DESIGN AND CONSTRUCTION OF A REMEDIAL PUMPING SYSTEM

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Design and Construction of a Remedial Pumping System

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ABSTRACT

This senior project discusses the design and construction of a remedial pumping system at Cal Poly’s Swanton Pacific Ranch. The site the system is installed is called the College Well Station where it will be used to irrigate about two acres of turf. Excessive iron residue is in their water, so in order to prevent this residue from clogging the irrigation system, this system was installed. The system consists of a 2,500 gallon settling tank, booster pump, variable frequency drive (VFD), and a bladder tank. The settling tank will settle the iron particles to the bottom, preventing the pump from pumping the particles into the system.
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INTRODUCTION

Background

Iron is one of the most common elements on the planet, accounting for approximately 5% of the earth’s crust. This causes nearly all water supplies to have some kind of measureable amount of iron in them. The presence of iron in water can cause several issues: clogging of equipment, pipes and faucets, rust colored and bad tasting water. The United States Environmental Protection Agency (USEPA) determined that the presence of iron or iron bacteria in water is not dangerous to human consumption; however, due to iron’s affect on water color and taste, the USEPA has regulations in place that allow the water to be aesthetically pleasing to human consumption. In order to stay within these regulations and to avoid issues with clogging of equipment, there is a need to have ways of reducing the iron levels in water sources that are affected by it.

Justification

The Swanton Pacific Ranch, owned by California Polytechnic State University (Cal Poly), has been having major iron issues with their water supply. One particular spot the ranch has been having issues with is their College Station Well. This well is used to irrigate a small portion of lawn where they have been having issues with the iron levels in the water (see Figure 1).

Figure 1. Orange residue buildup on existing piping at Swanton Pacific Ranch.

Notice the brownish orange residue on the pipeline, this is due to the iron levels in the water and is a common side effect to piping with iron contaminated water flowing
through it. The high concentrations of iron in the irrigation water have been causing the sprinklers clog up with the particulate matter the iron forms when it becomes oxidized.

**Objective**

The objective of this project is to solve the iron issues the Swanton Pacific Ranch has been having in their water supply. A remedial pumping system will be designed and constructed at the ranch to help remove the iron from the water. A 2,500 gallon tank, pump with a variable frequency drive, and a 85 gallon bladder tank will be constructed and tested at the Irrigation Training and Research Center’s (ITRC) Water Resources Facility (WRF) to ensure the basic set up will work at the College Station Well at Swanton Pacific Ranch. After the system has been tested at the WRF the system will then be disassembled and transported to the ranch and reassembled for final installation.
LITERATURE REVIEW

Variable Frequency Drives

There are many reasons variable frequency drives are used in irrigation applications. The ITRC at Cal Poly discussed five uses of VFDs in a paper called “Pump Operation with VFD Controlled Motors”. Below is a brief summary of these reasons:

1. Pumps must be designed to match the characteristics of the system. Good engineers will over design a pump so it can produce more pressure than needed for the system. The reason to over design pumps are for the following reasons.
   a. Pump impeller will wear out over time, thus reducing the pressure output and efficiency.
   b. Pump curves are only accurate within certain plus/minus accuracy.
   c. The exact hydraulics of the system will be different than what the engineer designed the system for.
   d. The lift a pump will have to pull the water to start pumping can change over time. The engineer will have to design for the maximum condition.

2. Flow rate requirements of a system may change over time. Extra flow will have to either be bypassed or the extra pressure the pump produces will need to be dissipated. Both of these options increase power consumption of the pump. Using a VFD controlled pump will help reduce energy consumption at periods of low flow.

3. VFDs give operators the ability to fine-tune flow rates when precise control of water levels or pressures is required.

4. The slow start and slow stop capability of VFDs helps minimize water hammer when pumping begins or ends.

5. VFDs help to increase the longevity of well life. Single speed well pump have very high flow rates at start up because the total dynamic head (TDH) is low. This causes rapid drawdown in the casing, thus weaken the pipe and pulling in sand at startup.

Bladder Tanks

Pressure tanks, also known as hydro pneumatic tanks, are used in water supply systems, hot water heating systems and other water systems (Lane, 1989). These tanks provide small amounts of pressurized water in on demand systems when the pump is turned off, or they allow water to expand inside of them to prevent damage to pipes and fittings (Lane, 1989).

The assembly of a pressure tank consists of the tank connected to the system to allow water flow into and out of the tank. The air inside the tank will then compress as it fills with water, thus pressurizing the system (Lane, 1989).

Bladder tanks are simply pressure tanks with some type of bladder/diaphragm that is used to separate the water from the pressurized air. Having the bladder/diaphragm will
prevent air entering the system, causing issues with corrosion in the tank and system, and efficient performance of the system (Lane, 1989).

**Pumps**

Basic knowledge of pumps was researched for this project to better understand and select the appropriate pump required for the application. A pump is a machine with a rotating impeller inside a housing and the rotation of impeller transfer energy in the forms of pressure and velocity to the water (ITRC, 2009). Different combinations of impellers and housings will provide a system with different flow rates and pressures. Opening or closing a discharge valve will cause the pump to flow and pressure outputs to increases or decrease (ITRC, 2009). Pressure and flow rate are inversely related, meaning if the pressure of the system increases the flow rate decreases and vice versa. Regardless of the flow rate and pressure output of the pump, the impeller will still spin at the same speed (ITRC, 2009).

Pumps operate most efficiently within a small range of flow rates, but are also capable of providing other flows rates at a loss of efficiency (ITRC, 2009). The ITRC has two basic steps to selecting the right pump for a particular situation.

1. Determine the required input (total head and corresponding flow rate) for the pumping system, and
2. Find a pump that provides that pressure and flow rate at a high efficiency.

**Types of Flow.** There are many types of pumps for different applications that are classified by their impeller designs. “The three broad categories of impeller designs are radial, axial and mixed flow” (ITRC, 2009).

Radial flow impellers discharge the fluid passing through them at a right angle to the axis of rotation along which the fluid enters. This type of impeller produces a flat head-capacity curve, meaning the pressure increases “relatively” little as the flow output increases. Motor selection must be carefully considered if the system flow rate will ever exceed the design flow rate due to the fact that as flow increases the horsepower required increases. This impeller type is most commonly used in well and booster pumps because they are typically designed for high lift applications (ITRC, 2009).

Axial flow impellers discharge the water parallel to the axis of rotation. Because the water does not change direction this impeller does not create as much pressure as a radial impeller but very large flow rates can be obtained with this type of flow. For this impeller the horsepower decreases as flow rate increases, so motor the motor should be designed to meet conditions of maximum pressure, thus maximum horsepower. This impeller type is used for lifting large flow rates (ITRC, 2009).

Mixed flow impellers are a balance between the radial and axial flow impellers. These impellers discharge the water at an angle of 45-80° towards the horizontal from the axis of rotation. The head developed by this impeller decreases consistently as the flow rate increases. The horsepower required across a range of
flows stays almost constant, so there will be less risk in exceeding the motor’s rated horsepower (ITRC, 2009).

**Total Dynamic Head.** The TDH of a pump is the amount of head pressure that is put out by the pump. There are several factors that need to be considered when calculating the TDH of a pump. These factors include: friction loss along the length of the pipe, minor losses through fittings (i.e. valves, elbow, tees etc.), elevation change, and whether the pump needs to lift the water before pumping or if it is flooded suction.

**Types of Iron**

Iron is present in many different forms in water supplies. Edstrom Industries, Inc. published a short manual called “Iron and Iron Bacteria in Water” that gave the following descriptions for four commonly occurring types of iron in water supplies.

**Ferrous Iron.** The first is dissolved or ferrous iron which is usually found in groundwater supplies that have not been exposed to oxygen. Water that contains ferrous iron will appear to be clear and colorless. When this water is exposed to air, oxygen reacts with the iron to form an insoluble ferric oxide, or “red rust”.

**Undissolved Iron.** Undissolved iron is the insoluble ferric oxide that dissolved iron forms when it reacts with oxygen. It can color the water yellow to reddish-brown. Rust-colored stains that occur in chlorinated swimming pools most likely contain undissolved iron.

**Iron Bacteria.** There are several types of bacteria that grow in water and use dissolved iron as part of their metabolism. The iron is oxidized by these types of bacteria into its insoluble ferric state and cause the following issues: unpleasant odors and taste following the death of the bacteria, increased organic content in the water the bacteria is thriving in, piping clogged with rusty sludge, corroded piping and plumbing equipment, and increased chances of sulfur bacteria infestation.

**Organic Iron.** That last type of iron is organic iron. This is iron that has been combined with organic matter that is picked up as groundwater flows through decaying or decayed vegetation. Organic iron can cause water to appear to be weak tea or coffee.

**Remediation Techniques**

Extensive research has been conducted to find efficient ways of removing the iron from the water source before it can cause problems because of all the issues that these different types of iron in water causes. The Idaho Water Resources Research Institute published a piece of work titled “Iron Bacteria in Water Wells: Maintenance Recommendations and Remediation Techniques” which discusses two steps to successfully remEDIATE iron bacteria from water wells. These steps are: 1) breakup and remove the bacterial mass and other insoluble precipitants and 2) sterilize the well screen, pump and adjacent aquifer area to reduce the remaining residual bacteria population. Following these two steps with the proper methods of remediation should take care of the iron bacteria problems in the water well.
PROCEDURES AND METHODS

System Components

The first step was to order a pump, VFD and a bladder tank. A number of different companies were asked to provide quotes for these three items. Halstead Pump, Inc., Cal West Rain, and Pacific Ag Water, Inc. were the three companies that responded with quotes. Pacific Ag Water gave the least expensive quote for these components and they were chosen to provide them.

Pump Selection. As requested by Dr. Stuart Styles, a pump had to be ordered that will be able to pump 20 gallons per minute (gpm) at a TDH of 70 pounds per square inch (psi). The pump is Goulds 9BF 7.5 horsepower (hp) three phase pump (see Figure 2).

![Goulds 9BF 7.5hp booster pump](image)

Figure 2. Goulds 9BF 7.5hp booster pump.

Variable Frequency Drive. A VFD was required for this design to allow the pump to turn off at a set pressure using a pressure switch upstream of the bladder tank. The brand of the VFD is Aquavar SPD™ (see Figure 3). The frame size of the VFD used is frame size 3 (see Appendix C for the instruction manual). The VFD requires a single phase power source and converts it to three phase to power the pump.

![Aquavar SPD™ variable frequency drive](image)

Figure 3. Aquavar SPD™ variable frequency drive.
**Bladder Tank.** An 85 gallon bladder tank (see Figure 4) was required to help shut the pump off when a set pressure in the line was reached. The pressure tank was pressurized to about 70psi. It was plumbed in just downstream of the pump with a pressure gage and pressure switch upstream of it.

![Figure 4. 85 gallon PRO-Source® Bladder Tank.](image)

The instruction manual for the bladder tank gave a good explanation and illustration of how the bladder tank operates (see Figure 5). The full manual can be found in Appendix D.

**OPERATING CYCLE**

1. Tank nearly empty – air expands filling area above vinyl water cell (Fig. 2A).
2. Water begins to enter tank – air is compressed above water cell as it fills with water (Fig. 2B).
3. Pump-up cycle completed – air now compressed to cut off setting of pressure switch (Fig. 2C).
4. Water being drawn from tank – compressed tank air forces water out of water cell (Fig. 2D).
5. Water cell completely empty – new cycle ready to begin (Fig. 2A).

![Figure 2](image)

**Figure 5.** Operating cycle of the bladder tank (see Appendix D).
Construction Procedure at the Water Resources Facility

The construction of the system was broken up into two parts. First, the system was set up and tested at the WRF that the ITRC operates. The purpose of this was to set up the VFD and make sure the pump was able to provide 20gpm at 70psi.

**Electrical.** The first step of getting the VFD operational was to provide power to it. In the shop at the WRF there is a 240 volt power source, so an extension cable with a dryer type plug on it was wired to the VFD panel. Twenty-five feet of 8-gage 4-wire cable was purchased to provide power from the VFD to the pump. The last electrical concern was to set up the VFD.

Section 7 of the manual is the section on how to set up the VFD. The first thing that had to be done was to set the motor overload percentage. The manual instructed that the motor overload must not exceed 50% for single phase input power, so the motor overload was set to 50%.

The final step was to set the shut off pressure. The pressure switch (see Figure 6) was installed upstream of the bladder tank and it is wired into the VFD. There are two factory preset system pressures, SP1 and SP2. SP1’s preset pressure is 50psi and SP2’s preset pressure is 75psi with SP1 as the default system pressure. The default system pressure was changed to SP2. This pressure can be adjusted up or down, but 75psi was sufficient.

![Figure 6. Pressure switch and 160psi pressure gage upstream of bladder tank.](image)

**Piping.** The piping used for the test set up was mostly schedule 40 PVC. The only schedule 80 pieces used were the 2in and 1in couplings just upstream and downstream of the pump, respectively and the 1-1/4in coupling upstream of the bladder tank. These couplings were used so the pump and bladder tank can easily be disconnected from the
system if any maintenance is required in the future. Appendix B includes tables of the plumbing parts list for the test setup at the WRF.

A valve manifold (see Figure 7) had to be constructed with four different valves to provide water to various parts of the irrigation system at Swanton Pacific Ranch. Galvanized steel pipe was chosen to be used because this manifold will be installed above ground.

![Figure 7. Final assembly of valve manifold.](image)

Two inch PVC schedule 40 pipe was used; this was to ensure a velocity below 5ft/s. Equations 1 and 2 below are the velocity calculations at 20 and 30gpm.

\[
\text{(1)} \quad \text{------} \quad \text{-----}
\]

\[
\text{------} \quad \text{-----} \quad \text{(2)}
\]

These velocities are appropriate for each flow rate.

**Final Test Setup.** After all the piping was glued together the storage tank was filled with water. The VFD and pump were turned on using the breaker the plug was connected to. Once the VFD warmed up, the pump turned on. The middle two gate valves on the manifold were fully closed, while the two outside ones were adjusted to change the flow rate and pressure of the pump. The steps for adjusting the VFD settings that were discussed above were followed until the desired shut off pressure was achieved.

There was an issue with the VFD not shutting off the pump when the shut off pressure was reached. Matt Hart from Pacific Ag Water was called to help solve this problem.
The issue turned out to be that the preset pressure in the bladder tank was too far from the set shut off pressure on the VFD of 75psi. An air compressor was used to fill the tank up to about 70psi. The VFD and pump were turned on again and the valve on the manifold was closed all the way and the pump shut off. When the valve was opened again, the system pressure dropped below the shut off pressure and the pump turned back on. The bladder tank prevents the pressure dropping too much because of the 70psi air pressure inside. Figure 8 is a picture of the final test setup.

![Figure 8. Final test setup at the WRF.](image)

Construction Procedure at Swanton Pacific Ranch

In the fall of 2012 the BRAE 433 concrete design class poured the concrete slab that this system is set up on. Also a new 50amp power supply was wired into the existing gutter box to provide power to the VFD and pump (see Figure 9).

![Figure 9. Pre-system installation with new concrete slab and new power supply.](image)
Shortly after the testing was done at the WRF, the system was transported up to the College Well Station for final installation. The VFD was mounted next to the existing gutter box and power supply (see Figure 10).

![Mounted VFD next to gutter box.](image)

**Figure 10. Mounted VFD next to gutter box.**

**Electrical.** A new outlet to fit the 240V dryer plug had to be installed in the gutter box at the College Well Station. During initial testing the main disconnect for the newly installed 240V outlet was shutoff then the dryer plug was plugged in. When the pump was ready to turn on the main disconnect was turned back on.

**Piping.** It was decided to use 2 inch galvanized steel piping for the final setup at the College Well Station because the system will be above ground. Two inch foam pipe insulation was wrapped around the above ground pipes to prevent the water from freezing in the pipes and potentially breaking fittings during winter months.

The discharge of the pump goes to an underground 2in. PVC pipe that runs about 200ft to the inlet of the valve manifold. There the three valves will provide water to different blocks of the irrigation system. Appendix B includes tables of the plumbing parts list for the test setup at the WRF and the final setup at the College Well Station.

Pipe dope was applied to all pipe threads before threading them together to ensure no leaking. After the plumbing was finished the system was turned on. One of the valves on the manifold was closed all the way to check that VFD will shut off the pump when the system pressure reaches the shut off pressure. When the pump shut off the valve was opened again and the VFD turned the pump back on as expected. Refer to Figure 11 for a picture of the final installation.
Figure 11. Final assembly of the system.
RESULTS

After an initial test setup at the WRF the system was installed at the College Well Station at Swanton Pacific Ranch (see Figure 12). A VFD controller, a booster pump and bladder tank were installed to irrigation a small turf field. The existing well pump fills the large storage tank that the booster pump uses as a water supply. The VFD allows the pump to turn off when the system is not running via a pressure transducer. When a valve is opened to start irrigating the VFD turns on the pump. After the irrigation is completed the valve will be closed and the pump will shut off.

Figure 12. New system set up at the College Well Station at Swanton Pacific Ranch.

There was a concern that the VFD and pump will pull too much current and trip the 50amp break that the entire site is connected to. A current test was conducted to determine how much current the new pump pulls during operation. The current was measured at several different flow rates. Table 1 shows the results of this test.

Table 1. Current test results for the pump.

<table>
<thead>
<tr>
<th>Flow rate (gpm)</th>
<th>Current (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>48</td>
<td>14</td>
</tr>
</tbody>
</table>

As the table shows, the pump had a maximum current of 14amps at a flow rate of 48gpm. The system will not require more than 48gpm so these results confirm that the pump’s current requirement will not be an issue. Another current measurement was done to measure the current requirement when both pumps are running. The maximum current
that was measured was 40amps. This is well below the 50amp breaker so there will not be an issue of the breaker tripping if both pumps are running at the same time.

Electrical pumps only run at a single speed, thus they are only allows to operate on a single pump curve. A VFD changes the speed of a pump, allowing it to operate on different pump curves. The pump curve for the booster pump was acquired from the technical brochure (Appendix D).

