

**SELF-PRIMING PUMPS**

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One definition of a self-priming pump is "a pump that lifts liquid to its suction without the aid of an external priming device". Otherwise, a self-priming pump performs like a standard centrifugal, and has a similar curve. It also looks like other centrifugals, except the casing is bigger than it should be, and not the traditional volute shape. **Figure 1** shows a section of a self-priming pump for solids handling service.

**HOW HIGH CAN A SELF-PRIMING PUMP LIFT?**

The value published by the manufacturer we represent [Gorman-Rupp Company] is 7.6 metres of water, or 25 feet, and there are many installations with significant lifts. A lift of 7.6 metres is adequate for most applications. When selecting a self-priming pump, no "margin of safety" on the lift should be needed. If a pump is published as having a 7.6 metre capability, it will lift 7.6 metres. This is because Gorman-Rupp has already stated the lift conservatively.

**HOW DOES A SELF-PRIMING PUMP PRIME?**

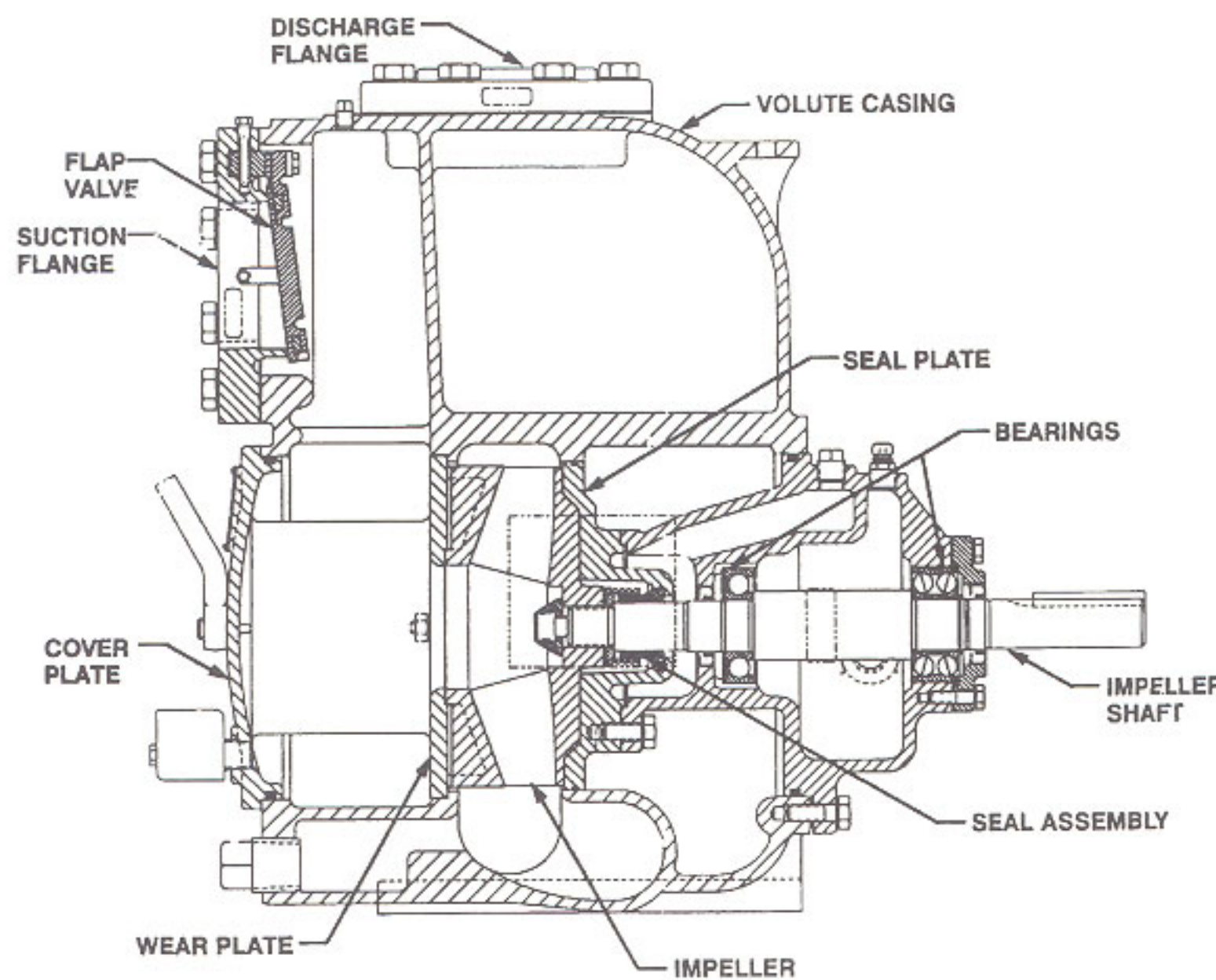
Suppose we have a self-priming pump on sewage lift station service that is about to be commissioned. The

contractor has filled the pump casing with water [ this is only done at commissioning or after the pump has been drained], and the signal to start the pump is given.

