Selecting a Vertical Turbine Pump

(Information required from client)

1. Liquid to be pumped:____
   (Note: If liquid is not clear water, the following must also be ascertained).

   a. Foreign material present in liquid (describe):_______________________________________
   b. Specific gravity at pumping temperature:____
   c. Vapor pressure at pumping temperature:____
   d. Viscosity at pumping temperature:____

2. Pumping temperature: ______________________F

3. Required capacity: __________________________GPM

4. Required pressure at centerline of discharge flange: ____________________PSI

5. Pumping water level ____________ft. below centerline of pump discharge (static water level plus drawdown).

6. Inside diameter of well or sump: __________inches. Note: Well or sump must be sufficiently straight or of sufficient diameter to allow bowl assembly and column to hand free and plumb).

7. Size of discharge __________inches. Companion flange required? _____Yes _____No

8. Required length of column or overall length of pump __________ft (indicate which).

9. Lineshaft lubrication arrangement (per below):

_____Open lineshaft (lubricated w/ liquid pumped)	____Enclosed lineshaft (oil lubricated)	_____Enclosed lineshaft (injection lubricated)
_____Rubber bearings	____Redwood bearings	_____Bronze bearings
_____Bronze bearings	____Bronze bearings	_____Rubber bearings

10. Suction pipe required? _____Yes length _________ft. _____No.

11. Strainer required? _____Yes (_____Conical _____Basket) _____No.

12. Special material requirements (describe)____

    If fluid is corrosive, list satisfactory materials____

13. Type of driver____

14. Speed of driver: _______________RPM Gear ratio____________________

15. __________Self release coupling or __________non reverse ratchet

16. Current characteristics __________phase ____________Hz ____________volts

17. Other driver requirements____

"Sample" Pump Data
Selecting a Vertical Turbine Pump

(Information required from client)

1. Liquid to be pumped: _***Clear water***____
   (Note: If liquid is not clear water, the following must also be ascertained).

   a. Foreign material present in liquid (describe):__***None***____________________________________
   b. Specific gravity at pumping temperature:__***1.0***____
   c. Vapor pressure at pumping temperature:____
   d. Viscosity at pumping temperature:____

2. Pumping temperature: _____***Amb.***________________F

3. Required capacity: ________***800***_________________GPM

4. Required pressure at centerline of discharge flange: _____***30***________________PSI

5. Pumping water level___ ***180 + 20***___ ft. below centerline of pump discharge (static water level plus drawdown).

6. Inside diameter of well or sump: __16"__inches. Note: Well or sump must be sufficiently straight or of sufficient diameter to allow bowl assembly and column to hand free and plumb).

7. Size of discharge ______8"________inches. Companion flange required? ______Yes ___X__No

8. Required length of column or overall length of pump ____250____ft (indicate which).

9. Lineshaft lubrication arrangement (per below):

___***X***___Open lineshaft (lubricated w/ liquid pumped)	_____Enclosed lineshaft (oil lubricated)	_____Enclosed lineshaft (injection lubricated)
__***X***_ Rubber bearings	_____Redwood bearings	_____Bronze bearings
_____Bronze bearings	_____Bronze bearings	_____Rubber bearings

10. Suction pipe required? _***X***__Yes length ___***10'***_____ft. _____No.

11. Strainer required? __***X***__Yes (__***X***__Conical _____Basket) _____No.

12. Special material requirements (describe)____

    If fluid is corrosive, list satisfactory materials____

13. Type of driver___***Electrical Motor***____

14. Speed of driver: ___***1800***_________RPM Gear ratio_____________________

15. __________Self release coupling or ______***X***____non reverse ratchet

16. Current characteristics ______***3***____phase ______***60***_____Hz _____***460***_____volts

17. Other driver requirements___ ***Vertical Hollow Shaft, WPI enclosure***___________________________

Selecting a Vertical Turbine Pump

Since the inside diameter of the well is 16 inches, a 15 inch (or smaller bowl assembly must be selected. With this in mind, refer to the performance curves in the catalog for a unit whose capacity at or near the best efficiency point is 800 GPM. It is found that a J11HC at 1760 RPM will produce 72.3 feed head per stage at this capacity.

Tentative Total Head must be determined by a summation of the required lift, discharge pressure, and an assumed column loss, (the actual column loss will be found later). Assume 5 feet loss per 100 feet of column (or 0.06 ft. per foot).

Calculate as follows:

Tentative Total Head = 180 + 20 + (30 x 2.31) + (0.05 x 250) = 281.8 ft.
Where: 180 = static water level below discharge.
20 = draw down in feet
30 = pressure at the centerline of the discharge in PSI
2.31 = feet of water equivalent to one PSI
0.05 = assumed loss per foot of column
250 = total length of column in feet

Number of Stages required is found by dividing the tentative total head by the head per stage as taken from the performance curve as follows:

$$\text{Number of stages} = \frac{281.8}{72.3} = 3.9$$

Where: 281.8 = tentative total head
72.3 = head per stage from performance curve
Since fractional stages are not feasible, the next larger whole number must be used. Or, in this case, 4 stages.