The system was set up to operate at 70psi (161.7ft TDH). If the pump did not have a VFD, when the flow rate decreases the TDH will increase, and vice versa, along the specific curve the pump operates on. However; with a VFD, when the flow rate decreases the VFD will adjust the speed of the pump so that the required amount of TDH is still available. An analysis of how the VFD changed the operation of the pump in reference to the pump curve was done (see Figure 13).

![Figure 13. Potential curves the VFD allows the pump to operate on (see Appendix D).](image)

The blue line represents a constant TDH of 161.7ft and the red curves represent potential operating curves that the VFD provides to the pump. The yellow dots are points where the pump can potentially operate at.
DISCUSSION

Three companies were contacted to request quotes for the pump, VFD and bladder tank: Halstead Pump, Inc., Pacific Ag Water and Cal West Rain. There was a miscommunication with the Halstead Pump, Inc. quote. The contact from the company was not clear on what was needed for the application and quoted a vertical turbine pump instead of a centrifugal booster pump. Had a specification drawing been provided, this issue could have been avoided.

During the initial setup there was an issue with the pump not shutting down when the system got to the shut off pressure of the VFD. The vendor of the bladder tank was called to help troubleshoot this issue. It turned out that the air pressure in the bladder tank was too low. An air compressor was used to increase the pressure in the tank to 70psi. After this was done the pump was finally able to shut off at the right pressure.

There were some minor difficulties with troubleshooting the VFD. One particular difficulty was when the pump was running fine then suddenly stopped running. The red indicator light turned on and started blink twice. The instruction manual was consulted and it was determined that that particular error signal indicates the pump losing prime, meaning there is no more water for the pump to pump.
RECOMMENDATIONS

There are still more steps that need to be completed that was not in the scope of the project. A meeting with the electrician that was hired to help with this project was conducted at the College Well Station after the pump, VFD, and bladder tank were installed. The meeting was to check how many amps the pump was pulling as well as how many amps the whole site was pulling, as discussed in the results section. The other reason for the meeting was to discuss what additional things that needed completed by the electrician. The list of what the electrician will be doing is below.

1. Install an underground conduit from the motor to the VFD. A longer pressure transducer cable will be spliced into the existing one and it will be zipped tied to the pump cable and ran through the conduit.
2. The power to the VFD will be piped directly into the gutter box.
3. The existing 240V outlet will be replaced with a 120V service outlet.
4. A 240V to 24V transformer will be installed inside the gutter box. This will be used to provide power to the solenoid operated valve that will be installed at the top of the storage tank. The cable will go through ½” pipe underground to the base of the tank, and then it will be zipped tied to the 2” PVC pipe up to the solenoid valve.
5. A mercury float switch will be placed inside the tank and connected to the solenoid valve. This will allow the tank to be filled when the water level drops below where the float switch is placed.
REFERENCES


APPENDIX A

HOW SENIOR PROJECT MEETS THE REQUIREMENT FOR THE BRAE MAJOR
Major Design Experience

The project must incorporate a major design experience. Design is the process of devising a system, component, or process to meet specific needs. The design process typically includes the following fundamental elements.

Establishment of Objectives and Criteria. The project objectives and criteria were established by Dr. Stuart Styles.

Synthesis and Analysis. The project will incorporate pump TDH calculations and friction loss calculations, also evaluation of iron removal techniques.

Construction, Testing and Evaluation. The pump and piping will be constructed and tested at the ITRC Water Resources Facility and then installed at Swanton Pacific Ranch.

Incorporation of Applicable Engineering Standards. Standard irrigation design principles will be used.

Capstone Design Experience

The engineering design project must be based on the knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses).

BRAE 151 AutoCAD
BRAE 312 Water Hydraulics
BRAE 414 Irrigation Engineering
ENGL 149 Technical Writing

Design Parameters and Constraints

The project addresses a significant number of the categories of constraints listed below.

Physical. The remediation system must fit on a 10.5’ x 20.5’ concrete slab

Economic. The budget is $6,000 (including the slab and pipeline that have been installed at a cost of $1,500).

Environmental. N/A

Sustainability. This project is designed to help with the long term sustainability of the well water used at Swanton Ranch.

Manufacturability. N/A

Health and Safety. N/A

Ethical. N/A

Social. N/A

Political. N/A
**Aesthetic.** The pipes and valves will be insulated to make the final product look professional and protect from freezing.
APPENDIX B

PLUMBING PARTS LIST
<table>
<thead>
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<th>Part</th>
<th>Quantity</th>
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</tr>
<tr>
<td>2in. x 8in. galvanized nipple</td>
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<tr>
<td>2in. x 12in. galvanized nipple</td>
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</tr>
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<td>1/4in. x 1in. galvanized nipple</td>
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</tr>
<tr>
<td>1in. x 3in. PVC Sch. 80 nipple</td>
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</tr>
<tr>
<td>2in. galvanized tee</td>
<td>3</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 slip tee</td>
<td>1</td>
</tr>
<tr>
<td>2in. x 2in. x 1/2in. PVC Sch. 40 slip tee</td>
<td>1</td>
</tr>
<tr>
<td>1/2in. PVC Sch. 40 slip tee</td>
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</tr>
<tr>
<td>2in. galvanized elbow</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 elbow</td>
<td>9</td>
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<td>2in. x 1in. galvanized bushing</td>
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</tr>
<tr>
<td>2in. x 1-1/4in. PVC Sch. 40 bushing SPGxS</td>
<td>1</td>
</tr>
<tr>
<td>2in. x 1in. PVC Sch. 40 bushing SPGxS</td>
<td>1</td>
</tr>
<tr>
<td>1/2in. x 1/4in. PVC Sch. 40 bushing SPGxMPT</td>
<td>2</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 female adapter SxFPT</td>
<td>4</td>
</tr>
<tr>
<td>2in. compression coupling</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>1in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>2in. gate valve</td>
<td>4</td>
</tr>
<tr>
<td>1/4in. ball valve</td>
<td>1</td>
</tr>
<tr>
<td>1in. air vent</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 pipe</td>
<td>about 22ft</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 40 pipe</td>
<td>about 2ft</td>
</tr>
<tr>
<td>Part</td>
<td>Quantity</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>2in. x 6 in. galvanized nipple</td>
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</tr>
<tr>
<td>2in. x 8in. galvanized nipple</td>
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<tr>
<td>2in. x 12in. galvanized nipple</td>
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</tr>
<tr>
<td>1/4in. x 1in. galvanized nipple</td>
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</tr>
<tr>
<td>1in. x 3in. PVC Sch. 80 nipple</td>
<td>1</td>
</tr>
<tr>
<td>2in. galvanized tee</td>
<td>5</td>
</tr>
<tr>
<td>2in. galvanized elbow</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 elbow</td>
<td>5</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 40 elbow SxMPT</td>
<td>1</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 40 elbow SxS</td>
<td>1</td>
</tr>
<tr>
<td>2in. x 1in. galvanized bushing</td>
<td>1</td>
</tr>
<tr>
<td>2in. x 1in. PVC Sch. 40 bushing SPGxS</td>
<td>1</td>
</tr>
<tr>
<td>1/2in. x 1/4in. PVC Sch. 40 bushing SPGxMPT</td>
<td>2</td>
</tr>
<tr>
<td>2in. galvanized adapter</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 male adapter MPTxS</td>
<td>4</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 female adapter SxFPT</td>
<td>4</td>
</tr>
<tr>
<td>2in. x 1-1/4in. galvanized reducer</td>
<td>1</td>
</tr>
<tr>
<td>2in. galvanized coupling</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>1in. PVC Sch. 80 coupling</td>
<td>1</td>
</tr>
<tr>
<td>2in. gate valve</td>
<td>4</td>
</tr>
<tr>
<td>2in. ball valve</td>
<td>1</td>
</tr>
<tr>
<td>1/4in. ball valve</td>
<td>1</td>
</tr>
<tr>
<td>2in. check valve</td>
<td>1</td>
</tr>
<tr>
<td>2in. magnetic flow meter</td>
<td>1</td>
</tr>
<tr>
<td>1in. air vent</td>
<td>1</td>
</tr>
<tr>
<td>2in. PVC Sch. 40 pipe</td>
<td>approx. 5ft</td>
</tr>
<tr>
<td>1-1/4in. PVC Sch. 40 pipe</td>
<td>approx. 2ft</td>
</tr>
<tr>
<td>2in. foam pipe insulation</td>
<td>approx. 12ft</td>
</tr>
</tbody>
</table>
APPENDIX C

INSTRUCTION MANUAL FOR VARIABLE FREQUENCY DRIVE
Aquavar SPD™
Variable Speed Pump Control
INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS
INDEX

Important Safety Instructions ...........................................................................................................................3
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Input and Output Functions (Control Terminals) ...........................................................................................19
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NOTE:

- Use Copper wire only.
- Suitable for use in a pollution degree 2 micro-environment.
- Motor overload protection provided at 100% of full load current.
- In order to maintain the environmental rating integrity of the enclosure, all openings must be closed by equipment rated 3, 3R, 3S, 4, 4X, 6 or 6P.
- Maximum Ambient temperature range: -22°F to 122°F.
- Maximum Humidity: 95% at 104°F non-condensing.
- Controller is rated TYPE 3R (Raintight) so it may be located outdoors.
SAFETY INSTRUCTIONS

Section 1

Important: Read all safety information prior to installation of the Controller.

NOTE

This is a SAFETY ALERT SYMBOL. When you see this symbol on the controller, pump or in this manual, look for one of the following signal words and be alert to the potential for personal injury or property damage. Obey all messages that follow this symbol to avoid injury or death.

DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION Used without a safety alert symbol indicates a potentially hazardous situation which, if not avoided, could result in property damage.

NOTE Indicates special instructions which are very important and must be followed.

NOTE

All operating instructions must be read, understood, and followed by the operating personnel. CentriPro accepts no liability for damages or operating disorders which are the result of non-compliance with the operating instructions.

1. This manual is intended to assist in the installation, operation and repair of the system and must be kept with the system.

2. Installation and maintenance MUST be performed by properly trained and qualified personnel.

3. Review all instructions and warnings prior to performing any work on the system.

4. Any safety decals MUST be left on the controller and/or pump system.

5. DANGER Hazardous Voltage The system MUST be disconnected from the main power supply before attempting any operation or maintenance on the electrical or mechanical part of the system. Failure to disconnect electrical power before attempting any operation or maintenance can result in electrical shock, burns or death.

6. CAUTION Hazardous Pressure When in operation, the motor and pump could start unexpectedly and cause serious injury.
SYSTEM COMPONENTS

Section 2

Please review the SPD components and insure that you have all the parts and are familiar with their names. Be sure to inspect all components CentriPro supplies for shipping damage.

SPD Variable Speed Controller:
1. SPD Controller
2. Pressure Transducer with Cable
3. Conduit Plate Caps

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DO NOT</strong> power the unit or run the pump until all electrical and plumbing connections, especially the pressure sensor connection, are completed. The pump should not be run dry. All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code (CEC) as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector or code enforcement agency. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury, death, damage to equipment, unsatisfactory performance and may void manufacturer’s warranty.</td>
</tr>
</tbody>
</table>

Controller Product Code Information

- **SPD**
- **Y**
- **XXXX**
- **F**

**F = with Output Filter for Submersible Pump Applications**
**BLANK = without Filter for Above Ground/Centrifugal Pump Applications.**

- 4 Digits for HP
  - 5 HP = 0050
  - 7.5 HP = 0075
  - 10 HP = 0100
  - 15 HP = 0150
  - 20 HP = 0200
  - 25 HP = 0250
  - 30 HP = 0300

- 1 Digit for Input Voltage
  - 230 volt = 2
  - 460 volt = 4
  - 575 volt = 5

SERIES
**NOTE**

Systems **MUST** be designed by qualified technicians only and meet all applicable state and local code requirements.

The following diagrams show a typical system using the SPD_F with Filter, Constant Pressure Controller. Diagram #1 shows a typical set up for a submersible system.

1. SPD_F CONTROLLER
2. FUSIBLE DISCONNECT
3. PRESSURE GAUGE
4. AIR DIAPHRAGM TANK
5. PRESSURE TRANSDUCER
6. 3 PHASE OUTPUT (ALWAYS)
7. DISCHARGE CHECK VALVE
8. GATE VALVE (HIGHLY RECOMMENDED)
9. SUBMERSIBLE PUMP END
10. SUBMERSIBLE MOTOR (3 PHASE)
11. PRESSURE RELIEF VALVE

**NOTE:** FOR SINGLE PHASE INPUT, CONNECT L1 AND L3, THEN SET MOTOR OVERLOAD SWITCHES TO 50% OF CONTROLLER RATING OR LOWER.
Diagram #2 shows a set-up for municipal water connection.

NOTES: For single phase input power, use L1 and L3 terminals and adjust motor overload switches to 50% of controller rating or lower.
Section 4

General

**NOTE**

All plumbing work must be performed by a qualified technician. Always follow all local, state and provincial codes.

A proper installation requires a pressure relief valve, a ¼” female N.P.T. threaded fitting for the pressure sensor, and properly sized pipe. Piping should be no smaller than the pump discharge and/or suction connections. Piping should be kept as short as possible. Avoid the use of unnecessary fittings to minimize friction losses.

*CAUTION*

Some pump and motor combinations supplied with this system can create dangerous pressure. Select pipe and fittings accordingly per your pipe suppliers’ recommendation. Consult local codes for piping requirements in your area.

All joints must be airtight. Use Teflon tape or another type of pipe sealant to seal threaded connections. Please be careful when using thread sealant as any excess that gets inside the pipe may plug the pressure sensor.

Galvanized fittings or pipe should never be connected directly to the stainless steel discharge head or casing as galvanic corrosion may occur. Barb type connectors should always be double clamped.

**Pressure Tank, Pressure Relief Valve and Discharge Piping**

Use only “pre-charged” tanks on this system. Do not use galvanized tanks. Select an area that is always above 34°F (1.1°C) in which to install the tank, pressure sensor and pressure relief valve. If this is an area where a water leak or pressure relief valve blow-off may damage property, connect a drain line to the pressure relief valve. **Run the drain line from the pressure relief valve to a suitable drain or to an area where water will not damage property.**

**Pressure Tank, System Pressure**

**Sizing** - A diaphragm tank (not included) is used to cushion the pressure system during start-up and shut-down. It should be sized to at least 20% of the total capacity of your pump. Example: If your pump is sized for 100 GPM then size your tank for at least 20 gal. total volume, not draw down. Pre-charge your bladder tank to 10-15 PSI below your system pressure. The controller is pre-set for 50 PSI at the factory. Therefore a 35-40 PSI pre-charge in your tank would be required. Use the higher tank pre-charge setting if the system drifts over 5 PSI at a constant flow rate. **NOTE: Pre-charge your tank before filling with water!**

*CAUTION*

Maximum working pressure of HydroPro diaphragm tank is 125 psi.

**Installing the Pressure Sensor**

The pressure sensor requires a ¼" FNPT fitting for installation. Install the pressure sensor with the electrical connector pointing up to avoid clogging the pressure port with debris. Install the pressure sensor in a straight run of pipe away from elbows or turbulence. For optimum pressure control install the pressure sensor in the same straight run of pipe as the pressure tank. Ensure the pressure sensor is within 10ft of the pressure tank. Installing the pressure sensor far away from the pressure tank may result in pressure oscillations. **Do not install the pressure sensor in a location where freezing can occur.** A frozen pipe can cause damage to the pressure sensor.
Section 4 (continued)

The pressure sensor cable is prewired to the controller. The cable can be shortened for a cleaner installation. Longer cable lengths are available, consult factory. Maximum recommended pressure sensor cable length is 300ft. Avoid leaving a coil of pressure sensor cable as this can induce unwanted transient voltages and noise into the system. Do not run the pressure sensor cable alongside the input or output wiring. Maintain a distance of at least 8” between the pressure sensor cable and input or output wiring.

Ensure the pressure sensor cable is connected as follows: Brown to terminal 7 (24VDC SUPPLY), White to terminal 6 (TRANSUDER INPUT), Drain to chassis. Connecting the Drain wire to the chassis electrically connects the sensor case to the chassis of the controller. In some cases this drain wire must be disconnected from the controller chassis. In cases where the there is grounded metal piping which is continuous between the transducer and the motor or the transducer is installed in grounded metal piping, a ground loop can result so the drain wire must be disconnected from the chassis. In cases where there are sections of nonmetallic piping between the transducer and motor or the transducer is installed in ungrounded piping this drain wire should be connected to the controller chassis.

Mounting the controller

Section 5

General
Mount the controller in a well ventilated, shaded area using 4 screws. The controller must be mounted vertically. Be sure to leave 8 inches of free air space on every side of the unit. The controller must be in an area with an ambient between -22°F and 122°F. If installation is above 3300 feet above sea level, ambient temperatures are derated 1% per 330 feet above 3300 feet. The altitude limit for this controller is 6500 ft. Do not install above 6500 ft.

NOTE
Do not block the heat sink (fins) or fans and do not set anything on the units.

WARNING

The controller access cover should always be securely fastened to the control box due to the dangerous voltage/shock hazard inside the unit. A lock can be used to prevent unwanted entry.
Section 6

Power Supply

NOTE

Installation and maintenance MUST be performed by properly trained and qualified personnel. Always follow the National Electrical Code (NEC) or Canadian Electric Code (CEC), as well as all state, local and provincial codes when wiring the system.

The type of transformer and the connection configuration feeding a drive plays an important role in its performance and safety. The following is a brief description of some of the more common configurations and a discussion of their virtues and shortcomings. Always ask what type of power system the site has before sizing the drive.

Delta/Wye with grounded Wye neutral

This configuration is one of if not the most common. It provides rebalancing of unbalanced voltage with a 30 degree phase shift. Depending on the output connections from the drive to motor, the grounded neutral may be a path for common mode current caused by the drive output.