The wet well is being acted on by atmospheric pressure. So the absolute pressure at the inlet to the suction pipe is approximately 101 kPa [14.7 PSI]. But inside the pump, a spinning impeller has reduced the local pressure to full vacuum. We now have unbalanced pressures in a closed system - 101 kPa at the suction inlet, 0 kPa at the pump. **Figure 2** on page 254 illustrates this.

The higher pressure at the suction inlet forces liquid up into the suction line, displacing the air, which is pushed into the pump. Air mixes with the liquid put in the pump casing before startup, and air and liquid pass through the impeller to the discharge side of the pump casing, where because of their different densities, they separate. Liquid falls to the bottom of the casing, to be directed back to the impeller. Air rises through the pump discharge connection. It reaches an air release valve and is returned to the sump via a vent line.

Once all the air has been exhausted from the system, the self-priming pump begins to operate like



**FIGURE 1. A SELF-PRIMING PUMP FOR SOLIDS HANDLING SERVICE.**

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any other centrifugal pump. It will do so even when the duty cycle is over - in our example, when the level in the lift station wet well has been lowered to the pump "off" level. The control system turns the pump off, but this does not mean all the liquid will drain from the pump and suction line. There is a check valve in the pump casing. When the pump stops, this valve closes, and prevents any liquid falling back. Next cycle, the pump does not have to reprime, but starts pumping immediately.

**WHERE SELF-PRIMING PUMPS ARE APPLIED**

Self-priming pumps are used in sewage collection systems, and treatment plants. They are also found in landfill sites. Water plants and distribution systems make use of their special characteristics to move potable water and its byproducts.

In a sewage collection system, self-priming pumps are well suited for lift station service. The liquid to be pumped is below grade, but the pump can lift it, and send it through kilometers of forcemain. Once the sewage reaches the treatment plant, self-priming "raw sewage" pumps provide lift to sedimentation or other treatment. Self-priming pumps are also installed on a

variety of sludge services up to 8 per cent concentration.

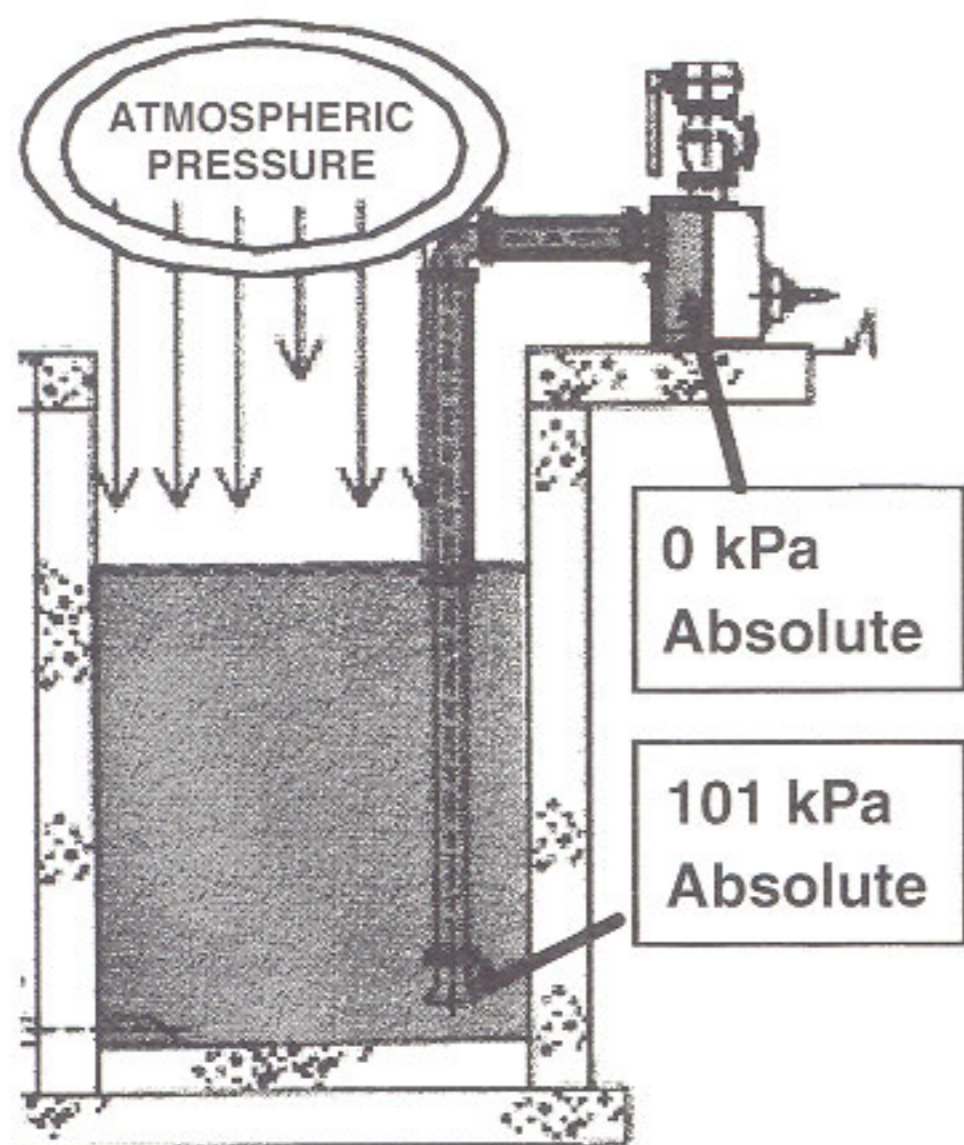
Leachate wells in landfill sites are another area where self-priming pumps may be applied. There is a static lift on the suction side. The atmosphere in the wet well is noxious, and leachate has attacked the cable seals of submersible pumps, resulting in unforeseen failures.