Efficiency as shown on the performance curve must be corrected in accordance with the schedule at the top of the performance curve for number of stages (corrections are also required when bowls and/or impellers are non-standard materials). Note that in this example, no efficiency correction is required and the bowl efficiency shown on the curve can be used.

Tentative Brake Horsepower can be calculated as follows:

$$\text{Tentative BHP} = \frac{281.8 \times 800 \times 1.0}{3960 \times .86} = 66.20$$

Where: 281.8 = tentative total head in feed
800 = capacity in gallons per minutes
1.0 = specific gravity of water
3960. = a constant for converting feed TDH and gallons per minutes to horsepower
0.86 = the efficiency as read from the performance curve and corrected by the schedule on the curve. (Expressed as decimal).

At this point, refer to the "Bowl Assembly Data and Limitations" table located in the Engineering Section of the catalog. This table shows that the maximum recommended number of stages for a J11HC is 20. Since the selection that has been made contains four stages, this is satisfactory.

It is further noted that the bowl diameter is 11-1/8" which is small enough to be installed in a 16" well. The maximum head (Bowl Assembly Data and Limitations) for this pump is 377 PSI (871 feet), but the required total head for this application is only 281.8 feet, therefore, this is satisfactory. It will also be noted in the Bowl Assembly Data and Limitation table that a J11HC has a 1-11/16" diameter bowl shaft. The horsepower rating chart for lineshafts shows that a 1-11/16" shaft is adequate for 335 horsepower therefore, since the estimated horsepower required for this application is 66.20, the standard bowlshaft size is satisfactory.

Lineshaft size depends on the speed, (RPM), horsepower and downthrust. The "Shaft Horsepower Rating" chart in the engineering section shows a 1 ¼" lineshaft to be adequate for this application.

Column size depends on the sizes which will fit any given bowl selection, the lineshaft size and the capacity in gallons per minute. From the pump data dimensions page (on the bottom of the curve sheet), it is found that a J11HC can be adapted to a column and from the Column Friction Loss Chart in the engineering section it is found that at 800 GPM, an 8" column with a 1 ¼" lineshaft produces a friction loss of 2.2 feet per 100 feet of column and that a 6" column size is not recommended for this capacity.

A generally accepted criteria for column size selection is that the size be selected such that the friction loss will not exceed 5 feet per 100 feet of column.

Total Head required can now be found by using the hydraulic friction loss for an 8" column with a 1 ¼" shaft as follows:

$$\text{TDH} = 180 + 20 + \frac{2.2 \times 250}{100} + (30 \times 2.31) + 0.11 = 274.9 \text{ ft.}$$

Where: 180 = static water level below discharge
20 = drawdown
2.2 = hydraulic friction loss per 100 ft. column
250 = length of column
30 = required pressure (PSI) at centerline of discharge
2.31 = feed of water equivalent to one PSI
0.11 = friction loss for 8" cast discharge head (engineering section)

Since four stages are required in this illustration, the head requirement per stage is 274.9 divided by 4 = 68.73 ft. Upon re-checking the performance curve in the catalog, it is found that the required head per stage at 800 GPM lies between the top curve and the middle curve and that the efficiency is 86%. In other applications in which the hydraulic condition point is found to lie above the highest head curve on the performance curve, it indicates that the pump will fall short of the desired hydraulic performance and that another stage should be added. In cases where the hydraulic condition point falls below the lowest head curve on the performance curve it suggests that the number of stages should be reduced or the factory contacted if reducing the number of stages is not practical.

Hydraulic Thrust = 274.9 x 7.8 = 2144 lbs.

Where: 274.9 = total head
7.8 = thrust factor for impeller

The thrust factor can be found on the performance curve or Bowl Assembly Data and Limitation page (Engineering section or bottom of the curve sheet).

Shaft Elongation can be found by using the value shown in the "Shaft Elongation Chart" (Engineering section). The elongation of a 1 ¼" lineshaft, 250 feet long, with 2144 pounds hydraulic thrust is 0.18" (0.070 x 2.5) (0.070 is interpolated). This shaft elongation must be less than the maximum lateral dimension shown in the Bowl Assembly Data and Limitation table. For a J11HC, the lateral dimension is 1". This indicates that the standard lateral available in the bowl assembly is adequate for the shaft stretch.

Total Downthrust is found by the summation of the hydraulic thrust and the total weight of the rotating assembly:

Total downthrust = 2144 + (18.5 x 4) + (250 x 4.17) = 3260.50 lbs.