Delta/Delta with grounded leg

Another common configuration providing voltage rebalancing with no phase shift between input and output. Again, depending on the output connections from the drive to motor, the grounded neutral may be a path for common mode current caused by the drive output.

In this case the line to ground voltage on the phases that are not grounded will be equal to the phase to phase voltage. This voltage can exceed the voltage ratings of the EMC filter and input MOV protection devices. This can cause catastrophic controller failure if the line to ground EMC filter and input MOV protection devices are not disconnected. Refer to Disconnecting EMC Filter and MOVs for details on line to ground voltage limitations and disconnecting these devices.

WARNING

If the secondary of the transformer is a delta with a grounded leg (corner grounded delta), the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result.
Grounding of the transformer secondary is essential to the safety of personnel as well as the safe operation of the drive. Leaving the secondary floating can permit dangerously high voltages between the chassis of the drive and the internal power structure components. In many cases this voltage could exceed the rating of the EMC filter and input MOV protection devices of the drive causing a catastrophic failure. In all cases, the input power to the drive should be referenced to ground. If the transformer cannot be grounded, then an isolation transformer must be installed with the secondary of the transformer grounded.

In this configuration the line to ground voltage from the incoming power supply may exceed the voltage rating of the line to ground EMC filter components and line to ground MOV protection. This can cause catastrophic controller failure if the line to ground EMC filter and input MOV protection devices are not disconnected. Refer to Disconnecting EMC Filter and MOVs for details on line to ground voltage limitations and disconnecting these devices.

### WARNING

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous voltage</td>
</tr>
</tbody>
</table>

If a power system with an ungrounded secondary is used, the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result.

### Resistance grounding and ground fault protection

Connecting the Wye secondary neutral to ground through a resistor is an acceptable method of grounding. Under a short circuit secondary condition, any of the output phases to ground will not exceed the normal line to line voltage. This is within the rating of the MOV input protection devices on the drive. The resistor is often used to detect ground current by monitoring the associated voltage drop. Since high frequency ground current can flow through this resistor, care should be taken to properly connect the drive motor leads using the recommended cables and methods. In some cases, multiple drives on one transformer can produce a cumulative ground current that can trigger the ground fault interrupt circuit.
This type of configuration is common on 230 volt systems. From time to time it may be encountered where only single phase power is available and three-phase power is required. The technique uses two single phase transformers to derive a third phase. When used to power a drive this configuration must be derated to about 70% of the single phase rating of one transformer. This system provides poor regulation and it is possible that only the two line connected phases will provide power. In this case the drive must be derated to 50 % of its rating. (Ex. A 20 HP 230 volt drive now becomes a 10 HP 230 volt drive.)

### WARNING

“Open Delta” power systems should be sized using the 50% derate factor. Consult factory.

**Disconnecting EMC Filter and MOVs**

For all controllers, if the line to ground voltage from the incoming power supply is greater than 300Vac then the line to ground EMC filter components must be disconnected as described below. For 230V controllers, if the line to ground voltage from the incoming power supply exceeds 300Vac then the line to ground MOVs must be disconnected as described below. For 460V controllers, if the line to ground voltage from the incoming power supply exceeds 550Vac then the line to ground MOVs must be disconnected as described below.

To disconnect the line to ground EMC filter components, locate the jumper shown below. The jumper is on the left hand side of the controller on the main board. Move to the disconnected position shown to the right.

To disconnect the line to ground MOV protection, locate the jumper shown below. The jumper is located between the input and output terminal blocks on the main board. Move to the position shown.

**For Frame Size 1 Controllers:**

**For Frame Sizes 2 and 3 Controllers:**
### Single Phase Connection

For small drives with diode rectifier front end it is possible to run a three phase output with a single phase input. Only part of the three phase input bridge is used. Ripple current becomes 120 Hz rather than 360. This places a greater demand on the DC filter components (capacitor bank and DC choke). The result is that the drive must be derated to 50% current.

The chart below shows the full load output current ratings of the controller when single phase or 3 phase power is used. If single phase input power is used the Motor Overload switches must be set to 50% or lower.

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>Frame Size</th>
<th>Model Number</th>
<th>Nominal HP Rating</th>
<th>Controller Full Load Output Current Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>208/230</td>
<td>1</td>
<td>SPD20050</td>
<td>5.0</td>
<td>SPD20050F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20050F</td>
<td>2.0</td>
<td>17.8</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPD20075</td>
<td>7.5</td>
<td>SPD20075F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20075F</td>
<td>3.0</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20100</td>
<td>10.0</td>
<td>SPD20100F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20100F</td>
<td>5.0</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPD20150</td>
<td>15.0</td>
<td>SPD20150F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20150F</td>
<td>7.5</td>
<td>47.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20200</td>
<td>20.0</td>
<td>SPD20200F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20200F</td>
<td>10.0</td>
<td>60.6</td>
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<td></td>
<td>4</td>
<td>SPD20250</td>
<td>25.0</td>
<td>SPD20250F</td>
</tr>
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<td></td>
<td>SPD20250F</td>
<td>12.0</td>
<td>76.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20300</td>
<td>30.0</td>
<td>SPD20300F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20300F</td>
<td>15.0</td>
<td>94.0</td>
</tr>
<tr>
<td>460</td>
<td>1</td>
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<td>5.0</td>
<td>SPD40050F</td>
</tr>
<tr>
<td></td>
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<td>SPD40050F</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td>SPD40075F</td>
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<td></td>
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<td>13.2</td>
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<td></td>
<td>2</td>
<td>SPD40100</td>
<td>10.0</td>
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<td>15.0</td>
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<td></td>
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<td>23.7</td>
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<td></td>
<td>3</td>
<td>SPD40250</td>
<td>25.0</td>
<td>SPD40250F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40250F</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40300</td>
<td>30.0</td>
<td>SPD40300F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40300F</td>
<td>47.0</td>
<td></td>
</tr>
</tbody>
</table>
Conduit, Wire and Fuse Sizing

The use of metal conduit with metal conduit connectors is recommended for all electrical connections. Use the NEC or CEC to determine the required conduit size for the application.

Refer to the chart below for the minimum allowable wire size for each controller. Note that these wire sizes are not adjusted for voltage drop due to long cable lengths. Refer to the wire sizing chart in the appendix to determine the maximum length for the input cable. Refer to the motor manual for maximum output cable length. The maximum recommended voltage drop on both input and output cable combined is 5%. Standard wire sizing charts give maximum cable lengths for only input or output cables. Because of this the lengths given in the table must be adjusted so the total voltage drop does not exceed 5%. For example, if the input wire sizing chart in the appendix gives the maximum length of 400’ and only 100’ is used then only 25% of the total voltage drop (1.25% drop) is used. The maximum output cable length read from the motor’s wire sizing chart must then be adjusted to 75% of its value so that the maximum voltage drop of 5% is not exceeded.

Use only fast acting class T fuses. The wire used for the input power connections on models SPD20300 and SPD20300F must have a temperature rating of 90°C minimum. All other wire must be rated 75 °C minimum. The chart below shows the recommended sizes for wire and fuses for each controller. Note that the wire sizes were not adjusted for voltage drop due to long cable lengths.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Frame Size</th>
<th>Model Number</th>
<th>Full Load Output Current</th>
<th>Nominal HP</th>
<th>Fuse Size</th>
<th>Generator Size (VA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>208/230</td>
<td>1</td>
<td>SPD20050</td>
<td>17.8</td>
<td>5.0</td>
<td>30.0</td>
<td>7700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20050F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPD20075</td>
<td>26.4</td>
<td>7.5</td>
<td>40.0</td>
<td>11400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20075F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20100</td>
<td>37.0</td>
<td>10.0</td>
<td>50.0</td>
<td>16000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20100F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>460</td>
<td>1</td>
<td>SPD40050</td>
<td>8.9</td>
<td>5.0</td>
<td>15.0</td>
<td>7700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40050F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40075</td>
<td>13.2</td>
<td>7.5</td>
<td>20.0</td>
<td>11400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40075F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPD40100</td>
<td>18.5</td>
<td>10.0</td>
<td>30.0</td>
<td>16000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40100F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40150</td>
<td>23.7</td>
<td>15.0</td>
<td>40.0</td>
<td>20500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40150F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40200</td>
<td>30.3</td>
<td>20.0</td>
<td>50.0</td>
<td>26200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40200F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPD40250</td>
<td>37.5</td>
<td>25.0</td>
<td>60.0</td>
<td>32400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40250F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40300</td>
<td>47.0</td>
<td>30.0</td>
<td>70.0</td>
<td>40600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40300F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Input Power and Line Transformer Requirements**

The line input voltage and transformer power must meet certain phase and balance requirements. If you or your installing electrical contractor is in doubt of the requirements, the following provide guidelines for installation. When in doubt contact the local power utility or the factory.

Before connecting power to the controller measure the line to line and line to ground voltage from the power source. The line to line voltage must be in the range of 195Vac to 265Vac (230V +/- 15%) for 230V models and 391Vac to 529Vac (460V +/- 15%) for 460V models. The maximum phase to phase imbalance is +/- 3%. If the phase to phase imbalance is greater than +/- 3% then an isolation transformer may be necessary. The line to ground voltage must be less than 110% of the nominal (230V or 460V) line to line voltage. If the line to ground voltage is not in this range the EMC filter and MOV components may need to be removed (see section on “Ungrounded secondary” transformers) or an isolation transformer with a grounded secondary may be necessary.

If an isolation transformer is used, the best choice is ONE three phase, six winding transformer. A delta primary is best for third harmonic cancellation. A wye secondary avoids circulating current problems and provides the very desirable option of grounding the secondary neutral for minimum voltage stress and ripple to ground. The transformer should have a KVA rating at least 1.1 times the maximum connected HP. A K factor of 6 is sufficient if transformer impedance is greater than 2%. A K Factor of 5 is sufficient if transformer impedance is greater than 3%. The transformer manufacturer may provide derating for non K Factor rated transformers to operate at the drive produced K Factor levels.

Other transformer configurations are acceptable. **Three single phase transformers can be used if they are identical for phase to phase symmetry and balance.** A wye connected primary neutral should never be grounded. Great care should be taken with delta primary delta secondary configurations. Any lack of phase to phase symmetry could result in circulating currents and unacceptable transformer heating.

**WARNING**

Never use phase converters with drives as nuisance tripping and possible damage may occur. Instead, use single phase input power and 50% derate factor.

**STARTING THE SYSTEM**

**Section 7**

**Output Power Connections**

Run the motor lead wire from the motor or conduit box through metal conduit to the bottom of the controller. Use metal conduit and metal conduit connectors. Size the conduits according to the NEC, CEC or local codes. Connect conduit and insert the wires through the second or third opening from the left. Choose the opening that fits or is larger than the conduit used. If the opening is larger than the conduit, use conduit bushings to attach the conduit to the controller.

Consult motor manual to determine the wire size for the application. Ensure the ground connection to the motor is continuous. Connect wires to the output terminal block labeled T1/U, T2/V, T3/W, and GND/. Connect the ground wire to the terminal labeled GND/. Connect the other phase leads to T1/U, T2/V and T3/W.

For CentriPro Motors, connecting T1/U to Red, T2/V to Black and T3/W to Yellow will give the correct rotation.
Starting the System

Section 7 (continued)

**DANGER**

The controller has high leakage current to ground. The output terminals marked “GND” or “GND” must be directly connected to the motor ground. Failure to properly ground the controller or motor will create an electrical shock hazard.

**Input Power Connections**

**DANGER**

Make sure disconnect switches or circuit breakers are securely in the OFF position before making this connection. Run the input power wires from the fused disconnect through metal conduit to the bottom of the controller. Use metal conduit and metal conduit connectors. Size the conduits according to the NEC, CEC or local codes. Use the wire sizing chart in the appendix to determine the size of the input power wires. Connect the conduit and insert the wires into the far left opening on the controller. Connect wires to the “INPUT” terminal block. Connect the ground wire to the terminal labeled GND. For three phase input, connect the input phase wires to L1, L2 and L3. For single phase input, connect the input wires to L1 and L3. If single phase input is used the motor overload switches must be set to 50% or lower.

**CAUTION**

The wire used for input power connections on models SPD20300 and SPD20300F must have a temperature rating of 90°C minimum.

**DANGER**

The controller has a high leakage current to ground. The input terminals marked “GND” must be directly connected to the service entrance ground. Failure to properly ground the controller or motor will create an electrical shock hazard.

**NOTE**

If single phase input power is used the Motor Overload switches must be set to 50% or lower or nuisance input phase loss errors can result.

**NOTE**

Do not use GFCI protection with this controller. Nuisance tripping will result.

**DANGER**

Status Code Indicator Light is not a voltage indicator! Always turn off disconnect switch and circuit breaker and wait 5 minutes before servicing.

**DANGER**

The controller will remain electrically charged for 5 minutes after power is turned off. Wait 5 minutes after disconnecting power before opening controller access cover as there is a severe shock hazard.
**Section 7 (continued)**

**Setting the Motor Overload Switches**

The Motor Overload Setting Switches adjust the level of motor overload current protection necessary to protect the motor in case of an over current condition.

Bank 1 switches 1, 2 and 3 allow adjustment of the motor overload setting. These switches adjust the motor overload protection as a percentage of the full load output current rating of the controller. Choose a motor overload setting that meets or is less than the motor's SFA rating. For example, if the full load output current rating of the controller is 37A and the motor SFA rating is 33A, the motor overload setting should be set to 85% (33A/37A = 89%, next lowest setting is 85%).

In applications where the pump and motor are not used to the full capacity the system may not draw current close to the motor's SFA rating. In this case choose a motor overload setting that is close to the actual full load running current.

**NOTE**

If single phase input power is used the motor overload switches must be set to 50% or lower or nuisance input phase loss errors can result.

The chart below shows the motor overload setting for each model.

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>Frame Size</th>
<th>Model Number</th>
<th>Motor Overload Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>SPD20050, SPD20050F</td>
<td>100% 95% 90% 85% 80% 70% 50% 40%</td>
</tr>
<tr>
<td>208/230</td>
<td>2</td>
<td>SPD20075, SPD20075F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPD20100, SPD20100F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>SPD20150, SPD20150F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD20200, SPD20200F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>460</td>
<td>SPD40050, SPD40050F</td>
<td>100% 95% 90% 85% 80% 70% 50% 40%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPD40075, SPD40075F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPD40100, SPD40100F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40150, SPD40150F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>SPD40200, SPD40200F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPD40250, SPD40250F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPD40300, SPD40300F</td>
<td></td>
</tr>
</tbody>
</table>
Setting the Acceleration/Deceleration Switches
Switch 4 from bank 1 and switches 1 and 2 from bank 2 control the acceleration/deceleration ramp times. The acceleration/deceleration switches (ACCEL/DECEL RAMP SETTINGS) control how fast the controller will change the speed of the motor. The ramp setting is the time it takes the motor to change from minimum speed to maximum speed. For example, if the ramp setting is set to 1 second and the minimum speed is set to 30Hz, the motor will ramp up from 30Hz to 60Hz in 1 second. A faster ramp setting should be used in systems where the flow rate can change quickly. This means that the motor can react faster to maintain the set pressure. A slower ramp setting should be used in systems where the flow rate changes slowly or where fast changes in speed can cause water hammer or pressure surges.

Setting the No Water Restart Time Switches
Switches 3 and 4 from bank 2 control the no water restart time. The no water (dry well) restart time switches control the time between a no water (dry well) error and the restart of the system. For example, if the no water restart time switches are set to 30 minutes, the system will restart 30 minutes after a no water (dry well) error has been detected. For the 10 minute restart time, the controller will not restart if 5 faults are detected within 60 minutes. All other settings will continue to restart after the chosen restart time.

NOTE
Failure to properly set the motor overload switches can result in nuisance no water (dry well) faults.

Setting the Minimum Frequency Switch
Switch 1 from bank 3 controls the minimum frequency. The minimum frequency switch controls the slowest speed that the motor will run. For submersible pump/motor applications these switches must always be set to 30Hz minimum speed. For above ground applications with high suction pressure, the 15Hz setting can be used to prevent pressure oscillation at low speeds. In some cases the suction pressure may be high enough that the pump exceeds the pressure setting at 30Hz. In this case the 15Hz setting can be used.

CAUTION
Failure to properly set the minimum frequency switch can result in motor damage and will void the motor warranty. The minimum frequency must be set to 30Hz for submersible applications.

Setting the Carrier Frequency Switch
Switch 2 from bank 3 controls the carrier frequency. For model numbers without the F suffix, the switch can be used to change the output carrier frequency to avoid audible noise issues in above ground applications. For model numbers with the F suffix, this switch is disabled and the carrier frequency is always set to 2 kHz.

Setting the Pressure
When power is applied the pump will start and the system pressure will increase to the factory preset pressure (50 PSI if SP1 is enabled and a 300 PSI sensor is used or 75PSI if SP2 is enabled and a 300 PSI sensor is used). After the pressure has stabilized, use the increase (INC) or decrease (DEC) pressure adjust pushbuttons to adjust the pressure setting. Push and Hold the increase or decrease pushbutton until the desired pressure setting is reached. The new pressure setting will save when the system goes into standby mode (solid green light/pump off). Pressure set point 1 will be adjusted and stored when the SP2/SP1 switch input is open. Pressure set point 1 is preset to 50 PSI when used with a 300 PSI transducer. Pressure set point 2 will be adjusted and stored when the SP2/SP1 switch input is closed. Pressure set point 2 is preset to 75 PSI when used with a 300 PSI transducer.
Motor Rotation Direction
If the pressure/flow seems low or the system is indicating Motor Overload error check the motor rotation direction. Turn the breaker/disconnect switch to the off position and wait 5 minutes. Switch any two leads on the controller output (T1/U, T2/V or T3/W). Turn the breaker/disconnect switch to the on position. Observe pressure and flow. If the pressure or flow still seems low check plumbing.
For CentriPro Motors, connecting T1/U to Red, T2/V to Black and T3/W to Yellow will give the correct rotation.