Self-priming pumps are installed in water applications. In raw water service, water is drawn from a natural basin such as a lake or river. The ability to lift on the suction side is convenient, and unlike a vertical turbine pump, the self-primer's bearings are not in the liquid, so not subject to wear from solids found in natural waters. Filter backwash sludge is a service which suits the self-primer. And the distribution system can employ self-priming pumps, where the ability to lift is useful, whether that lift is from the clear well or a reservoir.

**WHY WOULD I USE A SELF-PRIMING PUMP?**

Self-priming pumps have a number of benefits to offer the water/wastewater user:-

- > Self-priming pumps are capable of pumping from a sump, of lifting liquid without the aid of external priming devices.
- > With self-priming pumps, pumping equipment is not in the wet well. Every major piece of the pumping station - pumps, drivers, valves, controls is accessible for inspection and repair.
- > Confined space entry, with its costs and potential hazards, is avoided.
- > Self-priming pumps are quick and easy to maintain. The Gorman Rupp "T" Series is the pump used in the WEAO and WEFTEC Operator's Challenge. The fastest teams are disassembling and reassembling the pump in four minutes.
- > Self-priming pumps are driven by standard horizontal electric motors. Standard motors are inexpensive to buy, are universally available and quickly rewound or replaced.



**FIGURE 2. HOW A SELF-PRIMING PUMP WORKS DURING THE PRIMING CYCLE.**

**SELF-PRIMING PUMPS - CONTINUED**

**DESIGNING A SYSTEM WITH SELF-PRIMING PUMPS**

Designing a system with self-priming pumps is similar to designing with other kinds of pumps. The steps are:

