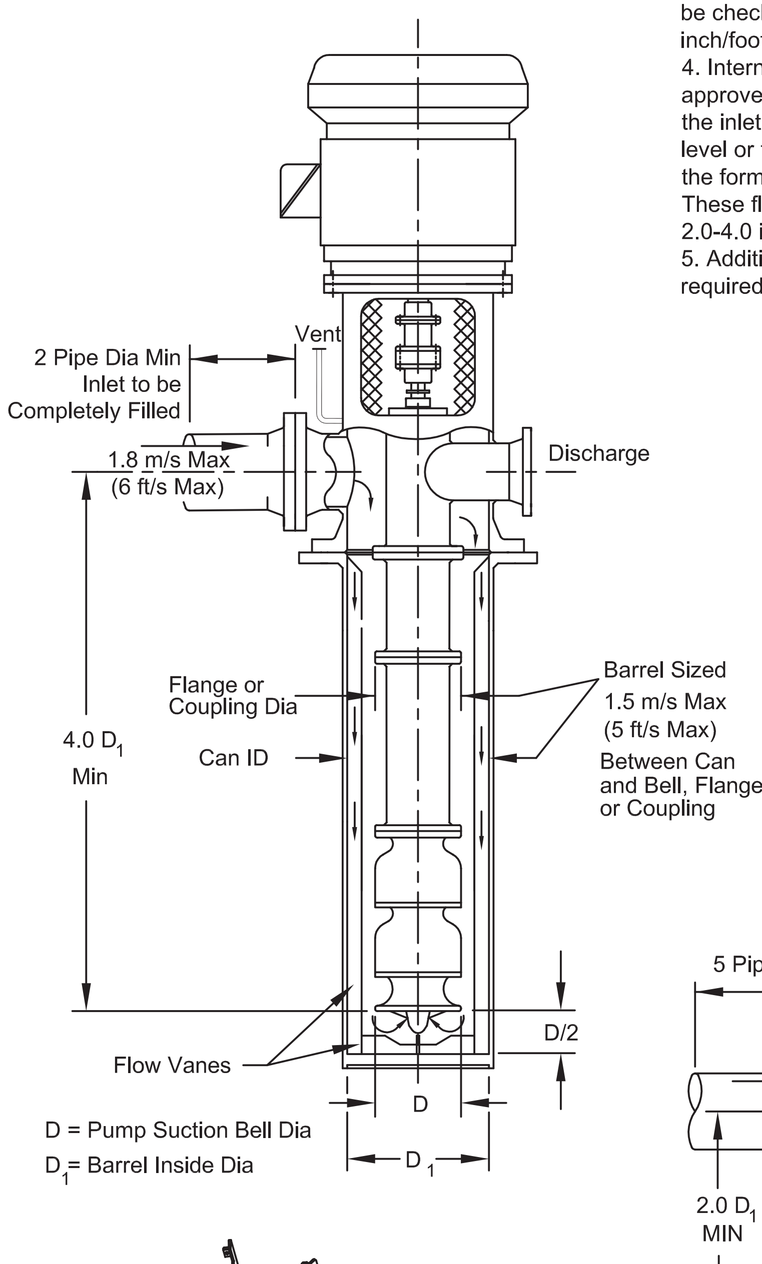
PENTAIR

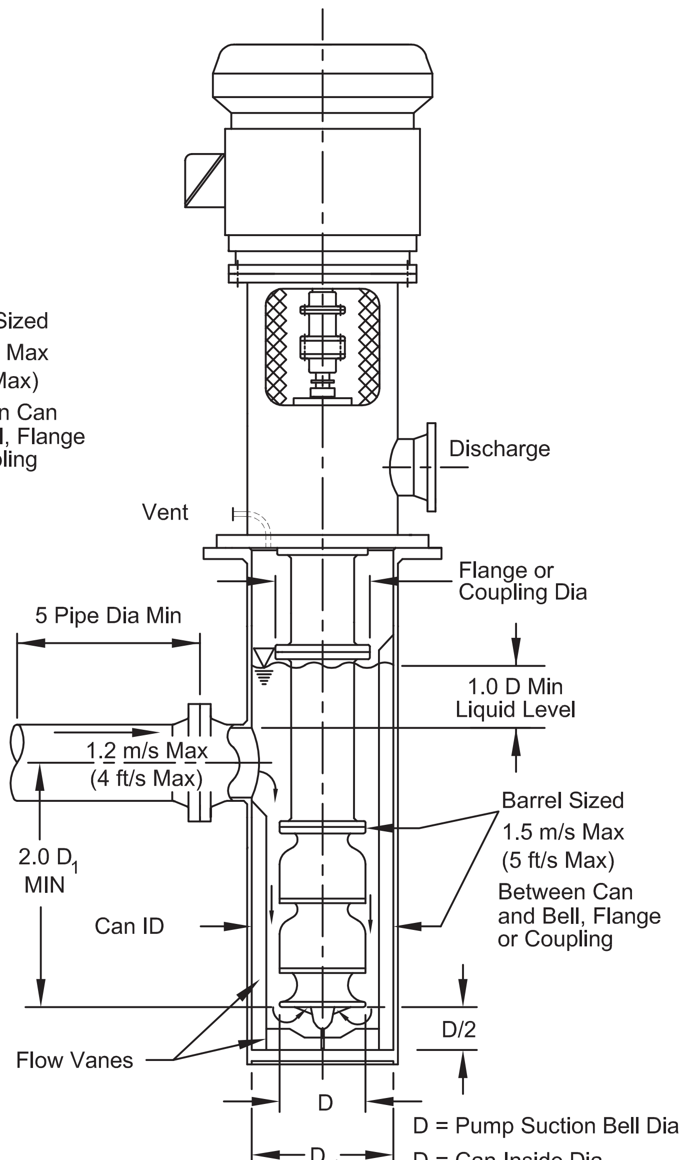
SUCTION CAN DESIGN STANDARD

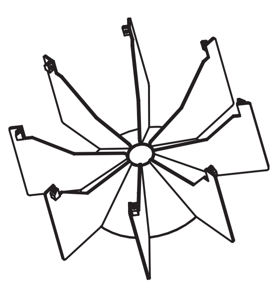
Issued: 9/12/97, By: A.Sdano, Rev #2: 07/14/04