NOTE
It is possible for the pump to maintain constant pressure with a low flow or a high suction head even if the pump is rotating backwards. While the pump is running use an amp probe on one of the output power leads connected to the motor and compare the current draw between the two rotation directions. The lowest current reading indicates the pump is running in the correct direction.

System Status
The status indicator light displays the status of the controller. A constant green status code indicates that the pump is in standby mode (pump not running). A blinking green status code indicates that the pump is running. A constant orange light indicates the input voltage is low. A blinking or constant red light indicates a problem with the controller or system. Refer to the access cover side panel for a list of status codes. See Section 9 for more details.

DANGER
The status code indicator light is not a voltage indicator! Always turn off disconnect switch and circuit breaker and wait 5 minutes before servicing.
**Section 8**

The control terminal strips allow for a variety of input and output functions.

**Warning:** Turn off all power to the controller before wiring devices to the control terminals.

**Warning:** Inputs RUN/STOP, HAND/AUTO, SP2/SP1 and PRESSURE DROP are switch inputs. Do not connect power to these inputs or damage to the controller will result. Only connect non-powered switch contacts to these inputs.

**RUN/STOP:** This input allows the pump/motor to be turned on and off by an external switch. Connect the contacts of a non-powered external switch to terminals 1 (COM) and 2 (RUN/STOP). When the switch is closed the controller is in RUN mode (output to motor is enabled). When the switch is open the controller is in STOP mode (output to motor is disabled).

**HAND/AUTO:** This input allows the controller to run the motor at full speed without the use of a pressure transducer. This input can be controlled by an external non-powered switch. Connect the contacts of a non-powered external switch to terminals 3 (COM) and 4 (HAND/AUTO). While in HAND mode the RUN/STOP input is used to start and stop the motor and the pressure transducer input is ignored. When the switch is open the controller is in AUTO mode. While in AUTO mode the controller uses the pressure transducer feedback to control the speed of the motor.

**INPUT and +24V:** These terminals are the transducer feedback and transducer power supply. Connect the white lead from the transducer cable to terminal 6 (INPUT). Connect the brown lead from the transducer cable to terminal 7 (+24V). Connecting the drain (bare) wire to the chassis allows grounding of the case of the pressure transducer. The controller is configured with a 300 PSI 4-20mA output pressure transducer.

**ANALOG OUTPUT:** This output is a 4-20mA signal based on motor speed (4mA = 0Hz, 20mA = 60Hz) and can be connected to external monitoring or external control devices. Connect terminal 10 (ANALOG OUTPUT) to the 4-20mA input of the external device. Connect terminal 9 (COM) to the negative side of the current loop on the external device. The external device must have an input resistance (impedance) in the range of 45Ω to 250Ω. The maximum output voltage is 24V.

**SP2/SP1:** This input allows the system to operate at one of 2 pressure settings. This input can be controlled by an external non-powered switch. Connect the contacts of a non-powered external switch to terminals 5 (COM) and 11 (SP2/SP1). When the switch is closed pressure set point 2 is enabled (preset to 75 PSI when used with a 300 PSI transducer). When the switch is open pressure set point 1 is enabled (preset to 50 PSI when used with a 300 PSI transducer).

**PRESSURE DROP:** This input allows the user to select the amount of pressure drop in the system before the pump starts. This input can be controlled by an external non-powered switch. Connect the contacts of a non-powered external switch to terminals 5 or 9 (COM) and 12 (PRESSURE DROP). When the switch is closed the system pressure will drop 20 PSI (when used with a 300 PSI transducer) before restarting the pump. When the switch is open the system pressure will drop 5 PSI (when used with a 300 PSI transducer) before restarting the pump.

**RUN RELAY:** This output indicates when the pump/motor is running. This output can be used to control power to a light, an alarm or other external device. When the pump/motor is off terminal 13 (RELAY1 - NO) will be open and terminal 14 (RELAY 1 - NC) will be connected to terminal 15 (RELAY1 - COM). When the pump/motor is on terminal 13 (RELAY1 - NO) will be connected to terminal 15 (RELAY1 - COM) and terminal 14 (RELAY 1 - NC) will be open. The relay rating is 250Vac, 5 amps maximum.

**FAULT RELAY:** This output indicates when the system is faulted. This output can be used to control power to a light, an alarm or other external device. When the system is not faulted terminal 16 (RELAY2 - NO) will be open and terminal 17 (RELAY 2 - NC) will be connected to terminal 18 (RELAY2 - COM). When the system is faulted terminal 16 (RELAY2 - NO) will be connected to terminal 18 (RELAY2 - COM) and terminal 17 (RELAY 2 - NC) will be open. The relay rating is 250Vac, 5 amps maximum.
TROUBLESHOOTING

Section 9

General

The Aquavar SPD drives are self-diagnosing controllers. If a problem occurs, observe the Status Code Indicator Light on the front of the unit. No Status Code Indicator Light means either no or low input voltage (less than 140Vac).

**DANGER**

Status Code Indicator Light is not a voltage indicator! Always turn off disconnect switch and circuit breaker and wait 5 minutes before servicing. High voltage may still remain on controller.

Refer to the status code label on the side of the controller access cover to diagnose system errors. See the following diagram.

### STATUS CODES

#### GREEN LIGHT CODES

<table>
<thead>
<tr>
<th>Constant</th>
<th>STANDBY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinking</td>
<td>PUMP RUNNING</td>
</tr>
</tbody>
</table>

#### ORANGE LIGHT CODES

<table>
<thead>
<tr>
<th>Constant</th>
<th>UNDER VOLTAGE</th>
</tr>
</thead>
</table>

#### RED LIGHT CODES

<table>
<thead>
<tr>
<th>Constant</th>
<th>REPLACE CONTROLLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Blinks</td>
<td>NO WATER/LOSS OF PRIME</td>
</tr>
<tr>
<td>3 Blinks</td>
<td>SENSOR FAULT</td>
</tr>
<tr>
<td>4 Blinks</td>
<td>PUMP OR MOTOR BOUND</td>
</tr>
<tr>
<td>5 Blinks</td>
<td>SHORT CIRCUIT/GROUND FAULT</td>
</tr>
<tr>
<td>6 Blinks</td>
<td>INPUT PHASE LOSS</td>
</tr>
<tr>
<td>7 Blinks</td>
<td>TEMPERATURE</td>
</tr>
<tr>
<td>8 Blinks</td>
<td>OVER VOLTAGE</td>
</tr>
<tr>
<td>9 Blinks</td>
<td>MOTOR OVERLOAD</td>
</tr>
</tbody>
</table>

Use the following table to help troubleshoot problems.

<table>
<thead>
<tr>
<th>Red Flashes</th>
<th>Fault Code</th>
<th>Restart Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Replace Controller</td>
<td>Controller will not restart. Power must be reset to clear the fault.</td>
</tr>
<tr>
<td>2 Blinks</td>
<td>No Water / Loss of Prime</td>
<td>Controller will restart automatically according to the No Water Restart Time switches (switches 3&amp;4 of bank 2).</td>
</tr>
<tr>
<td>3 Blinks</td>
<td>Sensor Fault</td>
<td>Controller will restart automatically when the sensor signal is within the valid operating range.</td>
</tr>
<tr>
<td>4 Blinks</td>
<td>Pump or Motor Bound</td>
<td>Controller will restart automatically 5 times. After 5 faults the power must be reset to clear the fault.</td>
</tr>
<tr>
<td>5 Blinks</td>
<td>Short Circuit / Ground Fault</td>
<td>Controller will not restart. Power must be reset to clear the fault.</td>
</tr>
<tr>
<td>6 Blinks</td>
<td>Input Phase Loss</td>
<td>Controller will restart automatically 5 times. After 5 faults the power must be reset to clear the fault.</td>
</tr>
<tr>
<td>7 Blinks</td>
<td>Temperature</td>
<td>Controller will restart automatically when temperature is within the operating range of the controller.</td>
</tr>
<tr>
<td>8 Blinks</td>
<td>Over Voltage</td>
<td>Controller will restart automatically when the input voltage is within the operating range of the controller.</td>
</tr>
<tr>
<td>9 Blinks</td>
<td>Motor Overload</td>
<td>Controller will restart automatically.</td>
</tr>
</tbody>
</table>

Page 20
# Troubleshooting

## No Light

<table>
<thead>
<tr>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low/No Input Voltage</td>
<td>Check the input voltage to the controller. Measure the input voltage between phases using an AC Voltmeter. This voltage should be greater than 140Vac for the status indicator light to turn on.</td>
</tr>
</tbody>
</table>

## Green Light Codes

<table>
<thead>
<tr>
<th>Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Standby</td>
<td>Constant Green Light indicates the pump is off. The system is in Standby mode when there is no flow in the system and the pressure setting has been reached or the RUN/STOP input is set to STOP (open switch).</td>
</tr>
<tr>
<td>Blinking</td>
<td>Pump Running</td>
<td>Flashing Green Light indicates the pump is running.</td>
</tr>
</tbody>
</table>

## Orange Light Codes

<table>
<thead>
<tr>
<th>Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Low Input Voltage</td>
<td>Constant Orange Light indicates the system input voltage is low. For 230V units, the orange light will be indicated when the input voltage is between 140Vac and 170Vac. For 460V units, the orange light will be displayed when the input voltage is between 140Vac and 310Vac.</td>
</tr>
<tr>
<td>Blinking</td>
<td>No Water/Loss of Prime Fault Disabled</td>
<td>Blinking Orange Light indicates the No Water/Loss of Prime Fault is disabled and the pump/motor is running. For details see 2 Blinks under Red Light Codes.</td>
</tr>
</tbody>
</table>

## Red Light Codes

<table>
<thead>
<tr>
<th>Number of Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Controller Error</td>
<td>Internal controller fault. The controller may be internally damaged. Verify the error by turning power off, waiting 5 minutes then apply power. If the error persists, replace controller.</td>
</tr>
<tr>
<td>2 Blinks</td>
<td>No Water/Loss of Prime</td>
<td>This fault can be caused by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Water supply level in well falls below suction inlet of pump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plugged suction screen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Restriction in pipe between pump and pressure sensor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Air bound pump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Deadheaded pump, pump running against a closed valve.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Filling long irrigation lines on start-up**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Incorrect setting of Motor Overload Setting switches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>In systems where the motor operates at less than Service Factor Amps the controller may show a false No Water/Loss of Prime fault. Reducing the motor overload setting will eliminate the false readings.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If problem persists, please verify supply capacity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller will automatically restart according to the No Water Restart Time switches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** Controllers with software revision A3 or later allow the user to disable this function by holding down both push buttons for 5 seconds while the pump/motor is running. While the no water/loss of prime function is disabled, the status LED will blink orange while the pump/motor is running. To re-enable the function, hold down both push buttons for 5 seconds while fault is disabled and the pump/motor is running.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is not recommended to keep the No Water/Loss of Prime fault disabled after the system has been primed. Doing so can result in damage to the pump.</td>
</tr>
</tbody>
</table>
RED LIGHT CODES

<table>
<thead>
<tr>
<th>Number of Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
</table>
| 3 Blinks          | Sensor Fault      | This fault can be caused by:  
• Disconnected sensor. Disconnect sensor from sensor cable connector and reconnect to ensure a good connection.  
• Disconnected sensor cable lead inside the controller. Check for loose wires where the sensor cable connects to the circuit board by tugging on each wire.  
• Broken wire in the sensor cable.  
• Miswired sensor cable. Check that the wires are connected to the correct terminals on the control terminal block. Connect terminal 7 (24VDC SUPPLY) to the Brown wire. Connect terminal 6 (TRANSUDER INPUT) to the White wire. Connect the Drain wire to the chassis.  
• Vacuum in the system. A vacuum condition may exist in the system piping. Remove the sensor from the piping to release the vacuum.  
• Failed sensor. To diagnose this failure a meter capable of reading milliamperes (mA) and DC voltage (VDC) is required.  
  - Set the meter to read DC voltage (VDC)  
  - Place the black lead on terminal 5 (COM) and the red lead on terminal 7 (24VDC SUPPLY)  
  - If functioning properly, the DC voltage will be 24VDC +/- 15%. If this voltage is not present, disconnect all control terminals and repeat the measurement. If voltage does not recover, replace controller.  
  - Disconnect the White wire in the sensor cable from terminal 6.  
  - Set the meter to read DC current (mA)  
  - Connect the black lead from the meter to terminal 6 (TRANSUDER INPUT)  
  - Connect the black lead from the meter to terminal 6 (TRANSUDER INPUT)  
  - Connect the red lead from the meter to the White wire in the sensor cable.  
  - The meter will display the output of the sensor. If functioning properly, the output of the sensor will be between 4mA and 20mA depending on the pressure in the system. Refer to the chart below to determine the sensor feedback at various pressures.  

![Pressure Transducer Output vs. Applied Pressure for a 300 PSI, 4-20mA Output Transducer](image)

The following formula gives the transducer output based on applied pressure:

\[
\text{Output Current} = \left( \frac{\text{Output Current Range}}{\text{Pressure Range}} \right) \times \text{System Pressure} + 4mA
\]
## TROUBLESHOOTING

### RED LIGHT CODES

<table>
<thead>
<tr>
<th>Number of Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
</table>
| 3 Blinks (continued) | Sensor Fault (continued) | Where:  
- Output Current is the transducer output  
- Output Current Range is the maximum output signal of the transducer minus the minimum output signal of the transducer. In this case: 
  - Output Current Range = 20mA - 4mA, or 16mA  
- Pressure Range is the pressure that corresponds to the maximum output signal. For a 300 PSI transducer the Pressure Range = 300 PSI - 0 PSI = 300 PSI  
- System Pressure is the system pressure as read on the pressure gauge. |
| 4 Blinks | Pump or Motor Bound | This fault can be caused by:  
- Mechanical binding from debris in pump.  
- Electrical failure of the motor.  
- Incorrect setting of Motor Overload Setting switches.  
- Incorrect rotation.  
- Motor phase loss.  
This fault will be displayed if the output current exceeds 125% of the controller rating. The controller will attempt to restart 5 times. If the condition persists the controller will lock out and will need to be reset. Verify the error by turning power to controller off for 5 minutes and then on. Pump/Motor/Wiring must be checked if fault persists. |
| 5 Blinks | Short Circuit/Ground Fault | This fault can be caused by:  
- Electrical failure of the motor  
- Electrical failure of wiring between controller and motor.  
This fault will be displayed if the output current exceeds 150% of the controller rating. Verify the error by turning power to controller off for 1 minute and then on. If error persists, motor and wiring between controller and motor must be checked. Turn power off for 5 minutes. Remove the three motor wires from the terminal block. Check output wiring and motor for shorting phase to phase and phase to ground. Refer to motor’s manual for information on resistance readings and megger readings. |
| 6 Blinks | Input Phase Loss | This fault can be caused by:  
- Disconnected input power phase.  
- Incorrect Motor Overload Setting switches. When using single phase input power the Motor Overload Setting switches must be set to 50% or lower.  
For three phase input operation; this fault will be displayed if input voltage imbalance is more than 3%. The controller will attempt to restart 5 times. If the condition persists the controller will lock out and will need to be reset. |
| 7 Blinks | Temperature | This fault can be caused by:  
- High ambient temperature. The maximum ambient temperature rating is 122°F (50°C).  
- Low ambient temperature. The minimum ambient temperature rating is -22°F (-30°C).  
This fault will be displayed if the ambient temperature is greater than 122°F (50°C) or less than -22°F (-30°C). Do not install the controller where it will be exposed to direct sunlight. Check for a fan failure. The fans on the back of the controller will turn on only when needed. The fans will turn on when the motor is running and the heatsink temperature reaches 104°F (40°C). |
### Troubleshooting Red Light Codes

<table>
<thead>
<tr>
<th>Number of Flashes</th>
<th>Controller Status</th>
<th>Description</th>
</tr>
</thead>
</table>
| 8 Blinks          | Over Voltage      | This fault can be caused by:  
• High input voltage.  
This fault will be displayed if the phase to phase input voltage is greater than 275V for 230V units and 560V for 460V units. |
| 9 Blinks          | Motor Overload    | This fault can be caused by:  
• Mechanical binding from debris in pump.  
• Electrical failure of the motor.  
• Incorrect setting of Motor Overload Setting switches.  
• Incorrect rotation.  
The controller will protect the motor from over current by limiting the current applied to the motor. The current limit is set according to the Motor Overload Setting switches. This fault is displayed if the output frequency is reduced to limit the current to the motor by more than 10Hz for 5 minutes. |
### Maximum Allowable Conductor Length (40°C Ambient, 5% drop)