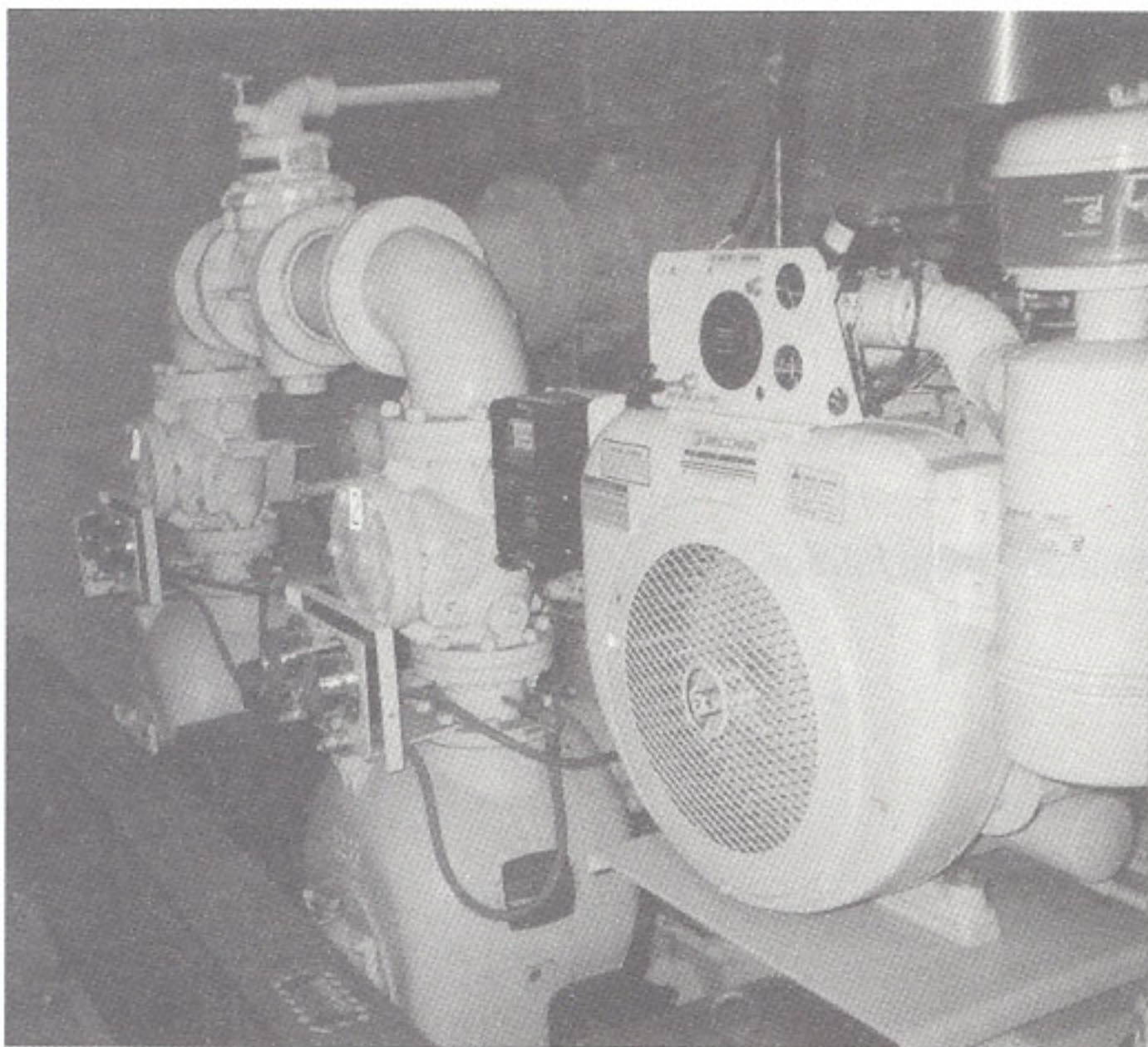
1. Obtain a dimension drawing or sketch.
2. Plot the system curve[s].
3. Plot the pump curve.
4. Check NPSH.
5. Check reprime lift.
6. Check for adequate submergence.

From the dimension drawings, it should be possible to compute the maximum and minimum static head. From friction tables and the total equivalent length of the piping system, the friction head as a function of flow can be calculated and added to the maximum and minimum static head. The most popular formula for calculating friction is the Hazen & Williams equation, which includes a "roughness coefficient" [really a smoothness coefficient] for which values are published for various types and ages of pipe. It is prudent to plot curves for both old and new pipe, and maximum and minimum static head. The use of a

spreadsheet/chart program e.g. Microsoft® Excel, takes some time initially, but the results are worth it.

Next the pump curve can be added to the plot. In design, the desired flow is known, and it is customary to select a pump to give this flow at the maximum static head, and for old pipe. This becomes the operating point, which will be achievable at some pump speed. Again, with a spreadsheet/chart program it is possible to lay in one speed from the manufacturer's curve, then produce curves for other speeds using the affinity laws.

Now the curves for NPSH available and NPSH required can be added. The first is a characteristic of the system, and can be plotted as a function of flow [sample calculations available]. The second is a pump quantity and is obtained from the manufacturer's curve. Once this has been done, read down from the duty point at the intersection of the pump curve and the system curve for new pipe and minimum static head. This will be at the maximum flow the pump should ever attain. Ensure that at this flow, the NPSH available exceeds the NPSH required by whatever margin is customary. [Gorman Rupp builds a 0.6 m or 2 foot safety factor into its