Where: 2144 = hydraulic thrust
18.5 = weight of each stage taken from the Bowl Assembly Data and Limitation table.
4 = number of stages (or impellers)
250 = length of column (or shaft)
4.7 = weight per foot of 1 ¼ inch line shafting taken from the Shaft Weight Table (Section I)

Shaft Mechanical Friction Loss is found on the Shaft Friction Loss Chart (Engineering section). This chart show that 0.79 BHP is lost per 100 feet of 1 ¼" shafting at 1760 RPM. This loss must be included in the determination of the prime mover horsepower requirement as follows:

$$BHP = \frac{274.9 \times 800 \times 1.0}{3960 \times .86} + \frac{0.79 \times 250}{100} = 66.55$$

Where: 274.9 = total head in feet
800 = capacity in gallons per minute
1.0 = specific gravity of water
3960 = Ft-GPM/HP constant
0.86 = efficiency expressed as a decimal
0.79 = shaft losses per 100 feet
250 = length of column in feet

The above horsepower represents the requirement at the design point of 800 GPM and 30 PSI at the centerline of the discharge, but when selecting a prime mover, the maximum horsepower across the performance curve must also be considered.

Referring back to the J11HC performance curve it is found that the maximum horsepower is approximately 4 horsepower per stage higher at 1300 GPM that at 800 GPM for the top curve and 2 horsepower higher at 1250 GPM for the middle curve. Since the job requirements (hydraulic performance) lie between the top and middle curves it can be estimated that the maximum horsepower will be 3 horsepower per stage more than design horsepower and occur at 1275 GPM. The approximate maximum horsepower can be calculated as follows:

Max BHP =- 66.55 + (3 x 4) = 78.50

Where: 66.55 = design HP as calculated
3 = estimated rise in HP per stage
4 = number of stages

It is usually good practice and in many cases necessary to size the prime mover for the higher horsepower. The final decision as to whether or not the prime mover should be sized for the higher horsepower depends on the type of application. If the pump installation is such that they hydraulic conditions at the higher horsepower can never exist, then the higher horsepower is of no importance but, on the other hand, if there is a possibility that the unit may operate for an extended period at the higher horsepower conditions then the prime mover should be sized for the higher horsepower. From the above, it can now be said that the pump will require 66.55 horsepower when operating at design head and capacity but 78.5 horsepower may be required under other operating conditions. With this information and the other motor requirements as set forth by the client, a motor catalog can be consulted for further details.

Motor or engine and right angle gear size depends on the speed (RPM), total downthrust and horsepower requirement of the pump. In this illustration, a vertical hollowshaft electric motor is to be used, therefore, a right angle gear will not be required. Right angle gears are used only when the prime mover is designed for horizontal mounting, such as an engine, turbine, etc.

In this application it is apparent that we can use a 75 horsepower 1800 RPM, 3 phase, 60 cycle, 460 volt vertical hollow shaft motor in a weather protected enclosure with a non-reverse ratchet and thrust bearings capable of sustaining 3622 lbs. downthrust. Note that a 75 horsepower motor with a 1.15 service factor is capable of 86 horsepower (75 x 1.15) but may not be used for this application if the pump has to be non-overloading on the curve. A 100 HP motor should be used. At this point, it is advisable to recheck the horsepower rating of the lineshaft that was selected. In the preliminary selection of the lineshaft, hydraulic thrust was used whereas the total thrust should be used for final sizing. Also, the possibility that the pump may on occasions be operated at a higher horsepower was not taken into account. Upon rechecking the Lineshaft Horsepower Rating Chart, it is found that the previously selected 1 ¼" lineshaft with 3260 pounds downthrust has a horsepower limitation of 124 horsepower. Therefore, the lineshaft as initially selected is adequate for this application.

Discharge Head selection depends on the discharge size, column size and the base diameter (BD) of the driver. In this particular example, it will be noted in the electric motor catalog that a 75 horsepower 1800 RPM VHS motor has a BD dimension of either 16 ½ inches or 12 inches. Therefore an 8 inch discharge head with either a 12" or 16 ½" BD will be satisfactory.

Referring to the Discharge Head section of the catalog, it will be found that an N8-260 discharge head has a BD dimension of 16 ½" which is satisfactory for the motor required. The N8-260 discharge head will accept the 8" column and 1 ¼" shaft and has an 8" discharge and is satisfactory for 250' setting.

Suction Pipe and Strainers should be selected to fit the intake connection of the bowl assembly. Referring to the performance curve; the J11HC will accept 8" suction pipe. It is common to use the same size suction pipe as column pipe so an 8" suction pipe would be selected.

Conical strainers are recommended for well service while the basket type strainers are used when pumping from sumps or other large bodies of liquid. Size to fit the suction pipe or bowl assembly.

Lubrication of the lineshaft bearings of an open lineshaft pump is accomplished by the pumped fluid, however some method of providing initial lubrication as start up must be provided see "Pre-lubrication Recommendations" in this section of the catalog.

Enclosed lineshaft pumps are usually lubricated by oil, the necessary reservoir and fittings for a manual system are included as standard equipment with the discharge head assembly.

The pump selection is now completed and can be summarized as follows:

1. Suction pipe with strainer
2. 4 stage J11HC bowl assembly
3. 250 feet of 8" x 1 ¼" column and open lineshaft
4. N8-260 discharge head assembly
5. 75 horsepower 1800 RPM 3/60/460 volt VHS weather protected motor for 3622 lbs. downthrust and with non-reverse ratchet.