<table>
<thead>
<tr>
<th>Controller Input</th>
<th>Motor HP</th>
<th>Motor SFA</th>
<th>Input Current</th>
<th>Conductor Size for 75°C Rated Wire (Lengths in Bold Require 90°C Rated Wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>7.6</td>
<td>17.6</td>
<td>112 185 306 495 776 1243 1566 1980 2496 3152 3979</td>
</tr>
<tr>
<td>230V, 1Ø Input</td>
<td>3</td>
<td>10.1</td>
<td>23.3</td>
<td>224 367 579 931 1174 1485 1874 2368 2991 3787</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>17.5</td>
<td>40.4</td>
<td>321 524 666 846 1071 1356 1717 2171 2740 3238 3889</td>
</tr>
<tr>
<td></td>
<td>7 1/2</td>
<td>26.4</td>
<td>61.0</td>
<td>333 428 548 697 886 1127 1427 1805 2136 2568 3005 3440</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>33.0</td>
<td>76.2</td>
<td>331 427 547 698 891 1132 1434 1700 2045 2395 2749 3421</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>46.0</td>
<td>106.2</td>
<td>373 482 622 794 1012 1204 1451 1702 1954 2440 2942 3696</td>
</tr>
<tr>
<td>230V, 3Ø Input</td>
<td>2</td>
<td>7.6</td>
<td>8.9</td>
<td>276 444 715 1138 1774 2832 3561</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10.1</td>
<td>11.9</td>
<td>203 329 534 853 1332 2128 2677 3383</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>17.5</td>
<td>20.6</td>
<td>177 297 484 761 1221 1539 1946 2454 3101 3915</td>
</tr>
<tr>
<td></td>
<td>7 1/2</td>
<td>26.4</td>
<td>31.1</td>
<td>310 494 800 1011 1282 1619 2048 2588 3271</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>33.0</td>
<td>38.8</td>
<td>240 387 632 802 1019 1289 1632 2065 2611 3294 3893</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>46.0</td>
<td>54.1</td>
<td>264 440 563 719 912 1159 1471 1862 2353 2784 3345 3914</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>60.0</td>
<td>70.6</td>
<td>418 538 687 876 1116 1416 1793 2124 2554 2990 3425</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>76.0</td>
<td>89.4</td>
<td>410 528 677 868 1104 1402 1665 2004 2349 2693 3359</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>94.0</td>
<td>110.6</td>
<td>531 687 878 1119 1333 1606 1885 2165 2705 3260</td>
</tr>
<tr>
<td>460V</td>
<td>2</td>
<td>3.8</td>
<td>4.5</td>
<td>1130 1561 2495 3956</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5.3</td>
<td>6.2</td>
<td>804 1114 1785 2833</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>8.5</td>
<td>10.0</td>
<td>489 684 1104 1760 2745</td>
</tr>
<tr>
<td></td>
<td>7 1/2</td>
<td>13.5</td>
<td>15.9</td>
<td>252 414 682 1098 1719 2751 3464</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>17.2</td>
<td>20.2</td>
<td>313 524 853 1341 2152 2712 3430</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>23.0</td>
<td>27.1</td>
<td>377 625 991 1598 2018 2555 3225</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>30.0</td>
<td>35.3</td>
<td>464 745 1211 1535 1947 2461 3115 3940</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>37.0</td>
<td>43.5</td>
<td>590 968 1232 1566 1984 2514 3184</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>47.0</td>
<td>55.3</td>
<td>744 952 1217 1545 1963 2492 3155 3988</td>
</tr>
</tbody>
</table>

Lengths in **BOLD** require 90°C wire. Input connections for models SPD20300 and SPD20300F always require 90°C wire.
## Maximum Allowable Conductor Length (40˚C Ambient, 5% drop)

| Controller Input | Motor HP | Motor SFA | 14 | 12 | 10 | 8 | 6 | 4 | 3 | 2 | 1 | 1/0 | 2/0 | 3/0 | 4/0 | 250 | 300 | 350 | 400 | 500 | 600 | 750 | 1000 |
|------------------|---------|-----------|----|----|----|---|---|---|---|---|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **230V**         |         |           |    |    |    |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 2                | 7.6     | 327       | 525| 843| 1340|2089|3333|
| 3                | 10.1    | 242       | 391| 631| 1006|1569|2505|3152|3981|
| 5                | 17.5    | 129       | 214| 355| 573 | 899 | 1440|1813|2293|2890|3651 |
| 7 1/2            | 26.4    | 224       | 371| 587| 946 | 1195|1513|1909|2413|3049|3852 |
| 10               | 33.0    | 171       | 289| 463| 751 | 950 |1205|1522|1925|2435|3077|3880 |
| 15               | 46.0    |           | 320| 526| 670 | 854 |1081|1371|1737|2198|2775|3281|3941 |
| 20               | 60.0    |           |   |    |     |     |     |     |     |     |     |     |     |
| 25               | 76.0    |           |   |    |     |     |     |     |     |     |     |     |     |
| 30               | 94.0    |           |   |    |     |     |     |     |     |     |     |     |     |

| **460V**         |         |           |    |    |    |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 2                | 3.8     | 1332      | 2123| 3391|
| 3                | 5.3     | 950       | 1517| 2427|3851|
| 5                | 8.5     | 582       | 935 |1505|2395|3733|
| 7 1/2            | 13.0    | 366       | 597 | 972 |1556|2432|3888|
| 10               | 16.5    | 277       | 458 | 756 |1218|1909|3056|3848|
| 15               | 23.0    | 309       | 525 | 860 |1356|2180|2750|3480|
| 20               | 30.0    | 384       | 644 |1025|1658|2096|2656|3354|
| 25               | 37.0    |           | 507 |817 |1331|1687|2141|2708|3428|
| 30               | 47.0    |           |   |    |     |     |     |     |     |     |     |     |

Lengths in **BOLD** require 90˚C wire
XYLEM INC. LIMITED WARRANTY

This warranty applies to all SPD and SPD Plus Drives sold by Xylem Inc.
Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twenty-four (24) months from date of installation or thirty (30) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Xylem Inc. distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Xylem Inc. Customer Service Department.

The warranty excludes:
(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:
(1) “Distributor” means any individual, partnership, corporation, association, or other legal relationship that stands between Xylem Inc. and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) “Dealer” means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) “Customer” means any entity who buys or leases the subject pumps from a dealer. The “customer” may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.
APPENDIX D

INSTRUCTION MANUAL FOR BLADDER TANK
Installation/Operation/Parts

For further operating, installation, or maintenance assistance:

Call 1-262-728-5551
READ AND FOLLOW SAFETY INSTRUCTIONS!

This is the safety alert symbol. When you see this symbol on your pump or in this manual, look for one of the following signal words and be alert to the potential for personal injury.

⚠️ DANGER ⚠️ warns about hazards that will cause serious personal injury, death or major property damage if ignored.

⚠️ WARNING ⚠️ warns about hazards that can cause serious personal injury, death or major property damage if ignored.

⚠️ CAUTION ⚠️ warns about hazards that will or can cause minor personal injury or property damage if ignored.

The label NOTICE indicates special instructions which are important but not related to hazards.

Carefully read and follow all safety instructions in this manual and on pump.

Keep safety labels in good condition.

Replace missing or damaged safety labels.

California Proposition 65 Warning

⚠️ WARNING ⚠️ This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

RULES FOR SAFE INSTALLATION AND OPERATION

Read the Owner’s Manual and Rules for Safe Operation and Installation Instructions carefully. Failure to follow these Rules and Instructions could cause serious bodily injury and/or property damage. Install system according to local codes.

Always test water from well for purity before using. Check your local health department for testing procedure.

Before installing or servicing your tank, BE SURE pump electric power source is disconnected.

BE SURE your pump electrical circuit is properly grounded.

Remove bleeder orifices, air volume controls or other air charging devices in existing system.

⚠️ WARNING ⚠️ Hazardous pressure. To prevent possible serious or fatal injury and/or damage to equipment, system pressure must be less than 100 pounds per square inch (PSI) (Models PSP19 and PSP35) or 125 PSI (Models PSP50 and PSP85) under any circumstances. Failure to follow this instruction can result in tank blowup. If system discharge pressure can exceed listed pressures, install a relief valve capable of passing the full pump volume at listed pressures.

⚠️ WARNING ⚠️ Hazardous pressure. Read owner’s manual before attempting to install, operate, or service this tank. To avoid possible equipment failure, severe injury, and property damage, do not allow pump, tank, or piping system to freeze.
GENERAL INFORMATION

All tanks are factory pre-charged with air. When installing tank, adjust pre-charge to 2 PSI below pump cut-in pressure setting. To do this, bleed or add air through valve on top of tank.

NOTICE: Transport and install tank in vertical position ONLY!

NOTICE: Always set pre-charge with NO WATER in tank.

Check pressure frequently with an accurate tire pressure gauge until correct pressure has been reached. For correct pre-charge pressure settings, see Chart 1, below.

CHART I

<table>
<thead>
<tr>
<th>Pressure Switch Setting</th>
<th>Tank Pre-charge (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-40 PSI</td>
<td>18</td>
</tr>
<tr>
<td>30-50 PSI</td>
<td>28</td>
</tr>
<tr>
<td>40-60 PSI</td>
<td>38</td>
</tr>
</tbody>
</table>

Tank Pre-charge Settings for use with PENTEK INTELLIDRIVE Variable Frequency Drives

Set the pressure tank’s pre-charge to 70% of the system operating pressure. When using an external set point as well as an internal set point, pre-charge the tank to 70% of the lower set point of the two. Some applications may require a different percentage when figuring the set point. Refer to your PENTEK INTELLIDRIVE operator’s manual for additional information.

OPERATING CYCLE

1. Tank nearly empty – air expands filling area above vinyl water cell (Fig. 2A).
2. Water begins to enter tank – air is compressed above water cell as it fills with water (Fig. 2B).
3. Pump-up cycle completed – air now compressed to cut off setting of pressure switch (Fig. 2C).
4. Water being drawn from tank – compressed tank air forces water out of water cell (Fig. 2D).
5. Water cell completely empty – new cycle ready to begin (Fig. 2A).

NOTICE: Replace and tighten air valve cap if it is removed for any reason. Failure to replace air cap may allow loss of air pressure and eventually lead to tank waterlogging and water cell failure.

Pre-charged storage tanks can be connected together to increase the supply of usable water (drawdown). Two tanks of the same size will double the supply and three tanks will triple the supply. See Figures No. 1A and 1B for typical installations of this kind.

CHART II – Water Yield Per Pump Cycle (drawdown) in Gallons

<table>
<thead>
<tr>
<th>Model</th>
<th>Pressure Switch Setting (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20-40</td>
</tr>
<tr>
<td>PSP19S-T02SA-25PSI</td>
<td>6.9</td>
</tr>
<tr>
<td>PSP19T-T02SA-25PSI</td>
<td>6.9</td>
</tr>
<tr>
<td>PSP35-T05SA-25PSI</td>
<td>12.7</td>
</tr>
<tr>
<td>PSP50-T50SA-25PSI</td>
<td>18.3</td>
</tr>
<tr>
<td>PSP85-T52SA-25PSI</td>
<td>30.0</td>
</tr>
</tbody>
</table>
4 Installation

Connect system pipe to tank flange. Use plastic or steel pipe as required. To prevent leaks, use PTFE pipe thread sealant tape on male threads of all threaded connections to tank.

NOTICE: To be sure that joint is not cross-threaded and that threads are clean, always make connections by hand (without sealer) first. After making sure that threads are clean, remove pipe, add PTFE pipe thread sealant tape and remake connection. Tighten by hand first; finish with pipe wrench for tight seal.

NOTICE: When replacing a standard tank in a submersible pump system, raise pump and discharge pipe far enough to remove bleeder orifices in discharge pipe and plug tees. When replacing a standard tank in a jet pump system, remove Air Volume Control (AVC) and plug AVC port in pump.

In areas where the temperature is high for long periods of time, the tank pre-charge pressure may increase. This may reduce the tank drawdown (amount of water available per cycle). If this occurs, reduce the pre-charge pressure to two PSI below the pump cut-in setting of the pressure switch.

It is necessary to flush all air out of the piping system and water reservoir portion of the pre-charged tank. This is required on new installations, pumps requiring re-priming and pumps that have been disassembled for service. Do this as follows:

1. Open faucets furthest from tank and allow pump to operate.
2. Air in the system will cause a sputtering flow; allow faucets to run until you have a steady, air free stream.
3. Open and close faucets repeatedly until you are sure all air has been removed.
4. If stream does not become steady, air may be leaking into the system; check for leaks in the piping on the suction side of the pump.

**TO CHECK TANK AIR CHARGE**

If drawdown (amount of water that comes out of tank per pump cycle) decreases significantly, check as follows:

1. To check air charge in tank, shut off electric power to pump, open faucet near tank, and drain completely.
2. At the air valve in top of tank, check air pressure with a standard tire gauge. Air pressure should be 2 PSI below pump pressure switch cut-in setting.
3. If the air pressure is more than 2 PSI below the cut-in setting, add air to the tank. Use an air compressor or a portable air storage tank.
4. Use soap or liquid detergent to check for air leaks around air valve. Continuous bubbling indicates a leak. If necessary, install new core in air valve. This is the same as those used for automobile tubeless tires.

**TO CHECK PUMP PRESSURE SWITCH SETTING**

1. To check pressure switch setting, disconnect power to pump at supply panel (but be sure to leave pressure switch connected to power supply wires).
2. Remove pressure switch cover.
3. Open a faucet near tank.
4. Bleed pressure down until pressure switch contacts close; immediately close faucet.
5. Check pressure at valve with standard tire gauge or with pump pressure gauge (if supplied). Pressure gauge should read 2 PSI below pump cut-in setting (28 PSI for 30-50 switch, 18 PSI for 20-40 switch, etc.) If not:
   A. Adjust switch according to switch manufacturer’s instructions.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum Capacity U.S. Gallons</th>
<th>Tank Diameter</th>
<th>Tank Height</th>
<th>Tank Discharge Tapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSP19S-T02SA-25PSI</td>
<td>19</td>
<td>20”</td>
<td>22”</td>
<td>1”</td>
</tr>
<tr>
<td>PSP19T-T02SA-25PSI</td>
<td>19</td>
<td>16”</td>
<td>27-1/2”</td>
<td>1”</td>
</tr>
<tr>
<td>PSP35-T05SA-25PSI</td>
<td>35</td>
<td>20”</td>
<td>32-3/4”</td>
<td>1”</td>
</tr>
<tr>
<td>PSP50-T50SA-25PSI</td>
<td>50</td>
<td>24”</td>
<td>32-1/2”</td>
<td>1-1/4”</td>
</tr>
<tr>
<td>PSP85-T52SA-25PSI</td>
<td>85</td>
<td>24”</td>
<td>50-1/2”</td>
<td>1-1/4”</td>
</tr>
</tbody>
</table>
B. Reconnect power supply to pump and pump up pressure in system.

C. Disconnect power supply to pump again and re-check switch setting.

D. Repeat until pressure switch starts pump within ±1 PSI of proper setting.

E. If cut-in setting is too low, system will rattle or develop water hammer when pump starts.

F. Cut-out setting is not as critical as cut-in setting. Make sure that pump will stop running in a reasonable time. If it does not, cut-out setting may need to be adjusted down slightly. Be sure that after readjustment, system does not rattle or hammer on startup.

7. Re-check tank air pre-charge to be sure it is 2 PSI below pump pressure switch cut-in setting (see Page 3).

**TESTING FOR WATER CELL LEAKAGE**

1. Disconnect power to pump.

2. Drain all water from tank water cell by opening faucet closest to tank.

3. Remove valve cap from valve and release all pressure possible by depressing valve core. When air stops coming from valve, remove valve core to release remaining pressure.

4. Disconnect piping from elbow on tank flange.

5. Carefully turn tank upside down or lay it on its side.

   **WARNING** Retained water in tank may cause sudden weight shift when lowering. Support tank so that it cannot fall when being lowered or inverted.

6. If water cell leaks, water will run out of valve. If so, replace water cell.

**WATER CELL REPLACEMENT**

   **CAUTION** To be sure cover flange cannot blow off of tank, release all air from system before removing nuts from cover flange.

1. Disconnect power to pump.

2. Follow steps 2 through 5 under “Testing For Water cell Leakage”, above.

3. Remove nuts from tank cover flange. Tap cover flange to break seal and remove. Base will come off with flange.

4. Water cell will not come out in one piece. Hold water cell with pliers and cut wherever convenient with single edge razor blade or sharp knife. Continue holding and cutting until water cell is removed.

5. Clean and dry inside of tank.

6. Before water cell can be inserted into tank, it must be tightly rolled up as follows:
   - A. Place water cell on clean surface with opening to one end and flatten to force air out. Pull ends out flat (see Figure 3).
   - B. To get tightest possible wrap, start on one side at top and TIGHTLY roll water cell diagonally to other side (see Figure 4). To force out as much air as possible, be sure to roll toward water cell neck opening.

7. To help insert water cell, sprinkle outside of it with talcum powder. With tank on its side, push tightly rolled water cell into tank, hooking water cell neck ring over edge of tank head.

8. Insert arm in water cell and push sidewalls outward. It is not necessary to remove all wrinkles from water cell.

   **NOTICE:** Don’t push water cell into tank further than its own length. In a large tank, water cell can slip out of reach if pushed too far.

9. Clean tank head sealing surface and lip ring groove of cover flange.

10. Pull lip ring of water cell through tank opening and seat it against tank head.

   **Figure 3 – Force all air out of water cell**

   **Figure 4 – Roll diagonally toward neck**
11. Clean sealing surface and groove of cover flange; place on tank (see Figure 5). Be sure to capture the base with the flange (the tabs on the base fit the notches on the flange).

**NOTICE:** Be sure discharge port lines up with hole in base.

![Figure 5 – Proper installation and seating](image)

12. **NOTICE:** Tighten nuts as follows:
   A. Hand tighten all nuts.
   B. Tighten one nut snug.
   C. Tighten opposite nut snug.
   D. Proceed, tightening opposite pairs of nuts to a snug fit.
   E. Recheck all nuts, using same pattern. Be sure all nuts are tight and that you have a good seal.

**NOTICE:** Do not overtighten; you may twist studs off of tank. If you have a torque wrench, tighten to 85 inch-pounds torque.

13. Stand tank on feet and reconnect piping.
14. Recharge tank to proper air pressure (see Page 4).
15. Prime pump (see pump owner’s manual).

## AIR VALVE REPLACEMENT

**WARNING** Hazardous Pressure. To be sure air valve and core cannot blow out of tank, release all air pressure from tank before removing valve core or valve.

1. Disconnect power to pump.
2. Drain ALL water in system by opening faucet closest to tank.
3. Depress valve core to release ALL air pressure in tank. When air stops coming out of valve, remove core from inside of valve to release remaining pressure.
4. Unscrew valve from tank and install new valve. Do not overtighten.
5. Recharge tank (see Page 4), turn on power, fill system, and tank is ready for service.