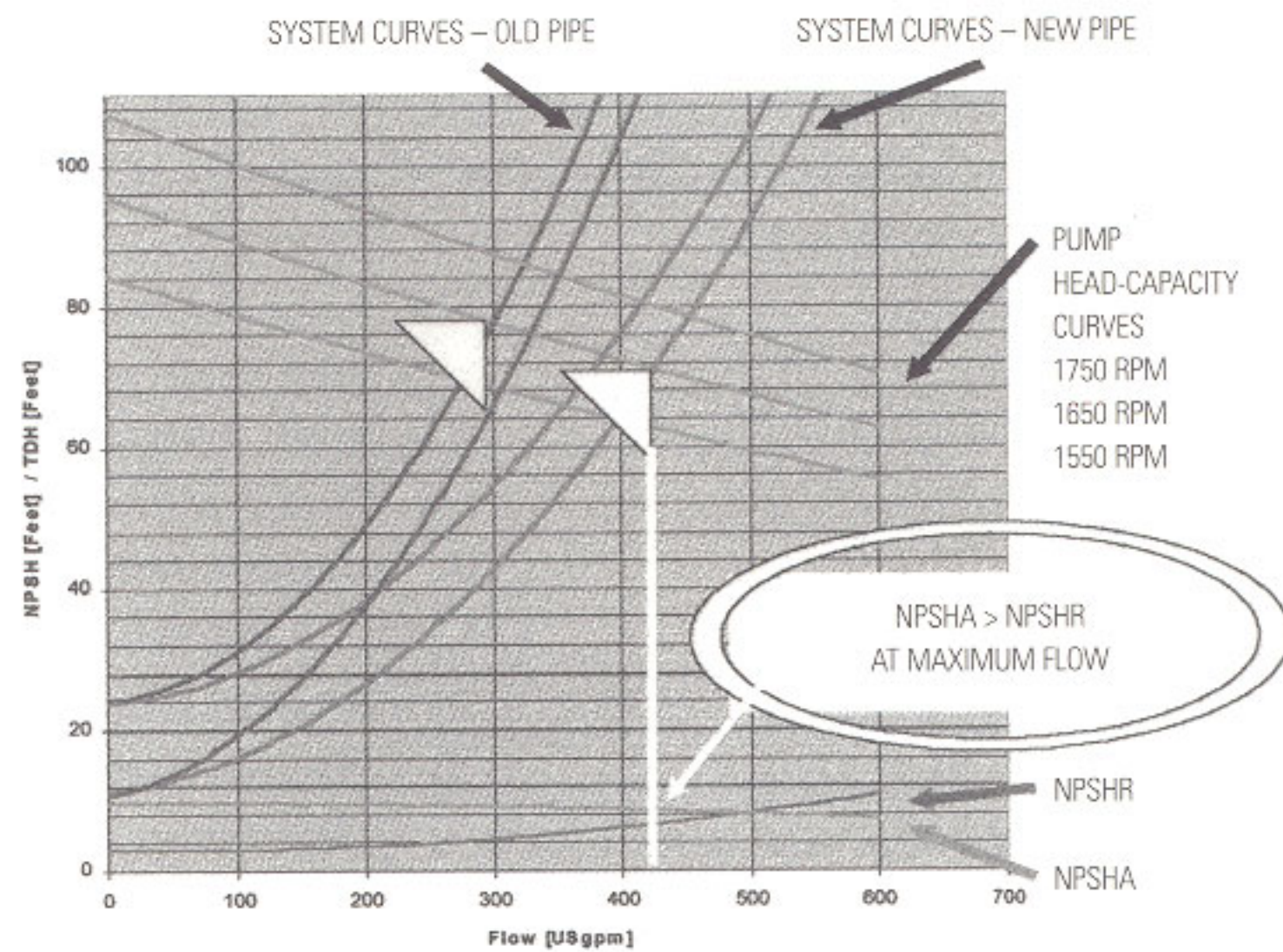
**SELF-PRIMING PUMPS IN LIFT STATION SERVICE**

**SELF-PRIMING PUMPS - CONTINUED**

NPSHA calculations]. If this is done, the designer has taken a rational approach to prevent the pump from "running out" on its curve and cavitation will be unlikely.

Checking reprime lift is straightforward. The distance between the centreline of the pump suction connection and grade, and between grade and the pump "on" level are computed. They are added and compared to the published reprime lift. The reprime lift should be greater than the sum of the other two dimensions. If it is, the lift is acceptable, and the pump will prime.

Vortexing is a condition which occurs when liquid level above the suction pipe inlet is inadequate. Air is drawn down into the liquid and enters the suction pipe. This condition is highly dependant on the velocity of the liquid as it enters the suction pipe. This is why many suction lines have a "bell" or increaser at their inlet: velocity is decreased, and the required height of liquid cover over the end of the suction pipe is reduced. The required liquid depth, or submergence, to prevent vortexing is given in a chart published by Gorman-Rupp, which is available on request.



**DESIGNING A SYSTEM WITH SELF-PRIMING PUMPS.**