Note:

1. After installation of the can is complete, the mounting surface of the pumps must be level enough and the can shall be plumb enough to assure that the suction bell can be centered within 3% of of the suction bell diameter (0.03 x D).
2. When cans are cast in concrete, the buoyancy forces placed on the can must be restrained to avoid having the can "move" out of level.
3. Before installing the pump, the pump mounting surface must be checked to verify that the surface is level within 0.005 inch/foot in all directions.
4. Internal flow straightening vanes are required unless otherwise approved by Engineering. A pair of vanes should be centered on the inlet to the barrel and extended to above the normal liquid level or to the top of the barrel, as applicable. A set of vanes in the form of a cross should be provided under the pump bell. These flow straightening vanes must be designed to provide for 2.0-4.0 inch clearance to the suction bell.
5. Additional straightening vanes or a vortex suppresser are required for pumps with flow rates above 18,000 GPM.

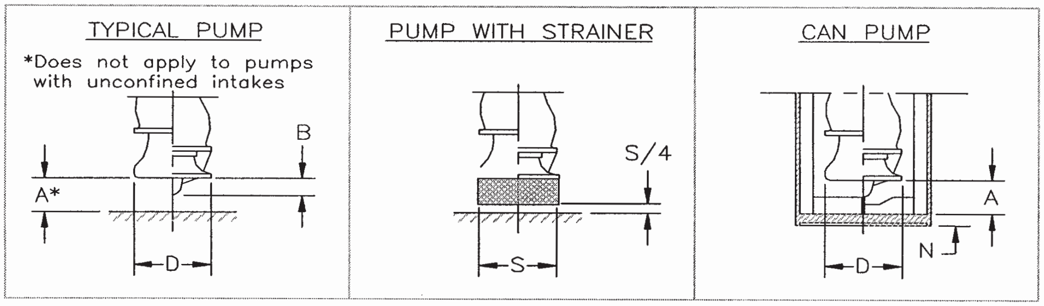






VORTEX SUPPRESSER

DISTANCE OF BELL TO FLOOR FOR TURBINE PUMPS



PUMP	A	B	D	S	PUMP	A	B	D	S
6A, 6B	4	3.25	5.50	6.00	15H	9	7.19	14.75	14.75
6M	3	N/A	5.50	N/A	16E	8.5	3.00	17.25	18.00
6D, 6F	4	3.25	5.50	6.00	17M	10	7.37	18.00	18.00
6G, 6J	4	3.25	5.50	6.00	17H	10	7.94	16.75	16.75
7M	3	N/A	5.75	N/A	18H	8.12	4.00	17.25	18.00
7A, 7B, 7D	3.75	0.75	7.50	8.00	19A, 19B	8.75	2.75	17.25[1]	18.00[2]
8M	6	3.82	8.00	8.00	20HLC	11	1.20	21.50	RTF
8P, 8T, 8V	5	4.25	9.50	10.00	21H	10	5.19	20.75	20.75
8B	4.5	3.88	7.50	8.00	22A, 22B	11.25	6.25	22.5	23.00
10M	7	4.93	10.00	10.00	23HH	14	2.50	29.00	29.00
10A, 10B, 10D, 10E	5.5	4.00	9.50	10.00	23HM	14	2.50	29.00	29.00
10G, 10J	5	4.18	9.50	10.00	23HL	14	2.50	29.00	29.00
11M	7	5.45	11.38	11.50	24E	11.25	6.25	22.5	23.00
11H	7	5.34	11.38	11.50	27M	14	5.99	28.11	28.00
12V	6	3.25	11.50	12.00	30D, 30E	13.5	4.75	27.00	27.50
12N, 12U, 12W	7	6.50	13.00	13.62	31M	15	12.19	31.30	31.00
12M	8	6.13	13.00	13.00	33HH	21	3.25	41.50	RTF
12E, 12G, 12I	6.5	6.00	13.00	14.00	33HM	21	3.25	41.50	RTF
12A, 12B, 12D, 12F	6.25	5.30	11.50	12.00	33HL	21	3.25	41.50	RTF
12K, 12S	5.75	4.80	11.50	12.00	34H	16	N/A	32.00	31.00
13E, 13F	6	3.00	11.50	12.00	36F, 36G	20	6.25	40.00	40.50
13H	6	4.13	13.00	13.00	38A, 38B	17.13	3.00	34.25	34.75
14I, 14J	8.5	6.75	17.00	18.00	42A	20	6.00	40.00	40.50
14M	9	6.85	14.75	14.75	44A, 44B	21.5	4.00	43.00	RTF
14C, 14D, 14F	8.5	8.00	17.00	18.00	57H	27	N/A	54.00	54.00

[1]Bell Diameter for wells or barrels. Bell diameter for sumps is 22.5”.
[2]Basket diameter for wells or barrels. Basket diameter for sumps is 23”.

Suction Pot	
Size	N
12	1.25
14	1.25
16	1.50
18	1.50
20	1.75
24	2.50
30	3.00
36	3.75
42	4.25
48	RTF
54	RTF
60	RTF
72	RTF
84	RTF
96	RTF