## PIPING CONNECTIONS

**SUBMERSIBLE AND MULTI-STAGE INSTALLATIONS**

**NOTICE:** When using metal pipe with plastic fittings use only PTFE pipe thread sealant tape on male threads.

**Tank with Submersible Pump**

**Tank with Multi-Stage Pump**
### REPAIR PARTS LIST – Pro-Source Plus Tanks

<table>
<thead>
<tr>
<th>Key No.</th>
<th>Part Description</th>
<th>No. Used</th>
<th>PSP19S-T02 SA-25PSI 19 Gal.</th>
<th>PSP19T-T02 SA-25PSI 19 Gal.</th>
<th>PSP35-T05 SA-25PSI 35 Gal.</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Air Valve with Cap</td>
<td>1</td>
<td>U212-266</td>
<td>U212-266</td>
<td>U212-266</td>
</tr>
<tr>
<td>2</td>
<td>Water cell - Vinyl</td>
<td>1</td>
<td>U20-8</td>
<td>U20-15S</td>
<td>U20-15S</td>
</tr>
<tr>
<td>3</td>
<td>Base</td>
<td>1</td>
<td>U31-505P</td>
<td>U31-505P</td>
<td>U31-505P</td>
</tr>
<tr>
<td>4</td>
<td>Cover Flange</td>
<td>1</td>
<td>U31-511SS*</td>
<td>U231-531</td>
<td>U231-531</td>
</tr>
<tr>
<td>5</td>
<td>Flanged Nut 5/16 - 18 Hex</td>
<td>6</td>
<td>U36-202BT</td>
<td>U36-202BT</td>
<td>U36-202BT</td>
</tr>
</tbody>
</table>

* Does not require Stand Pipe.

---

<table>
<thead>
<tr>
<th>Key No.</th>
<th>Part Description</th>
<th>No. Used</th>
<th>PSP50-T50 SA-25PSI 50 Gal.</th>
<th>PSP85-T52 SA-25PSI 85 Gal.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Air Valve with Cap</td>
<td>1</td>
<td>U212-266</td>
<td>U212-266</td>
</tr>
<tr>
<td>2</td>
<td>Water cell - Vinyl</td>
<td>1</td>
<td>U20-10</td>
<td>U20-17</td>
</tr>
<tr>
<td>3</td>
<td>Base</td>
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<td>U31-512P</td>
<td>U31-512P</td>
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<td>4</td>
<td>Cover Flange</td>
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<td>U231-533</td>
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<tr>
<td>5</td>
<td>Flanged Nut 5/16 - 18 Hex</td>
<td>6</td>
<td>U36-202BT</td>
<td>U36-202BT</td>
</tr>
</tbody>
</table>

* Does not require Stand Pipe.
APPENDIX E

TECHNICAL BROCHURE FOR BOOSTER PUMP
3656/3756 S-Group

CAST IRON, BRONZE FITTED CENTRIFUGAL PUMPS

BOMBAS CENTRÍFUGAS EN HIERRO FUNDIDO CON ACCESORIOS DE BRONCE
The 3656 and 3756 S-Group pumps from Goulds Water Technology have been designed with technical benefits to meet the needs of users in a variety of water supply, recirculation, and cooling applications.

- The model 3656 offers close coupled design for space saving and simplified maintenance.
- The model 3756 offers a bearing frame mounted design for flexibility of installation and drive arrangements.
- Back pull-out to reduce maintenance down time.
- Standard Type 21 mechanical seal for both reliability and availability. Carbon/ceramic/BUNA standard, with other faces and elastomers available.
- 3656/3756 available in all iron, bronze fitted or all bronze construction for application versatility.
- Replaceable wearing components include stainless steel shaft sleeve and casing and hub wear rings to maintain peak efficiency.

- Packed box sealing is also available as an option.
- Enclosed impeller design, dynamic balancing and renewable wear rings reduce losses affecting performance and pump life.
- Suction and discharge pipe connections are NPT threaded, except 3 x 4 – 7 which has 125 lb. ANSI flat faced flanges.
- Rigid cast iron motor adapter provides support and registered fits maintain positive unit alignment.
- Standard NEMA motor frame, JM or JP shaft extension, C-face mounting, single phase or three phase, 3500 or 1750 RPM. Open drip proof and totally enclosed fan cooled.
- Optional explosion proof or high efficiency motors available.
- Optional rigid carbon steel bedplate, sheet metal coupling guard and T. B. Woods spacer coupling for 3756 models.

Las bombas 3656 y 3756 del Grupo S de Goulds Water Technology han sido diseñadas con beneficios técnicos para satisfacer las necesidades de los usuarios en variadas aplicaciones de suministro y recirculación de agua y aplicaciones de refrigeración.

- El modelo 3656 cuenta con diseño de acoplamiento corto para ahorrar espacio y simplificar el mantenimiento.
- El modelo 3756 cuenta con diseño de montaje sobre bastidor que ofrece gran flexibilidad en los arreglos de instalación y accionamiento.
- Desmontaje posterior que reduce el tiempo de inactividad por mantenimiento.
- Sello mecánico estándar Tipo 21, brinda gran confiabilidad y asegura la disponibilidad. Estándar de carbono/cerámica / BUNA, también se encuentran disponibles con otras caras y elastómeros.
- Los modelos 3656 y 3756 se fabrican en todo hierro, con accesorios de bronce o en todo bronce, para una mayor versatilidad de aplicación.
- Los componentes de desgaste reemplazables incluyen los anillos de desgaste de la carcasa y del rodeté y la camisa del eje, de acero inoxidable, para mantener la eficiencia pico.
PERFORMANCE COVERAGE
CAMPO DE DESEMPEÑO

3500 Coverage Curve, Curva de alcance 3500

1750 Coverage Curve, Curva de alcance 1750
Commercial Water

3656/3756 S-GROUP NUMBERING SYSTEM FOR ALL UNITS BUILT AFTER AUGUST 3, 1998

SISTEMA DE NUMERACIÓN DEL GRUPO S, MODELOS 3656/3756, PARA TODAS LAS UNIDADES FABRICADAS LUEGO DEL 3 DE AGOSTO DE 1998

The various versions of the 3656 and 3756 S-Group are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown below.

Not all combinations of motor, impeller and seal options are available for every pump model. Please check with Goulds Water Technology on non-cataloged numbers.

Not recommended for operation beyond printed H-Q curve. For critical application conditions consult factory.

Example Product Code, Ejemplo del código de producto

9 BF 1 H 2 G 0 H

High Head Impeller (1½ x 2 – 6H Only), Impulsor de carga alta (1½ x 2 – 6H Únicamente)

Mechanical Seal and O-ring, Sello mecánico y anillo en O

Type 21 Mechanical Seal, Tipo 21 sello mecánico

Impeller Option Code, Código de opción de impulsor

Driver, Elemento motor

1 = 1 PH, fase, ODP 4 = 1PH, fase, TEF 7 = 3 PH, fases, XP 0 = 1 PH, fase, XP
2 = 3 PH, fases, ODP 5 = 3 PH, fases, TEF 8 = 3 PH, fases, 575 V, XP
3 = 3 PH, fases, 575 V, ODP 6 = 3 PH, fases, 575 V, TEF 9 = 3 PH, fases, TEF, PREEF

1 PH, fase = Monofásico; 3 PH, fases = Trifásico

HP Rating, Potencia nominal, HP

C = ½ HP  F = 1½ HP  J = 5 HP  M = 15 HP
D = ¼ HP  G = 2 HP  K = 7½ HP  N = 20 HP
E = 1 HP  H = 3 HP  L = 10 HP

Driver: Hertz/Pole/RPM, Elemento motor: Hertz/Polos/RPM

1 = 60 Hz, 2 pole, 3500 RPM 4 = 50 Hz, 2 pole, 2900 RPM
2 = 60 Hz, 4 pole, 1750 RPM 5 = 50 Hz, 4 pole, 1450 RPM
3 = 60 Hz, 6 pole, 1150 RPM

Material, Material

BF = Bronze fitted, Accesorios de bronce   AI = All iron, Todo hierro   AB = All bronze, Todo bronce

Pump Size, Tamaño de bomba

3 = 1 ½ x 2 – 6(H) 5 = 1½ x 2 – 8 9 = 1 x 2 – 8
4 = 2½ x 3 – 7 6 = 3 x 4 – 7* 22 = 1 x 2 – 7

*Flanged design suction and discharge. Succión y descarga brida del diseño.

The 1 x 2 – 8 and 1 x 2 – 7 are only available in Bronze Fitted. Los tamaños 1 x 2 – 8 y 1 x 2 – 7 están disponibles con accesorios de bronce únicamente.
PERFORMANCE CURVES – 60 HZ, 3500 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 3500 RPM

These curves show the performance of the 3656 and 3756 at 3500 RPM and 1750 RPM, 60 Hz, and at 2900 RPM and 1450 RPM, 50 Hz. Standard impeller trims are shown.

Model 3656/3756 S-Group
22 BF / Size (Tamaño) 1 x 2 — 7
Imp. Dwg. CN0724R00

NOTE: Not recommended for operation beyond printed H-Q curve.
NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

Optional Impeller
Impulsor optativo
Ordering Code Código de pedido Dia. Diá.
A 6 ¼" A
B 6 ¾"
C 7"
D 7 ½"
E 7 ¾"
F 8 ¼"
G 8 ½"
H 8 ¾"
J 9"
K 9 ¼"
L 9 ½"

NOTE: Pump will pass a sphere to 3/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 3/16 de pulgada de diámetro.

Goulds Water Technology

PAGE 5
**PERFORMANCE CURVES – 60 HZ, 3500 RPM**
**CURVAS DE DESEMPEÑO – 60 HZ, 3500 RPM**

Model 3656/3756 S-Group 3500 RPM
3Al, BF, AB / Size (Tamaño) 1½ x 2 – 6 ODP & TEFC
Imp. Dwg. 114-04

### NPSH – FEET (PIES)

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<thead>
<tr>
<th>Total Dynamic Head</th>
<th>NPSH_a</th>
</tr>
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<tbody>
<tr>
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<td>6'</td>
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<td>10'</td>
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<td>11'</td>
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### % EFF

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### Note:
Not recommended for operation beyond printed H-Q curve.

### Optional Impeller

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<tr>
<th>Code</th>
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<td>A</td>
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<tr>
<td>B</td>
<td>5 5/16&quot;</td>
</tr>
<tr>
<td>C</td>
<td>5 1/8&quot;</td>
</tr>
<tr>
<td>D</td>
<td>4 3/4&quot;</td>
</tr>
</tbody>
</table>

### Note:
Pump will pass a sphere to 5/16" diameter.

---

**Model 3656/3756 S-Group 3500 RPM**
3Al, BF, AB / Size (Tamaño) 1½ x 2 – 6 ODP & TEFC
Imp. Dwg. 114-18 H = High Head Impeller H = Impulsor de carga alta

### NPSH – FEET (PIES)

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<thead>
<tr>
<th>Total Dynamic Head</th>
<th>NPSH_a</th>
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</thead>
<tbody>
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<td>7'</td>
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<tr>
<td>10'</td>
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<td>11'</td>
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### % EFF

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<th>Capacity (U.S. GPM)</th>
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<tbody>
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<td>5 HP</td>
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### Note:
Not recommended for operation beyond printed H-Q curve. May utilize 1.15 motor service factor.

### Optional Impeller

<table>
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<tr>
<th>Code</th>
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<td>A</td>
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</tr>
<tr>
<td>B</td>
<td>5 5/16&quot;</td>
</tr>
<tr>
<td>C</td>
<td>5 1/8&quot;</td>
</tr>
</tbody>
</table>

### Note:
Pump will pass a sphere to 3/16" diameter.

---

**Note:** La bomba dejará pasar una esfera de hasta 3/16 de pulgada de diámetro.
Optional Impeller
Impulsor optativo
Ordering Code
Código de pedido | Dia. Diá.
---|---
A | 8 7/16" \\
E | 7 15/16" \\
B | 7 7/8" \\
F | 7 \\
C | 6 1/2" \\
G | 6 1/2" \\
H | 6 1/2" \\
D | 5 7/8" \\

NOTE: Pump will pass a sphere to 5/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 5/16 de pulgada de diámetro.

Optional Impeller
Impulsor optativo
Ordering Code
Código de pedido | Dia. Diá.
---|---
A | 7 1/4" \\
B | 6 1/2" \\
C | 6 1/4" \\
D | 6 \\
E | 5 7/8" \\
F | 5 1/2" \\
G | 5 3/4" \\
H | 4 1/4" \\
J | 4 1/2" \\
K | 4 3/4" \\

NOTE: Pump will pass a sphere to 7/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 7/16 de pulgada de diámetro.
PERFORMANCE CURVES – 60 HZ, 3500 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 3500 RPM

NOTE: Not recommended for operation beyond printed H-Q curve. May utilize 1.15 motor service factor.

Model 3656/3756 S-Group
6A, BF / Size 3 x 4-7
Imp. Dwg. 114-05

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido
Dia.
Dia.
B 6⅛”
C 5½
D 4⅞
E 5⅛

NOTE: Pump will pass a sphere to ½” diameter.

NOTE: La bomba dejará pasar una esfera de hasta ½ de pulgada de diámetro.

PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 1750 RPM

NOTE: Not recommended for operation beyond printed H-Q curve.

Model 3656/3756 S-Group
22 BF / Size (Tamaño) 1 x 2 — 7
Imp. Dwg. 277-75

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido
Dia.
Dia.
A 6⅛”
B 6⅛
C 5½
D 5⅛
E 4⅞
F 4⅞
G 4⅞
H 4⅞
J 4⅞
K 4⅞
L 3⅛

NOTE: Pump will pass a sphere to ⅛” diameter.

NOTE: La bomba dejará pasar una esfera de hasta ⅛ de pulgada de diámetro.
Commercial Water

**PERFORMANCE CURVES – 60 HZ, 1750 RPM**

**CURVAS DE DESEMPEÑO – 60 HZ, 1750 RPM**

**Model 3656/3756 S-Group**

9BF / Size (Tamaño) 1 x 2 – 8

Imp. Dwg. 120-67

NOTE: Not recommended for operation beyond printed H-Q curve.

NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

<table>
<thead>
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<th>Ordering Code (Código de pedido)</th>
<th>Dia.</th>
<th>Dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 8 15/16&quot;</td>
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<td></td>
</tr>
<tr>
<td>C 7 7/16&quot;</td>
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<td></td>
</tr>
<tr>
<td>E 6 5/16&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F 6 3/16&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G 5 3/8&quot;</td>
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<td></td>
</tr>
<tr>
<td>H 5 11/16&quot;</td>
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</tbody>
</table>

NOTE: Pump will pass a sphere to 3/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 3/16 de pulgada de diámetro.

---

**Model 3656/3756 S-Group**

3AI, BF, AB / Size (Tamaño) 1 1/2 x 2 – 6

Imp. Dwg. 114-04

NOTE: Not recommended for operation beyond printed H-Q curve.

NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

<table>
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<tr>
<th>Ordering Code (Código de pedido)</th>
<th>Dia.</th>
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<tbody>
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<td>A 5 13/16&quot;</td>
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</tr>
<tr>
<td>B 5 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td>C 5 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td>D 4 5/16&quot;</td>
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</tbody>
</table>

NOTE: Pump will pass a sphere to 5/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 5/16 de pulgada de diámetro.
PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 1750 RPM

Model 3656/3756 S-Group

1750 RPM

NOTE: Not recommended for operation beyond printed H-Q curve.

NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido

Dia.
Diá.

A 5 15/16"
B 5 5/8"

NOTE: Pump will pass a sphere to 3/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 3/16 de pulgada de diámetro.

Model 3656/3756 S-Group

1725 RPM

NOTE: Not recommended for operation beyond printed H-Q curve.

NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido

Dia.
Diá.

A 8 1/16"
B 7 7/8"
C 6 3/4"
D 5 3/4"

NOTE: Pump will pass a sphere to 5/16" diameter.

NOTA: La bomba dejará pasar una esfera de hasta 5/16 de pulgada de diámetro.
Model 3656/3756 S-Group  1750 RPM  

**NOTE:** Not recommended for operation beyond printed H-Q curve.  
**NOTA:** No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

**Optional Impeller**  
*Impulsor optativo*  
*Ordening Code*  
*Código de pedido*  
*Día. Diá.*

- A 7 7/16"  
- B 6 7/8"  
- C 6 5/16"  
- D 6  
- E 5 11/16"  
- F 5 7/16"  
- G 5 3/16"  
- H 4 3/4"  
- J 4 1/2"  
- K 4 1/16"  

**NOTE:** Pump will pass a sphere to 7/16" diameter.  
**NOTA:** La bomba dejará pasar una esfera de hasta 7/16 de pulgada de diámetro.

---

**Model 3656/3756 S-Group  1750 RPM**  

**NOTE:** Not recommended for operation beyond printed H-Q curve.  
**NOTA:** No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

**Optional Impeller**  
*Impulsor optativo*  
*Ordening Code*  
*Código de pedido*  
*Día. Diá.*

- A 7 7/16"  
- B 6 7/8"  
- C 6 5/16"  
- D 6  
- E 5 11/16"  
- F 5 7/16"  
- G 5 3/16"  
- H 4 3/4"  
- J 4 1/2"  
- K 4 1/16"  

**NOTE:** Pump will pass a sphere to 1/2" diameter.  
**NOTA:** La bomba dejará pasar una esfera de hasta 1/2 de pulgada de diámetro.
PERFORMANCE CURVES – 50 HZ, 2900 RPM
CURVAS DE DESEMPEÑO – 50 HZ, 2900 RPM

Model 3656/3756 S-Group
22 BF / Size (Tamaño) 1 x 2 — 7
Imp. Dwg. 277-75

NOTE: Not recommended for operation beyond printed H-Q curve.
NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido
Dia. (Diá.)
A 6¾”
B 6⅛)
C 6
D 5⅛
E 5⅛
F 5⅛
G 4⅜
H 4⅜
J 4⅛
K 4⅛
L 3⅛

NOTE: Pump will pass a sphere to ¾” diameter.
NOTA: La bomba dejará pasar una esfera de hasta ¾” de diámetro.

Model 3656/3756 S-Group
9 BF / Size (Tamaño) 1 x 2 — 8
Imp. Dwg. 120-67

NOTE: Not recommended for operation beyond printed H-Q curve.
NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

Optional Impeller
Impulsor optativo

Ordering Code
Código de pedido
Dia. (Diá.)
A 8½”
B 7½
C 7½
D 7
E 6½
F 6½
G 5½
H 5½

NOTE: Pump will pass a sphere to ¾” diameter.
NOTA: La bomba dejará pasar una esfera de hasta ¾” de diámetro.
**PERFORMANCE CURVES – 50 HZ, 2900 RPM**

**CURVAS DE DESEMPEÑO – 50 HZ, 2900 RPM**

**Model 3656/3756 S-Group 2900 RPM**

**3A, BF, AB / Size (Tamaño) 11/2 x 2 – 6**

**Imp. Dwg. 114-04**

**NOTE:** Not recommended for operation beyond printed H-Q curve.

**NOTA:** No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

---

**Optional Impeller**

**Impulsor optativo**

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Código de pedido</th>
<th>Dia.</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5 1/8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5 5/8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5 1/8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>4 3/4&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Pump will pass a sphere to 7/16" diameter.

**NOTA:** La bomba dejará pasar una esfera de hasta 7/16 de pulgada de diámetro.

---

**Model 3656/3756 S-Group 2900 RPM**

**3A, BF, AB / Size (Tamaño) 11/2 x 2 – 6H**

**Imp. Dwg. 114-18**

**H = High Head Impeller**

**NOTE:** Not recommended for operation beyond printed H-Q curve.

**NOTA:** No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

---

**Optional Impeller**

**Impulsor optativo**

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Código de pedido</th>
<th>Dia.</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5 1/8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5 5/8&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Pump will pass a sphere to 1/2" diameter.

**NOTA:** La bomba dejará pasar una esfera de hasta 1/2 pulgada de diámetro.
PERFORMANCE CURVES – 50 HZ, 2900 RPM
CURVAS DE DESEMPEÑO – 50 HZ, 2900 RPM

Model 3656/3756 S-Group 2900 RPM

NOTE: Not recommended for operation beyond printed H-Q curve.
NOTA: No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

NOTE: Pump will pass a sphere to 3/16” diameter.
NOTA: La bomba dejará pasar una esfera de hasta 3/16 de pulgada de diámetro.
**PERFORMANCE CURVES – 50 HZ, 2900 RPM**

**CURVAS DE DESEMPEÑO – 50 HZ, 2900 RPM**

**Model 3656/3756 S-Group 2900 RPM**

**Imp. Dwg. 114-05**

**NOTE:** Not recommended for operation beyond printed H-Q curve.

**NOTA:** No se recomienda la operación más allá de la curva impresa de H-Q (carga-capacidad).

**Optional Impeller Impulsor optativo**

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Código de pedido</th>
<th>Dia. Día.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7 1/16”</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>6 3/8”</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5 1/2”</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>4 11/16”</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>6”</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Pump will pass a sphere to 7/16” diameter.

**NOTA:** La bomba dejará pasar una esfera de hasta 7/16 de pulgada de diámetro.
### 3656 S-GROUP MATERIALS OF CONSTRUCTION
#### MATERIALES DE CONSTRUCCIÓN - GRUPO S, MODELO 3756

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Casing, Carcasa</td>
<td>All Iron</td>
</tr>
<tr>
<td>101</td>
<td>Impeller, Impulsor</td>
<td>All Iron</td>
</tr>
<tr>
<td>103</td>
<td>Casing wear ring, Anillo de desgaste de la carcasa</td>
<td>All Iron</td>
</tr>
<tr>
<td>108</td>
<td>Adapter, Adaptador</td>
<td>All Iron</td>
</tr>
<tr>
<td>184</td>
<td>Seal housing, Cubierta del sello</td>
<td>All Iron</td>
</tr>
<tr>
<td>126</td>
<td>Shaft sleeve, Camisa del eje</td>
<td>All Iron</td>
</tr>
<tr>
<td>198</td>
<td>Impeller bolt, Perno del impulsor</td>
<td>All Iron</td>
</tr>
<tr>
<td>199</td>
<td>Impeller washer, Arandela del impulsor</td>
<td>All Iron</td>
</tr>
<tr>
<td>178</td>
<td>Impeller key, Chaveta del impulsor</td>
<td>All Iron</td>
</tr>
<tr>
<td>370</td>
<td>Hex head cap screw (adapter to case), Tornillo de cabeza hexagonal (del adaptador a la cubierta)</td>
<td>All Iron</td>
</tr>
<tr>
<td>371</td>
<td>Hex head cap screw (adapter to motor), Tornillo de cabeza hexagonal (del adaptador al motor)</td>
<td>All Iron</td>
</tr>
<tr>
<td>383</td>
<td>Mechanical seal, Sello mecánico</td>
<td>All Iron</td>
</tr>
<tr>
<td>408</td>
<td>Pipe plug ¼&quot; o ½&quot;, Tapón de tubos de ¼ de pulgada ó ½ de pulgada</td>
<td>All Iron</td>
</tr>
<tr>
<td>513</td>
<td>O-ring, Anillo en O</td>
<td>All Iron</td>
</tr>
</tbody>
</table>

### NOTE:
- For separate seal housing and adapter construction, all bronze material only, see repair parts page.
- Para la construcción separada del compartimento del sello y el adaptador, materiales de bronce únicamente, consulte la página de piezas de repuesto.
- Pumps will be shipped with top-vertical discharge position as standard. For other orientations, remove casing bolts — rotate discharge to desired position — replace and tighten bolts to 25 ft./lbs. Note that discharge may extend below motor mounting surface in bottom-horizontal position; adequate clearance must be provided.

### Packed Box Arrangement, Caja prensaestopas

<table>
<thead>
<tr>
<th>Item No., No. Item</th>
<th>Description, Descripción</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>Lantern ring, Aro de linterna</td>
<td>Teflon™</td>
</tr>
<tr>
<td>106</td>
<td>Packing, 5 rings, Empaquetadura, 5 años</td>
<td>Teflon Impregnated, Impregnado de Teflon</td>
</tr>
<tr>
<td>107</td>
<td>Gland, Casquillo</td>
<td>AISI 316SS</td>
</tr>
<tr>
<td>126</td>
<td>Shaft sleeve, Camisa del eje</td>
<td>AISI Type 300 Series Stainless Steel</td>
</tr>
<tr>
<td>353</td>
<td>Gland stud, Perno del casquillo</td>
<td>AISI Type 300 Series Stainless Steel</td>
</tr>
<tr>
<td>355</td>
<td>Gland nut, Tuerca del casquillo</td>
<td>AISI Type 300 Series Stainless Steel</td>
</tr>
</tbody>
</table>

### Type 21 Mechanical Seal, Tipo 21 sello mecánico

<table>
<thead>
<tr>
<th>Seal Code, Código del Sello</th>
<th>Rotary, Rotativo</th>
<th>Stationary, Estacionario</th>
<th>Elastomers, Elastómeros</th>
<th>Metal Parts, Partes Metálicas</th>
<th>Part No., Pieza Número</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Carbon, Carbón</td>
<td>Ceramic, Cerámica</td>
<td>BUNA-N</td>
<td>316 SS, 316 Acero inoxidable</td>
<td>10K13</td>
</tr>
<tr>
<td>1</td>
<td>Sil-Carbide, Carburo de silicona</td>
<td>EPR</td>
<td>Viton</td>
<td>10K13</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sil-Carbide</td>
<td>EPR</td>
<td>Viton</td>
<td>10K27</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sil-Carbide</td>
<td>EPR</td>
<td>Viton</td>
<td>10K64</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Packed Box Design with BUNA O-Ring, Diseño de prensaestopas empaquetado con anillo en O de BUNA</td>
<td>BUNA-N</td>
<td>15K16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** 10K27 replaces obsolete 10K25, **Nota:** La 10K27 reemplaza la obsoleta 10K25.
### 3756 S-GROUP MATERIALS OF CONSTRUCTION

#### MATERIALES DE CONSTRUCCIÓN - GRUPO S, MODELO 3756

#### Commercial Water

**Item No., No. Item**  
**Descripción**

<table>
<thead>
<tr>
<th>Item No. No. Item</th>
<th>Material Code, Código de material</th>
<th>Description, Descripción</th>
<th>Engineering Standard, Norma de ingeniería</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Casing, Carcasa</td>
<td>All Iron</td>
<td>Cast iron ASTM A48 CL20, Hierro fundido ASTM A48 CL20</td>
</tr>
<tr>
<td>101</td>
<td>Impeller, Impulsores</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>103</td>
<td>Casing wear ring, Anillo de desgaste de la carcasa</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>108</td>
<td>Adapter, Adaptador</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>112</td>
<td>Ball bearing (outboard), Cofinete de las bolas (exterior)</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>122</td>
<td>Shaft, Eje</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>123</td>
<td>V-ring (Deflector), Anillo en V (Deflector)</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>126</td>
<td>Shaft sleeve, Camisa del eje</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>134</td>
<td>Bearing cover, Cubierta del cojinete</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>168</td>
<td>Ball bearing (inboard), Cofinete de las bolas (interior)</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>178</td>
<td>Impeller key, Chaveta del impulsores</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>197</td>
<td>Impeller washer, Ananada del impulsores</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>198</td>
<td>Impeller screw, Tornillo del impulsores</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>228</td>
<td>Bearing frame, Marco de cojinetes</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>333A</td>
<td>Lip seal, Sello con reborde</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>370</td>
<td>Hex head cap screw (adapter to case), Tornillo de cabeza hexagonal (del adaptador a la cubierta)</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>370B</td>
<td>Hex head cap screw (adapter to bearing frame), Tornillo de cabeza hexagonal (del adaptador al marco de cojinetes)</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>370C</td>
<td>Retaining ring, Anillo de retención</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>382</td>
<td>Mechanical seal, Sello mecánico</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
<tr>
<td>408</td>
<td>Pipe plug ½” or ¾”, Lápiz de tubos de ½ pulgada o ¾ de pulgada</td>
<td>Steel SAE 1200 Grade 5, Acero SAE 1200 grado 5</td>
<td>Steel SAE 1200 Grade 5, Acero SAE 1200 grado 5</td>
</tr>
<tr>
<td>513</td>
<td>O-ring, Anillo en O</td>
<td>All Iron</td>
<td>Silicon bronze ASTM 8584, C87500, Silicio de bronce ASTM 8584, C87500</td>
</tr>
</tbody>
</table>

**NOTE:**

Above shows typical AI or BF construction. For separate seal housing adapter, all bronze construction, see repair parts.

Pumps will be shipped with top-vertical discharge position as standard. For other orientations, remove casing bolts – rotate discharge to desired position— replace and tighten bolts to 25 ft/lbs. Note that discharge may extend below motor mounting surface in bottom-horizontal position; adequate clearance must be provided.

**NOTA:**

Esta información corresponde a las construcciones típicas AI y BF. Para el adaptador separado del compartimiento de sellos y construcción en todo bronce, consulte las partes de repuesto.

Las bombas salen de la fábrica con la descarga orientada en posición vertical superior de manera estándar. Para modificar la orientación, retirar los pernos de la carcasa, hacer girar la descarga hasta la posición deseada y volver a colocar los pernos, ajustándolos a una torsión de 25 pies/lbs. Se ha de notar que la descarga se puede extender por debajo de la superficie de montaje del motor en la posición horizontal inferior, por lo tanto, debe proveerse suficiente espacio.
**3656 S-GROUP DIMENSIONS AND WEIGHTS**
**GRUPO S, MODELO 3656 - PESO Y DIMENSIONES**

**Pump Dimensions and Weights** (Dimension “L” determined by Pump and Motor)

<table>
<thead>
<tr>
<th>Pump Size</th>
<th>AB</th>
<th>MAX</th>
<th>DC Max</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 - 7</td>
<td>1</td>
<td>27</td>
<td>4</td>
<td>3½</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>4</td>
<td>52</td>
</tr>
<tr>
<td>1 x 2 - 8</td>
<td>1</td>
<td>23</td>
<td>3½</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3½</td>
<td>4½</td>
<td>52</td>
</tr>
<tr>
<td>1½ x 2 - 6</td>
<td>1½</td>
<td>27½</td>
<td>4½</td>
<td>2½</td>
<td>3½</td>
<td>4½</td>
<td>5½</td>
<td>6</td>
<td>54</td>
</tr>
<tr>
<td>2½ x 3 - 7</td>
<td>3</td>
<td>2½</td>
<td>5½</td>
<td>4½</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>6</td>
<td>49</td>
</tr>
<tr>
<td>3 x 4 - 7</td>
<td>4½</td>
<td>3½</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
<td>4½</td>
<td>5½</td>
<td>6</td>
<td>82</td>
</tr>
</tbody>
</table>

Motor Dimensions and Weights (may vary with manufacturer)*

<table>
<thead>
<tr>
<th>Frame Size JM</th>
<th>A</th>
<th>AB (Max.)</th>
<th>B</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>P (Max.)</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>143</td>
<td>6½</td>
<td>5½</td>
<td>6</td>
<td>3½</td>
<td>2½</td>
<td>2½</td>
<td>½</td>
<td>½</td>
<td>6½</td>
<td>41</td>
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<td>145</td>
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<td>6½</td>
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<tr>
<td>182</td>
<td>8½</td>
<td>5½</td>
<td>6½</td>
<td>3½</td>
<td>2½</td>
<td>2½</td>
<td>½</td>
<td>½</td>
<td>6½</td>
<td>77</td>
</tr>
<tr>
<td>184</td>
<td>8½</td>
<td>5½</td>
<td>6½</td>
<td>3½</td>
<td>2½</td>
<td>2½</td>
<td>½</td>
<td>½</td>
<td>6½</td>
<td>97</td>
</tr>
<tr>
<td>213</td>
<td>9½</td>
<td>7½</td>
<td>8</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
<td>½</td>
<td>½</td>
<td>6½</td>
<td>155</td>
</tr>
<tr>
<td>215</td>
<td>9½</td>
<td>7½</td>
<td>8</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
<td>½</td>
<td>½</td>
<td>6½</td>
<td>122</td>
</tr>
<tr>
<td>254 TCZ</td>
<td>11¼</td>
<td>9</td>
<td>9¼</td>
<td>6½</td>
<td>5</td>
<td>4½</td>
<td>½</td>
<td>½</td>
<td>11½</td>
<td>265</td>
</tr>
<tr>
<td>256 TCZ</td>
<td>11¼</td>
<td>9</td>
<td>9¼</td>
<td>6½</td>
<td>5</td>
<td>4½</td>
<td>½</td>
<td>½</td>
<td>11½</td>
<td>320</td>
</tr>
</tbody>
</table>

NOTE: All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 25 ft/lbs. torque.

**Motor Frames and Horsepower**

<table>
<thead>
<tr>
<th>Motor Frame Bastidor</th>
<th>3500 RPM</th>
<th>1750 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Phase ODP</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3 Phase TEFC</td>
<td>5</td>
<td>7½</td>
</tr>
</tbody>
</table>

All dimensions in inches and weights in lbs. Do not use for construction purposes.

*For use with ANSI class 150 mating flange. All others are NPT connections.

*Para usar con brida de contacto ANSI clase 150. Todas las demás son conexiones NTP.

**NOTA:**

Todas las bombas se embarcan con la descarga en posición vertical. Esta posición puede rotarse en incrementos de 90°. Ajustar los pernos de la carcasa a una torsión de 25 pies/lb.

All dimensions in inches and weights in lbs. Do not use for construction purposes.

Todas las dimensiones están en pulgadas, el peso en libras. No utilizar para fines de construcción.
# 3656 S-GROUP DIMENSIONS AND WEIGHTS

**GRUPO S, MODELO 3656 - PESO Y DIMENSIONES**

## Pump Dimensions and Weights (Dimension “L” determined by Pump and Motor)  
**Peso y dimensiones de la bomba** (la dimensión “L” está determinada por la bomba y el motor)

<table>
<thead>
<tr>
<th>Pump</th>
<th>Suction</th>
<th>Discharge</th>
<th>CP Max.</th>
<th>DC Max.</th>
<th>DD</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs.)</th>
<th>Motor Frame Size, Bastidor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 – 7</td>
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<td>30</td>
<td>4½</td>
<td>3½</td>
<td>1½</td>
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<tr>
<td>1 x 2 – 8</td>
<td>1½</td>
<td>26¼</td>
<td>3½</td>
<td>1½</td>
<td>7¼</td>
<td>5</td>
<td>2½</td>
<td>3¼</td>
<td>34</td>
<td>12¾</td>
<td>13¾</td>
<td>14¾</td>
</tr>
<tr>
<td>1½ x 2 – 6</td>
<td>1½</td>
<td>26½</td>
<td>3½</td>
<td>1½</td>
<td>7¼</td>
<td>5</td>
<td>2½</td>
<td>3¼</td>
<td>34</td>
<td>12¾</td>
<td>13¾</td>
<td>14¾</td>
</tr>
<tr>
<td>1½ x 2 – 8</td>
<td>1½</td>
<td>26½</td>
<td>3½</td>
<td>1½</td>
<td>7¼</td>
<td>5</td>
<td>2½</td>
<td>3¼</td>
<td>34</td>
<td>12¾</td>
<td>13¾</td>
<td>14¾</td>
</tr>
<tr>
<td>2½ x 3 – 7</td>
<td>3</td>
<td>28¾</td>
<td>5½</td>
<td>4½</td>
<td>1¾</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>49</td>
<td>13¾</td>
<td>13¾</td>
<td>14¾</td>
</tr>
<tr>
<td>3 x 4 – 7</td>
<td>4½</td>
<td>28¼</td>
<td>5½</td>
<td>5½</td>
<td>3½</td>
<td>7¼</td>
<td>2½</td>
<td>4½</td>
<td>82</td>
<td>12¾</td>
<td>13¾</td>
<td>14¾</td>
</tr>
</tbody>
</table>

*For use with ANSI class 150 mating flange. All others are NPT connections.  
*Para uso con brida de contacto ANSI clase 150. Todas las demás son conexiones NPT.

## Motor Dimensions and Weights (may vary with manufacturer)*  
**Peso y dimensiones del motor** (pueden variar de acuerdo al fabricante) *

<table>
<thead>
<tr>
<th>Frame Size JP</th>
<th>A</th>
<th>AB (Max.)</th>
<th>B</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>P (Max.)</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>143 JP</td>
<td>6½</td>
<td>5½</td>
<td>6</td>
<td>3½</td>
<td>2¼</td>
<td>2</td>
<td>½</td>
<td>½⁴</td>
<td>6¼</td>
<td>41</td>
</tr>
<tr>
<td>145 JP</td>
<td>6½</td>
<td>5½</td>
<td>6</td>
<td>3½</td>
<td>2¼</td>
<td>2</td>
<td>½</td>
<td>½⁴</td>
<td>6¼</td>
<td>57</td>
</tr>
<tr>
<td>182 JP</td>
<td>8½</td>
<td>5½</td>
<td>6½</td>
<td>4½</td>
<td>3¼</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>7¼</td>
<td>77</td>
</tr>
<tr>
<td>184 JP</td>
<td>8½</td>
<td>5½</td>
<td>6½</td>
<td>4½</td>
<td>3¼</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>7¼</td>
<td>88</td>
</tr>
<tr>
<td>213 TCZ</td>
<td>9½</td>
<td>7¼</td>
<td>8</td>
<td>5½</td>
<td>4½</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>7¼</td>
<td>122</td>
</tr>
<tr>
<td>215 TCZ</td>
<td>10½</td>
<td>7¼</td>
<td>8</td>
<td>5½</td>
<td>4½</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>7¼</td>
<td>155</td>
</tr>
<tr>
<td>254 TCZ</td>
<td>11¼</td>
<td>9</td>
<td>9¼</td>
<td>6½</td>
<td>5</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>11½</td>
<td>265</td>
</tr>
<tr>
<td>256 TCZ</td>
<td>12½</td>
<td>11½</td>
<td>6½</td>
<td>5</td>
<td>2½</td>
<td>½⁴</td>
<td>½⁴</td>
<td>11½</td>
<td>320</td>
<td></td>
</tr>
</tbody>
</table>

TCZ indicates west coast fit.

## Motor Frames and Horsepower  
**Bastidores del motor y potencia en HP**

<table>
<thead>
<tr>
<th>Motor Frame Bastidor del motor</th>
<th>3500 RPM</th>
<th>1750 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Phase</td>
<td>3 Phase</td>
</tr>
<tr>
<td></td>
<td>ODP</td>
<td>TECF</td>
</tr>
<tr>
<td>143 JP</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>145 JP</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>182 JP</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>184 JP</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>213 TCZ</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>215 TCZ</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>254 TCZ</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>256 TCZ</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

All dimensions in inches and weights in lbs. Do not use for construction purposes.  
Todas las dimensiones están en pulgadas, el peso en libras. No utilizar para fines de construcción.  
TCZ indicates west coast fit.
### Pump Dimensions and Weights

<table>
<thead>
<tr>
<th>Pump</th>
<th>Suction</th>
<th>Discharge</th>
<th>CP</th>
<th>DC Max.</th>
<th>L</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 - 7</td>
<td>2</td>
<td>16¾</td>
<td>1/4</td>
<td>4</td>
<td>3½</td>
<td>8</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1 x 2 - 8</td>
<td>1½</td>
<td>16½</td>
<td>4</td>
<td>5½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1½ x 2 - 6</td>
<td>1½</td>
<td>16½</td>
<td>3½</td>
<td>5½</td>
<td>1½</td>
<td>6</td>
<td>11½</td>
<td>3</td>
<td>4</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>2½ x 3 - 7</td>
<td>3×2</td>
<td>16½</td>
<td>16½</td>
<td>5½</td>
<td>3½</td>
<td>7½</td>
<td>4½</td>
<td>3</td>
<td>4</td>
<td>114</td>
<td></td>
</tr>
</tbody>
</table>

*For use with ANSI class 150 mating flange. All others are NPT connections.

**NOTE:**

All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 25 ft./lbs. torque.

Dimensions in inches, weights in lbs. Do not use for construction purposes.

### Peso y dimensiones de la bomba

<table>
<thead>
<tr>
<th>Bomba</th>
<th>succión</th>
<th>descarga</th>
<th>CP</th>
<th>DC Max.</th>
<th>L</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (libras)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 - 7</td>
<td>2</td>
<td>16¾</td>
<td>1/4</td>
<td>4</td>
<td>3½</td>
<td>8</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1 x 2 - 8</td>
<td>1½</td>
<td>16½</td>
<td>4</td>
<td>5½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1½ x 2 - 6</td>
<td>1½</td>
<td>16½</td>
<td>3½</td>
<td>5½</td>
<td>1½</td>
<td>6</td>
<td>11½</td>
<td>3</td>
<td>4</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>2½ x 3 - 7</td>
<td>3×2</td>
<td>16½</td>
<td>16½</td>
<td>5½</td>
<td>3½</td>
<td>7½</td>
<td>4½</td>
<td>3</td>
<td>4</td>
<td>114</td>
<td></td>
</tr>
</tbody>
</table>

*Para uso con brida de contacto ANSI clase 150. Todas las demás son conexiones NPT.*

**NOTA:**

Todas las bombas se embarcan con la descarga en posición vertical. Esta posición puede rotarse en incrementos de 90°. Ajustar los pernos de la carcasa a una torsión de 25 pies/lbs.

Dimensiones en pulgadas, peso en libras. No utilizar para fines de construcción.
## Pump Dimensions and Weights

*(Dimension “L” determined by Pump and Motor)*

**Peso y dimensiones de la bomba** *(la dimensión “L” está determinada por la bomba y el motor)*

<table>
<thead>
<tr>
<th>Pump</th>
<th>Suction</th>
<th>Discharge</th>
<th>CP</th>
<th>DC Max.</th>
<th>DD</th>
<th>L</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 – 7</td>
<td>2</td>
<td>1</td>
<td>199/16</td>
<td>4 1/4</td>
<td>3 1/8</td>
<td>11 1/16</td>
<td>1 1/16</td>
<td>7 3/8</td>
<td>5 1/8</td>
<td>3</td>
<td>4</td>
<td>84</td>
</tr>
<tr>
<td>1 x 2 – 8</td>
<td>4</td>
<td>3 1/4</td>
<td>11 1/4</td>
<td>7</td>
<td>5 1/2</td>
<td>3 1/2</td>
<td>4 1/2</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1/2 x 2 – 6</td>
<td>1 1/2</td>
<td>19 3/4</td>
<td>5 1/2</td>
<td>4 1/2</td>
<td>10 3/16</td>
<td>1 1/16</td>
<td>7 3/8</td>
<td>5</td>
<td>2 1/8</td>
<td>4 1/2</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>1 1/2 x 2 – 8</td>
<td>2 1/2</td>
<td>19 3/4</td>
<td>5 1/2</td>
<td>4 1/2</td>
<td>11 3/16</td>
<td>11 3/16</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 4 – 7</td>
<td>3</td>
<td>3</td>
<td>19 3/4</td>
<td>5 1/2</td>
<td>10 3/16</td>
<td>3 1/4</td>
<td>7 3/8</td>
<td>2 1/4</td>
<td>4 1/4</td>
<td>114</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For use with ANSI class 150 mating flange. All others are NPT connections.

**NOTE:**

All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 25 ft./lbs. torque.

Dimensions in inches, weights in lbs. Do not use for construction purposes.

*Para uso con brida de contacto ANSI clase 150. Todas las demás son conexiones NPT.

**NOTA:**

Todas las bombas se embarcan con la descarga en posición vertical. Esta posición puede rotarse en incrementos de 90°. Ajustar los pernos de la carcasa a una torsión de 25 pies/lbs.

Dimensiones en pulgadas, peso en libras. No utilizar para fines de construcción.
### Commercial Water

#### Goulds Water Technology

#### 3756 S-GROUP DIMENSIONS AND WEIGHTS

**GROUP S, MODELO 3756 - PESO Y DIMENSIONES**

**Pump Dimensions and Weights**

<table>
<thead>
<tr>
<th>Pump</th>
<th>Suction</th>
<th>Discharge</th>
<th>CP Max.</th>
<th>DC Max.</th>
<th>DD</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 - 7</td>
<td>2</td>
<td>1</td>
<td>16½</td>
<td>4½</td>
<td>3½</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
<td>84</td>
</tr>
<tr>
<td>1 x 2 - 8</td>
<td>1½</td>
<td>1½</td>
<td>16½</td>
<td>5</td>
<td>3½</td>
<td>1½</td>
<td>4½</td>
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<td>4</td>
<td>84</td>
</tr>
<tr>
<td>1½ x 2 - 6</td>
<td>1½</td>
<td></td>
<td>5</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1½ x 2 - 8</td>
<td>1½</td>
<td></td>
<td>5</td>
<td>1½</td>
<td>4½</td>
<td>5½</td>
<td>3</td>
<td>4</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2½ x 3 - 7</td>
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<td>2½</td>
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<td>5½</td>
<td>4½</td>
<td>1½</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>81</td>
</tr>
<tr>
<td>3 x 4 - 7</td>
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<td>3½</td>
<td>16½</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
<td>4</td>
<td>2½</td>
<td>4½</td>
<td>114</td>
<td>9½</td>
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</tbody>
</table>

*For use with ANSI class 150 mating flange. All others are NPT connections.*

#### Motor Dimensions and Weights, Peso y dimensiones del motor

<table>
<thead>
<tr>
<th>Motor Frame</th>
<th>3500 RPM</th>
<th>1750 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP</td>
<td>TEFC</td>
<td>ODP</td>
</tr>
<tr>
<td>143 T</td>
<td>¼</td>
<td>1,1½</td>
</tr>
<tr>
<td>145 T</td>
<td>2</td>
<td>2,3</td>
</tr>
<tr>
<td>182 T</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>184 T</td>
<td>5</td>
<td>3,5</td>
</tr>
<tr>
<td>213 T</td>
<td>7½</td>
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<td>215 T</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>254 T</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>256 T</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>284 TS/T</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**NOTE:**
1. All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 25 ft./lbs. torque.
2. Dimensions in inches, weights in lbs. Do not use for construction purposes.
3. Motor dimensions and weights vary with manufacturer.

#### Bedplate Dimensions and Weights, Pesos y dimensiones de la place de asiento

<table>
<thead>
<tr>
<th>Motor Frame</th>
<th>HA</th>
<th>HB</th>
<th>HD</th>
<th>HE</th>
<th>HF</th>
<th>HG</th>
<th>HP</th>
<th>Bearing Frame Shim Cuña del marco de cojinetes</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>143 T</td>
<td>10</td>
<td>28</td>
<td>8</td>
<td>3½</td>
<td>24</td>
<td>2½</td>
<td>¼</td>
<td>—</td>
<td>48</td>
</tr>
<tr>
<td>145 T</td>
<td>12</td>
<td>31</td>
<td>8</td>
<td>4½</td>
<td>29</td>
<td>3</td>
<td>1</td>
<td>—</td>
<td>65</td>
</tr>
<tr>
<td>182 T</td>
<td>13</td>
<td>42</td>
<td>9½</td>
<td>5</td>
<td>38½</td>
<td>4</td>
<td>1¼</td>
<td>1</td>
<td>110</td>
</tr>
<tr>
<td>184 T</td>
<td>14</td>
<td>45</td>
<td>10½</td>
<td>5½</td>
<td>40½</td>
<td>3½</td>
<td>1¼</td>
<td>1½</td>
<td>124</td>
</tr>
</tbody>
</table>

* **HP** Dimension at Motor end only. * **Dimensión “HP” al extremo del motor únicamente.”
3756 S-GROUP DIMENSIONS AND WEIGHTS

GRUPO S, MODELO 3756 - PESO Y DIMENSIONES

PUMP DIMENSIONS AND WEIGHTS

(Dimension “HL” determined by Pump and Motor)

Peso y dimensiones de la bomba (la dimensión “HL” está determinada por la bomba y el motor)

<table>
<thead>
<tr>
<th>Pump</th>
<th>Suction</th>
<th>Discharge</th>
<th>CP Max.</th>
<th>DC Max.</th>
<th>DD</th>
<th>R</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 2 - 7</td>
<td>2</td>
<td>19(\frac{1}{8})</td>
<td>4(\frac{1}{4})</td>
<td>3(\frac{1}{4})</td>
<td>1(\frac{1}{4})</td>
<td>7(\frac{1}{8})</td>
<td>5(\frac{1}{2})</td>
<td>3</td>
<td>4</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>1 x 2 - 6</td>
<td>1(\frac{1}{2})</td>
<td>19(\frac{1}{8})</td>
<td>3(\frac{1}{8})</td>
<td>1(\frac{1}{4})</td>
<td>7(\frac{1}{8})</td>
<td>4(\frac{1}{4})</td>
<td>3(\frac{1}{2})</td>
<td>3</td>
<td>6</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>1(\frac{1}{2}) x 2 - 8</td>
<td>2(\frac{1}{2})</td>
<td>19(\frac{1}{8})</td>
<td>5(\frac{1}{4})</td>
<td>5(\frac{1}{2})</td>
<td>5</td>
<td>4(\frac{1}{4})</td>
<td>86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2(\frac{1}{2}) x 3 - 7</td>
<td>4(\frac{1}{2})</td>
<td>3(\frac{1}{8})</td>
<td>19(\frac{1}{8})</td>
<td>5(\frac{1}{8})</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Motor Dimensions and Weights

(Tamaño del bastidor y peso del motor)

<table>
<thead>
<tr>
<th>Motor Frame Size, Tamaño del bastidor</th>
<th>1 Phase</th>
<th>3 Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 / 180</td>
<td>210</td>
<td>250 / 280</td>
</tr>
<tr>
<td>12(\frac{1}{8})</td>
<td>10(\frac{1}{8})</td>
<td>10(\frac{1}{8})</td>
</tr>
</tbody>
</table>

Bedplate Dimensions and Weights

(Pesos y dimensiones de la place de asiento)

<table>
<thead>
<tr>
<th>Motor Frame</th>
<th>Bastidor del motor</th>
<th>HA</th>
<th>HB</th>
<th>HD</th>
<th>HE</th>
<th>HF</th>
<th>HG</th>
<th>HP*</th>
</tr>
</thead>
<tbody>
<tr>
<td>143 T 145 T 182 T 184 T 213 T 215 T 254 T 256 T 284 TS/T</td>
<td>10</td>
<td>28</td>
<td>8</td>
<td>3(\frac{3}{4})</td>
<td>24</td>
<td>2(\frac{3}{4})</td>
<td>1(\frac{1}{4})</td>
<td>1(\frac{1}{8})</td>
</tr>
</tbody>
</table>

NOTE:

1. All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 25 ft./lbs. torque.
2. Dimensions in inches, weights in lbs. Do not use for construction purposes.
3. Motor dimensions and weights vary with manufacturer.

* "HP" Dimension at Motor end only. * Dimensión "HP" al extremo del motor únicamente.

*For use with ANSI class 150 mating flange. All others are NPT connections.

* Para uso con brida de contacto ANSI clase 150. Todas las demás son conexiones NPT.

* "HP" Dimension at Motor end only.
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Capacities to:</th>
<th>Capacidad hasta:</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 GPM (125 m³/hr) at 3500 RPM</td>
<td>550 GPM (125 m³/hr) a 3500 RPM</td>
</tr>
<tr>
<td>350 GPM (79 m³/hr) at 1750 RPM</td>
<td>350 GPM (79 m³/hr) a 1750 RPM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heads to:</th>
<th>Cargas hasta:</th>
</tr>
</thead>
<tbody>
<tr>
<td>280 feet TDH (85 m) at 3500 RPM</td>
<td>280 pies (85 m) carga dinámica total a 3500 RPM</td>
</tr>
<tr>
<td>67 feet TDH (20 m) at 1750 RPM</td>
<td>67 pies (20 m) carga dinámica total a 1750 RPM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working pressure to:</th>
<th>Presión de operación hasta:</th>
</tr>
</thead>
<tbody>
<tr>
<td>175 PSIG (12 bars)</td>
<td>175 PSIG (12 bars)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suction pressure to:</th>
<th>Presión de succión hasta:</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 PSIG (7 bars)</td>
<td>100 PSIG (7 bars)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum temperature to:</th>
<th>Temperatura máxima:</th>
</tr>
</thead>
<tbody>
<tr>
<td>212°F (100°C) with standard seal or 250°F (121°C) with optional seal.</td>
<td>212 °F (100 °C) con sello estándar o 250 °F (121 °C) con sello optativo.</td>
</tr>
</tbody>
</table>

| Motor: | Bastidor NEMA JM estándar en el modelo 3656 y bastidor NEMA T estándar en el modelo 3756. Las cubiertas disponibles son: abierta a prueba de filtración, totalmente encerrada con enfriamiento por ventilador y a prueba de explosiones. Monofásico (115/208 – 230 V), ½ a 3 HP; (208 – 230 V) 5 HP y (230 V solamente) 7½ a 10 HP. Trifásico (208 – 230/460 V) estándar. Los motores de 20 a 25 HP son de 230/460 V. |

<table>
<thead>
<tr>
<th>Direction of Rotation:</th>
<th>Dirección de rotación:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise viewed from motor end.</td>
<td>Dextrorsa (sentido de las agujas del reloj) cuando se mira desde el extremo del motor.</td>
</tr>
</tbody>
</table>

### TYPICAL APPLICATIONS

- Booster service
- Spraying systems
- Irrigation
- Water circulation
- Liquid transfer
- General purpose pumping

### APLICACIONES TÍPICAS

- Servicio de refuerzo
- Sistemas de rociado
- Sistemas de riego
- Circulación de agua
- Transferencia de líquidos
- Aplicaciones de bombeo en general